doi : 10.17596/0002742

R/V Mirai Cruise Report MR17-08

Study on air-sea interaction
over upwelling region in the eastern Indian Ocean

Tropical eastern Indian Ocean "Maritime Continent"
November 11, 2017 - January 18, 2018

Japan Agency for Marine-Earth Science and Technology

JAMSTEC, Japan

Agency for the Assessment and Application of Technology

BPPT, Indonesia

MR17-08 Cruise Report
--- Contents ---

1. Introduction

The Indonesian Maritime Continent (IMC) is known to play significant roles in global climate system. It is argued that pronounced interannual variability of El Niño and Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) could not exist without IMC. Indonesian Throughflow (ITF) controls transport of surface and subsurface waters from the Pacific Ocean to the Indian Ocean. From the viewpoint of atmospheric sciences, the IMC is characterized by vigorous deep convection that drives atmospheric global circulation.

The Madden-Julian Oscillation (MJO), which is the dominant mode of intraseasonal variability in the tropical atmosphere and characterized by eastward migration of an area of vigorous deep convection from the equatorial Indian Ocean to the Pacific Ocean, is also affected by the IMC. For example, about 40 % of the MJO events found over the Indian Ocean cannot go through the IMC but dissipate over it, while others can reach the Pacific Ocean. To investigate physical processes how the IMC affects the behavior of the MJO will provide knowledge useful for improvement of prediction of the MJO. It is expected that interaction of the MJO with local-scale variability such as land-sea breeze and diurnal cycle of convection might be a key to understand the influence of the IMC. One of the major purposes of this research cruise is to reveal interaction between the MJO and the local circulation through better understanding of precipitation systems from the viewpoint of ocean-atmosphere-land interaction. This is tightly related to an international research project, YMC (Years of the Maritime Continent).

Among the IMC, this research cruise focuses on the western coastal waters of Sumatra Island, which is located in the westernmost part of Indonesia. This region is known as the MJO's "entrance" into the IMC, and thus the influence of the IMC on the MJO is expected to be simpler and easier to understand than in any other regions in the IMC.

Furthermore, this region is characterized by coastal ocean upwelling, which plays a fundamental role in ocean circulation, material circulation, and their variability, such as the IOD. Another main purpose of this research cruise is to understand complicated physical and biogeochemical processes underlying the upwelling in this region, which is tightly related to another international project, EIOURI (Eastern Indian Ocean Upwelling Research Initiative).

For these purposes, we collected observational data in the atmosphere and ocean in this region. In particular, we conducted station observation at (4-14.4S, 102-31.2E) for the period from December 5, 2017 through January 1, 2018. Observational items include 3-hourly radiosonde, CTD, and TurboMAP observations, in addition to a series of continuous observations. Before and after the station observation, oceanographic observation consisting of CTD, UCTD, and XCTD was carried out along the straight line connecting (5S, 100E) and (4S, 102E).

Maintenance of ADCP subsurface mooring and m-TRITON buoys is another purpose of this cruise. In particular, we recovered and deployed an ADCP subsurface mooring at (0N, 90E), recovered the subsurface part of an m-TRITON buoy at (1.5S, 90E), deployed and recovered the buoys at (8S, 95E) and (5S, 95E), and deployed the buoy at (5S, 100E). We also deployed two ARGO floats at (5S, 95E).

In addition, continuous observations by the autonomous and/or underway instruments were carried out wherever possible throughout the cruise, and 6-hourly radiosonde observation was also performed in the Indonesian EEZ during leg 2.

This cruise report summarizes the observational items and preliminary results during the R/V Mirai MR17-08 cruise. First several sections describe the basic information such as cruise track and on-board personnel list. Details of observational items are described in Section 5, followed by additional information and figures in Appendices.

** Remarks **
This cruise report is a preliminary documentation as of the end of the cruise. Contents may be not updated after the end of the cruise, or subject to change without notice. Data on this report may be raw or not processed. Please ask the Chief Scientist and the Principal Investigators for the latest information.

2. Cruise Summary

2.1 Ship

Name	Research Vessel MIRAI
L x B x D	128.6m x 19.0m x 13.2m
Gross Tonnage	8,706 tons
Call Sign	JNSR
Home Port	Mutsu, Aomori Prefecture, Japan

2.2 Cruise Code

MR17-08

2.3 Project Name (Main mission)

"Study on air-sea interaction over upwelling region in the eastern Indian Ocean",
(as a part of the Japan-Indonesia collaborative research project "Tropical Ocean Climate Observational Studies")

2.4 Undertaking Institute

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
2-15, Natsushima, Yokosuka, Kanagawa 237-0061, JAPAN
Agency for Assessment and Application of Technology (BPPT)
Jalan Mohammad Hunsni Thamrin 8, Jakarta 10340, INDONESIA

2.5 Chief Scientist

Satoru YOKOI
Department of Coupled Ocean-Atmosphere-Land Processes Research, JAMSTEC
Fadli Syamsudin
Agency for the Assessment and Application of Technology (BPPT)

2.6 Periods and Ports of Call

Nov. 11, 2017:	departed Nakagusuku, Japan
Nov. 18, 2017:	called Singapore
Jan. 04, 2018:	called Jakarta, Indonesia
Jan. 18, 2018:	arrived Shimizu, Japan

2.7 Research Themes of Sub-missions and Principal Investigators (PIs)

(1) The monitoring of ocean climate change from surface to deep layer in the Indian Ocean by using Argo-type floats (PI: Shuhei MASUDA / JAMSTEC)
(2) On variations of precipitation and vapor isotope ratio associated with Madden Julian Oscillation (PI: Kei YOSHIMURA / University of Tokyo)

(3) Researches on the organized precipitating systems and their accompanying cold pools in the maritime continents region (PI: Hiroaki MIURA / University of Tokyo)
(4) Observational study on clouds and mixed layer depths over the tropical ocean (PI: Kazuaki YASUNAGA / Toyama University)
(5) A study on the mechanisms for convective clustering from thermally induced local circulations over the Maritime Continent (PI: Tetsuya TAKEMI: Kyoto University)
(6) Aerosol optical characteristics measured by ship-borne sky radiometer (PI: Kazuma AOKI / Toyama University)

2.8 Observation Summary

GPS Radiosonde	355 times	Nov. 27 to Jan. 11
GNSS water vapor observation	continuously	Nov. 22 to Jan. 18
C-band Doppler radar	continuously	Nov. 22 to Jan. 17
Micro rain radar	continuously	Nov. 22 to Jan. 18
Disdrometers	continuously	Nov. 22 to Jan. 18
Lidar	continuously	Nov. 22 to Jan. 18
Ceilometer	continuously	Nov. 22 to Jan. 18
Sky Radiometer	continuously	Nov. 22 to Jan. 18
Aerosol and gas observations	continuously	Nov. 22 to Jan. 18
Stable isotope measurement	continuously	Nov. 22 to Jan. 18
Surface Meteorology	continuously	Nov. 22 to Jan. 18
Sea surface water monitoring	continuously	Nov. 22 to Jan. 18
CTDO profiling	235 profiles	Nov. 25 to Jan. 1
Sea water sampling	116 casts	Nov. 28 to Jan. 1
LADCP	234 profiles	Nov. 25 to Jan. 1
Micro structure profiler	217 profiles	Dec. 5 to Jan. 1
Underway CTD	23 profiles	Nov. 28-29, Dec. 3-4 and Jan. 1
eXpendable CTD	9 profiles	Dec. 4 and Jan. 1
Deployment of Wave Glider	1 time	Dec. 3 to Dec. 30
Deployment of surface buoy	3 systems	(8S, 95E), (5S, 95E) and (5S, 100E)
Recovery of surface buoy	3 systems	(1.5S, 90E), (8S, 95E) and (5S, 95E)
Deployment of subsurface buoy	1 system	(Eq, 90E)
Recovery of subsurface buoy	1 system	(Eq, 90E)
Deployment of Argo float	2 floats	(5S, 95E)
Gravity/Magnetic force	continuously	Nov. 22 to Jan. 18
Bathymetry	continuously	Nov. 22 to Jan. 18

2.9 Overview

In order to investigate atmospheric and oceanic variations in the Maritime Continent, the intensive observations with the use of R/V Mirai were carried out, which is the main purpose of this cruise. This cruise is a component of the joint field campaign under collaboration of JAMSTEC and BPPT.

In the first half of the cruise, recovery and deployment of an ADCP subsurface mooring and m-TRITON buoys were performed in the eastern Indian Ocean.

Then, station observation was performed at (4.24S, 101.52E) for 28 days from December 5, 2017, through

January 1, 2018. Before and after the station observation, CTD, UCTD, and XCTD observations were performed along a section between (5S, 100E) and (4S, 102E). Autonomous instruments were in operation continuously wherever possible during the whole cruise.

In summary, we could conduct almost all the observational items we had planned. In the station observation period, we observed no little amount of precipitation which varied with wide range of time scales from hours to weeks, several events of freshening of surface water, and shoaling of thermocline.

These observed results will be analyzed further, with combining data observed at land sites in Bengkulu. Such activities are expected to contribute to deepening the understanding of ocean-atmosphere-land interaction in this region and its impact on large-scale weather and climate systems.

2.10 Acknowledgments

We would like to express our sincere thanks to Captain T. Akutagawa and his crew for their skillful ship operation. Special thanks are extended to the technical staff of Nippon Marine Enterprises, Ltd., and Marine Works Japan, Ltd. for their continuous and skillful support to conduct the observations. Supports from collaborators in the project, especially by the member of BPPT and BMKG, are greatly acknowledged.

3. Cruise Track and Log

3.1 Cruise Track

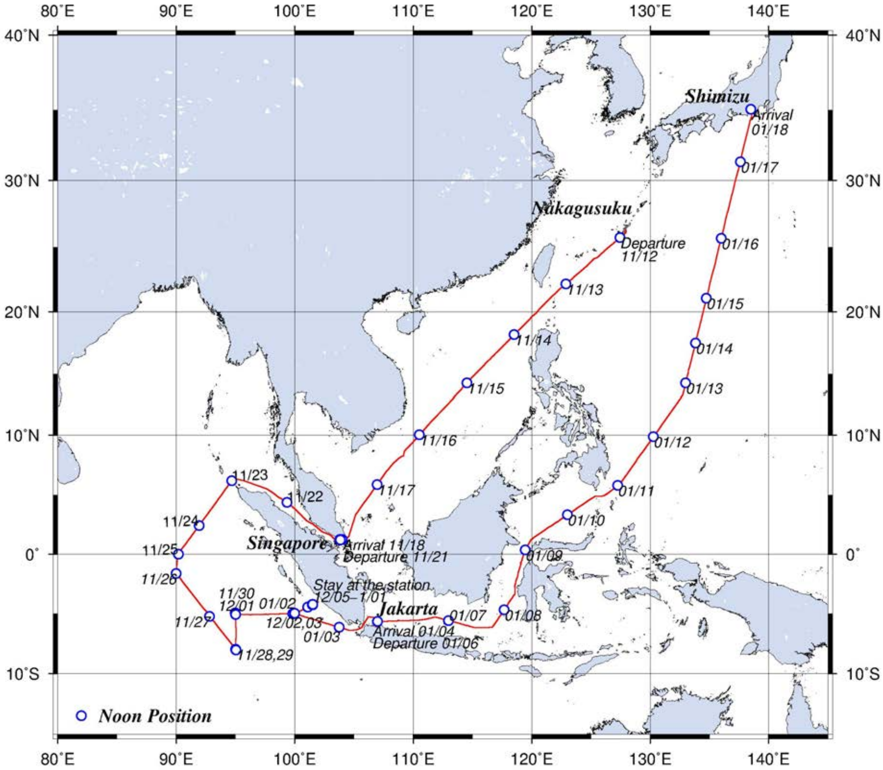


Fig. 3.1-1: Cruise track for all period.

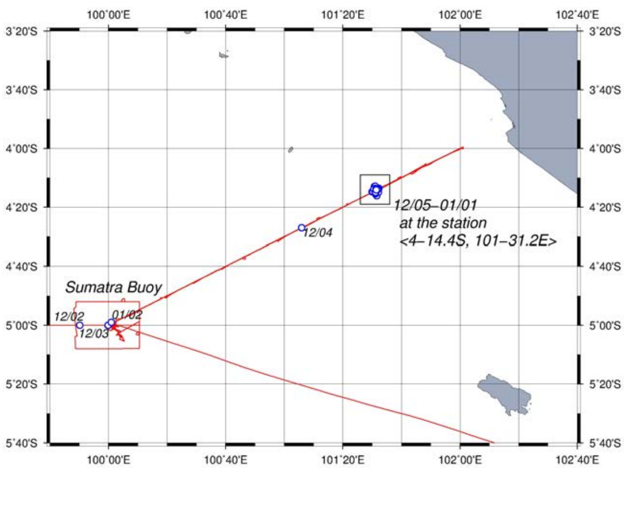


Fig. 3.1-2: Cruise track around the west coast of Sumatra Island, including cross section (5S,100E) - (4S,102E).

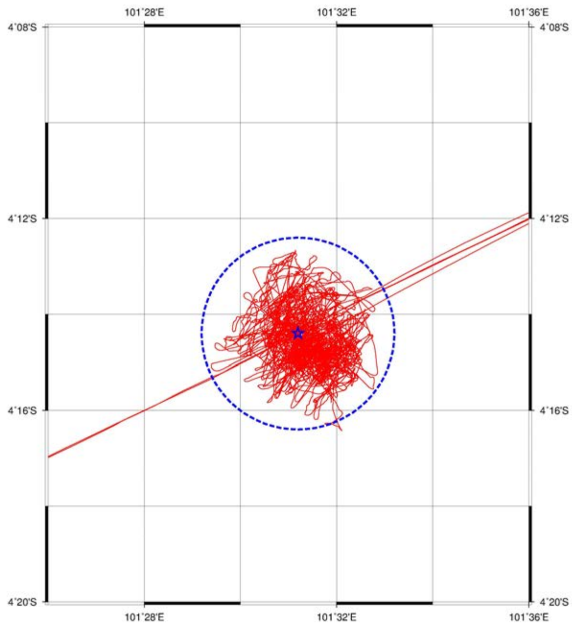


Fig. 3.1-3: Cruise track around the station (4-14.4S, 101-31.2E). Nominal station is shown by blue star. Blue circle indicates the area within 2 miles from the station.

3.2 Cruise Log

Date and Time (in UTC)		SMT	Location	Event
Nov 11	2300	0800		Departure from Nakagusuku, Japan
Nov 12	0030	0930		Start sea surface water monitoring
Nov 13	0100	1000		Enter Taiwan EEZ
				Pause sea surface water monitoring
Nov 15	1300	----		Revision of ship mean time (to UTC+8h)
Nov 18	0640	1440		Arrival at Singapore, Singapore
Nov 21	0010	0810		Departure from Singapore, Singapore
	0300	1100		Embarkation of Indonesian Security Officer and scientist from Indonesia
Nov 22	0558	1358		Enter Indonesian EEZ
	0730	1530		Resume sea surface water monitoring
				Start C band radar observation
	1400	----		Revision of ship mean time (to UTC+7h)
Nov 23	1500	----		Revision of ship mean time (to UTC+6h)
Nov 25	0058	0658		Sampling seawater with bucket
	0200	0800	(Eq., 90E)	Recovery of ADCP
	0637	1237	(Eq., 90E)	Deployment of ADCP
	1031	1631	(00-0.15N, 90-09.17E)	CTD #1; 500m
	2355	0555	(1.5S, 90E)	Sampling seawater with bucket
Nov 26	0450	1050	(1.5S, 90E)	Recovery of m-TRITON buoy
Nov 27	0238	0838	(04-40.67S, 92-25.48E)	Radiosonde #1
	0530	1130	(05-08.41S, 92-47.31E)	Radiosonde #2
	0830	1430	(05-39.07S, 93-11.20E)	Radiosonde #3
	1600	----		Revision of ship mean time (to UTC+7h)
Nov 28	0117	0817	(08S, 95E)	Deployment of m-TRITON buoy
	0730	1430	(07-59.25S, 95-02.66E)	CTD #2; 1000m (with sampling seawater)
	0900	1600	(07-58.41S, 95-00.67E)	UCTD #1; 1200m (Test)
	2257	0557	(08-03.78S, 95-05.27E)	CTD #3; 1000m
Nov 29	0110	0810	(08S, 95E)	Recovery of m-TRITON buoy
	0230	0930	(08-04.52S, 95-04.70E)	Radiosonde #4
	0521	1221	(08-04.02S, 95-01.74E)	UCTD #2; 300m
	0830	1530	(07-41.44S, 95-02.12E)	Radiosonde #5
	2330	0630	(04-56.63S, 95-02.83E)	Radiosonde #6
Nov 30	0108	0808	(05S, 95E)	Deployment of m-TRITON buoy
	0231	0931	(04-57.00S, 95-05.05E)	Radiosonde #7
	0530	1230	(04-56.92S, 94-58.05E)	Radiosonde #8
	0611	1311	(04-56.19S, 94-58.43E)	CTD #4; 4001m (with sampling seawater)
	0730	1430	(04-56.21S, 94-58.40E)	Radiosonde #9
	0830	1530	(04-56.33S, 94-58.49E)	Radiosonde #10
	1131	1831	(05-04.36S, 94-59.79E)	Radiosonde #11
	1430	2130	(05-06.62S, 95-00.65E)	Radiosonde #12
	1730	0030	(05-06.07S, 95-02.87E)	Radiosonde #13
	2030	0330	(05-06.77S, 95-03.25E)	Radiosonde #14
	2300	0600	(05-06.47S, 94-59.90E)	CTD #5; 1000m
	2331	0631	(05-06.51S, 94-59.52E)-	Radiosonde #15
Dec 01	0127	0827	(05S, 95E)	Recovery of m-TRITON buoy
	0234	0934	(05-05.06S, 94-59.45E)	Radiosonde #16
	0530	1230	(05-03.58S, 95-02.28E)	Radiosonde #17
	0550	1250	(05-03.58S, 95-02.71E)	Deployment of Deep NINJA
	0552	1252	(05-03.58S, 95-02.81E)	Deployment of Argo float
	0830	1530	(05-04.96S, 95-34.54E)	Radiosonde #18
	1130	1830	(05-05.16S, 96-11.20E)	Radiosonde #19
	1430	2130	(05-03.73S, 96-48.45E)	Radiosonde #20

	1730	0030	(05-03.21S, 97-26.27E)	Radiosonde #21
	2030	0330	(05-02.26S, 98-04.59E)	Radiosonde #22
	2330	0630	(05-00.76S, 98-43.04E)	Radiosonde #23
Dec 02	0230	0930	(05-00.20S, 99-21.04E)	Radiosonde #24
	0429	1129		Start bathymetry survey around (5.0S, 100.0E)
	0530	1230	(05-00.01S, 99-55.39E)	Radiosonde #25
	0830	1530	(04-51.19S, 100-04.81E)	Radiosonde #26
	0930	1630	(04-52.00S, 99-57.00E)	Radiosonde #27
	1030	1730	(04-54.2S, 99-48.4E)	Radiosonde #28
	1130	1830	(05-03.8S, 99-48.9E)	Radiosonde #29
	1440	2140	(05-02.51S, 100-09.94E)	Radiosonde #30
	1515	2215		End bathymetry survey around (5.0S, 100.0E)
	1730	0030	(05-03.41S, 100-04.02E)	Radiosonde #31
	2030	0330	(05-03.34S, 100-03.89E)	Radiosonde #32
	2330	0630	(05-03.38S, 100-02.82E)	Radiosonde #33
Dec 03	0112	0812	(5S, 100E)	Deployment of m-TRITON buoy
	0230	0930	(05-01.90S, 100-03.86E)	Radiosonde #34
	0530	1230	(04-59.65S, 99-59.80E)	Radiosonde #35
	0636	1336	(04-59.27S, 99-59.15E)	Deployment of wave glider
	0825	1525	(04-59.64S, 100-00.27E)	Radiosonde #36
	1130	1830	(04-59.48S, 100-01.08E)	Radiosonde #37
	1258	1958	(04-59.64S, 100-00.50E)	CTD #6; 1000m (with sampling seawater)
	1430	2130	(04-58.19S, 100-02.48E)	Radiosonde #38
	1445	2145	(04-57.48S, 100-04.84E)	UCTD #3; 500m
	1558	2258	(04-55.27S, 100-09.78E)	CTD #7; 501m
	1658	2358	(04-52.79S, 100-14.42E)	UCTD #4
	1730	0030	(04-50.89S, 100-15.38E)	Radiosonde #39
	1756	0056	(04-50.41S, 100-19.46E)	CTD #8; 500m (with sampling seawater)
	1758	0058	(04-50.38S, 100-19.35E)	Radiosonde #40
	1925	0225	(04-47.99S, 100-24.05E)	UCTD #5; 500m
	2027	0327	(04-45.74S, 100-28.90E)	CTD #9; 500m
	2033	0333	(04-45.66S, 100-28.88E)	Radiosonde #41
	2138	0438	(04-43.18S, 100-33.64E)	UCTD #6; 500m
	2230	0530	(04-40.84S, 100-38.55E)	CTD #10; 500m (with sampling seawater)
	2330	0630	(04-40.91S, 100-38.85E)	Radiosonde #42
Dec 04	0008	0708	(04-38.38S, 100-43.23E)	UCTD #7; 500m
	0055	0755	(04-36.06S, 100-48.11E)	CTD #11; 500m
	0159	0859	(04-33.61S, 100-52.88E)	UCTD #8; 500m
	0226	0926	(04-31.97S, 100-56.23E)	Radiosonde #43
	0257	0957	(04-31.20S, 100-57.97E)	CTD #12; 500m (with sampling seawater)
	0423	1123	(04-28.81S, 101-02.43E)	UCTD #9; 500m
	0525	1225	(04-26.36S, 101-07.17E)	Radiosonde #44
	0527	1227	(04-26.44S, 101-07.22E)	CTD #13; 500m (with sampling seawater)
	0700	1400	(04-23.96S, 101-12.03E)	XCTD #1
	0734	1434	(04-21.62S, 101-16.82E)	XCTD #2
	0830	1530	(04-18.85S, 101-21.49E)	Radiosonde #45
	0842	1542	(04-19.06S, 101-21.61E)	CTD #14; 500m (with sampling seawater)
	1012	1712	(04-16.79S, 101-26.41E)	UCTD #10; 300m
	1114	1814	(04-14.41S, 101-31.16E)	CTD #15; 500m
	1130	1830	(04-14.41S, 101-31.16E)	Radiosonde #46
	1230	1930	(04-11.99S, 101-36.03E)	UCTD #11; 300m
	1312	2012	(04-09.67S, 101-40.77E)	CTD #16; 502m (with sampling seawater)
	1430	2130	(04-08.64S, 101-43.35E)	Radiosonde #47
	1450	2150	(04-07.30S, 101-45.66E)	UCTD #12; 500m
	1542	2242	(04-04.84S, 101-50.46E)	CTD #17; 500m
	1655	2355	(04-02.41S, 101-55.21E)	UCTD #13; 300m
	1730	0030	(04-00.18S, 101-59.69E)	Radiosonde #48
	1742	0042	(04-00.07S, 102-00.03E)	CTD #18; 206m (with sampling seawater)

	2030	0330	(04-05.32S, 101-48.22E)	Radiosonde #49
	2330	0630	(04-14.42S, 101-31.15E)	Radiosonde #50
	2333	0633	(04-14.35S, 101-31.02E)	CTD #19; 300m (with sampling seawater)
Dec 05	0022	0722	(04-14.27S, 101-30.74E)	TurboMAP #1; 349m
	0230	0930	(04-14.25S, 101-30.96E)	Radiosonde #51
	0230	0930	(04-14.30S, 101-30.87E)	CTD #20; 300m
	0258	0958	(04-14.37S, 101-30.81E)	TurboMAP #2; 360m
	0330	1030	(04-14.58S, 101-30.80E)	Deployment of Sea-snake
	0535	1235	(04-12.89S, 101-30.96E)	CTD #21; 500m (with sampling seawater)
	0545	1245	(04-12.83S, 101-31.00E)	Radiosonde #52
	0626	1326	(04-13.30S, 101-30.67E)	TurboMAP #3; 404m
	0830	1530	(04-13.15S, 101-31.69E)	Radiosonde #53
	0835	1535	(04-13.17S, 101-31.62E)	CTD #22; 300m
	0858	1558	(04-13.25S, 101-31.44E)	TurboMAP #4; 364m
	1130	1830	(04-14.10S, 101-30.21E)	Radiosonde #54
	1134	1834	(04-14.07S, 101-30.12E)	CTD #23; 300m (with sampling seawater)
	1221	1921	(04-14.16S, 101-29.86E)	TurboMAP #5; 349m
	1430	2130	(04-13.87S, 101-30.37E)	Radiosonde #55
	1433	2133	(04-13.87S, 101-30.33E)	CTD #24; 300m
	1505	2205	(04-14.09S, 101-30.15E)	TurboMAP #6; 368m
	1730	0030	(04-14.14S, 101-30.41E)	Radiosonde #56
	1732	0032	(04-14.15S, 101-30.25E)	CTD #25; 300m (with sampling seawater)
	1817	0117	(04-14.44S, 101-29.96E)	TurboMAP #7; 350m
	2030	0330	(04-13.74S, 101-30.34E)	Radiosonde #57
	2032	0332	(04-13.71S, 101-30.27E)	CTD #26; 300m
	2056	0356	(04-13.90S, 101-30.16E)	TurboMAP #8; 367m
	2330	0630	(04-13.44S, 101-31.07E)	Radiosonde #58
	2335	0635	(04-13.75S, 101-30.86E)	CTD #27; 300m (with sampling seawater)
Dec 06	0027	0727	(04-13.77S, 101-30.77E)	TurboMAP #9; 410m
	0230	0930	(04-13.61S, 101-31.26E)	Radiosonde #59
	0236	0926	(04-13.55S, 101-31.24E)	CTD #28; 300m
	0300	1000	(04-13.60S, 101-31.09E)	TurboMAP #10; 385m
	0530	1230	(04-13.48S, 101-32.73E)	Radiosonde #60
	0536	1236	(04-13.48S, 101-32.54E)	CTD #29; 500m (with sampling seawater)
	0632	1332	(04-13.62S, 101-32.24E)	TurboMAP #11; 365m
	0830	1530	(04-14.18S, 101-31.45E)	Radiosonde #61
	0837	1537	(04-14.11S, 101-31.34E)	CTD #30; 300m
	0900	1600	(04-14.15S, 101-31.24E)	TurboMAP #12; 385m
	0945	1645		Recovery of Sea-snake
	1130	1830	(04-14.52S, 101-31.16E)	Radiosonde #62
	1137	1837	(04-14.43S, 101-31.11E)	CTD #31; 300m (with sampling seawater)
	1226	1926	(04-14.60S, 101-30.93E)	TurboMAP #13; 326m
	1430	2130	(04-14.96S, 101-30.78E)	Radiosonde #63
	1436	2136	(04-14.99S, 101-30.65E)	CTD #32; 299m
	1501	2201	(04-15.19S, 101-30.50E)	TurboMAP #14; 345m
	1730	0030	(04-14.56S, 101-31.55E)	Radiosonde #64
	1736	0036	(04-14.56S, 101-31.41E)	CTD #33; 300m (with sampling seawater)
	1821	0121	(04-14.99S, 101-31.10E)	TurboMAP #15; 339m
	2030	0330	(04-14.06S, 101-32.66E)	Radiosonde #65
	2036	0336	(04-14.03S, 101-32.54E)	CTD #34; 300m
	2100	0400	(04-14.20S, 101-32.39E)	TurboMAP #16; 344m
	2330	0630	(04-15.23S, 101-31.18E)	Radiosonde #66
	2337	0637	(04-15.34S, 101-31.01E)	CTD #35; 300m (with sampling seawater)
Dec 07	0025	0725	(04-15.71S, 101-30.66E)	TurboMAP #17; 417m
	0232	0932	(04-14.05S, 101-31.57E)	CTD #36; 300m
	0248	0948	(04-14.07S, 101-31.54E)	Radiosonde #67
	0257	0957	(04-14.13S, 101-31.43E)	TurboMAP #18; 369m
	0334	1034	(04-14.15S, 101-31.45E)	Deployment of Sea-snake

	0530	1230	(04-13.63S, 101-31.97E)	Radiosonde #68
	0536	1236	(04-13.61S, 101-31.74E)	CTD #37; 500m (with sampling seawater)
	0631	1331	(04-13.87S, 101-31.28E)	TurboMAP #19; 323m
	0830	1530	(04-13.60S, 101-31.06E)	Radiosonde #69
	0836	1536	(04-13.67S, 101-31.00E)	CTD #38
	0858	1558	(04-13.38S, 101-30.94E)	TurboMAP #20; 372m
	1130	1830	(04-14.45S, 101-31.33E)	Radiosonde #70
	1138	1838	(04-14.41S, 101-31.40E)	CTD #39: 300m (with sampling seawater)
	1223	1923	(04-14.92S, 101-31.35E)	TurboMAP #21; 355m
	1438	2138	(04-14.48S, 101-31.31E)	CTD #40; 300m
	1446	2146	(04-14.45S, 101-31.35E)	Radiosonde #71
	1503	2203	(04-14.66S, 101-31.16E)	TurboMAP #22; 334m
	1730	0030	(04-13.85S, 101-31.34E)	Radiosonde #72
	1731	0031	(04-14.01S, 101-31.24E)	CTD #41: 300m (with sampling seawater)
	1823	0123	(04-14.24S, 101-30.94E)	TurboMAP #23; 314m
	2030	0330	(04-14.80S, 101-32.10E)	Radiosonde #73
	2031	0331	(04-14.92S, 101-31.97E)	CTD #42; 300m
	2054	0354	(04-15.38S, 101-31.83E)	TurboMAP #24; 344m
	2326	0626	(04-13.72S, 101-31.11E)	Radiosonde #74
	2332	0632	(04-14.00S, 101-31.05E)	CTD #43; 300m (with sampling seawater)
Dec 08	0021	0721	(04-14.50S, 101-xx.xxE)	TurboMAP #25; 336m
	0230	0930	(04-14.31S, 101-31.02E)	Radiosonde #75
	0236	0936	(04-14.53S, 101-31.06E)	CTD #44; 300m
	0300	1000	(04-14.84S, 101-31.25E)	TurboMAP #26; 314m
	0530	1230	(04-13.57S, 101-30.91E)	Radiosonde #76
	0535	1235	(04-13.77S, 101-30.96E)	CTD #45; 500m (with sampling seawater)
	0629	1329	(04-14.28S, 101-31.24E)	TurboMAP #27; 343m
	0830	1530	(04-14.21S, 101-30.70E)	Radiosonde #77
	0837	1537	(04-14.45S, 101-30.78E)	CTD #46; 300m
	0900	1600	(04-14.69S, 101-30.96E)	TurboMAP #28; 323m
	1130	1830	(04-14.01S, 101-30.82E)	Radiosonde #78
	1135	1835	(04-14.05S, 101-30.73E)	CTD #47; 300m (with sampling seawater)
	1224	1924	(04-14.52S, 101-30.93E)	TurboMAP #29; 344m
	1430	2130	(04-14.42S, 101-30.52E)	Radiosonde #79
	1435	2135	(04-14.45S, 101-30.45E)	CTD #48; 300m
	1458	2158	(04-14.65S, 101-30.51E)	TurboMAP #30; 330m
	1730	0030	(04-13.57S, 101-30.62E)	Radiosonde #80
	1738	0038	(04-13.54S, 101-30.52E)	CTD #49; 300m (with sampling seawater)
	1821	0121	(04-13.78S, 101-30.43E)	TurboMAP #31; 341m
	2030	0330	(04-12.86S, 101-31.57E)	Radiosonde #81
	2036	0336	(04-12.81S, 101-31.51E)	CTD #50; 300m
	2059	0359	(04-13.03S, 101-31.45E)	TurboMAP #32; 338m
	2330	0630	(04-13.15S, 101-30.72E)	Radiosonde #82
	2337	0637	(04-13.27S, 101-30.64E)	CTD #51; 300m (with sampling seawater)
Dec 09	0024	0724	(04-13.59S, 101-30.57E)	TurboMAP #33; 350m
	0230	0930	(04-12.96S, 101-30.76E)	Radiosonde #83
	0236	0936	(04-13.01S, 101-30.62E)	CTD #52; 300m
	0300	1000	(04-13.11S, 101-30.61E)	TurboMAP #34; 350m
	0530	1230	(04-12.90S, 101-30.90E)	Radiosonde #84
	0537	1237	(04-13.05S, 101-30.79E)	CTD #53; 500m (with sampling seawater)
	0634	1334	(04-13.32S, 101-30.76E)	TurboMAP #35; 343m
	0830	1530	(04-13.78S, 101-30.52E)	Radiosonde #85
	0837	1537	(04-13.90S, 101-30.43E)	CTD #54; 301m
	0900	1600	(04-14.00S, 101-30.51E)	TurboMAP #36; 329m
	1130	1830	(04-14.60S, 101-30.75E)	Radiosonde #86
	1136	1836	(04-14.64S, 101-30.66E)	CTD #55; 300m (with sampling seawater)
	1226	1926	(04-14.79S, 101-30.88E)	TurboMAP #37; 333m
	1430	2130	(04-14.77S, 101-31.18E)	Radiosonde #87

	1436	2136	(04-14.79S, 101-31.10E)	CTD #56; 300m
	1459	2159	(04-14.98S, 101-31.26E)	TurboMAP #38; 328m
	1730	0030	(04-14.17S, 101-30.93E)	Radiosonde #88
	1734	0034	(04-14.18S, 101-30.68E)	CTD #57; 301m (with sampling seawater)
	1828	0128	(04-14.35S, 101-30.59E)	TurboMAP #39; 331m
	2030	0330	(04-13.26S, 101-32.07E)	Radiosonde #89
	2038	0338	(04-13.12S, 101-31.95E)	CTD #58; 300m
	2100	0400	(04-13.29S, 101-31.88E)	TurboMAP #40; 325m
	2330	0630	(04-13.51S, 101-31.16E)	Radiosonde #90
	2337	0637	(04-13.48S, 101-30.98E)	CTD #59; 300m (with sampling seawater)
Dec 10	0026	0726	(04-13.86S, 101-30.80E)	TurboMAP #41; 346m
	0230	0930	(04-14.19S, 101-30.97E)	Radiosonde #91
	0237	0937	(04-14.25S, 101-30.86E)	CTD #60; 300m
	0300	1000	(04-14.43S, 101-30.76E)	TurboMAP #42; 366m
	0530	1230	(04-14.42S, 101-30.34E)	Radiosonde #92
	0536	1236	(04-14.42S, 101-30.22E)	CTD #61; 500m (with sampling seawater)
	0625	1325	(04-14.50S, 101-30.06E)	TurboMAP #43; 392m
	0830	1530	(04-13.13S, 101-31.34E)	Radiosonde #93
	0836	1536	(04-13.14S, 101-31.20E)	CTD #62; 300m
	0900	1600	(04-13.16S, 101-31.07E)	TurboMAP #44; 370m
	1130	1830	(04-14.02S, 101-31.09E)	Radiosonde #94
	1137	1837	(04-14.07S, 101-31.17E)	CTD #63; 300m (with sampling seawater)
	1224	1924	(04-14.12S, 101-31.60E)	TurboMAP #45; 319m
	1430	2130	(04-14.14S, 101-31.85E)	Radiosonde #95
	1437	2137	(04-14.21S, 101-31.85E)	CTD #64; 300m
	1458	2158	(04-14.29S, 101-32.01E)	TurboMAP #46; 325m
	1730	0030	(04-14.75S, 101-31.69E)	Radiosonde #96
	1735	0035	(04-14.76S, 101-31.52E)	CTD #65; 300m (with sampling seawater)
	1822	0122	(04-15.01S, 101-31.82E)	TurboMAP #47; 320m
	2031	0331	(04-13.69S, 101-31.97E)	Radiosonde #97
	2035	0335	(04-13.54S, 101-31.93E)	CTD #66; 300m
	2100	0400	(04-13.66S, 101-32.00E)	TurboMAP #48; 320m
	2330	0630	(04-14.53S, 101-31.33E)	Radiosonde #98
	2336	0636	(04-14.55S, 101-31.28E)	CTD #67; 300m (with sampling seawater)
Dec 11	0027	0727	(04-14.67S, 101-31.28E)	TurboMAP #49; 384m
	0230	0930	(04-14.76S, 101-30.90E)	Radiosonde #99
	0236	0936	(04-14.73S, 101-30.82E)	CTD #68; 300m
	0300	1000	(04-14.76S, 101-30.78E)	TurboMAP #50; 404m
	0530	1230	(04-13.73S, 101-32.49E)	Radiosonde #100
	0538	1238	(04-13.74S, 101-32.38E)	CTD #69; 500m (with sampling seawater)
	0630	1330	(04-13.87S, 101-32.39E)	TurboMAP #51; 389m
	0830	1530	(04-13.16S, 101-31.68E)	Radiosonde #101
	0838	1538	(04-13.16S, 101-31.62E)	CTD #70; 300m
	0900	1600	(04-13.24S, 101-31.65E)	TurboMAP #52; 341m
	1130	1830	(04-14.24S, 101-31.70E)	Radiosonde #102
	1135	1835	(04-14.26S, 101-31.61E)	CTD #71; 300m (with sampling seawater)
	1223	1923	(04-14.28S, 101-31.95E)	TurboMAP #53; 320m
	1430	2130	(04-14.73S, 101-32.40E)	Radiosonde #103
	1435	2135	(04-14.78S, 101-32.36E)	CTD #72; 300m
	1459	2159	(04-14.94S, 101-32.43E)	TurboMAP #54; 337m
	1730	0030	(04-14.59S, 101-32.46E)	Radiosonde #104
	1735	0035	(04-14.50S, 101-32.34E)	CTD #73; 301m (with sampling seawater)
	1817	0117	(04-14.66S, 101-32.24E)	TurboMAP #55; 327m
	2030	0330	(04-14.87S, 101-31.97E)	Radiosonde #105
	2038	0338	(04-14.79S, 101-31.87E)	CTD #74; 300m
	2100	0400	(04-14.94S, 101-31.94E)	TurboMAP #56; 344m
	2330	0630	(04-14.68S, 101-32.01E)	Radiosonde #106
	2348	0638	(04-14.73S, 101-31.95E)	CTD #75; 300m (with sampling seawater)

Dec 12	0024	0724	(04-14.90S, 101-31.91E)	TurboMAP #57; 366m
	0230	0930	(04-14.00S, 101-32.50E)	Radiosonde #107
	0236	0936	(04-14.01S, 101-32.41E)	CTD #76; 300m
	0258	0958	(04-14.03S, 101-32.39E)	TurboMAP #58; 346m
	0530	1230	(04-14.71S, 101-32.13E)	Radiosonde #108
	0536	1236	(04-14.71S, 101-32.09E)	CTD #77; 500m (with sampling seawater)
	0629	1329	(04-14.86S, 101-32.04E)	TurboMAP #59; 385m
	0700	1400		Check Sea-snake
	0830	1530	(04-15.24S, 101-32.23E)	Radiosonde #109
	0836	1536	(04-15.21S, 101-32.17E)	CTD #78; 300m
	0858	1558	(04-15.20S, 101-32.14E)	TurboMAP #60; 355m
	1130	1830	(04-14.14S, 101-31.90E)	Radiosonde #110
	1136	1836	(04-14.26S, 101-31.94E)	CTD #79; 300m (with sampling seawater)
	1225	1925	(04-14.60S, 101-32.26E)	TurboMAP #61; 318m
	1430	2130	(04-14.83S, 101-32.08E)	Radiosonde #111
	1436	2136	(04-14.87S, 101-32.07E)	CTD #80; 301m
	1458	2158	(04-15.05S, 101-32.20E)	TurboMAP #62; 320m
	1734	0034	(04-15.12S, 101-31.81E)	CTD #81; 300m (with sampling seawater)
	1742	0042	(04-15.12S, 101-31.79E)	Radiosonde #112
	1820	0120	(04-15.22S, 101-31.86E)	TurboMAP #63; 330m
	2030	0330	(04-14.25S, 101-32.00E)	Radiosonde #113
	2030	0330	(04-14.32S, 101-32.09E)	CTD #82; 300m
	2051	0351	(04-14.48S, 101-32.16E)	TurboMAP #64; 330m
	2336	0636	(04-14.60S, 101-32.02E)	Radiosonde #114
	2344	0644	(04-14.80S, 101-32.04E)	CTD #83; 300m (with sampling seawater)
Dec 13	0006	0706	(04-14.83S, 101-32.02E)	Radiosonde #115
	0033	0733	(04-14.99S, 101-32.14E)	TurboMAP #65; 371m
	0230	0930	(04-15.29S, 101-31.55E)	Radiosonde #116
	0236	0936	(04-15.30S, 101-31.52E)	CTD #84; 300m
	0258	0958	(04-15.38S, 101-31.62E)	TurboMAP #66; 325m
	0527	1227	(04-14.02S, 101-31.53E)	Radiosonde #117
	0531	1231	(04-14.12S, 101-31.60E)	CTD #85; 500m (with sampling seawater)
	0626	1326	(04-14.24S, 101-31.87E)	TurboMAP #67; 372m
	0830	1530	(04-14.48S, 101-32.67E)	Radiosonde #118
	0836	1536	(04-14.45S, 101-32.67E)	CTD #86; 301m
	0858	1558	(04-14.44S, 101-32.75E)	TurboMAP #68; 378m
	1130	1830	(04-14.68S, 101-31.91E)	Radiosonde #119
	1135	1835	(04-14.68S, 101-31.97E)	CTD #87; 300m (with sampling seawater)
	1219	1919	(04-14.86S, 101-32.37E)	TurboMAP #69; 317m
	1430	2130	(04-14.86S, 101-31.99E)	Radiosonde #120
	1438	2138	(04-14.91S, 101-32.02E)	CTD #88; 300m
	1458	2158	(04-14.92S, 101-32.33E)	TurboMAP #70; 319m
	1730	0030	(04-12.72S, 101-31.08E)	Radiosonde #121
	1737	0037	(04-12.84S, 101-31.16E)	CTD #89; 300m (with sampling seawater)
	1821	0121	(04-13.02S, 101-31.23E)	TurboMAP #71; 337m
	2030	0330	(04-13.43S, 101-31.21E)	Radiosonde #122
	2036	0336	(04-13.38S, 101-31.20E)	CTD #90; 300m
	2058	0358	(04-13.52S, 101-31.31E)	TurboMAP #72; 332m
	2330	0630	(04-14.81S, 101-31.41E)	Radiosonde #123
	2336	0636	(04-14.71S, 101-31.37E)	CTD #91; 300m (with sampling seawater)
Dec 14	0024	0724	(04-14.69S, 101-31.43E)	TurboMAP #73; 367m
	0230	0930	(04-14.47S, 101-30.80E)	Radiosonde #124
	0237	0937	(04-14.45S, 101-30.73É)	CTD #92; 300m
	0300	1000	(04-14.50S, 101-30,75E)	TurboMAP #74
	0530	1230	(04-14.22S, 101-30.77E)	Radiosonde #125
	0535	1235	(04-14.22S, 101-30,72E)	CTD #93; 500m (with sampling seawater)
	0623	1323	(04-14.42S, 101-30.74E)	TurboMAP #75; 354m
	0830	1530	(04-14.52S, 101-30.88E)	Radiosonde #126

	0836	1536	(04-14.54S, 101-30.80E)	CTD #94; 300m
	0858	1558	(04-14.62S, 101-30.76E)	TurboMAP #76; 360m
	1130	1830	(04-15.00S, 101-30,87E)	Radiosonde #127
	1136	1836	(04-14.99S, 101-30,75E)	CTD #95; 300m (with sampling seawater)
	1223	1923	(04-15.22S, 101-30,74E)	TurboMAP #77; 334m
	1430	2130	(04-14.50S, 101-31.28E)	Radiosonde #128
	1435	2135	(04-14.45S, 101-31.20E)	CTD #96; 300m
	1457	2157	(04-14.59S, 101-31.22E)	TurboMAP #78; 318m
	1730	0030	(04-14.52S, 101-31.54E)	Radiosonde #129
	1734	0034	(04-14.55S, 101-31.45E)	CTD #97; 300m (with sampling seawater)
	1816	0116	(04-14.74S, 101-31.59E)	TurboMAP #79; 327m
	1730	0330	(04-14.82S, 101-31,31E)	Radiosonde #130
	1734	0334	(04-14.70S, 101-31.33E)	CTD #98; 300m
	1757	0357	(04-14.88S, 101-31.25E)	TurboMAP #80; 357m
	2330	0630	(04-14.94S, 101-31.34E)	Radiosonde #131
	2335	0635	(04-15.15S, 101-31.33E)	CTD #99; 300m (with sampling seawater)
Dec 15	0024	0724	(04-15.13S, 101-31.31E)	TurboMap #81; 373m
	0230	0930	(04-14.47S, 101-31.31.E)	Radiosonde #132
	0236	0936	(04-14.32S, 101-31.25E)	CTD #100; 300m
	0259	0959	(04-14.30S, 101-31.14E)	TurboMAP #82; 340m
	0530	1230	(04-13.15S, 101-31.20E)	Radiosonde #133
	0536	1236	(04-13.14S, 101-31.19E)	CTD #101; 500m (with sampling seawater)
	0623	1323	(04-13.16S, 101-31.22E)	TurboMAP #83 (1st cast); 330m
	0640	1340	(04-13.18S, 101-31.27E)	TurboMAP #83 (2nd cast); 326m
	0830	1530	(04-13.42S, 101-31.44E)	Radiosonde #134
	0835	1535	(04-13.40S, 101-31.41E)	CTD #102; 300m
	0857	1557	(04-13.47S, 101-31.39E)	TurboMAP #84 (1st cast); 351m
	0917	1617	(04-13.50S, 101-31.36E)	TurboMAP #84 (2nd cast); 340m
	1130	1830	(04-14.28S, 101-31.59E)	Radiosonde #135
	1134	1834	(04-14.34S, 101-31.58E)	CTD #103; 301m (with sampling seawater)
	1225	1925	(04-14.77S, 101-31.69E)	TurboMAP #85 (1st cast); 325m
	1252	1952	(04-13.92S, 101-31.83E)	TurboMAP #85 (2nd cast); 322m
	1430	2130	(04-14.31S, 101-31.88E)	Radiosonde #136
	1434	2134	(04-14.35S, 101-31.85E)	CTD #104; 301m
	1456	2156	(04-14.55S, 101-31.91E)	TurboMAP #86
	1730	0030	(04-14.52S, 101-31.62E)	Radiosonde #137
	1733	0033	(04-13.50S, 101-31.53E)	CTD #105; 300m (with sampling seawater)
	1817	0117	(04-14.67S, 101-31.47E)	TurboMAP #87 (1st cast); 315m
	1837	0137	(04-14.74S, 101-31.51E)	TurboMAP #87 (2nd cast); 320m
	2035	0335	(04-14.31S, 101-31.85E)	Radiosonde #138
	2038	0338	(04-14.25S, 101-31.79E)	CTD #106; 300m
	2102	0402	(04-14.38S, 101-31.89E)	TurboMAP #88; 329m
	2330	0630	(04-14.46S, 101-31.74E)	Radiosonde #139
	2339	0639	(04-14.47S, 101-31.71E)	CTD #107; 300m (with sampling seawater)
Dec 16	0021	0721	(04-14.54S, 101-31.66E)	TurboMAP #89; 347m
	0225	0925	(04-14.24S, 101-31.10E)	Radiosonde #140
	0232	0932	(04-14.21S, 101-31.02E)	CTD #108; 300m
	0254	0954	(04-14.22S, 101-30.95E)	TurboMAP #90; 341m
	0536	1236	(04-13.50S, 101-31.62E)	CTD #109; 500m (with sampling seawater)
	0550	1250	(04-13.50S, 101-31.62E)	Radiosonde #141
	0626	1326	(04-13.55S, 101-31.63E)	TurboMAP #91; 328m
	0830	1530	(04-13.91S, 101-31.70E)	Radiosonde #142
	0835	1535	(04-13.92S, 101-31.70E)	CTD #110; 301m
	0857	1557	(04-14.02S, 101-31.84E)	TurboMAP #92; 327m
	1130	1830	(04-14.43S, 101-32.10E)	Radiosonde #143
	1135	1835	(04-14.38S, 101-32.09E)	CTD #111; 300m (with sampling seawater)
	1219	1919	(04-14.57S, 101-32.19E)	TurboMAP #93; 345m
	1425	2125	(04-14.88S, 101-32.04E)	Radiosonde #144

	1432	2132	(04-14.72S, 101-32.08E)	CTD #112; 300m
	1454	2154	(04-14.90S, 101-32.67E)	TurboMAP #94; 350m
	1730	0030	(04-14.84S, 101-31.28E)	Radiosonde #145
	1731	0031	(04-14.88S, 101-31.31E)	CTD #113; 301m (with sampling seawater)
	1815	0115	(04-15.09S, 101-31.43E)	TurboMAP #95; 335m
	2029	0329	(04-14.84S, 101-31.60E)	Radiosonde #146
	2031	0331	(04-14.90S, 101-31.68E)	CTD #114; 300m
	2053	0353	(04-15.08S, 101-31.78E)	TurboMAP #96; 345m
	2330	0630	(04-14.77S, 101-31.89E)	Radiosonde #147
	2336	0636	(04-14.94S, 101-32.02E)	CTD #115; 300m (with sampling seawater)
Dec 17	0024	0724	(04-15.20S, 101-32.24E)	TurboMAP #97; 382m
	0230	0930	(04-14.80S, 101-31,76E)	Radiosonde #148
	0236	0936	(04-14.82S, 101-31.85E)	CTD #116; 300m
	0258	0958	(04-14.91S, 101-31.94E)	TurboMAP #98
	0530	1230	(04-14.54S, 101-31.68E)	Radiosonde #149
	0535	1235	(04-14.52S, 101-31.77E)	CTD #117; 500m (with sampling seawater)
	0632	1332	(04-14.51S, 101-31.90E)	TurboMAP #99; 366m
	0830	1530	(04-14.28S, 101-31.94E)	Radiosonde #150
	0834	1534	(04-14.24S, 101-32.03E)	CTD #118; 300m
	0856	1556	(04-14.32S, 101-32.19E)	TurboMAP #100; 377m
	1130	1830	(04-14.62S, 101-31.65E)	Radiosonde #151
	1134	1834	(04-14.58S, 101-31.73E)	CTD #119; 300m (with sampling seawater)
	1222	1922	(04-14.60S, 101-31.60E)	TurboMAP #101; 355m
	1430	2130	(04-14.67S, 101-31.58E)	Radiosonde #152
	1434	2134	(04-14.63S, 101-31.59E)	CTD #120; 300m
	1456	2156	(04-14.72S, 101-31.68E)	TurboMAP #102; 353m
	1730	0030	(04-14.77S, 101-31.17E)	Radiosonde #153
	1733	0033	(04-14.77S, 101-31.13E)	CTD #121; 300m (with sampling seawater)
	1819	0119	(04-14.99S, 101-31.34E)	TurboMAP #103; 336m
	2030	0330	(04-14.83S, 101-31.32E)	Radiosonde #154
	2034	0334	(04-14.73S, 101-31.30E)	CTD #122; 300m
	2056	0356	(04-14.81S, 101-31.45E)	TurboMAP #104; 354m
	2330	0630	(04-14.81S, 101-31.14E)	Radiosonde #155
	2335	0635	(04-14.75S, 101-31.12E)	CTD #123; 300m (with sampling seawater)
Dec 18	0017	0717	(04-14.81S, 101-31.17E)	TurboMAP #105; 390m
	0230	0930	(04-14.75S, 101-31.18E)	Radiosonde #156
	0236	0936	(04-14.72S, 101-31.15E)	CTD #124; 300m
	0259	0959	(04-14.80S, 101-31.17E)	TurboMAP #106; 355m
	0530	1230	(04-14.87S, 101-31.06E)	Radiosonde #157
	0535	1235	(04-14.82S, 101-31.05E)	CTD #125; 500m (with sampling seawater)
	0623	1323	(04-14.91S, 101-31.03E)	TurboMAP #107; 386m
	0651	1351		Start taking care of Sea-snake
	0657	1357		End taking care of Sea-snake
	0830	1530	(04-14.88S, 101-31.37E)	Radiosonde #158
	0835	1535	(04-14.83S, 101-31.37E)	CTD #126; 301m
	0857	1557	(04-14.91S, 101-31.41E)	TurboMAP #108; 360m
	1130	1830	(04-14.79S, 101-31.04E)	Radiosonde #159
	1134	1834	(04-14.87S, 101-31.06E)	CTD #127; 300m (with sampling seawater)
	1220	1920	(04-15.07S, 101-31.17E)	TurboMAP #109; 359m
	1430	2130	(04-14.73S, 101-31.02E)	Radiosonde #160
	1435	2135	(04-14.74S, 101-30.96E)	CTD #128; 300m
	1455	2155	(04-14.88S, 101-31.07E)	TurboMAP #110; 357m
	1730	0030	(04-14.80S, 101-31.17E)	Radiosonde #161
	1733	0033	(04-14.85S, 101-31.15E)	CTD #129; 300m (with sampling seawater)
	1820	0120	(04-14.07S, 101-31.23E)	TurboMAP #111; 336m
	2030	0330	(04-14.67S, 101-31.17E)	Radiosonde #162
	2034	0334	(04-14.59S, 101-31.16E)	CTD #130; 300m
	2056	0356	(04-14.69S, 101-31.25E)	TurboMAP #112; 342m

	2330	0630	(04-14.58S, 101-31.14E)	Radiosonde #163
	2334	0634	(04-14.64S, 101-31.10E)	CTD #131; 300m (with sampling seawater)
Dec 19	0014	0714	(04-14.69S, 101-31.27E)	TurboMAP #113; 355m
	0230	0930	(04-14.50S, 101-30.64E)	Radiosonde #164
	0236	0936	(04-14.40S, 101-30.63E)	CTD #132; 300m
	0258	0958	(04-14.42S, 101-30.61E)	TurboMAP #114; 340m
	0530	1230	(04-14.51S, 101-30.28E)	Radiosonde #165
	0535	1235	(04-14.48S, 101-30.18E)	CTD #133; 500m (with sampling seawater)
	0627	1327	(04-14.61S, 101-30.17E)	TurboMAP #115; 356m
	0825	1525	(04-14.85S, 101-30.78E)	Radiosonde #166
	0830	1530	(04-14.79S, 101-30.72E)	CTD #134; 300m
	0851	1551	(04-14.79S, 101-30.69E)	TurboMAP #116; 323m
	0933	1633	(04-14.54S, 101-30.80E)	Radiosonde #167
	1030	1730	(04-14.67S, 101-30.78E)	Radiosonde #168
	1130	1830	(04-14.80S, 101-30.80E)	Radiosonde #169
	1134	1834	(04-14.79S, 101-30.82E)	CTD #135; 300m (with sampling seawater)
	1217	1917	(04-14.90S, 101-31.05E)	TurboMAP #117; 330m
	1230	1930	(04-14.90S, 101-31.07E)	Radiosonde #170
	1330	2030	(04-14.86S, 101-31.03E)	Radiosonde #171
	1430	2130	(04-15.00S, 101-31.21E)	Radiosonde #172
	1434	2134	(04-15.02S, 101-31.20E)	CTD #136; 300m
	1455	2155	(04-15.09S, 101-31.35E)	TurboMAP #118; 329m
	1530	2230	(04-14.79S, 101-31.55E)	Radiosonde #173
	1630	2330	(04-14.85S, 101-31.27E)	Radiosonde #174
	1730	0030	(04-14.82S, 101-31.35E)	Radiosonde #175
	1734	0034	(04-14.73S, 101-31.21E)	CTD #137; 300m (with sampling seawater)
	1821	0121	(04-14.91S, 101-31.59E)	TurboMAP #119; 335m
	2020	0320	(04-14.47S, 101-31.78E)	Radiosonde #176
	2028	0328	(04-14.41S, 101-31.61E)	CTD #138; 300m
	2050	0350	(04-14.43S, 101-30.78E)	TurboMAP #120; 340m
	2330	0630	(04-15.03S, 101-31.85E)	Radiosonde #177
	2334	0634	(04-14.97S, 101-31.77E)	CTD #139; 300m (with sampling seawater)
Dec 20	0016	0716	(04-15.05S, 101-32.02E)	TurboMAP #121; 355m
	0230	0930	(04-15.56S, 101-31.83E)	Radiosonde #178
	0236	0936	(04-15.54S, 101-31.76E)	CTD #140; 300m
	0258	0958	(04-15.59S, 101-31.82E)	TurboMAP #122; 353m
	0530	1230	(04-15.86S, 101-31.60E)	Radiosonde #179
	0534	1234	(04-15.79S, 101-31.53E)	CTD #141; 500m (with sampling seawater)
	0622	1322	(04-15.82S, 101-31.58E)	TurboMAP #123; 397m
	0825	1525	(04-14.70S, 101-31.71E)	Radiosonde #180
	0830	1530	(04-14.65S, 101-31.64E)	CTD #142; 300m
	0852	1552	(04-14.63S, 101-31.61E)	TurboMAP #124; 341m
	0930	1630	(04-14.52S, 101-31.58E)	Radiosonde #181
	1030	1730	(04-14.54S, 101-31.45E)	Radiosonde #182
	1130	1830	(04-14.50S, 101-31.49E)	Radiosonde #183
	1134	1834	(04-14.54S, 101-31.53E)	CTD #143; 300m (with sampling seawater)
	1222	1922	(04-14.61S, 101-31.77E)	TurboMAP #125; 339m
	1230	1930	(04-14.63S, 101-31.72E)	Radiosonde #184
	1330	2030	(04-15.07S, 101-31.85E)	Radiosonde #185
	1430	2130	(04-15.33S, 101-31.62E)	Radiosonde #186
	1434	2134	(04-15.34S, 101-31.58E)	CTD #144; 300m
	1456	2156	(04-15.39S, 101-31.64E)	TurboMAP #126; 360m
	1530	2230	(04-15.20S, 101-31.71E)	Radiosonde #187
	1630	2330	(04-14.75S, 101-31.72E)	Radiosonde #188
	1725	0025	(04-14.58S, 101-31.73E)	Radiosonde #189
	1730	0030	(04-14.45S, 101-31.68E)	CTD #145; 300m (with sampling seawater)
	1814	0114	(04-14.64S, 101-31.58E)	TurboMAP #127; 353m
	2030	0330	(04-14.32S, 101-31.32E)	Radiosonde #190

	2034	0334	(04-14.28S, 101-31.18E)	CTD #146; 300m
	2056	0356	(04-14.28S, 101-31.26E)	TurboMAP #128; 351m
	2330	0630	(04-15.12S, 101-32.22E)	Radiosonde #191
	2335	0635	(04-15.19S, 101-32.12E)	CTD #147; 300m (with sampling seawater)
Dec 21	0016	0716	(04-15.26S, 101-32.14E)	TurboMAP #129; 372m
	0220	0920	(04-15.42S, 101-31.04E)	Radiosonde #192
	0228	0928	(04-15.42S, 101-30.89E)	CTD #148; 300m
	0250	0950	(04-15.56S, 101-30.84E)	TurboMAP #130; 358m
	0530	1230	(04-13.58S, 101-31.03E)	Radiosonde #193
	0535	1235	(04-13.72S, 101-30.96E)	CTD #149; 500m (with sampling seawater)
	0623	1323	(04-14.08S, 101-30.93E)	TurboMAP #131; 393m
	0830	1530	(04-14.90S, 101-30.82E)	Radiosonde #194
	0834	1534	(04-14.91S, 101-30.73E)	CTD #150; 300m
	0856	1556	(04-15.04S, 101-30.55E)	TurboMAP #132; 378m
	0930	1630	(04-14.98S, 101-30.50E)	Radiosonde #195
	1030	1730	(04-13.94S, 101-31.02E)	Radiosonde #196
	1130	1830	(04-14.31S, 101-31.21E)	Radiosonde #197
	1135	1835	(04-14.38S, 101-31.13E)	CTD #151; 300m (with sampling seawater)
	1219	1919	(04-14.61S, 101-31.16E)	TurboMAP #133; 352m
	1230	1930	(04-14.61S, 101-31.16E)	Radiosonde #198
	1330	2030	(04-15.09S, 101-31.47E)	Radiosonde #199
	1430	2130	(04-15.14S, 101-31.27E)	Radiosonde #200
	1436	2136	(04-15.26S, 101-31.24E)	CTD #152; 300m
	1455	2155	(04-15.41S, 101-31.39E)	TurboMAP #134; 348m
	1530	2230	(04-15.27S, 101-31.45E)	Radiosonde #201
	1630	2330	(04-14.53S, 101-31.61E)	Radiosonde #202
	1730	0030	(04-14.85S, 101-31.89E)	Radiosonde #203
	1733	0033	(04-14.90S, 101-31.81E)	CTD #153; 300m (with sampling seawater)
	1819	0119	(04-15.09S, 101-31.69E)	TurboMAP #135; 385m
	2030	0330	(04-15.12S, 101-31.16E)	Radiosonde #204
	2035	0335	(04-15.22S, 101-31.03E)	CTD #154; 300m
	2057	0357	(04-15.31S, 101-31.16E)	TurboMAP #136; 353m
	2330	0630	(04-14.67S, 101-32.27E)	Radiosonde #205
	2335	0635	(04-14.74S, 101-32.22E)	CTD #155; 300m (with sampling seawater)
Dec 22	0015	0715	(04-15.02S, 101-32.23E)	TurboMAP #137; 361m
	0230	0930	(04-14.25S, 101-32.20E)	Radiosonde #206
	0235	0935	(04-14.33S, 101-32.08E)	CTD #156; 300m
	0256	0956	(04-14.45S, 101-32.04E)	TurboMAP #138; 391m
	0527	1227	(04-15.50S, 101-31.06E)	Radiosonde #207
	0533	1233	(04-15.41S, 101-30.86E)	CTD #157; 500m (with sampling seawater)
	0622	1322	(04-15.56S, 101-30.46E)	TurboMAP #139; 377m
	0830	1530	(04-14.50S, 101-31.66E)	Radiosonde #208
	0834	1534	(04-14.40S, 101-31.53E)	CTD #158; 300m
	0856	1556	(04-14.44S, 101-31.40E)	TurboMAP #140; 382m
	0930	1630	(04-14.55S, 101-31.39E)	Radiosonde #209
	1030	1730	(04-14.93S, 101-31.14E)	Radiosonde #210
	1130	1830	(04-14.31S, 101-31.87E)	Radiosonde #211
	1134	1834	(04-14.30S, 101-31.79E)	CTD #159; 300m (with sampling seawater)
	1217	1917	(04-14.51S, 101-31.92E)	TurboMAP #141; 349m
	1230	1930	(04-14.52S, 101-31.93E)	Radiosonde #212
	1330	2030	(04-14.66S, 101-31.89E)	Radiosonde #213
	1430	2130	(04-14.76S, 101-31.42E)	Radiosonde #214
	1436	2136	(04-14.80S, 101-31.35E)	CTD #160; 300m
	1455	2155	(04-14.87S, 101-31.52E)	TurboMAP #142; 342m
	1543	2243	(04-14.35S, 101-31.66E)	Radiosonde #215
	1631	2331	(04-14.89S, 101-31.63E)	Radiosonde #216
	1720	0020	(04-15.41S, 101-31.70E)	Radiosonde #217
	1730	0030	(04-15.52S, 101-31.51E)	CTD #161; 300m (with sampling seawater)

	1815	0115	(04-15.96S, 101-31.37E)	TurboMAP #143; 371m
	2030	0330	(04-15.33S, 101-32.38E)	Radiosonde #218
	2033	0333	(04-15.32S, 101-32.37E)	CTD #162; 300m
	2055	0355	(04-15.45S, 101-32.25E)	TurboMAP #144; 357m
	2330	0630	(04-14.72S, 101-32.38E)	Radiosonde #219
	2335	0635	(04-14.81S, 101-32.23E)	CTD #163; 300m (with sampling seawater)
Dec 23	0016	0716	(04-15.12S, 101-32.07E)	TurboMAP #145; 376m
	0230	0930	(04-15.31S, 101-31.41E)	Radiosonde #220
	0235	0935	(04-15.34S, 101-31.32E)	CTD #164; 300m
	0257	0957	(04-15.37S, 101-31.24E)	TurboMAP #146; 402m
	0530	1230	(04-14.93S, 101-32.39E)	Radiosonde #221
	0534	1234	(04-14.95S, 101.32.40E)	CTD #165; 500m (with sampling seawater)
	0624	1324	(04-15.09S, 101-32.31E)	TurboMAP #147; 381m
	0830	1530	(04-14.55S, 101-32.04E)	Radiosonde #222
	0834	1534	(04-14.63S, 101-32.00E)	CTD #166; 299m
	0856	1556	(04-14.76S, 101-31.98E)	TurboMAP #148; 350m
	1130	1830	(04-14.77S, 101-31.61E)	Radiosonde #223
	1135	1835	(04-14.84S, 101-31.75E)	CTD #167; 300m (with sampling seawater)
	1219	1919	(04-14.62S, 101-32.27E)	TurboMAP #149; 350m
	1430	2130	(04-14.66S, 101-31.40E)	Radiosonde #224
	1434	2134	(04-14.66S, 101-31.57E)	CTD #168; 300m
	1455	2155	(04-14.62S, 101-31.76E)	TurboMAP #150; 369m
	1730	0030	(04-14.47S, 101-32.32E)	Radiosonde #225
	1733	0033	(04-14.58S, 101-32.47E)	CTD #169; 300m (with sampling seawater)
	1816	0116	(04-14.69S, 101-32.40E)	TurboMAP #151; 383m
	2030	0330	(04-13.68S, 101-31.93E)	Radiosonde #226
	2034	0334	(04-13.59S, 101-32.07E)	CTD #170; 300m
	2056	0356	(04-13.53S, 101-31.95E)	TurboMAP #152; 362m
	2330	0630	(04-14.37S, 101-30.86E)	Radiosonde #227
	2334	0634	(04-14.20S, 101-30.96E)	CTD #171; 300m (with sampling seawater)
Dec 24	0015	0715	(04-13.76S, 101-31.06E)	TurboMAP #153; 392m
	0230	0930	(04-13.92S, 101-31.22E)	Radiosonde #228
	0234	0934	(04-13.82S, 101-31.33E)	CTD #172; 300m
	0255	0955	(04-13.71S, 101-31.39E)	TurboMAP #154; 408m
	0530	1230	(04-13.42S, 101-31.26E)	Radiosonde #229
	0531	1231	(04-13.34S, 101-31.32E)	CTD #173; 500m (with sampling seawater)
	0619	1319	(04-13.11S, 101-31.48E)	TurboMAP #155; 408m
	0830	1530	(04-13.28S, 101-31.01E)	Radiosonde #230
	0831	1531	(04-13.16S, 101-31.01E)	CTD #174; 300m
	0853	1553	(04-12.96S, 101-30.98E)	TurboMAP #156; 367m
	0930	1630	(04-12.78S, 101-31.06E)	Radiosonde #231
	1030	1730	(04-15.25S, 101-30.61E)	Radiosonde #232
	1130	1830	(04-14.57S, 101-31.56E)	Radiosonde #233
	1131	1831	(04-14.42S, 101-31.51E)	CTD #175; 300m (with sampling seawater)
	1218	1918	(04-13.74S, 101-31.28E)	TurboMAP #157; 339m
	1230	1930	(04-13.94S, 101-31.28E)	Radiosonde #234
	1330	2030	(04-14.14S, 101-30.74E)	Radiosonde #235
	1430	2130	(04-15.03S, 101-31.32E)	Radiosonde #236
	1436	2136	(04-14.88S, 101-31.33E)	CTD #176; 300m
	1457	2157	(04-14.74S, 101-31.18E)	TurboMAP #158; 340m
	1530	2230	(04-14.63S, 101-31.15E)	Radiosonde #237
	1630	2330	(04-14.38S, 101-31.79E)	Radiosonde #238
	1730	0030	(04-14.05S, 101-32.30E)	Radiosonde #239
	1733	0033	(04-13.97S, 101-32.14E)	CTD #177; 300m (with sampling seawater)
	1820	0120	(04-14.08S, 101-31.83E)	TurboMAP #159; 360m
	2030	0330	(04-14.76S, 101-29.98E)	Radiosonde #240
	2032	0332	(04-14.66S, 101-29.97E)	CTD #178; 300m
	2056	0356	(04-14.54S, 101-29.73E)	TurboMAP #160; 355m

	2330	0630	(04-14.74S, 101-31.82E)	Radiosonde #241
	2332	0632	(04-14.69S, 101-31.82E)	CTD #179; 300m (with sampling seawater)
Dec 25	0012	0712	(04-14.47S, 101-31.86E)	TurboMAP #161; 393m
	0230	0930	(04-14.87S, 101-30.15E)	Radiosonde #240
	0234	0934	(04-14.87S, 101-30.22E)	CTD #180; 300m
	0259	0959	(04-14.81S, 101-30.21E)	TurboMAP #162; 402m
	0533	1233	(04-14.06S, 101-31.17E)	Radiosonde #243
	0537	1237	(04-14.08S, 101-30.99E)	CTD #181; 500m (with sampling seawater)
	0625	1325	(04-14.22S, 101-30.73E)	TurboMAP #163; 374m
	0830	1530	(04-14.62S, 101-30.98E)	Radiosonde #244
	0831	1531	(04-14.58S, 101-30.92E)	CTD #182; 300m
	0853	1553	(04-14.63S, 101-30.85E)	TurboMAP #164; 387m
	0930	1630	(04-13.09S, 101-30.64E)	Radiosonde #245
	1030	1730	(04-14.51S, 101-30.75E)	Radiosonde #246
	1130	1830	(04-14.81S, 101-30.73E)	Radiosonde #247
	1134	1834	(04-14.86S, 101-30.67E)	CTD #183; 300m (with sampling seawater)
	1218	1918	(04-14.93S, 101-30.90E)	TurboMAP #165; 356m
	1230	1930	(04-14.94S, 101-30.93E)	Radiosonde #248
	1330	2030	(04-15.55S, 101-30.70E)	Radiosonde #249
	1430	2130	(04-14.43S, 101-30.61E)	Radiosonde #250
	1435	2135	(04-14.48S, 101-30.60E)	CTD #184; 300m
	1458	2158	(04-14.64S, 101-30.69E)	TurboMAP #166; 367m
	1539	2230	(04-14.58S, 101-30.70E)	Radiosonde #251
	1630	2330	(04-14.05S, 101-30.93E)	Radiosonde #252
	1730	0030	(04-13.71S, 101-31.43E)	Radiosonde #253
	1733	0033	(04-13.76S, 101-31.28E)	CTD #185; 300m (with sampling seawater)
	1819	0119	(04-14.26S, 101-31.29E)	TurboMAP #167; 349m
	2030	0330	(04-15.15S, 101-30.92E)	Radiosonde #254
	2033	0333	(04-15.25S, 101-30.80E)	CTD #186; 300m
	2056	0356	(04-15.55S, 101-30.74E)	TurboMAP #168; 351m
	2330	0630	(04-14.35S, 101-31.32E)	Radiosonde #255
	2334	0634	(04-14.35S, 101-31.32E)	CTD #187; 300m (with sampling seawater)
Dec 26	0013	0713	(04-14.44S, 101-30.97E)	TurboMAP #169; 368m
	0230	0930	(04-14.17S, 101-32.04E)	Radiosonde #256
	0234	0934	(04-14.13S, 101-31.95E)	CTD #188; 300m
	0258	0958	(04-14.23S, 101-31.88E)	TurboMAP #170; 405m
	0530	1230	(04-15.09S, 101-31.73E)	Radiosonde #257
	0534	1234	(04-15.13S, 101-31.66E)	CTD #189; 500m (with sampling seawater)
	0621	1321	(04-15.17S, 101-31.45E)	TurboMAP #171; 396m
	0648	1348		Start taking care of Sea-snake
	0655	1355		End taking care of Sea-snake
	0830	1530	(04-15.17S, 101-31.67E)	Radiosonde #258
	0835	1535	(04-15.18S, 101-31.73E)	CTD #190; 300m
	0856	1556	(04-15.29S, 101-31.64E)	TurboMAP #172; 392m
	0925	1625	(04-15.36S, 101-31.58E)	Radiosonde #259
	1030	1730	(04-14.58S, 101-31.44E)	Radiosonde #260
	1130	1830	(04-14.57S, 101-31.70E)	Radiosonde #261
	1133	1833	(04-14.67S, 101-31.67E)	CTD #191; 300m (with sampling seawater)
	1217	1917	(04-15.10S, 101-31.50E)	TurboMAP #173; 341m
	1230	1930	(04-15.19S, 101-31.50E)	Radiosonde #262
	1330	2030	(04-15.07S, 101-32.02E)	Radiosonde #263
	1430	2130	(04-14.68S, 101-31.63E)	Radiosonde #264
	1434	2134	(04-14.67S, 101-31.62E)	CTD #192; 300m
	1456	2156	(04-14.84S, 101-31.59E)	TurboMAP #174; 378m
	1530	2230	(04-14.93S, 101-31.82E)	Radiosonde #265
	1630	2330	(04-15.29S, 101-31.89E)	Radiosonde #266
	1730	0030	(04-14.80S, 101-31.59E)	Radiosonde #267
	1734	0034	(04-15.00S, 101-31.58E)	CTD #193; 300m (with sampling seawater)

	1817	0117	(04-15.43S, 101-31.79E)	TurboMAP #175; 343m
	2030	0330	(04-14.83S, 101-32.05E)	Radiosonde #268
	2033	0333	(04-14.87S, 101-32.09E)	CTD #194; 300m
	2055	0355	(04-15.11S, 101-32.15E)	TurboMAP #176; 365m
	2330	0630	(04-14.60S, 101-31.62E)	Radiosonde #269
	2334	0634	(04-14.59S, 101-31.61E)	CTD #195; 300m (with sampling seawater)
Dec 27	0012	0712	(04-14.72S, 101-31.62E)	TurboMAP #177; 388m
	0230	0930	(04-14.45S, 101-31.73E)	Radiosonde #270
	0234	0934	(04-14.37S, 101-31.74E)	CTD #196; 300m
	0257	0957	(04-14.43S, 101-31.71E)	TurboMAP #178; 419m
	0530	1230	(04-14.67S, 101-32.20E)	Radiosonde #271
	0534	1234	(04-14.90S, 101-32.34E)	CTD #197; 500m (with sampling seawater)
	0622	1322	(04-15.40S, 101-32.78E)	TurboMAP #179; 425m
	0830	1530	(04-14.36S, 101-31.91E)	Radiosonde #272
	0837	1537	(04-14.36S, 101-31.98E)	CTD #198; 300m
	0858	1558	(04-14.54S, 101-31.98E)	TurboMAP #180; 379m
	1130	1830	(04-13.87S, 101-31.16E)	Radiosonde #273
	1134	1834	(04-13.91S, 101-31.13E)	CTD #199; 300m (with sampling seawater)
	1219	1919	(04-14.19S, 101-31.23E)	TurboMAP #181; 365m
	1430	2130	(04-13.59S, 101-31.28E)	Radiosonde #274
	1434	2134	(04-13.63S, 101-31.29E)	CTD #200; 300m
	1457	2157	(04-13.77S, 101-31.33E)	TurboMAP #182; 388m (1st cast)
	1516	2216	(04-13.98S, 101-31.42E)	TurboMAP #182; 370m (2nd cast due to data noise in the 1st cast)
	1730	0030	(04-14.29S, 101-31.97E)	Radiosonde #275
	1734	0034	(04-14.42S, 101-32.03E)	CTD #201; 300m (with sampling seawater)
	1820	0120	(04-14.84S, 101-32.24E)	TurboMAP #183; 356m
	2030	0330	(04-14.31S, 101-31.47E)	Radiosonde #276
	2033	0333	(04-14.43S, 101-31.52E)	CTD #202; 300m
	2056	0356	(04-14.63S, 101-31.70E)	TurboMAP #184; 366m
	2330	0630	(04-14.16S, 101-31.31E)	Radiosonde #277
	2335	0635	(04-14.14S, 101-31.28E)	CTD #203; 300m (with sampling seawater)
Dec 28	0013	0713	(04-14.38S, 101-31.36E)	TurboMAP #185; 385m
	0230	0930	(04-13.89S, 101-30.59E)	Radiosonde #278
	0236	0936	(04-13.74S, 101-30.84E)	CTD #204; 300m
	0258	0958	(04-13.65S, 101-31.00E)	TurboMAP #186; 363m
	0530	1230	(04-13.76S, 101-30.75E)	Radiosonde #279
	0534	1234	(04-13.76S, 101-30.73E)	CTD #205; 500m (with sampling seawater)
	0622	1322	(04-13.99S, 101-30.81E)	TurboMAP #187; 406m
	0830	1530	(04-13.64S, 101-31.36E)	Radiosonde #280
	0835	1535	(04-13.63S, 101-31.34E)	CTD #206; 300m
	0856	1556	(04-13.81S, 101-31.36E)	TurboMAP #188; 407m
	0930	1630	(04-13.90S, 101-31.45E)	Radiosonde #281
	1030	1730	(04-13.95S, 101-31.34E)	Radiosonde #282
	1130	1830	(04-14.26S, 101-31.19E)	Radiosonde #283
	1134	1834	(04-14.28S, 101-31.10E)	CTD #207; 300m (with sampling seawater)
	1215	1915	(04-14.46S, 101-31.22E)	TurboMAP #189; 353m
	1230	1930	(04-14.52S, 101-31.24E)	Radiosonde #284
	1330	2030	(04-14.18S, 101-31.10E)	Radiosonde #285
	1430	2130	(04-13.83S, 101-30.84E)	Radiosonde #286
	1435	2135	(04-13.84S, 101-30.79E)	CTD #208; 300m
	1457	2157	(04-13.92S, 101-30.84E)	TurboMAP #190; 393m
	1530	2230	(04-13.87S, 101-30.96E)	Radiosonde #287
	1630	2330	(04-13.99S, 101-30.65E)	Radiosonde #288
	1730	0030	(04-13.26S, 101-31.37E)	Radiosonde #289
	1733	0033	(04-13.24S, 101-31.32E)	CTD #209; 300m (with sampling seawater)
	1817	0117	(04-13.50S, 101-31.41E)	TurboMAP #191; 358m
	2030	0330	(04-14.47S, 101-30.99E)	Radiosonde #290

	2033	0333	(04-14.50S, 101-30.97E)	CTD #210; 300m
	2056	0356	(04-14.70S, 101-31.04E)	TurboMAP #192; 370m
	2330	0630	(04-13.95S, 101-31.04E)	Radiosonde #291
	2336	0636	(04-13.94S, 101-30.95E)	CTD #211; 300m (with sampling seawater)
Dec 29	0014	0714	(04-14.12S, 101-31.02E)	TurboMAP #193; 379m
	0230	0930	(04-14.52S, 101-29.82E)	Radiosonde #292
	0236	0936	(04-14.48S, 101-29.71E)	CTD #212; 300m
	0258	0958	(04-14.63S, 101-29.71E)	TurboMAP #194; 389m
	0530	1230	(04-13.48S, 101-31.90E)	Radiosonde #293
	0535	1235	(04-13.60S, 101-31.78E)	CTD #213; 500m (with sampling seawater)
	0623	1323	(04-13.06S, 101-31.75E)	TruboMAP #195; 372m
	0830	1530	(04-14.73S, 101-31.37E)	Radiosonde #294
	0834	1534	(04-14.75S, 101-31.34E)	CTD #214; 300m
	0855	1555	(04-14.96S, 101-31.35E)	TurboMAP #196; 385m
	0930	1630	(04-15.00S, 101-31.48E)	Radiosonde #295
	1030	1730	(04-14.63S, 101-31.43E)	Radiosonde #296
	1130	1830	(04-14.36S, 101-31.18E)	Radiosonde #297
	1134	1834	(04-14.52S, 101-31.17E)	CTD #215; 300m (with sampling seawater)
	1218	1918	(04-14.93S, 101-31.62E)	TurboMAP #197; 342m
	1230	1930	(04-14.93S, 101-31.67E)	Radiosonde #298
	1331	2031	(04-14.40S, 101-31.21E)	Radiosonde #299
	1430	2130	(04-14.11S, 101-31.01E)	Radiosonde #300
	1434	2134	(04-14.27S, 101-30.97E)	CTD #216; 300m
	1457	2157	(04-14.50S, 101-31.65E)	TurboMAP #198; 337m
	1530	2230	(04-14.55S, 101-31.29E)	Radiosonde #301
	1630	2330	(04-14.08S, 101-31.99E)	Radiosonde #302
	1730	0030	(04-14.32S, 101-31.58E)	Radiosonde #303
	1733	0033	(04-14.37S, 101-31.51E)	CTD #217; 300m (with sampling seawater)
	1818	0118	(04-14.92S, 101-31.61E)	TurboMAP #199; 340m
	2020	0320	(04-14.??S, 101-32.??E)	Radiosonde #304
	2030	0330	(04-14.43S, 101-32.10E)	CTD #218: 300m
	2052	0352	(04-14.70S, 101-32.09E)	TurboMAP #200; 335m
	2330	0630	(04-14.16S, 101-31.23E)	Radiosonde #305
	2334	0634	(04-14.23S, 101-31.18E)	CTD #219; 300m (with sampling seawater)
Dec 30	0013	0713	(04-14.69S, 101-31.27E)	TurboMAP #201; 350m
	0230	0930	(04-13.94S, 101-30.76E)	Radiosonde #306
	0236	0936	(04-13.92S, 101-30.69E)	CTD #220; 300m
	0259	0959	(04-14.07S, 101-30.69E)	TurboMAP #202; 374m
	0530	1230	(04-14.53S, 101-31.37E)	Radiosonde #307
	0534	1234	(04-14.60S, 101-31.33E)	CTD #221; 500m (with sampling seawater)
	0621	1321	(04-14.96S, 101-31.25E)	TurboMAP #203; 402m
	0654	1354	(04-15.02S, 101-31.20E)	Recovery of Sea-snake
	0722	1422	(04-16.01S, 101-32.09E)	Recovery of wave glider
	0810	1510	(04-16.15S, 101-31.98E)	Deployment of Sea-snake
	0830	1530	(04-15.48S, 101-31.94E)	Radiosonde #308
	0835	1535	(04-15.51S, 101-31.88E)	CTD #222; 300m
	0857	1557	(04-15.68S, 101-31.89E)	TurboMAP #204; 380m
	0930	1630	(04-15.64S, 101-31.85E)	Radiosonde #309
	1030	1730	(04-14.44S, 101-31.71E)	Radiosonde #310
	1130	1830	(04-14.32S, 101-31.25E)	Radiosonde #311
	1134	1834	(04-14.47S, 101-31.30E)	CTD #223; 301m (with sampling seawater)
	1216	1916	(04-14.79S, 101-31.72E)	TurboMAP #205; 347m
	1230	1930	(04-14.85S, 101-31.77E)	Radiosonde #312
	1330	2030	(04-14.66S, 101-31.56E)	Radiosonde #313
	1430	2130	(04-14.28S, 101-31.07E)	Radiosonde #314
	1435	2135	(04-14.33S, 101-31.01E)	CTD #224; 300m
	1457	2157	(04-14.48S, 101-31.04E)	TurboMAP #206; 372m
	1530	2230	(04-14.70S, 101-31.18E)	Radiosonde #315

	1631	2331	(04-15.04S, 101-31.98E)	Radiosonde #316
	1738	0038	(04-14.84S, 101-31.72E)	Radiosonde #317
	1742	0042	(04-14.76S, 101-31.82E)	CTD #225; 300m (with sampling seawater)
	1825	0125	(04-14.85S, 101-31.58E)	TurboMAP #207; 360m
	2030	0330	(04-14.25S, 101-31.54E)	Radiosonde #318
	2033	0333	(04-14.45S, 101-31.70E)	CTD #226; 300m
	2056	0356	(04-14.53S, 101-31.88E)	TurboMAP #208; 345m
	2330	0630	(04-14.27S, 101-31.10E)	Radiosonde #319
	2336	0636	(04-14.20S, 101-31.06E)	CTD #227; 300m (with sampling seawater)
Dec 31	0014	0714	(04-14.29S, 101-31.10E)	TurboMAP #209; 398m
	0230	0930	(04-13.74S, 101-31.99E)	Radiosonde #320
	0233	0933	(04-13.76S, 101-31.06E)	CTD #228; 300m
	0255	0955	(04-13.70S, 101-31.14E)	TurboMAP #210; 370m
	0530	1230	(04-14.68S, 101-31.18E)	Radiosonde #321
	0535	1235	(04-14.76S, 101-31.12E)	CTD #229; 500m (with sampling seawater)
	0624	1324	(04-14.94S, 101-31.37E)	TurboMAP #211; 347m
	0830	1530	(04-13.39S, 101-31.39E)	Radiosonde #322
	0834	1534	(04-13.44S, 101-31.37E)	CTD #230; 300m
	0857	1557	(04-13.56S, 101-31.46E)	TurboMAP #212; 369m
	1130	1830	(04-14.33S, 101-31.29E)	Radiosonde #323
	1134	1834	(04-14.37S, 101-31.32E)	CTD #231; 300m
	1155	1855	(04-14.43S, 101-31.58E)	TurboMAP #213; 328m
	1430	2130	(04-14.66S, 101-31.33E)	Radiosonde #324
	1434	2134	(04-14.73S, 101-31.40E)	CTD #232; 300m
	1455	2155	(04-14.79S, 101-31.59E)	TurboMAP #214; 337m
	1730	0030	(04-13.82S, 101-31.47E)	Radiosonde #325
	1734	0034	(04-13.96S, 101-31.60E)	CTD #233; 300m
	1756	0056	(04-14.02S, 101-31.77E)	TurboMAP #215; 339m
	2034	0334	(04-13.35S, 101-31.61E)	Radiosonde #326
	2038	0338	(04-13.33S, 101-31.86E)	CTD #234; 300m
	2100	0400	(04-13.34S, 101-32.11E)	TurboMAP #216; 348m
	2330	0630	(04-14.24S, 101-31.52E)	Radiosonde #327
	2336	0636	(04-14.78S, 101-31.46E)	CTD #235; 300m
	2358	0658	(04-14.37S, 101-31.42E)	TurboMAP #217; 377m
Jan 01	0232	0932	(04-14.42S, 101-30.97E)	Radiosonde #328
	0237	0937	(04-14.37S, 101-30.99E)	XCTD #3
	0530	1230	(04-14.13S, 101-31.52E)	Radiosonde #329
	0537	1237	(04-14.14S, 101-31.57E)	XCTD #4
	0600	1300	(04-13.89S, 101-31.85E)	Recovery of Sea-snake
	0630	1330		Departure from the stationary point
	0830	1530	(04-02.23S, 101-55.68E)	Radiosonde #330
	0909	1609	(04-00.00S, 101-39.99E)	XCTD #5
	1006	1706	(04-05.01S, 101-50.01E)	UCTD #14; 500m
	1104	1804	(04-09.79S, 101-40.43E)	UCTD #15; 500m
	1130	1830	(04-09.78S, 101-39.50E)	Radiosonde #331
	1226	1926	(04-14.58S, 101-30.84E)	UCTD #16; 500m
	1325	2025	(04-19.21S, 101-21.60E)	XCTD #6
	1351	2051	(04-21.60S, 101-16.80E)	XCTD #7
	1417	2117	(04-24.00S, 101-12.00E)	XCTD #8
	1430	2130	(04-23.72S, 101-11.53E)	Radiosonde #332
	1509	2209	(04-26.40S, 101-07.20E)	XCTD #9
	1605	2305	(04-31.36S, 100-57.28E)	UCTD #17; 500m
	1707	0007	(04-36.17S, 100-47.68E)	UCTD #18; 500m
	1730	0030	(04-37.53S, 100-46.28E)	Radiosonde #333
	1824	0124	(04-40.97S, 100-38.09E)	UCTD #19; 500m
	1923	0223	(04-45.75S, 100-28.47E)	UCTD #20; 500m
	2030	0330	(04-50.58S, 100-19.91E)	Radiosonde #334
	2041	0341	(04-50.56S, 100-18.86E)	UCTD #21; 500m

	2141	0441	(04-55.36S, 100-09.26E)	UCTD #22; 500m
	2240	0540	(05-00.62S, 100-01.99E)	UCTD #23; 500m
	2330	0630	(05-01.07S, 100-01.70E)	Radiosonde #335
Jan 02	0900	1600		Departure from Sumatra buoy point
Jan 03	0200	0900		Stop sea surface water monitoring
	0900	1600		Stop C-band radar observation
Jan 04	0300	1000		Arrival at Jakarta (End of Leg 1)
Jan 06	0240	0940		Departure from Jakarta (Start of Leg 2)
	0550	1250		Start C-band radar observation
	0800	1500		Start sea surface water monitoring
	1130	1830	(05-34.49S, 108-42.06E)	Radiosonde #336
	1730	0030	(05-32.92S, 110-14.55E)	Radiosonde #337
	2329	0629	(05-18.00S, 111-40.77E)	Radiosonde #338
Jan 07	0530	1230	(05-36.22S, 113-05.63E)	Radiosonde #339
	1130	1830	(05-59.13S, 114-31.68E)	Radiosonde #340
	1730	0030	(06-09.77S, 115-53.32E)	Radiosonde #341
	2337	0637	(05-38.23S, 117-01.83E)	Radiosonde #342
Jan 08	0530	1230	(04-35.14S, 117-45.40E)	Radiosonde #343
	1130	1830	(03-29.38S, 118-29.04E)	Radiosonde #344
	1730	0030	(02-06.79S, 118-43.15E)	Radiosonde #345
	2330	0630	(00-37.82S, 119-07.42E)	Radiosonde #346
Jan 09	0530	1230	(00-25.36S, 119-31.28E)	Radiosonde #347
	1130	1830	(01-24.40N, 120-09.76E)	Radiosonde #348
	1730	0030	(02-06.69N, 121-10.90E)	Radiosonde #349
	2330	0630	(02-44.11N, 122-09.59E)	Radiosonde #350
Jan 10	0530	1230	(03-23.00N, 123-06.47E)	Radiosonde #351
	1130	1830	(04-01.58N, 124-03.08E)	Radiosonde #352
	1731	0031	(04-41.53N, 125-02.00E)	Radiosonde #353
	2330	0630	(05-02.08N, 126-16.64E)	Radiosonde #354
Jan 11	0530	1230	(05-52.81N, 127-21.79E)	Radiosonde #355
	0700	1400		Stop C-band radar observation
	0730	1430		Stop continuous observations Enter Philippine EEZ
	1500	----		Revision of ship mean time (to UTC+8hr)
Jan 12	0030	0830		Departure from Philippines EEZ Start continuous observations
Jan 14	1400	----		Revision of ship mean time (to UTC+9hr)
Jan 17	0530	1430		Stop sea surface water monitoring Stop SeaBeam
	0730	1630		Stop C-band radar observation
	2350	0850		Arrival at Shimizu, Japan (End of Leg 2)

4. List of Participants

4.1 Participants (on board)

Name	Affiliation	Theme No.*	onboard sections**
Satoru YOKOI	JAMSTEC	M	abc
Qoosaku MOTEKI	JAMSTEC	M	b
Daisuke TAKASUGA	JAMSTEC	M	b
Iwao UEKI	JAMSTEC	M	b
Takanori HORII	JAMSTEC	M	b
Masaki KATSUMATA	JAMSTEC	M	b
Biao GENG	JAMSTEC	M	b
Kyoko TANIGUCHI	JAMSTEC	M	b
Kazuhiko MATSUMOTO	JAMSTEC	M	b
Makito YOKOTA	JAMSTEC	M	b
Yoshiyuki NAKANO	JAMSTEC	M	a
Kelvin J. Richards	IPRC / Univ. Hawaii	M	b
Alfi RUSDIANSYAH	BPPT	M	b
Roni KURNIAWAN	BMKG	M	b
Fadli SYAMSUDIN	BPPT	M	c
Yuki TAKANO	Univ. Tokyo	2	b
Yuhi NAKAMURA	Univ. Tokyo	2	b
Shuhei MATSUGISHI	Univ. Tokyo	3	b
Taisei IIDA	Toyama Univ.	4	b
Souichiro SUEYOSHI	Nippon Marine Enterprise Inc. (NME)	T	b
Shinya OKUMURA	NME	T	a
Wataru TOKUNAGA	NME	T	b
Ryo OYAMA	NME	T	bc
Miki TAWATA	NME	T	bc
Kenichi KATAYAMA	Marine Works Japan Ltd. (MWJ)	T	b
Hiroki USHIROMURA	MWJ	T	b
Akira WATANABE	MWJ	T	b
Rei ITO	MWJ	T	b
Keisuke TAKEDA	MWJ	T	b
Rio KOBAYASHI	MWJ	T	b
Masaki YAMADA	MWJ	T	b
Kai FUKUDA	MWJ	T	b
Masanori ENOKI	MWJ	T	bc
Yoshiko ISHIKAWA	MWJ	T	b
Yasuhiro ARII	MWJ	T	b
Hiroshi HOSHINO	MWJ	T	ab
Atsushi ONO	MWJ	T	b
Erii Irie	MWJ	T	b

* "Theme number" corresponds to that shown in Section 2.7.
M and T means main mission and technical staff, respectively.

** Characters at "onboard section" indicate as follows:
a: Nakagusuku - Singapore
b: Singapore - Jakarta
c: Jakarta - Shimizu

4.2 Participants (not on board)

Name	Affiliation	*Theme No.
Kunio YONEYAMA	JAMSTEC	M
Shuhei MASUDA	JAMSTEC	1
Kei YOSHIMURA	Univ. Tokyo	2
Hiroaki MIURA	Univ. Tokyo	3
Kazuaki YASUNAGA	Toyama Univ.	4
Tetsuya TAKEMI	Kyoto Univ.	5
Kazuma AOKI	Toyama Univ.	6

4.3 Ship Crew

Name	Occupation	onboard sections*
Toshihisa AKUTAGAWA	Master	abc
Akimasa TSUJI	Chief Officer	abc
Yuki FURUKAWA	First Officer	abc
Haruhiko INOUE	Jr. First Officer	ab
Akihiro NUNOME	Second Officer	abc
Shintaro KAN	Third Officer	abc
Yoichi FURUKAWA	Chief Engineer	abc
Jun TAKAHASHI	First Engineer	abc
Hiroki TANAKA	Second Engineer	a
Kenta IKEGUCHI	Second Engineer	bc
Akihiro DEMURA	Third Engineer	abc
Masanori MURAKAMI	Chief Radio Operator	abc
Yosuke KUWAHARA	Boatswain	abc
Kazuyoshi KUDO	Quarter Master	abc
Tsuyoshi SATO	Quarter Master	abc
Tsuyoshi MONZAWA	Quarter Master	abc
Masashige OKADA	Quarter Master	ab
Shuji KOMATA	Quarter Master	bc
Hideaki TAMOTSU	Quarter Master	abc
Saikan HIRAI	Quarter Master	ab
Masaya TANIKAWA	Quarter Master	abc
Shohei UEHARA	Quarter Master	abc
Hideyuki OKUBO	Sailor	abc
Kazumi YAMASHITA	No.1 Oiler	abc
Fumihito KAIZUKA	Oiler	bc
Toshiyuki FURUKI	Oiler	abc
Daisuke TANIGUCHI	Oiler	abc
Shintaro ABE	Oiler	a
Keisuke YOSHIDA	Oiler	abc
Kazuya ANDO	Assistant Oiler	abc
Kiyotaka KOSUJI	Chief Steward	abc
Sakae HOSHIKUMA	Steward	abc
Yukio CHIBA	Steward	abc
Toshiyuki ASANO	Steward	abc
Masanao KUNITA	Steward	abc
Koki SHINOHARA	Steward	ab

** Characters at "onboard section" indicate same as in Section 4.1.

5. Summary of Observations

5.1 GPS Radiosonde

(1) Personnel

Satoru YOKOI	(JAMSTEC)	- Principal Investigator
Masaki KATSUMATA	(JAMSTEC)	
Biao GENG	(JAMSTEC)	
Kyoko TANIGUCHI	(JAMSTEC)	
Daisuke TAKASUKA	(JAMSTEC)	
Yuki TAKANO	(Univ. Tokyo)	
Yuhi NAKAMURA	(Univ. Tokyo)	
Taisei IIDA	(Univ. Toyama)	
Souichiro SUEYOSHI	(NME)	- Operation Leader
Wataru TOKUNAGA	(NME)	
Ryo OYAMA	(NME)	
Miki TAWATA	(NME)	
Masanori MURAKAMI	(MIRAI Crew)	

(2) Objectives

To obtain atmospheric profile of temperature, humidity, and wind speed/direction from the surface up to lower stratosphere.

(3) Methods

The on-board radiosonde system manufactured by Vaisala Oyj was mainly used, which consists of processor (SPS-311), processing and recording software (MW41, ver. 2.2.1), GPS antenna (GA20), UHF antenna (RB21), ground check kit (RI45), pressure sensor for ground check (PTB-330), and balloon launcher (ASAP). GPS radiosonde sensors (RS-41SGP) were launched with balloons (Totex TA-200 or TA-350). In case the relative wind to the ship is not appropriate for the launch using ASAP, handy launch was selected.

In addition to the on-board system, two sets of radiosonde systems were brought into the vessel and used occasionally. Components of these systems are similar to the on-board system, except for the version of MW41 (ver. 2.3.0 and ver. 2.6.1). Furthermore, the system that employs MW41 ver. 2.6.1 comprises RI45b instead of RI45 and PTB-330.

After 5 times of training launches, the radiosondes were launched every 3 hours from 00UTC on Nov. 30, 2017, to 00UTC on Jan. 2, 2018. Additional radiosonde launches were performed at 10, 11, 13, 14, 16, and 17UTC on Dec. 19, 20, 21, 22, 24, 25, 26, 28, 29, and 30, 2017. During leg 2, 6-hourly radiosonde launches were performed from 12UTC on Jan. 6, 2018 to 06UTC on 11, 2018. In total, 355 soundings were carried out, as listed in Table 5.1-1.

(4) Preliminary Results

Figure 5.1-1 is time-height cross section of potential temperature anomaly from averages over the period plotted, relative humidity, and zonal and meridional wind components, during leg 1. Several basic parameters are derived from the sounding data and plotted in Fig. 5.1-2, such as column-integrated water vapor (CWV), convective available potential energy (CAPE), and convective inhibition (CIN). Vertical profiles of temperature and dew point temperature on a thermodynamic chart with wind profiles for individual soundings are attached in Appendix A.

(5) Data archive

Data were sent to the world meteorological community via Global Telecommunication System (GTS) through the Japan Meteorological Agency, immediately after each observation. Raw data is recorded in Vaisala original binary format during both ascent and descent. The ASCII data is also available. These raw datasets will be submitted to JAMSTEC Data Management Group (DMG). The corrected datasets will be available from DARWIN at http://www.godac.jamstec.go.jp/darwin/e.

(6) Acknowledgments

One of the additional radiosonde system was kindly provided by the Institute of Arctic Climate and Environmental Research (IACE) of JAMSTEC.

Table 5.1-1: Radiosonde launch log, with surface values and maximum height.

ID	Nominal time YYYYMMDDhh	Launched location		Surface values						Max height	Clouds	
		Lat	Lon	P	T	RH	WD	WS	SST			
		deg.N	deg.E	hPa	deg.C	%	deg.	m/s	deg.C	m	Amount	Types
RS001	2017112703	-4.64543	92.38173	1005.8	27.6	82	247	8.4	28.83	26650	9	As, Cu
RS002	2017112706	-5.10004	91.74122	1004.6	27.5	79	228	7.1	28.83	26201	10	Cu, As
RS003	2017112709	-5.61114	93.13948	1002.6	27.3	83	230	8.7	28.79	26737	10	As, Cu
RS004	2017112903	-8.08052	95.08767	1007.2	27.6	73	169	8.9	28.42	26360	8	Cu,As,Ac
RS005	2017112909	-7.76921	95.05030	1004.5	27.6	70	157	7.1	28.25	25643	10	As,Cu
RS006	2017113000	-4.94806	95.02287	1006.3	27.1	84	225	4.2	28.98	25136	5	Cu,As
RS007	2017113003	-4.94910	95.08993	1007.9	27.7	81	249	3.6	29.00	26144	7	Cu,As,Ac,Cs
RS008	2017113006	-4.94989	94.98004	1006.3	27.9	75	252	5.2	29.17	24624	8	Cu,As,Cs
RS009	2017113008	-4.93616	94.97344	1004.7	27.8	79	244	4.6	29.15	23108	5	Cu,As,Ci
RS010	2017113009	-4.93722	94.97314	1003.9	27.8	78	251	3.1	29.19	20466	5	Cu,As,Ci
RS011	2017113012	-5.08388	95.00465	1005.0	27.7	77	237	2.1	29.12	20756	1	Cu,As,Ci
RS012	2017113015	-5.12183	95.01995	1007.0	28.0	75	227	4.0	29.00	21940	1	Cs
RS013	2017113018	-5.10455	95.04283	1006.7	27.9	73	221	3.8	29.02	21458	4	As,Sc
RS014	2017113021	-5.11690	95.05399	1005.2	27.7	75	212	2.8	28.98	20495	8	Cu
RS015	2017120100	-5.10764	94.99889	1006.3	25.4	91	287	2.6	28.94	4375	8	Cu,As,Ac
RS016	2017120103	-5.08920	94.99360	1007.8	27.2	79	127	0.6	29.00	22288	3	Sc,As,Ci,Cu
RS017	2017120106	-5.06066	95.03047	1006.4	27.8	75	354	2.2	29.08	19818	8	Cu,Ac,As,Nb
RS018	2017120109	-5.07494	95.51488	1004.2	28.5	77	71	0.2	29.37	21348	8	Cb,Sc,As
RS019	2017120112	-5.08195	96.11765	1004.8	28.1	78	152	1.8	29.84	19079	9	Cb,Cu
RS020	2017120115	-5.07909	96.72639	1007.3	25.2	91	233	4.3	29.28	17769	10	Cu,Nb
RS021	2017120118	-5.06072	97.35844	1006.2	25.7	89	278	3.6	29.22	21190	9	Nb,Ac,Sc
RS022	2017120121	-5.04527	97.97581	1004.8	27.1	84	249	8.9	29.03	20647	7	Cu
RS023	2017120200	-5.02357	98.63759	1005.1	28.1	76	265	8.1	29.13	24162	6	Cu,Ac,As,Cb
RS024	2017120203	-5.01611	99.26231	1007.0	28.1	81	240	5.6	29.19	22757	5	Cu,Ci,Cc,As
RS025	2017120206	-5.00012	99.84541	1005.8	27.3	88	328	7.5	29.49	22357	9	Cu,Nb,Ac,As
RS026	2017120209	-4.86662	100.13168	1004.2	28.1	79	277	8.2	29.30	26569	7	Cb,Ac,Cu
RS027	2017120210	-4.86636	100.02613	1004.3	26.8	89	199	5.0	29.29	22622	4	Cb,As
RS028	2017120211	-4.86665	99.83760	1004.6	27.1	86	160	1.1	29.26	21506	7	Cu,Ac,Nb,Sc
RS029	2017120212	-4.98953	99.81186	1005.3	27.4	85	163	3.5	29.32	24286	2	Cb,As,Sc
RS030	2017120215	-5.12945	100.17537	1007.0	26.6	87	170	7.6	29.25	25041	10	Nb,Cu

RS031	2017120218	-5.05190	100.05965	1006.5	25.6	91	125	5.1	29.20	23455	9	Nb,As
RS032	2017120221	-5.08052	100.08541	1004.6	26.8	85	147	4.3	29.19	21901	8	Cb,As,Cu
RS033	2017120300	-5.05474	100.05779	1005.2	27.7	81	175	6.4	29.15	24865	8	Cu,As,Cb
RS034	2017120303	-5.03331	100.06606	1007.2	27.5	83	183	8.3	29.15	26604	10	Cu,Nb,Sc,As
RS035	2017120306	-4.99888	99.99753	1006.6	25.4	92	0	3.4	29.04	27202	10	Cu,Nb,Sc
RS036	2017120309	-4.99165	100.00352	1005.1	25.7	90	274	3.0	28.88	26560	10	Cb,Cu,Sc
RS037	2017120312	-4.99686	100.03129	1004.7	25.6	94	243	9.3	28.83	20661	10	Sc
RS038	2017120315	-4.99529	100.01426	1007.3	26.9	86	240	6.4	28.78	22659	10	As
RS039	2017120318	-4.87192	100.25643	1006.8	27.6	73	249	4.7	28.82	199	unknown	unknown
RS040	2017120318	-4.84123	100.32041	1006.3	27.6	73	254	6.6	28.82	20710	9	As,Sc,Ac
RS041	2017120321	-4.76024	100.48291	1005.0	27.6	74	228	6.1	28.84	21867	8	Cu
RS042	2017120400	-4.68192	100.64355	1006.0	26.5	86	39	1.7	28.83	25208	9	Cu,Cb,Ns
RS043	2017120403	-4.55358	100.89387	1008.3	24.2	90	305	9.4	28.67	25643	10	Nb
RS044	2017120406	-4.44808	101.10470	1007.0	25.3	88	214	2.5	28.70	24468	10	Cu,Nb,Sc,As
RS045	2017120409	-4.32845	101.34355	1004.7	26.4	82	312	2.7	28.74	25065	7	As,Ci
RS046	2017120412	-4.23941	101.51965	1005.6	27.0	79	322	3.0	28.76	25002	7	As,Ci
RS047	2017120415	-4.16159	101.67623	1006.7	27.0	83	355	2.3	28.71	24318	9	As,Sc
RS048	2017120418	-4.02906	101.94302	1006.8	27.5	78	319	3.8	28.57	22843	9	As,Cs
RS049	2017120421	-4.07814	101.84101	1005.6	27.6	78	325	4.0	28.67	23844	3	As,Ac,Cu
RS050	2017120500	-4.23633	101.53537	1006.3	27.6	81	333	4.1	28.79	25204	8	Cb,As,Cu
RS051	2017120503	-4.23780	101.51539	1007.8	27.6	81	293	4.0	28.88	23489	9	Cu,Cb,Sc
RS052	2017120506	-4.21239	101.51866	1006.2	26.7	87	305	8.9	28.86	24554	9	Ac,Cu,Nb,Sc
RS053	2017120509	-4.21951	101.52431	1004.5	27.3	80	321	8.7	28.87	22941	5	Cu,Ac,Cb,As
RS054	2017120512	-4.23906	101.50061	1004.6	27.3	82	300	4.1	28.85	23667	3	As,Ci,Cu
RS055	2017120515	-4.23406	101.50439	1006.9	27.5	80	303	6.3	28.79	24482	4	As,Sc
RS056	2017120518	-4.23634	101.50670	1006.5	27.6	82	285	4.5	28.75	23119	5	Cu,Sc,As
RS057	2017120521	-4.23108	101.50328	1005.2	27.9	77	314	5.9	28.69	19277	8	Cu,As,Sc,Cb
RS058	2017120600	-4.22630	101.51421	1005.9	27.9	77	317	7.1	28.68	23917	9	Cu,As,Cb
RS059	2017120603	-4.22782	101.51724	1007.4	27.9	80	344	5.8	28.73	26030	6	Cu,Sc,As,Cs
RS060	2017120606	-4.22657	101.53944	1006.5	28.1	82	320	6.7	28.82	23802	6	Cu,Sc,As,Cs,Cc
RS061	2017120609	-4.23810	101.52245	1004.5	28.3	81	323	6.4	28.90	24053	4	Ac,As,Cc,Ci,Cu
RS062	2017120612	-4.24260	101.51671	1005.5	28.0	80	318	6.2	28.85	26454	4	Sc,Cu,Ac,As
RS063	2017120615	-4.25364	101.51006	1006.8	28.2	80	327	8.2	28.80	26238	2	As,Sc
RS064	2017120618	-4.24618	101.52122	1006.8	28.0	83	322	8.4	28.76	25792	4	As,Ac,Sc
RS065	2017120621	-4.24104	101.53801	1005.0	27.9	79	320	9.1	28.77	27776	4	Cu
RS066	2017120700	-4.25701	101.51318	1006.1	27.9	80	317	8.4	28.76	18274	3	Ac,As,Cu,Cb
RS067	2017120703	-4.23424	101.52910	1007.0	28.4	74	341	8.0	28.84	26176	3	Cu,Cb,As,Cc
RS068	2017120706	-4.22863	101.52513	1006.4	28.6	76	339	8.6	28.96	21208	2	Cu,Sc,Cb,Ac,As,Ci
RS069	2017120709	-4.23279	101.51067	1004.8	27.4	75	305	9.9	28.86	26230	8	As,Ac,Cu
RS070	2017120712	-4.24352	101.51171	1006.1	25.9	92	318	8.4	28.83	23999	7	As,Ns
RS071	2017120715	-4.23943	101.52311	1007.7	28.0	72	329	12.9	28.82	22224	2	As
RS072	2017120718	-4.23171	101.51990	1007.9	28.2	74	337	11.1	28.80	23643	4	As,Ac
RS073	2017120721	-4.23948	101.54153	1006.7	27.2	84	330	9.6	28.78	29706	10	Cu,Ac
RS074	2017120800	-4.23302	101.51179	1007.7	25.7	91	286	8.5	28.76	22651	10	Cu
RS075	2017120803	-4.24407	101.51727	1010.0	26.3	85	256	6.6	28.77	23527	8	Cu,Cb,Sc,As,Ac,Cc
RS076	2017120806	-4.23328	101.51617	1008.4	25.7	92	245	5.9	28.82	21109	10	Cu,Sc,Nb
RS077	2017120809	-4.23777	101.51485	1006.2	26.6	86	225	3.9	28.90	25585	4	As,Ac,Ci,Cu

RS078	2017120812	-4.24035	101.51445	1007.4	27.2	83	259	5.2	28.84	23782	7	As,Ac,Cu
RS079	2017120815	-4.25010	101.51177	1008.8	27.3	84	249	2.5	28.80	22652	5	As
RS080	2017120818	-4.23075	101.50758	1008.4	27.3	80	320	3.3	28.79	25306	9	Ns,As,Ac
RS081	2017120821	-4.22011	101.51921	1007.0	27.4	82	344	3.5	28.77	26505	10	Ac
RS082	2017120900	-4.21884	101.51289	1008.0	27.6	85	329	2.5	28.77	19477	8	Ac,Cu,As,Cb
RS083	2017120903	-4.22105	101.50922	1009.7	28.0	80	309	3.9	28.84	25444	5	Cu,As
RS084	2017120906	-4.21472	101.51781	1008.4	28.3	81	294	3.5	28.91	25804	10	Cu,St
RS085	2017120909	-4.22810	101.50928	1006.8	28.2	80	278	2.6	28.95	25892	5	Cu,Ac,As
RS086	2017120912	-4.24810	101.51158	1008.1	28.2	79	271	2.6	28.96	23369	6	Sc,Ac,Cu,As
RS087	2017120915	-4.25245	101.51720	1009.8	27.0	86	239	1.0	28.86	24102	10	Ns,Cb
RS088	2017120918	-4.23367	101.52005	1009.3	26.0	88	90	0.1	28.75	23119	8	As,Ns
RS089	2017120921	-4.22377	101.52543	1008.0	26.9	84	1	5.3	28.80	29797	5	Ac,As
RS090	2017121000	-4.22660	101.51754	1009.0	27.8	80	338	5.2	28.78	24947	4	Ac,As,Cu,Cb
RS091	2017121003	-4.23582	101.50947	1010.3	28.1	79	325	7.4	28.84	25466	4	Cu,Cb,Ac
RS092	2017121006	-4.24692	101.50034	1008.9	28.0	81	309	4.7	29.02	19157	4	Cu,Sc,Ci,Cc
RS093	2017121009	-4.22587	101.51716	1007.4	28.4	78	290	5.5	29.17	25591	2	Cu,Ci,Ac
RS094	2017121012	-4.23554	101.51883	1008.7	28.2	77	280	3.3	29.11	18601	2	Ci,Cu
RS095	2017121015	-4.23795	101.53211	1010.2	28.3	79	293	4.3	28.99	24338	8	As
RS096	2017121018	-4.25257	101.52930	1009.4	28.0	81	281	2.3	28.89	25811	8	As,Cs
RS097	2017121021	-4.23289	101.52939	1007.6	27.0	87	1	4.4	28.78	26461	6	Cu,As
RS098	2017121100	-4.24758	101.51868	1008.9	27.7	78	327	3.5	28.79	24771	8	Cb,Cu,As
RS099	2017121103	-4.24766	101.51771	1010.2	27.5	84	350	4.1	28.81	25469	8	Cu,Cb,As,Cs,Ci
RS100	2017121106	-4.23338	101.53582	1008.6	27.9	81	317	3.5	29.22	24366	5	Cu,Cb,Sc,Ac,As,Ci
RS101	2017121109	-4.22536	101.53014	1006.9	28.0	78	292	3.7	29.49	26249	6	Cs,Ci,Cu,As
RS102	2017121112	-4.24064	101.52814	1008.8	28.1	79	276	3.6	29.36	21505	6	Ac,As,Sc,Cu
RS103	2017121115	-4.24983	101.53963	1010.4	27.7	72	300	5.0	29.04	23773	9?	Cs?
RS104	2017121118	-4.24857	101.53905	1009.8	27.9	78	302	2.7	28.95	24797	4	As
RS105	2017121121	-4.25526	101.52878	1007.9	27.8	80	313	5.2	28.92	22100	8	unknown
RS106	2017121200	-4.25108	101.53049	1009.5	27.2	80	284	2.4	28.86	25216	9	Cu,Cb,As
RS107	2017121203	-4.23250	101.54279	1011.1	26.9	78	302	9.0	28.86	22945	9	Cu,Nb,Sc
RS108	2017121206	-4.24483	101.53540	1009.1	28.1	80	327	6.7	28.90	26417	9	Cu,Cb,Sc,As
RS109	2017121209	-4.25842	101.53250	1006.7	28.4	74	316	9.3	28.88	26372	6	Ac,As,Ci,Cu
RS110	2017121212	-4.23761	101.52360	1007.5	26.7	87	281	8.3	28.86	23527	2	As,Cu
RS111	2017121215	-4.25502	101.52901	1009.4	28.5	77	300	7.8	28.85	21308	8	As,Cs
RS112	2017121218	-4.25296	101.53043	1008.5	28.2	80	320	7.7	28.83	24883	7	As,Cs
RS113	2017121221	-4.23704	101.53608	1007.0	25.2	80	255	8.7	28.81	20795	10	Cb
RS114	2017121300	-4.25170	101.52869	1009.3	25.5	82	73	0.2	28.77	1956	unknown	unknown
RS115	2017121300	-4.24575	101.53410	1009.8	26.2	86	18	1.3	28.79	23137	10	Cu,Cb,As
RS116	2017121303	-4.25516	101.52646	1011.2	28.1	76	278	4.0	28.77	26666	10	Cu,Sc
RS117	2017121306	-4.23638	101.52289	1010.0	23.9	97	229	11.4	28.65	22051	10	Nb
RS118	2017121309	-4.24800	101.54031	1008.2	25.4	86	299	8.3	28.62	21494	10	As,Sc
RS119	2017121312	-4.24788	101.53362	1009.0	26.0	85	268	5.1	28.61	23601	10	As,Sc,Cu
RS120	2017121315	-4.24635	191.53421	1010.7	24.9	92	195	0.4	28.67	21726	10	Ns
RS121	2017121318	-4.21634	101.51591	1009.3	25.8	88	333	3.7	28.30	23898	5	As,Cs
RS122	2017121321	-4.22567	101.51682	1007.1	26.6	85	358	5.3	28.50	30532	2	unknown
RS123	2017121400	-4.24869	101.52059	1008.7	26.9	87	1	5.5	28.57	24918	7	Cu,Ci
RS124	2017121403	-4.24261	101.51495	1010.3	27.8	76	336	5.0	28.65	26966	3	Cu,Ci,Cs

RS125	2017121406	-4.24335	101.50465	1008.4	27.8	77	324	3.9	28.97	25689	4	Cu,Cb,As,Ci
RS126	2017121409	-4.24858	101.50708	1006.7	28.3	74	321	4.7	29.11	26164	2	Cu,Ci,As
RS127	2017121412	-4.25644	101.51192	1008.1	28.2	75	286	6.7	28.93	25355	3	Cb,Cu,Cs
RS128	2017121415	-4.24574	101.51978	1009.6	28.2	76	309	5.5	28.88	24011	3	As,Cb,Cu
RS129	2017121418	-4.25082	101.52306	1008.3	27.5	84	306	3.2	28.82	24281	5	As,Cs
RS130	2017121421	-4.24883	101.51892	1006.8	27.4	77	355	4.2	28.81	32087	7	unknown
RS131	2017121500	-4.25121	101.51927	1008.9	26.2	89	288	6.7	28.75	26602	9	As,Cu,Cb
RS132	2017121503	-4.24508	101.51815	1009.5	25.8	89	9	9.1	28.73	25771	10	Cu,Cb,Sc,As
RS133	2017121506	-4.22681	101.51857	1008.3	27.0	83	292	3.6	28.92	25370	8	Cu,Cb,Sc,As,Cs
RS134	2017121509	-4.22500	101.52188	1005.7	27.6	83	313	9.8	29.01	25630	8	Cb,Cu,Ci,As
RS135	2017121512	-4.24044	101.52332	1007.0	27.2	80	310	7.2	28.83	22180	9	As,Ac,Cu
RS136	2017121515	-4.24210	101.52645	1009.5	27.8	79	315	6.0	28.80	24889	10	As,Ac
RS137	2017121518	-4.24883	101.52242	1008.3	27.6	80	324	9.2	28.80	24409	8	As,Cs
RS138	2017121521	-4.24251	101.52709	1006.9	25.9	84	310	5.7	28.79	16781	8	Cb
RS139	2017121600	-4.24856	101.52487	1008.0	26.3	89	295	5.2	28.75	25405	10	As,Cu,Cb,Sc
RS140	2017121603	-4.24024	101.51738	1010.2	26.4	91	9	6.6	28.76	23896	10	Cu,Cb
RS141	2017121606	-4.22806	101.53107	1009.3	25.7	89	347	4.5	28.71	20047	10	Cu,Cb
RS142	2017121609	-4.23299	101.52735	1006.5	25.0	93	313	2.3	28.44	25342	10	As,Cu
RS143	2017121612	-4.24260	101.53261	1007.6	26.6	82	304	8.0	28.52	25488	10	As,Sc
RS144	2017121615	-4.24873	101.52832	1009.8	27.2	82	296	6.2	28.62	16942	9	As
RS145	2017121618	-4.24714	101.52198	1008.8	24.8	90	332	11.2	28.63	21572	10?	unknown
RS146	2017121621	-4.24675	101.52954	1007.3	25.7	91	333	10.7	28.63	19450	10	unknown
RS147	2017121700	-4.25005	101.52471	1008.6	26.0	85	312	8.8	28.54	23808	10	Ns,Cb
RS148	2017121703	-4.25010	101.52885	1010.7	27.9	75	305	8.3	28.59	25317	8	Cu,As
RS149	2017121706	-4.24467	101.52357	1009.4	28.1	72	306	8.4	28.65	26274	9	Cu,Ac,As
RS150	2017121709	-4.24156	101.52799	1006.9	28.1	73	304	6.0	28.74	25414	6	Ac,As,Cu,Sc
RS151	2017121712	-4.24708	101.52297	1007.5	28.1	73	308	7.0	28.67	25631	7	As,Ac,Ci,Cu
RS152	2017121715	-4.24787	101.51963	1009.7	28.0	80	338	6.9	28.62	24244	7	As,Cs
RS153	2017121718	-4.24780	101.51772	1009.2	27.9	80	306	5.8	28.72	26526	7	As,Cs
RS154	2017121721	-4.25100	101.51898	1007.2	27.9	79	314	4.4	28.72	27547	1	unknown
RS155	2017121800	-4.24831	101.51744	1007.7	27.7	82	342	5.5	28.73	25389	8	Cu,Ac,Cb
RS156	2017121803	-4.25001	101.51499	1009.7	27.9	81	313	4.1	28.79	26737	3	Cu,Cb,Cs
RS157	2017121806	-4.25087	101.51427	1008.6	26.6	84	347	4.0	28.87	23847	5	Cu,Cb,As,Cc
RS158	2017121809	-4.25134	101.52108	1006.2	28.3	74	279	6.6	28.97	26080	3	Ac,Ci,Cb,As
RS159	2017121812	-4.24914	101.51745	1007.5	28.1	80	271	6.8	28.88	25372	3	Ac,As,Ci,Cu
RS160	2017121815	-4.25100	101.51482	1009.4	28.2	79	266	7.3	28.81	25230	5	As,Ac
RS161	2017121818	-4.25018	101.51748	1008.4	28.0	79	283	7.4	28.79	26465	5	As
RS162	2017121821	-4.24726	101.51735	1007.3	27.9	78	280	5.4	28.80	26071	2	As
RS163	2017121900	-4.25134	101.51450	1007.3	27.9	77	294	6.5	28.79	25329	3	Cu,Cb,As,Ci
RS164	2017121903	-4.24456	101.51136	1008.9	28.1	81	320	3.9	28.83	25495	4	Cu,Cb,Ci,Cs,Cc
RS165	2017121906	-4.24643	101.50390	1007.6	28.5	76	316	5.8	29.01	23061	7	Cu,As,Ac,Ci,Cs
RS166	2017121909	-4.25105	101.51060	1005.9	27.6	78	295	9.1	29.04	26257	6	Cu,Cb,Ci,As
RS167	2017121910	-4.24627	101.51185	1006.2	27.3	81	253	4.0	29.01	27120	7	Cu,Cb,As
RS168	2017121911	-4.24377	101.51287	1006.4	27.8	85	282	6.7	29.01	22979	7	Ci,Cu,As
RS169	2017121912	-4.24678	101.51225	1007.1	27.8	80	239	8.0	28.98	25246	4	Ci,Cu,As
RS170	2017121913	-4.24711	101.51560	1007.9	27.4	83	236	6.6	28.96	24105	3	unknown
RS171	2017121914	-4.24879	101.51903	1008.4	27.4	80	250	7.2	28.94	25371	2	Cu,As

RS172	2017121915	-4.25004	101.51839	1008.9	27.6	82	263	5.8	28.94	25223	3	As
RS173	2017121916	-4.25093	101.52218	1009.4	28.0	81	289	5.9	28.93	25483	3	As,Cs
RS174	2017121917	-4.24791	101.52266	1009.0	27.7	83	266	6.9	28.91	25528	3	As,Cu
RS175	2017121918	-4.25085	101.52158	1008.7	27.8	82	266	5.0	28.88	26318	2	As,Cu
RS176	2017121921	-4.24307	101.51470	1007.5	27.7	84	276	6.3	28.84	26312	4	Cu
RS177	2017122000	-4.25121	101.53278	1008.2	27.4	85	282	6.1	28.84	26156	7	Cb,Cu,As
RS178	2017122003	-4.25870	101.53124	1009.5	28.1	79	285	4.6	28.93	26480	2	Cu,Cb,As
RS179	2017122006	-4.26903	101.52712	1008.3	28.4	80	309	4.0	29.23	23809	4	Cu,Cb,As,Ci
RS180	2017122009	-4.24795	101.52922	1006.3	27.4	81	309	4.0	29.24	26487	4	Cu,Ci,As
RS181	2017122010	-4.24348	101.52717	1006.0	27.9	82	304	3.7	29.25	25935	2	Cu,Ci,As
RS182	2017122011	-4.24213	101.52487	1006.4	28.4	76	285	5.1	29.29	27151	4	Cu,Ci,Ac,As
RS183	2017122012	-4.24380	101.52477	1007.1	28.3	78	278	5.1	29.23	26183	2	Cu,Ci
RS184	2017122013	-4.24270	101.52694	1007.6	28.3	83	277	4.7	29.14	26032	2	As
RS185	2017122014	-4.24757	101.53127	1008.4	28.1	79	271	4.2	29.05	25972	3	As
RS186	2017122015	-4.25490	101.52925	1009.0	28.0	79	279	5.4	29.05	25717	2	Cs,As
RS187	2017122016	-4.25607	101.52728	1009.1	28.1	80	293	4.4	29.04	22415	8	As,Cs,Cu
RS188	2017122017	-4.24653	101.52921	1008.9	27.4	84	7	3.7	29.00	23672	10	As,Ns
RS189	2017122018	-4.24575	101.52774	1008.6	26.3	87	337	8.0	29.00	23814	9	As,Cs,Ns
RS190	2017122021	-4.24566	101.51798	1007.1	26.4	84	330	4.4	28.99	29846	4	unknown
RS191	2017122100	-4.25423	101.54010	1007.9	27.3	85	264	4.7	28.99	25721	7	Cb,Cu,As
RS192	2017122103	-4.25986	101.52249	1008.9	26.8	80	312	3.2	28.98	26779	10	Cu,Sc,Cb,As
RS193	2017122106	-4.23405	101.51700	1007.6	27.7	81	276	6.3	29.06	25277	9	Cu,Sc,As,Ci
RS194	2017122109	-4.24950	101.51530	1005.6	28.0	75	292	6.6	29.03	23009	8	As,Ci,Cu,Ac
RS195	2017122110	-4.25007	101.50967	1006.2	27.6	76	285	6.5	29.04	24777	9	As,Cu
RS196	2017122111	-4.23624	101.51527	1006.5	27.5	78	280	6.0	29.01	22960	8	As,Cu
RS197	2017122112	-4.23713	101.51743	1006.5	27.7	75	277	6.9	29.00	25522	9	As,Ac,Cu,Ci
RS198	2017122113	-4.24032	101.51911	1007.3	27.8	78	287	7.5	28.98	16780	8	As
RS199	2017122114	-4.25064	101.52370	1007.7	28.1	79	278	7.7	28.95	24717	8	Cu,As
RS200	2017122115	-4.25561	101.52530	1007.8	27.5	82	269	7.9	28.93	25507	10	Cs,As
RS201	2017122116	-4.25663	101.52338	1007.6	27.3	83	263	9.6	28.93	24801	9	As,Cb,Cu
RS202	2017122117	-4.24578	101.52582	1007.7	27.4	87	259	9.1	28.93	26136	9	As,Cu,Cs
RS203	2017122118	-4.24899	101.52900	1007.5	27.0	83	273	10.2	28.91	18330	10	As,Cu
RS204	2017122121	-4.25941	101.51918	1005.9	27.0	79	281	5.2	28.88	31056	8	unknown
RS205	2017122200	-4.24240	101.53991	1006.5	26.6	87	256	5.7	28.83	21916	8	As,Cb,Cu
RS206	2017122203	-4.23680	101.53831	1007.9	27.1	80	262	3.7	28.86	26401	9	Cu,Cb,Ac,As,Cs
RS207	2017122206	-4.25827	101.51881	1006.6	26.8	78	320	6.3	28.88	25348	10	Cu,St,As
RS208	2017122209	-4.24864	101.52441	1004.9	26.4	87	295	4.0	28.76	24759	9	As,Ns,Cu
RS209	2017122210	-4.24033	101.52364	1004.8	27.0	83	306	8.6	28.78	27118	9	As,Cu
RS210	2017122211	-4.24651	101.52089	1005.2	26.8	88	313	6.3	28.74	19900	8	Ac,As,Cu
RS211	2017122212	-4.24429	101.52636	1005.7	26.8	86	271	3.7	28.72	25645	5	As,Ac,Ci,Cu
RS212	2017122213	-4.23985	101.53057	1006.2	27.3	80	311	5.6	28.71	25124	5	As
RS213	2017122214	-4.24523	101.53182	1007.0	27.3	83	326	5.8	28.71	23204	-	unknown
RS214	2017122215	-4.24745	101.52585	1007.0	27.4	80	297	5.0	28.70	23694	9	As,Cu,Cs
RS215	2017122216	-4.24714	101.52449	1007.4	25.2	92	278	10.3	28.65	11031	10	Ns
RS216	2017122217	-4.24344	101.52692	1006.7	25.9	91	293	9.4	28.68	18406	10	Ns
RS217	2017122218	-4.25565	101.52909	1006.7	25.6	90	268	8.3	28.66	19359	10	Ns
RS218	2017122221	-4.25353	101.53912	1004.7	26.3	87	302	7.5	28.62	21144	10	Ns

RS219	2017122300	-4.24955	101.53683	1005.5	25.9	88	301	7.7	28.57	21314	10	Ns,Cu,As
RS220	2017122303	-4.26124	101.51620	1006.8	25.3	94	300	8.0	28.55	21150	10	St,As
RS221	2017122306	-4.25031	101.53537	1005.8	26.4	88	325	5.6	28.57	25286	10	Ns,Sc,Cu,As
RS222	2017122309	-4.24595	101.53187	1003.8	25.8	90	264	3.9	28.59	25164	10	As,Cu,Ns
RS223	2017122312	-4.25228	101.53030	1004.9	26.8	86	213	2.9	28.58	23397	8	Cu,As
RS224	2017122315	-4.24996	101.51025	1006.2	26.8	85	143	5.1	28.57	23862	10	As,Cu
RS225	2017122318	-4.24504	101.53399	1005.5	26.8	82	138	2.4	28.50	25579	2	As
RS226	2017122321	-4.22565	101.52990	1004.8	26.9	81	103	2.6	28.53	26642	8	As
RS227	2017122400	-4.23778	101.51469	1006.3	27.1	77	102	3.4	28.53	24743	9	As,Ac,Cu
RS228	2017122403	-4.23213	101.51877	1007.1	27.5	79	75	4.1	28.53	22273	3	Cu,Ac,Ci,Cs
RS229	2017122406	-4.22944	101.52307	1006.0	26.8	85	14	3.5	28.83	25838	8	Cu,Cb,Sc,As,Ac,Ci
RS230	2017122409	-4.22613	101.52047	1004.2	26.9	82	329	2.4	28.78	23722	9	As,Cu,Cb
RS231	2017122410	-4.21648	101.51627	1003.8	27.1	80	352	1.2	28.80	23475	7	As,Cu,Ac.Cb
RS232	2017122411	-4.23623	101.51183	1004.0	27.2	79	334	1.9	28.90	24553	7	As.Cu,Ac,Ci
RS233	2017122412	-4.25007	101.52303	1004.6	27.3	80	17	1.6	28.84	17700	8	Ac,As,Cu,Ci
RS234	2017122413	-4.23643	101.52290	1005.2	27.4	78	6	0.5	28.77	24451	5	As
RS235	2017122414	-4.22368	101.51757	1005.5	27.4	80	58	0.9	28.75	24731	6	As,Ac
RS236	2017122415	-4.24955	101.51435	1005.7	27.4	78	7	1.3	28.74	24073	8	As,Cs
RS237	2017122416	-4.24622	101.52021	1006.5	27.5	80	351	2.8	28.72	24016	10	As,Cu,Cs
RS238	2017122417	-4.24161	101.52451	1006.4	27.5	80	351	2.2	28.71	22238	8	Cs,As
RS239	2017122418	-4.23652	101.52558	1006.0	27.5	79	347	2.3	28.68	23507	4	As,Cs
RS240	2017122421	-4.24425	101.49329	1004.3	27.2	84	39	2.2	28.63	28441	5	Cu
RS241	2017122500	-4.24150	101.52094	1005.0	27.3	80	5	2.2	28.61	24487	8	Cu,As,Cb
RS242	2017122503	-4.24869	101.49808	1006.8	27.5	81	80	2.5	28.65	24348	9	Cu,Cb,St,Sc,Ac,Cc,Cs
RS243	2017122506	-4.23542	101.51591	1005.9	26.1	88	239	5.3	28.78	21491	10	Cu,Cb,St,Sc
RS244	2017122509	-4.25063	101.51785	1004.1	27.3	84	298	0.7	29.06	18816	4	Ci,Cu,As
RS245	2017122510	-4.24397	101.51465	1004.1	27.8	79	274	3.0	29.20	23501	2	Ci,Cu
RS246	2017122511	-4.22503	101.51324	1004.4	27.9	78	280	2.4	29.00	24910	2	Ci,Cu,As,Ac
RS247	2017122512	-4.24297	101.51518	1005.1	27.8	77	267	2.8	28.95	23792	4	Ac,Ci,As,Cu
RS248	2017122513	-4.24813	101.51258	1005.9	27.8	77	302	1.2	28.95	24095	7	As
RS249	2017122514	-4.25816	101.51447	1006.6	28.0	76	302	3.1	28.98	23262	8	As,Cu
RS250	2017122515	-4.24681	101.51178	1006.7	28.1	79	297	2.6	28.99	23254	9	Cu,As,Cs,Cb
RS251	2017122516	-4.24333	101.51141	1006.8	27.8	77	335	2.5	28.96	19850	10	Cu,As,Cs,Cb
RS252	2017122517	-4.23378	101.51650	1006.8	27.3	85	318	5.6	28.82	23165	10	As,Cs,Cu
RS253	2017122518	-4.23050	101.52058	1006.5	27.5	81	314	4.5	28.71	22650	9	As,Cs
RS254	2017122521	-4.25305	101.50901	1005.3	26.7	88	348	6.3	28.63	27443	9	As
RS255	2017122600	-4.24224	101.51914	1005.3	27.1	82	339	7.4	28.49	22632	4	Cu,As
RS256	2017122603	-4.23604	101.52847	1007.0	27.9	76	335	7.4	28.56	8683	4	Cu,Cb,As,Ci,Cc
RS257	2017122606	-4.25194	101.52135	1005.7	28.1	76	339	10.0	28.73	29454	8	Cu,Cb,Cs,Cc
RS258	2017122609	-4.25158	101.52006	1005.0	25.7	86	51	0.8	28.89	26217	7	Cu,As,Cb,Ci
RS259	2017122610	-4.25471	101.52804	1005.2	26.0	88	260	2.3	28.92	21880	9	Cu,As,Ns,Cb
RS260	2017122611	-4.24903	101.52155	1006.0	25.3	95	293	4.9	28.89	22815	10	Ns,As
RS261	2017122612	-4.24202	101.52743	1006.1	25.3	91	303	4.5	28.90	23023	8	As,Cu,St,Ci
RS262	2017122613	-4.24770	101.52644	1006.6	25.4	85	302	2.3	28.88	25458	7	As,Ci
RS263	2017122614	-4.25276	101.52966	1007.5	26.0	84	31	2.8	28.87	19946	10	As
RS264	2017122615	-4.24657	101.52766	1008.1	25.9	82	341	2.5	28.87	19578	10	As,Cu
RS265	2017122616	-4.24695	101.52688	1008.0	26.8	79	317	6.1	28.86	21247	10	As,Cu

RS266	2017122617	-4.25461	101.52904	1007.9	26.9	81	327	5.2	28.83	19680	10	As,Cu
RS267	2017122618	-4.24837	101.52262	1007.3	27.0	83	323	4.3	28.80	23037	10	As,Cu
RS268	2017122621	-4.25003	101.52891	1005.9	27.3	81	334	4.5	28.68	28578	8	Cu,As
RS269	2017122700	-4.24564	101.52623	1006.9	27.0	82	341	5.4	28.53	20816	9	Cu,As,Cb,Ac
RS270	2017122703	-4.24109	101.52566	1008.6	27.2	82	349	5.4	28.59	26707	10	Cu,Cb,Ns,As
RS271	2017122706	-4.23529	101.53130	1007.4	26.3	85	71	0.6	28.66	23111	10	Cu,St,Sc,As
RS272	2017122709	-4.24322	101.52723	1005.3	26.9	82	320	2.4	28.88	25919	4	Ci,Cu,As,Cb
RS273	2017122712	-4.23265	101.51768	1005.7	27.2	81	305	2.0	28.74	23293	2	Ci,As,Cu
RS274	2017122715	-4.22969	101.51990	1007.3	27.4	81	315	2.0	28.69	24861	9	As,Ac
RS275	2017122718	-4.24193	101.52879	1007.1	27.4	82	308	2.8	28.69	22883	9	As,Cu,Cs
RS276	2017122721	-4.24315	101.52191	1005.3	27.4	81	298	3.3	28.67	26417	1	unknown
RS277	2017122800	-4.23908	101.52206	1006.7	27.6	83	332	3.4	28.51	21801	6	Cu,Ci,As
RS278	2017122803	-4.23428	101.51209	1007.4	27.5	77	308	2.3	28.65	24869	8	Cu,Cb,c,Ci,Cs
RS279	2017122806	-4.23127	101.50997	1006.5	28.1	77	321	3.9	28.92	22286	10	Cu,Cb,Cs
RS280	2017122809	-4.23463	101.51256	1004.0	28.2	78	319	2.1	29.16	23026	3	Ci,Cu
RS281	2017122810	-4.22899	101.52245	1003.8	28.2	77	302	1.8	29.09	26238	4	Ci,As,Cu
RS282	2017122811	-4.23222	101.52214	1004.6	28.1	80	309	2.3	29.11	23039	3	Ci,As,Cu
RS283	2017122812	-4.23629	101.52021	1004.7	28.0	79	324	2.2	29.08	24956	2	Ci,Ac,As
RS284	2017122813	-4.23904	101.51935	1005.7	28.1	78	288	2.9	29.06	23867	3	Ci,As,Cu
RS285	2017122814	-4.24035	101.51920	1006.1	28.1	79	286	4.0	29.07	24380	4	As,Ci,Cu
RS286	2017122815	-4.23331	101.51611	1006.3	28.1	79	288	3.6	29.06	23834	8	Cs,As,Ci
RS287	2017122816	-4.23109	101.51359	1006.4	28.2	79	298	4.0	28.94	22592	8	Cs,As,Ac
RS288	2017122817	-4.22558	101.51742	1006.4	28.0	82	306	3.4	28.95	24931	3	Cu,As,Cs
RS289	2017122818	-4.22601	101.51875	1005.9	28.0	82	301	3.2	28.93	21654	5	Cu,As,Cs
RS290	2017122821	-4.24467	101.51474	1004.6	27.9	78	323	4.5	28.80	23700	3	unknown
RS291	2017122900	-4.23530	101.51559	1005.8	28.0	78	315	4.0	28.82	23952	9	Cu,As
RS292	2017122903	-4.24135	101.50097	1007.6	28.1	82	344	5.4	28.90	24886	9	Cu.Cb,As,Cs
RS293	2017122906	-4.22905	101.52338	1005.9	28.2	80	330	6.5	29.04	31749	9	Cu,Cb,Sc,As,Ci
RS294	2017122909	-4.24828	101.52144	1003.7	28.5	79	302	5.5	29.01	24869	9	As,Cu
RS295	2017122910	-4.24847	101.52279	1004.2	28.5	77	302	4.8	28.98	23638	9	As,Cu
RS296	2017122911	-4.24806	101.52532	1004.5	28.4	77	244	5.5	28.95	22164	9	As,Cu
RS297	2017122912	-4.24210	101.52029	1005.0	28.2	83	284	3.5	28.93	24043	8	Ac,Cu,As
RS298	2017122913	-4.24486	101.52168	1006.0	28.5	80	310	4.9	28.81	22371	9	As,Ac,Cu
RS299	2017122914	-4.24581	101.52465	1006.7	28.3	81	309	6.3	28.97	24912	9	As,Cs,Cu
RS300	2017122915	-4.23883	101.51897	1007.5	28.4	82	302	4.6	28.99	22983	10	Cs,As,Cu
RS301	2017122916	-4.24073	101.51877	1007.4	28.3	80	307	3.5	28.96	21741	9	As,Cs,Cu
RS302	2017122917	-4.23679	101.52771	1007.1	28.2	84	314	4.8	28.93	23956	10	Cu,As,Cs
RS303	2017122918	-4.24126	101.52557	1007.1	28.3	79	323	4.3	28.92	25386	8	Cu,As
RS304	2017122921	-4.23978	101.53727	1005.2	27.9	85	309	5.2	28.87	18272	10	Ns
RS305	2017123000	-4.23752	101.52168	1006.1	26.8	88	298	5.5	28.82	25631	10	Cb,Cu,As
RS306	2017123003	-4.23609	101.51406	1008.4	26.9	86	301	0.9	28.91	18797	10	Cu.Cb,Sc,As
RS307	2017123006	-4.24899	101.51842	1006.4	27.0	85	273	5.4	28.93	23209	10	Cu,Cb,St,As
RS308	2017123009	-4.27316	101.53503	1003.9	27.5	83	281	3.8	28.97	22891	10	As,Cu
RS309	2017123010	-4.26063	101.53175	1004.2	27.4	84	258	3.9	28.97	24914	10	As,Cu
RS310	2017123011	-4.24695	101.52892	1004.8	27.6	84	248	3.2	28.97	22813	10	As,Cu
RS311	2017123012	-4.23979	101.52443	1005.2	27.5	84	250	2.1	28.97	21301	10	As,Cu,Ac
RS312	2017123013	-4.24457	101.52546	1006.1	27.7	83	348	1.0	28.96	24540	10	As

RS313	2017123014	-4.24702	101.52740	1007.0	27.8	84	339	2.4	28.94	22689	10	As,Cu,Cs
RS314	2017123015	-4.24179	101.52204	1007.7	27.9	83	341	1.8	28.94	21737	10	As,Cu,Ac
RS315	2017123016	-4.24019	101.51730	1007.9	28.0	83	35	0.6	28.94	22561	10	As,Ns
RS316	2017123017	-4.24930	101.52703	1007.7	27.1	88	293	2.9	28.93	21189	10	unknown
RS317	2017123018	-4.24540	101.52401	1007.3	26.0	88	58	3.6	28.92	22934	10	As,Cu
RS318	2017123021	-4.22560	101.52559	1005.1	26.6	87	53	1.4	28.91	26660	9	As,Cu
RS319	2017123100	-4.24213	101.51765	1005.6	26.2	90	33	2.4	28.84	25785	8	Ns,Cu
RS320	2017123103	-4.22367	101.51041	1008.0	27.5	80	60	1.6	28.89	24668	7	Cu,CbSc,As,Ac,Cc
RS321	2017123106	-4.24945	101.51997	1006.2	26.5	82	268	2.1	28.96	23503	7	Cu,Cb,Sc,St,As,Ac
RS322	2017123109	-4.22872	101.52506	1003.4	27.2	84	245	4.4	29.66	22781	5	Cu,Ac,Ci,As
RS323	2017123112	-4.24340	101.52129	1004.5	27.2	85	266	4.9	29.03	23401	8	Cu,As
RS324	2017123115	-4.24790	101.52378	1006.3	27.5	85	278	1.0	29.00	22846	10	Cu,As
RS325	2017123118	-4.23476	101.52013	1006.0	26.2	90	22	3.1	28.80	22169	10	Cu,As,Ac
RS326	2017123121	-4.22857	101.52215	1004.8	24.9	95	351	5.6	28.75	18622	10	Ns
RS327	2018010100	-4.23735	101.51823	1005.3	24.8	92	350	2.7	28.63	21732	10	Sc,As
RS328	2018010103	-4.24173	101.51583	1007.9	24.5	95	326	6.1	28.64	22295	10	Ns
RS329	2018010106	-4.23610	101.52305	1005.4	26.2	84	311	8.9	28.76	23352	9	Cu,Cb,Sc,St,Ns,As,Ci
RS330	2018010109	-4.07485	101.85029	1003.0	27.2	82	330	7.3	29.03	23991	7	Cu, As, Ci
RS331	2018010112	-4.16393	101.67243	1003.6	26.9	81	341	6.2	28.75	21659	9	Cu,As,Ac
RS332	2018010115	-4.38066	101.23849	1005.9	27.4	81	353	4.4	28.62	23608	10	As,Cu,Ac,Cc
RS333	2018010118	-4.59897	101.80267	1005.9	27.6	82	9	4.4	28.74	23538	9	Cu,As
RS334	2018010121	-4.80889	101.38169	1003.4	28.0	80	326	5.8	28.77	21215	8	Cu
RS335	2018010200	-5.02413	101.02737	1003.8	27.0	85	298	8.8	28.93	25955	10	Cu,Cb,As,Ac,Cs
RS336	2018010612	-5.60888	108.58466	1005.1	28.3	78	261	4.3	29.26	21969	10	As, Ac
RS337	2018010618	-5.55353	110.13872	1006.2	28.3	84	319	5.4	29.03	23609	9	Sc
RS338	2018010700	-5.33486	111.61891	1007.3	26.2	88	211	2.6	28.99	23330	10	Ns,Sc,St
RS339	2018010706	-5.58760	112.99287	1007.2	25.9	88	293	4.0	29.13	23103	10	Ns,Sc,St
RS340	2018010712	-5.97726	114.42986	1006.8	27.8	79	279	7.1	29.57	23602	7	Cu, Ac, As
RS341	2018010718	-6.16823	115.79242	1006.7	28.0	81	272	4.7	29.30	22678	7	Cu,Ns
RS342	2018010800	-5.70729	116.97451	1007.1	27.8	80	290	0.9	29.40	21224	9	Sc, St, Cu
RS343	2018010806	-4.65862	117.70499	1005.9	27.6	83	0	6.6	29.76	25345	7	Cu,Sc,St,As
RS344	2018010812	-3.55043	118.42533	1006.7	27.8	76	23	2.7	29.53	23901	9	As, Ci
RS345	2018010818	-2.17948	118.68558	1007.9	25.2	92	62	6.3	29.45	22922	8	Ns,Cu
RS346	2018010900	-0.81518	119.08380	1008.5	27.0	82	161	3.6	29.43	11305	9	NS, Cb, Sc, Ac
RS347	2018010906	0.36410	119.48129	1005.7	27.2	80	56	1.8	29.34	22849	9	St,Sc,Ac,Ns,As
RS348	2018010912	1.31018	120.04982	1006.9	27.4	82	351	3.8	29.30	23030	7	Cu, As
RS349	2018010918	2.03295	121.07960	1006.9	27.4	79	25	5.8	29.18	22175	7	Cu,As
RS350	2018011000	2.70967	122.09449	1007.4	27.7	80	72	5.4	28.69	23905	7	As, Cu, Cb, As
RS351	2018011006	3.34782	123.04406	1005.4	28.0	76	34	3.7	29.54	24715	6	Sc,Cu,As,Ns
RS352	2018011012	3.99963	123.99146	1006.7	28.0	82	66	7.1	28.89	23492	1	Sc
RS353	2018011018	4.63261	124.93085	1005.3	28.3	83	47	7.1	28.84	21860	10	Ns,Cu
RS354	2018011100	4.99759	126.18634	1008.0	28.1	77	50	4.5	29.04	22248	4	Cb,Cu,As
RS355	2018011106	5.83198	127.29774	1004.5	27.8	75	48	4.6	29.19	23291	6	As,Cs,Sc,Cu,Ns

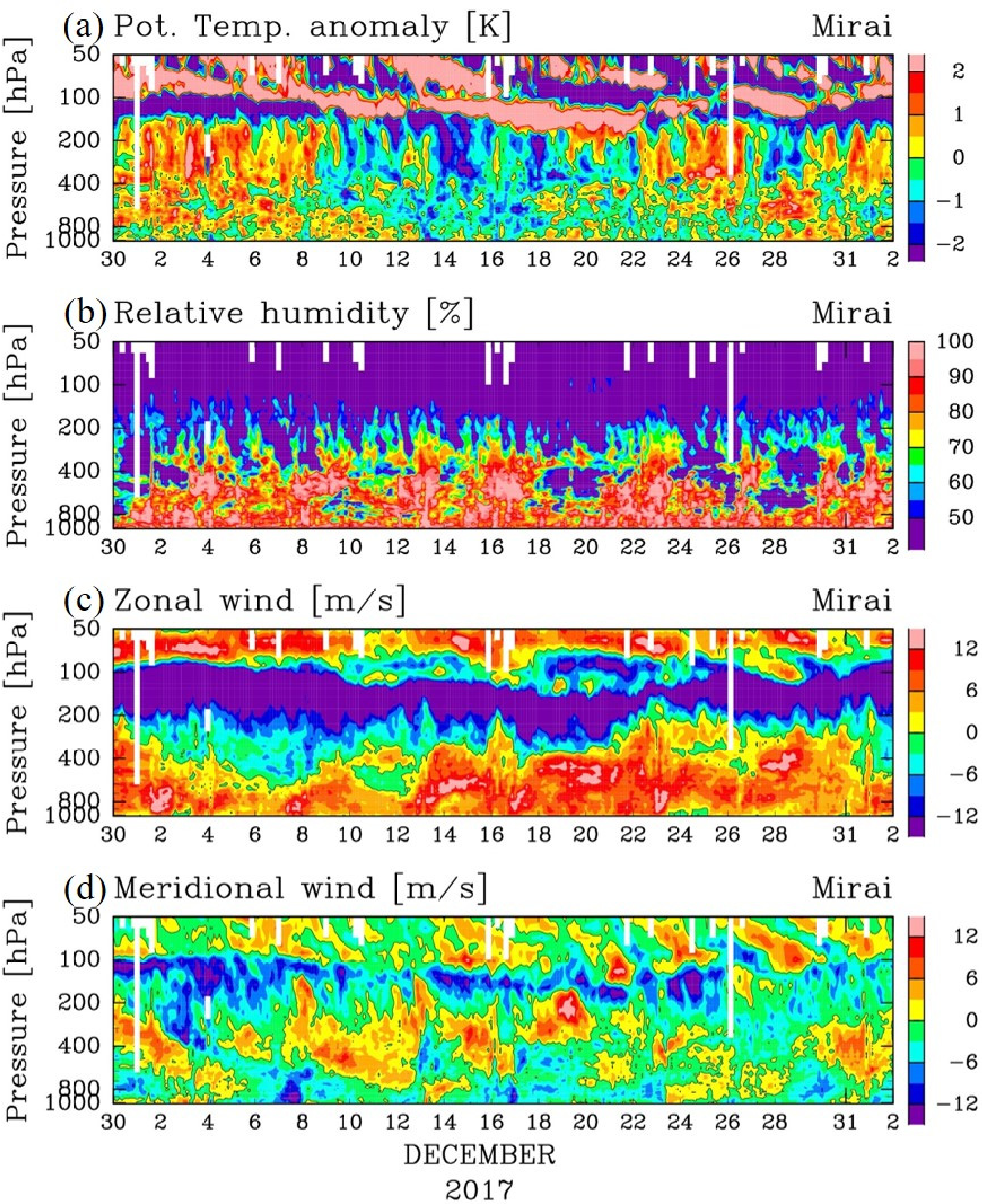


Fig. 5.1-1: Time-height cross sections of observed parameters during Leg. 1; (a) potential temperature anomaly from averages over the period plotted, (b) water vapor relative humidity, (c) zonal wind, and (d) meridional wind.

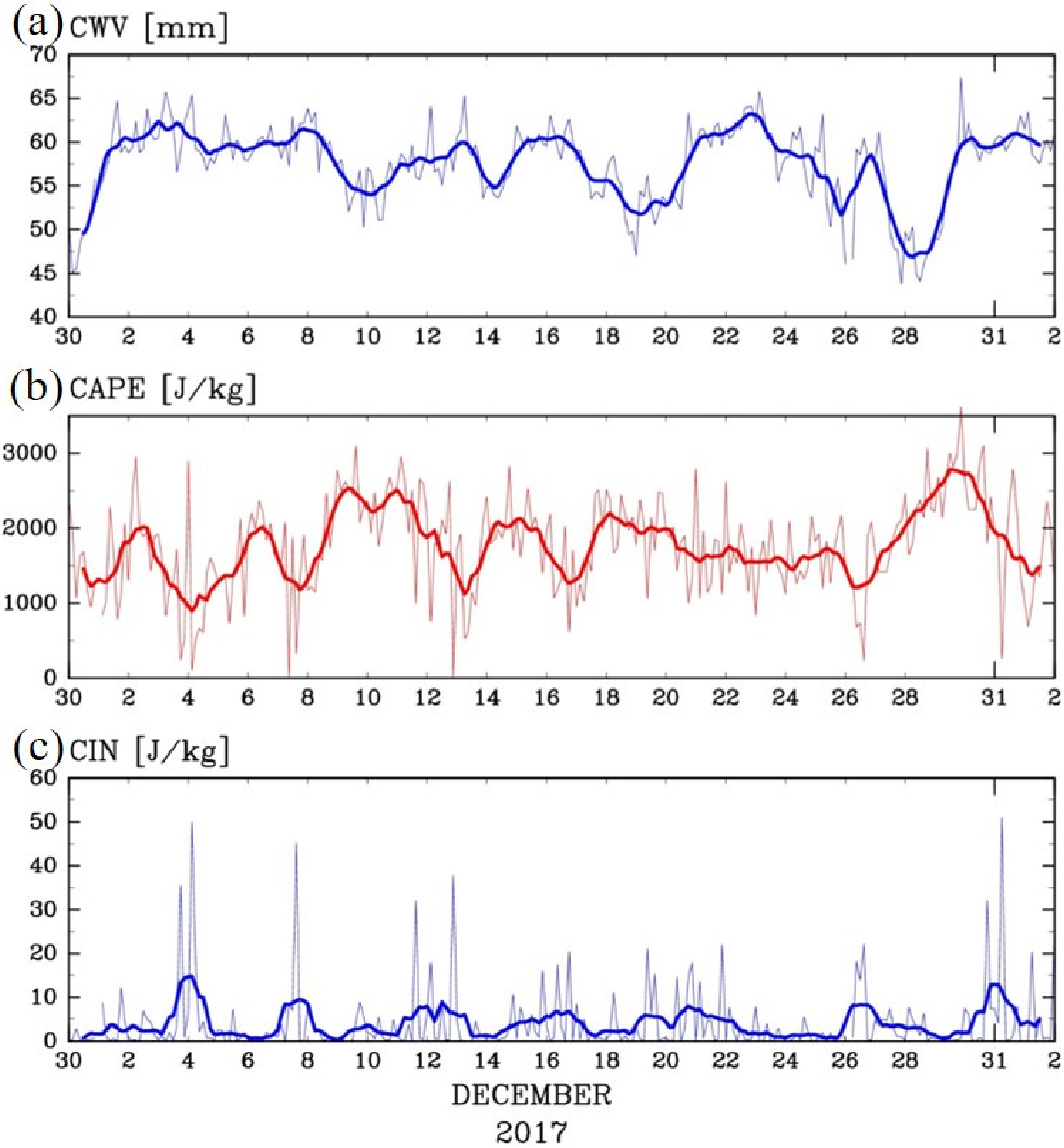


Fig. 5.1-2: Time series of (a) column-integrated water vapor (CWV), (b) convective available potential energy (CAPE), and (c) convective inhibition (CIN). Thin lines are from the 3-hourly time series, while thick lines represent diurnal running averages.

5.2 GNSS precipitable water

(1) Personnel

Masaki KATSUMATA	(JAMSTEC)	- Onboard Principal Investigator
Souichiro SUEYOSHI	(NME)	- Operation Leader
Wataru TOKUNAGA	(NME)	
Ryo OYAMA	(NME)	
Miki TAWATA	(NME)	
Mikiko FUJITA	(JAMSTEC)	(not on board)
Kyoko TANIGUCHI	(JAMSTEC)	
Satoru YOKOI	(JAMSTEC)	

(2) Objective

Getting the GNSS satellite data to estimate the total column integrated water vapor content of the atmosphere.

(3) Method

The GNSS satellite data was archived to the receiver (Trimble NetR9) with 5 sec interval. The GNSS antenna (Margrin) was set on the roof of aft wheel house. The observations were carried out all thru the cruise.

(4) Results

Raw data is obtained through the cruise, except the period / area without permission. Raw data is recorded as T02 format and stream data every 5 seconds. We will calculate the total column integrated water from observed GNSS satellite data after the cruise.

(5) Data archive

These raw datasets are available from Mikiko Fujita of JAMSTEC. Corrected data will be submitted to JAMSTEC Marine-Earth Data and Information Department and will be archived there.

5.3 C-band Weather Radar

(1) Personnel

Biao GENG	(JAMSTEC)	- Principal Investigator
Masaki KATSUMATA	(JAMSTEC)	
Kyoko TANIGUCHI	(JAMSTEC)	
Souichiro SUEYOSHI	(NME)	- Operation Leader
Wataru TOKUNAGA	(NME)	
Ryo OYAMA	(NME)	
Miki TAWATA	(NME)	

(2) Objective

The objective of weather radar observations in this cruise is to evaluate the performance of the radar, develop the better strategy of the radar observation, and investigate the structure and evolution of precipitating systems around the Maritime Continent.

(3) Radar specifications

The C-band weather Doppler radar on board the R/V Mirai is used. Basic specifications of the radar are as follows:

Frequency:	5370 MHz (C-band)
Polarimetry:	Horizontal and vertical (simultaneously transmitted and received)
Transmitter:	Solid-state transmitter
Pulse Configuration:	Using pulse-compression
Output Power:	6 kW (H) + 6 kW (V)
Antenna Diameter:	4 meter
Beam Width:	1.0 degrees
Laser Gyro:	PHINS (Ixsea S.A.S.)

(4) Available radar variables

Radar variables, which are converted from the power and phase of the backscattered signal at vertically- and horizontally-polarized channels, are as follows:

Radar reflectivity:	Z
Doppler velocity:	Vr
Spectrum width of Doppler velocity:	SW
Differential reflectivity:	ZDR
Differential propagation phase:	ΦDP
Specific differential phase:	KDP
Co-polar correlation coefficients:	ρHV

(5) Operational methodology

The antenna is controlled to point the commanded ground-relative direction, by controlling the azimuth and elevation to cancel the ship attitude (roll, pitch and yaw) detected by the laser gyro. The Doppler velocity is also corrected by subtracting the ship movement in beam direction.

For the maintenance, internal signals of the radar are checked and calibrated at the beginning and the end of the cruise. Meanwhile, the following parameters are checked daily; (1) frequency, (2) mean output power, (3) pulse width, and (4) PRF (pulse repetition frequency).

During the cruise, the radar is operated in the mode shown in Tables 5.3-1. A dual PRF mode is used for a volume scan. For a RHI, vertical point, and surveillance PPI scans, a single PRF mode is used.

(6) Data

The C-band weather radar observations were conducted from Nov. 22, 2017 to Jan. 17, 2018, except the area without permissions. During the period from Dec. 5, 2017 to Jan. 2, 2018, fixed point observations were executed at (4.24S and 101.52E). Figure 5.3-1 shows a time series of the areal coverage of radar echoes. The figure illustrates the evolution of precipitation systems in the period when the Mirai remains stationary. During this period, many precipitating systems have been observed. These precipitation systems developed and evolved in time scales ranging from diurnal to intra-seasonal variations. Detailed analyses of the data observed by the weather radar will be performed after the cruise.

All data of the Doppler radar observations during this cruise will be submitted to the JAMSTEC Data Management Group (DMG).

Table 5.3-1 Parameters for the scan mode

	Surveillance PPI Scan	Volume Scan						RHI Scan	Vertical Point Scan
Repeated Cycle (min.)	30	6						12	
Times in One Cycle	1	1						3	3
Pulse Width (long / short, in microsec)	200 / 2	64 / 1		32 / 1		32 / 1		32 / 1	32 / 1
Scan Speed (deg/sec)	36	18		24		36		9	36
PRF(s) (Hz)	400	dual PRF (ray alternative)						1250	2000
		667	833	938	1250	1333	2000		
Pulses / Ray	8	26	33	27	34	37	55	32	64
Ray Spacing (deg.)	0.7	0.7		0.7		1.0		0.2	1.0
Azimuth (deg)	Full Circle							Option	Full Circle
Bin Spacing (m)	150								
Max. Range (km)	300	150		100		60		100	60
Elevation Angle(s) (deg.)	0.5	0.5		1.0, 1.8, 2.6, 3.4, 4.2, 5.1, 6.2, 7.6, 9.7, 12.2, 15.2		18.7, 23.0, 27.9, 33.5, 40.0		0.0~ 60.0	90

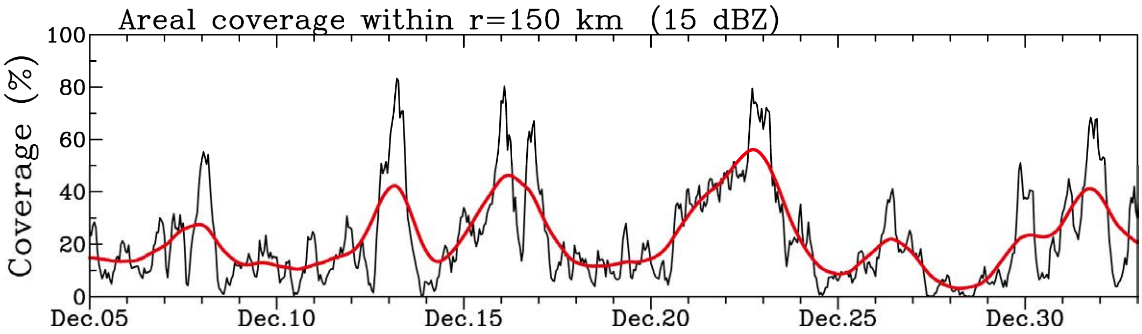


Figure 5.3-1. Time series of the areal coverage of echoes (black line) within a radius of 150 km from the radar. The red line shows a twenty-four-hour running mean time series of the area coverage of echoes.

5.4 Micro Rain Radar

(1) Personnel

Masaki KATSUMATA (JAMSTEC) - Principal Investigator
Biao GENG (JAMSTEC)
Kyoko TANIGUCHI (JAMSTEC)

(2) Objectives

The micro rain radar (MRR) is a compact vertically-pointing Doppler radar, to detect vertical profiles of rain drop size distribution. The objective of this observation is to understand detailed vertical structure of the precipitating systems.

(3) Instruments and Methods

The MRR-2 (METEK GmbH) was utilized. The specifications are in Table 5.4-1. The antenna unit was installed at the starboard side of the anti-rolling systems (see Fig. 5.4-1), and wired to the junction box and laptop PC inside the vessel.

The data was averaged and stored every one minute. The vertical profile of each parameter was obtained every 200 meters in range distance (i.e. height) up to 6200 meters, i.e. well beyond the melting layer. The recorded parameters were; Drop size distribution, radar reflectivity, path-integrated attenuation, rain rate, liquid water content and fall velocity.

Fig. 5.4-1: Photo of the antenna unit of MRR

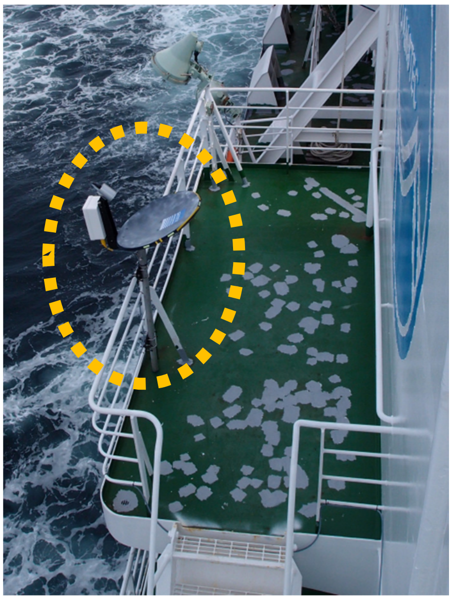


Table 5.4-1: Specifications of the MRR-2.

Transmitter power	50 mW
Operating mode	FM-CW
Frequency	24.230 GHz (modulation 1.5 to 15 MHz)
3dB beam width	1.5 degrees
Spurious emission	< -80 dBm / MHz
Antenna Diameter	600 mm
Gain	40.1 dBi

(4) Preliminary Results

The data have been obtained all through the cruise, except EEZs without permission.

Figure 5.4-2 displays an example of the time-height cross section for one day. The temporal variation reasonably corresponds to the rainfall measured by the Mirai Surface Met sensors (see Section 5.11), disdrometers (see Section 5.3), etc. The further analyses will be after the cruise.

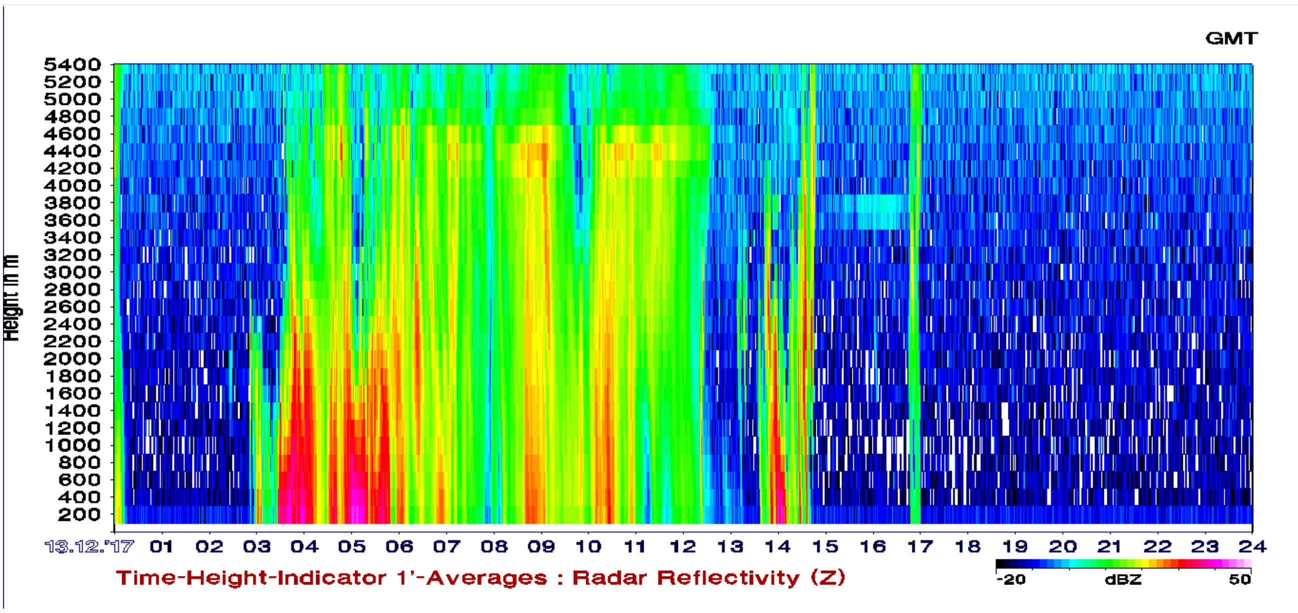


Fig. 5.4-2: An example of the time-height cross section of the radar reflectivity, from 00UTC on Dec. 13 to 00UTC on Dec.14 (24 hours).

(5) Data Archive

All data obtained during this cruise will be submitted to the JAMSTEC Data Management Group (DMG).

(6) Acknowledgment

The operations are supported by Japan Aerospace Exploration Agency (JAXA) Precipitation Measurement Mission (PMM).

5.5 Disdrometers

(1) Personnel

Masaki KATSUMATA (JAMSTEC) - Principal Investigator
Biao GENG (JAMSTEC)
Kyoko TANIGUCHI (JAMSTEC)

(2) Objectives

The disdrometer can continuously obtain size distribution of raindrops. The objective of this observation is (a) to reveal microphysical characteristics of the rainfall, depends on the type, temporal stage, etc. of the precipitating clouds, (b) to retrieve the coefficient to convert radar reflectivity (especially from Doppler radar in Section 5.3) to the rainfall amount, and (c) to validate the algorithms and the product of the satellite-borne precipitation radars; TRMM/PR and GPM/DPR.

(3) Methods

Three different types of disdrometers are utilized to obtain better reasonable and accurate value on the moving vessel. All three, and one optical rain gauge, are installed in one place, the starboard side on the roof of the anti-rolling system of R/V Mirai, as in Fig. 5.5-1. The details of the sensors are described below. All the sensors archive data every one minute, except Parsivel for every 10 seconds.

Fig. 5.5-1: Two disdrometers (Parsivel and LPM), installed on the roof of the anti-rolling system.

(3-1) Laser Precipitation Monitor (LPM) optical disdrometer

The "Laser Precipitation Monitor (LPM)" (Adolf Thies GmbH & Co) is an optical disdrometer. The instrument consists of the transmitter unit which emit the infrared laser, and the receiver unit which detects the intensity of the laser come thru the certain path length in the air.

When a precipitating particle fall thru the laser, the received intensity of the laser is reduced. The receiver unit detect the magnitude and the duration of the reduction and then convert them onto particle size and fall speed. The sampling volume, i.e. the size of the laser beam “sheet”, is 20 mm (W) x 228 mm (D) x 0.75 mm (H).

The number of particles are categorized by the detected size and fall speed and counted every minutes. The categories are shown in Table 5.6-2.

(3-2) “Parsivel” optical disdrometer

The “Parsivel” (Adolf Thies GmbH & Co) is another optical disdrometer. The principle is same as the LPM. The sampling volume, i.e. the size of the laser beam “sheet”, is 30 mm (W) x 180 mm (D). The categories are shown in Table 5.6-3.

(4) Preliminary Results

The data have been obtained all through the cruise, except EEZs without permission. An example of the obtained data is shown in Fig. 5.5-1. The further analyses for the rainfall amount, drop-size-distribution parameters, etc., will be carried out after the cruise.

(5) Data Archive

All data obtained during this cruise will be submitted to the JAMSTEC Data Management Group (DMG).

(6) Acknowledgment

The operations are supported by Japan Aerospace Exploration Agency (JAXA) Precipitation Measurement Mission (PMM) .

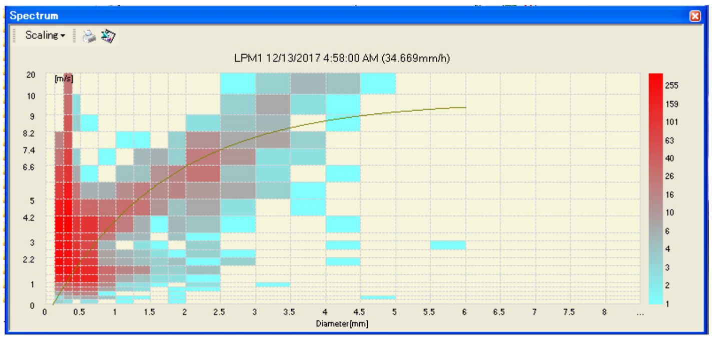


Fig. 5.5-1: An example of 1-minute raw data, obtained by LPM at 0458UTC on Dec.13, 2017. Data is shown by two-dimensional histogram to display numbers of observed raindrops categorized by diameter and fall speed.

Table 5.5-1: Categories of the size and the fall speed for LPM.

Particle Size		
Class	Diameter [mm]	Class width [mm]
1	≥ 0.125	0.125
2	≥ 0.250	0.125
3	≥ 0.375	0.125
4	≥ 0.500	0.250
5	≥ 0.750	0.250
6	≥ 1.000	0.250
7	≥ 1.250	0.250
8	≥ 1.500	0.250
9	≥ 1.750	0.250
10	≥ 2.000	0.500
11	≥ 2.500	0.500
12	≥ 3.000	0.500
13	≥ 3.500	0.500
14	≥ 4.000	0.500
15	≥ 4.500	0.500
16	≥ 5.000	0.500
17	≥ 5.500	0.500
18	≥ 6.000	0.500
19	≥ 6.500	0.500
20	≥ 7.000	0.500
21	≥ 7.500	0.500
22	≥ 8.000	unlimited

Fall Speed		
Class	Speed [m/s]	Class width [m/s]
1	≥ 0.000	0.200
2	≥ 0.200	0.200
3	≥ 0.400	0.200
4	≥ 0.600	0.200
5	≥ 0.800	0.200
6	≥ 1.000	0.400
7	≥ 1.400	0.400
8	≥ 1.800	0.400
9	≥ 2.200	0.400
10	≥ 2.600	0.400
11	≥ 3.000	0.800
12	≥ 3.400	0.800
13	≥ 4.200	0.800
14	≥ 5.000	0.800
15	≥ 5.800	0.800
16	≥ 6.600	0.800
17	≥ 7.400	0.800
18	≥ 8.200	0.800
19	≥ 9.000	1.000
20	≥ 10.000	10.000

Table 5.5-3: Categories of the size and the fall speed for Parsivel.

Particle Size			Fall Speed		
Class	Average Diameter [mm]	Class spread [mm]	Class	Average Speed [m/s]	Class Spread [m/s]
1	0.062	0.125	1	0.050	0.100
2	0.187	0.125	2	0.150	0.100
3	0.312	0.125	3	0.250	0.100
4	0.437	0.125	4	0.350	0.100
5	0.562	0.125	5	0.450	0.100
6	0.687	0.125	6	0.550	0.100
7	0.812	0.125	7	0.650	0.100
8	0.937	0.125	8	0.750	0.100
9	1.062	0.125	9	0.850	0.100
10	1.187	0.125	10	0.950	0.100
11	1.375	0.250	11	1.100	0.200
12	1.625	0.250	12	1.300	0.200
13	1.875	0.250	13	1.500	0.200
14	2.125	0.250	14	1.700	0.200
15	2.375	0.250	15	1.900	0.200
16	2.750	0.500	16	2.200	0.400
17	3.250	0.500	17	2.600	0.400
18	3.750	0.500	18	3.000	0.400
19	4.250	0.500	19	3.400	0.400
20	4.750	0.500	20	3.800	0.400
21	5.500	1.000	21	4.400	0.800
22	6.500	1.000	22	5.200	0.800
23	7.500	1.000	23	6.000	0.800
24	8.500	1.000	24	6.800	0.800
25	9.500	1.000	25	7.600	0.800
26	11.000	2.000	26	8.800	1.600
27	13.000	2.000	27	10.400	1.600
28	15.000	2.000	28	12.000	1.600
29	17.000	2.000	29	13.600	1.600
30	19.000	2.000	30	15.200	1.600
31	21.500	3.000	31	17.600	3.200
32	24.500	3.000	32	20.800	3.200

5.6 Lidar

(1) Personal

Masaki KATSUMATA	(JAMSTEC)	- Principal Investigator
Kyoko TANIGUCHI	(JAMSTEC)	
Tomoaki NISHIZAWA	(NIES)	(not on board)
Atsushi SHIMIZU	(NIES)	(not on board)

(2) Objective

To capture distributions of water vapor, aerosol and cloud in high temporal and special resolutions.

(3) Instrumentation and Methods

The Mirai lidar transmits wavelengths of 1064nm, 532nm and 355nm in 10Hz. The lidar detects elastic scattering of these wavelengths up to 21km range. The lidar divides 532nm and 355nm signals into parallel and perpendicular components to capture depolarization properties. In addition, the lidar collects water vapor and nitrogen Raman signals. Specifically, water vapor signals in 660nm and 408nm and nitrogen signals in 607nm and 387nm with 532nm and 355nm as light sources, respectively. Based on these Raman signals, the system offers water vapor mixing ratio observation.

During this cruise, the system obtained background noise data at 23:56-00:00UTC by closing a shutter along the signal path. At the same time, observation window was wiped manually.

(4) Preliminary Results

Fig 5.6-1 shows preliminary results of 355 nm, 532 nm and 1064 nm data obtained between 16:00 and 23:56 UTC on 17 December 2017. Fig 5.6-2 is the depolarization of 532nm and 355nm at the same period. Strong signals in Fig 5.6-1 signifies clouds in general. The intensity of depolarization characterizes the clouds into water or ice clouds. From the continuous observed data, the estimated melting layer height is between 4.5 and 5 km around the station. Remarkably, lidar observed clouds with low depolarization above the melting layer, such as between 19:30 and 20:30 around 7.5km. We witnessed such phenomena several times in this cruise.

Fig 5.6-3 is a preliminary result of water vapor and nitrogen Raman signal ratios on Dec. 19, 2017 UTC. These ratios are a proportional to the water vapor mixing ratio. The both ratios indicate the drier air sank from 1.5km to 0.5km height around 13:30 UTC and the height of higher water vapor content recovers gradually in three hours.

(5) Data Archive

The lidar was operated from Nov. 23, 2017 to Jan. 4, 2018, and Jan. 6, 2018 to Jan. 11, 2018. All data will be reviewed and quality-controlled after the cruise. The data obtained during this cruise will be submitted to the JAMSTEC Data Management Group (DMG).

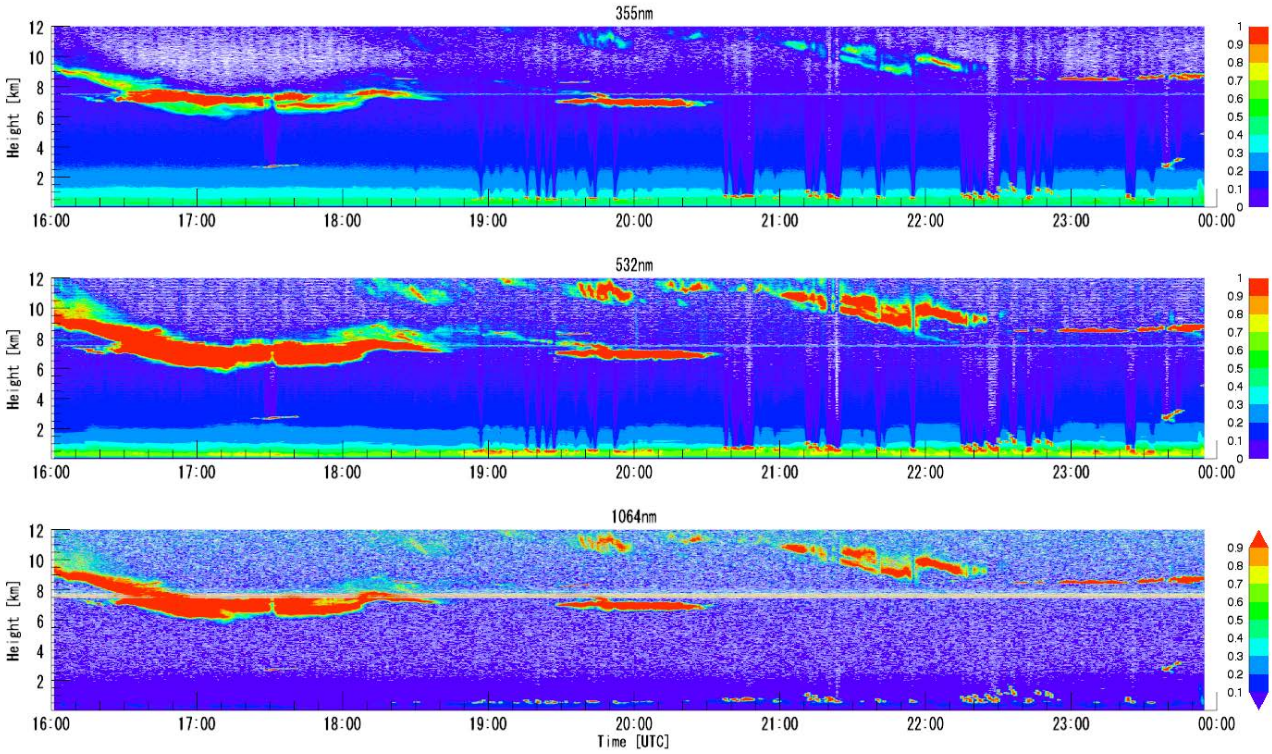


Fig 5.6-1: Preliminary results of 355nm, 532nm and 1064nm data obtained between 12:00 and 16:00 UTC on 17 December 2017.

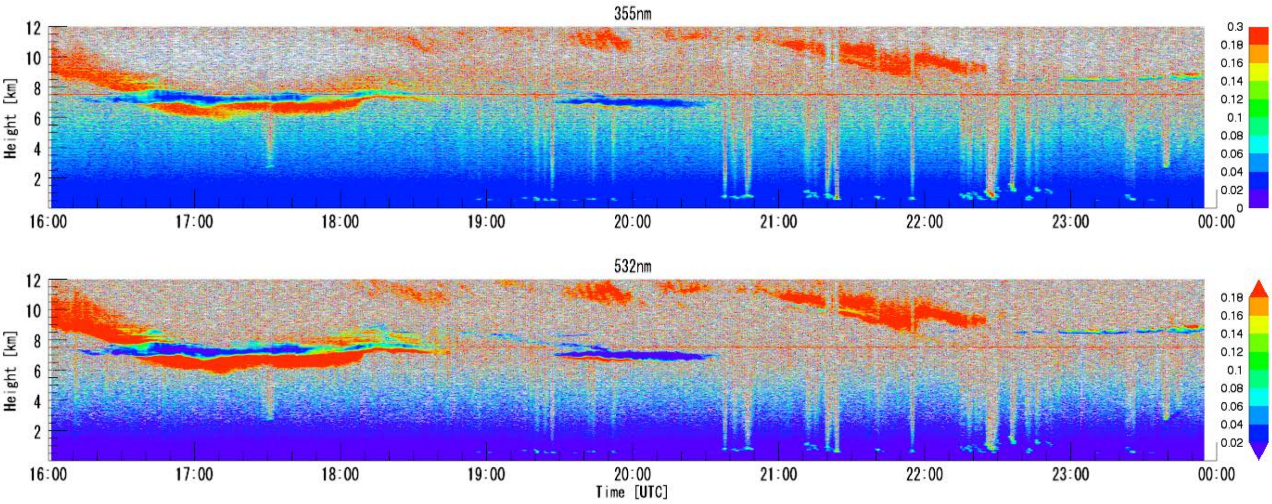


Fig 5.6-2: Preliminary results of 355nm, 532nm depolarization data obtained between 12:00 and 16:00 UTC on 17 December 2017.

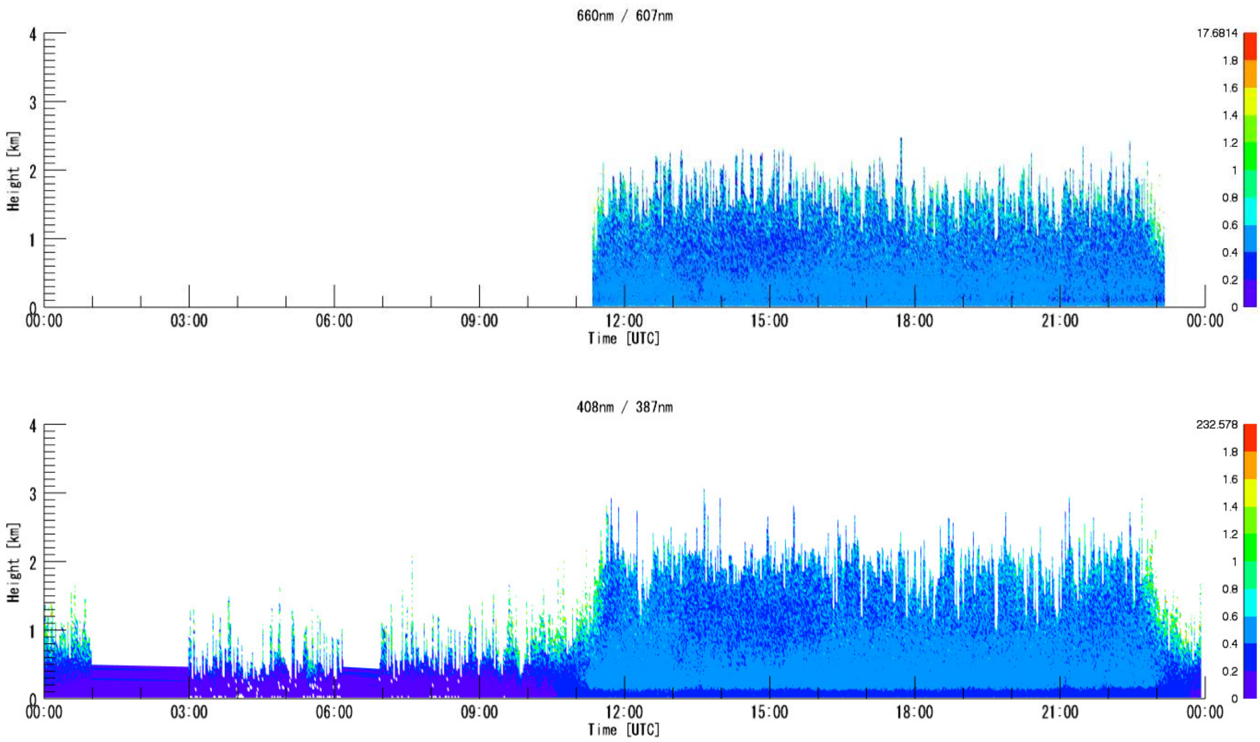


Fig 5.6-3: Preliminary results of water vapor and nitrogen Raman signal ratios obtained on 19 December 2017. a) ratio of 660nm and 607nm, b) ratio of 408nm and 387nm.

5.7 Ceilometer

(1) Personnel

Satoru YOKOI	(JAMSTEC) -Principal Investigator	
Souichiro SUEYOSHI	(Nippon Marine Enterprises Ltd., NME)	- Leg1 -
Shinya OKUMURA	(NME)	- Leg1 -
Wataru TOKUNAGA	(NME)	- Leg1 -
Ryo OYAMA	(NME)	- Leg1,2 -
Miki TAWATA	(NME)	- Leg1,2 -
Masanori MURAKAMI	(MIRAI Crew)	- Leg1,2 -

(2) Objectives

The information of cloud base height and the liquid water amount around cloud base is important to understand the process on formation of the cloud. As one of the methods to measure them, the ceilometer observation was carried out.

(3) Parameters

1. Cloud base height [m].
2. Backscatter profile, sensitivity and range normalized at 10 m resolution.
3. Estimated cloud amount [oktas] and height [m]; Sky Condition Algorithm.

(4) Methods

We measured cloud base height and backscatter profile using ceilometer (CL51, VAISALA, Finland) throughout the MR17-08 cruise.

Major parameters for the measurement configuration are as follows;

Laser source:	Indium Gallium Arsenide (InGaAs) Diode Laser
Transmitting center wavelength:	910±10 nm at 25 degC
Transmitting average power:	19.5 mW
Repetition rate:	6.5 kHz
Detector:	Silicon avalanche photodiode (APD)
Measurement range:	0 ~ 15 km
	0 ~ 13 km (Cloud detection)
Resolution:	10 meter in full range
Sampling rate:	36 sec
Sky Condition	0, 1, 3, 5, 7, 8 oktas (9: Vertical Visibility)
	(0: Sky Clear, 1:Few, 3:Scattered, 5-7: Broken, 8: Overcast)

On the archive dataset, cloud base height and backscatter profile are recorded with the resolution of 10 m (33 ft).

(5) Preliminary results

Fig.5.7-1 shows the time series plot of the lowest, second and third cloud base height during the cruise.

(6) Data archive

Ceilometer data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via "Data Research System for Whole Cruise Information in JAMSTEC

(DARWIN)” in JAMSTEC web site. <http://www.godac.jamstec.go.jp/darwin/e>

(7) Remarks

1) Window Cleaning

04:39UTC 27 Nov. 2017

11:03UTC 10 Dec. 2017

03:39UTC 18 Dec. 2017

11:25UTC 02 Jan. 2018

2) The following period, data acquisition was stopped due to recording PC trouble.

00:00UTC - 02:07UTC 01 Dec. 2017

3) The following period, data acquisitions were suspended in the foreign EEZ.

01:00UTC 12 Nov. 2017 to 07:30UTC 22 Nov. 2017

07:30UTC, 11 Jan. 2018 to 00:30UTC, 12 Jan. 2018

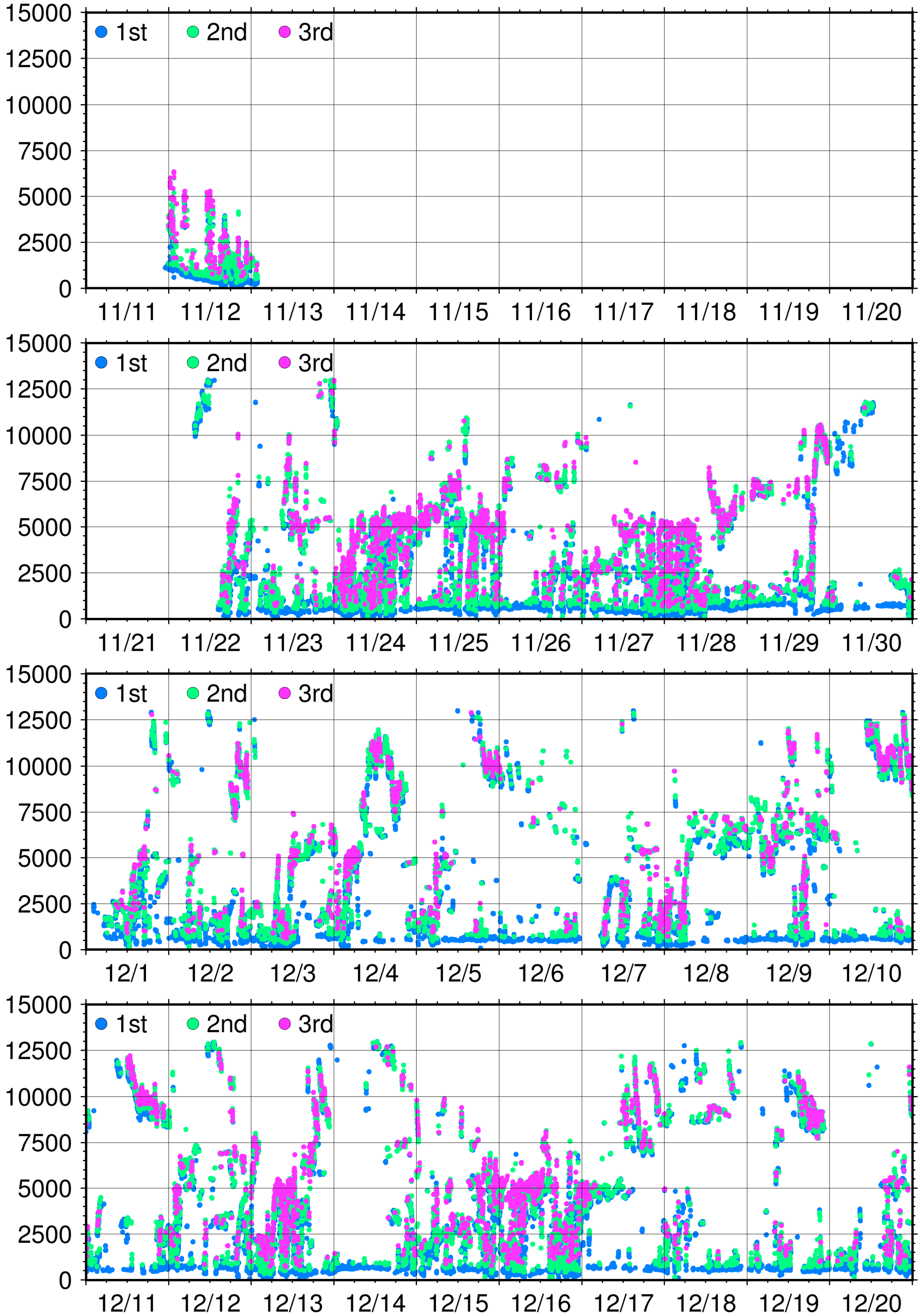


Fig. 5.7-1 First (Blue), 2nd (Green) and 3rd (Red) lowest cloud base height during the cruise.

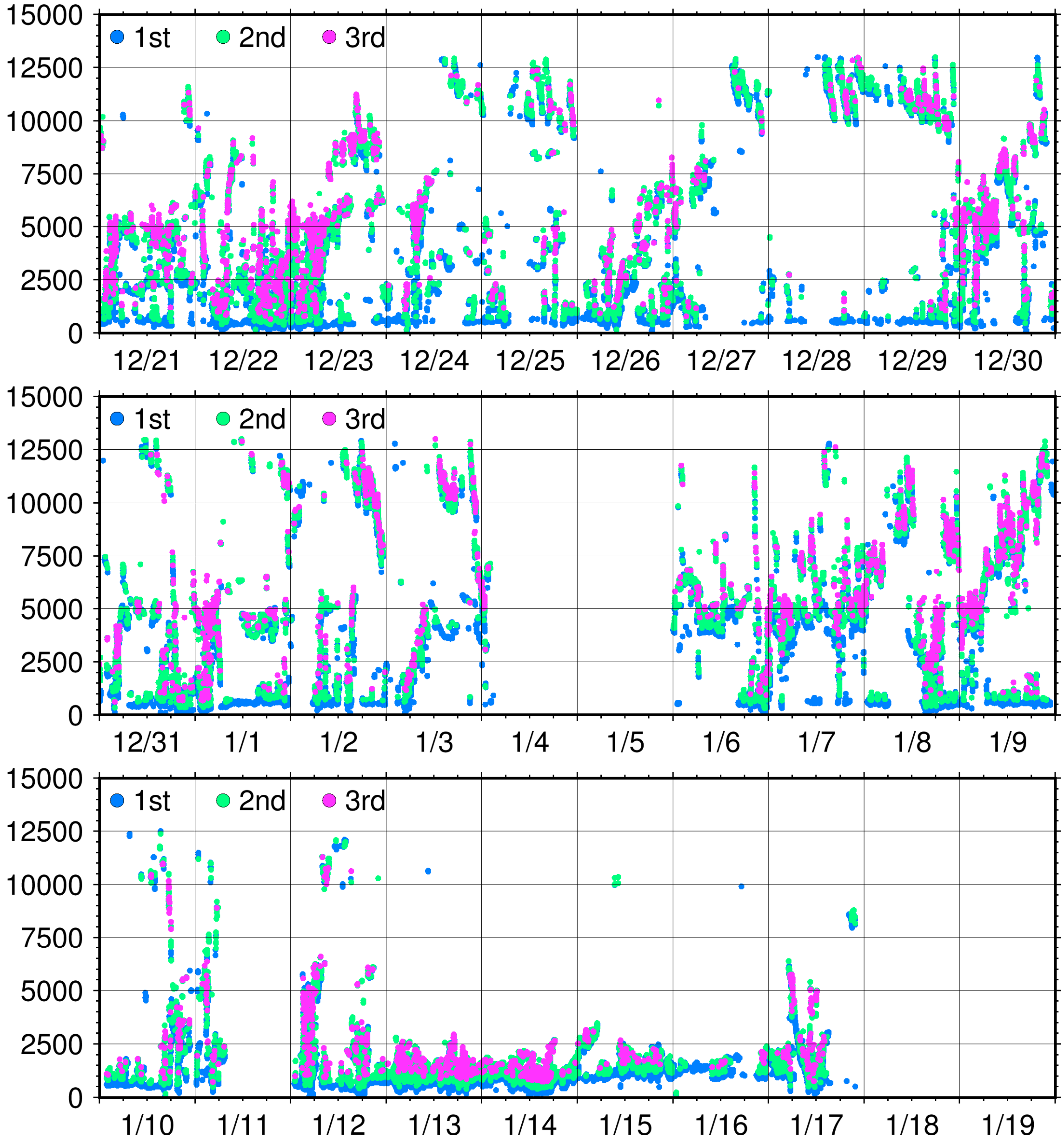


Fig. 5.7-1 (continue)

5.8 Aerosol optical characteristics measured by ship-borne sky radiometer

(1) Personnel

Kazuma Aoki (University of Toyama) Principal Investigator / not onboard
Tadahiro Hayasaka (Tohoku University) Co-worker / not onboard
Masahiro Hori (JAXA) Co-worker / not onboard
Sky radiometer operation was supported by Nippon Marine Enterprises, Ltd.

(2) Objective

Objective of this observation is to study distribution and optical characteristics of marine aerosols by using a ship-borne sky radiometer (POM-01 MK-III: PREDE Co. Ltd., Japan). Furthermore, collections of the data for calibration and validation to the remote sensing data were performed simultaneously.

(3) Parameters

- Aerosol optical thickness at five wavelengths (400, 500, 675, 870 and 1020 nm)
- Ångström exponent
- Single scattering albedo at five wavelengths
- Size distribution of volume (0.01 μm – 20 μm)
- # GPS provides the position with longitude and latitude and heading direction of the vessel, and azimuth and elevation angle of the sun. Horizon sensor provides rolling and pitching angles.

(4) Instruments and Methods

The sky radiometer measures the direct solar irradiance and the solar aureole radiance distribution with seven interference filters (0.315, 0.4, 0.5, 0.675, 0.87, 0.94, and 1.02 μm). Analysis of these data was performed by SKYRAD.pack version 4.2 developed by Nakajima *et al*. 1996.

(5) Data archives

Aerosol optical data are to be archived at University of Toyama (K.Aoki, SKYNET/SKY: http://skyrad.sci.u-toyama.ac.jp/) after the quality check and will be submitted to JAMSTEC.

5.9 Aerosol and gas observations

(1) Personnel

Yugo KANAYA (JAMSTEC RCGC, not on board)
Fumikazu TAKETANI (JAMSTEC RCGC, not on board)
Takuma MIYAKAWA (JAMSTEC RCGC, not on board)
Hisahiro TAKASHIMA (JAMSTEC RCGC, not on board)
Operation was supported by Nippon Marine Enterprises, Ltd.

(2) Objectives

Objectives of the observations are to investigate roles of atmospheric aerosols and gases, including black carbon and ozone, in the marine atmosphere in relation to climate change, and to investigate processes of biogeochemical cycles between the atmosphere and the ocean.

(3) Methods and Instruments

The observed parameters are

- Black carbon (BC) particles
- Aerosol optical depth (AOD) and aerosol extinction coefficient (AEC)
- Surface ozone (O_3), and carbon monoxide (CO) mixing ratios

Online observations black carbon (BC) particles were made by the instruments based on laser-induced incandescence (SP2, Droplet Measurement Technologies). Ambient air was continuously sampled from the flying bridge and drawn through a ~3-m-long conductive tube and introduced to the instruments after dried.

Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS), a passive remote sensing technique measuring spectra of scattered visible and ultraviolet (UV) solar radiation, was used for atmospheric aerosol and gas profile measurements. Our MAX-DOAS instrument consists of two main parts: an outdoor telescope unit and an indoor spectrometer (Acton SP-2358 with Princeton Instruments PIXIS-400B), connected to each other by a 14-m bundle optical fiber cable. The line of sight was in the directions of the portside of the vessel and the multiple elevation angles, 1.5, 3, 5, 10, 20, 30, 90 degrees, were scanned repeatedly (every ~15-min) using a movable prism. For the selected spectra recorded with elevation angles with good accuracy, DOAS spectral fitting was performed to quantify the slant column density (SCD) of NO_2 (and other gases) and O_4 (O_2-O_2, collision complex of oxygen) for each elevation angle. Then, the O_4 SCDs were converted to the aerosol optical depth (AOD) and the vertical profile of aerosol extinction coefficient (AEC) using an optimal estimation inversion method with a radiative transfer model. Using derived aerosol information, retrievals of the tropospheric vertical column/profile of NO_2 and other gases were made.

For ozone and CO measurements, ambient air was continuously sampled on the compass deck and drawn through ~20-m-long Teflon tubes connected to a gas filter correlation CO analyzer (Model 48iTLE, Thermo Fisher Scientific) and a UV photometric ozone analyzer (Model 49C, Thermo Fisher Scientific), located in the Research Information Center. The data will be used for characterizing air mass origins.

(4) Preliminary results

N/A (Data analysis is to be conducted.)

(5) Data archives

These data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via "Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)" in JAMSTEC web site.
<http://www.godac.jamstec.go.jp/darwin/e>

5.10 Stable isotope in the vapor and rainwater

(1) Personnel

Kei YOSHIMURA	(IIS, U-Tokyo) (Not on board)	- Principal Investigator
Yukari TAKAYABU	(AORI, U-Tokyo) (Not on board)	
Kimpei ICHIYANAGI	(Kumamoto U.) (Not on board)	
Yuki TAKANO	(AORI, U-Tokyo)	
Yuhi NAKAMURA	(AORI, U-Tokyo)	

(2) Objectives

By using the stable isotopic ratios of water ($\delta^{18}O$ and δD) both in precipitation and vapor, we will investigate the processes of water circulation during MJO events.

(3) Instruments and Methods

We installed a laser spectroscopic analyzer (Picarro, L2120-i) in the indoor labo space of the ship for water vapor isotope measurement. Two air-sampling inlets were installed on the side of the ship at two different heights (10 m and 20 m from the water surface), and isotope ratio of the sampled air is analyzed continuously. In addition, an automatic rain collector (Eigenbrodt, NSA181) is installed at the top floor of the ship, and isotopic ratio of the rain samples were analyzed, typically for every 30 minutes to a few hours.

(4) Results

The rainwater samples data (122 samples) is summarized in Table 5.10-1. We will further investigate the data of vapor and precipitation isotopes after the cruise.

(5) Data archive

Isotope data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via "Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)" in JAMSTEC web site. <http://www.godac.jamstec.go.jp/darwin/e>

(6) Remarks

There were some dew forming issues during the cruise and some isotopic values of the vapor were wrongly measured. We will carefully check the whole data and make them open.

Table 5.10-1 Summary of rainwater samples. Note that “Amount” column shows water level of the sampling bottle, not rainfall amount.

#	Start (UTC)	Stop (UTC)	Latitude	Longitude	Amount (cm)
1	2017/11/22 20:17	2017/11/22 21:57	06-06.52440N	095-57.99890E	5.3
2	2017/11/23 4:42	2017/11/23 6:41	05-57.30240N	094-30.17870E	full
3	2017/11/23 12:14	2017/11/23 12:43	05-02.10270N	093-50.95640E	0.8
4	2017/11/23 13:02	2017/11/23 15:01	04-41.13990N	093-34.79190E	0.6
5	2017/11/23 17:24	2017/11/23 19:23	04-00.94450N	093-06.32000E	2.5
6	2017/11/23 23:13	2017/11/24 0:56	03-09.40490N	092-28.03830E	0.2
7	2017/11/24 1:01	2017/11/24 2:59	02-51.45940N	092-14.68830E	8.5
8	2017/11/24 4:24	2017/11/24 6:23	02-22.52130N	091-53.62600E	0.5
9	2017/11/24 6:24	2017/11/24 8:25	02-05.00560N	091-40.78560E	6.7
10	2017/11/24 10:30	2017/11/24 12:29	01-31.72620N	091-16.59190E	6
11	2017/11/25 0:51	2017/11/25 2:59	00-00.82760S	090-10.02990E	0.5
12	2017/11/25 5:11	2017/11/25 7:09	00-00.22260N	090-11.54410E	0.3
13	2017/11/25 7:12	2017/11/25 9:10	00-00.26410S	090-09.06660E	0.7
14	2017/11/25 22:24	2017/11/26 0:24	01-37.01460S	089-59.23410E	0.2
15	2017/11/26 11:08	2017/11/26 13:01	02-21.14470S	090-34.11300E	0.8
16	2017/11/26 13:35	2017/11/26 15:26	02-44.86510S	090-52.99760E	1.5
17	2017/11/26 15:38	2017/11/26 17:38	03-08.28360S	091-11.14440E	2.4
18	2017/11/26 21:09	2017/11/26 23:07	04-05.64770S	091-56.18360E	0.3
19	2017/11/26 23:08	2017/11/27 1:01	04-25.52230S	092-11.92370E	0.7
20	2017/11/26 23:08	2017/11/27 1:01	04-25.52230S	092-11.92370E	small
21	2017/11/27 2:41	2017/11/27 4:41	05-01.69050S	092-41.36290E	4.5
22	2017/11/27 10:57	2017/11/27 12:40	06-23.34130S	093-45.09200E	0.2
23	2017/11/27 17:12	2017/11/27 19:10	07-28.03170S	094-37.12620E	full
24	2017/11/27 19:16	2017/11/27 21:14	07-47.08530S	094-52.07540E	full
25	2017/11/28 5:48	2017/11/28 7:47	07-59.32120S	095-02.62780E	3
26	2017/11/28 8:36	2017/11/28 10:35	07-58.41730S	095-08.61250E	7.2
27	2017/11/28 13:50	2017/11/28 15:50	08-03.22400S	095-10.90520E	0.5
28	2017/11/29 16:32	2017/11/29 18:33	05-38.41200S	095-00.66420E	1.4
29	2017/11/30 20:34	2017/11/30 22:33	05-06.16040S	095-00.48040E	4.3
30	2017/11/30 20:34	2017/11/30 22:33	05-06.16040S	095-00.48040E	small
31	2017/12/1 11:35	2017/12/1 13:35	05-04.72360S	096-36.87500E	full
32	2017/12/1 13:35	2017/12/1 15:35	05-03.64330S	097-02.03320E	1.2
33	2017/12/1 17:35	2017/12/1 19:35	05-02.88180S	097-52.70570E	small
34	2017/12/2 4:48	2017/12/2 6:14	05-00.01210S	100-02.79720E	1.5
35	2017/12/2 6:48	2017/12/2 9:49	04-52.00640S	099-53.86530E	1.3
36	2017/12/2 13:13	2017/12/2 15:12	04-59.81080S	100-10.58470E	4.6
37	2017/12/2 15:25	2017/12/2 17:24	05-03.29770S	100-03.99640E	2.3
38	2017/12/2 20:06	2017/12/2 20:55	05-03.71270S	100-03.88490E	0.5
39	2017/12/3 4:13	2017/12/3 6:13	04-59.60080S	099-59.91930E	1.1
40	2017/12/3 6:13	2017/12/3 8:13	04-59.60190S	100-00.24620E	5.7
41	2017/12/3 8:28	2017/12/3 10:27	05-00.46300S	100-03.43040E	full
42	2017/12/3 10:28	2017/12/3 11:23	04-59.49370S	100-00.83280E	0.5
43	2017/12/3 23:50	2017/12/4 1:49	04-34.36270S	100-51.32730E	8.3
44	2017/12/4 2:15	2017/12/4 4:14	04-29.60740S	101-00.92260E	6.5
45	2017/12/4 4:15	2017/12/4 6:04	04-26.50450S	101-07.25410E	small
46	2017/12/5 3:35	2017/12/5 5:08	04-12.94720S	101-30.87740E	1.7
47	2017/12/5 17:29	2017/12/5 19:28	04-14.07770S	101-30.06960E	6.2
48	2017/12/6 21:56	2017/12/6 23:56	04-15.40580S	101-30.97770E	small
49	2017/12/7 6:08	2017/12/7 8:08	04-13.84070S	101-30.66470E	1
50	2017/12/7 10:55	2017/12/7 12:55	04-15.01610S	101-31.50690E	4.8
51	2017/12/7 12:55	2017/12/7 14:55	04-14.50050S	101-31.27050E	0.5
52	2017/12/7 21:31	2017/12/7 23:31	04-13.72840S	101-31.09890E	0.5
53	2017/12/7 23:35	2017/12/8 1:35	04-14.61110S	101-30.96280E	0.5
54	2017/12/8 1:35	2017/12/8 3:35	04-14.85070S	101-31.38740E	2
55	2017/12/8 5:32	2017/12/8 7:32	04-14.34260S	101-30.95510E	0.5
56	2017/12/9 12:47	2017/12/9 14:46	04-14.78740S	101-31.10220E	2.6
57	2017/12/9 14:53	2017/12/9 16:26	04-14.04630S	101-31.27520E	7.9
58	2017/12/9 14:53	2017/12/9 16:26	04-14.04630S	101-31.27520E	0.5
59	2017/12/10 23:11	2017/12/11 1:09	04-14.75600S	101-31.35460E	1
60	2017/12/11 2:06	2017/12/11 2:50	04-14.74640S	101-30.81510E	1
61	2017/12/11 20:18	2017/12/11 22:16	04-15.27650S	101-31.79070E	0.8

Table 5.10-1 (*continue*)

#	Start (UTC)	Stop (UTC)	Latitude	Longitude	Amount (cm)
62	2017/12/12 1:03	2017/12/12 1:44	04-14.06410S	101-32.50630E	small
63	2017/12/12 19:02	2017/12/12 20:51	04-14.38810S	101-32.13100E	small
64	2017/12/12 21:39	2017/12/12 23:16	04-14.93260S	101-31.82730E	full
65	2017/12/13 1:59	2017/12/13 3:58	04-14.98760S	101-31.53970E	full
66	2017/12/13 6:09	2017/12/13 8:08	04-14.89900S	101-32.40890E	9.2
67	2017/12/13 8:27	2017/12/13 10:26	04-14.75770S	101-32.45270E	2.4
68	2017/12/13 12:38	2017/12/13 14:37	04-14.90650S	101-32.01150E	full
69	2017/12/13 12:38	2017/12/13 14:37	04-14.90650S	101-32.01150E	small
70	2017/12/14 19:20	2017/12/14 20:17	04-14.86200S	101-31.11270E	1
71	2017/12/14 21:44	2017/12/14 22:16	04-14.92480S	101-31.25560E	5.3
72	2017/12/15 17:50	2017/12/15 19:49	04-14.91880S	101-31.61080E	4.2
73	2017/12/15 20:23	2017/12/15 21:56	04-14.68740S	101-31.85550E	full
74	2017/12/15 22:51	2017/12/16 0:36	04-14.54410S	101-31.65220E	0.7
75	2017/12/16 0:49	2017/12/16 2:48	04-14.22390S	101-31.00600E	full
76	2017/12/16 7:05	2017/12/16 9:03	04-13.99740S	101-31.81940E	0.7
77	2017/12/16 9:34	2017/12/16 12:34	04-14.57210S	101-32.20990E	0.7
78	2017/12/16 13:36	2017/12/16 15:34	04-14.90830S	101-32.01650E	7.5
79	2017/12/16 15:55	2017/12/16 18:34	04-15.13980S	101-31.49350E	full
80	2017/12/16 18:34	2017/12/16 21:34	04-15.21060S	101-31.82740E	full
81	2017/12/16 21:34	2017/12/17 0:26	04-15.16280S	101-32.21340E	6.1
82	2017/12/17 23:10	2017/12/18 2:08	04-15.00460S	101-30.86520E	6.4
83	2017/12/18 2:58	2017/12/18 5:08	04-15.04000S	101-30.81980E	4.6
84	2017/12/19 8:23	2017/12/19 9:03	04-14.78460S	101-30.69150E	7.5
85	2017/12/19 8:23	2017/12/19 9:03	04-14.78460S	101-30.69150E	small
86	2017/12/19 20:21	2017/12/19 22:54	04-15.04990S	101-32.00280E	0.5
87	2017/12/20 6:01	2017/12/20 8:59	04-14.62810S	101-31.61190E	7.2
88	2017/12/20 14:55	2017/12/20 14:59	04-15.35580S	101-31.61750E	small
89	2017/12/20 14:59	2017/12/20 17:59	04-14.49580S	101-31.63740E	1.4
90	2017/12/20 17:59	2017/12/20 20:59	04-14.28460S	101-31.21770E	1.4
91	2017/12/20 20:59	2017/12/20 22:49	04-15.46240S	101-31.82020E	1
92	2017/12/21 0:17	2017/12/21 3:10	04-15.60930S	101-30.80100E	0.8
93	2017/12/21 0:17	2017/12/21 3:10	04-15.60930S	101-30.80100E	small
94	2017/12/22 4:23	2017/12/22 6:52	04-15.46760S	101-30.42070E	2.1
95	2017/12/22 6:52	2017/12/22 9:52	04-14.68250S	101-31.29200E	0.9
96	2017/12/22 13:52	2017/12/22 15:52	04-14.36510S	101-31.61980E	full
97	2017/12/22 16:04	2017/12/22 18:51	04-16.03590S	101-31.50330E	5.7
98	2017/12/22 18:52	2017/12/22 21:52	04-15.79420S	101-31.78840E	full
99	2017/12/22 21:52	2017/12/22 22:50	04-15.30820S	101-31.98290E	1
100	2017/12/22 22:50	2017/12/23 2:03	04-15.66500S	101-30.98230E	full
101	2017/12/23 2:06	2017/12/23 5:03	04-15.00320S	101-32.11740E	4.2
102	2017/12/23 5:03	2017/12/23 8:03	04-14.94580S	101-31.80070E	full
103	2017/12/23 11:23	2017/12/23 14:03	04-15.06570S	101-30.52130E	3.4
104	2017/12/24 3:47	2017/12/24 6:46	04-13.03260S	101-31.53550E	9.3
105	2017/12/24 6:46	2017/12/24 9:46	04-13.28650S	101-30.94640E	0.5
106	2017/12/26 6:09	2017/12/26 7:52	04-15.18890S	101-31.27070E	1.3
107	2017/12/26 8:08	2017/12/26 10:52	04-14.53650S	101-31.63510E	6.5
108	2017/12/26 17:31	2017/12/26 19:52	04-15.05250S	101-31.84010E	full
109	2017/12/27 2:29	2017/12/27 5:27	04-14.64060S	101-32.14810E	2.3
110	2017/12/27 2:29	2017/12/27 5:27	04-14.64060S	101-32.14810E	0.6
111	2017/12/29 21:58	2017/12/30 0:29	04-14.74950S	101-31.26680E	0.7
112	2017/12/30 1:59	2017/12/30 3:29	04-14.16940S	101-30.67070E	0.5
113	2017/12/30 15:08	2017/12/30 17:34	04-14.93460S	101-31.64480E	full
114	2017/12/30 22:02	2017/12/30 22:02	04-15.37910S	101-31.96160E	1
115	2017/12/31 2:20	2017/12/31 5:18	04-14.88350S	101-31.14390E	full
116	2017/12/31 2:20	2017/12/31 5:18	04-14.88350S	101-31.14390E	0.6
117	2017/12/31 12:16	2017/12/31 14:18	04-14.92300S	101-31.35040E	8.9
118	2017/12/31 14:18	2017/12/31 17:18	04-13.95130S	101-31.22700E	full
119	2017/12/31 17:30	2017/12/31 20:18	04-13.40560S	101-31.40660E	full
120	2017/12/31 20:18	2017/12/31 22:54	04-14.23130S	101-30.93510E	3.8
121	2017/12/31 23:53	2018/1/1 2:52	04-14.35560S	101-30.78670E	full
122	2018/1/1 2:52	2018/1/1 5:52	04-14.11950S	101-31.47190E	0.6

5.11 Surface Meteorological Observations

(1) Personnel

Satoru YOKOI	(JAMSTEC) - Principal Investigator	
Souichro SUEYOSHI	(Nippon Marine Enterprises Ltd., NME)	- Leg1 -
Shinya OKUMURA	(NME)	- Leg1 -
Wataru TOKUNAGA	(NME)	- Leg1 -
Ryo OYAMA	(NME)	- Leg1,2 -
Miki TAWATA	(NME)	- Leg1,2 -
Masanori MURAKAMI	(Mirai Crew)	- Leg1,2 -

(2) Objectives

Surface meteorological parameters are observed as a basic dataset of the meteorology. These parameters provide the temporal variation of the meteorological condition surrounding the ship.

(3) Methods

Surface meteorological parameters were observed throughout the MR17-08 cruise. During this cruise, we used two systems for the observation.

i. *MIRAI Surface Meteorological observation (SMet) system*

Instruments of SMet system are listed in Table 5.11-1 and measured parameters are listed in Table 5.11-2. Data were collected and processed by KOAC-7800 weather data processor made by Koshin-Denki, Japan. The data set consists of 6-second averaged data.

ii. *Shipboard Oceanographic and Atmospheric Radiation (SOAR) measurement system*

SOAR system designed by BNL (Brookhaven National Laboratory, USA) consists of major six parts.

a) Portable Radiation Package (PRP) designed by BNL – short and long wave downward radiation.
b) Analog meteorological data sampling with CR1000 logger manufactured by Campbell Inc. Canada – wind pressure, and rainfall (by a capacitive rain gauge) measurement.
c) Digital meteorological data sampling from individual sensors - air temperature, relative humidity and rainfall (by optical rain gauge (ORG)) measurement.
d) "SeaSnake" the floating thermistor designed by BNL – skin sea surface temperature (SSST) measurement.
e) Photosynthetically Available Radiation (PAR) and Ultraviolet Irradiance (UV) sensor manufactured by Biospherical Instruments Inc (USA) – PAR and UV measurement
f) Scientific Computer System (SCS) developed by NOAA (National Oceanic and Atmospheric Administration, USA) – centralized data acquisition and logging of all data sets.

SCS recorded PRP, air temperature and relative humidity, CR1000 and ORG data. SCS composed Event data (JamMet) from these data and ship's navigation data every 6 seconds. Instruments and their locations are listed in Table 5.11-3 and measured parameters are listed in Table 5.11-4.

SeaSnake has two thermistor probes and output voltage was converted to SSST by Steinhart-Hart equation with the following coefficients led from the calibration data.

Sensor	a	b	c
T01-005 Sensor:	8.15759E-04	-2.10917E-04	-7.29365E-08
T01-100 Sensor:	8.49767E-04	-2.06344E-04	-8.46958E-08

y = a + b * x + c * x**3
x = log (1 / ((Vref / V - 1) * R2 - R1))
T = 1 / y - 273.15
Vref = 2500[mV], R1=249000[Ω], R2=1000[Ω]
T: Temperature [degC], V: Sensor output voltage [mV]

For the quality control as post processing, we checked the following sensors, before and after the cruise.

i. Young Rain gauge (SMet and SOAR)
Inspect of the linearity of output value from the rain gauge sensor to change Input value by adding fixed quantity of test water.
ii. Barometer (SMet and SOAR)
Comparison with the portable barometer value, PTB220, VAISALA
iii. Thermometer (air temperature and relative humidity) (SMet and SOAR)
Comparison with the portable thermometer value, HM70, VAISALA
iv. SeaSnake SSST (SOAR)
SeaSnake thermistor probe was calibrated by the bath equipped with SBE-3 plus, Sea-Bird Electronics, Inc.

(4) Preliminary results

Figure 5.11-1 shows the time series of the following parameters;

Wind (SOAR)
Air temperature (SMet)
Relative humidity (SMet)
Precipitation (SOAR, ORG)
Short/long wave radiation (SOAR)
Barometric Pressure (SMet)
Sea surface temperature (SMet)
Significant wave height (SMet)

Figure 5.11-2 shows the time series of SSST compared to sea surface temperature (TSG).

(5) Data archives

These data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via “Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)” in JAMSTEC web site. <http://www.godac.jamstec.go.jp/darwin/e>

(6) Remarks

1. The following periods, SST data was available.

00:30UTC 12 Nov. 2017 - 23:30UTC 12 Nov. 2017
07:30UTC 22 Nov. 2017 - 02:00UTC 3 Jan. 2018
08:00UTC 6 Jan. 2018 - 07:30UTC 11 Jan. 2018
00:30UTC 12 Jan. 2018 - 05:30UTC 17 Jan. 2018

2. The following period, SeaSnake SSST data was available.
   03:44UTC 05 Dec. 2017 - 06:00UTC 01 Jan. 2018
3. The following periods, SSST observation was suspended.
   04:25UTC 05 Dec. 2017 - 04:26UTC 05 Dec. 2017
   09:45UTC 06 Dec. 2017 - 03:35UTC 07 Dec. 2017
   06:54UTC 30 Dec. 2017 - 08:17UTC 30 Dec. 2017
4. The following periods, SSST data were invalid due to maintenance.
   06:53UTC 10 Dec. 2017 - 06:57UTC 10 Dec. 2017
   06:58UTC 12 Dec. 2017 - 07:10UTC 12 Dec. 2017
   06:51UTC 18 Dec. 2017 - 06:57UTC 18 Dec. 2017
   06:50UTC 21 Dec. 2017 - 06:52UTC 21 Dec. 2017
   06:49UTC 22 Dec. 2017 - 06:50UTC 22 Dec. 2017
   06:51UTC 26 Dec. 2017 - 06:54UTC 26 Dec. 2017
   06:51UTC 31 Dec. 2017 - 06:53UTC 31 Dec. 2017
5. The following time, increasing of SMet capacitive rain gauge data was invalid due to transmitting for MF/HF radio.
   04:10UTC 14 Dec. 2017
6. The following period, data acquisitions were suspended in the foreign EEZ.
   01:00UTC 12 Nov. 2017 to 07:30UTC 22 Nov. 2017
   07:30UTC, 11 Jan. 2018 to 00:30UTC, 12 Jan. 2018

Table 5.11-1: Instruments and installation locations of MIRAI Surface Meteorological observation system

Sensors	Type	Manufacturer	Location (altitude from surface)
Anemometer	KE-500	Koshin Denki, Japan	foremast (24 m)
Tair/RH	HMP155	Vaisala, Finland with	
43408 Gill aspirated radiation shield		R.M. Young, USA	compass deck (21 m) starboard side and port side
Thermometer: SST	RFN2-0	Koshin Denki, Japan	4th deck (-1m, inlet -5m)
Barometer	Model-370	Setra System, USA	captain deck (13 m) weather observation room
Rain gauge	50202	R. M. Young, USA	compass deck (19 m)
Optical rain gauge	ORG-815DS	Osi, USA	compass deck (19 m)
Radiometer (short wave)	MS-802	Eko Seiki, Japan	radar mast (28 m)
Radiometer (long wave)	MS-202	Eko Seiki, Japan	radar mast (28 m)
Wave height meter	WM-2	Tsurumi-seiki, Japan	bow (10 m)

Table 5.11-2: Parameters of MIRAI Surface Meteorological observation system

Parameter	Units	Remarks
1 Latitude	degree	
2 Longitude	degree	
3 Ship's speed	knot	Mirai log
4 Ship's heading	degree	Mirai gyro
5 Relative wind speed	m/s	6sec./10min. averaged
6 Relative wind direction	degree	6sec./10min. averaged
7 True wind speed	m/s	6sec./10min. averaged
8 True wind direction	degree	6sec./10min. averaged
9 Barometric pressure	hPa	adjusted to sea surface level 6sec. averaged
10 Air temperature (starboard side)	degC	6sec. averaged
11 Air temperature (port side)	degC	6sec. averaged
12 Dewpoint temperature (starboard side)	degC	6sec. averaged
13 Dewpoint temperature (port side)	degC	6sec. averaged
14 Relative humidity (starboard side)	%	6sec. averaged
15 Relative humidity (port side)	%	6sec. averaged
16 Sea surface temperature	degC	6sec. averaged
17 Rain rate (optical rain gauge)	mm/hr	hourly accumulation
18 Rain rate (capacitive rain gauge)	mm/hr	hourly accumulation
19 Down welling shortwave radiation	W/m2	6sec. averaged
20 Down welling infra-red radiation	W/m2	6sec. averaged
21 Significant wave height (bow)	m	hourly
22 Significant wave height (aft)	m	hourly
23 Significant wave period (bow)	second	hourly
24 Significant wave period (aft)	second	hourly

Table 5.11-3: Instruments and installation locations of SOAR system

Sensors (Meteorological)	Type	Manufacturer	Location (altitude from surface)
Anemometer	05106	R.M. Young, USA	foremast (25 m)
Barometer	PTB210	Vaisala, Finland	foremast (23 m)
	with 61002 Gill pressure port, R.M. Young, USA		
Rain gauge	50202	R.M. Young, USA	foremast (24 m)
Tair/RH	HMP155	Vaisala, Finland	foremast (23 m)
	with 43408 Gill aspirated radiation shield R.M. Young, USA		
Optical rain gauge	ORG-815DR	Osi, USA	foremast (24 m)

Sensors (PRP)	Type	Manufacturer	Location (altitude from surface)
Radiometer (short wave)	PSP	Epply Labs, USA	foremast (25 m)
Radiometer (long wave)	PIR	Epply Labs, USA	foremast (25 m)
Fast rotating shadowband radiometer		Yankee, USA	foremast (25 m)

Sensor (PAR&UV)	Type	Manufacturer	Location (altitude from surface)
PAR&UV sensor	PUV-510	Biospherical Instrum -ents Inc., USA	Navigation deck (18m)

Sensors (SeaSnake)	Type	Manufacturer	Location (altitude from surface)
Thermistor	107	Campbell Scientific, USA	bow, 5m extension (0 m)

Table 5.11-4: Parameters of SOAR system

Parameter	Units	Remarks
1 Latitude	degree	
2 Longitude	degree	
3 SOG	knot	
4 COG	degree	
5 Relative wind speed	m/s	
6 Relative wind direction	degree	
7 Barometric pressure	hPa	
8 Air temperature	degC	
9 Relative humidity	%	
10 Rain rate (optical rain gauge)	mm/hr	
11 Precipitation (capacitive rain gauge)	mm	reset at 50 mm
12 Down welling shortwave radiation	W/m2	
13 Down welling infra-red radiation	W/m2	
14 Defuse irradiance	W/m2	
15 “SeaSnake” raw data	mV	
16 SSST (SeaSnake)	degC	
17 PAR	microE/cm2/sec.	
18 UV	microW/cm2/nm	

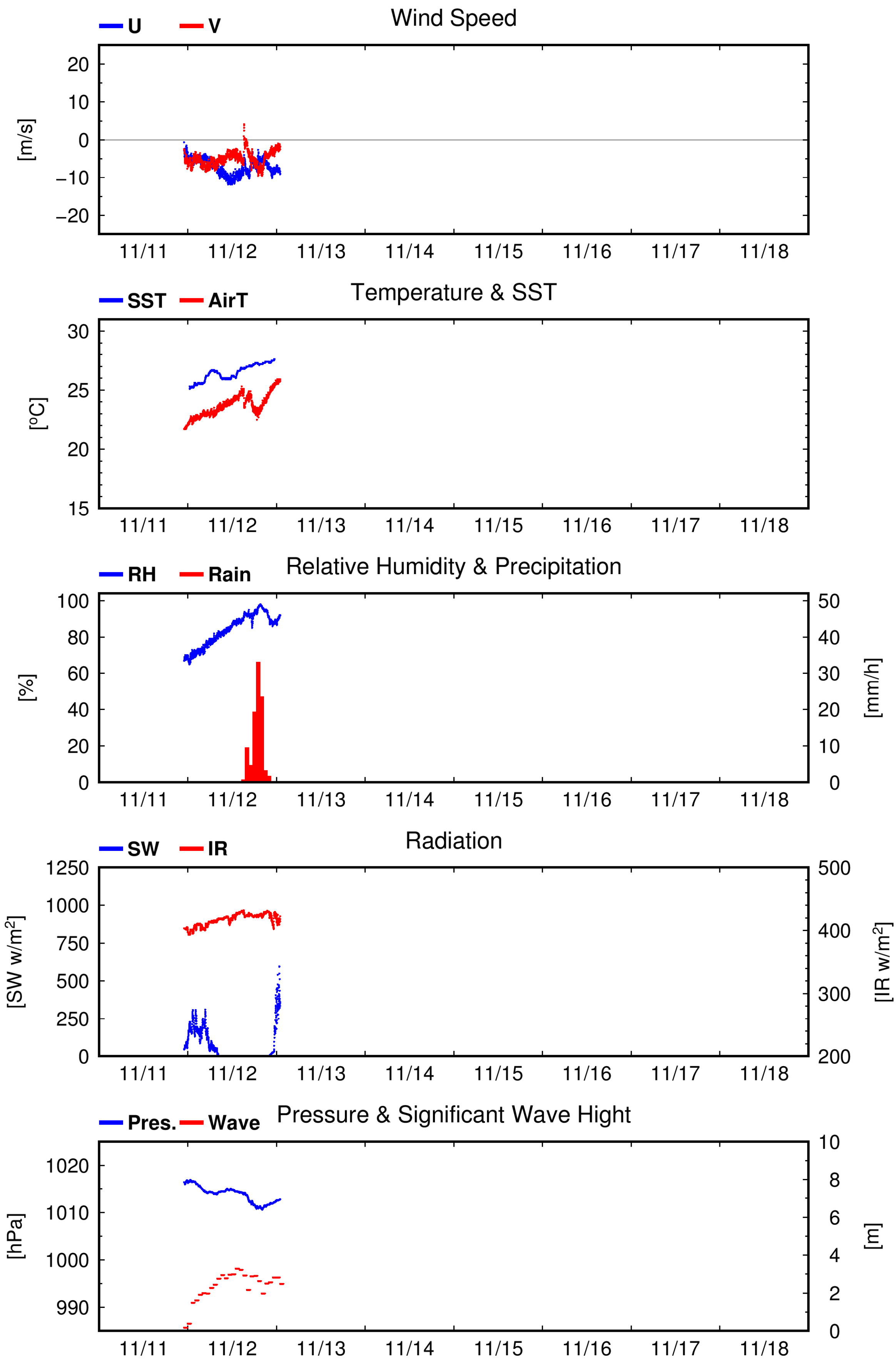


Fig. 5.11-1 Time series of surface meteorological parameters during the cruise

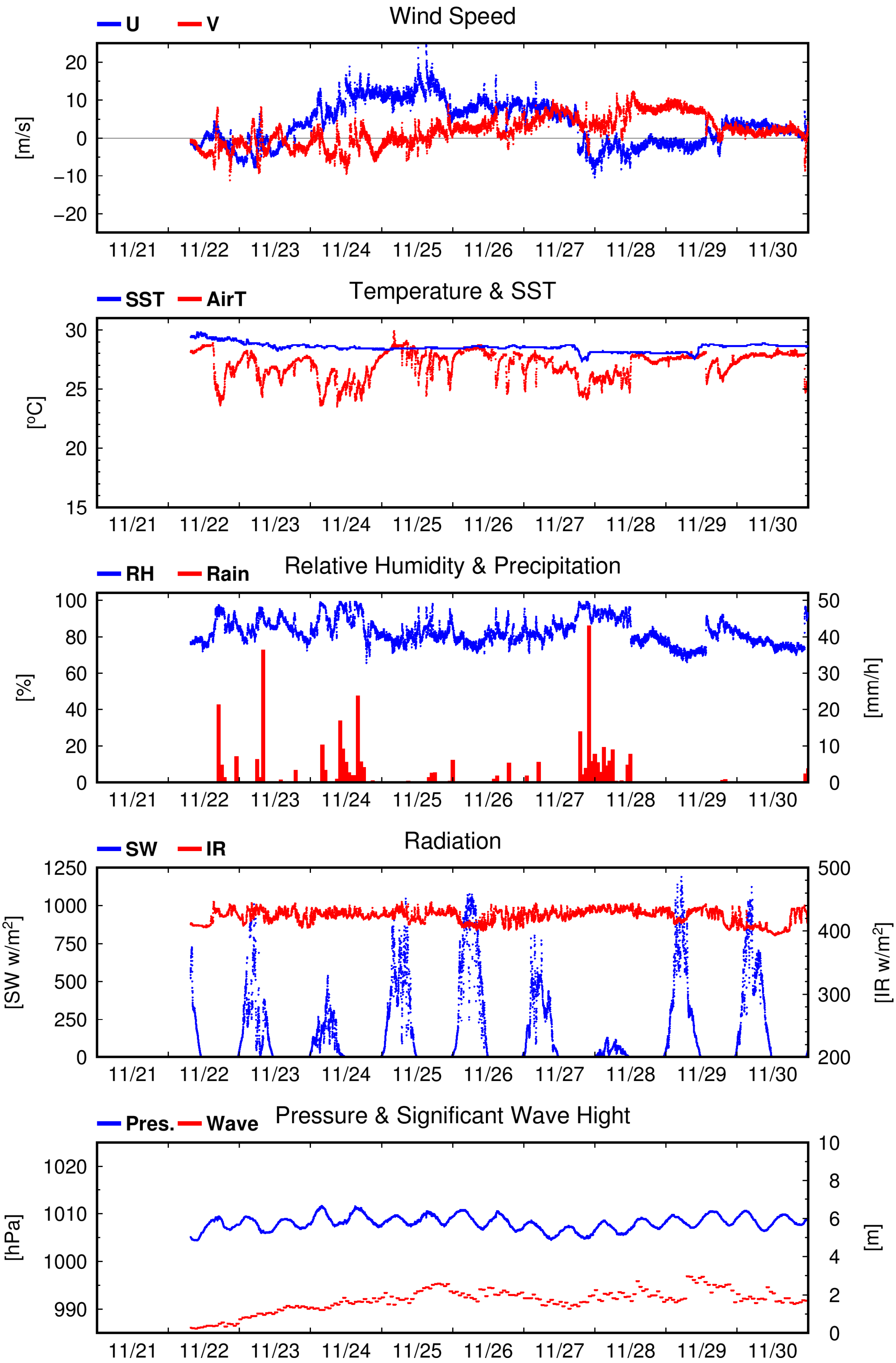


Fig. 5.11-1 (Continued)

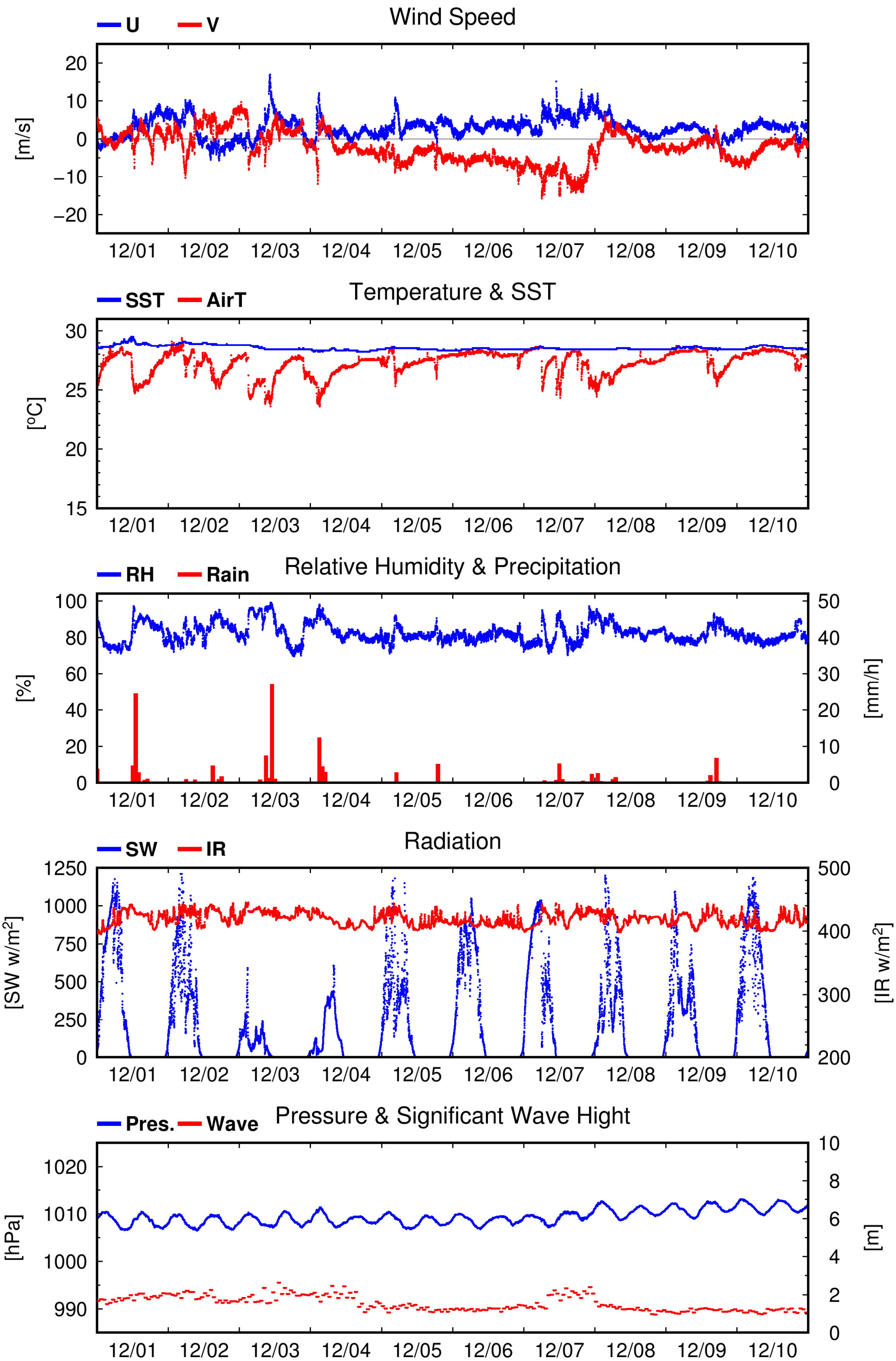


Fig. 5.11-1 (Continued)

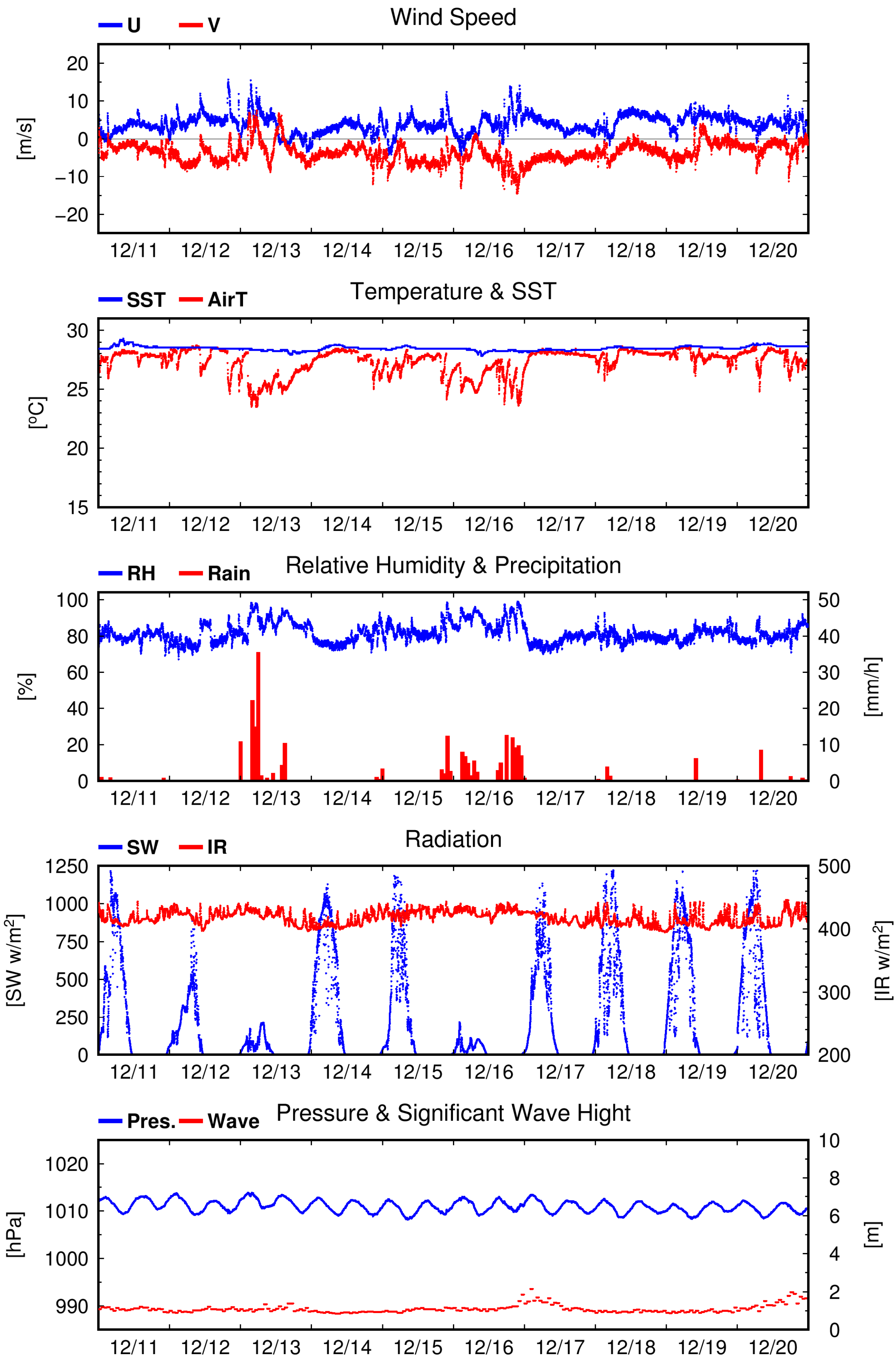


Fig. 5.11-1 (Continued)

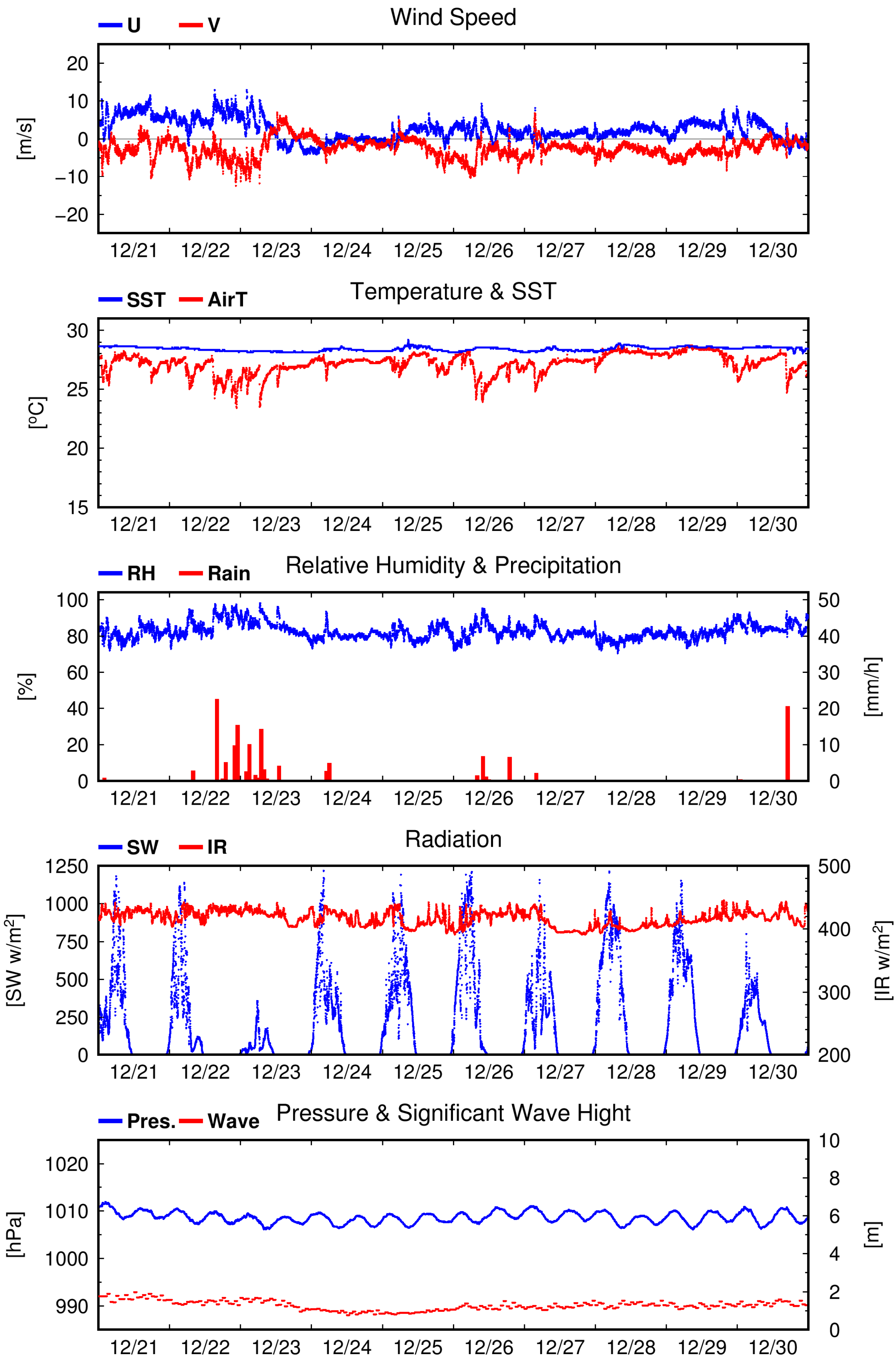


Fig. 5.11-1 (Continued)

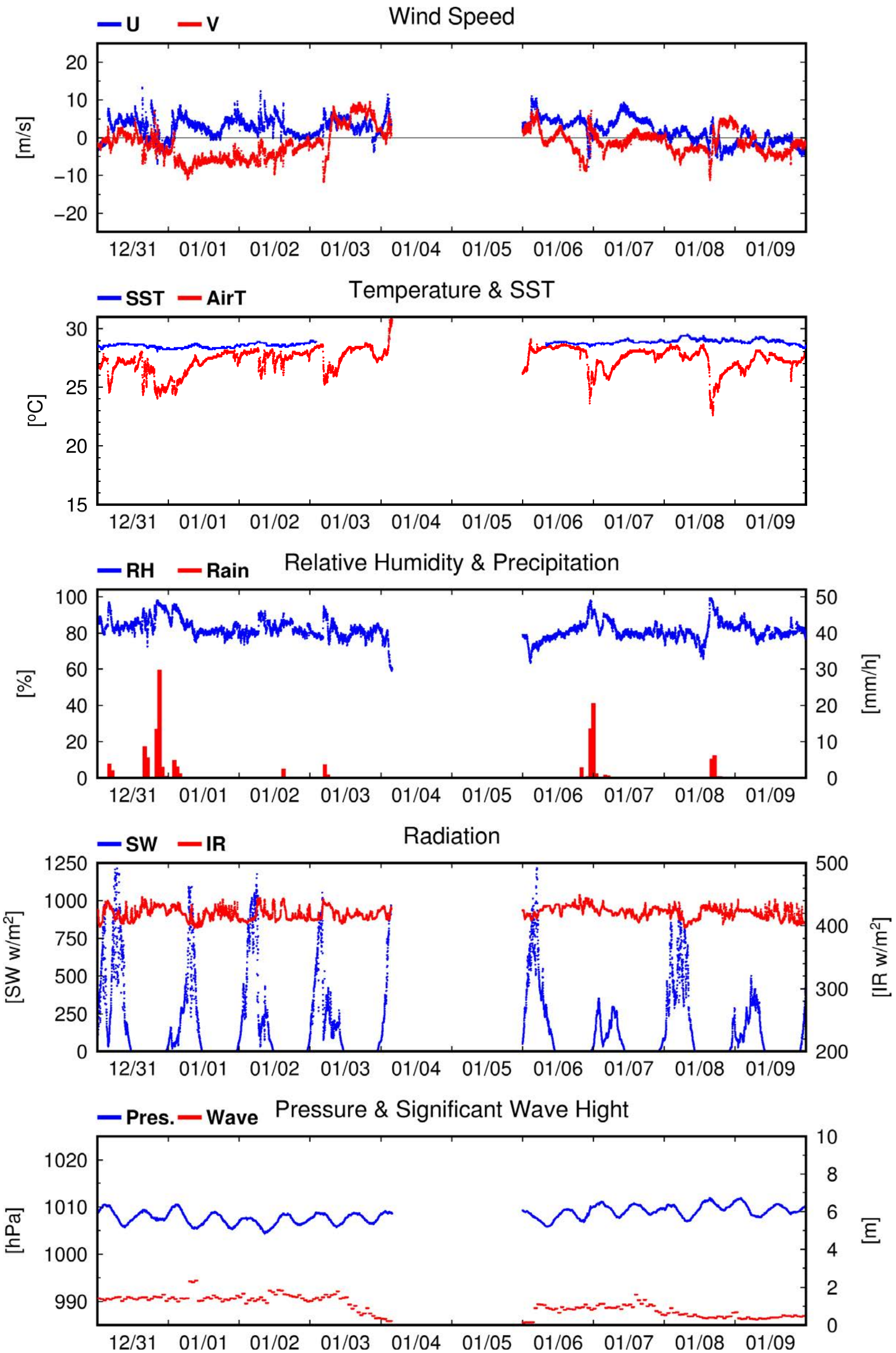


Fig. 5.11-1 (Continued)

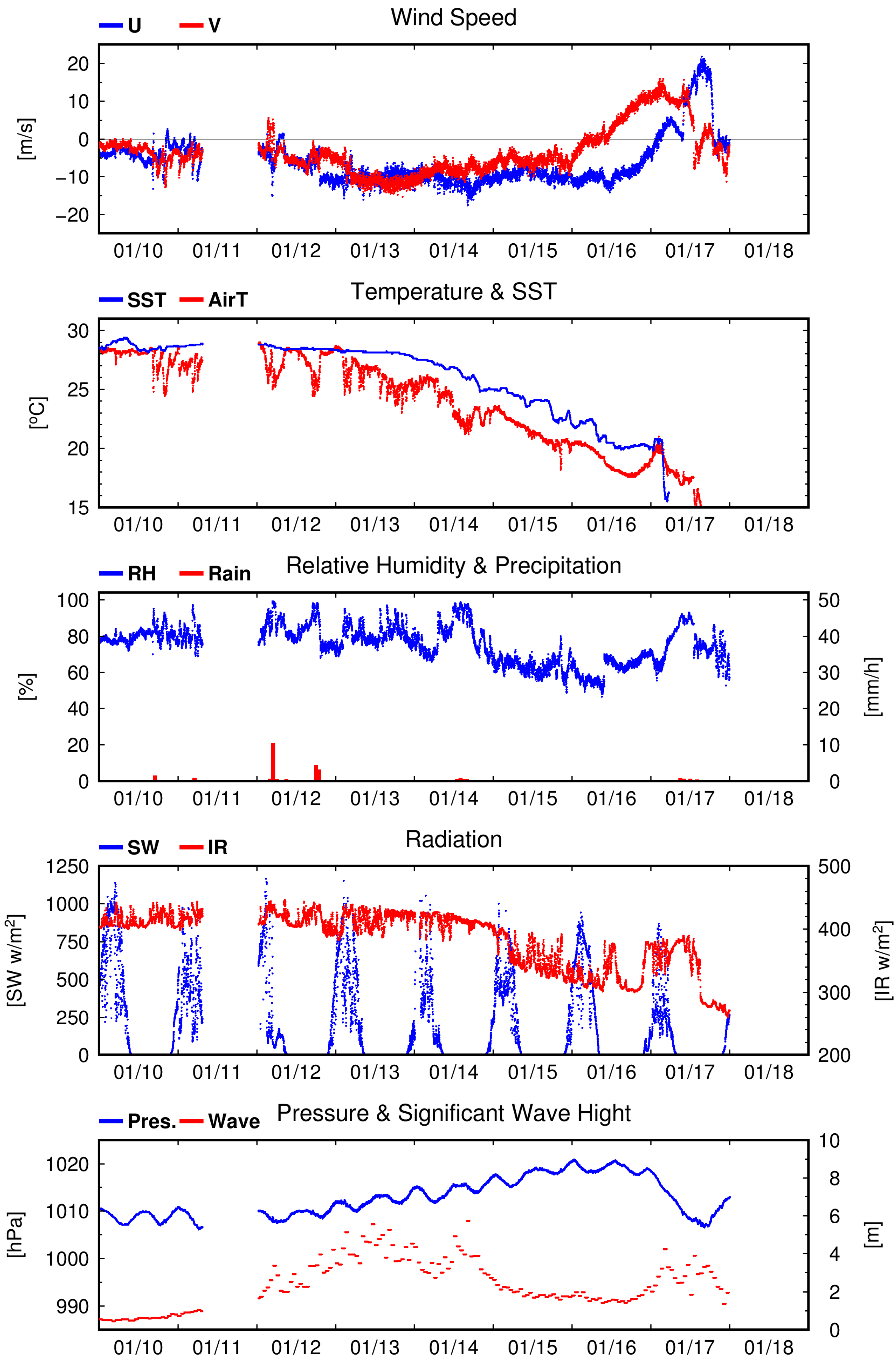


Fig. 5.11-1 (Continued)

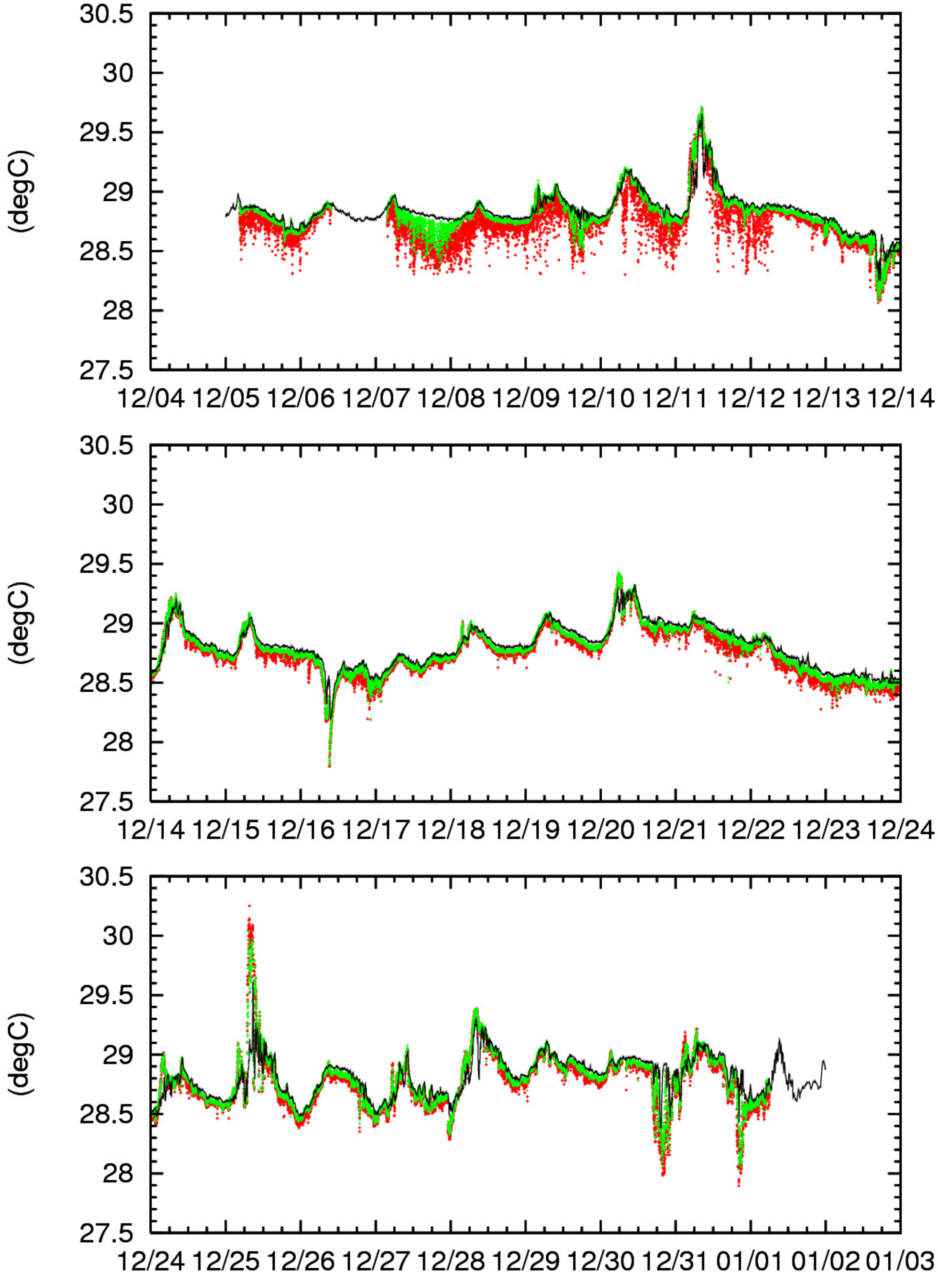


Fig. 5.11-2 Time series of Skin Sea Surface Temperature (SSST; 5cm:Red, 100cm:Green) and Sea Surface Temperature (TSG:Black).

5.12 Continuous monitoring of surface seawater

(1) Personnel

Satoru YOKOI	(JAMSTEC)	: Principal Investigator
Masanori ENOKI	(MWJ)	: Operation leader
Hiroshi HOSHINO	(MWJ)	
Atsushi ONO	(MWJ)	
Erii IRIE	(MWJ)	

(2) Objective

The purpose is to obtain temperature, salinity, dissolved oxygen, fluorescence, and total dissolved gas pressure data continuously in near-sea surface water.

(3) Parameters

Temperature
Salinity
Dissolved oxygen
Fluorescence
Turbidity
Total dissolved gas pressure

(4) Instruments and Methods

The Continuous Sea Surface Water Monitoring System (Marine Works Japan Co. Ltd.) has four sensors and automatically measures temperature, salinity, dissolved oxygen, fluorescence, and turbidity in near-sea surface water every one minute. This system is located in the "sea surface monitoring laboratory" and connected to shipboard LAN-system. Measured data, time, and location of the ship were stored in a data management PC. Sea water was continuously pumped up to the laboratory from an intake placed at the approximately 4.5 m below the sea surface and flowed into the system through a vinyl-chloride pipe. The flow rate of the surface seawater was adjusted to 10 dm^3 min^{-1}.

a. Instruments

Software

Seamoni-kun Ver.1.50

Sensors

Specifications of the each sensor in this system are listed below.

Temperature and Conductivity sensor

Model:	SBE-45, SEA-BIRD ELECTRONICS, INC.
Serial number:	4552788-0264
Measurement range:	Temperature -5 ºC - +35 ºC
	Conductivity 0 S m^{-1} - 7 S m^{-1}
Initial accuracy:	Temperature 0.002 ºC
	Conductivity 0.0003 S m^{-1}
Typical stability (per month):	Temperature 0.0002 ºC
	Conductivity 0.0003 S m^{-1}
Resolution:	Temperature 0.0001 ºC
	Conductivity 0.00001 S m^{-1}

Bottom of ship thermometer

Model:	SBE 38, SEA-BIRD ELECTRONICS, INC.
Serial number:	3852788-0457
Measurement range:	-5 ºC - +35 ºC
Initial accuracy:	±0.001 ºC
Typical stability (per 6 month):	0.001 ºC
Resolution:	0.00025 ºC

Dissolved oxygen sensor

Model:	RINKO II, JFE ADVANTECH CO. LTD.
Serial number:	13
Measuring range:	0 mg L^{-1} - 20 mg L^{-1}
Resolution:	0.001 mg L^{-1} - 0.004 mg L^{-1} (25 ºC)
Accuracy:	Saturation ± 2 % F.S. (non-linear) (1 atm, 25 ºC)

Fluorescence & Turbidity sensor

Model:	C3, TURNER DESIGNS
Serial number:	2300384
Measuring range:	Chlorophyll in vivo 0 μg L^{-1} – 500 μg L^{-1}
Minimum Detection Limit:	Chlorophyll in vivo 0.03 μg L^{-1}
Measuring range:	Turbidity 0 NTU - 1500 NTU
Minimum Detection Limit:	Turbidity 0.05 NTU

Total dissolved gas pressure sensor

Model:	HGTD-Pro, PRO OCEANUS
Serial number:	37-394-10

Temperature range:	-2 °C - 50 °C
Resolution:	0.0001 %
Accuracy:	0.01 % (Temperature Compensated)
Sensor Drift:	0.02 % per year max (0.001 % typical)

(5) Observation log

Periods of measurement, maintenance, and problems during this cruise are listed in Table 5.12-1.

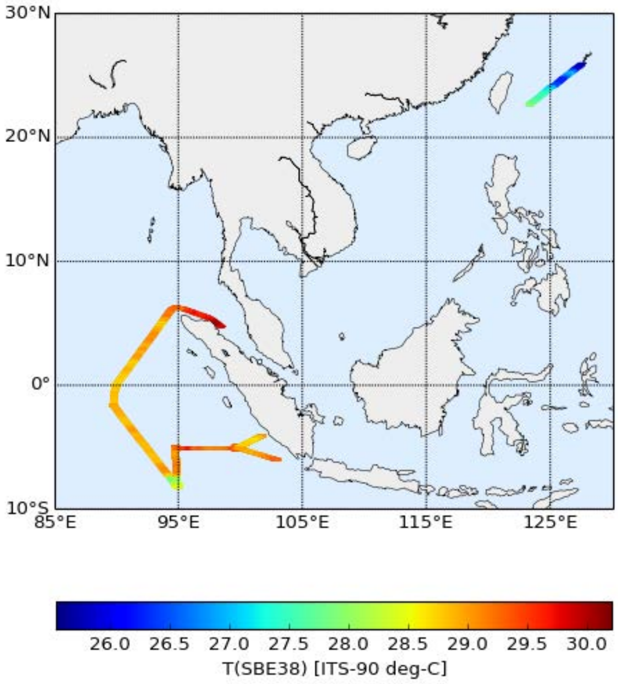
Table 5.12-1. Events list of the Sea surface water monitoring during MR17-08 leg1 and 2

System Date [UTC]	System Time [UTC]	Events	Remarks
2017/11/12	01:21	All the measurements started and data was available.	Start
2017/11/12	23:32	All the measurements stopped.	Entry EEZ
2017/11/22	07:30	All the measurements started and data was available.	Start
2017/12/1 – 7	9:23 (12/1) – 5:24 (12/7)	Leak of the sea surface water pump line	DO, Turbidity and Total dissolved gas pressure data lost
2017/12/6	08:18	All the measurements stopped	Filter Cleaning
2017/12/6	09:59	All the measurements started and data was available.	Logging restart
2017/12/13	17:34 – 18:23	Water leak because of unloosed blade hose	Total dissolved gas pressure data lost
2017/12/13	17:47 – 17:48	Sea flow stop	All data lost
2017/12/23	14:01	All the measurements stopped.	Filter Cleaning
2017/12/23	15:25	All the measurements started and data was available.	Logging restart
2018/1/3	2:00	All the measurements stopped.	Leg1 Cruise end
2018/1/6	08:24	All the measurements started and data was available.	Leg2 Start
2018/1/6 ― 2018/1/11	03:24 (1/6) – 07:30 (1/11)	Leak of the sea surface water pump line	DO, and Total dissolved gas pressure data lost
2018/1/11	07:31	All the measurements stopped.	Entry EEZ

2018/1/12	00:30	All the measurements started and data was available.	Out of EEZ Logging restart
2018/1/17	03:04 － 03:43	Water leak because of unloosed pipe	DO, and Total dissolved gas pressure data lost
2018/1/17	05:30	All the measurements stopped.	Leg2 Cruise end

We took the surface water samples from this system once a day to compare sensor data with bottle data of salinity, dissolved oxygen, and chlorophyll *a*. The results are shown in Fig. 5.12-3. All the salinity samples were analyzed by the Model 8400B "AUTOSAL" manufactured by Guildline Instruments Ltd. (see Section 5.14), and dissolve oxygen samples were analyzed by Winkler method (see Section 5.15), chlorophyll *a* were analyzed by 10-AU manufactured by Turner Designs. (see Section 5.17).

(a)



(b)

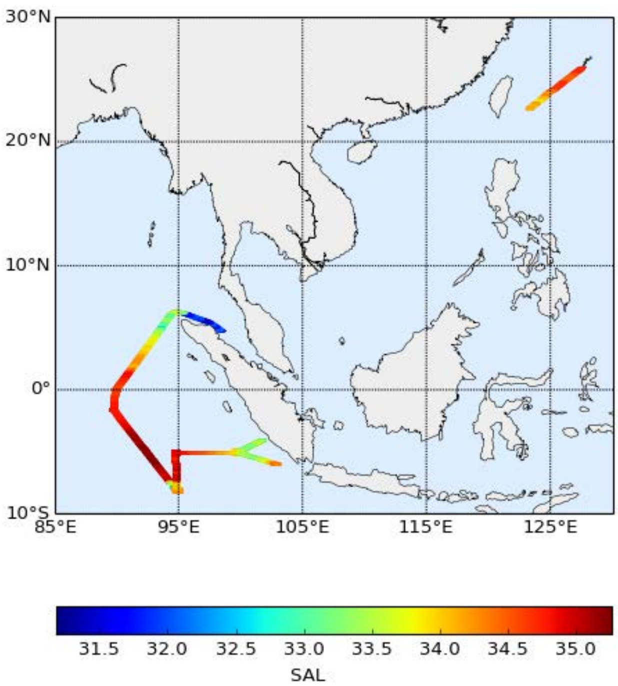
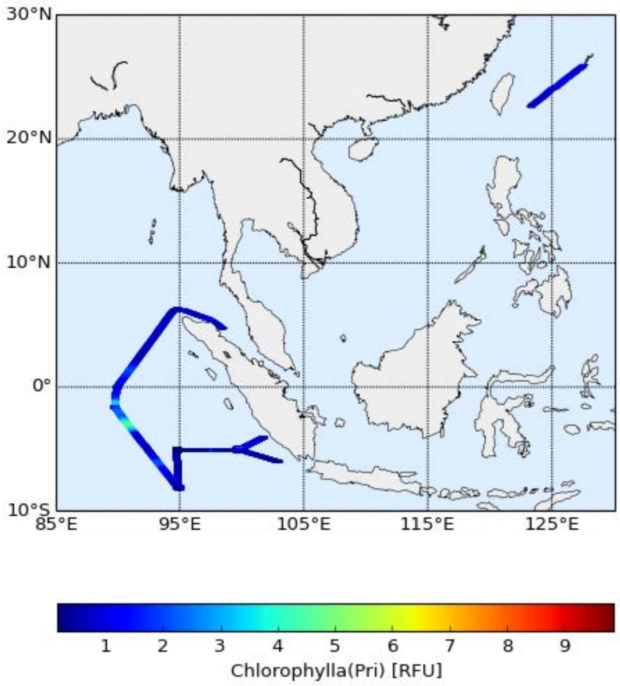


Figure 5.12-1 Spatial and temporal distribution of (a) temperature, (b) salinity, (c) dissolved oxygen, and (d) fluorescence in MR17-08 leg1 cruise. The data obtained during the leak of the sea surface water pump line was excluded from dissolved oxygen dataset.

(c)



(d)

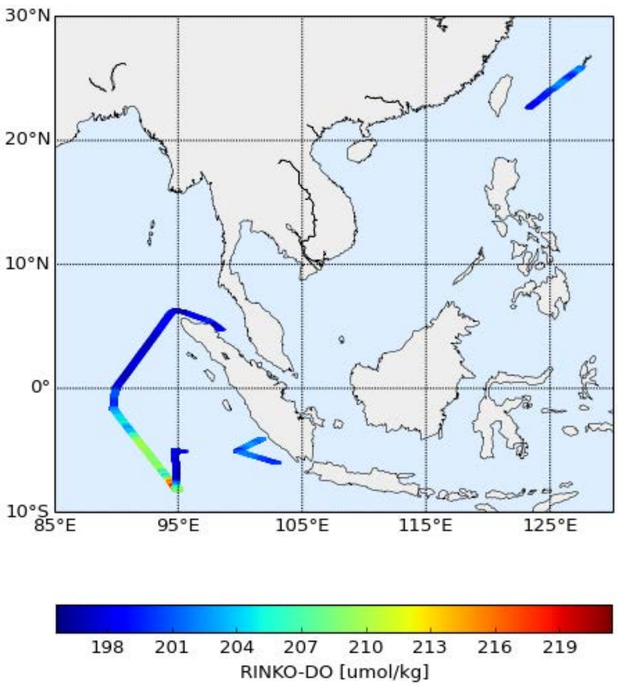
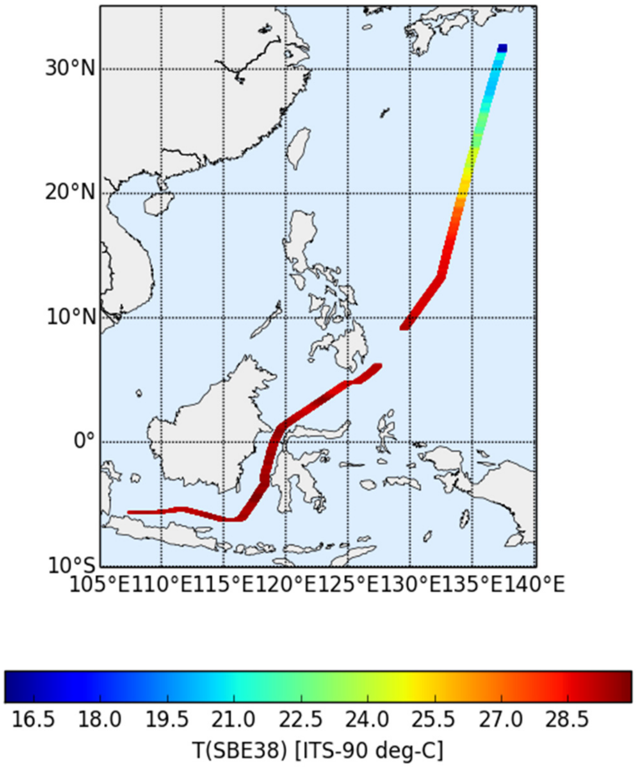


Figure 5.12-1 (continued)

(a)



(b)

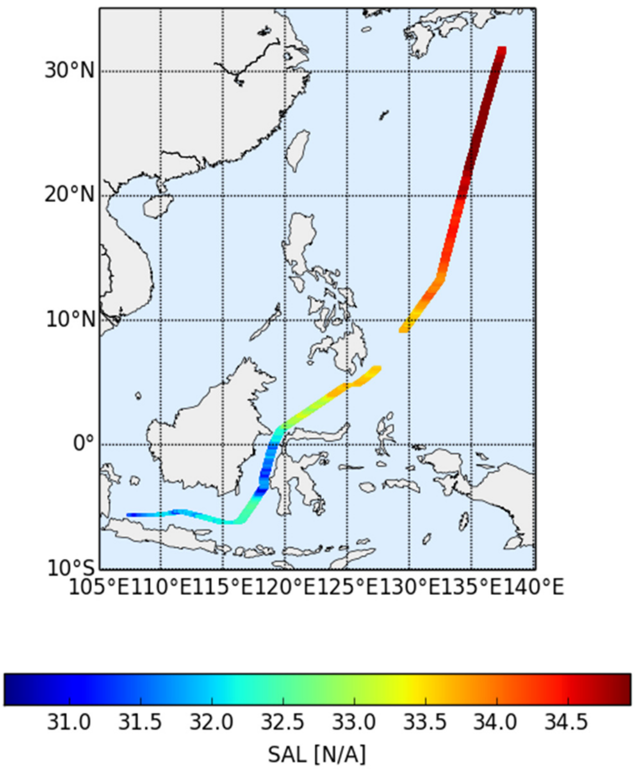
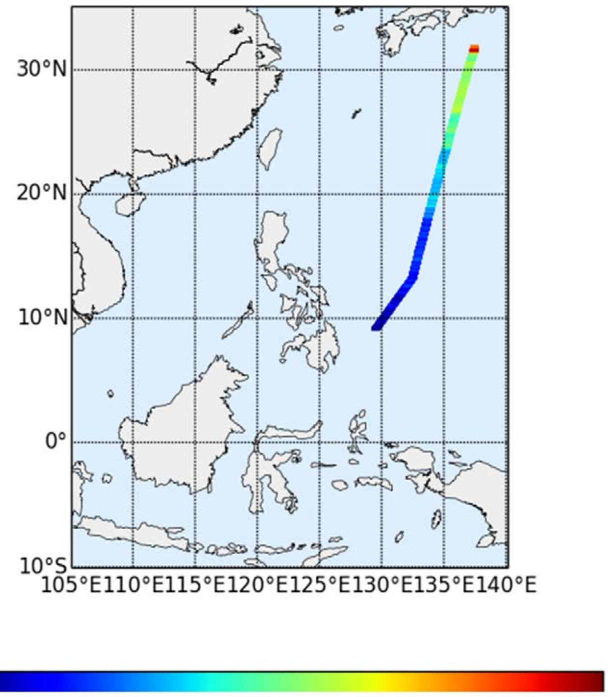


Figure 5.12-2 Spatial and temporal distribution of (a) temperature, (b) salinity, (c) dissolved oxygen, and (d) fluorescence in MR17-08 leg2 cruise. The data obtained during the leak of the sea surface water pump line was excluded from dissolved oxygen dataset.

(c)



(d)

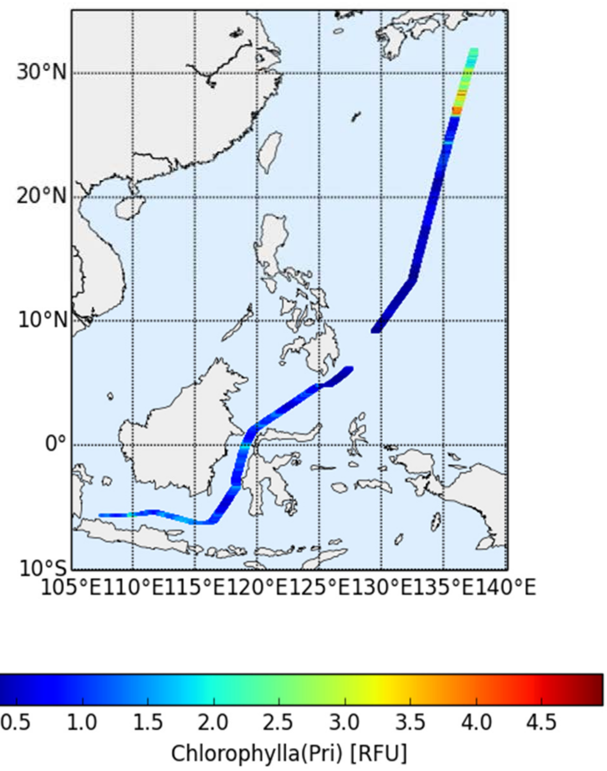


Figure 5.12-2 (continued)

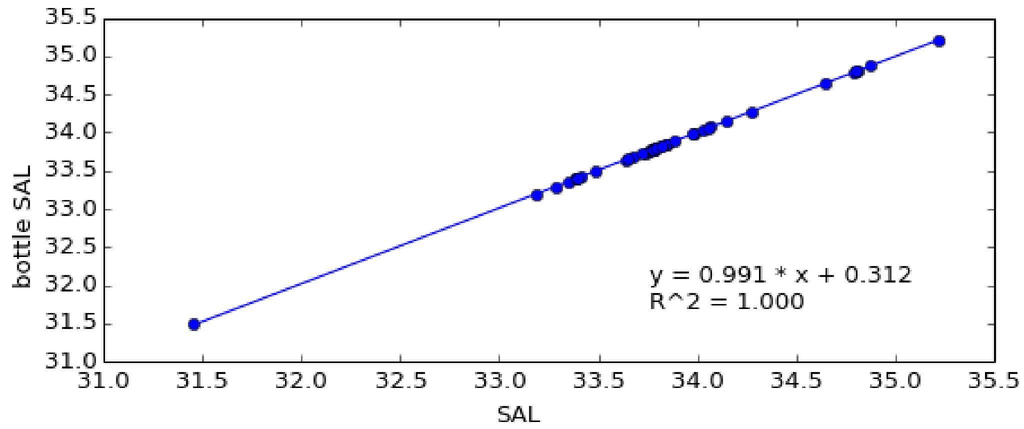


Figure 5.12-3-1 Correlation of salinity between sensor data and bottle data, except for flag 3 or 4 bottle data, during MR17-08 leg1.

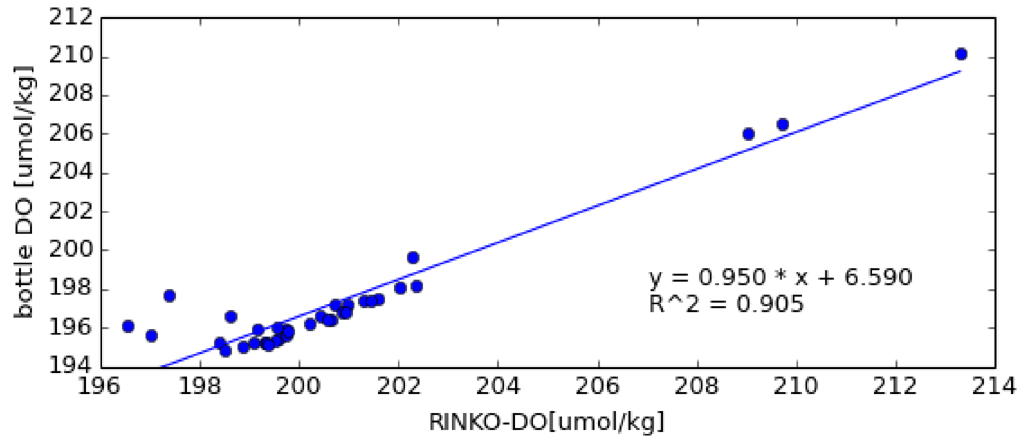


Figure 5.12-3-2 Correlation of dissolved oxygen between sensor data and bottle data, except for flag 3 or 4 bottle data, during MR17-08 leg1.

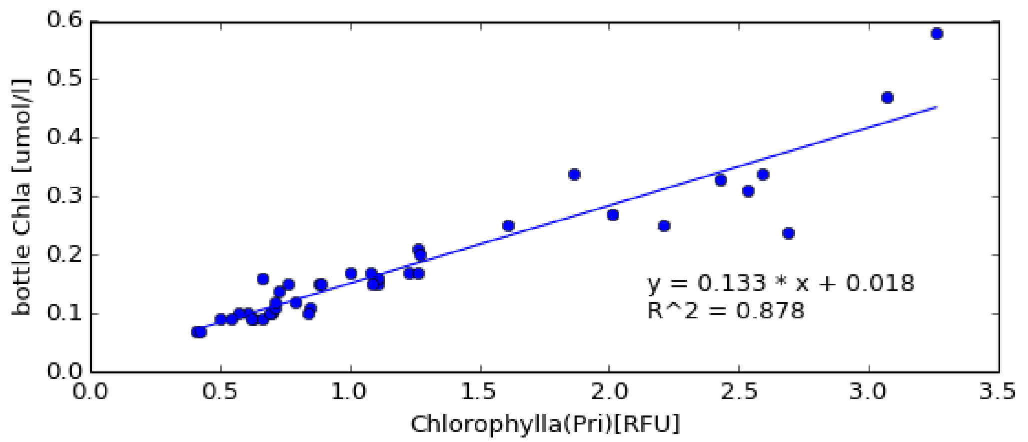


Figure 5.12-3-3 Correlation of fluorescence between sensor data and bottle data, except for flag 3 or 4 bottle data, during MR17-08 leg1.

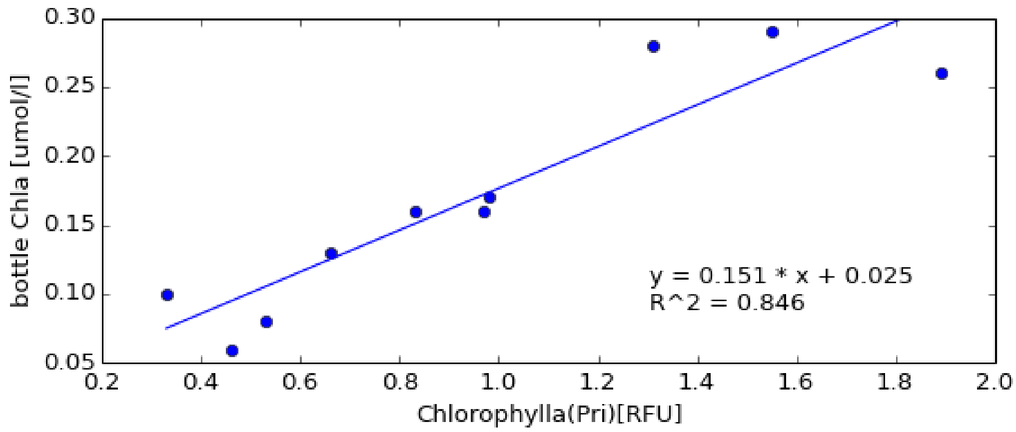


Figure 5.12-3-4 Correlation of dissolved oxygen between sensor data and bottle data, except for flag 3 or 4 bottle data, during MR17-08 leg2.

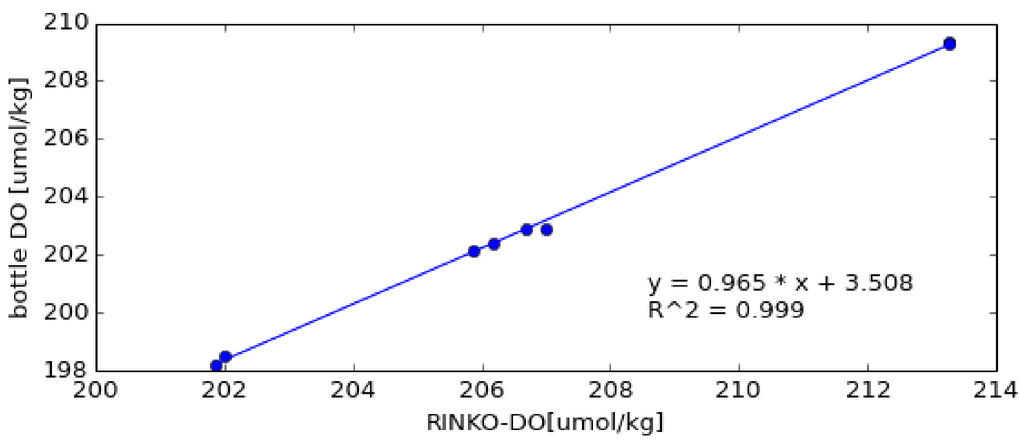


Figure 5.12-3-5 Correlation of fluorescence between sensor data and bottle data, except for flag 3 or 4 bottle data, during MR17-08 leg2.

(6) Data archives

These data obtained in this cruise will be submitted to the Data Management Group (DMG) of JAMSTEC, and will opened to the public via “Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)” in JAMSTEC web site.
<http://www.godac.jamstec.go.jp/darwin/e>

5.13 CTDO profiling

(1) Personnel

Satoru YOKOI	(JAMSTEC)	*Principal investigator
Rio KOBAYASHI	(MWJ)	*Operation leader
Kenichi KATAYAMA	(MWJ)	
Hiroki USHIROMURA	(MWJ)	
Yasuhiro ARII	(MWJ)	
Masaki YAMADA	(MWJ)	
Akira WATANABE	(MWJ)	
Kai FUKUDA	(MWJ)	
Rei ITO	(MWJ)	
Keisuke TAKEDA	(MWJ)	

(2) Objective

Investigation of oceanic structure and water sampling.

(3) Parameters

Temperature (Primary and Secondary)
Conductivity (Primary and Secondary)
Pressure
Dissolved Oxygen (Primary and Secondary)
Fluorescence
Photosynthetically Active Radiation
Altimeter

(4) Instruments and Methods

CTD/Carousel Water Sampling System, which is a 36-position Carousel Water Sampler (CWS) with Sea-Bird Electronics, Inc. CTD (SBE 9plus), was used during this cruise. 12-liter sample Bottles were used for sampling seawater. Some sample Bottles were washed by alkaline detergent and HCl. The sensors attached on the CTD were temperature (primary and secondary), conductivity (primary and secondary), pressure, dissolved oxygen (primary and secondary), fluorescence, photosynthetically active radiation and altimeter. Salinity was calculated by measured values of pressure, conductivity and temperature. The CTD/CWS was deployed from starboard on working deck.

Specifications of the sensors are listed below.

CTD: SBE 911plus CTD system

Under water unit:

SBE 9plus (S/N: 09P38273-0575, Sea-Bird Electronics, Inc.)

Pressure sensor: Digiquartz pressure sensor (S/N: 79492)

Calibrated Date: 25 May 2017

Carousel water sampler:

SBE32 (S/N: 3221746-0278, Sea-Bird Electronics, Inc.)

Temperature sensors:
Primary: SBE03-04/F (S/N: 03P2730, Sea-Bird Electronics, Inc.)
Calibrated Date: 26 Aug. 2017
Secondary: SBE03-04/F (S/N: 03P5329, Sea-Bird Electronics, Inc.)
Calibrated Date: 30 Aug. 2017

Conductivity sensors:
Primary: SBE04C (S/N: 041172, Sea-Bird Electronics, Inc.)
Calibrated Date: 08 Sep. 2017
Secondary: SBE04C (S/N: 043889, Sea-Bird Electronics, Inc.)
Calibrated Date: 01 Sep. 2017

Dissolved Oxygen sensor:
Primary: SBE43 (S/N: 430205, JFE Advantech Co., Ltd.)
Calibrated Date: 26 Aug. 2017
Secondary: SBE43 (S/N: 432036, Sea-Bird Electronics, Inc.)
Calibrated Date: 06 Aug. 2016

Fluorescence:
Chlorophyll Fluorometer (S/N: 3618, Seapoint Sensors, Inc.)
Gain setting: 10X, 0-15 μg/l
Calibrated Date: None
Offset: 0.000

Photosynthetically Active Radiation:
PAR sensor (S/N: 1025, Satlantic Inc.)
Calibrated Date: 06 Jul. 2015

Altimeter:
Benthos PSA-916T (S/N: 1100, Teledyne Benthos, Inc.)

Submersible Pump:
Primary: SBE5T (S/N: 052627, Sea-Bird Electronics, Inc.)
Secondary: SBE5T (S/N: 050984, Sea-Bird Electronics, Inc.)

Bottom contact switch: (Sea-Bird Electronics, Inc.)

Deck unit: SBE11plus (S/N 11P7030-0272, Sea-Bird Electronics, Inc.)

Configuration file: MR1708_A.xmlcon
C01M001 – STNM217

The CTD raw data were acquired on real time using the Seasave-Win32 (ver.7.23.2) provided by Sea-Bird Electronics, Inc. and stored on the hard disk of the personal computer. Seawater was sampled during the up cast by sending fire commands from the personal computer.

For depths where vertical gradient of water properties were exchanged to be large, the bottle was exceptionally fired after waiting from the stop for 60 seconds to enhance exchanging the water between inside and outside of the bottle. 30 seconds below thermocline to stabilize then fire. 233 casts of CTD observations were conducted (Table 5.13-1).

Data processing procedures and used utilities of SBE Data Processing-Win32 (ver.7.23.2) and SEASOFT were as follows:

(The process in order)

DATCNV: Convert the binary raw data to engineering unit data. DATCNV also extracts bottle information where scans were marked with the bottle confirm bit during acquisition. The duration was set to 3 seconds, and the offset was set to 0.0 seconds.

TCORP (original module): Corrected the pressure sensitivity of the temperature (SBE3) sensor.
S/N 03P2730: -3.7312e-007 (degC/dbar)

BOTTLESUM: Create a summary of the bottle data. The data were averaged over 3 seconds.

ALIGNCTD: Convert the time-sequence of sensor outputs into the pressure sequence to ensure that all calculations were made using measurements from the same parcel of water. Dissolved oxygen data are systematically delayed with respect to depth mainly because of the long time constant of the dissolved oxygen sensor and of an additional delay from the transit time of water in the pumped pluming line. This delay was compensated by 3 seconds advancing dissolved oxygen sensor (SBE43) output (dissolved oxygen voltage) relative to the temperature data.

WILDEDIT: Mark extreme outliers in the data files. The first pass of WILDEDIT obtained the accurate estimate of the true standard deviation of the data. The data were read in blocks of 1000 scans. Data greater than 10 standard deviations were flagged. The second pass computed a standard deviation over the same 1000 scans excluding the flagged values. Values greater than 20 standard deviations were marked bad. This process was applied to pressure, depth, temperature, conductivity, dissolved oxygen voltage (SBE43).

CELLTM: Remove conductivity cell thermal mass effects from the measured conductivity. Typical values used were thermal anomaly amplitude alpha = 0.03 and the time constant 1/beta = 7.0.

FILTER: Perform a low pass filter on pressure and depth data with a time constant of 0.15 second. In order to produce zero phase lag (no time shift) the filter runs forward first then backward

WFILTER: Perform a median filter to remove spikes in the fluorescence data.
A median value was determined by 49 scans of the window.

SECTIONU (original module of SECTION): Select a time span of data based on scan number in order to reduce a file size. The minimum number was set to be the starting time when the CTD package was beneath the sea-surface after activation of the pump. The maximum number of was set to be the end time when the package came up from the surface.

LOOPEDIT: Mark scans where the CTD was moving less than the minimum velocity of 0.0 m/s (traveling backwards due to ship roll).

DERIVE: Compute dissolved oxygen (SBE43).

BINAVG: Average the data into 1-dbar pressure bins and 1-sec time bins.

BOTTOMCUT (original module): Deletes discontinuous scan bottom data, when it's created by BINAVG.

DERIVE: Compute salinity, potential temperature, and sigma-theta.

SPLIT: Separate the data from the input .cnv file into down cast and up cast files.

(5) Station list

During this cruise, 233 casts of CTD observation were carried out on buoy observation, line observation and stationary observation. Date, time and locations of the CTD casts are listed in Table 5.13-1.

(6) Preliminary Results

The time series contours of primary temperature, salinity with pressure are shown in Fig. 5.13-1, and temperature, salinity oxygen and fluorescence with pressure are shown Figure 5.13-2. Vertical profile (down cast) of secondary temperature, salinity and dissolved oxygen with pressure are shown in the appendix.

In some casts, we judged noise, spike or shift in the data. These were as follows.
During this cruise, we judged noise, spike or shift in the data of some casts. These were as follows.

C02M002: Primary temperature
down 114: spike
C03M001: Secondary salinity
down 2675: spike
L20M001: Primary temperature
up 158 - up 119: shift
Primary salinity
up 158 - up 119: shift
Primary oxygen
up 158 - up 119: shift
STNM012
Primary salinity
down 89 - down 90: spike
STNM020
Secondary oxygen
down 167 - down 169: spike
STNM028
Secondary oxygen
down 168 - down 170: spike
STNM035
Secondary salinity
down 70: spike
STNM038
Primary salinity
down 43: spike
STNM052
Primary salinity
down 229 - down 230 : spike
STNM076
Primary salinity

down 38 : spike

STNM086

Primary salinity

down 89 : spike

STNM089

Secondary salinity

down 59 : spike

STNM104

Secondary salinity

down 81 - up 79 : shift

Secondary oxygen

down 3 - up 67 : shift

STNM141

Primary salinity

down 229 : shift

STNM191

Secondary oxygen

down 303 : spike

STNM200

Secondary oxygen

down 267 - down 271 : spike

STNM207

Primary Salinity

down 47 - down 177 : spike

Primary oxygen

down 39 - down 177 : spike

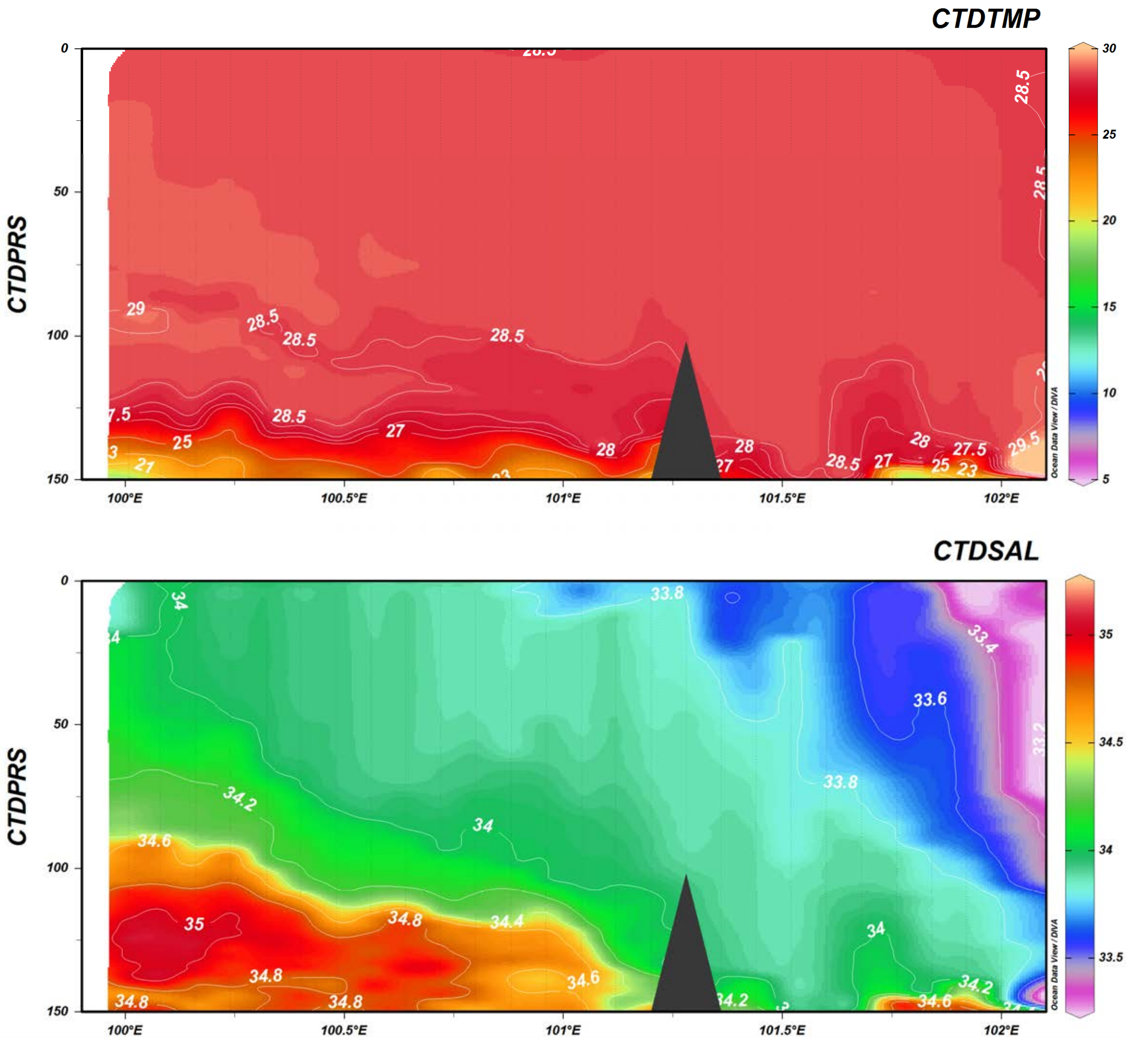


Figure 5.13-1 the time series contours (temperature, salinity) in line observation (L01M001 ~ L26M001).

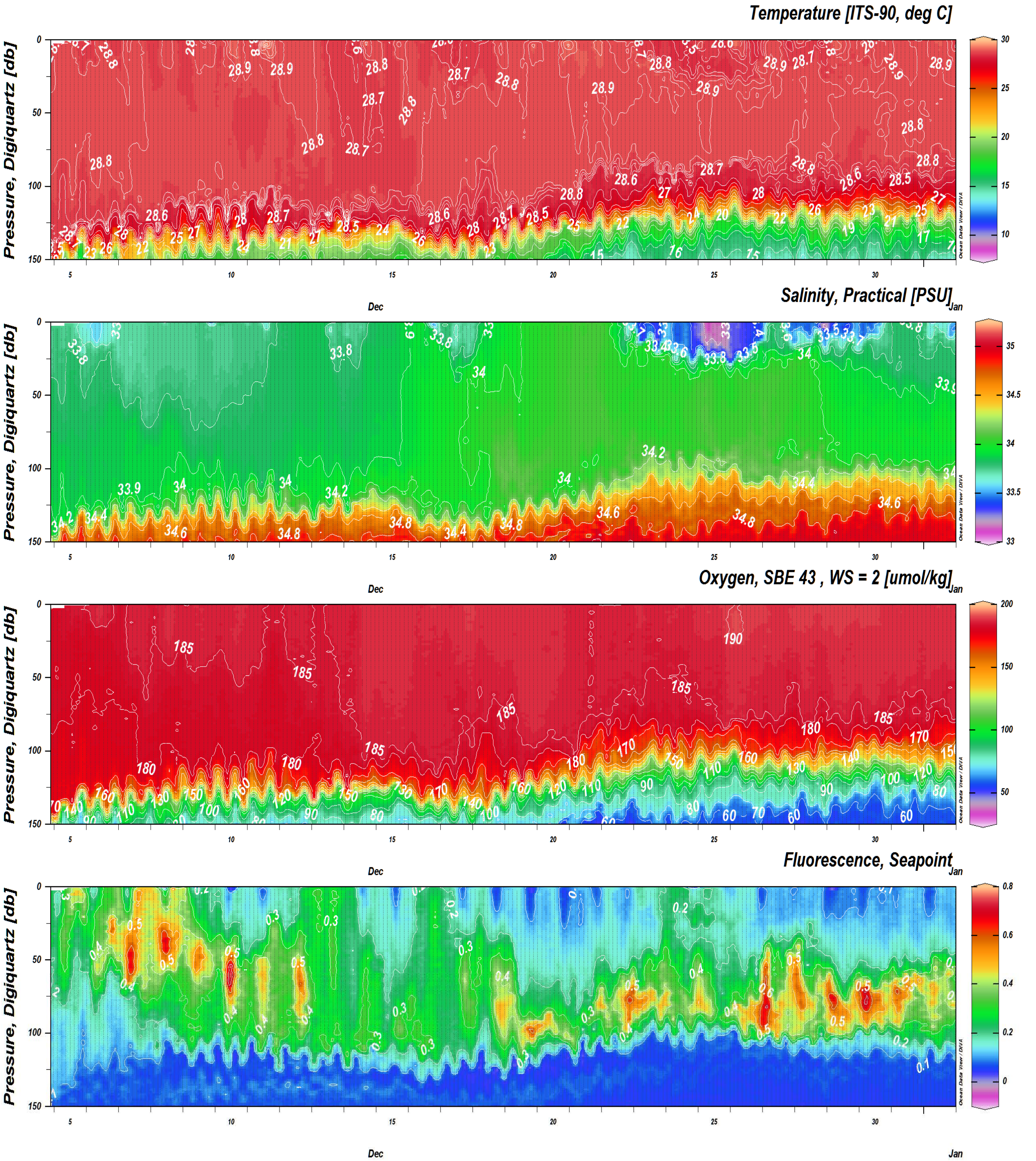


Figure 5.13-2 the time series contours (temperature, salinity, oxygen, and fluorescence) in stationary observation (STNM001 ~ STNM217).

(7) Remarks

JES-10 profiler mounted with CTD frame for the purpose of comparing the data of JES-10 profiler with that of CTD data at station C01M001. Moreover, CTD stopped winch when heaving up at 500m, 300m and 200m for 5 minutes. Besides, in some casts, JES10 profiler's pump (SBE5T or domestic pump) was attached to 9plus.

(8) RINKO profiler

For the purpose of evaluation of conductivity, temperature, dissolved oxygen, and fluorescence, we conducted simultaneous measurements with SBE9plus system during line observation from 03 Dec. to 04 Dec. 2017 (Stn. L01, L03, L05, L07, L09, L11, L13, L15, L18, L20, L22, L24, and L26). Through the comparison, good performance of C and T measurements by RINKO profiler was confirmed. In terms of the dissolved oxygen and fluorescence, correction by sampled water analysis is effective for quantitative analysis.

Measurements for upper layer within 10 m depth also conducted during stationary observation from 05 Dec. 2017 to 01 Jan. 2018 (Figure. 5.13.3).

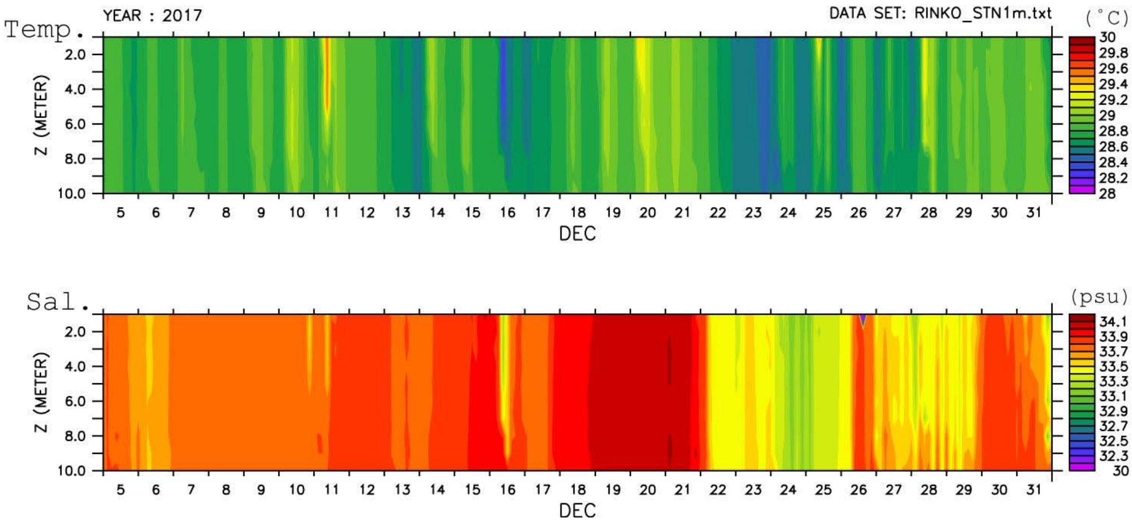


Figure. 5.13-3 Time-depth diagram of temperature (upper) and salinity (lower) observed with RINKO profiler

(9) Data archive

These data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via “Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)” in JAMSTEC web site <http://www.godac.jamstec.go.jp/darwin/e>.

Table 5.13-1 MR17-08 CTD cast table

Stnnbr	Castno	Date(UTC) (mmddyy)	Time(UTC) Start	End	BottomPosition Latitude	Longitude	Depth (m)	Wire Out (m)	HT Above Bottom (m)	Max Depth (m)	Max Pressure (dbar)	CTD Filename	Remark
C01	1	112517	10:37	11:15	00-00.15S	090-09.17E	4091.0	497.4	-	500.6	504.0	C01M001	JES10 cast
C02	1	112817	07:35	08:14	07-59.25S	095-02.66E	5197.0	1004.0	-	1001.9	1010.0	C02M001	m-TRITION 19 Dep.
C02	2	112817	23:03	00:06	08-03.78S	095-05.27E	5250.0	998.5	-	1000.9	1009.0	C02M002	m-TRITION 19 Rec.
C03	1	113017	06:16	08:20	04-56.19S	094-58.40E	5005.0	3999.8	-	4002.2	4063.0	C03M001	m-TRITION 17 Dep.
C03	2	113017	23:04	00:07	05-06.47S	094-59.90E	5019.0	999.8	-	1001.0	1009.0	C03M002	m-TRITION 17 Rec.
L01	1	120317	13:04	14:08	04-59.71S	100-00.62E	5554.0	997.2	-	1000.0	1008.0	L01M001	Smatra buoy Dep.
L03	1	120317	16:02	16:24	04-55.27S	100-09.78E	5747.0	499.1	-	501.6	505.0	L03M001	
L05	1	120317	18:01	18:45	04-50.41S	100-19.46E	6020.0	501.1	-	500.6	504.0	L05M001	
L07	1	120317	20:33	20:53	04-45.74S	100-28.90E	5991.0	500.2	-	500.6	504.0	L07M001	
L09	1	120317	22:36	23:21	04-40.84S	100-38.55E	4260.0	498.9	-	501.6	505.0	L09M001	
L11	1	120417	01:00	01:22	04-36.06S	100-48.12E	2886.0	497.4	-	500.6	504.0	L11M001	
L13	1	120417	03:03	03:48	04-31.33S	100-57.68E	2276.0	497.8	-	501.6	505.0	L13M001	
L15	1	120417	05:32	06:17	04-26.44S	101-07.22E	527.0	498.5	20.4	501.6	505.0	L15M001	
L18	1	120417	08:46	09:30	04-19.06S	101-21.61E	544.0	501.7	-	501.6	505.0	L18M001	
L20	1	120417	11:18	11:41	04-14.40S	101-31.16E	1011.0	502.4	-	503.6	507.0	L20M001	
L22	1	120417	13:17	14:01	04-09.66S	101-40.77E	1143.0	500.9	-	502.6	506.0	L22M001	
L24	1	120417	15:48	16:10	04-04.84S	101-50.46E	932.0	498.2	-	501.6	505.0	L24M001	
L26	1	120417	17:47	18:21	04-00.07S	102-00.03E	217.0	203.6	9.2	206.7	208.0	L26M001	
STN	1	120417	23:39	00:16	04-14.36S	101-31.02E	1007.0	297.7	-	301.1	303.0	STNM001	
STN	2	120517	02:38	02:50	04-14.29S	101-30.87E	1003.0	297.3	-	300.1	302.0	STNM002	
STN	3	120517	05:40	06:20	04-12.89S	101-30.97E	1006.0	501.8	-	501.6	505.0	STNM003	
STN	4	120517	08:40	08:53	04-13.17S	101-31.62E	1029.0	298.8	-	301.1	303.0	STNM004	

STN	5	120517	11:39	12:15	04-14.07S	101-30.12E	973.0	298.1	-	301.1	303.0	STNM005	
STN	6	120517	14:39	14:51	04-13.86S	101-30.28E	984.0	299.7	-	302.1	304.0	STNM006	
STN	7	120517	17:37	18:11	04-14.15S	101-30.25E	974.0	300.8	-	303.1	305.0	STNM007	
STN	8	120517	20:38	20:50	04-13.71S	101-30.27E	988.0	298.2	-	301.1	303.0	STNM008	
STN	9	120517	23:41	00:18	04-13.52S	101-30.99E	1022.0	299.3	-	302.1	304.0	STNM009	
STN	10	120617	02:41	02:53	04-13.55S	101-31.24E	1029.0	296.9	-	300.1	302.0	STNM010	
STN	11	120617	05:42	06:27	04-13.48S	101-32.54E	1060.0	502.2	-	500.6	504.0	STNM011	
STN	12	120617	08:42	08:54	04-14.11S	101-31.34E	1027.0	299.9	-	300.1	302.0	STNM012	
STN	13	120617	11:41	12:19	04-14.43S	101-31.12E	1011.0	299.0	-	300.1	302.0	STNM013	
STN	14	120617	14:43	14:55	04-14.99S	101-30.65E	990.0	300.6	-	300.1	302.0	STNM014	
STN	15	120617	17:41	18:15	04-14.56S	101-31.41E	1025.0	301.2	-	301.1	303.0	STNM015	
STN	16	120617	20:41	20:53	04-14.02S	101-32.54E	1066.0	300.6	-	301.1	303.0	STNM016	
STN	17	120617	23:42	00:19	04-15.34S	101-31.01E	1001.0	302.3	-	302.1	304.0	STNM017	
STN	18	120717	02:38	02:50	04-14.05S	101-31.57E	1037.0	300.1	-	301.1	303.0	STNM018	
STN	19	120717	05:42	06:25	04-13.61S	101-31.74E	1043.0	504.0	-	502.6	506.0	STNM019	
STN	20	120717	08:41	08:53	04-13.68S	101-31.00E	1015.0	301.2	-	302.1	304.0	STNM020	
STN	21	120717	11:41	12:17	04-14.48S	101-31.42E	1025.0	297.5	-	301.1	303.0	STNM021	
STN	22	120717	14:44	14:56	04-14.48S	101-31.33E	1020.0	298.8	-	300.1	302.0	STNM022	
STN	23	120717	17:36	18:16	04-14.01S	101-31.24E	1026.0	301.0	-	301.1	303.0	STNM023	
STN	24	120717	20:35	20:48	04-14.92S	101-31.97E	1046.0	300.3	-	301.1	303.0	STNM024	
STN	25	120717	23:38	00:14	04-13.98S	101-31.05E	1014.0	300.1	-	301.1	303.0	STNM025	
STN	26	120817	02:42	02:54	04-14.54S	101-31.06E	1008.0	297.7	-	301.1	303.0	STNM026	
STN	27	120817	05:41	06:24	04-13.77S	101-30.96E	1010.0	502.8	-	502.6	506.0	STNM027	
STN	28	120817	08:41	08:54	04-14.45S	101-30.78E	1000.0	301.4	-	301.1	303.0	STNM028	
STN	29	120817	11:41	12:19	04-14.05S	101-30.77E	997.0	300.6	-	301.1	303.0	STNM029	
STN	30	120817	14:40	14:52	04-14.45S	101-30.45E	989.0	299.5	-	301.1	303.0	STNM030	
STN	31	120817	17:40	18:14	04-13.54S	101-30.52E	1000.0	299.9	-	301.1	303.0	STNM031	
STN	32	120817	20:41	20:53	04-12.81S	101-31.51E	1022.0	299.9	-	301.1	303.0	STNM032	
STN	33	120817	23:42	00:19	04-13.27S	101-30.62E	996.0	302.1	-	303.1	305.0	STNM033	
STN	34	120917	02:41	02:53	04-13.01S	101-30.62E	997.0	299.5	-	301.1	303.0	STNM034	
STN	35	120917	05:43	06:28	04-13.05S	101-30.79E	1002.0	504.0	-	503.6	507.0	STNM035	
STN	36	120917	08:42	08:54	04-13.90S	101-30.43E	987.0	301.0	-	301.1	303.0	STNM036	

STN	37	120917	11:41	12:20	04-14.64S	101-30.66E	992.0	301.7	-	303.1	305.0	STNM037	
STN	38	120917	14:41	14:52	04-14.79S	101-31.10E	1010.0	298.8	-	300.1	302.0	STNM038	
STN	39	120917	17:46	18:22	04-14.18S	101-30.68E	993.0	300.6	-	302.1	304.0	STNM039	
STN	40	120917	20:42	20:54	04-13.13S	101-31.95E	1037.0	296.0	-	301.1	303.0	STNM040	
STN	41	120917	23:42	00:19	04-13.48S	101-30.98E	1021.0	301.7	-	303.1	305.0	STNM041	
STN	42	121017	02:42	02:54	04-14.25S	101-30.86E	1004.0	300.1	-	301.1	303.0	STNM042	
STN	43	121017	05:41	06:20	04-14.42S	101-30.22E	973.0	501.7	-	500.6	504.0	STNM043	
STN	44	121017	08:41	08:53	04-13.14S	101-31.20E	1015.0	299.9	-	301.1	303.0	STNM044	
STN	45	121017	11:42	12:18	04-14.05S	101-31.14E	1018.0	301.9	-	302.1	304.0	STNM045	
STN	46	121017	14:40	14:52	04-14.21S	101-31.85E	1046.0	300.1	-	300.1	302.0	STNM046	
STN	47	121017	17:40	18:16	04-14.76S	101-31.52E	1031.0	298.6	-	301.1	303.0	STNM047	
STN	48	121017	20:40	20:53	04-13.54S	101-31.93E	1048.0	299.9	-	301.1	303.0	STNM048	
STN	49	121017	23:42	00:21	04-14.54S	101-31.28E	1019.0	299.0	-	300.1	302.0	STNM049	
STN	50	121117	02:42	02:54	04-14.74S	101-30.82E	995.0	299.3	-	300.1	302.0	STNM050	
STN	51	121117	05:43	06:26	04-13.74S	101-32.38E	1061.0	502.0	-	502.6	506.0	STNM051	
STN	52	121117	08:43	08:54	04-13.16S	101-31.62E	1030.0	299.5	-	300.1	302.0	STNM052	
STN	53	121117	11:41	12:17	04-14.25S	101-31.61E	1034.0	298.8	-	302.1	304.0	STNM053	
STN	54	121117	14:40	14:52	04-14.77S	101-32.36E	1064.0	300.3	-	301.1	303.0	STNM054	
STN	55	121117	17:39	18:12	04-14.50S	101-32.35E	1062.0	299.3	-	301.1	303.0	STNM055	
STN	56	121117	20:41	20:52	04-14.79S	101-31.87E	1044.0	299.2	-	300.1	302.0	STNM056	
STN	57	121117	23:41	00:17	04-14.73S	101-31.95E	1048.0	299.7	-	302.1	304.0	STNM057	
STN	58	121217	02:41	02:53	04-14.01S	101-32.41E	1061.0	299.2	-	301.1	303.0	STNM058	
STN	59	121217	05:41	06:25	04-14.71S	101-32.06E	1051.0	502.2	-	502.6	506.0	STNM059	
STN	60	121217	08:41	08:52	04-15.21S	101-32.17E	1060.0	299.3	-	300.1	302.0	STNM060	
STN	61	121217	11:42	12:20	04-14.24S	101-31.93E	1052.0	300.1	-	301.1	303.0	STNM061	
STN	62	121217	14:41	14:53	04-14.88S	101-32.07E	1051.0	300.3	-	301.1	303.0	STNM062	
STN	63	121217	17:40	18:15	04-15.12S	101-31.81E	1040.0	299.0	-	301.1	303.0	STNM063	
STN	64	121217	20:35	20:46	04-14.32S	101-32.09E	1054.0	301.9	-	301.1	303.0	STNM064	
STN	65	121217	23:50	00:26	04-14.80S	101-32.03E	1051.0	298.2	-	301.1	303.0	STNM065	
STN	66	121317	02:41	02:53	04-15.30S	101-31.52E	1028.0	299.5	-	300.1	302.0	STNM066	
STN	67	121317	05:36	06:20	04-14.12S	101-31.71E	1044.0	504.0	-	501.6	505.0	STNM067	
STN	68	121317	08:40	08:51	04-14.42S	101-32.67E	1075.0	300.1	-	301.1	303.0	STNM068	

STN	69	121317	11:40	12:15	04-14.68S	101-31.97E	1053.0	299.5	-	301.1	303.0	STNM069	
STN	70	121317	14:40	14:52	04-14.91S	101-32.12E	1056.0	304.0	-	301.1	303.0	STNM070	
STN	71	121317	17:41	18:16	04-12.84S	101-31.16E	1014.0	299.9	-	301.1	303.0	STNM071	
STN	72	121317	20:40	20:52	04-13.37S	101-31.19E	1023.0	299.2	-	300.1	302.0	STNM072	
STN	73	121317	23:42	00:18	04-14.71S	101-31.37E	1021.0	299.9	-	301.1	303.0	STNM073	
STN	74	121417	02:42	02:54	04-14.45S	101-30.73E	996.0	299.0	-	300.1	302.0	STNM074	
STN	75	121417	05:40	06:18	04-14.22S	101-30.72E	991.0	503.5	-	500.6	504.0	STNM075	
STN	76	121417	08:41	08:52	04-14.54S	101-30.80E	999.0	300.3	-	301.1	303.0	STNM076	
STN	77	121417	11:41	12:18	04-14.98S	101-30.75E	994.0	297.3	-	300.1	302.0	STNM077	
STN	78	121417	14:40	14:52	04-14.45S	101-31.20E	1012.0	298.6	-	301.1	303.0	STNM078	
STN	79	121417	17:38	18:11	04-14.55S	101-31.45E	1029.0	301.4	-	302.1	304.0	STNM079	
STN	80	121417	20:39	20:50	04-14.70S	101-31.33E	1019.0	299.5	-	301.1	303.0	STNM080	
STN	81	121417	23:41	00:18	04-15.00S	101-31.33E	1018.0	299.2	-	301.1	303.0	STNM081	
STN	82	121517	02:41	02:53	04-14.32S	101-31.25E	1020.0	300.4	-	301.1	303.0	STNM082	
STN	83	121517	05:40	06:18	04-13.14S	101-31.19E	1014.0	503.5	-	502.6	506.0	STNM083	
STN	84	121517	08:40	08:51	04-13.41S	101-31.41E	1032.0	300.1	-	301.1	303.0	STNM084	
STN	85	121517	11:39	12:20	04-14.34S	101-31.58E	1033.0	297.5	-	301.1	303.0	STNM085	
STN	86	121517	14:39	14:51	04-14.35S	101-31.85E	1045.0	299.9	-	302.1	304.0	STNM086	
STN	87	121517	17:38	18:13	04-14.49S	101-31.54E	1031.0	299.7	-	301.1	303.0	STNM087	
STN	88	121517	20:44	20:55	04-14.25S	101-31.79E	1043.0	299.3	-	300.1	302.0	STNM088	
STN	89	121517	23:41	00:14	04-14.46S	101-31.72E	1038.0	299.3	-	301.1	303.0	STNM089	
STN	90	121617	02:37	02:49	04-14.21S	101-31.02E	1014.0	299.9	-	300.1	302.0	STNM090	
STN	91	121617	05:41	06:21	04-13.50S	101-31.62E	1040.0	502.0	-	502.6	506.0	STNM091	
STN	92	121617	08:39	08:51	04-13.92S	101-31.70E	1042.0	301.0	-	301.1	303.0	STNM092	
STN	93	121617	11:41	12:14	04-14.38S	101-32.09E	1054.0	297.9	-	301.1	303.0	STNM093	
STN	94	121617	14:37	14:49	04-14.72S	101-32.08E	1054.0	299.0	-	300.1	302.0	STNM094	
STN	95	121617	17:36	18:10	04-14.86S	101-31.31E	1018.0	297.9	-	301.1	303.0	STNM095	
STN	96	121617	20:36	20:47	04-14.89S	101-31.68E	1038.0	297.7	-	300.1	302.0	STNM096	
STN	97	121617	23:42	00:17	04-14.93S	101-32.03E	1136.0	296.8	-	300.1	302.0	STNM097	
STN	98	121717	02:41	02:53	04-14.82S	101-31.85E	1049.0	298.8	-	301.1	303.0	STNM098	
STN	99	121717	05:43	06:26	04-14.52S	101-31.77E	1038.0	499.8	-	500.6	504.0	STNM099	
STN	100	121717	08:39	08:51	04-14.24S	101-32.03E	1054.0	300.1	-	301.1	303.0	STNM100	

STN	101	121717	11:38	12:16	04-14.58S	101-31.73E	1038.0	299.2	-	301.1	303.0	STNM101	
STN	102	121717	14:39	14:51	04-14.62S	101-31.59E	1030.0	300.3	-	301.1	303.0	STNM102	
STN	103	121717	17:38	18:13	04-14.77S	101-31.13E	1009.0	297.9	-	300.1	302.0	STNM103	
STN	104	121717	20:39	20:51	04-14.72S	101-31.29E	1017.0	298.6	-	300.1	302.0	STNM104	
STN	105	121717	23:40	00:11	04-14.75S	101-31.12E	1011.0	301.0	-	301.1	303.0	STNM105	
STN	106	121817	02:41	02:53	04-14.72S	101-31.15E	1010.0	299.5	-	301.1	303.0	STNM106	
STN	107	121817	05:40	06:18	04-14.84S	101-31.02E	1007.0	500.4	-	500.6	504.0	STNM107	
STN	108	121817	08:40	08:51	04-14.83S	101-31.37E	1021.0	299.9	-	301.1	303.0	STNM108	
STN	109	121817	11:39	12:15	04-14.87S	101-31.05E	1006.0	300.6	-	301.1	303.0	STNM109	
STN	110	121817	14:39	14:50	04-14.73S	101-30.96E	1001.0	299.3	-	301.1	303.0	STNM110	
STN	111	121817	17:38	18:14	04-14.83S	101-31.15E	1014.0	299.2	-	301.1	303.0	STNM111	
STN	112	121817	20:39	20:50	04-14.59S	101-31.16E	1010.0	299.0	-	300.1	302.0	STNM112	
STN	113	121817	23:39	00:09	04-14.57S	101-31.10E	1009.0	298.6	-	300.1	302.0	STNM113	
STN	114	121917	02:41	02:53	04-14.40S	101-30.63E	995.0	298.8	-	300.1	302.0	STNM114	
STN	115	121917	05:40	06:22	04-14.48S	101-30.19E	975.0	500.0	-	500.6	504.0	STNM115	
STN	116	121917	08:35	08:46	04-14.79S	101-30.72E	992.0	299.2	-	301.1	303.0	STNM116	
STN	117	121917	11:38	12:12	04-14.79S	101-30.81E	995.0	298.8	-	300.1	302.0	STNM117	
STN	118	121917	14:39	14:51	04-15.03S	101-31.21E	1012.0	299.2	-	300.1	302.0	STNM118	
STN	119	121917	17:38	18:15	04-14.73S	101-31.21E	1013.0	298.4	-	301.1	303.0	STNM119	
STN	120	121917	20:33	20:44	04-14.41S	101-30.60E	991.0	299.0	-	301.1	303.0	STNM120	
STN	121	121917	23:39	00:10	04-14.97S	101-31.77E	1037.0	300.3	-	302.1	304.0	STNM121	
STN	122	122017	02:41	02:52	04-15.54S	101-31.76E	1047.0	299.3	-	300.1	302.0	STNM122	
STN	123	122017	05:39	06:17	04-15.79S	101-31.53E	1024.0	499.6	-	500.6	504.0	STNM123	
STN	124	122017	08:35	08:46	04-14.65S	101-31.64E	1032.0	298.6	-	300.1	302.0	STNM124	
STN	125	122017	11:39	12:17	04-14.53S	101-31.53E	1033.0	300.1	-	301.1	303.0	STNM125	
STN	126	122017	14:39	14:51	04-15.34S	101-31.58E	1032.0	299.7	-	300.1	302.0	STNM126	
STN	127	122017	17:35	18:09	04-14.45S	101-31.68E	1035.0	298.6	-	301.1	303.0	STNM127	
STN	128	122017	20:39	20:50	04-14.26S	101-31.18E	1015.0	299.7	-	301.1	303.0	STNM128	
STN	129	122017	23:40	00:11	04-15.19S	101-32.12E	1054.0	297.9	-	300.1	302.0	STNM129	
STN	130	122117	02:34	02:45	04-15.41S	101-30.88E	1003.0	300.4	-	301.1	303.0	STNM130	
STN	131	122117	05:39	06:18	04-13.72S	101-30.96E	1014.0	505.3	-	500.6	504.0	STNM131	
STN	132	122117	08:39	08:50	04-14.91S	101-30.65E	985.0	300.3	-	301.1	303.0	STNM132	

STN	133	122117	11:39	12:15	04-14.35S	101-31.11E	1011.0	301.4	-	304.1	306.0	STNM133	
STN	134	122117	14:39	14:50	04-15.26S	101-31.24E	1014.0	301.5	-	300.1	302.0	STNM134	
STN	135	122117	17:38	18:13	04-14.90S	101-31.81E	1039.0	301.0	-	300.1	302.0	STNM135	
STN	136	122117	20:39	20:51	04-15.22S	101-31.03E	1003.0	301.5	-	300.1	302.0	STNM136	
STN	137	122117	23:40	00:09	04-14.79S	101-32.22E	1058.0	298.1	-	301.1	303.0	STNM137	
STN	138	122217	02:39	02:51	04-14.33S	101-32.08E	1055.0	299.9	-	301.1	303.0	STNM138	
STN	139	122217	05:38	06:16	04-15.41S	101-30.86E	1003.0	500.6	-	500.6	504.0	STNM139	
STN	140	122217	08:39	08:50	04-14.40S	101-31.53E	1032.0	300.1	-	301.1	303.0	STNM140	
STN	141	122217	11:39	12:13	04-14.31S	101-31.79E	1047.0	299.3	-	301.1	303.0	STNM141	
STN	142	122217	14:39	14:50	04-14.80S	101-31.35E	1024.0	299.0	-	300.1	302.0	STNM142	
STN	143	122217	17:34	18:10	04-15.62S	101-31.51E	1031.0	299.9	-	301.1	303.0	STNM143	
STN	144	122217	20:38	20:49	04-15.32S	101-32.37E	1061.0	299.7	-	301.1	303.0	STNM144	
STN	145	122217	23:40	00:10	04-14.81S	101-32.24E	1057.0	297.9	-	300.1	302.0	STNM145	
STN	146	122317	02:40	02:52	04-15.34S	101-31.31E	1018.0	300.4	-	300.1	302.0	STNM146	
STN	147	122317	05:40	06:18	04-14.95S	101-32.40E	1069.0	501.7	-	500.6	504.0	STNM147	
STN	148	122317	08:39	08:51	04-14.63S	101-31.99E	1053.0	300.1	-	300.1	302.0	STNM148	
STN	149	122317	11:40	12:15	04-14.84S	101-31.68E	1036.0	301.5	-	302.1	304.0	STNM149	
STN	150	122317	14:39	14:50	04-14.66S	101-31.57E	1031.0	300.6	-	301.1	303.0	STNM150	
STN	151	122317	17:38	18:11	04-14.58S	101-32.47E	1065.0	300.3	-	301.1	303.0	STNM151	
STN	152	122317	20:39	20:50	04-13.59S	101-32.07E	1051.0	300.3	-	301.1	303.0	STNM152	
STN	153	122317	23:39	00:09	04-14.20S	101-30.96E	1008.0	301.0	-	301.1	303.0	STNM153	
STN	154	122417	02:39	02:51	04-13.82S	101-31.33E	1025.0	299.3	-	300.1	302.0	STNM154	
STN	155	122417	05:36	06:14	04-13.34S	101-31.32E	1025.0	501.3	-	501.6	505.0	STNM155	
STN	156	122417	08:36	08:48	04-13.16S	101-31.01E	1016.0	299.5	-	300.1	302.0	STNM156	
STN	157	122417	11:36	12:11	04-14.45S	101-31.52E	1030.0	301.0	-	301.1	303.0	STNM157	
STN	158	122417	14:39	14:51	04-14.88S	101-31.33E	1020.0	300.8	-	301.1	303.0	STNM158	
STN	159	122417	17:38	18:15	04-13.97S	101-32.13E	1057.0	300.8	-	301.1	303.0	STNM159	
STN	160	122417	20:38	20:50	04-14.67S	101-29.97E	972.0	300.3	-	301.1	303.0	STNM160	
STN	161	122417	23:37	00:06	04-14.71S	101-31.82E	1042.0	299.3	-	301.1	303.0	STNM161	
STN	162	122517	02:40	02:52	04-14.87S	101-30.22E	976.0	300.1	-	302.1	304.0	STNM162	
STN	163	122517	05:42	06:20	04-14.08S	101-30.99E	1012.0	499.8	-	500.6	504.0	STNM163	
STN	164	122517	08:36	08:48	04-14.58S	101-30.92E	1002.0	299.5	-	301.1	303.0	STNM164	

STN	165	122517	11:38	12:12	04-14.86S	101-30.67E	989.0	299.7	-	300.1	302.0	STNM165	
STN	166	122517	14:40	14:52	04-14.48S	101-30.60E	996.0	300.8	-	300.1	302.0	STNM166	
STN	167	122517	17:38	18:13	04-13.76S	101-31.28E	1025.0	299.5	-	302.1	304.0	STNM167	
STN	168	122517	20:38	20:50	04-15.24S	101-30.80E	993.0	301.2	-	301.1	303.0	STNM168	
STN	169	122517	23:39	00:08	04-14.34S	101-31.22E	1018.0	299.5	-	302.1	304.0	STNM169	
STN	170	122617	02:40	02:52	04-14.13S	101-31.96E	1052.0	298.4	-	300.1	302.0	STNM170	
STN	171	122617	05:39	06:16	04-15.13S	101-31.67E	1032.0	500.4	-	500.6	504.0	STNM171	
STN	172	122617	08:40	08:51	04-15.18S	101-31.74E	1038.0	298.4	-	301.1	303.0	STNM172	
STN	173	122617	11:38	12:14	04-14.66S	101-31.68E	1034.0	301.0	-	301.1	303.0	STNM173	
STN	174	122617	14:39	14:51	04-14.67S	101-31.62E	1031.0	299.9	-	301.1	303.0	STNM174	
STN	175	122617	17:39	18:12	04-15.00S	101-31.58E	1032.0	299.9	-	300.1	302.0	STNM175	
STN	176	122617	20:38	20:50	04-14.87S	101-32.09E	1052.0	300.1	-	301.1	303.0	STNM176	
STN	177	122617	23:39	00:07	04-14.59S	101-31.61E	1035.0	299.5	-	301.1	303.0	STNM177	
STN	178	122717	02:40	02:52	04-14.37S	101-31.74E	1042.0	299.0	-	301.1	303.0	STNM178	
STN	179	122717	05:39	06:17	04-14.90S	101-32.46E	1065.0	509.6	-	501.6	505.0	STNM179	
STN	180	122717	08:42	08:54	04-14.36S	101-31.98E	1048.0	299.9	-	300.1	302.0	STNM180	
STN	181	122717	11:38	12:13	04-13.89S	101-31.12E	1018.0	299.2	-	301.1	303.0	STNM181	
STN	182	122717	14:39	14:51	04-13.63S	101-31.29E	1028.0	299.7	-	300.1	302.0	STNM182	
STN	183	122717	17:39	18:15	04-14.37S	101-32.02E	1047.0	301.0	-	302.1	304.0	STNM183	
STN	184	122717	20:38	20:51	04-14.43S	101-31.52E	1030.0	304.9	-	301.1	303.0	STNM184	
STN	185	122717	23:40	00:08	04-14.14S	101-31.28E	1022.0	299.0	-	300.1	302.0	STNM185	
STN	186	122817	02:41	02:53	04-13.74S	101-30.84E	1009.0	299.7	-	302.1	304.0	STNM186	
STN	187	122817	05:39	06:17	04-13.76S	101-30.73E	1004.0	500.7	-	500.6	504.0	STNM187	
STN	188	122817	08:40	08:52	04-13.62S	101-31.34E	1035.0	299.5	-	301.1	303.0	STNM188	
STN	189	122817	11:38	12:10	04-14.28S	101-31.10E	1011.0	299.2	-	301.1	303.0	STNM189	
STN	190	122817	14:39	14:52	04-13.84S	101-30.79E	1002.0	299.2	-	301.1	303.0	STNM190	
STN	191	122817	17:38	18:12	04-13.24S	101-31.31E	1025.0	301.0	-	303.1	305.0	STNM191	
STN	192	122817	20:38	20:50	04-14.50S	101-30.97E	1006.0	300.6	-	300.1	302.0	STNM192	
STN	193	122817	23:41	00:09	04-13.94S	101-30.96E	1010.0	299.9	-	302.1	304.0	STNM193	
STN	194	122917	02:41	02:53	04-14.48S	101-29.71E	958.0	299.3	-	301.1	303.0	STNM194	
STN	195	122917	05:40	06:18	04-13.60S	101-31.78E	1044.0	504.6	-	501.6	505.0	STNM195	
STN	196	122917	08:39	08:51	04-14.75S	101-31.34E	1019.0	299.5	-	301.1	303.0	STNM196	

STN	197	122917	11:38	12:12	04-14.50S	101-31.15E	1011.0	300.1	-	300.1	302.0	STNM197	
STN	198	122917	14:39	14:52	04-14.27S	101-30.97E	1007.0	301.9	-	301.1	303.0	STNM198	
STN	199	122917	17:37	18:13	04-14.37S	101-31.51E	1029.0	299.2	-	300.1	302.0	STNM199	
STN	200	122917	20:35	20:47	04-14.43S	101-32.10E	1051.0	298.4	-	300.1	302.0	STNM200	
STN	201	122917	23:39	00:08	04-14.24S	101-31.18E	1018.0	300.6	-	301.1	303.0	STNM201	
STN	202	123017	02:41	02:53	04-13.94S	101-30.71E	997.0	299.0	-	300.1	302.0	STNM202	
STN	203	123017	05:39	06:16	04-14.60S	101-31.33E	1018.0	502.0	-	500.6	504.0	STNM203	
STN	204	123017	08:40	08:52	04-15.51S	101-31.88E	1048.0	299.3	-	300.1	302.0	STNM204	
STN	205	123017	11:37	12:11	04-14.47S	101-31.30E	1019.0	304.5	-	302.1	304.0	STNM205	
STN	206	123017	14:39	14:51	04-14.33S	101-31.02E	1006.0	299.3	-	301.1	303.0	STNM206	
STN	207	123017	17:47	18:20	04-14.76S	101-31.84E	1043.0	298.4	-	301.1	303.0	STNM207	
STN	208	123017	20:38	20:51	04-14.45S	101-31.69E	1036.0	300.4	-	300.1	302.0	STNM208	
STN	209	123017	23:41	00:09	04-14.21S	101-31.05E	1014.0	301.2	-	302.1	304.0	STNM209	
STN	210	123117	02:38	02:50	04-13.76S	101-31.06E	1015.0	299.3	-	301.1	303.0	STNM210	
STN	211	123117	05:41	06:19	04-14.76S	101-31.12E	1010.0	502.6	-	501.6	505.0	STNM211	
STN	212	123117	08:40	08:51	04-13.44S	101-31.37E	1028.0	300.1	-	301.1	303.0	STNM212	
STN	213	123117	11:39	11:51	04-14.36S	101-31.31E	1019.0	301.4	-	301.1	303.0	STNM213	
STN	214	123117	14:38	14:50	04-14.73S	101-31.40E	1022.0	301.2	-	301.1	303.0	STNM214	
STN	215	123117	17:39	17:50	04-13.95S	101-31.60E	1041.0	300.6	-	300.1	302.0	STNM215	
STN	216	123117	20:43	20:55	04-13.34S	101-31.86E	1041.0	304.7	-	300.1	302.0	STNM216	
STN	217	123117	23:41	23:52	04-14.20S	101-31.47E	1031.0	299.2	-	300.1	302.0	STNM217	

5.14 Salinity of sampled water

(1) Personnel

Satoru YOKOI	(JAMSTEC)	- Principal Investigator
Rei ITO	(MWJ)	- Operation Leader

(2) Objective

To provide calibrations for the measurements of salinity collected from CTD casts and The Continuous Sea Surface Water Monitoring System (TSG).

(2) Method

a. Salinity Sample Collection

Seawater samples were collected with 12 liter Niskin-X bottles and TSG. The salinity sample bottle of the 250ml brown glass bottle with screw cap was used for collecting the sample water. Each bottle was rinsed 3 times with the sample water, and was filled with sample water to the bottle shoulder. All of sample bottle were sealed with a plastic cone and a screw cap because we took into consideration the possibility of storage for about a month. The cone was rinsed 3 times with the sample seawater before its use. Each bottle was stored for more than 12 hours in the laboratory before the salinity measurement.

The kind and number of samples taken are shown as follows ;

Table 5.17-1 Kind and number of samples

Kind of Samples	Number of Samples
Samples for CTD	91
Samples for TSG	40
Total	131

b. Instruments and Method

The salinity analysis was carried out on R/V MIRAI during the cruise of MR17-08 using the salinometer (Model 8400B “AUTOSAL” ; Guildline Instruments Ltd.: S/N 62556) with an additional peristaltic-type intake pump (Ocean Scientific International, Ltd.). A pair of precision digital thermometers (Model 9540 ; Guildline Instruments Ltd.) were used. The thermometer monitored the ambient temperature and the other monitored a bath temperature.

The specifications of the AUTOSAL salinometer and thermometer are shown as follows ;

Salinometer (Model 8400B “AUTOSAL” ; Guildline Instruments Ltd.)

Measurement Range	:	0.005 to 42 (PSU)
Accuracy	:	Better than ±0.002 (PSU) over 24 hours without re-standardization
Maximum Resolution	:	Better than ±0.0002 (PSU) at 35 (PSU)

Thermometer (Model 9540 ; Guildline Instruments Ltd.)

Measurement Range	:	-40 to +180 deg C
Resolution	:	0.001
Limits of error ±deg C	:	0.01 (24 hours @ 23 deg C ±1 deg C)
Repeatability	:	±2 least significant digits

The measurement system was almost the same as Aoyama *et al.* (2002). The salinometer was operated in the air-conditioned ship's laboratory at a bath temperature of 24 deg C. The ambient temperature varied from approximately 22 deg C to 24 deg C, while the bath temperature was very stable and varied within +/- 0.004 deg C on rare occasion. The measurement for each sample was done with a double conductivity ratio and defined as the median of 31 readings of the salinometer. Data collection was started 5 seconds after filling the cell with the sample and it took about 10 seconds to collect 31 readings by a personal computer. Data were taken for the sixth and seventh filling of the cell. In the case of the difference between the double conductivity ratio of these two fillings being smaller than 0.00002, the average value of the double conductivity ratio was used to calculate the bottle salinity with the algorithm for the practical salinity scale, 1978 (UNESCO, 1981). If the difference was greater than or equal to 0.00003, an eighth filling of the cell was done. In the case of the difference between the double conductivity ratio of these two fillings being smaller than 0.00002, the average value of the double conductivity ratio was used to calculate the bottle salinity. The measurement was conducted in about 4 hours per day and the cell was cleaned with soap after the measurement of the day.

(4) Results

a. Standard Seawater

Standardization control of the salinometer was set to 608 and all measurements were done at this setting. The value of STANDBY was 24+5135 and that of ZERO was 0.0+0000. The conductivity ratio of IAPSO Standard Seawater batch P160 was 0.99983 (double conductivity ratio was 1.99966) and was used as the standard for salinity. 12 bottles of P160 were measured.

Fig.5.14-1 shows the time series of the double conductivity ratio of the Standard Seawater batch P160. The average of the double conductivity ratio was 1.99966 and the standard deviation was 0.00001 which is equivalent to 0.0002 in salinity.

Fig.5.14-2 shows the time series of the double conductivity ratio of the Standard Seawater batch P160 after correction. The average of the double conductivity ratio after correction was 1.99966 and the standard deviation was 0.00001, which is equivalent to 0.0001 in salinity.

The specifications of SSW used in this cruise are shown as follows ;

batch	:	P160
conductivity ratio	:	0.99983
salinity	:	34.993
use by	:	20th Jul. 2019

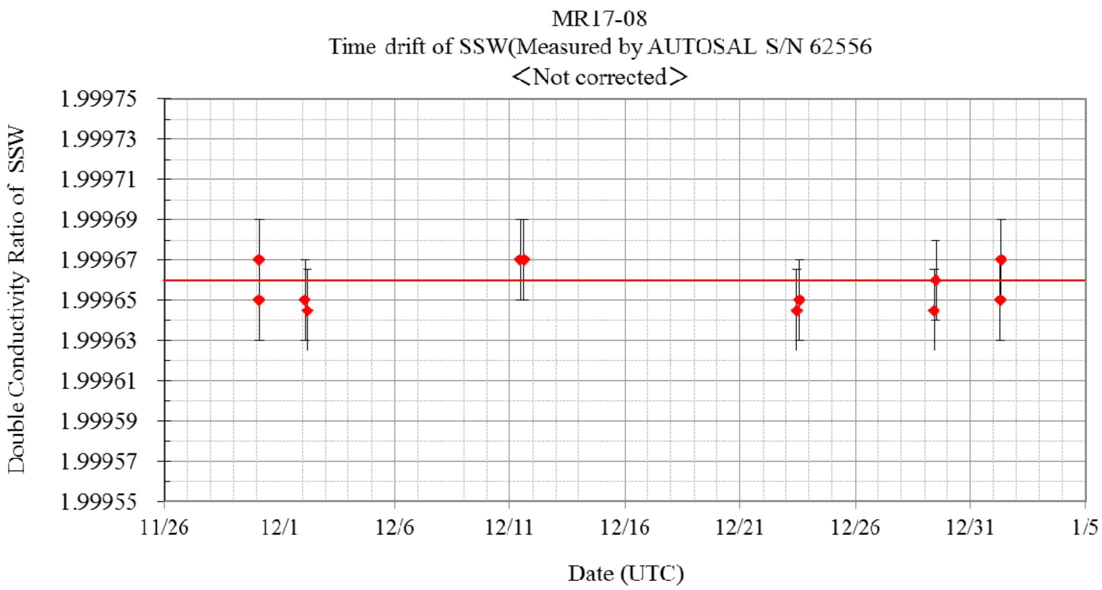


Fig. 5.14-1: Time series of double conductivity ratio for the Standard Seawater batch P160 (before correction)

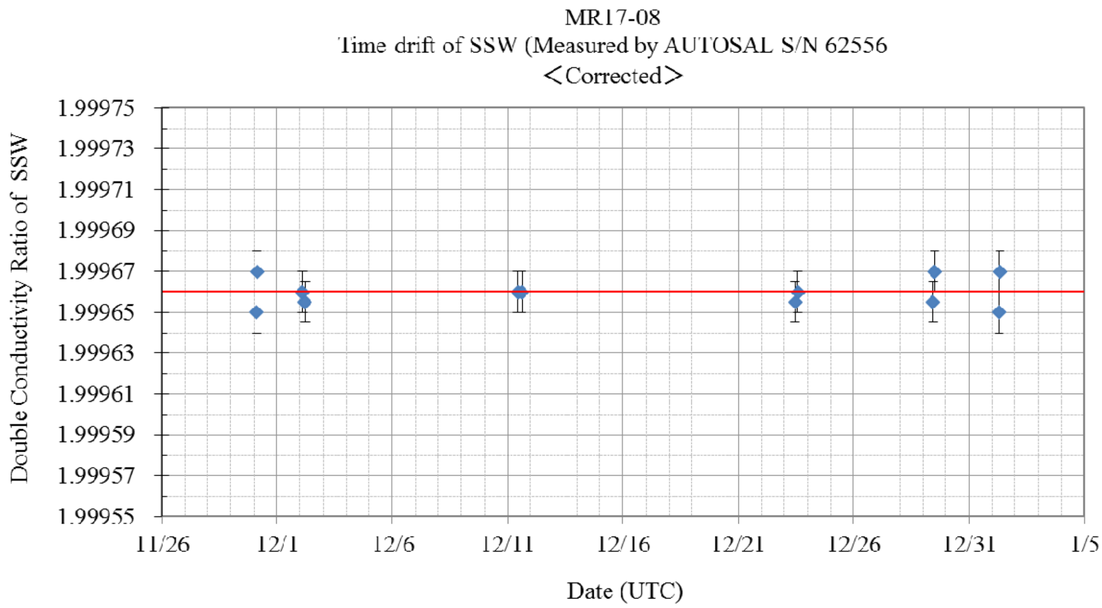


Fig. 5.14-2: Time series of double conductivity ratio for the Standard Seawater batch P160 (after correction)

b. Sub-Standard Seawater

Sub-standard seawater was made from Surface-sea water filtered by a pore size of 0.22 micrometer and stored in a 20 liter container made of polyethylene and stirred for at least 24 hours before measuring. It was measured about every 6 samples in order to check for the possible sudden drifts of the salinometer.

c. Replicate Samples

We estimated the precision of this method using 39 pairs of replicate samples taken from the same Niskin bottle. The average and the standard deviation of absolute difference among 39 pairs of replicate samples were 0.00032 and 0.00026 in salinity, respectively.

(5) Data archive

These raw datasets will be submitted to JAMSTEC Data Management Office (DMO).

(6) Reference

・ Aoyama, M., T. Joyce, T. Kawano and Y. Takatsuki : Standard seawater comparison up to P129. Deep-Sea Research, I, Vol. 49, 1103～1114, 2002

・UNESCO : Tenth report of the Joint Panel on Oceanographic Tables and Standards. UNESCO Tech. Papers in Mar. Sci., 36, 25 pp., 1981

5.15 Dissolved oxygen of sampled water

(1) Personnel

Satoru YOKOI	(JAMSTEC)	: Principal Investigator
Masanori ENOKI	(MWJ)	: Operation Leader
Atsushi ONO	(MWJ)	
Erii IRIE	(MWJ)	

(2) Objective

Determination of dissolved oxygen in seawater by Winkler titration.

(3) Parameters

Dissolved Oxygen

(4) Instruments and Methods

Following procedure is based on Winkler method (Dickson, 1996; Culberson, 1991).

a. Instruments

Burette for sodium thiosulfate and potassium iodate;

Automatic piston burette (APB-510 / APB-620) manufactured by Kyoto Electronics Manufacturing Co., Ltd. / 10 cm^3 of titration vessel

Detector;

Automatic photometric titrator (DOT-01X) manufactured by Kimoto Electric Co., Ltd.

Software;

DOT_Terminal Ver. 1.2.0

b. Reagents

Pickling Reagent I: Manganese (II) chloride solution (3 mol dm^{-3})

Pickling Reagent II:

Sodium hydroxide (8 mol dm^{-3}) / sodium iodide solution (4 mol dm^{-3})

Sulfuric acid solution (5 mol dm^{-3})

Sodium thiosulfate (0.025 mol dm^{-3})

Potassium iodate (0.001667 mol kg^{-1})

c. Sampling

Seawater samples were collected with Niskin bottle attached to the CTD/Carousel Water Sampling System (CTD system). Seawater for oxygen measurement was transferred from the bottle to a volume calibrated flask (ca. 100 cm^3), and three times volume of the flask was overflowed. Temperature was simultaneously measured by digital thermometer during the overflowing. After transferring the sample, two reagent solutions (Reagent I and II) of 1 cm^3 each were added immediately and the stopper was inserted carefully into the flask. The sample flask was then shaken vigorously to mix the contents and to disperse the precipitate finely throughout. After the precipitate has settled at least halfway down the flask, the flask was shaken again vigorously to disperse the precipitate. The sample flasks containing pickled samples were stored in a laboratory until they were titrated.

d. Sample measurement

For over two hours after the re-shaking, the pickled samples were measured on board. Sulfuric acid solution with its volume of 1 cm^3 and a magnetic stirrer bar were put into the sample flask and the sample was stirred. The samples were titrated by sodium thiosulfate solution whose morality was determined by potassium iodate solution. Temperature of sodium thiosulfate during titration was recorded by a digital thermometer. Dissolved oxygen concentration (μmol kg^{-1}) was calculated by sample temperature during seawater sampling, salinity of the sensor on CTD system, flask volume, and titrated volume of sodium thiosulfate solution without the blank. During this cruise, 2 sets of the titration apparatus were used.

e. Standardization and determination of the blank

Concentration of sodium thiosulfate titrant was determined by potassium iodate solution. Pure potassium iodate was dried in an oven at 130 ºC, and 1.7835 g of it was dissolved in deionized water and diluted to final weight of 5 kg in a flask (0.001667 mol kg^{-1}). After 10 cm^3 of the standard potassium iodate solution was added to an another flask using a volume-calibrated dispenser, 90 cm^3 of deionized water, 1 cm^3 of sulfuric acid solution, and 1 cm^3 of pickling reagent solution II and I were added in order. Amount of titrated volume of sodium thiosulfate for this diluted standard potassium iodate solution (usually 5 times measurements average) gave the morality of sodium thiosulfate titrant.

The oxygen in the pickling reagents I (1 cm^3) and II (1 cm^3) was assumed to be 3.8×10^{-8} mol (Murray et al., 1968). The blank due to other than oxygen was determined as follows. First, 1 and 2 cm^3 of the standard potassium iodate solution were added to each flask using a calibrated dispenser. Then 100 cm^3 of deionized water, 1 cm^3 of sulfuric acid solution, 1 cm^3 of pickling II reagent solution, and same volume of pickling I reagent solution were added into the flask in order. The blank was determined by difference between the first (1 cm^3 of potassium iodate) titrated volume of the sodium thiosulfate and the second (2 cm^3 of potassium iodate) one. The titrations were conducted for 3 times and their average was used as the blank value.

(5) Observation log

a. Standardization and determination of the blank

Table 5.5.15-1 shows results of the standardization and the blank determination during this cruise.

b. Repeatability of sample measurement

Replicate samples were taken at every CTD casts. The standard deviation of the replicate measurement (Dickson et al., 2007) was 0.16μmol kg^{-1} (n=114).

(6) Data archives

These data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via “Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)” in JAMSTEC web site <http://www.godac.jamstec.go.jp/darwin/e>.

Table 5.5.15-1 Results of the standardization and the blank determinations during cruise.

Date (yyyy/mm/dd)	potassium iodate ID	Sodium thiosulfate ID	DOT-01X (No.7)		DOT-01X (No.8)		Stations
			E.P. (cm^3)	Blank (cm^3)	E.P. (cm^3)	Blank (cm^3)	
2017/12/2	K1704D03	T1704I	3.977	0.000	3.980	0.006	L01cast1,L05cast1, L09cast1,L13cast1, L15cast1,L18cast1, L22cast1,L26cast1, STNcast1,3,5,7,9, 11,13,15
2017/12/7	K1704D08	T1704J	3.990	-0.002	3.997	0.002	STNcast17,19,21, 23,25,27,29,31,33, 35,37,39
2017/12/9	K1704D06	T1704J	3.990	-0.003	3.997	0.003	STNcast41,43,45, 47,49,51,53,55,57, 59,61,63
2017/12/12	K1704D07	T1704J	3.992	-0.002	3.996	0.002	STNcast65,67,69, 71,73,75,77,79,81, 83,85,87,89,91,93, 95
2017/12/17	K1704D09	T1704K	3.971	-0.002	3.973	0.000	STNcast97,101,103, 105,107,109,111, 113,115,117,119, 121,123,125,127, 129,131,133,135, 137,139,141,143
2017/12/23	K1704E02	T1704K	3.971	-0.002	3.977	0.004	STNcast145,147, 149,151,153,155, 157,159,161,163, 165,167,169,171, 173,175,177,179
2017/12/27	K1704E03	T1704L	3.971	-0.003	3.980	0.005	STNcast181,183, 185,187,189,191, 193,195,197,199, 201,203,205,207, 209,211

(7) References

Culberson, C. H. (1991). *Dissolved Oxygen.* WHPO Publication 91-1.

Dickson, A. G. (1996). Determination of dissolved oxygen in sea water by Winkler titration. In *WOCE Operations Manual*, Part 3.1.3 Operations & Methods, WHP Office Report WHPO 91-1.

Dickson, A. G., Sabine, C. L., & Christian, J. R.(Eds.), (2007). *Guide to best practices for ocean CO_2 measurements, PICES Special Publication 3*: North Pacific Marine Science Organization.

Murray, C. N., Riley, J. P., & Wilson, T. R. S. (1968). The solubility of oxygen in Winklerreagents used for the determination of dissolved oxygen. *Deep Sea Res.*, 15, 237-238.

5.16 Nutrients of sampled water

(1) Personnel

Satoru YOKOI	(JAMSTEC)	: Principal Investigator
Yoshiko ISHIKAWA	(MWJ)	: Operation Leader

(2) Objectives

The objectives of nutrients analyses during the R/V Mirai MR17-08 cruise in the East Indian Ocean, of which EXPOCODE is 49NZ20171121, is as follows:

- Describe the present status of nutrients concentration with excellent comparability using certified reference material of nutrient in seawater.

(3) Parameters

The determinants are nitrate, nitrite, silicate, and phosphate in the East Indian Ocean.

(4) Instruments and methods

(4.1) Analytical detail using QuAAtro 2-HR systems (BL TEC K.K.)

Nitrate + nitrite and nitrite are analyzed following a modification of the method of Grasshoff (1976). The sample nitrate is reduced to nitrite in a cadmium tube the inside of which is coated with metallic copper. The sample stream after reduction is treated with an acidic, sulfanilamide reagent to produce a diazonium ion. N-1-Naphthylethylenediamine Dihydrochloride added to the sample stream to produce a red azo dye. With reduction of the nitrate to nitrite, both nitrate and nitrite react and are measured; without reduction, only nitrite reacts. Thus, for the nitrite analysis, no reduction is performed and the alkaline buffer is not necessary. Nitrate is computed by difference.

The silicate method is analogous to that described for phosphate. The method used is essentially that of Grasshoff et al. (1999). Silicomolybdic acid is first formed from the silicate in the sample and molybdic acid. The silicomolybdic acid is reduced to silicomolybdous acid, or "molybdenum blue," using ascorbic acid.

The phosphate analysis is a modification of the procedure of Murphy and Riley (1962). Molybdic acid is added to the seawater sample to form phosphomolybdic acid which is in turn reduced to phosphomolybdous acid using L-ascorbic acid as the reductant.

The ammonia in seawater is mixed with an alkaline containing EDTA, ammonia as gas state is formed from seawater. The ammonia (gas) is absorbed in sulfuric acid by way of 0.5 μm pore size membrane filter (ADVANTEC PTFE) at the dialyzer attached to analytical system. The ammonia absorbed in sulfuric acid is determined by coupling with phenol and hypochlorite to form indophenols blue. Wavelength using ammonia analysis is 630 nm, which is absorbance of indophenols blue.

The details of modification of analytical methods for four parameters, Nitrate, Nitrite, Silicate and Phosphate, used in this cruise are also compatible with the methods described in nutrients section in GO-SHIP repeat hydrography manual (Hydes et al., 2010), while an analytical method of ammonium is compatible with Determination of ammonia in seawater using a vaporization membrane permeability method (Kimura, 2000). The flow diagrams and reagents for each parameter are shown in Figures 5.16-1 to 5.16-4.

(4.2) Nitrate + Nitrite Reagents

50 % Triton solution

50 mL Triton^{TM} X-100 provided by Sigma-Ardrich Japan G. K. (CAS No. 9002-93-1), were mixed with 50 mL Ethanol (99.5 %).

Imidazole (buffer), 0.06 M (0.4 % w/v)

Dissolve 4 g Imidazole (CAS No. 288-32-4), in 1000 mL Ultra-pure water, add 2 mL Hydrogen chloride (CAS No. 7647-01-0). After mixing, 1 mL 50 % Triton solution is added.

Sulfanilamide, 0.06 M (1 % w/v) in 1.2 M HCl

Dissolve 10 g 4-Aminobenzenesulfonamide (CAS No. 63-74-1), in 900 mL of Ultra-pure water, add 100 mL Hydrogen chloride (CAS No. 7647-01-0). After mixing, 2 mL 50 % Triton solution is added.

NED, 0.004 M (0.1 % w/v)

Dissolve 1 g N-(1-Naphthalenyl)-1,2-ethanediamine, dihydrochloride (CAS No. 1465-25-4), in 1000 mL of Ultra-pure water and add 10 mL Hydrogen chloride (CAS No. 7647-01-0). After mixing, 1 mL 50 % Triton solution is added. This reagent was stored in a dark bottle.

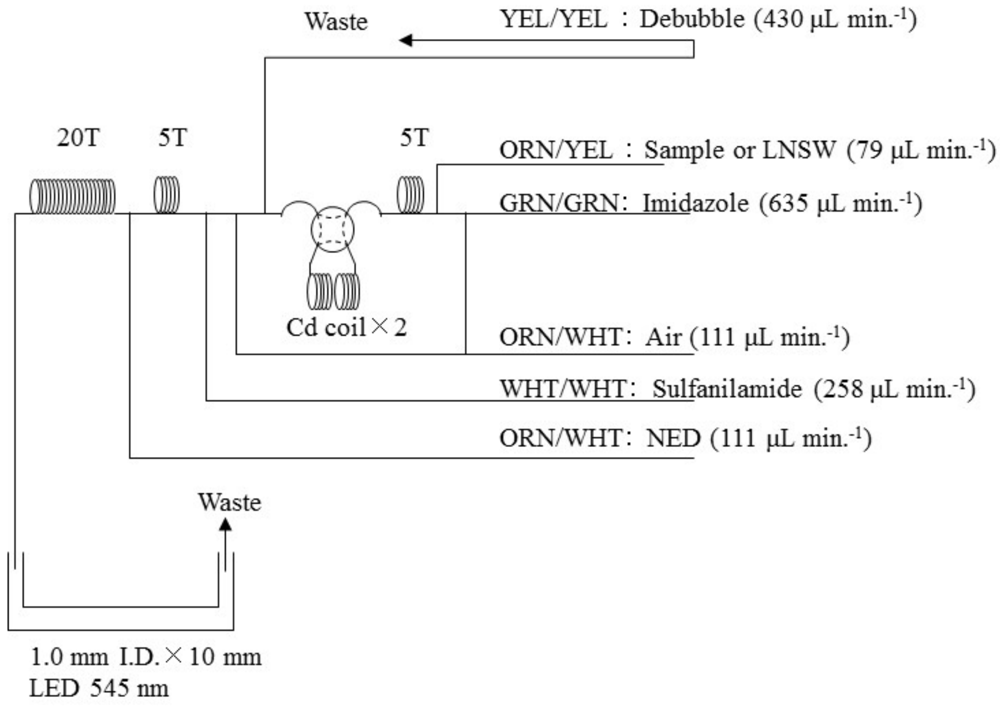


Figure 5.16-1 NO_3+NO_2 (1ch.) Flow diagram.

(4.3) Nitrite Reagents

50 % Triton solution

50 mL Triton™ X-100 provided by Sigma-Ardrich Japan G. K. (CAS No. 9002-93-1), were mixed with 50 mL Ethanol (99.5 %).

Sulfanilamide, 0.06 M (1 % w/v) in 1.2 M HCl

Dissolve 10 g 4-Aminobenzenesulfonamide (CAS No. 63-74-1), in 900 mL of Ultra-pure water, add 100 mL Hydrogen chloride (CAS No. 7647-01-0). After mixing, 2 mL 50 % Triton solution is added.

NED, 0.004 M (0.1 % w/v)

Dissolve 1 g N-(1-Naphthalenyl)-1,2-ethanediamine, dihydrochloride (CAS No. 1465-25-4), in 1000 mL of Ultra-pure water and add 10 mL Hydrogen chloride (CAS No. 7647-01-0). After mixing, 1 mL 50 % Triton solution is added. This reagent was stored in a dark bottle.

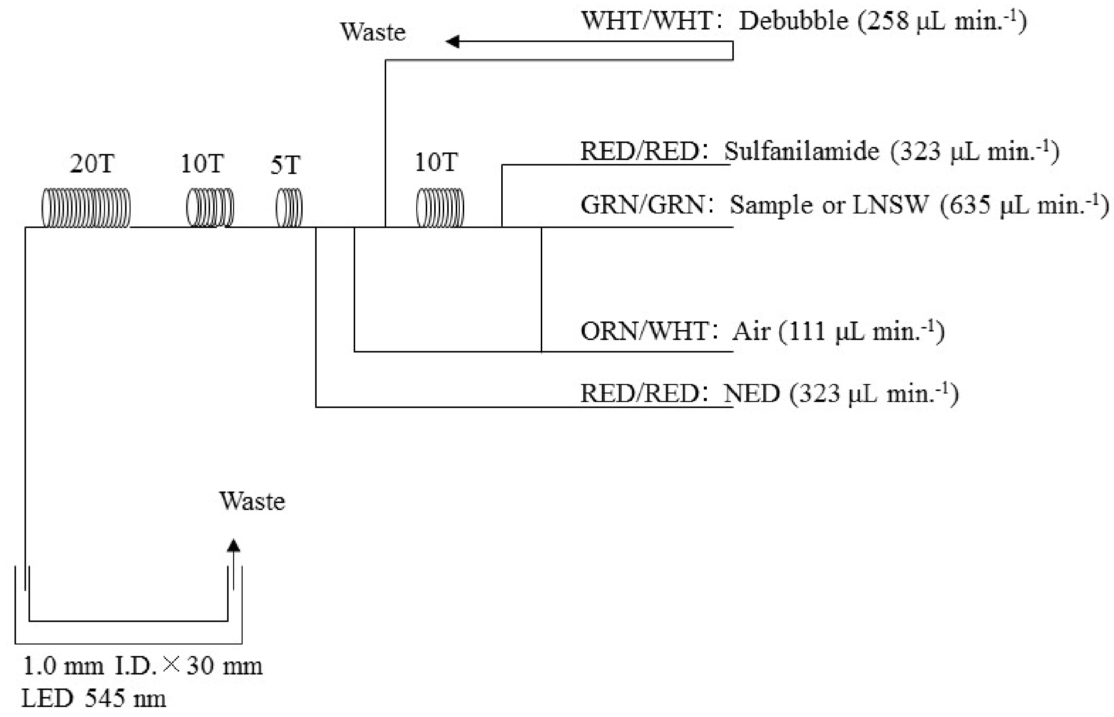


Figure 5.16-2 NO_2 (2ch.) Flow diagram.

(4.4) Silicate Reagents

15 % Sodium dodecyl sulfate solution

75 g Sodium dodecyl sulfate (CAS No. 151-21-3) were mixed with 425 mL Ultra-pure water.

Molybdic acid, 0.06 M (2 % w/v)

Dissolve 15 g Sodium molybdate dihydrate (CAS No. 10102-40-6), in 980 mL Ultra-pure water, add 8 mL Sulfuric acid (CAS No. 7664-93-9). After mixing, 20 mL 15 % Sodium dodecyl sulfate solution is added.

Oxalic acid, 0.6 M (5 % w/v)

Dissolve 50 g Oxalic acid (CAS No. 144-62-7), in 950 mL of Ultra-pure water.

Ascorbic acid, 0.01 M (3 % w/v)

Dissolve 2.5 g L-Ascorbic acid (CAS No. 50-81-7), in 100 mL of Ultra-pure water. This reagent was freshly prepared at every day.

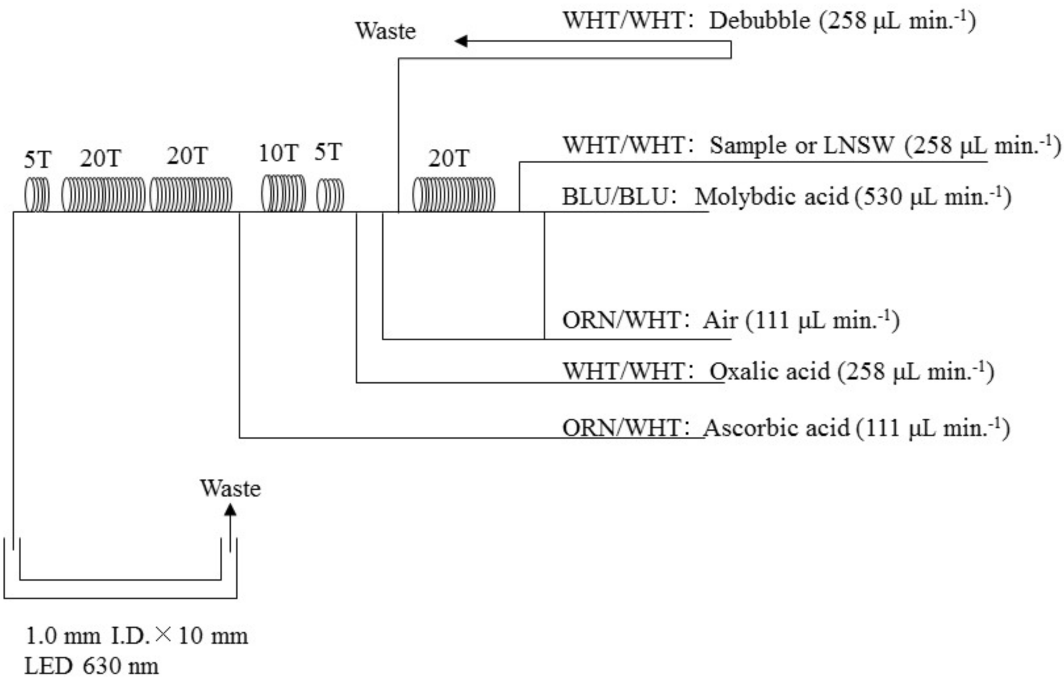


Figure 5.16-3 SiO_2 (3ch.) Flow diagram.

(4.5) Phosphate Reagents

15 % Sodium dodecyl sulfate solution

75 g Sodium dodecyl sulfate (CAS No. 151-21-3) were mixed with 425 mL Ultra-pure water.

Stock molybdate solution, 0.03 M (0.8 % w/v)

Dissolve 8 g Sodium molybdate dihydrate (CAS No. 10102-40-6), and 0.17 g Antimony potassium tartrate trihydrate (CAS No. 28300-74-5), in 950 mL of Ultra-pure water and added 50 mL Sulfuric acid (CAS No. 7664-93-9).

PO_4 color reagent

Dissolve 1.2 g L-Ascorbic acid (CAS No. 50-81-7), in 150 mL of stock molybdate solution. After mixing, 3 mL 15 % Sodium dodecyl sulfate solution is added. This reagent was freshly prepared before every measurement.

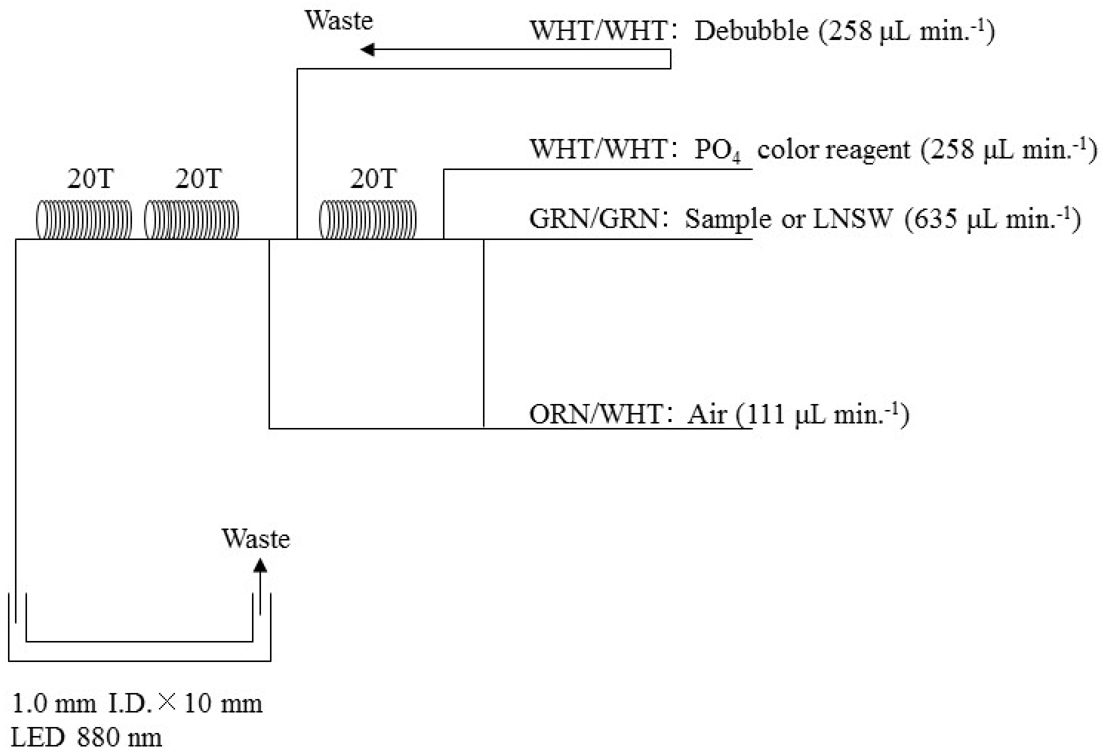


Figure 5.16-4 PO_4 (4ch.) Flow diagram.

(4.6) Sampling procedures

Sampling of nutrients followed that oxygen, salinity and trace gases. Samples were drawn into a virgin 10 mL polyacrylates vials without sample drawing tubes. These were rinsed three times before filling and vials were capped immediately after the drawing. The vials are put into water bath adjusted to ambient temperature, 20.8 ± 0.4 degree Celsius, in about 30 minutes before use to stabilize the temperature of samples.

No transfer was made and the vials were set an auto sampler tray directly. Samples were analyzed after collection within 24 hours, except for C01M001, M01001, L15M001, L18M001, STNM001, STNM003, STNM009, STNM011, and STNM019.

(4.7) Data processing

Raw data from QuAAtro 2-HR were treated as follows:

- Check baseline shift.
- Check the shape of each peak and positions of peak values taken, and then change the positions of peak values taken if necessary.
- Carry-over correction and baseline drift correction were applied to peak heights of each samples followed by sensitivity correction.
- Baseline correction and sensitivity correction were done basically using liner regression.
- Load pressure and salinity from uncalibrated CTD data to calculate density of seawater tentatively. To calculate the final nutrients concentration we used salinity from uncalibrated CTD

data for 2,058 samples.
- Calibration curves to get nutrients concentration were assumed second order equations.

(4.8) Summary of nutrients analysis

We made 33 QuAAtro runs for the water columns sample collected by 118 casts at 13 stations and rain water sample at 30 points during MR17-08. The total amount of layers of the seawater sample reached to 2,118. We made basically duplicate measurement. The station locations for nutrients measurement is shown in Figure 5.16-5.

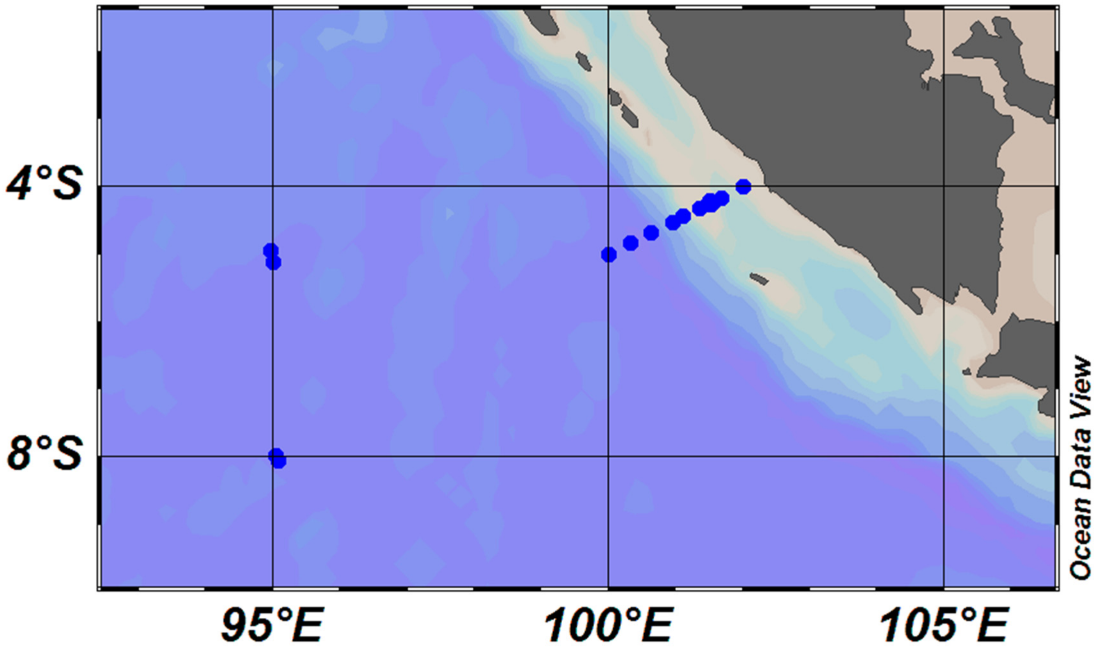


Figure 5.16-5 Sampling positions of nutrients sample.

(5) Station list

The sampling station list for nutrients is shown in Table 5.13.1 (CTD cast table).

(6) Certified Reference Material of nutrients in seawater

KANSO CRMs (Lot: CJ) were used to ensure the comparability and traceability of nutrient measurements during this cruise. The details of CRMs are shown below.

<u>Production</u>

KANSO CRMs are certified reference material (CRM) for inorganic nutrients in seawater. These were produced by KANSO Co.,Ltd. This certified reference material has been produced using autoclaved natural seawater on the basis of quality control system under ISO Guide 34 (JIS Q 0034).

KANSO Co.,Ltd. has been accredited under the Accreditation System of National Institute of Technology and Evaluation (ASNITE) as a CRM producer since 2011. (Accreditation No.: ASNITE 0052 R)

Property value assignment

The certified values are arithmetic means of the results of 30 bottles from each batch (measured in duplicates) analyzed by KANSO Co.,Ltd. and Japan Agency for Marine-Earth Science and Technology (JAMSTEC) using the colorimetric method (continuous flow analysis, CFA, method). The salinity of calibration solutions were adjusted to the salinity of this CRM ± 0.5.

Metrological Traceability

Each certified value of nitrate, nitrite, and phosphate of KANSO CRMs were calibrated versus one of Japan Calibration Service System (JCSS) standard solutions for each nitrate ions, nitrite ions, and phosphate ions. JCSS standard solutions are calibrated versus the secondary solution of JCSS for each of these ions. The secondary solution of JCSS is calibrated versus the specified primary solution produced by Chemicals Evaluation and Research Institute (CERI), Japan. CERI specified primary solutionsare calibrated versus the National Metrology Institute of Japan (NMIJ) primary standards solution of nitrate ions, nitrite ions and phosphate ions, respectively.

For a certified value of silicate of KANSO CRM was determined by one of Merck KGaA silicon standard solution 1000 mg L^{-1} Si traceable to National Institute of Standards and Technology (NIST) SRM of silicon standard solution (SRM 3150).

The certified values of nitrate, nitrite, and phosphate of KASNO CRM are thus traceable to the International System of Units (SI) through an unbroken chain of calibrations, JCSS, CERI and NMIJ solutions as stated above, each having stated uncertainties. The certified values of silicate of KANSO CRM are traceable to the International System of Units (SI) through an unbroken chain of calibrations, Merck KGaA and NIST SRM 3150 solutions, each having stated uncertainties.

As stated in the certificate of NMIJ CRMs each certified value of dissolved silica, nitrate ions, and nitrite ions was determined by more than one method using one of NIST (National Institute of Standards and Technology) SRM of silicon standard solution and NMIJ primary standards solution of nitrate ions and nitrite ions. The concentration of phosphate ions as stated information value in the certificate was determined NMIJ primary standards solution of phosphate ions. Those values in the certificate of NMIJ CRMs are traceable to the International System of Units (SI).

One of analytical methods used for certification of NMIJ CRM for nitrate ions, nitrite ions, phosphate ions and dissolved silica was colorimetric method (continuous mode and batch one). The colorimetric method is same as the analytical method (continuous mode only) used for certification of KANSO CRM. For certification of dissolved silica, exclusion chromatography/isotope dilution-inductively coupled plasma mass spectrometry and Ion exclusion chromatography with post-column detection were used. For certification of nitrate ions, Ion chromatography by direct analysis and Ion chromatography after halogen-ion separation were used. For certification of nitrite ions, Ion chromatography by direct analysis was used.

NMIJ CRMs were analyzed at the time of certification process for CRM and the results were confirmed within expanded uncertainty stated in the certificate of NMIJ CRMs.

(6.1) CRM for this cruise

CRM lot CJ assignment was completely done based on random number. The CRM bottles were stored at a room in the ship, REAGENT STORE, where the temperature was maintained around 20.7 degree Celsius - 26.7 degree Celsius.

(6.2) CRM concentration

We used nutrients concentrations for CRM lot CJ as shown in Table 5.16-1.

Table 5.16-1 Certified concentration and uncertainty (k=2) of CRM.

unit: μmol kg^{-1}

Lot	Nitrate	Nitrite	Silicate	Phosphate
CJ	16.20 ± 0.20	0.03 ± 0.01	38.50 ± 0.40	1.190 ± 0.020

(7) Nutrients standards

(7.1) Volumetric laboratory ware of in-house standards

All volumetric glass ware and polymethylpentene (PMP) ware used were gravimetrically calibrated. Plastic volumetric flasks were gravimetrically calibrated at the temperature of use within 4 K.

(7.1.1) Volumetric flasks

Volumetric flasks of Class quality (Class A) are used because their nominal tolerances are 0.05 % or less over the size ranges likely to be used in this work. Class A flasks are made of borosilicate glass, and the standard solutions were transferred to plastic bottles as quickly as possible after they are made up to volume and well mixed in order to prevent excessive dissolution of silicate from the glass. PMP volumetric flasks were gravimetrically calibrated and used only within 4 K of the calibration temperature.

The computation of volume contained by glass flasks at various temperatures other than the calibration temperatures were done by using the coefficient of linear expansion of borosilicate crown glass.

Because of their larger temperature coefficients of cubical expansion and lack of tables constructed for these materials, the plastic volumetric flasks were gravimetrically calibrated over the temperature range of intended use and used at the temperature of calibration within 4 K. The weights obtained in the calibration weightings were corrected for the density of water and air buoyancy.

(7.1.2) Pipettes

All pipettes have nominal calibration tolerances of 0.1 % or better. These were gravimetrically calibrated in order to verify and improve upon this nominal tolerance.

(7.2) Reagents, general considerations

(7.2.1) Specifications

For nitrate standard, "potassium nitrate 99.995 suprapur®" provided by Merck, Lot. B0993065, CAS No. 7757-79-1, was used.

For nitrite standard solution, we used "nitrite ion standard solution (NO_2^- 1000) provided by Wako, Lot DSK6251, Code. No. 140-06451." This standard solution was certified by Wako using Ion chromatograph method. Calibration result is 1006 mg L^{-1} at 20 degree Celsius. Expanded uncertainty of calibration (k=2) is 0.7 % for the calibration result.

For the silicate standard, we use "Silicon standard solution SiO_2 in NaOH 0.5 M CertiPUR®" provided by Merck, Code. No. 170236, of which lot number is HC68513536 are used. The silicate concentration is certified by NIST-SRM3150 with the uncertainty of 0.7 %. HC68513536 is certified as 1000 mg L^{-1}.

For phosphate standard, "potassium dihydrogen phosphate anhydrous 99.995 suprapur®" provided by Merck, Lot. B1144508, CAS No.: 7778-77-0, was used.

(7.2.2) Ultra-pure water

Ultra-pure water (Milli-Q water) freshly drawn was used for preparation of reagent, standard solutions and for measurement of reagent and system blanks.

(7.2.3) Low nutrients seawater (LNSW)

Surface water having low nutrient concentration was taken and filtered using 0.20 μm pore capsule cartridge filter at MR16-09 cruise on March, 2017. This water is stored in 20 L cubitainer with cardboard box.

LNSW concentrations were assigned to November, 2017 in this cruise.

(7.2.4) Concentrations of nutrients for A, D, B and C standards

Concentrations of nutrients for A, D, B and C standards are set as shown in Table 5.16-2. The C standard is prepared according recipes as shown in Table 5.16-3. All volumetric laboratory tools were calibrated prior the cruise as stated in chapter (6.1) Then the actual concentration of nutrients in each fresh standard was calculated based on the ambient, solution temperature and determined factors of volumetric laboratory wares.

The calibration curves for each run were obtained using 5 levels, C-1, C-2, C-3, C-4, and C-

5.

Table 5.16-2 Nominal concentrations of nutrients for A, D, B and C standards.

	A	D	B	C-1	C-2	C-3	C-4	C-5
NO_3 (μM)	45000	1800	670	LNSW	7	14	28	42
NO_2 (μM)	21900	870	26	LNSW	0.2	0.5	1.0	1.5
SiO_2 (μM)	35800		1420	LNSW	15	30	58	86
PO_4 (μM)	6000		60	LNSW	0.6	1.2	2.4	3.6

Table 5.16-3 Working calibration standard recipes.

C Std.	B Std.
C-1	0 mL
C-2	5 mL
C-3	10 mL
C-4	20 mL
C-5	30 mL

(7.2.5) Renewal of in-house standard solutions

In-house standard solutions as stated in paragraph (6.2) were renewed as shown in Table 5.16-4(a) to (c).

Table 5.16-4(a) Timing of renewal of in-house standards.

NO_3, NO_2, SiO_2, PO_4	Renewal
A-1 Std. (NO_3)	maximum a month
A-2 Std. (NO_2)	commercial prepared solution
A-3 Std. (SiO_2)	commercial prepared solution
A-4 Std. (PO_4)	maximum a month
D-1 Std.	maximum 8 days
D-2 Std.	maximum 8 days
B Std. (mixture of A-1, D-2, A-3, A-4 std.)	maximum 8 days

Table 5.16-4(b) Timing of renewal of working calibration standards.

Working standards	Renewal
C Std. (dilute B Std.)	every 24 hours

Table 5-16-4(c) Timing of renewal of in-house standards for reduction estimation.

Reduction estimation	Renewal
36 μM NO_3 (dilute D-1 Std.)	when C Std. renewed

35 µM NO_2 (dilute D-2 Std.)	when C Std. renewed

(8) Quality control

(8.1) Precision of nutrients analyses during the cruise

Precision of nutrients analyses during this cruise was evaluated based on the 5 to 11 measurements, which are measured every 8 to 14 samples, during a run at the concentration of C-5 std. Summary of precisions are shown as shown in Table 5.16-5. The precisions for each parameter are generally good considering the analytical precisions during the R/V Mirai cruses conducted in 2009 - 2017. During in this cruise, analytical precisions were 0.17 % for nitrate, 0.21 % for nitrite, 0.12 % for silicate, and 0.16 % for phosphate in terms of median of precision, respectively. Then we can conclude that the analytical precisions for nitrate, nitrite, silicate, and phosphate were maintained throughout this cruise.

Table 5.16-5 Summary of precision based on the replicate analyses.

	Nitrate	Nitrite	Silicate	Phosphate
	CV %	CV %	CV %	CV %
Median	0.17	0.21	0.12	0.16
Mean	0.18	0.23	0.14	0.16
Maximum	0.55	0.47	0.43	0.32
Minimum	0.03	0.06	0.06	0.10
N	33	33	33	33

(8.2) CRM lot. CJ measurement during this cruise

CRM lot. CJ was measured every run to keep the comparability. The results of lot. CJ during this cruise are shown as Table 5.16-6.

Table 5.16-6 Summary of concentration of CRM.

unit: µmol kg^{-1}

Lot	Nitrate	Nitrite	Silicate	Phosphate
CJ	16.18 ± 0.09	0.04 ± 0.00	38.56 ± 0.15	1.191 ± 0.007

(8.3) Carry over

We can also summarize the magnitudes of carry over throughout the cruise. These are small enough within acceptable levels as shown in Table 5.16-7.

Table 5.16-7 Summary of carry over throughout MR17-08.

	Nitrate %	Nitrite %	Silicate %	Phosphate %
Median	0.10	0.10	0.17	0.19
Mean	0.11	0.10	0.17	0.20
Maximum	0.16	0.32	0.23	0.30
Minimum	0.06	0.00	0.11	0.00
N	33	33	33	33

(9) Problems / improvements occurred and solutions.

STNM037, STNM039, STNM041, and STNM043 samples were measured again at STNM053-STN059 run, because of calibration curves of all parameter were not linear.

(10) List of reagent

List of reagent is shown in Table 5.16-8.

Table 5.16-8 List of reagent in MR17-08.

IUPAC name	CAS Number	Formula	Compound Name	Manufacture	Grade
4-Aminobenzenesulfonamide	63-74-1	$C_6H_8N_2O_2S$	Sulfanilamide	Wako Pure Chemical Industries, Ltd.	JIS Special Grade
Antimony potassium tartrate trihydrate	28300-74-5	$K_2(SbC_4H_2O_6)_2 \cdot 3H_2O$	Bis[(+)-tartrato]diantimonate(III) Dipotassium Trihydrate	Wako Pure Chemical Industries, Ltd.	JIS Special Grade
Hydrogen chloride	7647-01-0	HCl	Hydrochloric Acid	Wako Pure Chemical Industries, Ltd.	JIS Special Grade
Imidazole	288-32-4	$C_3H_4N_2$	Imidazole	Wako Pure Chemical Industries, Ltd.	JIS Special Grade
L-Ascorbic acid	50-81-7	$C_6H_8O_6$	L-Ascorbic Acid	Wako Pure Chemical Industries, Ltd.	JIS Special Grade
N-(1-Naphthalenyl)-1,2-ethanediamine, dihydrochloride	1465-25-4	$C_{12}H_{16}Cl_2N_2$	N-1-Naphthylethylenediamine Dihydrochloride	Wako Pure Chemical Industries, Ltd.	for Nitrogen Oxides Analysis
Oxalic acid	144-62-7	$C_2H_2O_4$	Oxalic Acid	Wako Pure Chemical Industries, Ltd.	Wako Special Grade
Sodium dodecyl sulfate	151-21-3	$C_{12}H_{25}NaO_4S$	Sodium Dodecyl Sulfate	Wako Pure Chemical Industries, Ltd.	for Biochemistry
Sodium molybdate dihydrate	10102-40-6	$Na_2MoO_4 \cdot 2H_2O$	Disodium Molybdate(VI) Dihydrate	Wako Pure Chemical Industries, Ltd.	JIS Special Grade
Sulfuric acid	7664-93-9	H_2SO_4	Sulfuric Acid	Wako Pure Chemical Industries, Ltd.	JIS Special Grade
Synonyms: t-Octylphenoxypolyethoxyethanol 4-(1,1,3,3-Tetramethylbutyl)phenyl-polyethylene glycol Polyethylene glycol tert-octylphenyl ether	9002-93-1	$(C_2H_4O)_nC_{14}H_{22}O$	Triton™ X-100	Sigma-Aldrich Japan G.K.	-

(11) Data archives

These data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via “Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)” in JAMSTEC web site.
<http://www.godac.jamstec.go.jp/darwin/e>

(12) References

Grasshoff, K. 1976. Automated chemical analysis (Chapter 13) in Methods of Seawater Analysis. With contribution by Almgreen T., Dawson R., Ehrhardt M., Fonselius S. H., Josefsson B., Koroleff F., Kremling K. Weinheim, New York: Verlag Chemie.

Grasshoff, K., Kremling K., Ehrhardt, M. et al. 1999. Methods of Seawater Analysis. Third, Completely Revised and Extended Edition. WILEY-VCH Verlag GmbH, D-69469 Weinheim (Federal Republic of Germany).

Hydes, D.J., Aoyama, M., Aminot, A., Bakker, K., Becker, S., Coverly, S., Daniel, A., Dickson, A.G., Grosso, O., Kerouel, R., Ooijen, J. van, Sato, K., Tanhua, T., Woodward, E.M.S., Zhang, J.Z., 2010. Determination of Dissolved Nutrients (N, P, Si) in Seawater with High Precision and Inter-Comparability Using Gas-Segmented Continuous Flow Analysers, In: GO-SHIP Repeat Hydrography Manual: A Collection of Expert Reports and Guidelines. IOCCP Report No. 14, ICPO Publication Series No 134.

Kimura, 2000. Determination of ammonia in seawater using a vaporization membrane permeability method. 7th auto analyzer Study Group, 39-41.

Murphy, J., and Riley, J.P. 1962. Analytica chimica Acta 27, 31-36.

5.17 Chlorophyll *a* of sampled water

(1) Personnel

Kazuhiko MATSUMOTO	(JAMSTEC)	: Principal Investigator (PI)
Masanori ENOKI	(MWJ)	: Operation leader
Atsushi ONO	(MWJ)	
Erii IRIE	(MWJ)	

(2) Objective

We measured total chlorophyll *a* and size-fractionated chlorophyll *a* in seawater by using the fluorometric method.

(3) Parameters

Total chlorophyll *a*
Size-fractionated chlorophyll *a*

(4) Instruments and methods

We collected samples for total chlorophyll *a* (chl-*a*) from 12 depths and size-fractionated chl-*a* from 6 depths between the surface and 200 m depth including a chl-*a* maximum layer. The chl-*a* maximum layer was determined by a fluorometer (Seapoint Sensors, Inc.) attached to the CTD system.

Water samples for total chl-*a* were vacuum-filtrated (<0.02MPa) through 25mm-diameter Whatman GF/F filter. Water samples for size-fractionated chl-*a* were passed through 10 µm, 3µm and 1µm pore-size nuclepore filter (47 mm in diameter), and Whatman GF/F filter (25 mm in diameter) under gentle vacuum (<0.02MPa). Phytoplankton pigments retained on the filters were immediately extracted in a polypropylene tube with 7 ml of N,N-dimethylformamide (Wako Pure Chemical Industries Ltd.). The tubes were stored at –20°C under the dark condition to extract chl-*a* at least for 24 hours.

Fluorescences of each sample were measured by Turner Design fluorometer (10-AU-005), which was calibrated against a pure chl-*a* (Sigma chemical Co.). We applied fluorometric determination for the samples of chl-*a* "Non-acidification method" (Welschmeyer, 1994). Analytical conditions of this method were listed in Table 5.17-1.

(5) Station list

Samples for total and size-fractionated chl-*a* were collected at 11 Station and 116 casts. Samples for size-fractionated chl-*a* were collected at 2 Station and 5 casts. The numbers of samples for total and size-fractionated chl-*a* were 1392 and 120, respectively.

(6) Preliminary results

Temporal profile for chl-*a* at stn. STN is shown in Fig. 5.17-1. Size-fractionated chl-*a* concentration during this cruise is shown in Fig. 5.17-2.

At each station, water samples were taken in replicate for water of chl-*a* maximum layer. The relative error was 3 % (n = 116).

(7) Data archives

These data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via "Data Research System for Whole Cruise Information in JAMSTEC (DARWIN) in JAMSTEC web site.
<http://www.godac.jamstec.go.jp/darwin/e>

(8) Reference

Welschmeyer, N. A. (1994): Fluorometric analysis of chlorophyll *a* in the presence of chlorophyll *b* and pheopigments. *Limnol. Oceanogr.*, 39, 1985–1992.

Table 5.17-1. Analytical conditions of non-acidification method for chlorophyll *a* with Turner Design fluorometer (10-AU).

Excitation filter (nm)	: 436
Emission filter (nm)	: 680
Lamp	: Blue F4T5,B2/BP

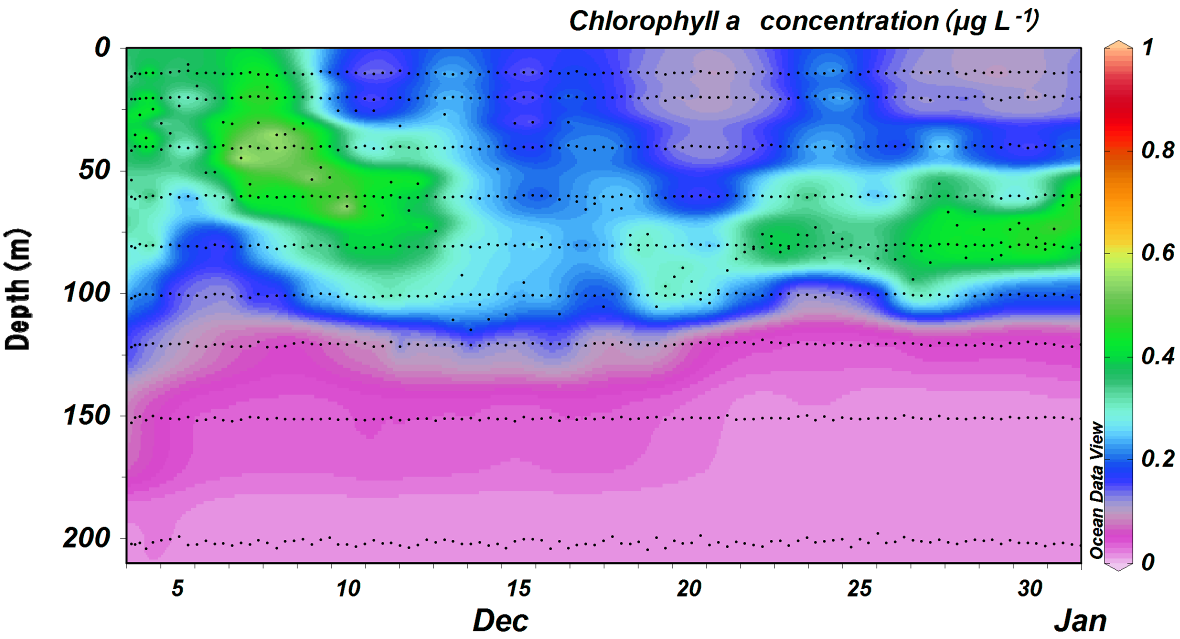


Figure 5.17-1. Temporal profile of Total chlorophyll *a at* Stn.STN.

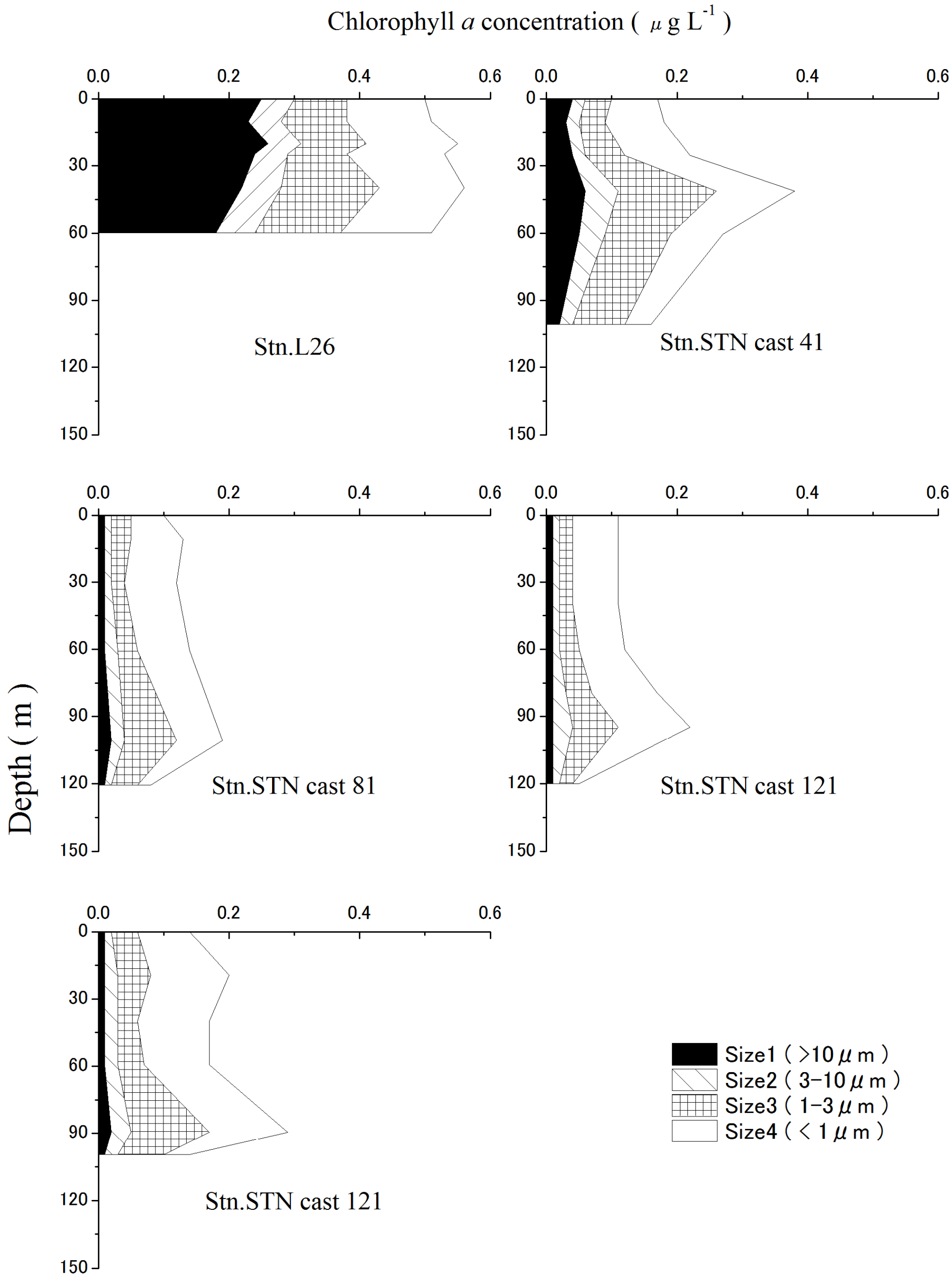


Figure 5.17-2. Size-fractionated Chlorophyll *a* concentrations at during this cruise.

5.18 Primary Production

(1) Personnel

MATSUMOTO Kazuhiko (JAMSTEC) - Principle Investigator
HOSHINO Hiroshi (MWJ)

(2) Objectives

To understand the processes of biogeochemical cycles, oceanic primary production and the related substances are estimated by the incubation experiments in the water baths.

(3) Methods and Instruments

i. Sampling

Seawater samples were collected at three depths within the euphotic layer using Teflon-coated and acid-cleaned Niskin bottles, except for the surface water, which was taken by a bucket. Seawater samples were transferred into acid-cleaned, transparent bottles. Just before the incubation, $NaH^{13}CO_3$ was added to each bottles at a final concentration of 0.2 mM, sufficient to enrich the bicarbonate concentration by about 10%.

ii. Incubation

(a) On-deck incubation

The bottles were placed in containers, the light levels within which were adjusted with blue acrylic plates. The containers were placed in a water bath cooled by running surface seawater. Incubations were started from early morning for 24 h. To estimate the incorporation rate of nitrate, another experiments were conducted during noon and midnight for 2 h with adding $K^{15}NO_3$, respectively.

(b) P vs. E curve experiment

To investigate the relationship between phytoplankton photosynthetic rate (P) and scalar irradiance (E), incubations for the P vs. E curve experiment were conducted in the laboratory. Three incubators were filled with water, and water temperature was controlled appropriately by circulating water coolers, respectively (Fig. 5.18-1). Each incubator was illuminated at one end by a 500W halogen lamp, and bottles were arranged linearly against the lamp and controlled light intensity by shielding with a neutral density filter on lamp side. Incubations for the P vs. E curve experiment were conducted around noon for 3 h.

iii. Measurement

(a) Particulate organic carbon (POC) production

After the incubation, water samples were immediately filtered through a pre-combusted GF/F filter, then the filters were dehydrated in a dry oven (45 ºC). Inorganic carbon in the filter was removed by fuming HCl before the analysis, and the ^{13}C and ^{15}N content of the particulate fraction were measured with a stable isotope ratio mass spectrometer (Sercon, Ltd.) based on the method of Hama et al. (1983).

The analytical function and parameter values used to describe the relationship between the photosynthetic rate (P) and scalar irradiance (E) are best determined using a least-squares procedure from the following equation (Platt et al., 1980).

$$P = P_{max}(1-e^{-\alpha E/Pmax})e^{-b\alpha E/Pmax}$$

where, P_{max} is the light-saturated maximum photosynthetic rate, α is the initial slope of the P vs. E curve, b is a dimensionless photoinhibition parameter.

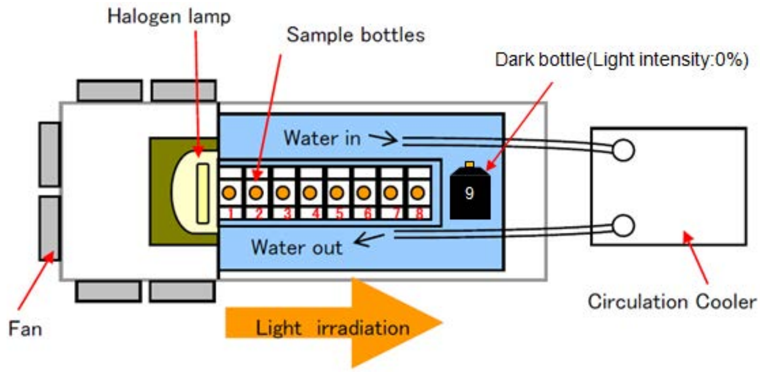


Fig. 5.18-1 Look down view of incubator for the P vs. E curve experiment

(b) Dissolved organic carbon (DOC) production

The filtrate of the on-deck 24 h incubation samples were desalinated using an electro dialyzer equipped with AC-220-550 cartridge (Micro Acilyzer S3, ASTOM Corp.). The desalinated seawater samples were concentrated to 5 mL with a rotary evaporator at 45 ºC. Dissolved inorganic carbon was removed by adding HCl and subsequent degassing. The samples were further concentrated to 700 µL and absorbed onto pre-combusted GF/F filter in a tin capsule, and dehydrated completely by the vacuum dry treatment (45 ºC). The ^{13}C content of the dissolved fraction (extracellular release of phytoplankton) were measured as described above.

iv. Transparent exopolymer particle (TEP) measurement

TEP are very sticky, and it aggregates with other suspended particles, resulting in the formation of sinking marine snow. TEP are formed by coagulation of colloidal TEP precursors present in the phytoplankton released dissolved organic matter. The water samples of 200 mL were filtered onto 0.4-µm polycarbonate filters, and the filters were stained with 500 µL alcian blue solution, and rinsed twice with 1 mL of Milli-Q water. Each filter was soaked for 2 h in 6 mL of 80% sulfuric acid (H_2SO_4) to dissolve the dye and then the absorbance of the solution was measured at 787 nm in a 1 cm cuvette.

(3) Preliminary Results

Figure 5.18-2 is the P vs. E curve at the depths of 0, 40 and 95m (chl-*a* maximum depth) obtained during 2017 Dec. 20 (cast_121).

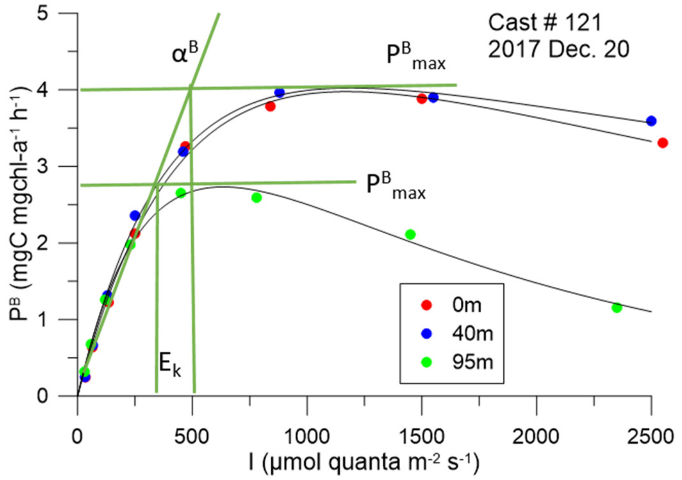


Fig. 5.18-2 P vs. E relationships with fitting curves

(5) Data archive

The data obtained during this cruise will be submitted to the JAMSTEC Data Management Group (DMG).

(6) References

Hama T, Miyazaki T, Ogawa Y, Iwakuma T, Takahashi M, Otsuki A, Ichimura S (1983) Measurement of photosynthetic production of a marine phytoplankton population using a stable 13C isotope. Marine Biology 73: 31-36.

Platt T, Gallegos CL, Harrison WG (1980) Photoinhibition of photosynthesis in natural assemblages of marine phytoplankton. Journal of Marine Research 38: 687-701.

5.19 Shipboard ADCP

(1) Personnel

Satoru YOKOI	(JAMSTEC) -Principal Investigator	
Souichiro SUEYOSHI	(Nippon Marine Enterprises Ltd., NME)	- Leg1 -
Shinya OKUMURA	(NME)	- Leg1 -
Wataru TOKUNAGA	(NME)	- Leg1 -
Ryo OYAMA	(NME)	- Leg1,2 -
Miki TAWATA	(NME)	- Leg1,2 -
Masanori MURAKAMI	(MIRAI Crew)	- Leg1,2 -

(2) Objectives

To obtain continuous measurement data of the current profile along the ship's track.

(3) Instruments and methods

Upper ocean current measurements were made in this cruise, using the hull-mounted Acoustic Doppler Current Profiler (ADCP) system. For most of its operation, the instrument was configured for water-tracking mode. Bottom-tracking mode, interleaved bottom-ping with water-ping, was made to get the calibration data for evaluating transducer misalignment angle in the shallow water. The system consists of following components;

1. R/V MIRAI has installed the Ocean Surveyor for vessel-mount ADCP (frequency 76.8 kHz; Teledyne RD Instruments, USA). It has a phased-array transducer with single ceramic assembly and creates 4 acoustic beams electronically. We mounted the transducer head rotated to a ship-relative angle of 45 degrees azimuth from the keel.
2. For heading source, we use ship's gyro compass (TOKYO KEIKI, Japan), continuously providing heading to the ADCP system directory. Additionally, we have Inertial Navigation System (Phins, Ixblue, France) which provide high-precision heading, attitude information, pitch and roll. They are stored in ".N2R" data files with a time stamp.
3. Differential GNSS system (StarPack-D, Fugro, Netherlands) providing precise ship's position.
4. We used VmDas software version 1.46.5 (TRDI) for data acquisition.
5. To synchronize time stamp of ping with Computer time, the clock of the logging computer is adjusted to GPS time server continuously by the application software.
6. Fresh water is charged in the sea chest to prevent bio fouling at transducer face.
7. The sound speed at the transducer does affect the vertical bin mapping and vertical velocity measurement, and that is calculated from temperature, salinity (constant value; 35.0 PSU) and depth (6.5 m; transducer depth) by equation in Medwin (1975).

Data was configured for "8 m" layer intervals starting about 23m below sea surface, and recorded every ping as raw ensemble data (.ENR). Additionally, 10 seconds averaged data were recorded as short-term average (.STA). 300 seconds averaged data were long-term average (.LTA), respectively.

(4) **Parameters**

Major parameters for the measurement, Direct Command, are shown in Table 5.19-1.

Table 5.19-1: Major parameters

Bottom-Track Commands	
BP = 001	Pings per Ensemble (almost less than 1,300m depth)
Environmental Sensor Commands	
EA = 04500	Heading Alignment (1/100 deg)
ED = 00065	Transducer Depth (0 - 65535 dm)
EF = +001	Pitch/Roll Divisor/Multiplier (pos/neg) [1/99 - 99]
EH = 00000	Heading (1/100 deg)
ES = 35	Salinity (0-40 pp thousand)
EX = 00000	Coordinate Transform (Xform:Type; Tilts; 3Bm; Map)
EZ = 10200010	Sensor Source (C; D; H; P; R; S; T; U)
C (1): Sound velocity calculates using ED, ES, ET (temp.)	
D (0): Manual ED	
H (2): External synchro	
P (0), R (0): Manual EP, ER (0 degree)	
S (0): Manual ES	
T (1): Internal transducer sensor	
U (0): Manual EU	
EV = 0	Heading Bias(1/100 deg)
Water-Track Commands	
WA = 255	False Target Threshold (Max) (0-255 count)
WC = 120	Low Correlation Threshold (0-255)
WD = 111 100 000	Data Out (V; C; A; PG; St; Vsum; Vsum^2; #G; P0)
WE = 1000	Error Velocity Threshold (0-5000 mm/s)
WF = 0800	Blank After Transmit (cm)
WN = 100	Number of depth cells (1-128)
WP = 00001	Pings per Ensemble (0-16384)
WS = 800	Depth Cell Size (cm)
WV = 0390	Mode 1 Ambiguity Velocity (cm/s radial)

(5) Preliminary results

Fig.5.19-1 shows the time series plot of the current velocity during the cruise.

(6) Data Archives

ADCP data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via “Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)” in JAMSTEC web site.

<http://www.godac.jamstec.go.jp/darwin/e>

(7) Remarks

The follwing period, data acquisitions were suspended in the foreign EEZ.

01:00UTC 12 Nov. 2017 to 07:30UTC 22 Nov. 2017

07:30UTC, 11 Jan. 2018 to 00:30UTC, 12 Jan. 2018

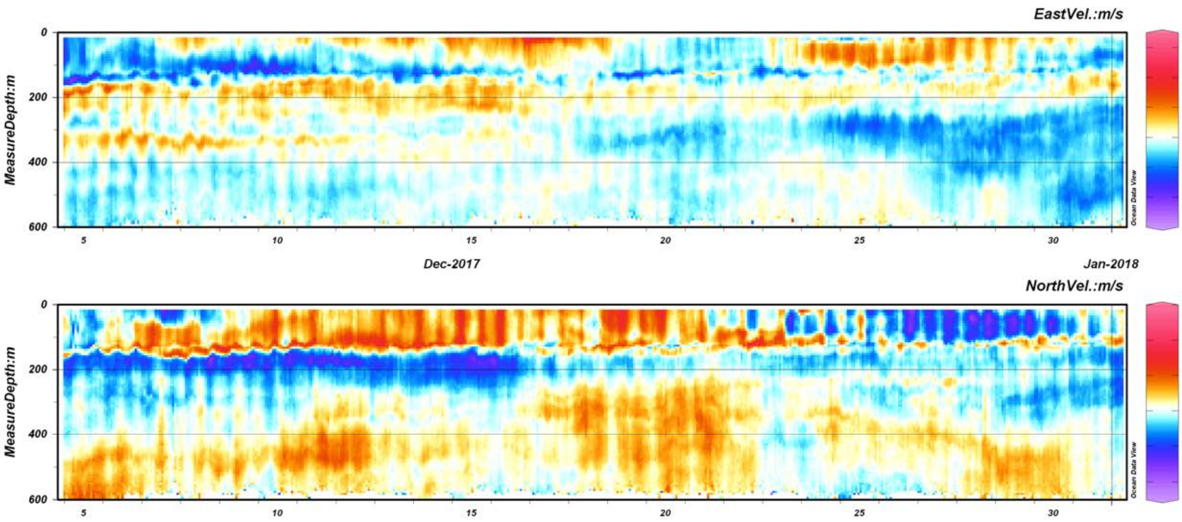


Fig. 5.19-1 current velocity during the station point.

5.20 LADCP

(1) Personnel

Takanori Horii	(JAMSTEC)	Principal investigator
Kelvin Richards	(IPRC, University of Hawaii)	
Rio Kobayashi	(MWJ)	Operation leader
Kenichi Katayama	(MWJ)	
Hiroki Ushiromura	(MWJ)	
Yasuhiro Arii	(MWJ)	
Masaki Yamada	(MWJ)	
Akira Watanabe	(MWJ)	
Kai Fukuda	(MWJ)	
Rei Ito	(MWJ)	
Keisuke Takeda	(MWJ)	

(2) Objectives

To obtain horizontal current velocity in high vertical resolution

(3) Methods

In order to measure the velocity structure at fine vertical scales a high frequency ADCP was used in lowered mode (LADCP). The instrument was a Teledyne RDI Workhorse Sentinel 600kHz ADCP rated for 1000m depth.

The instrument was attached to the frame of the CTD system using a steel collar sealed around the instrument by three bolts on each side, with the collar attached to the rosette frame by two u-bolts on two mounting points.

The instrument was deployed on all CTD stations, performing well throughout its use. The instrument is self-contained with an internal battery pack. The health of the battery is monitored by the recorded voltage count.

(4) Setup and Parameter settings

The instrument was controlled at deploy and recover stages by the RDI software (BBTalk) installed on the Windows PC. The commands sent to the instrument at setup were contained in ladcp600.cmd. The instrument was set up to have a relatively small bin depth (2m) and a fast ping rate (every 0.25 sec). The full list of commands sent to the instrument was as follows.

CR1	# Retrieve parameter (default)
TC2	# Ensemble per burst
WP1	# Pings per ensemble
TE 00:00:00.00	# Time per ensemble (time between data collection cycles)
TP 00:00.25	# Time between pings in mm:ss
WN25	# Number of Depth cells
WS0200	# Depth cell size (in cm)
WF0088	# Blank after transit (recommended setting for 600kHz)
WB0	# Mode 1 bandwidth control (default - wide)
WV250	# Ambiguity velocity (in cm/s)
EZ0111101	# Sensor source (speed of sound excluded)
EX00000	# Beam coordinates
CF11101	# Data flow control parameters

(See the RDI Workhorse "Commands and Data Output Format" document for details.)

(5) Preliminary results

During the cruise, 230 profiles were obtained in total, including the first line observation (3–4 December 2017), station observation southwest of Sumatra (5 December 2017–1 January 2018), and the second line observation (1–2 January 2018). All the data has to be converted and quality-controlled before the analyses.

Examples of the on-board processed data are presented in Figure 5.20-1. The data processing was performed using a script developed by Eric Firing (University of Hawaii). This script is based on the shear method: the baroclinic velocity is got by vertically integrating the shear between bins, the barotropic velocity is got by integrating with time, and depth and the ship's velocity are got from the CTD pressure and GPS, respectively.

(6) Data archive

All data obtained during this cruise will be submitted to the JAMSTEC Data Management Office (DMO).

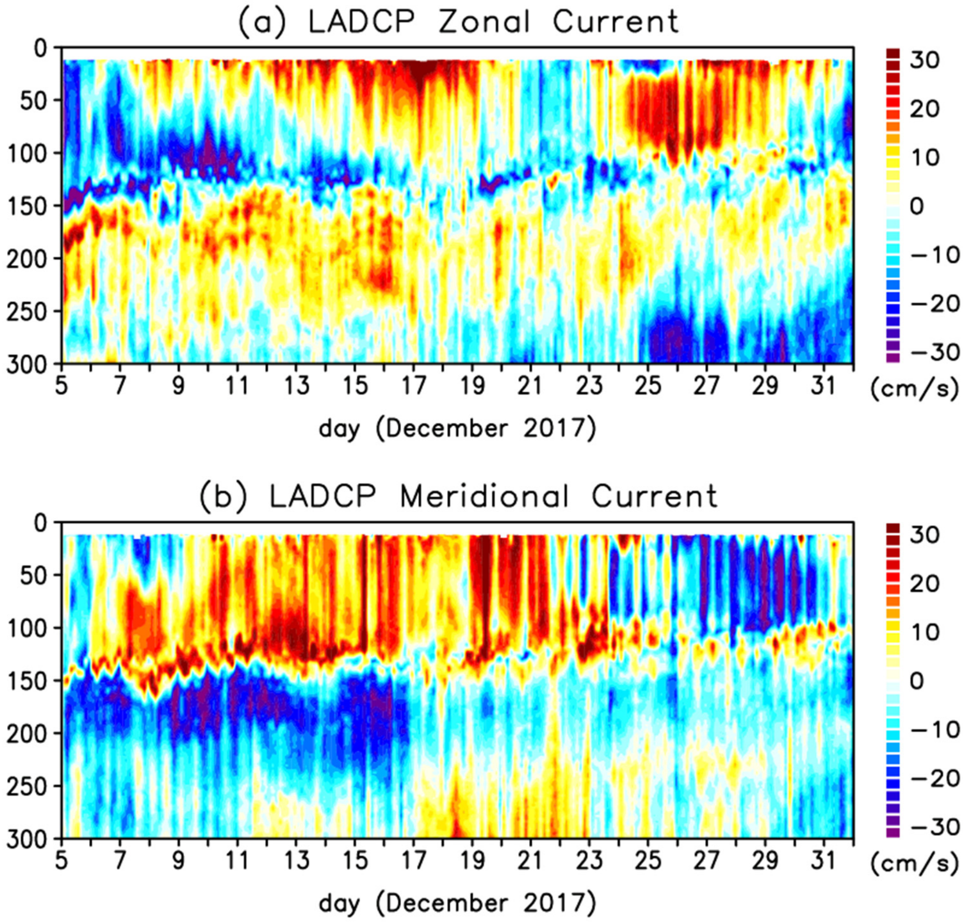


Figure 5.20-1 Time-depth sections of vertical profiles of (a) zonal and (b) meridional velocity observed by LACP during the station observation southwest of Sumatra from 5 December 2017 to 1 January 2018.

5.21 Microstructure profiler (MSP) for the ocean

(1) Personnel

MOTEKI Qoosaku	(JAMSTEC)	- Principle Investigator
RICHARDS Kelvin	(IPRC, Univ. of Hawaii)	
HORII Takanori	(JAMSTEC)	
MATSUGISHI Shuhei	(Univ. of Tokyo)	
SUEYOSHI Soichiro	(NME)	- Operation Leader
TOKUNAGA Wataru	(NME)	
OYAMA Ryo	(NME)	
TAWATA Miki	(NME)	

(2) Objectives

To obtain oceanic vertical profiles of the dissipation rate of turbulent kinematic energy, as well as dissipation rate of temperature variance, turbulent mixing rate of substances, etc.

(3) Methods

The instrument in this observation consists of sensor unit “TurboMAP-L” (manufactured by JFE Advantech Inc., serial no. 34) and the software “TMtools” (ver. 3.04D) on PC to monitor, record and process the data. The probes on the TurboMAP sensor unit are as follows:

- Vertical shear of the horizontal current speed (two sensors, 512 Hz)
- Fast thermistor temperature “FPO-7” (512Hz)
- Slow response temperature (64Hz)
- Conductivity (64Hz)
- Pressure (64Hz)
- Acceleration in X, Y and Z dimensions (256Hz for horizontal, 64Hz for vertical)
- Fluorescence (256Hz) (*see (6)Remarks)
- Turbidity (256Hz)

These parameters were obtained during the sensor descends without artificial accelerations (i.e. “free fall”). The obtained data was monitored and stored in the PC on the vessel in real-time. The instruments were operated to obtain profiles down to 300m depth (see (6) Remarks for exceptions). To do it by minimized time consumption, the cable between PC and the sensor unit were deployed until the sensor unit reached 260-m depth, and then started winding up when sensor reached 300-m depth. The data was recorded until the sensor stopped its free-fall (i.e. falling speed start decreasing).

All profiles were obtained at (4-14S, 101-31E). The observations were conducted 8 times per day during the stationary observation period (00 UTC 5 December, 2018 – 00 UTC 1 January 2018). Each profile was obtained sequentially, while one or several profiles were obtained occasionally. As in Table 5.20-1, 225 profiles were obtained in total during the present cruise.

(4) Preliminary Results

Figure 5.21-1 is the time-depth cross section of the dissipation rate of kinematic energy ($\log_{10}(\varepsilon)$ W/kg) and temperature variance ($\log_{10}(\chi)$ $C^{\circ 2}$/s). The high $\log_{10}(\varepsilon)$ values in the layer of 0-100 m generally corresponds to the mixed layer deepening. The high $\log_{10}(\chi)$ values appear in the mixed layer and the thermocline around 100-180 m depth. The further detailed analyses will be in near future.

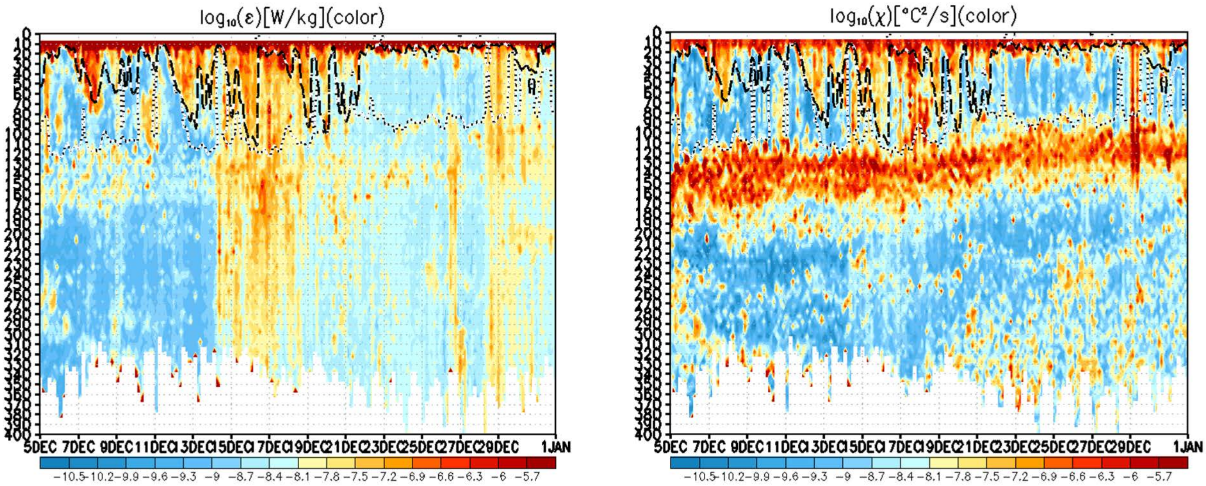


Fig.5.21-1: Time-depth cross section of the dissipation ratios of the kinematic energy (left: $\log_{10}(\varepsilon)$ W/kg) and temperature variance (right: $\log_{10}(\chi)$ $C^{\circ 2}$/s) from 00 UTC 5 December to 00 UTC 1 January, 2018. The bold dashed and dotted lines indicate the depths of the mixed layer and isothermal layer defined by the density difference that is equivalent to the 0.1 K temperature difference and 0.1 K temperature difference, respectively.

(5) Data archive

All collected data during this cruise will be available at YMC website.

(6) Remarks

Data from the secondary sensor were not used from 6 December because of the serious noise trouble. Also, the first sensor might have some noises especially after 14 December although it seems to be included qualitative information for the natural variation.

Table 5.21-1 List of the MSP

Num	Date	Latitude	Longitude	Start	End	Depth	Obs.Depth	Cable	Filename
001	2017/12/05	04-14.2369S	101-30.7669E	0:22	0:34	1003	349	470	MR1708-1.BIN
002	2017/12/05	04-14.3710S	101-30.8034E	2:58	3:10	998	360	510	MR1708-2.BIN
003	2017/12/05	04-13.3020S	101.30.6712E	6:26	6:39	999	404	530	MR1708-3.BIN
004	2017/12/05	04-13.2157S	101-31.5092E	8:58	9:09	1029	364	480	MR1708-4.BIN
005	2017/12/05	04-14.0903S	101-29.9150E	12:21	12:32	966	349	480	MR1708-5.BIN
006	2017/12/05	04-14.0129S	101-30.2044E	15:06	15:16	982	368	480	MR1708-6.BIN
007	2017/12/05	04-14.4925S	101-30.0318E	18:19	18:28	971	350	440	MR1708-7.BIN
008	2017/12/05	04-13.8254S	101-30.2226E	20:57	21:08	986	367	470	MR1708-8.BIN
009	2017/12/06	04-13.7468S	101-30.8184E	0:27	0:40	1010	410	480	MR1708-9.BIN
010	2017/12/06	04-13-5643S	101-31.1329E	3:02	3:14	1026	385	490	MR1708-10.BIN
011	2017/12/06	04-13.5448S	101-32.3012E	6:32	6:43	1054	365	480	MR1708-11BIN
012	2017/12/06	04-14.1236S	101-31.2732E	9:00	9:12	1025	385	490	MR1708-12.BIN
013	2017/12/06	04-14.2355S	101-31.1873E	9:20	9:30	1025	335	510	MR1708-13.BIN
014	2017/12/06	04-14.4654S	101-30.9664E	12:26	12:37	1010	326	540	MR1708-14.BIN
015	2017/12/06	04-15.1171S	101-30.5436E	15:02	15:12	985	345	480	MR1708-15.BIN
016	2017/12/06	04-14.8807S	101-31.1558E	18:22	18:32	1013	339	510	MR1708-16.BIN
017	2017/12/06	04-14.1433S	101-32.4651E	21:00	21:10	1065	344	470	MR1708-17.BIN
018	2017/12/07	04-15.6739S	101-30.7147E	0:25	0:38	999	417	490	MR1708-18.BIN
019	2017/12/07	04-14.0992S	101-31.4741E	2:57	3:09	1034	369	480	MR1708-19.BIN
020	2017/12/07	04-13.7621S	101-31.3643E	6:31	6:42	1029	323	550	MR1708-20.BIN
021	2017/12/07	04-13.8208S	101-30.9556E	9:00	9:11	1012	372	485	MR1708-21.BIN
022	2017/12/07	04-14.8116S	101-31.3791E	12:23	12:34	1027	355	530	MR1708-22.BIN
023	2017/12/07	04-14.5560S	101-31.2219E	15:03	15:13	1016	334	510	MR1708-23.BIN

024	2017/12/07	04-14.1193S	101-30.9693E	18:23	18:33	1010	314	540	MR1708-24.BIN
025	2017/12/07	04-15.0588S	101-31.8973E	20:54	21:04	1044	344	520	MR1708-25.BIN
026	2017/12/08	04-14.3929S	101-30.9781E	0:20	0:31	1004	336	520	MR1708-26.BIN
027	2017/12/08	04-14.7288S	101-31.1740E	3:01	3:10	1010	314	520	MR1708-27.BIN
028	2017/12/08	04-14.2021S	101-31.1918E	6:30	6:41	1016	343	530	MR1708-28.BIN
029	2017/12/08	04-14.5896S	101-30.8800E	8:59	9:10	999	323	530	MR1708-29.BIN
030	2017/12/08	04-14.4386S	101-30.8596E	12:24	12:35	1002	344	530	MR1708-30.BIN
031	2017/12/08	04-14.5597S	101-30.4934E	14:58	15:10	991	330	460	MR1708-31.BIN
032	2017/12/08	04-13.6975S	101-30.4379E	18:21	18:32	996	341	530	MR1708-32.BIN
033	2017/12/08	04-12.9555S	101-31.4350E	21:00	21:10	1023	338	490	MR1708-33.BIN
034	2017/12/09	04-13.5066S	101-30.5302E	0:24	0:36	1002	350	550	MR1708-34.BIN
035	2017/12/09	04-13.0627S	101-30.6276E	3:00	3:11	999	350	500	MR1708-35.BIN
036	2017/12/09	04-13.2545S	101-30.7681E	6:34	6:45	1002	343	470	MR1708-36.BIN
037	2017/12/09	04-13.9468S	101-30.4627E	9:00	9:11	988	329	520	MR1708-37.BIN
038	2017/12/09	04-14.7778S	101-30.7873E	12:26	12:36	991	333	500	MR1708-38.BIN
039	2017/12/09	04-14.8977S	101-30.1624E	14:59	15:09	1015	328	480	MR1708-39.BIN
040	2017/12/09	04-14.3122S	101-30.6454E	18:28	18:38	992	334	460	MR1708-40.BIN
041	2017/12/09	04-13.2328S	101-31.8829E	21:00	21:10	1037	325	500	MR1708-41.BIN
042	2017/12/10	04-13.7685S	101-30.8670E	0:26	0:38	1006	346	510	MR1708-42.BIN
043	2017/12/10	04-14.4263S	101-30.6793E	3:00	3:12	998	366	530	MR1708-43.BIN
044	2017/12/10	04-14.4263S	101-30.6793E	3:26	3:36	998	360	500	MR1708-44.BIN
045	2017/12/10	04-14.5176S	101-30.1013E	6:25	6:38	975	392	490	MR1708-45.BIN
046	2017/12/10	04-13.1681S	101-31.1278E	9:00	9:13	1013	370	500	MR1708-46.BIN
047	2017/12/10	04-14.1134S	101-31.5062E	12:23	12:34	1036	319	540	MR1708-47.BIN
048	2017/12/10	04-14.2461S	101-31.9461E	14:58	15:08	1049	325	490	MR1708-48.BIN

049	2017/12/10	04-14.9871S	101-31.7664E	18:22	18:31	1038	320	490	MR1708-49.BIN
050	2017/12/10	04-13.6213S	101-31.9623E	21:00	21:10	1050	320	520	MR1708-50.BIN
051	2017/12/11	04-14.6545S	101-31.2536E	0:27	0:40	1016	384	480	MR1708-51.BIN
052	2017/12/11	04-14.7741S	101-30.7942	3:00	3:12	995	404	480	MR1708-52.BIN
053	2017/12/11	04-13.8504S	101-32.3842E	6:30	6:43	1061	399	510	MR1708-53.BIN
054	2017/12/11	04-13.2082S	101-31.6410E	9:00	9:12	1032	341	500	MR1708-54.BIN
055	2017/12/11	04-14.2715S	101-31.8961E	12:23	12:33	1048	320	490	MR1708-55.BIN
056	2017/12/11	04-14.9053S	101-32.3771E	14:59	15:08	1061	337	480	MR1708-56.BIN
057	2017/12/11	04-14.6117S	101-32.2048E	18:22	18:31	1058	327	480	MR1708-57.BIN
058	2017/12/11	04-14.8801S	101-31.9182E	21:00	21:10	1046	344	510	MR1708-58.BIN
059	2017/12/12	04-14.8793S	101-31.9122E	0:24	0:36	1049	366	470	MR1708-59.BIN
060	2017/12/12	04-14.0226S	101-32.3832E	2:59	3:10	1063	344	460	MR1708-60.BIN
061	2017/12/12	04-14.8250S	101-32.0432E	6:30	6:42	1050	385	520	MR1708-61.BIN
062	2017/12/12	04-15.2149S	101-32.1356E	8:59	9:11	1056	355	450	MR1708-62.BIN
063	2017/12/12	04-14.5369S	101-32.1876E	12:25	12:35	1060	318	500	MR1708-63.BIN
064	2017/12/12	04-14.9749S	101-32.1354E	14:59	15:09	1054	320	520	MR1708-64.BIN
065	2017/12/12	04-15.1703S	101-31.8783E	18:20	18:31	1042	330	490	MR1708-65.BIN
066	2017/12/12	04-14.4094S	101-32.1413E	20:52	21:02	1052	330	500	MR1708-66.BIN
067	2017/12/13	04-14.9736S	101-32.1740E	0:33	0:46	1056	371	540	MR1708-67.BIN
068	2017/12/13	04-15.3322S	101-31.5689E	2:58	3:08	1031	325	490	MR1708-68.BIN
069	2017/12/13	04-14.2362S	101-31.8615E	6:26	6:38	1048	372	500	MR1708-69.BIN
070	2017/12/13	04-14.4340S	101-32.7216E	8:58	9:10	1075	383	500	MR1708-70.BIN
071	2017/12/13	04-14.8311S	101-32.2529E	12:20	12:29	1059	317	520	MR1708-71.BIN
072	2017/12/13	04-14.9374S	101-32.2477E	14:57	15:07	1057	319	490	MR1708-72.BIN
073	2017/12/13	04-12.9758S	101-31.2085E	18:21	18:31	1017	337	520	MR1708-73.BIN

074	2017/12/13	04-13.4575S	101-31.2719E	20:58	21:09	1024	332	510	MR1708-74.BIN
075	2017/12/14	04-14.6925S	101-31.4282E	0:24	0:37	1024	367	500	MR1708-75.BIN
076	2017/12/14	04-14.4964S	101-30.7507E	2:59	3:10	1000	321	470	MR1708-76.BIN
077	2017/12/14	04-14.3887S	101-30.7470E	6:23	6:34	997	354	520	MR1708-77.BIN
078	2017/12/14	04-14.5925S	101-30.7885E	8:59	9:10	997	360	480	MR1708-78.BIN
079	2017/12/14	04-15.1553S	101-30.7216E	12:23	12:33	987	334	500	MR1708-79.BIN
080	2017/12/14	04-14.5434S	101-31.1928E	14:57	15:07	1016	318	500	MR1708-80.BIN
081	2017/12/14	04-14.7097S	101-31.5322E	18:16	18:26	1032	327	490	MR1708-81.BIN
082	2017/12/14	04-14.8259S	101-31.3668E	20:57	21:07	1026	357	510	MR1708-82.BIN
083	2017/12/15	04-15.1547S	101-31.3353E	0:25	0:33	1020	310	510	MR1708-83.BIN
084	2017/12/15	04-14.2951S	101-31.1848E	2:59	3:10	1016	340	510	MR1708-84.BIN
085	2017/12/15	04-13.1703S	101-31.2420E	6:23	6:33	1019	330	530	MR1708-85.BIN
086	2017/12/15	04-13.1703S	101-31.2420E	6:39	6:49	1019	326	520	MR1708-86.BIN
087	2017/12/15	04-13.4478S	101-31.4044E	8:58	9:09	1029	351	510	MR1708-87.BIN
088	2017/12/15	04-13.4743S	101-31.3745E	9:16	9:27	1029	340	470	MR1708-88.BIN
089	2017/12/15	04-14.6589S	101-31.6558E	12:24	12:34	1032	325	560	MR1708-89.BIN
090	2017/12/15	04-14.8323S	101-31.7722E	12:43	12:53	1039	322	530	MR1708-90.BIN
091	2017/12/15	04-14.4429S	101-31.8865E	14:56	15:06	1042	324	500	MR1708-91.BIN
092	2017/12/15	04-14.6230S	101-31.4632E	18:16	18:26	1032	327	490	MR1708-92.BIN
093	2017/12/15	04-14.6895S	101-31.5036E	18:36	18:45	1027	324	540	MR1708-93.BIN
094	2017/12/15	04-14.3208S	101-31.8793E	21:02	21:12	1048	329	500	MR1708-94.BIN
095	2017/12/16	04-14.5309S	101-31.6719E	0:21	0:32	1038	347	480	MR1708-95.BIN
096	2017/12/16	04-14.2365S	101-30.9792E	2:54	3:05	1009	341	480	MR1708-96.BIN
097	2017/12/16	04-13.5547S	101-31.6130E	6:26	6:37	1038	328	500	MR1708-97.BIN
098	2017/12/16	04-13.9826S	101-31.7930E	8:57	9:07	1044	327	500	MR1708-98.BIN

099	2017/12/16	04-14.5207S	101-32.1848E	12:19	12:30	1058	345	530	MR1708-99.BIN
100	2017/12/16	04-14.8214S	101-32.1322E	14:54	15:04	1057	350	520	MR1708-100.BIN
101	2017/12/16	04-15.0355S	101-31.3928E	18:15	18:25	1021	335	540	MR1708-101.BIN
102	2017/12/16	04-15.0071S	101-31.7540E	20:53	21:04	1037	345	530	MR1708-102.BIN
103	2017/12/17	04-15.1616S	101-32.2102E	0:24	0:36	1058	382	530	MR1708-103.BIN
104	2017/12/17	04-14.8661S	101-31.8918E	2:58	3:09	1044	350	530	MR1708-104.BIN
105	2017/12/17	04-14.5140S	101-31.8574E	6:32	6:43	1044	366	520	MR1708-105.BIN
106	2017/12/17	04-14.2846S	101-32.1342E	8:56	9:08	1056	377	540	MR1708-106.BIN
107	2017/12/17	04-14.6460S	101-31.7876E	12:21	12:32	1040	355	530	MR1708-107.BIN
108	2017/12/17	04-14.6550S	101-31.6244E	14:56	15:07	1032	353	500	MR1708-108.BIN
109	2017/12/17	04-14.9391S	101-31.2466E	18:19	18:30	1016	336	520	MR1708-109.BIN
110	2017/12/17	04-14.7598S	101-31.3749E	20:56	21:07	1020	354	530	MR1708-110.BIN
111	2017/12/18	04-14.7947S	101-31.1161E	0:17	0:29	1008	390	500	MR1708-111.BIN
112	2017/12/18	04-14.7699S	101-31.1554E	2:59	3:10	1013	355	470	MR1708-112.BIN
113	2017/12/18	04-14.8913S	101-31.0157E	6:23	6:35	1005	386	490	MR1708-113.BIN
114	2017/12/18	04-14.8796S	101-31.3800E	8:57	9:08	1024	360	490	MR1708-114.BIN
115	2017/12/18	04-15.0144S	101-31.1299E	12:20	12:30	1013	359	490	MR1708-115.BIN
116	2017/12/18	04-14.8026S	101-31.0106E	14:55	15:06	1004	357	490	MR1708-116.BIN
117	2017/12/18	04-14.9947S	101-31.1848E	18:20	18:30	1011	336	460	MR1708-117.BIN
118	2017/12/18	04-14.6287S	101-31.2039E	20:56	21:06	1015	332	500	MR1708-118.BIN
119	2017/12/19	04-14.6534S	101-31.2171E	0:14	0:25	1015	355	510	MR1708-119.BIN
120	2017/12/19	04-14.4171S	101-30.6191E	2:58	3:08	992	340	450	MR1708-120.BIN
121	2017/12/19	04-14.5827S	101-30.1723E	6:27	6:38	980	356	530	MR1708-121.BIN
122	2017/12/19	04-14.7865S	101-30.6948E	8:52	9:02	988	323	430	MR1708-122.BIN
123	2017/12/19	04-14.8660S	101-30.9864E	12:17	12:27	1006	330	520	MR1708-123.BIN

124	2017/12/19	04-15.0568S	101-31.2718E	14:56	15:05	1016	329	480	MR1708-124.BIN
125	2017/12/19	04-14.8946S	101-31.4950E	18:22	18:32	1030	335	480	MR1708-125.BIN
126	2017/12/19	04-14.4505S	101-30.7009E	20:50	21:01	995	340	500	MR1708-126.BIN
127	2017/12/20	04-15.0138S	101-31.9649E	0:15	0:26	1046	355	540	MR1708-127.BIN
128	2017/12/20	04-15.5673S	101-31.7975E	2:58	3:09	1042	353	480	MR1708-128.BIN
129	2017/12/20	04-15.7911S	101-31.5884E	6:23	6:34	1025	397	580	MR1708-129.BIN
130	2017/12/20	04-14.6327S	101-31.6192E	8:52	9:03	1031	341	450	MR1708-130.BIN
131	2017/12/20	04-14.6179S	101-31.6906E	12:22	12:32	1037	339	500	MR1708-131.BIN
132	2017/12/20	04-15.3466S	101-31.5790E	14:56	15:05	1035	360	480	MR1708-132.BIN
133	2017/12/20	04-14.5893S	101-31.5608E	18:14	18:24	1029	357	500	MR1708-133.BIN
134	2017/12/20	04-14.2871S	101-31.2080E	20:56	21:07	1017	351	470	MR1708-134.BIN
135	2017/12/21	04-15.2390S	101-32.1353E	0:16	0:28	1057	372	480	MR1708-135.BIN
136	2017/12/21	04-15.4970S	101-30.8802E	2:50	3:01	1003	358	500	MR1708-136.BIN
137	2017/12/21	04-14.0155S	101-30.9552E	6:23	6:35	1009	393	540	MR1708-137.BIN
138	2017/12/21	04-14.9729S	101-30.5890E	8:56	9:07	982	378	530	MR1708-138.BIN
139	2017/12/21	04-14.5228S	101-31.1380E	12:19	12:30	1014	352	490	MR1708-139.BIN
140	2017/12/21	04-15.3165S	101-31.3154E	14:55	15:05	1016	348	530	MR1708-140.BIN
141	2017/12/21	04-15.0144S	101-31.7159E	18:19	18:31	1039	385	490	MR1708-141.BIN
142	2017/12/21	04-15.2789S	101-31.0859E	20:56	21:07	1005	353	500	MR1708-142.BIN
143	2017/12/22	04-14.9594S	101-32.2434E	0:15	0:26	1060	361	500	MR1708-143.BIN
144	2017/12/22	04-14.3920S	101-32.0678E	2:56	3:08	1051	391	490	MR1708-144.BIN
145	2017/12/22	04-15.5440S	101-30.5506E	6:22	6:33	992	377	520	MR1708-145.BIN
146	2017/12/22	04-14.3822S	101-31.4338E	8:56	9:08	1025	382	510	MR1708-146.BIN
147	2017/12/22	04-14.4716S	101-31.8420E	12:18	12:28	1043	349	510	MR1708-147.BIN
148	2017/12/22	04-14.8134S	101-31.4320E	14:55	15:05	1023	342	510	MR1708-148.BIN

149	2017/12/22	04-15.8714S	101-31.4230E	18:16	18:27	1019	371	470	MR1708-149.BIN
150	2017/12/22	04-15.3828S	101-32.3221E	20:56	21:06	1061	357	520	MR1708-150.BIN
151	2017/12/23	04-15.0804S	101-32.1551E	0:16	0:27	1056	376	510	MR1708-151.BIN
152	2017/12/23	04-15.3811S	101-31.2611E	2:57	3:09	1018	402	470	MR1708-152.BIN
153	2017/12/23	04-15.0363S	101-32.3098E	6:24	6:35	1062	381	480	MR1708-153.BIN
154	2017/12/23	04-14.6991S	101-31.9764E	8:57	9:07	1049	350	500	MR1708-154.BIN
155	2017/12/23	04-14.7777S	101-32.0991E	12:19	12:29	1058	340	500	MR1708-155.BIN
156	2017/12/23	04-14.6410S	101-31.6731E	14:55	15:05	1035	369	480	MR1708-156.BIN
157	2017/12/23	04-14.6145S	101-32.4224E	18:16	18:27	1063	383	500	MR1708-157.BIN
158	2017/12/23	04-15.3828S	101-32.3221E	20:56	21:06	1050	362	500	MR1708-158.BIN
159	2017/12/24	04-13.8354S	101-31.0254E	0:15	0:27	1013	392	490	MR1708-159.BIN
160	2017/12/24	04-13.7723S	101-31.3655E	2:55	3:07	1029	408	520	MR1708-160.BIN
161	2017/12/24	04-13.1654S	101-31.4340E	6:19	6:31	1023	408	530	MR1708-161.BIN
162	2017/12/24	04-13.0668S	101-31.0147E	8:53	9:04	1010	367	520	MR1708-162.BIN
163	2017/12/24	04-14.0283S	101-31.3268E	12:18	12:28	1028	339	490	MR1708-163.BIN
164	2017/12/24	04-13.7906S	101-31.2373E	12:36	12:46	1023	340	570	MR1708-164.BIN
165	2017/12/24	04-14.7825S	101-31.2710E	14:57	15:05	1019	340	490	MR1708-165.BIN
166	2017/12/24	04-14.0204S	101-31.8855E	18:20	18:27	1051	360	530	MR1708-166.BIN
167	2017/12/24	04-14.5516S	101-29.8257E	20:56	21:06	964	355	530	MR1708-167.BIN
168	2017/12/25	04-14.5434S	101-31.8635E	0:13	0:25	1042	393	530	MR1708-168.BIN
169	2017/12/25	04-14.8511S	101-30.2288E	2:59	3:11	977	402	500	MR1708-169.BIN
170	2017/12/25	04-14.1664S	101-30.8047E	6:25	6:37	997	374	540	MR1708-170.BIN
171	2017/12/25	04-14.6061S	101-30.9021E	8:53	9:05	1001	387	510	MR1708-171.BIN
172	2017/12/25	04-14.9518S	101-30.8688E	12:17	12:28	997	356	490	MR1708-172.BIN
173	2017/12/25	04-14.5459S	101-30.6639E	14:58	15:09	998	367	520	MR1708-173.BIN

174	2017/12/25	04-14.1415S	101-31.3146E	18:19	18:29	1026	349	510	MR1708-174.BIN
175	2017/12/25	04-15.4256S	101-30.7560E	20:56	21:07	995	351	510	MR1708-175.BIN
176	2017/12/26	04-14.4181S	101-31.0402E	0:13	0:25	1007	368	480	MR1708-176.BIN
177	2017/12/26	04-14.1979S	101-31.9105E	2:57	3:10	1048	405	520	MR1708-177.BIN
178	2017/12/26	04-15.1158S	101-31.4838E	6:21	6:33	1029	396	520	MR1708-178.BIN
179	2017/12/26	04-15.2293S	101-31.6786E	8:56	9:08	1036	392	510	MR1708-179.BIN
180	2017/12/26	04-14.9897S	101-31.5200E	12:17	12:27	1031	341	480	MR1708-180.BIN
181	2017/12/26	04-14.7543S	101-31.6196E	14:57	15:08	1032	371	500	MR1708-181.BIN
182	2017/12/26	04-15.2923S	101-31.6901E	18:18	18:29	1036	343	490	MR1708-182.BIN
183	2017/12/26	04-14.9721S	101-32.1069E	20:55	21:06	1051	365	490	MR1708-183.BIN
184	2017/12/27	04-14.6652S	101-31.6173E	0:12	0:24	1031	388	470	MR1708-184.BIN
185	2017/12/27	04-14.4022S	101-31.7274E	2:57	2:58	1040	419	510	MR1708-185.BIN
186	2017/12/27	04-15.3099S	101-32.7278E	6:22	6:35	1079	425	520	MR1708-186.BIN
187	2017/12/27	04-14.4353S	101-31.9811E	8:58	9:09	1049	379	520	MR1708-187.BIN
188	2017/12/27	04-14.1086S	101-31.1889E	12:19	12:30	1023	365	490	MR1708-188.BIN
189	2017/12/27	04-13.6838S	101-31.2990E	14:57	15:08	1026	388	510	MR1708-189.BIN
190	2017/12/27	04-13.8617S	101-31.3784E	15:16	15:25	1031	370	520	MR1708-190.BIN
191	2017/12/27	04-14.7553S	101-32.1889E	18:20	18:31	1056	356	490	MR1708-191.BIN
192	2017/12/27	04-14.5491S	101-31.5932E	20:56	21:07	1032	366	480	MR1708-192.BIN
193	2017/12/28	04-14.3231S	101-31.3580E	0:13	0:24	1025	385	490	MR1708-193.BIN
194	2017/12/28	04-13.6969S	101-30.9159E	2:58	3:09	1010	363	490	MR1708-194.BIN
195	2017/12/28	04-13.9089S	101-30.7794E	6:22	6:34	1002	406	510	MR1708-195.BIN
196	2017/12/28	04-13.7061S	101-31.3288E	8:57	9:08	1027	407	510	MR1708-196.BIN
197	2017/12/28	04-14.3910S	101-31.1686E	12:15	12:26	1012	353	490	MR1708-197.BIN
198	2017/12/28	04-13.8686S	101-30.7901E	14:57	15:08	1002	393	490	MR1708-198.BIN

199	2017/12/28	04-13.4054S	101-31.3520E	18:17	18:28	1025	358	490	MR1708-199.BIN
200	2017/12/28	04-14.6141S	101-30.9656E	20:56	21:07	1002	370	490	MR1708-200.BIN
201	2017/12/29	04-14.0336S	101-31.0238E	0:14	0:26	1014	379	490	MR1708-201.BIN
202	2017/12/29	04-14.5515S	101-29.6906E	2:58	3:10	955	389	490	MR1708-202.BIN
203	2017/12/29	04-13.9604S	101-31.7771E	6:23	6:34	1049	372	510	MR1708-203.BIN
204	2017/12/29	04-14.8628S	101-31.3386E	8:56	9:07	1023	385	490	MR1708-204.BIN
205	2017/12/29	04-14.8044S	101-31.4831E	12:18	12:28	1026	342	500	MR1708-205.BIN
206	2017/12/29	04-14.3992S	101-31.0580E	14:57	15:07	1006	337	510	MR1708-206.BIN
207	2017/12/29	04-14.7844S	101-31.5377E	18:18	18:29	1028	340	520	MR1708-207.BIN
208	2017/12/29	04-14.5476S	101-32.0784E	20:52	21:02	1052	335	480	MR1708-208.BIN
209	2017/12/30	04-14.5589S	101-31.2437E	0:13	0:24	1015	350	490	MR1708-209.BIN
210	2017/12/30	04-14.0098S	101-30.6958E	2:59	3:09	996	374	480	MR1708-210.BIN
211	2017/12/30	04-14.9094S	101-31.2767E	6:21	6:33	1017	402	530	MR1708-211.BIN
212	2017/12/30	04-15.6014S	101-31.8742E	8:57	9:08	1046	380	480	MR1708-212.BIN
213	2017/12/30	04-14.7072S	101-31.6729E	12:16	12:27	1038	347	490	MR1708-213.BIN
214	2017/12/30	04-14.3858S	101-31.0102E	14:57	15:08	1006	372	480	MR1708-214.BIN
215	2017/12/30	04-14.8368S	101-31.6253E	18:26	18:37	1034	360	480	MR1708-215.BIN
216	2017/12/30	04-14.4854S	101-31.7840E	20:56	21:07	1040	345	500	MR1708-216.BIN
217	2017/12/31	04-14.2378S	101-31.1238E	0:14	0:26	1013	398	500	MR1708-217.BIN
218	2017/12/31	04-13.7110S	101-31.0763E	2:55	3:06	1019	370	470	MR1708-218.BIN
219	2017/12/31	04-14.8827S	101-31.2960E	6:24	6:35	1018	347	520	MR1708-219.BIN
220	2017/12/31	04-13.5109S	101-31.4094E	8:56	9:07	1036	369	480	MR1708-220.BIN
221	2017/12/31	04-14.4131S	101-31.4312E	11:55	12:05	1024	328	560	MR1708-221.BIN
222	2017/12/31	04-14.7744S	101-31.4916E	14:55	15:05	1025	337	500	MR1708-222.BIN
223	2017/12/31	04-13.9973S	101-31.6866E	17:56	18:06	1042	339	480	MR1708-223.BIN

224	2017/12/31	04-13.3325S	101-31.9994E	21:00	21:10	1045	348	520	MR1708-224.BIN
225	2018/01/01	04-14.2992S	101-31.4601E	23:57	0:09	1030	377	500	MR1708-225.BIN

5.22 Underway CTD

(1) Personnel

Satoru YOKOI	(JAMSTEC) : Chief Scientist
Masaki KATSUMATA	(JAMSTEC)
Takanori HORII	(JAMSTEC)
Qoosaku MOTEKI	(JAMSTEC)
Keisuke TAKEDA	(MWJ): Operation Leader
Kenichi KATAYAMA	(MWJ)
Yasuhiro ARII	(MWJ)
Rei ITO	(MWJ)
Rio KOBAYASHI	(MWJ)

(2) Objective

The “Underway CTD” (UCTD) system measures vertical profiles of temperature, conductivity and pressure like traditional CTD system.

The purpose of UCTD observation in this cruise is to explore oceanic structure of temperature and salinity in offshore Sumatra over the Indian Ocean. The station locations is shown in Figure 5.22-1. Blue points show the observation locations before the fixed point. Red Points show the observation locations after the fixed point.

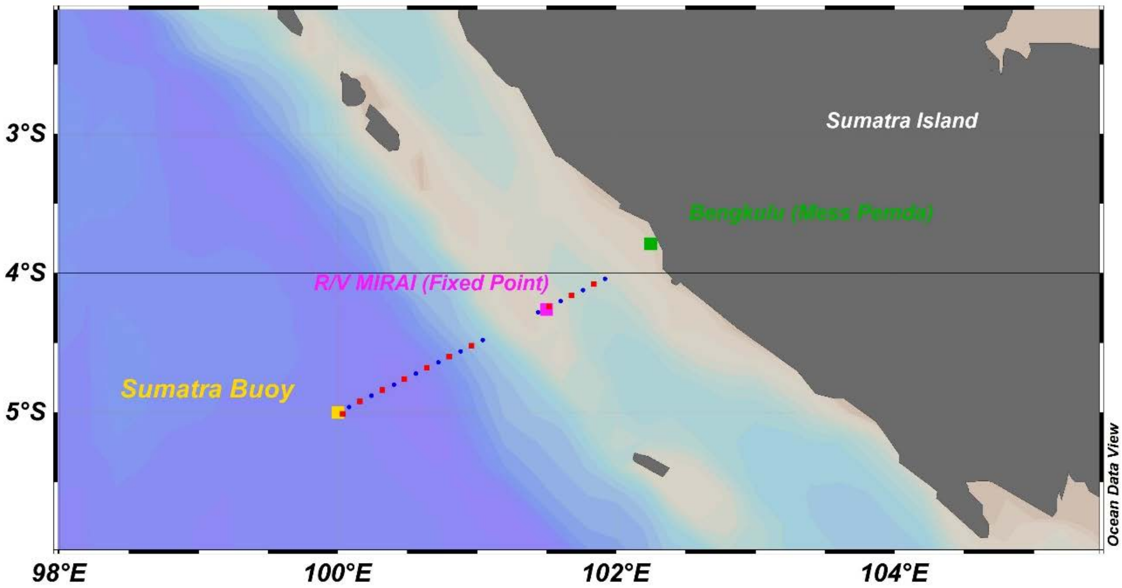


Figure 5.22-1 UCTD Station locations

(3) Methods

The UCTD system manufactured by Oceanscience is used in this cruise. The system consists of the probe unit and on-deck unit with the winch and the rewinder. After spooling the line for certain length onto the probe unit (in "tail spool" part), the probe unit is released from the vessel into ocean with connection to winch on the vessel by line, and then measure temperature, conductivity, and pressure during its free-fall with speed of about 4 m/s in the ocean, while the vessel traveling with speed of about 8 knot/h. After the probe unit reaches the targeted depth for observation, it is recovered by the winch.

The UCTD system used in this cruise observed temperature, conductivity (salinity), and pressure from the sea surface to a level exceeding 300 or 500 dbar with 16 Hz sampling rate.

The observed data were stored in the memory within the probe unit, and after recovery, downloaded into a PC via Bluetooth communication. The accuracy, resolution, and range of the UCTD observation are listed in Table 5.22-1.

Table 5.22-1: The accuracy, resolution, and range of the UCTD observation.

Parameter	Accuracy	Resolution	Range
Temperature (˚C)	0.004	0.002	−5 to 43
Conductivity (S/m)	0.0003	0.0005	0 to 9
Pressure (dbar)	1.0	0.5	0 to 2000

(4) Preliminary Results

During this cruise, 21 casts of UCTD observation were carried out. Date, time and locations of the UCTD casts are listed in Table 5.22-2.

Vertical profiles (down cast) of temperature, conductivity, salinity and descent rate are shown in Figure 5.22-2－5.22-7.

Table 5.22-2 UCTD observation list

Line Number	Station Number	Cast Number	Time Towed (UTC)	Position Towed		Depth to go (m)	Log speed (knot)		S/N of sensor	Notes
				Latitude (deg-min)	Longtude (deg-min)		Tow	Recovery		
Before Fixed Point	L02	1	Dec.03 2017 14:45	04-57.58S	100-04.83E	550	8.2	7.8	0236	
	L04	1	Dec.03 2017 16:57	04-52.79S	100-14.42E	550	7.8	7.8	0236	
	L06	1	Dec.03 2017 19:25	04-47.98S	100-24.05E	550	7.9	7.9	0236	
	L08	1	Dec.03 2017 21:38	04-43.18S	100-33.63E	550	8.0	8.0	0236	
	L10	1	Dec.04 2017 00:08	04-38.39S	100-43.22E	550	8.0	8.0	0236	
	L12	1	Dec.04 2017 01:58	04-33.62S	100-52.84E	550	7.8	8.0	0236	
	L14	1	Dec.04 2017 04:23	04-28.71S	101-02.63E	335	7.9	7.9	0236	shallow cast
	L19	1	Dec.04 2017 10:12	04-16.79S	101-26.41E	335	7.9	7.9	0236	shallow cast
	L21	1	Dec.04 2017 12:29	04-11.99S	101-36.02E	550	8.0	8.3	0236	
	L23	1	Dec.04 2017 14:50	04-07.30S	101-45.66E	550	7.9	7.9	0236	
	L25	1	Dec.04 2017 16:55	04-02.41S	101-55.21E	335	8.0	7.9	0236	shallow cast
After Fixed Point	L24	1	Jan. 01 2018 10:03	04-04.85S	101-50.35E	550	8.4	7.7	236	
	L22	1	Jan. 01 2018 11:04	04-09.63S	101-40.75E	550	8.0	8.1	236	
	L20	1	Jan. 01 2018 12:26	04-14.41S	101-31.17E	550	8.0	7.9	236	
	L13	1	Jan. 01 2018 16:05	04-31.21S	100-57.58E	550	8.1	7.8	236	
	L11	1	Jan. 01 2018 17:07	04-36.02S	100-47.98E	550	8.1	8.2	236	
	L09	1	Jan. 01 2018 18:24	04-40.83S	100-38.38E	550	8.2	8.1	236	
	L07	1	Jan. 01 2018 19:23	04-45.61S	100-28.76E	550	7.7	7.7	236	
	L05	1	Jan. 01 2018 20:41	04-50.42S	100-19.17E	550	8.1	8.1	236	
	L03	1	Jan. 01 2018 21:41	04-55.17S	100-09.62E	550	8.0	8.0	236	Started before 0.1 mille from target point.
	L01	1	Jan. 01 2018 22:40	05-00.42S	100-02.07E	550	5.2	4.8	257	

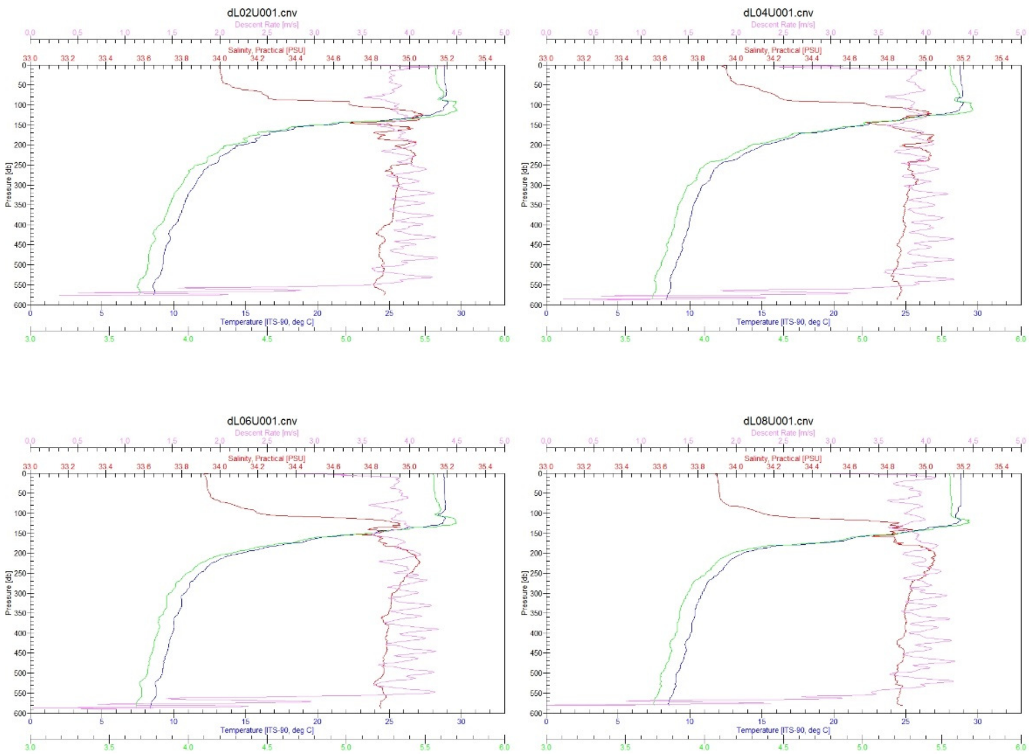


Figure 5.22-2 UCTD profiles (Stn.L01,Stn.L04, Stn.L06, Stn.L08)

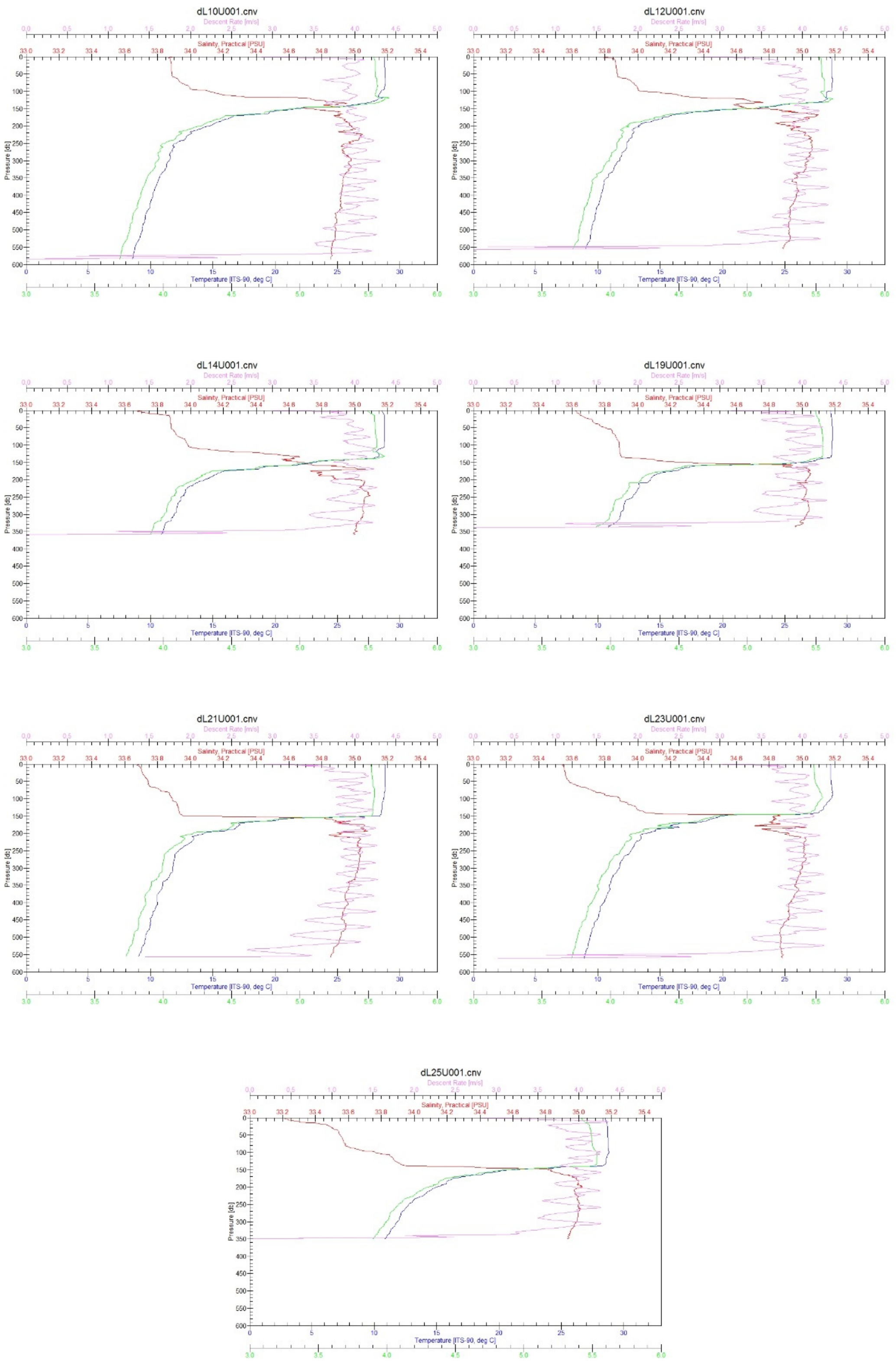


Figure 5.22-3 UCTD profiles (Stn.L10, Stn.L12, Stn.L14, Stn.L23, Stn.L25)

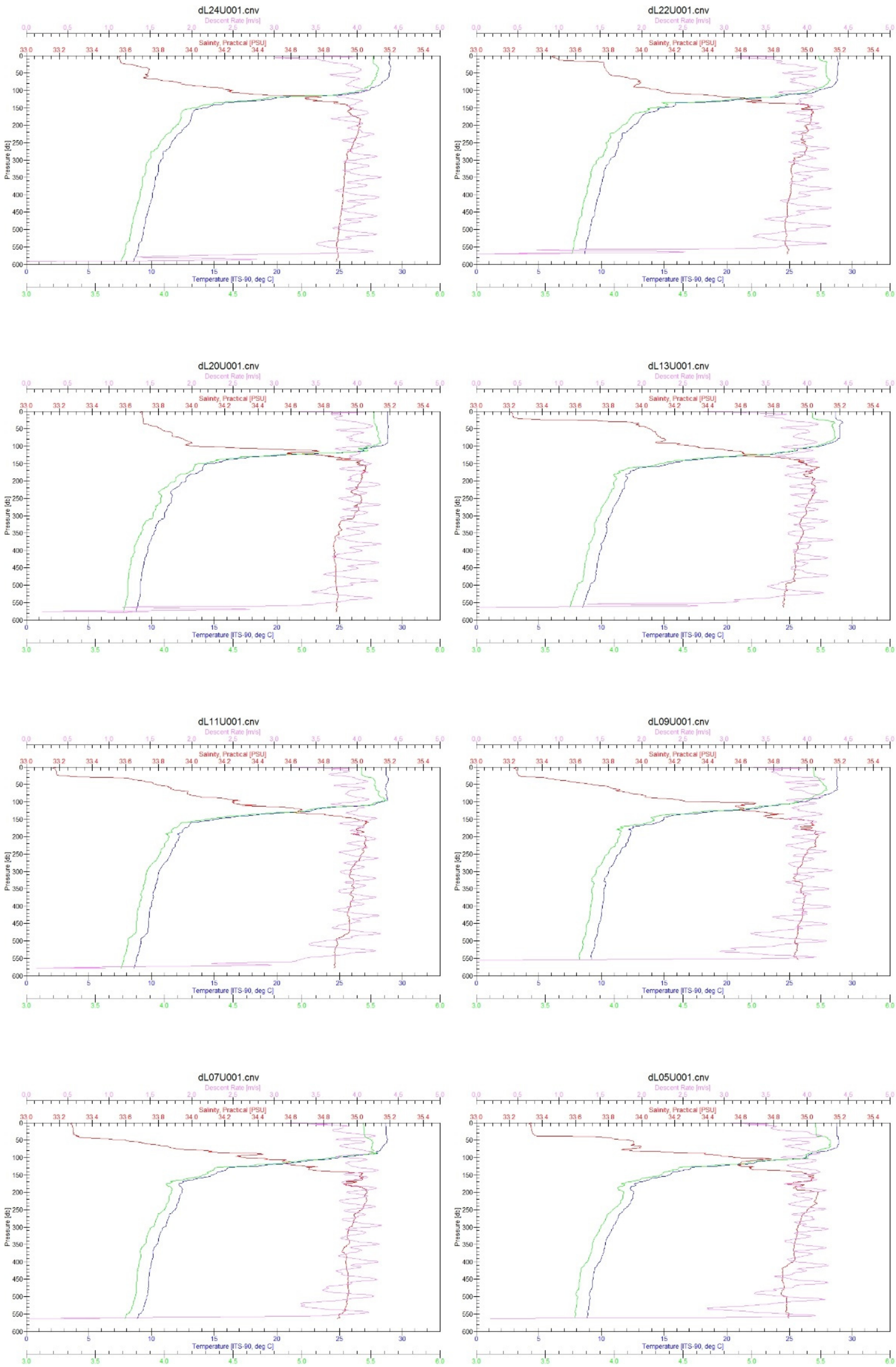


Figure 5.22-4 UCTD profiles (Stn.L24, Stn.L22, Stn.L20, Stn.L13, Stn.L11, Stn.L09, Stn.L07, Stn.L05)

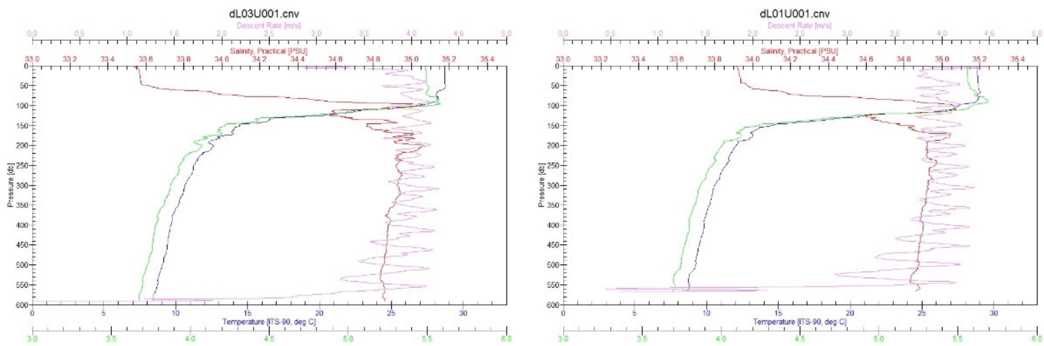


Figure 5.22-5 UCTD profiles (Stn.L03, Stn.L01)

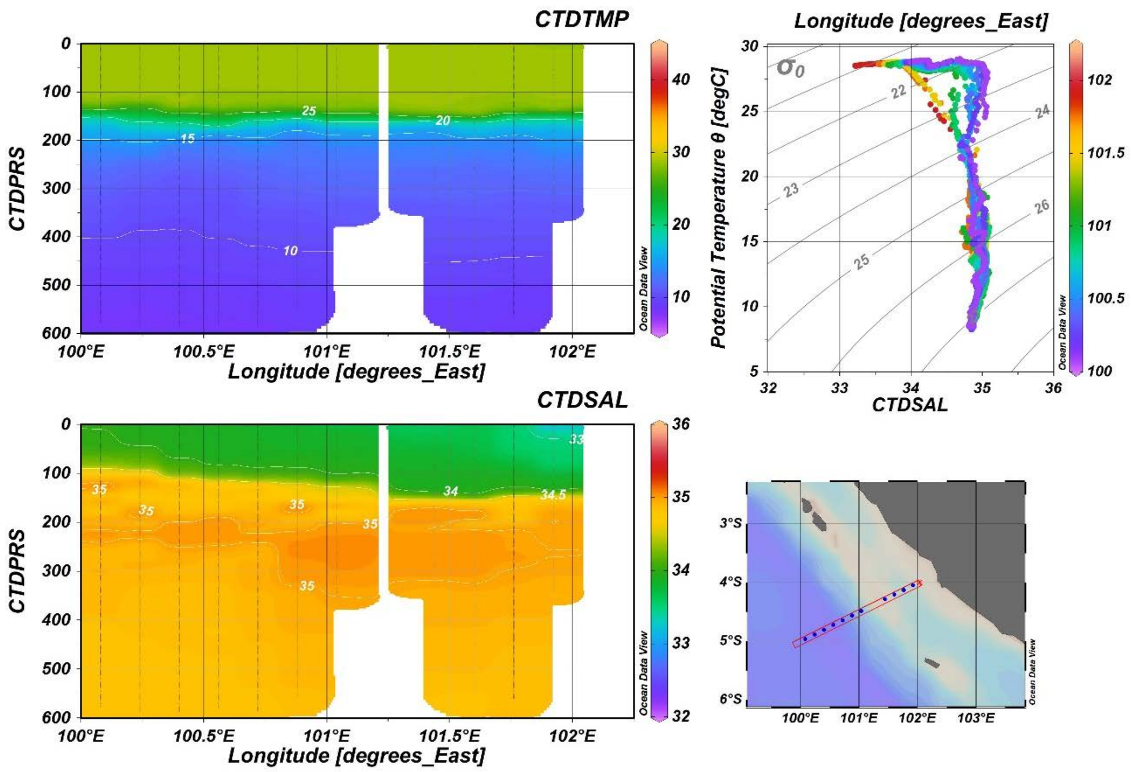


Figure 5.22-6 UCTD Section diagram (Before Fixed point)

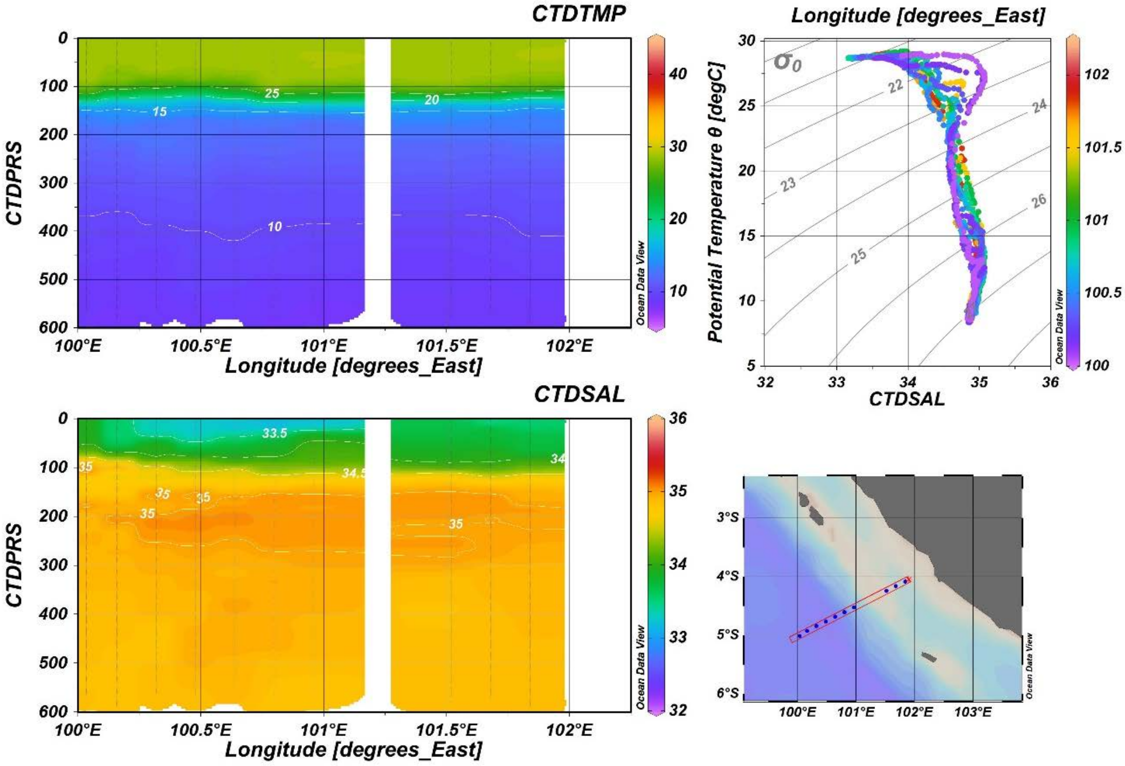


Figure 5.22-7 UCTD Section diagram (After Fixed point)

(5) Data archive

All data obtained during this cruise will be submitted to the JAMSTEC Data Management Office (DMO).

5.23 XCTD

(1) Personnel

Satoru YOKOI	(JAMSTEC) -Principal Investigator	
Souichiro SUEYOSHI	(Nippon Marine Enterprises Ltd., NME)	- Leg1 -
Shinya OKUMURA	(NME)	- Leg1 -
Wataru TOKUNAGA	(NME)	- Leg1 -
Ryo OYAMA	(NME)	- Leg1,2 -
Miki TAWATA	(NME)	- Leg1,2 -
Masanori MURAKAMI	(MIRAI Crew)	- Leg1,2 -

(2) Objective

Investigation of oceanic structure.

(3) Methods

We observed the vertical profiles of the sea water temperature and salinity measured by XCTD-1 (manufactured by Tsurumi-Seiki Co.). The signal was converted by MK-150N (Tsurumi-Seiki Co.) and was recorded by AL-12B software (Ver.1.1.4; Tsurumi-Seiki Co). The specifications of the measured parameters are as in Table 5.23-1. We launched probes by using automatic launcher during MR17-08 cruise as listed in Table 5.23-2.

Table 5.23-1: The range and accuracy of parameters measured by XCTD-1.

Parameter	Range	Accuracy
Conductivity	0 ~ 60 [mS/cm]	+/- 0.03 [mS/cm]
Temperature	-2 ~ 35 [deg-C]	+/- 0.02 [deg-C]
Depth	0 ~ 1000 [m]	5 [m] or 2 [%] (either of them is major)

(4) Data archive

XCTD data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via "Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)" in JAMSTEC web site <http://www.godac.jamstec.go.jp/darwin/e>.

Table 5.23-2: List of XCTD observations. SST (sea surface temperature) and SSS (sea surface salinity).

No.	Date [UTC]	Time [UTC]	Latitude [dd-mm.mmmm]	Longitude [ddd-mm.mmmm]	SST [deg-C]	SSS [PSU]	Probe S/N
01	2017/12/04	07:00	04-23.9647S	101-12.0328E	28.801	33.850	16071484
02	2017/12/04	07:34	04-21.6156S	101-16.8162E	28.879	33.867	16071483
03	2018/01/01	02:37	04-14.3702S	101-30.9895E	28.649	33.513	16071487
04	2018/01/01	05:37	04-14.1391S	101-31.5688E	28.740	33.610	16071490
05	2018/01/01	09:10	03-59.9969S	101-59.9894E	29.110	33.141	16071489
06	2018/01/01	13:25	04-19.2096S	101-21.5991E	28.780	33.683	16071488
07	2018/01/01	13:51	04-21.5986S	101-16.7972E	28.669	33.489	16071491
08	2018/01/01	14:17	04-24.0003S	101-11.9994E	28.615	33.301	16071485
09	2018/01/01	15:09	04-26.3960S	101-07.2026E	28.685	33.297	16071486

5.24 TRITON moorings

5.24.1 TRITON moorings

(1) Personnel

Makito Yokota	(JAMSTEC): Principal Investigator
Iwao Ueki	(JAMSTEC): Principal Investigator
Akira Watanabe	(MWJ): Operation Leader
Masaki Yamada	(MWJ): Technical Staff
Kai Fukuda	(MWJ): Technical Staff
Kenichi Katayama	(MWJ): Technical Staff
Hiroki Ushiromura	(MWJ): Technical Staff
Rei Ito	(MWJ): Technical Staff
Keisuke Takeda	(MWJ): Technical Staff
Rio Kobayashi	(MWJ): Technical Staff
Masanori Enoki	(MWJ): Technical Staff
Yasuhiro Arii	(MWJ): Technical Staff
Hiroshi Hoshino	(MWJ): Technical Staff
Atsushi Ono	(MWJ): Technical Staff

(2) Objectives

The large-scale air-sea interaction over the warmest sea surface temperature region in the western tropical Pacific Ocean called warm pool that affects the global atmosphere and causes El Nino phenomena. The formation mechanism of the warm pool and the air-sea interaction over the warm pool has not been well understood. Therefore long term data sets of temperature, salinity, currents and meteorological elements have been required at fixed locations. The TRITON program aims to obtain the basic data to improve the predictions of El Nino and variations of Asia-Australian Monsoon system.

TRITON buoy (included m-TRITON buoy) array is integrated with the existing TAO (Tropical Atmosphere Ocean) array, which is presently operated by the Pacific Marine Environmental Laboratory/National Oceanic and Atmospheric Administration of the United States. TRITON is a component of international research program of CLIVAR (Climate Variability and Predictability), which is a major component of World Climate Research Program sponsored by the World Meteorological Organization, the International Council of Scientific Unions, and the Intergovernmental Oceanographic Commission of UNESCO. TRITON will also contribute to the development of GOOS (Global Ocean Observing System) and GCOS (Global Climate Observing System).

Three m-TRITON buoys have been recovered and three m-TRITON buoys deployed during this cruise (MR17-08).

(3) Measured parameters

The m-TRITON buoy observes oceanic parameters and meteorological parameters as follows:

Meteorological parameters : wind speed, direction,
air temperature, relative humidity,
shortwave radiation,
precipitation,
atmospheric pressure

Oceanic parameters : water temperature and depth at 1m, 10m,
20m, 40m, 60m, 80m, 100m, 120m, 140m,
200m, 300m, 500m,
conductivity at 1m, 10m, 20m, 40m, 60m,80m,100m,
current speed and direction at 10m

*TRITON and m-TRITON observes same oceanic parameters and meteorological parameters.

(4) Instrument

Details of the instruments used on the m-TRITON buoy are summarized as follows:

Oceanic sensors

1) CTD (Conductivity-Temperature-Depth meter, Sea Bird Electronics Inc.)
SBE-37 IM Micro CAT
A/D cycles to average : 4
Sampling interval : 600sec
Measurement range, Temperature : -5～+35 deg-C
Measurement range, Conductivity : 0～+7 S/m
Measurement range, Pressure : 0～full scale range

2) TD (Temperature and Depth meter, Sea Bird Electronics Inc.)
SBE-39 IM
Sampling interval : 600sec
Measurement range, Temperature : -5～+35 deg-C
Measurement range, Pressure : 0～full scale range

3) CRN (Current meter, Nortek AS)
Aquadopp IM400
Sampling interval : 1800sec
Sensor frequency : 2MHz
Velocity Range : ±5m/s

Meteorological sensors

1) Precipitation (JAMSTEC) *

MODEL Y50203

Sampling interval : 600sec

2) Relative humidity/air temperature (JAMSTEC) *

MODEL MP103A

Sampling interval : 600sec

3) Shortwave radiation (JAMSTEC) *

MODEL EPSP

Sampling interval : 600sec

4) Wind speed/direction (JAMSTEC) *

MODEL Y85000

Sampling interval : 600sec

5) Atmospheric pressure (PAROSCIENTIFIC.Inc.)

DIGIQUARTZ FLOATING BAROMETER_6000SERIES

Sampling interval : 600sec.

*Meteorological sensors were assembled with A/D (Analog/Digital) conversion PCB (Print Circuit Board) made by MARITEC (Marine Technology Center)/JAMSTEC

Data logger and ARGOS transmitter (Iridium transmitter)

1) Data logger

Meteorological sensors are controlled by I/O RS485.

GPS and Inductive modem are controlled by RS232C.

2) ARGOS transmitter (Iridium transmitter)

The data in the interval of 10 minutes are being transmitted through ARGOS transmitter (Iridium transmitter).

(5) Locations of m-TRITON buoys deployment

Nominal location :	5S 95E
ID number at JAMSTEC :	17509
ARGOS PTT number :	171E68B (60600)
ARGOS backup PTT number :	29791
Deployed date :	30 Nov. 2017
Exact location :	04°56.95’ S, 94°58.49’ E
Depth :	5,007 m

Nominal location : 8S 95E
ID number at JAMSTEC : 19507
ARGOS PTT number : 9EB84D4 (96109)
ARGOS backup PTT number : 30591
Deployed date : 28 Nov. 2017
Exact location : 08°00.06’ S, 95°02.51’ E
Depth : 5,208 m

Nominal location : 5S 100E
ID number at JAMSTEC : 97502
Iridium ID : 300434061415870
ARGOS backup PTT number : 30829
Deployed date : 03 Dec. 2017
Exact location : 05°00.00’ S, 100°00.00’ E
Depth : 5,541 m

(6) Locations of m-TRITON buoys recovered

Nominal location : 5S 95E
ID number at JAMSTEC : 17508
ARGOS PTT number : 29EB779 (45735)
ARGOS backup PTT number : 96773
Deployed date : 17 Nov. 2016
Recovered date : 01 Dec. 2017
Exact location : 05°06.51’ S, 94°58.51’ E
Depth : ---- m

Nominal location : 1.5S 90E
ID number at JAMSTEC : 18508
ARGOS PTT number : CFD07AD (139322)
ARGOS backup PTT number : 30830
Deployed date : 07 Feb. 2015
Recovered date : 26 Nov. 2017
Exact location : 01°37.06’ S, 89°59.02’ E
Depth : 4,694 m

*Top buoy drifted from deployment position at 20 Jan 2016. Top buoy and all meteorological sensors had been recovered at 11 May 2016. Under the snaped point was recovered in this cruise.

Nominal location : 8S 95E

ID number at JAMSTEC : 19506

ARGOS PTT number : 29EB75F(45733)

ARGOS backup PTT number : 30830

Deployed date : 20 Nov. 2016

Recovered date : 29 Nov. 2017

Exact location : 08°05.04’ S, 95°08.16’ E

Depth : 5,123 m

*Dates are UTC and represent anchor drop times for deployments and release time for recoveries, respectively.

(7) Details of deployed buoys

We had deployed three m-TRITON buoys, described them in the list below.

Deployment of m-TRITON buoys

Observation No.	Location	Details
17509	5S 95E	Deploy with full spec and 2 optional units. Security camera :with top buoy JES10-CTD IM: 301m
19507	8S 95E	Deploy with full spec and 2 optional units. Security camera :with top buoy JES10-CTD IM: 301m
97502	5S 100E	Deploy with full spec and 3 optional units. Security camera :with top buoy CO_2 and pH sensor :with top buoy SBE-39 IM: 301m

(8) Data archive

The data in the interval of 10 minutes were transmitted via ARGOS (Iridium) satellite data-transmission system in real time. These data will be archived at the JAMSTEC Yokosuka Headquarters. And the data will be distributed worldwide through the internet from the JAMSTEC web site (http://www.jamstec.go.jp/).

5.24.2 Evaluation of CTD sensor for the mooring and for the new floats

(1) Personnel

Yukio TAKAHASHI (JAMSTEC, not on board) - Principal Investigator
Makito YOKOTA (JAMSTEC)
Kensuke WATARI (JAMSTEC, not on board)

(2) Objective

JES10-CTDIM was developed by Jamstec as CTD for the mooring. On the other hand, JES10-Profiler is developed as CTD for the profile float (Fig. 5.24.2-1). This operation was conducted to evaluate three things.

1) JES10-CTDIM evaluate the verification of calibration results by the CTD casting.
2) JES10-CTDIM evaluate pressure dependence of the water temperature sensor.
3) JES10-Profiler with pump compare profiling data with 9plus.
4) We evaluate the pump that was made by Yonago Shinko Ltd

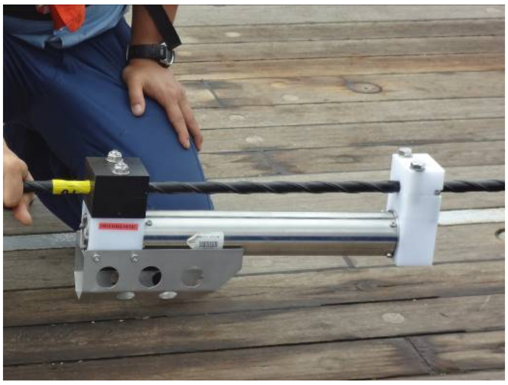


Fig5.24.2-1 JES10-CTDIM

Fig5.24.2-2 JES10-Profiler with pump

(3) Method

1) JES10-CTDIM evaluate the verification of calibration results and pressure dependence of the water temperature sensor by the CTD casting.

Three JES10-CTDIM were attached to the frame of the CTD (SBE9plus) water sampling system, were carried out CTD casting (Fig. 5.24.2-3). The CTD flame with 9Plus sensor was stopped for 5 minutes at each depth of 500m, 300m and 200m, these measurements were compared with the 9plus.

Table 5.24.2.-1 List of CTD casts for JES10-CTDIM.

Station	Date	Max Depth	Stop Depth(m) for 5min
C01M001	Nov.25 2017	500m	500,300,200 at ascent

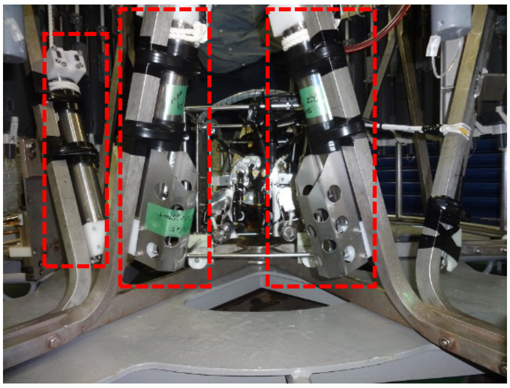


Fig 5.24.2.-3 CTD frame with JES10-CTDIM

3) JES10-Profiler with pump compare profiling data with 9plus.

The JES10-Profiler with pump was attached to the frame of the CTD (SBE9plus) water sampling system, were carried out CTD casting. We changed type of the pump and the water inlet position of the JES10-Profiler every casting. Profiling data was compared with the 9plus.

Table 5.24.2-1 List of CTD casts for JES10-Profiler.

Station	Date	Max Depth	Pump type	The water inlet position of the JES10-Profiler
M051	Dec.11 2017	500m	SBE5	Fig. 5.24.2.-5 a)
M059	Dec.12 2017	500m	SBE5	Fig. 5.24.2.-5 b)
M067	Dec.13 2017	500m	SBE5	Fig. 5.24.2.-5 a)
M091	Dec.16 2017	500m	Yonago Shinko Ltd.	Fig. 5.24.2.-5 a)
M099	Dec.17 2017	500m	Yonago Shinko Ltd.	Fig. 5.24.2.-5 b)
M107	Dec.18 2017	500m	Yonago Shinko Ltd.	Fig. 5.24.2.-5 c)
M123	Dec.20 2017	500m	SBE5	Fig. 5.24.2.-5 c)
M131	Dec.21 2017	500m	SBE5	Fig. 5.24.2.-5 d)
M139	Dec.22 2017	500m	SBE5	Fig. 5.24.2.-5 a)
M154	Dec.24 2017	500m	SBE5	Fig. 5.24.2.-5 a)
M162	Dec.25 2017	500m	-	Fig. 5.24.2.-5 e)

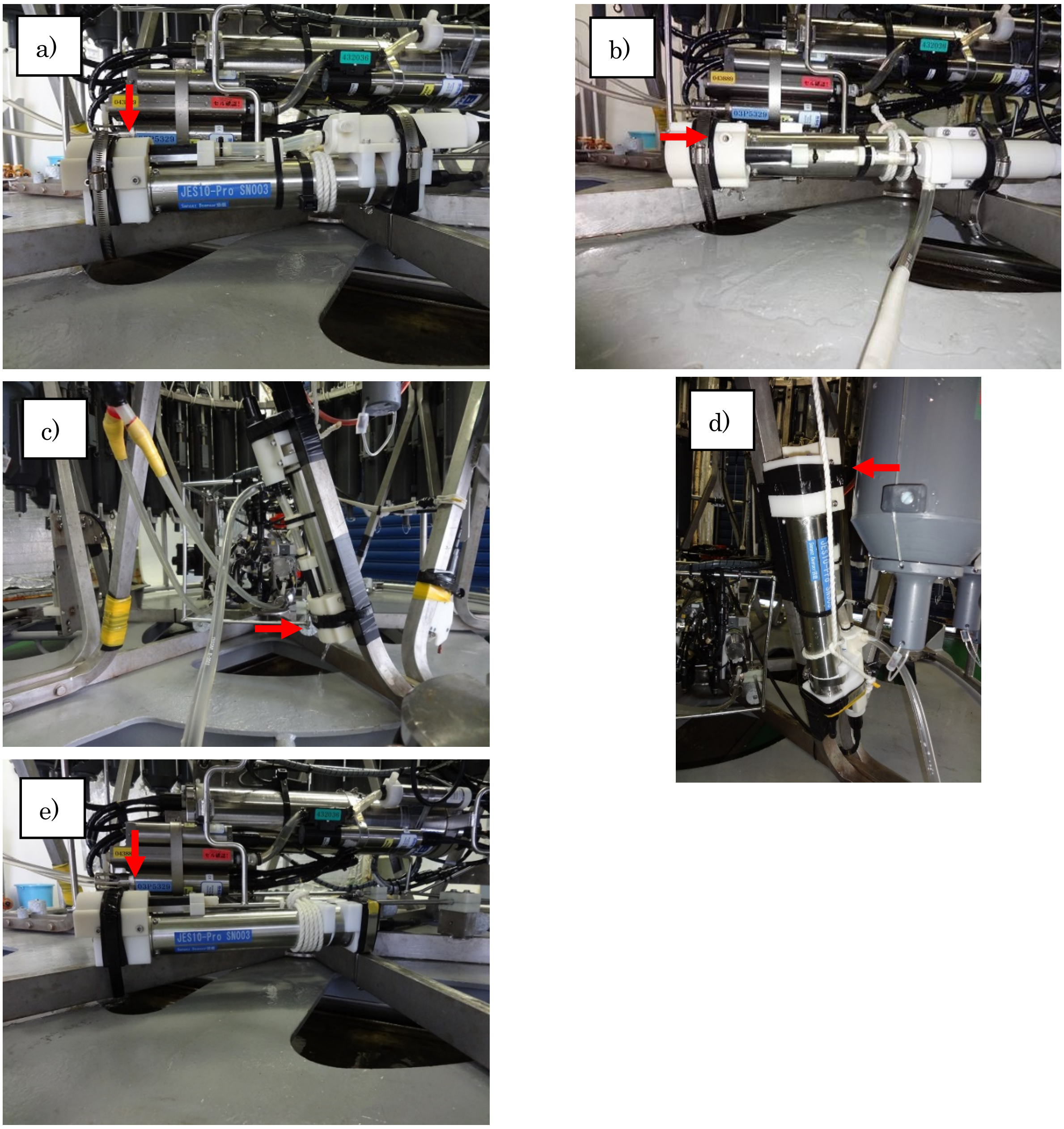


Fig. 5.24.2-4 The water inlet direction of the JES10-Profiler

(4) Preliminary Result

1) JES10-CTDIM evaluate the verification of calibration results, and evaluation pressure dependence of the water temperature sensor by the CTD casting.

   JES10-CTDIM is required temperature accuracy 0.005K and Salinity accuracy 0.01PSU. We evaluated JES10-CTDIM accuracy to compare with 9plus data. The result of comparison was less than accuracy requirement.

Table 5.24.2-2 List of difference between the JES10-CTDIM and 9plus.

SN	Temperature.(degC)	Pressure.(dbar)	Salinity
SN009	-0.0028	-0.2693	-0.0032
SN010	0.0049	0.7911	0.0032
SN011	0.0031	0.7215	-

2) JES10-Profiler with pump compare profiling data with 9plus.

The difference of salinity from 9plus was less than 0.01PSU when temperature was change 0.01 degrees C.

a) b)

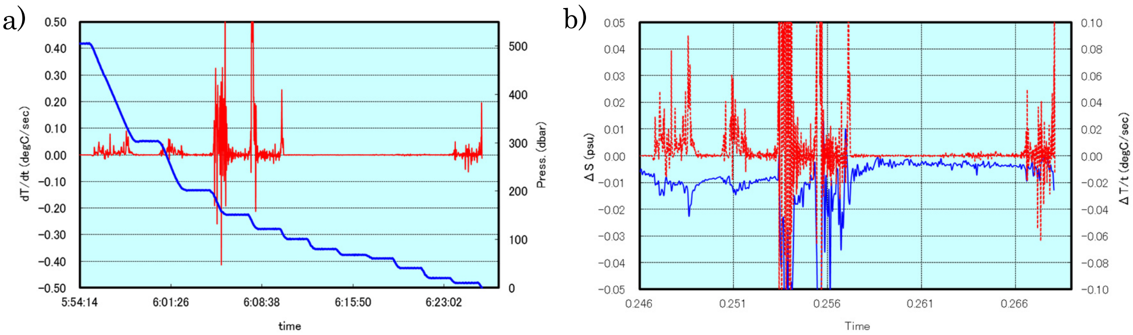


Fig. 5.24.2-5 Data difference between the JES10-Profiler and the 9plus.

for a) pressure profile and temperature difference of every 1 second. b) difference of salinity and temperature JES10-Profiler and 9plus.

3) We evaluate the pump that was made by Yonago Shinko Ltd

We conducted pump observation until 500 m depth three times. The pump continued to work during observation.

5.25 ADCP moorings

(1) Personnel

Iwao Ueki	(JAMSTEC)	Principal investigator
Takanori Horii	(JAMSTEC)	
Kentaro Ando	(JAMSTEC)	Not onboard
Hiroki Ushiromura	(MWJ)	Operation leader
Kenichi Katayama	(MWJ)	
Yasuhiro Arii	(MWJ)	
Rei Ito	(MWJ)	
Keisuke Takeda	(MWJ)	
Rio Kobayashi	(MWJ)	

(2) Objectives

The purpose of the ADCP subsurface mooring is to get knowledge of physical process underlying the dynamics of the equatorial current structure and associated processes in the eastern Indian Ocean. We have been observing subsurface currents using ADCP moorings along the equator. In this cruise (MR17-08), we recovered the mooring at Eq-90E and deployed another mooring at the same site.

(3) Parameters

・Current profiles
・Echo intensity
・Pressure, Temperature and Conductivity

(4) Methods

Two instruments are mounted at the top float of the mooring. One is ADCP (Acoustic Doppler Current Profiler) to observe upper-ocean currents from subsurface down to around 400m depth. The second instrument mounted below the float is CTD, which observes pressure, temperature and salinity for correction of sound speed and depth variability. Details of the instruments and their parameters are as follows:

1) ADCP

Work horse ADCP 75 kHz (Teledyne RD Instruments, Inc.)
Distance to first bin : 7.04 m
Pings per ensemble : 27
Time per ping : 6.66 seconds
Number of depth cells : 60
Bin length : 8.00 m

Sampling Interval : 3600 seconds

Recovered ADCP

- Serial Number : 13123 (Mooring No. 161125-EQ90E)

Deployed ADCP

- Serial Number : 14080 (Mooring No. 171125-EQ90E)

2) CTD

SBE-37 (Sea Bird Electronics Inc.)

Sampling Interval : 1800 seconds

Recovered CTD

- Serial Number : 1775 (Mooring No. 161125-EQ90E)

SBE-16 (Sea Bird Electronics Inc.)

Sampling Interval : 1800 seconds

Deployed CTD

- Serial Number : 1280 (Mooring No. 171125-EQ90E)

3) Other instrument

(a) Acoustic Releaser (BENTHOS,Inc.)

Recovered Acoustic Releaser

- Serial Number : 677 (Mooring No. 161125-EQ90E)
- Serial Number : 719 (Mooring No. 161125-EQ90E)

Deployed Acoustic Releaser

- Serial Number : 630 (Mooring No. 171125-EQ90E)
- Serial Number : 717 (Mooring No. 171125-EQ90E)

(b) Transponder (BENTHOS,Inc.)

Recovered Transponder

- Serial Number : 67491 (Mooring No. 161125-EQ90E)

Deployed Transponder

- Serial Number : 61940 (Mooring No. 171125-EQ90E)

(c) ST-400A Xenon Flasher (MetOcean Data Systems)

Recovered Transponder

- Serial Number : Z03-090 (Mooring No. 161125-EQ90E)

Deployed Transponder

- Serial Number : A02-056 (Mooring No. 171125-EQ90E)

(5) Deployment

Deployment of the ADCP mooring at Eq-90E were planned to mount the ADCP at about 400 m depth. During the deployment, we monitored the depth of the acoustic releaser after dropped the anchor.

The position of the mooring No. 171125-EQ90E

Date: 25 Nov. 2017 Lat.: 00-00.26S Long.: 090-08.67E Depth: 4,085 m

(6) Recovery

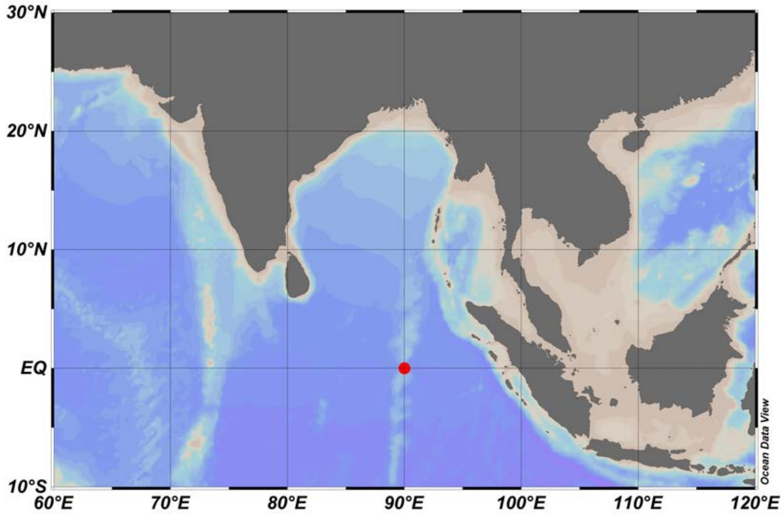
We recovered one ADCP mooring which was deployed on 25 Nov 2016 (R/V BARUNAJAYA). We uploaded ADCP and CTD data into a computer, and then raw data were converted into ASCII code.

The results of mooring show in Figure 5.25-1 - 5.25-2.

(7) Data archive

All data will be opened at the following web page:.

http://www.jamstec.go.jp/rcgc/j/tcvrp/ipocvrt/adcp_data.html



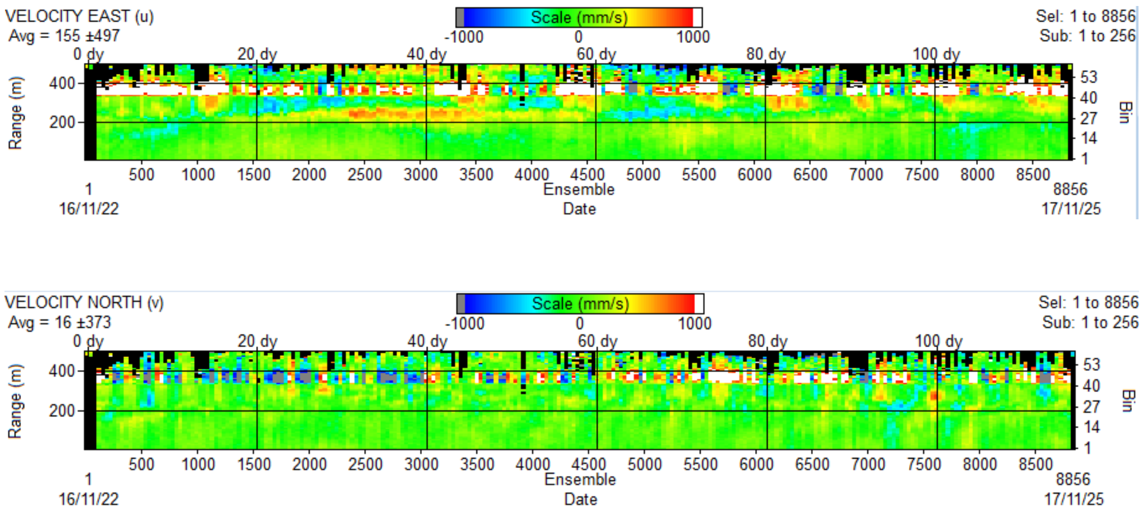


Fig. 5.25-1 Time-depth sections of observed zonal (*top panel*) and meridional (*bottom panel*) currents obtained from ADCP mooring at Eq-90E. (2016/11/25-2017/11/25)

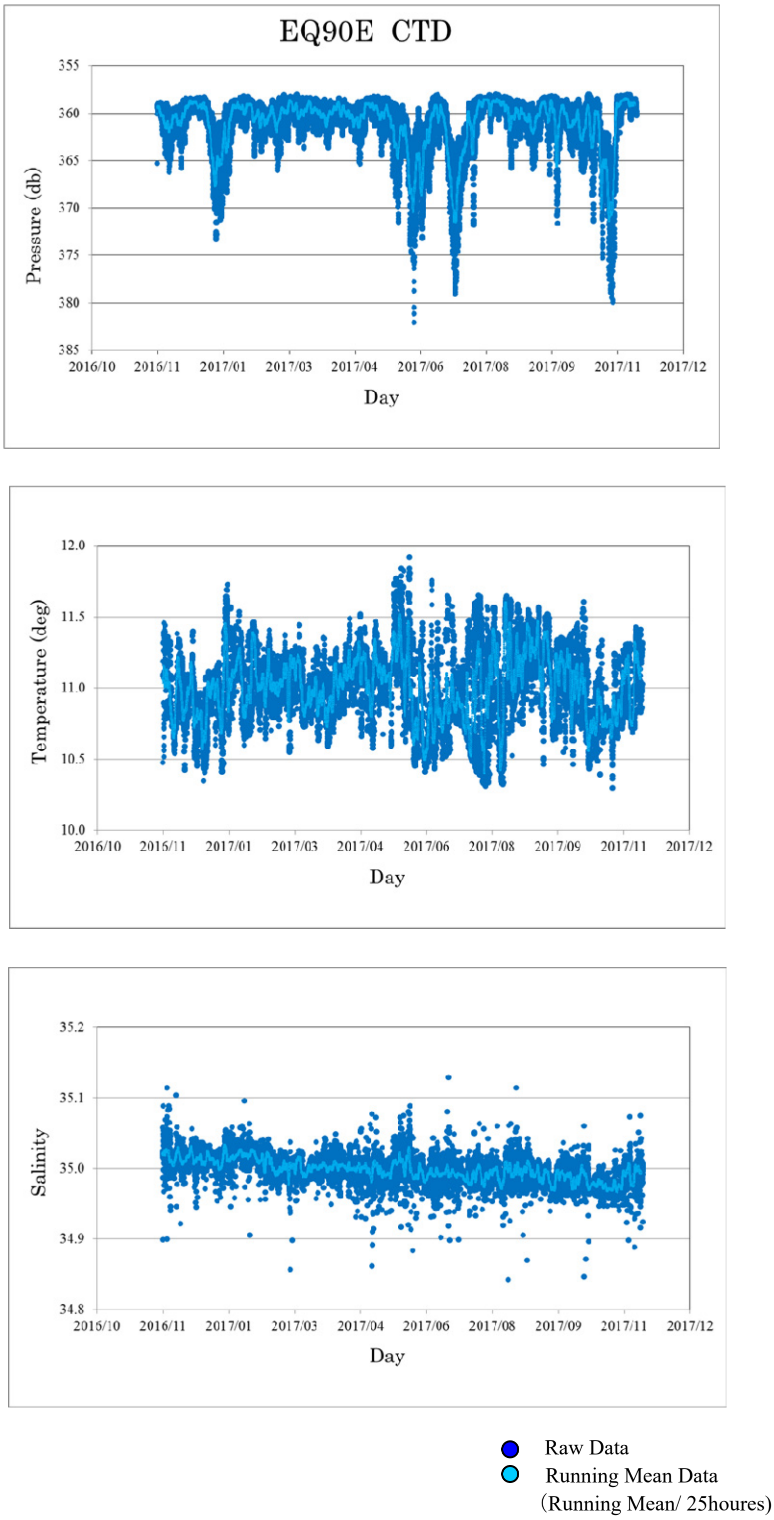


Fig. 5.25-2 Time-series of the observed pressure (*top panel*), temperature (*middle panel*) and salinity (*bottom panel*) obtained from CTD at Eq-90E. The *dark-blue* curve indicates the raw data, while the *light-blue* curve shows the filtered data from 25 hours running-mean.(2016/11/25-2017/11/25)

5.26 Wave Glider experiment

(1) Personnel

Iwao Ueki	(JAMSTEC)	Principal Investigator
Makito Yokota	(JAMSTEC)	
Masaki Katsumata	(JAMSTEC)	
Tatsuya Fukida	(JAMSTEC)	Not Onboard
Yasuhisa Ishihara	(JAMSTEC)	Not Onboard
Kentaro Ando	(JAMSTEC)	Not Onboard
Nobuhiro Fujii	(MWJ)	Not Onboard

(2) Background and Objectives

Although there are many global air-sea flux products mainly based on Satellite observation, in situ observations by research vessels and mooring buoys are still essential. As a part of the TAO (Tropical Atmosphere and Ocean)/TRITON (Triangle trans-ocean buoy network) array, we are conducting the air-sea flux observation in the western Pacific and eastern Indian Ocean. The mooring observation has the advantage to acquire detailed direct measurement record at a fixed point, however it takes relatively high cost to keep many sites. Because of progress of the development of unmanned ocean surface vehicles, such as the Wave Glider and the Saildrone, we can use these vehicles as a platform for air-sea flux observation. Using the Wave Glider, we are conducting development of air-sea flux observing system.

(3) Instrumentation

Wave Glider is an autonomous surface behicle, which utilize both wave energy for propulsion and solar power for supporting on-board computing, communications and sensor payloads. It can travel tens of thousands of miles, collect data in the most demanding conditions, and deliver this data in real time. The Wave Glider consists of two-part architecture; surface float and underwater glider with umbilical cable (Fig. 5.26-1). As payloads, we install three types of meteorological sensor units; the Weather Station, Weather Transmitter, and JAMMET (Fig. 5.26-2). The observed parameters are air temperature, relative humidity, barometric pressure longwave radiation, shortwave radiation, wind and rain fall amount. Underwater sensors for temperature, conductivity and pressure, thermistor chain for temperature profile within 11 m depth and ocean current profiler within 120 m depth are also installed (Fig. 5.26-3). The acquired data are recorded on logger system and transmitted to land station via iridium satellite communication system.

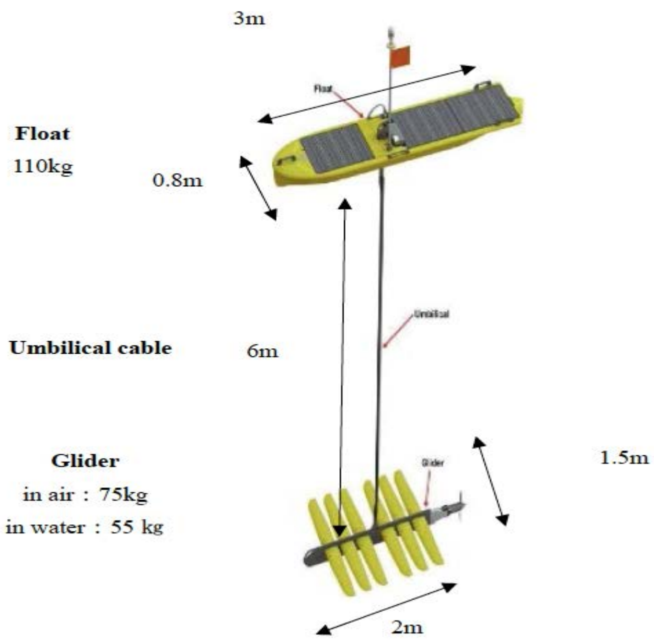


Fig. 5.26-1 Wave Glider SV3 configuration

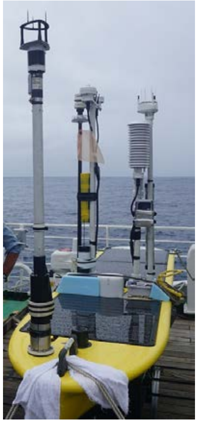


Fig. 5.26-2 Meteolorogical sensor units

Fig. 5.26-3 Thermistor chane and CTD sensor

(4) Observation

1) Data comparison with mooring observation
We conducted observation for confirmation of operational performance and data quality around m-TRITON sites at 5˚S 100˚E. We deployed the Wave Glider on 03 December 2017 (Fig. 5.26-4). Wave Gider made round along 4 nm radius circle centered on mooring anchor point of m-TRITON 2 times, and took 5 round trips along 100.08˚E during a period from 03 Dec. to 12 Dec. 2017 (Fig. 5.26-5).

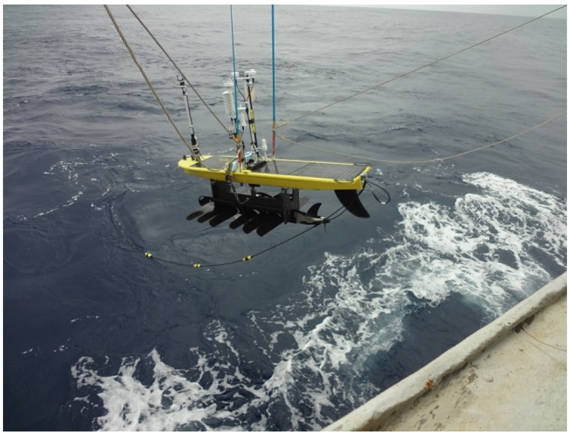


Fig. 5.26-4 Deployment of Wave Gilder on 03 December

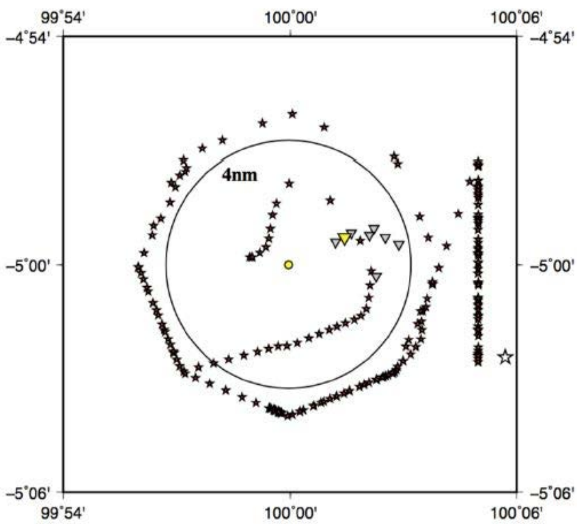


Fig. 5.26-5 Cruise track of the Wave Glider during the period from 03 Dec. to 12 Dec. 2017

2) Data comparison with R/V Mirai observation

The second observation is data comparison with the R/V Mirai. The Wave Glider moved near the R/V Mirai, and then observed between 4.27˚S 101.8˚E to 4.52˚S 101.55˚E 8 times during the period of 14 Dec. to 30 Dec. 2017 (Fig. 5.26-6). Distance from the R/V Mirai to the line is about 25 km. The Wave Glider was recovered 30 December 2017, as shown in Fig. 5.26-7.

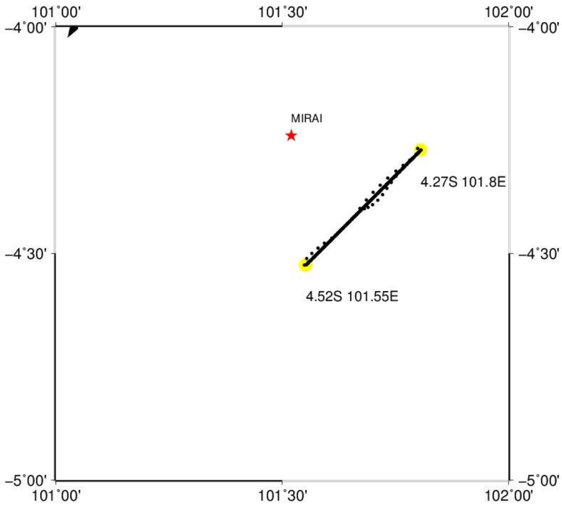


Fig. 5.26-6 Cruise track of the Wave Gilder on 14 December to 30 December 2017

Fig. 5.26-7 Recovery of Wave Glider on 30 December 2016

(5) Preliminary Results

1) Data comparison with mooring observation

Results of data comparison between the Wave Glider and m-TRITON mooring around 5˚S 100˚E are shown in Fig. 5.26-6. As shown in these figures, observed variables with both platform are consistent, which demonstrate effectiveness of the meteolorogical observation by the Wave Glider.

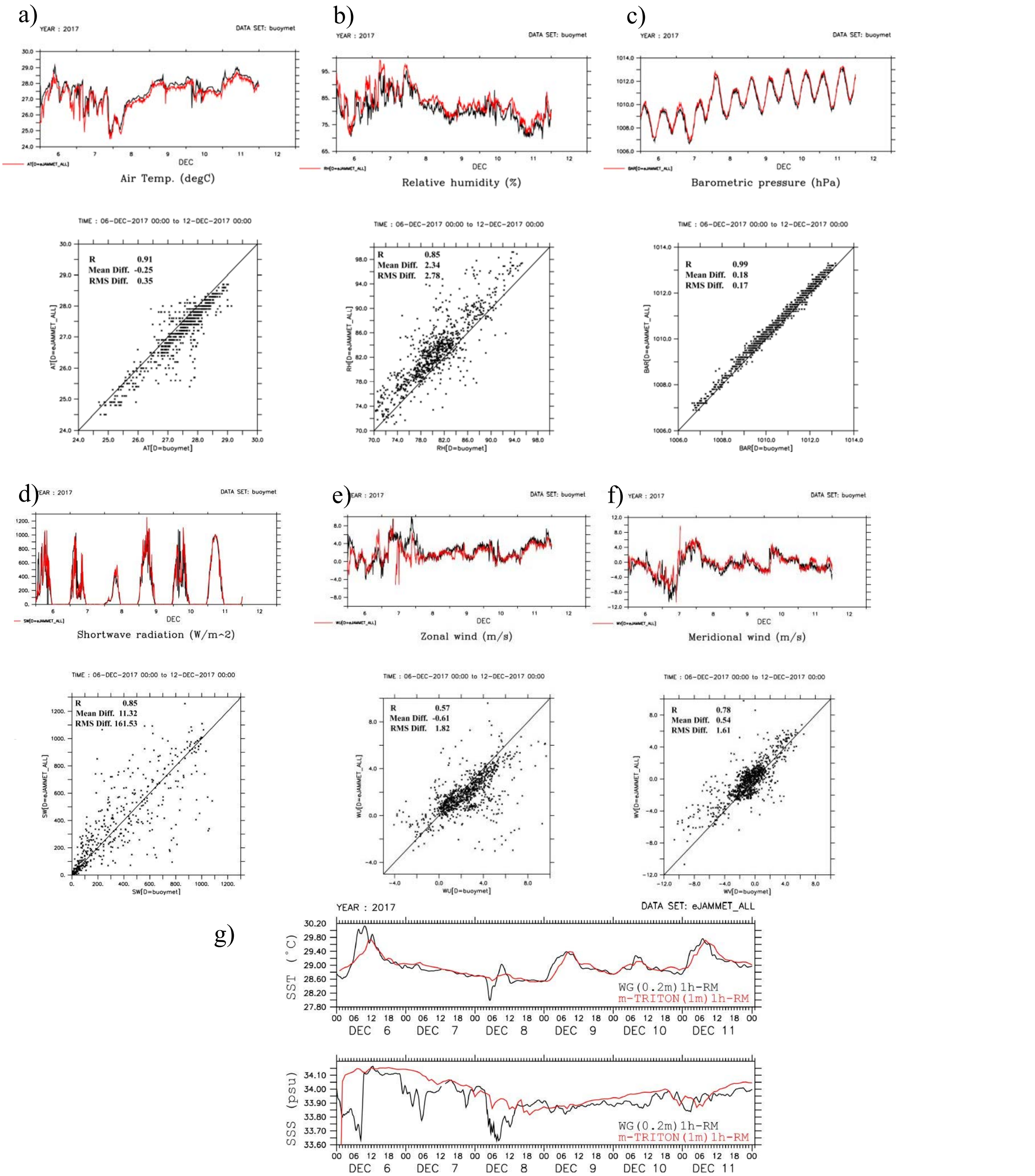


Fig. 5.26-8 Data comparison between the Wave Glider and the m-TRITON at 5˚S 100˚E.
for a) air temparature, b) relative humidity, c) barometric pressure, d) Shortwave radiation, e) zonal wind, f) meridional wind, f) SST, SSS.

2) Data comparison with the R/V Mirai

Although several damage for meteolorogical sensors were shown, the data comparison with the R/V Mirai were favorably conducted. Results of data comparison between the Wave Glider and the R/V Mirai are shown in Fig. 5.26-9. As shown in these figures, observed variables with both platform are consistent, which demonstrate effectiveness of the meteolorogical observation by the Wave Glider.

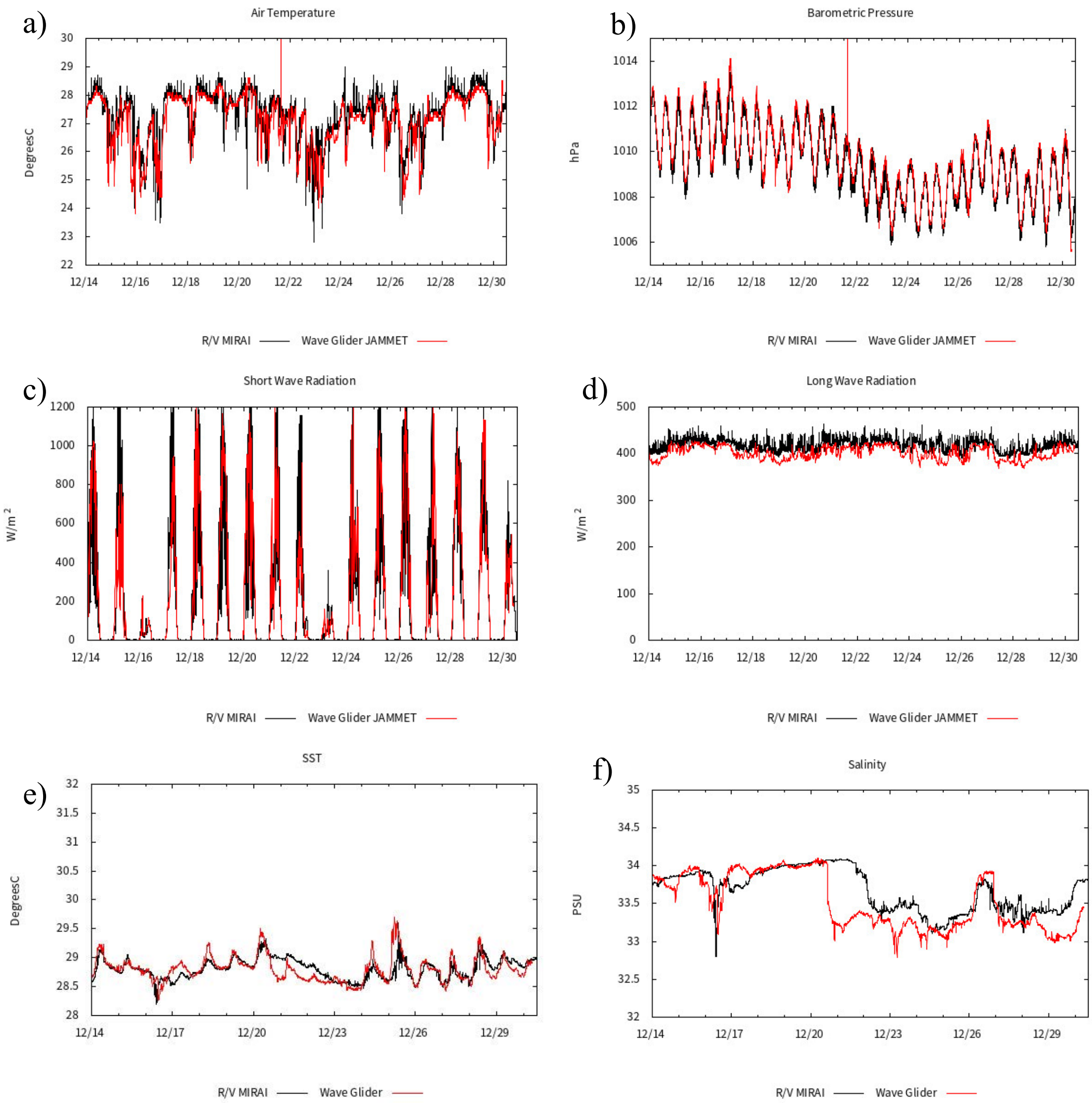


Fig. 5.26-9 Data comparison between the Wave Glider and R/V Mirai
for a) air temparature, b) barometric pressre, c) shortwave radiation, d) longwave radiation, e) SST, f) SSS.

5.27 Argo floats

(1) Personnel

Shuhei Masuda	(JAMSTEC/RCGC): Principal Investigator (not on board)
Shigeki Hosoda	(JAMSTEC/RCGC) (not on board)
Mizue Hirano	(JAMSTEC/RCGC) (not on board)
Fumihiko Akazawa	(JAMSTEC/RCGC) (not on board)
Kenichi Katayama	(MWJ): Operation Leader
Hiroki Ushiromura	(MWJ):

(2) Objectives

The objective of this study is to clarify the mechanisms of climate and oceanic environment variability for understanding changes of earth system through estimations of heat and material transports, and to improve their long-term forecasts of climate changes, by sustainably monitoring in the global ocean. To achieve the objective, automatically long-term measurements of physical parameters are carried out by deployment of Argo/Deep Argo floats in the equatorial Indian Ocean.

One Argo flat (Arvor) is deployed in the eastern equatorial Indian Ocean to maintain the core Argo observation network. The Argo float measures vertical profiles of temperature, salinity and above a depth of 2000dbar for several years, sending all data in real-time. Also, one deep Argo float (Deep NINJA) measures vertical profiles of temperature and salinity down to a depth of 4000dbar. Since deep Argo float observes frequent vertical profiles more than ship based observation, accurate temporal and spatial variability of the deeper ocean can be captured. The deployed deep float will also contribute to construct global deep Argo array, which is now constructing in collaboration with the other countries.

The core and deep Argo float data will be applied to the ESTOC, which is 4D-VAR data assimilation system to estimate state of global ocean for climate changes. This enable us to investigate whole mechanism of long-term changes in the global ocean associated with the global warming and/or climate changes.

(3) Parameters

・Water temperature, salinity, pressure.

(4) Methods

i. Profiling float deployment for core Argo

We launched one Arvor float manufactured by nke Instrumentation, which equipps SBE41 CTD sensor manufactured by Sea-Bird Electronics Inc.The observation cycle of the float set to 10 days, drifting for 9 days at a depth of 1000 dbar (called the parking depth), and then ascending from a depth of 2000 dbar to the sea surface every 10 days, measuring physical values every measurement depth following the depth table in vertical direction. During surfacing for approximately about 9 hours, the float sends the all measured data to the land via through the Argos telecommunication system. Life time of the float will be 4 years, depending on the size of battery. The status of float and its launching information is shown in Table 5.1.1.

Table 5.27-1 Status of float and launch

Arvor Float (2000dbar)

Float Type	Arvor float manufactured by nke instrumentation.
CTD sensor	SBE41 manufactured by Sea-Bird Electronics Inc.
Cycle	10 days (approximately 9 hours at the sea surface)
ARGOS transmit interval	30 sec
Target Parking Pressure	1000 dbar
Sampling layers	115 levels (2000,1950,1900,1850,1800,1750,1700,1650,1600,1550,1500, 1450, 1400, 1350, 1300, 1250, 1200, 1150, 1100, 1050, 1000, 980, 960, 940, 920, 900, 880, 860, 840, 820, 800, 780, 760, 740, 720, 700, 680, 660, 640, 620, 600, 580, 560, 540, 520, 500, 490, 480, 470, 460, 450, 440, 430, 420, 410, 400, 390, 380, 370, 360, 350, 340, 330, 320, 310, 300, 290, 280, 270, 260, 250, 240, 230, 220,210, 200, 195, 190, 185, 180, 175, 170, 165, 160, 155, 150, 145, 140, 135, 130, 125, 120, 115, 110, 105, 100, 95, 90, 85, 80, 75, 70, 65, 60, 55, 50, 45, 40, 35, 30, 25, 20, 15, 10, 4 or surface dbar)

Launch information

Float S/N	WMO ID	Date and Time of Launch(UTC)	Location of Launch	CTD St. No.
OIN 13-JAP-ARL-81	5905064	2017/12/1 05:34	5-03.5S [S] 095-02.81 [E]	CTD03 C03M001

ii. Profiling float deployment for deep Argo

We also launched Deep float (Deep NINJA) manufactured by Tsurumi Seiki Co.,Ltd. This float equipps SBE41 CTD for deep sensor manufactured by Sea-Bird Electronics Inc.. The float drifts at a depth of 2000 dbar (called the parking depth) for 9 days, then goes upward from a depth of 4000 dbar to the sea surface every 10 days. During the ascent, physical values are measured at given depths (depth table). During surfacing for approximately half an hour, the float sends the all measured data to the land via through the Iridium Short Burst data (SBD) service. Observation cycle of the deep float will be about one year. The status of float and its launching information is shown in Table 5.1.2.

Table 5.27-2 Status of float and launch of DeepFloat

Deep Float (Deep NINJA)

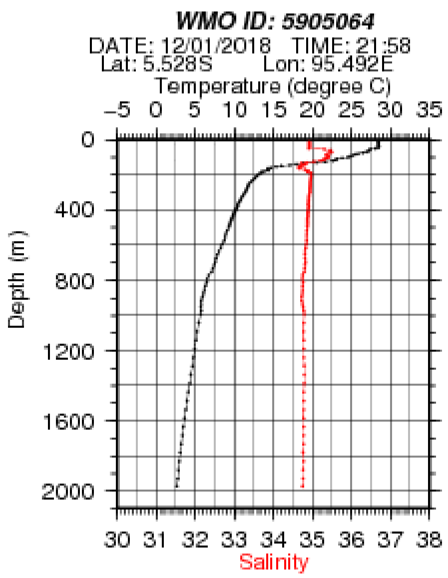
Float Type	Deep NINJA Tsurumi Seiki Co.,Ltd
CTD sensor	SBE41 for Deep manufactured by Sea-Bird Electronics Inc.
Cycle	10 days (approximately 30minutes at the sea surface)
Iridium transmit type	Short Burst Data Service (SBD)
Target Parking Pressure	2000 dbar
Sampling layers	5dbar interval from 4000 dbar to surface (approximately 800 layers)

Launche information

Float S/N	WMO ID	Date and Time of Launch(UTC)	Location of Launch	CTD St. No.
26	5905063	2017/12/1 05:25	5-03.58 [S] 095-02.71 [E]	CTD03 C03M001

(5) Data archive

The Argo float data with real-time quality control are provided to Global Data Assembly Center (GDAC: http://www.usgodae.org/argo/argo.html, http://www.coriolis.eu.org/) and Global Telecommunication System (GTS) within 24 hours following the procedure decided by Argo data management team. Delayed mode quality control is conducted for the float data within 6 months ~ 1 year, to satisfy their data accuracy for the use of research. Those quality controlled data are freely available via internet and utilized for not only research use but also weather forecasts and other variable uses. Below figures show vertical profiles of launched BGC APEX (WMO ID:5905064) and Deep NINJA (WMO ID: 5905064) as samples.



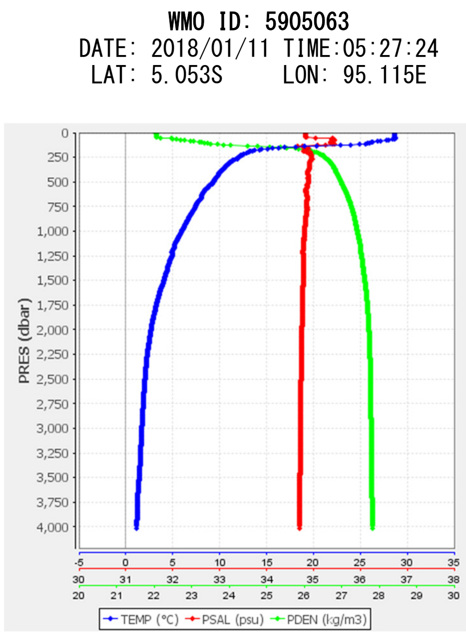


Fig. 5.27-1: Vertical profiles of launched core (left) and deep (right) Argo floats.

5.28 Underway Geophysics

Personnel

Satoru YOKOI	(JAMSTEC) -Principal Investigator	
Souichiro SUEYOSHI	(Nippon Marine Enterprises Ltd., NME)	- Leg1 -
Shinya OKUMURA	(NME)	- Leg1 -
Wataru TOKUNAGA	(NME)	- Leg1 -
Ryo OYAMA	(NME)	- Leg1, 2 -
Miki TAWATA	(NME)	- Leg1, 2 -
Masanori MURAKAMI	(MIRAI Crew)	- Leg1, 2 -

5.28.1 Sea surface gravity

(1) Introduction

The local gravity is an important parameter in geophysics and geodesy. We collected gravity data at the sea surface.

(2) Parameters

Relative Gravity [CU: Counter Unit]
[mGal] = (coef1: 0.9946) * [CU]

(3) Data Acquisition

We measured relative gravity using LaCoste and Romberg air-sea gravity meter S-116 (Micro-g LaCoste, LLC) during this cruise.

To convert the relative gravity to absolute one, we measured gravity, using portable gravity meter CG-5 (Scintrex), at Port of Nagagusuku and Shimizu as the reference points.

(4) Preliminary Results

Absolute gravity table was shown in Table.5.28.1-1.

Table 5.28.1-1 Absolute gravity table

No.	Date m/d	UTC hh:mm	Port	Absolute Gravity [mGal]	Sea Level [cm]	Ship Draft [cm]	Gravity at Sensor *1 [mGal]	S-116 Gravity [mGal]
#1	11/11	21:25	Nakagusuku	979,114.21	300	635	979,115.37	11398.82
#2	11/20	22:52	Singapore	-----	324	630	-----	-----
#3	1/4	08:49	Jakarta	-----	79	604	-----	-----
#4	1/19	03:24	Shimizu	979,729.01	242	643	979,730.01	12013.28

*1: Gravity at Sensor = Absolute Gravity + Sea Level*0.3086/100 + (Draft-530)/100*0.2222

(5) Data Archives

Surface gravity data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via “Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)” in JAMSTEC web site.

<http://www.godac.jamstec.go.jp/darwin/e>

(6) Remarks

1) The follwing period, data acquisitions were suspended in the foreign EEZ.
   01:00UTC 12 Nov. 2017 to 07:30UTC 22 Nov. 2017
   07:30UTC, 11 Jan. 2018 to 00:30UTC, 12 Jan. 2018

5.28.2 Sea surface three-component magnetometer

(1) Introduction

Measurement of magnetic force on the sea is required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. We measured geomagnetic field using a three-component magnetometer during this cruise.

(2) Principle of ship-board geomagnetic vector measurement

The relation between a magnetic-field vector observed on-board, *Hob*, (in the ship's fixed coordinate system) and the geomagnetic field vector, *F*, (in the Earth's fixed coordinate system) is expressed as:

$$Hob = A * R * P * Y * F + Hp \qquad \text{(a)}$$

where, *R*, *P* and *Y* are the matrices of rotation due to roll, pitch and heading of a ship, respectively. *A* is a 3 x 3 matrix which represents magnetic susceptibility of the ship, and *Hp* is a magnetic field vector produced by a permanent magnetic moment of the ship's body. Rearrangement of Eq. (a) makes

$$R * Hob + Hbp = R * P * Y * F \qquad \text{(b)}$$

where $R = A^{-1}$, and $Hbp = -R * Hp$. The magnetic field, *F*, can be obtained by measuring *R*, *P*, *Y* and *Hob*, if *R* and *Hbp* are known. Twelve constants in *R* and *Hbp* can be determined by measuring variation of *Hob* with *R*, *P* and *Y* at a place where the geomagnetic field, *F*, is known.

(3) Instruments on R/V MIRAI

A shipboard three-component magnetometer system (Tierra Tecnica SFG1214) is equipped on-board R/V MIRAI. Three-axes flux-gate sensors with ring-cored coils are fixed on the fore mast. Outputs from the sensors are digitized by a 20-bit A/D converter (1 nT/LSB), and sampled at 8 times per second. Ship's heading, pitch, and roll are measured by the Inertial Navigation System (INS) for controlling attitude of a Doppler radar. Ship's position (GPS) and speed data are taken from LAN every second.

(4) Data Archives

Surface gravity data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via “Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)” in JAMSTEC web site.

<http://www.godac.jamstec.go.jp/darwin/e>

(5) Remarks

1) The following period, data acquisitions were suspended in the foreign EEZ.
01:00UTC, 12 Nov. 2017 - 07:30UTC, 22 Nov. 2017
07:30UTC, 11 Jan. 2018 - 00:30UTC, 12 Jan. 2018

2) For calibration of the ship’s magnetic effect, we made a “figure-eight” turn (a pair of clockwise and counter-clockwise rotation). These calibrations were carried out as below.
10:33UTC to 10:54UTC, 28 Nov. 2017 around 07-54S, 095-08E.
23:46UTC, 01 Jan. to 00:12UTC, 02 Jan. 2018 around 05-00S, 100-02E.
20:53UTC to 21:18UTC, 17 Jan. 2018 around 35-02N, 138-37E.

5.28.3 Swath Bathymetry

(1) Introduction

R/V MIRAI is equipped with a Multi narrow Beam Echo Sounding system (MBES), SEABEAM 3012 Model (L3 Communications ELAC Nautik). The objective of MBES is collecting continuous bathymetric data along ship's track to make a contribution to geological and geophysical investigations and global datasets.

In addition, we surveyed map of developing positions at m-TRITON buoys and ADCP mooring buoy. And we measured the estimate depth of fixed those buoys anchor position at the deployment sites.

(2) Data Acquisition

The "SEABEAM 3012 Model" on R/V MIRAI was used for bathymetry mapping during this cruise.

To get accurate sound velocity of water column for ray-path correction of acoustic multibeam, we used Surface Sound Velocimeter (SSV) data to get the sea surface (6.62m) sound velocity, and the deeper depth sound velocity profiles were calculated by temperature and salinity profiles from CTD and Argo float data by the equation in Del Grosso (1974) during the cruise. Table 5.28.3-1 shows system configuration and performance of SEABEAM 3012 system.

Table 5.28.3-1 SEABEAM 3012 System configuration and performance

Frequency:	12 kHz
Transmit beam width:	2.0 degree
Transmit power:	4 kW
Transmit pulse length:	2 to 20 msec
Receive beam width:	1.6 degree
Depth range:	50 to 11,000 m
Beam spacing:	Equi-Angle
Number of beams:	301 beams
Swath width:	60 to 150 degree (max)
Depth accuracy:	< 1 % of water depth (average across the swath)

(3) Preliminary Results

The results will be published after primary processing.

(4) Data Archives

Bathymetric data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via "Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)" in JAMSTEC web site.

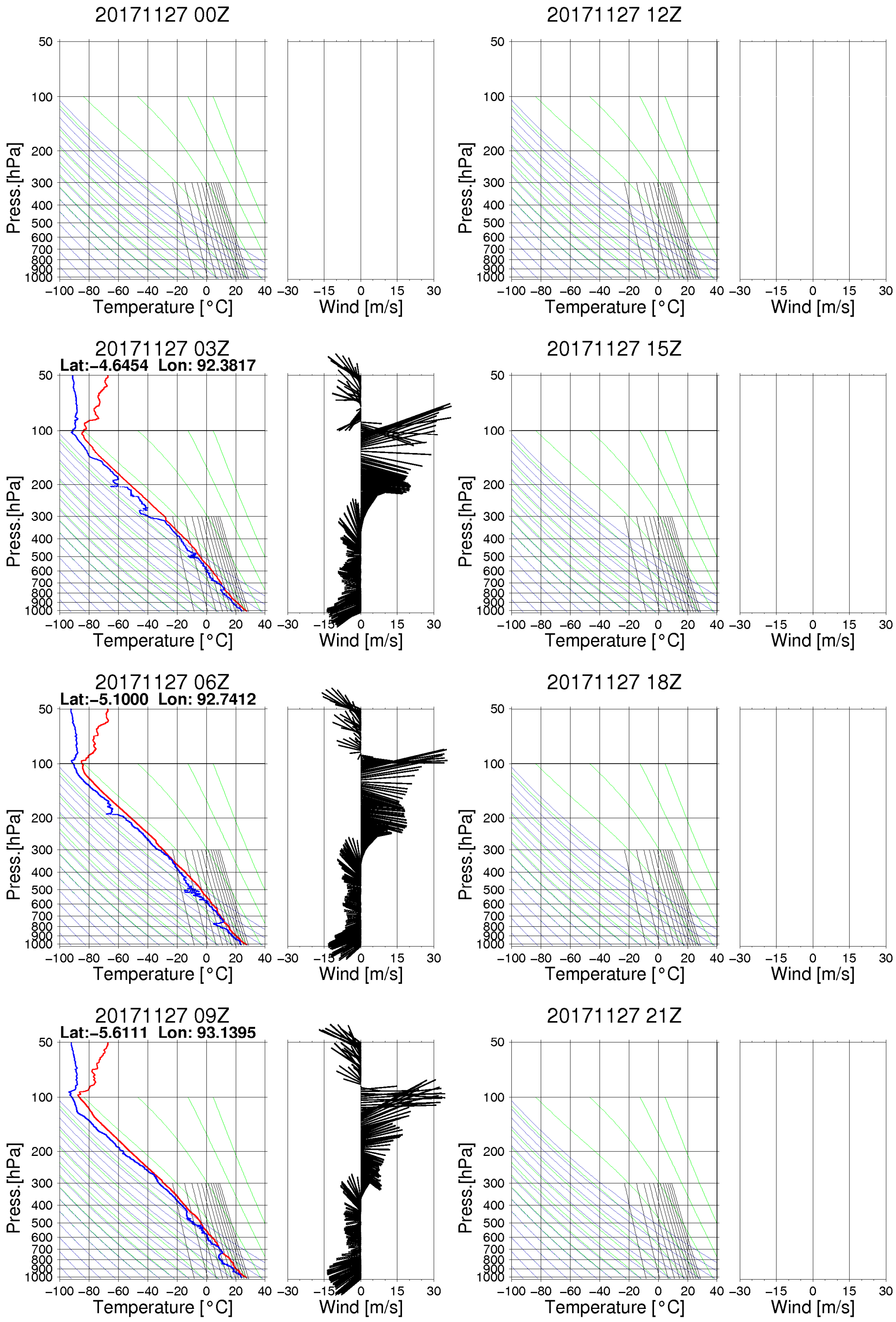
<http://www.godac.jamstec.go.jp/darwin/e>

(5) Remarks

1) The following period, system operations were stopped in the foreign EEZ.
23:30UTC, 12 Nov. 2017 - 15:22UTC, 22 Nov. 2017.
07:30UTC, 11 Jan. 2018 - 00:30UTC, 12 Jan. 2018.

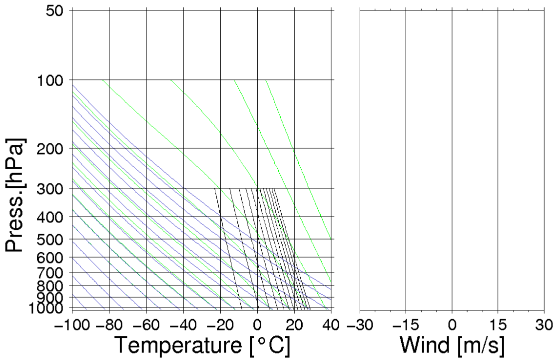
2) The following period, data acquisitions were suspended due to stationary observations.
23:51UTC, 04 Dec. 2017 - 06:26UTC, 01 Jan. 2018.

Appendix A: Atmospheric profiles by the radiosonde observations

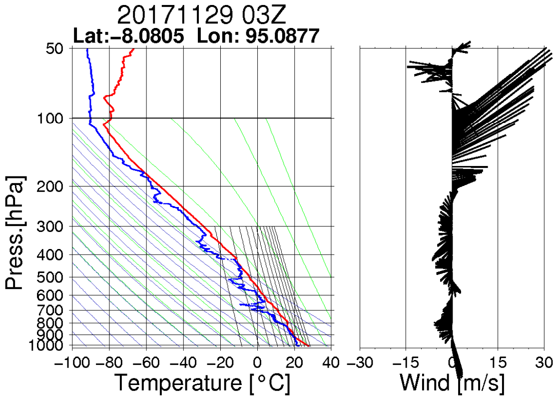


20171127 00Z
20171127 12Z
20171127 03Z
Lat:−4.6454 Lon: 92.3817
20171127 15Z
20171127 06Z
Lat:−5.1000 Lon: 92.7412
20171127 18Z
20171127 09Z
Lat:−5.6111 Lon: 93.1395
20171127 21Z
Press.[hPa]
Temperature [°C]
Wind [m/s]

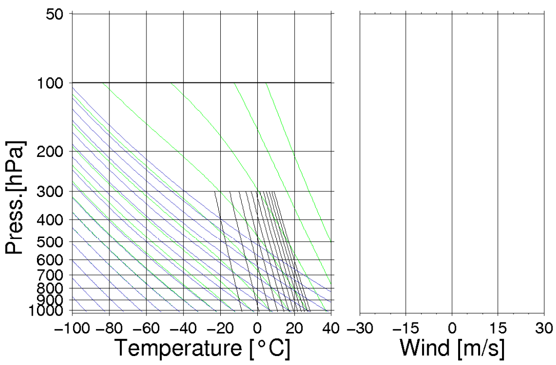
20171129 00Z



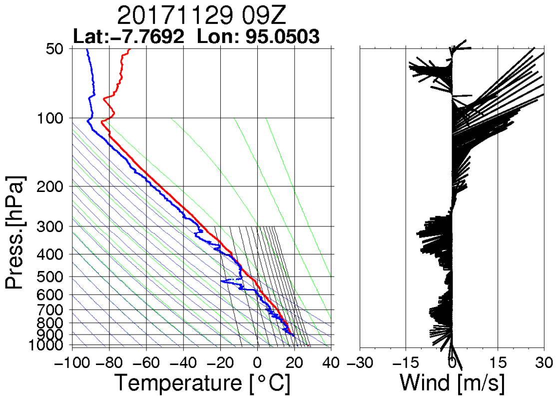
20171129 03Z



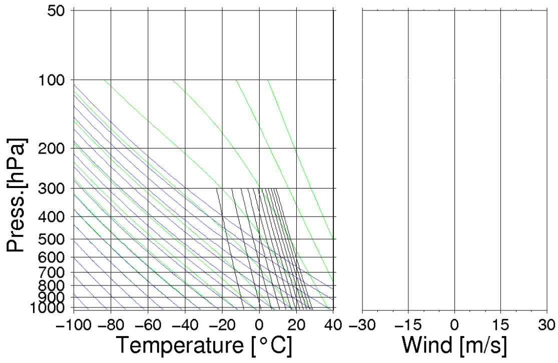
20171129 06Z



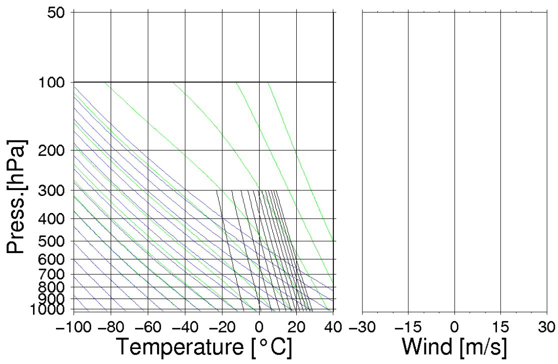
20171129 09Z



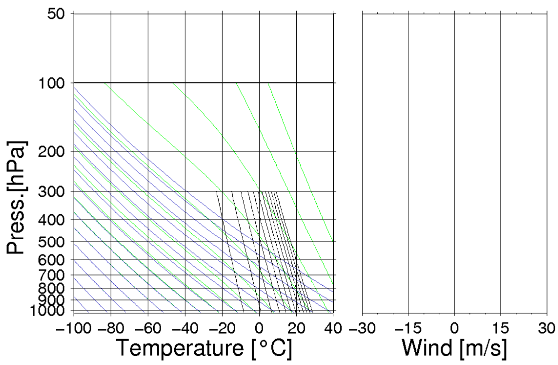
20171129 12Z



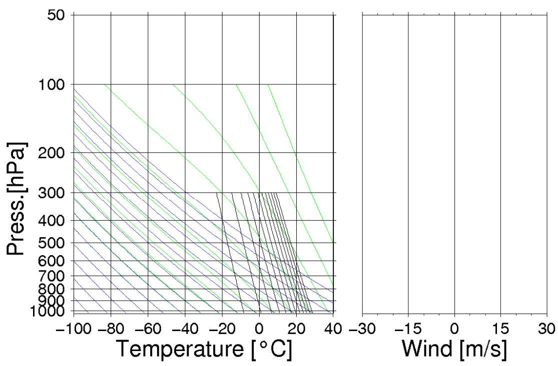
20171129 15Z



20171129 18Z

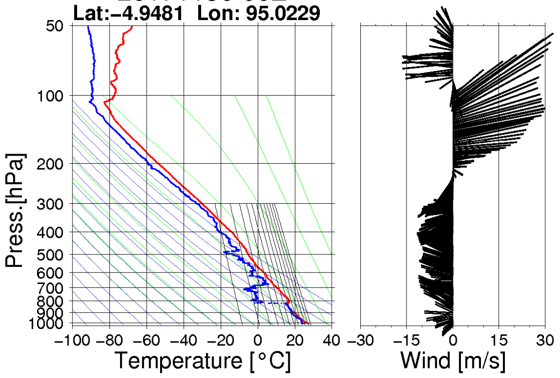


20171129 21Z



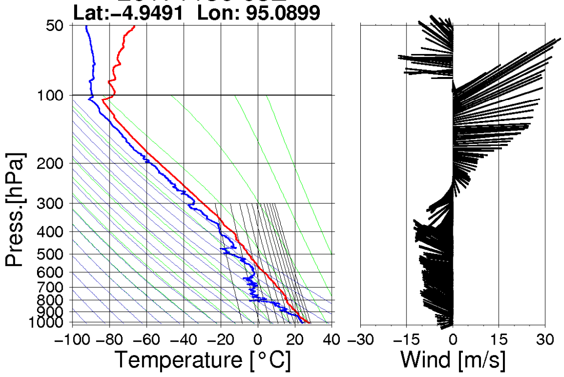
20171130 00Z

Lat:−4.9481 Lon: 95.0229



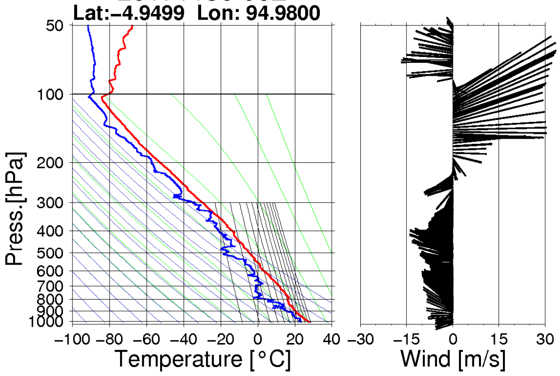
20171130 03Z

Lat:−4.9491 Lon: 95.0899



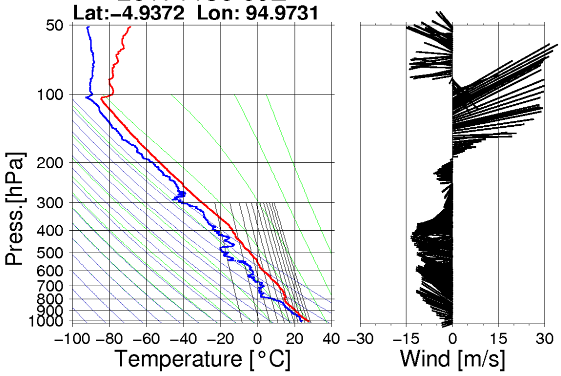
20171130 06Z

Lat:−4.9499 Lon: 94.9800



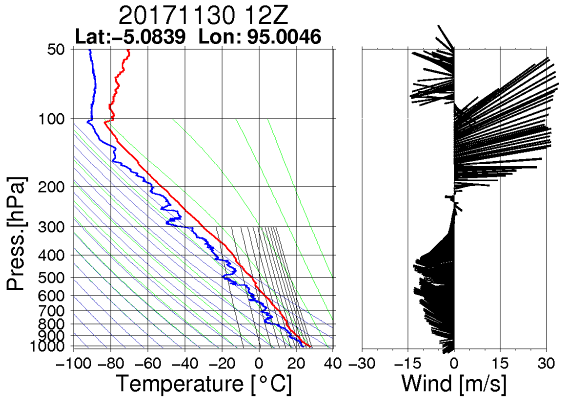
20171130 09Z

Lat:−4.9372 Lon: 94.9731



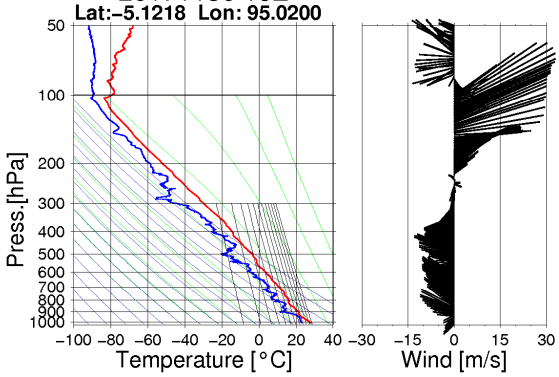
20171130 12Z

Lat:−5.0839 Lon: 95.0046



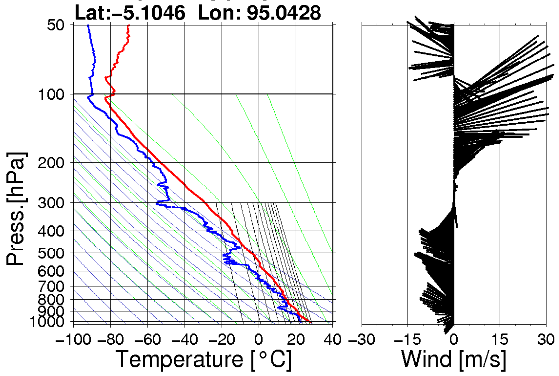
20171130 15Z

Lat:−5.1218 Lon: 95.0200



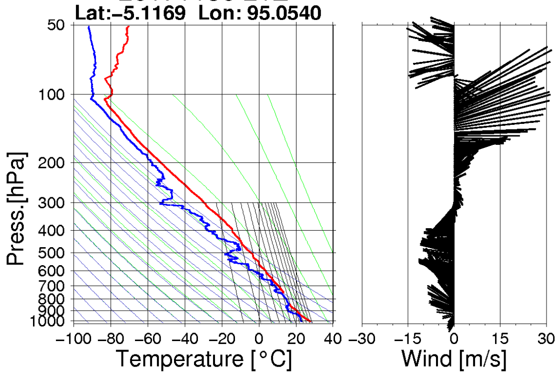
20171130 18Z

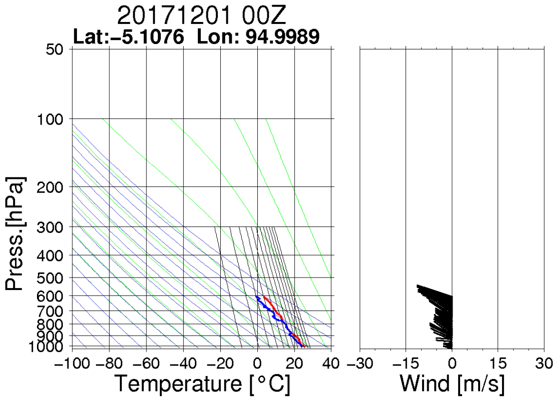
Lat:−5.1046 Lon: 95.0428

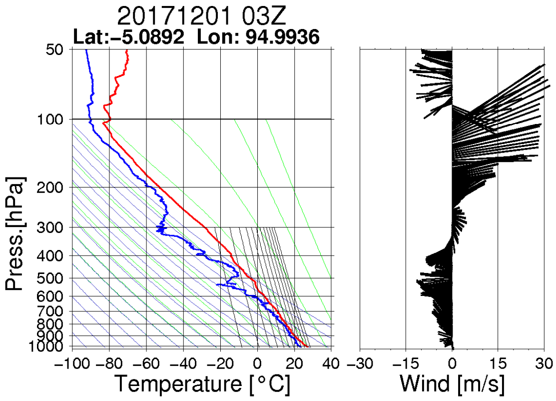


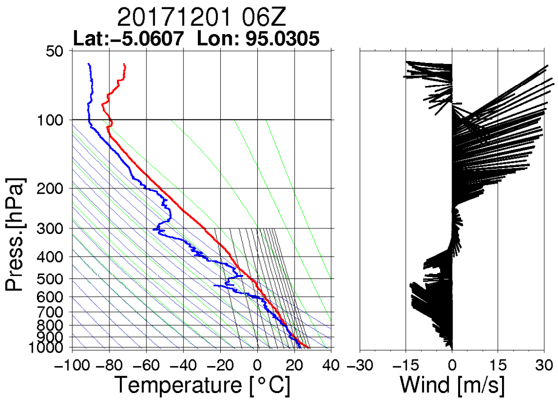
20171130 21Z

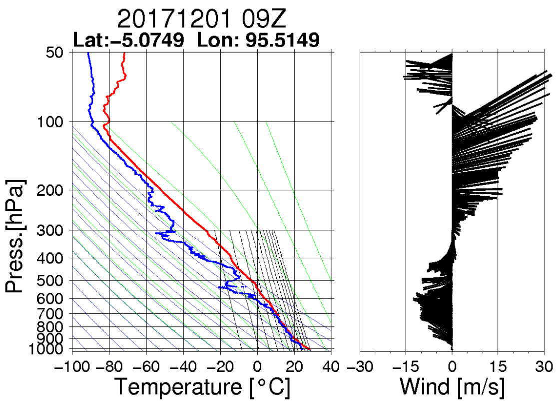
Lat:−5.1169 Lon: 95.0540

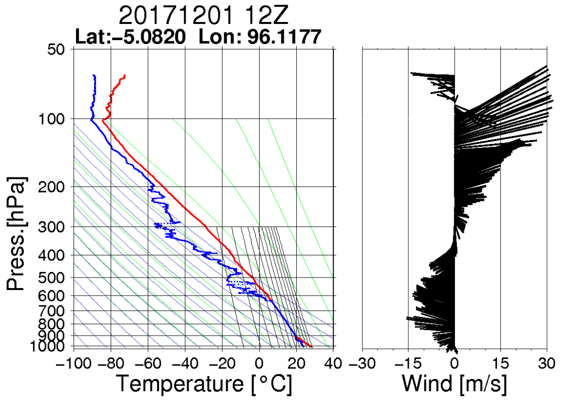


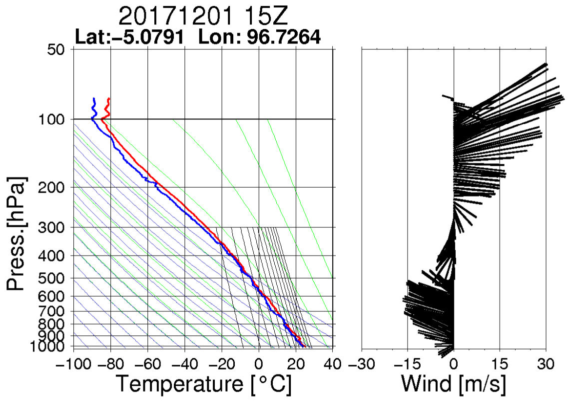

20171201 00Z
Lat:−5.1076 Lon: 94.9989
Press.[hPa]
Temperature [°C]
Wind [m/s]

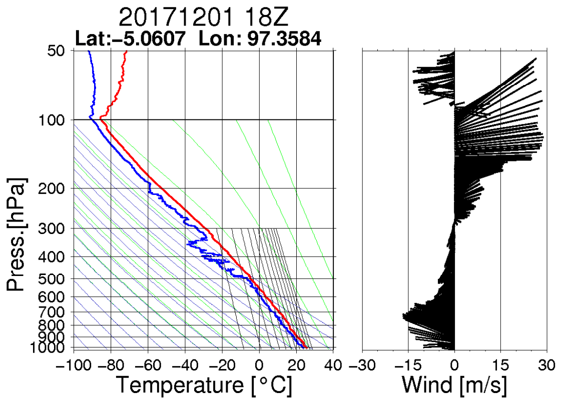

20171201 03Z
Lat:−5.0892 Lon: 94.9936
Press.[hPa]
Temperature [°C]
Wind [m/s]

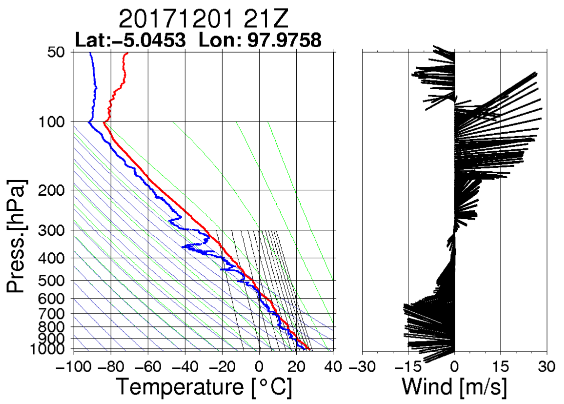

20171201 06Z
Lat:−5.0607 Lon: 95.0305
Press.[hPa]
Temperature [°C]
Wind [m/s]

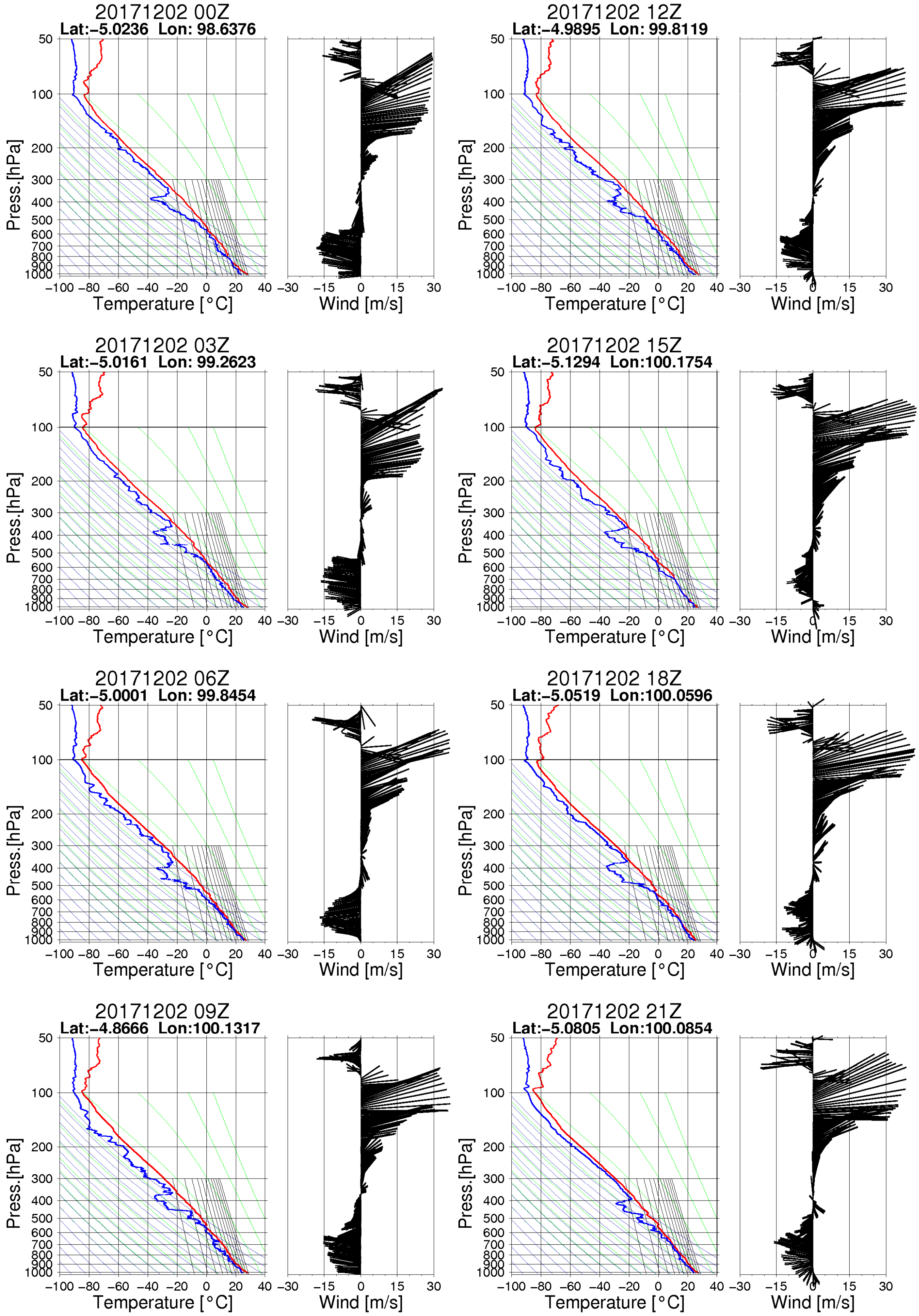

20171201 09Z
Lat:−5.0749 Lon: 95.5149
Press.[hPa]
Temperature [°C]
Wind [m/s]

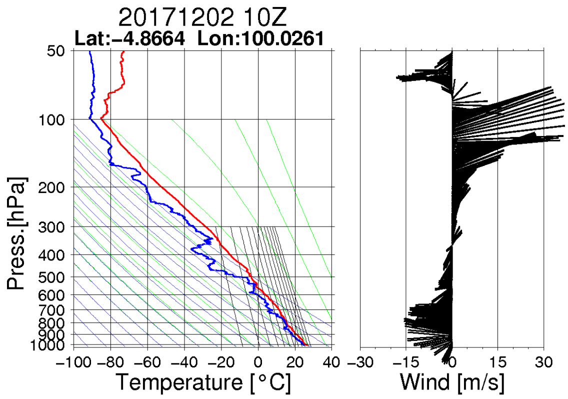

20171201 12Z
Lat:−5.0820 Lon: 96.1177
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171201 15Z
Lat:−5.0791 Lon: 96.7264
Press.[hPa]
Temperature [°C]
Wind [m/s]

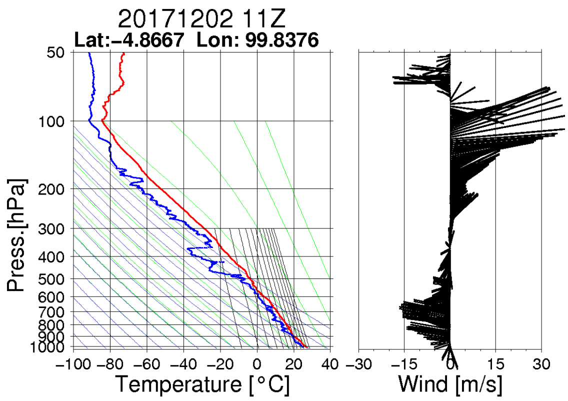

20171201 18Z
Lat:−5.0607 Lon: 97.3584
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171201 21Z
Lat:−5.0453 Lon: 97.9758
Press.[hPa]
Temperature [°C]
Wind [m/s]

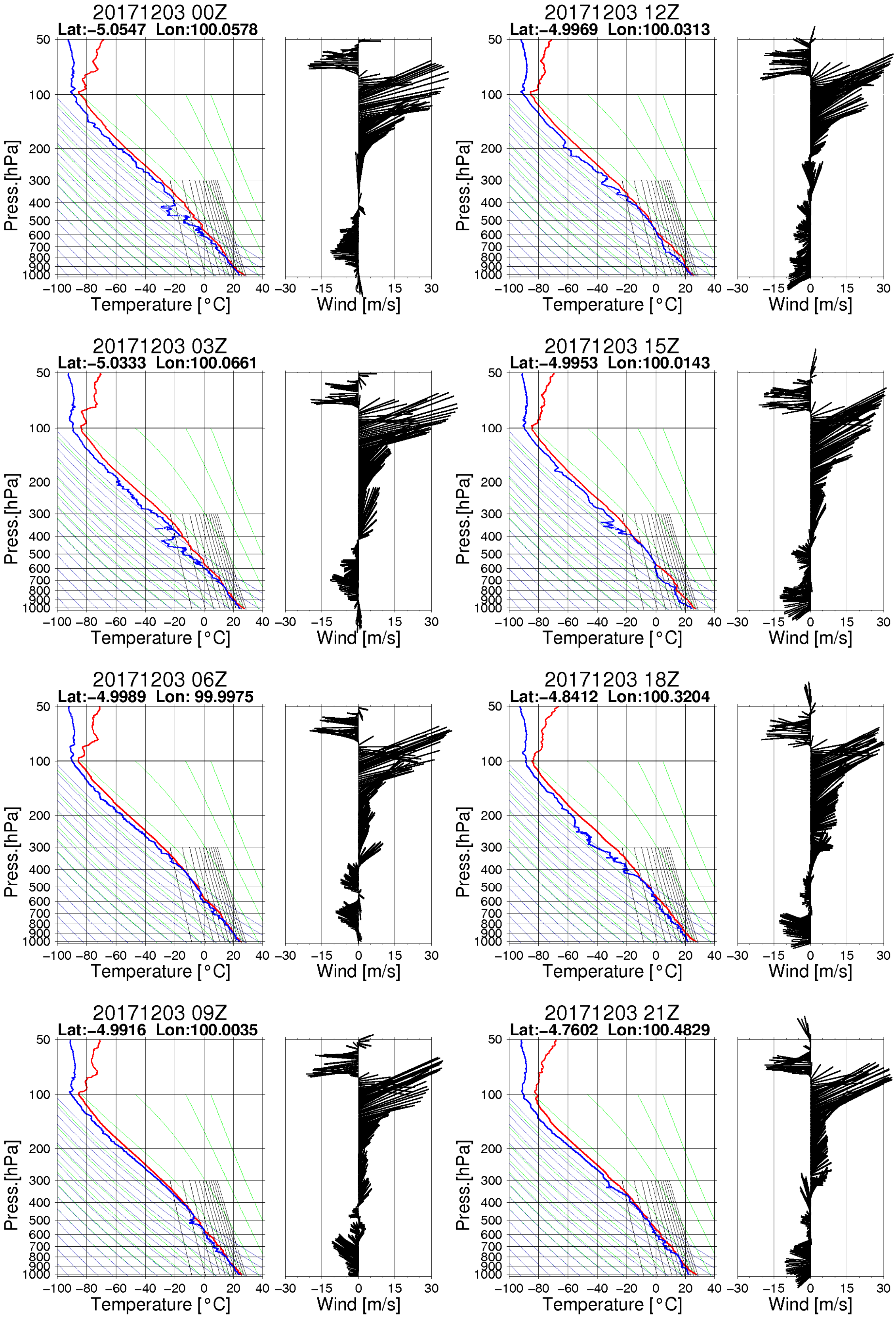

20171202 00Z
Lat:-5.0236 Lon: 98.6376
20171202 12Z
Lat:-4.9895 Lon: 99.8119
20171202 03Z
Lat:-5.0161 Lon: 99.2623
20171202 15Z
Lat:-5.1294 Lon:100.1754
20171202 06Z
Lat:-5.0001 Lon: 99.8454
20171202 18Z
Lat:-5.0519 Lon:100.0596
20171202 09Z
Lat:-4.8666 Lon:100.1317
20171202 21Z
Lat:-5.0805 Lon:100.0854
Press.[hPa]
Temperature [°C]
Wind [m/s]

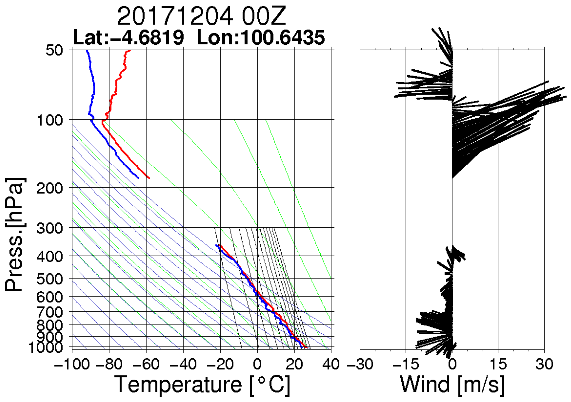


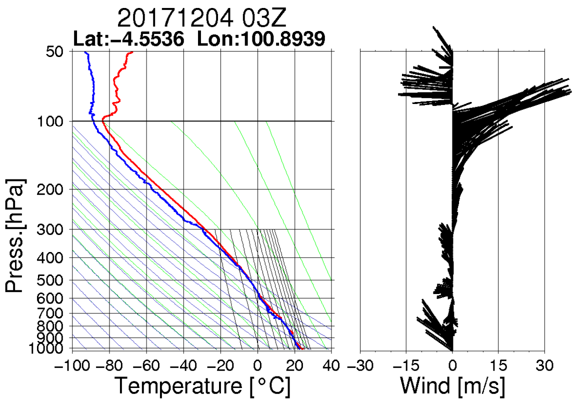
20171202 10Z
Lat:−4.8664 Lon:100.0261
Press.[hPa]
50
100
200
300
400
500
600
700
800
900
1000
−100 −80 −60 −40 −20 0 20 40
Temperature [°C]
−30 −15 0 15 30
Wind [m/s]

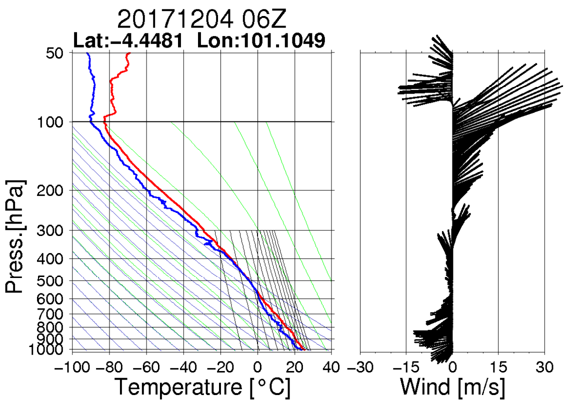


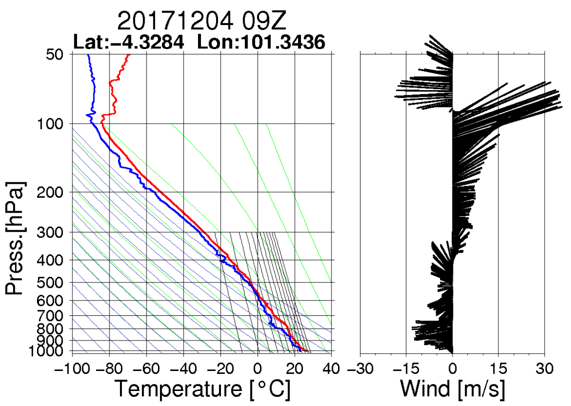
20171202 11Z
Lat:−4.8667 Lon: 99.8376
Press.[hPa]
50
100
200
300
400
500
600
700
800
900
1000
−100 −80 −60 −40 −20 0 20 40
Temperature [°C]
−30 −15 0 15 30
Wind [m/s]

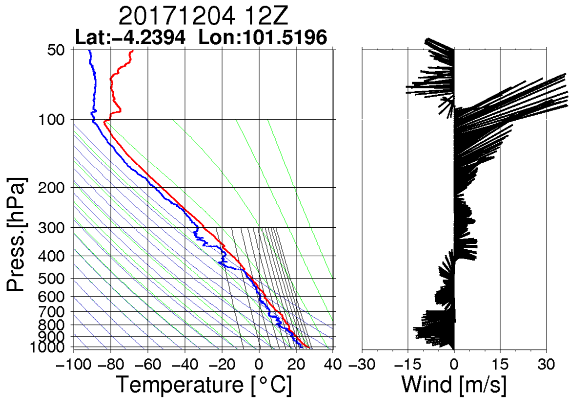

20171203 00Z
Lat:−5.0547 Lon:100.0578
20171203 12Z
Lat:−4.9969 Lon:100.0313
20171203 03Z
Lat:−5.0333 Lon:100.0661
20171203 15Z
Lat:−4.9953 Lon:100.0143
20171203 06Z
Lat:−4.9989 Lon: 99.9975
20171203 18Z
Lat:−4.8412 Lon:100.3204
20171203 09Z
Lat:−4.9916 Lon:100.0035
20171203 21Z
Lat:−4.7602 Lon:100.4829
Press.[hPa]
50
100
200
300
400
500
600
700
800
900
1000
−100 −80 −60 −40 −20 0 20 40
Temperature [°C]
−30 −15 0 15 30
Wind [m/s]

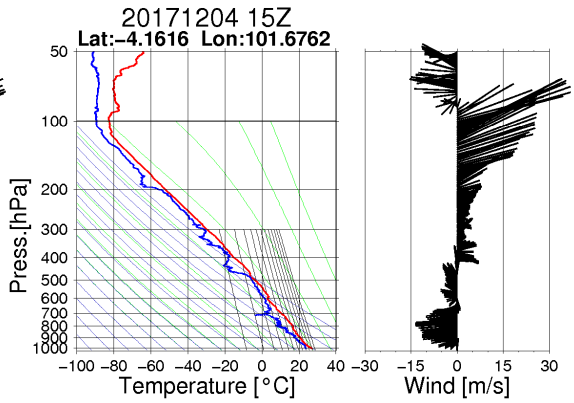

20171204 00Z
Lat:−4.6819 Lon:100.6435
Press.[hPa]
Temperature [°C]
Wind [m/s]

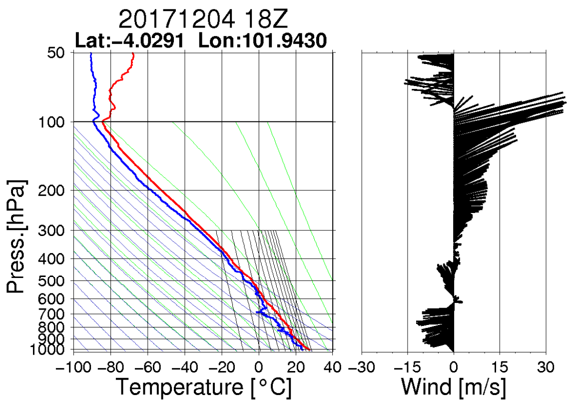

20171204 03Z
Lat:−4.5536 Lon:100.8939
Press.[hPa]
Temperature [°C]
Wind [m/s]

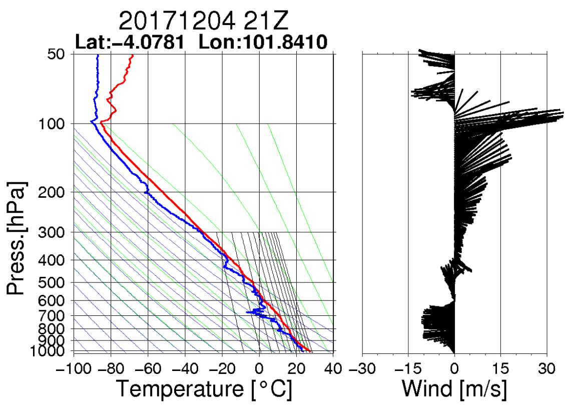

20171204 06Z
Lat:−4.4481 Lon:101.1049
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171204 09Z
Lat:−4.3284 Lon:101.3436
Press.[hPa]
Temperature [°C]
Wind [m/s]

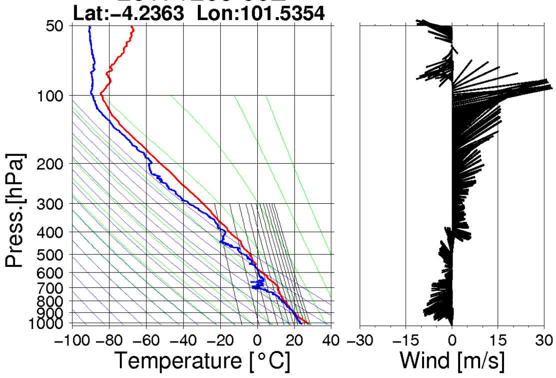

20171204 12Z
Lat:−4.2394 Lon:101.5196
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171204 15Z
Lat:−4.1616 Lon:101.6762
Press.[hPa]
Temperature [°C]
Wind [m/s]

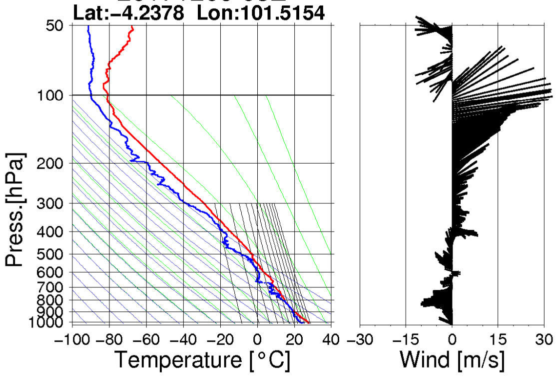

20171204 18Z
Lat:−4.0291 Lon:101.9430
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171204 21Z
Lat:−4.0781 Lon:101.8410
Press.[hPa]
Temperature [°C]
Wind [m/s]

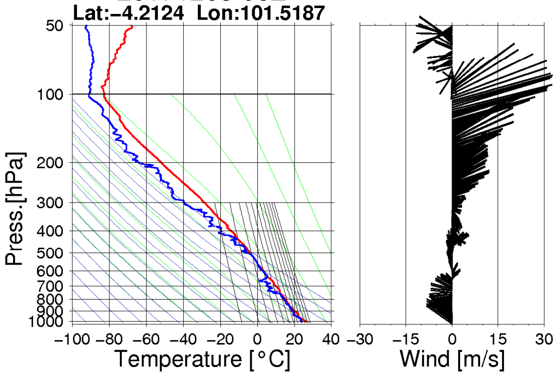
20171205 00Z
Lat:−4.2363 Lon:101.5354



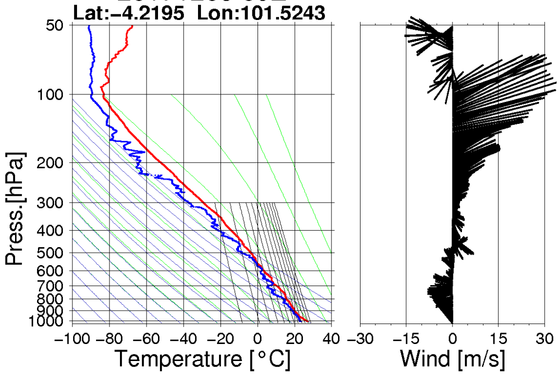
20171205 03Z
Lat:−4.2378 Lon:101.5154



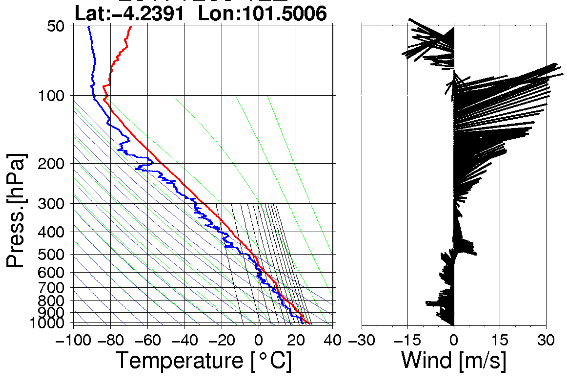
20171205 06Z
Lat:−4.2124 Lon:101.5187



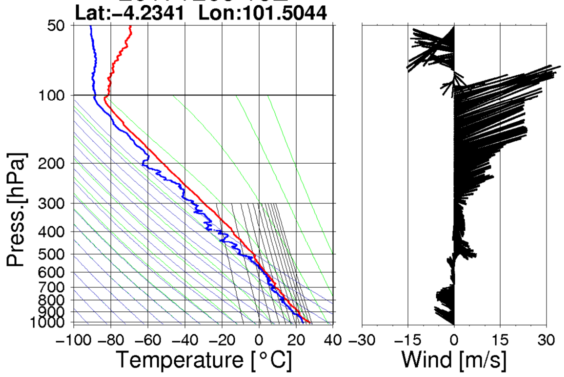
20171205 09Z
Lat:−4.2195 Lon:101.5243



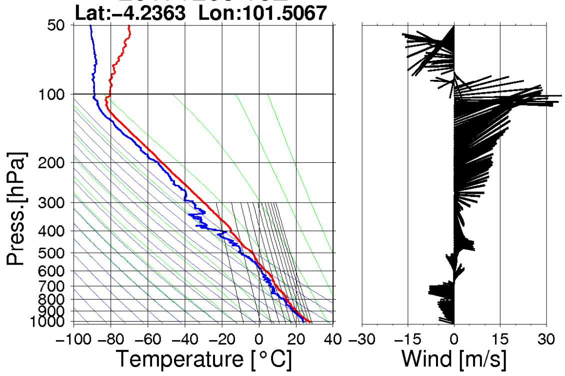
20171205 12Z
Lat:−4.2391 Lon:101.5006



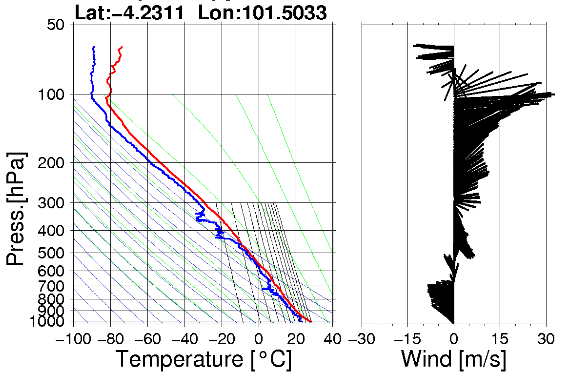
20171205 15Z
Lat:−4.2341 Lon:101.5044

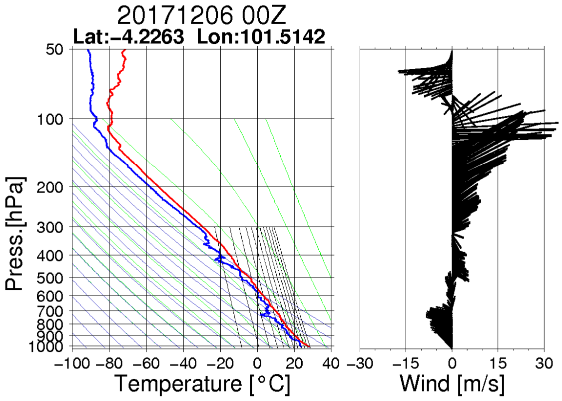


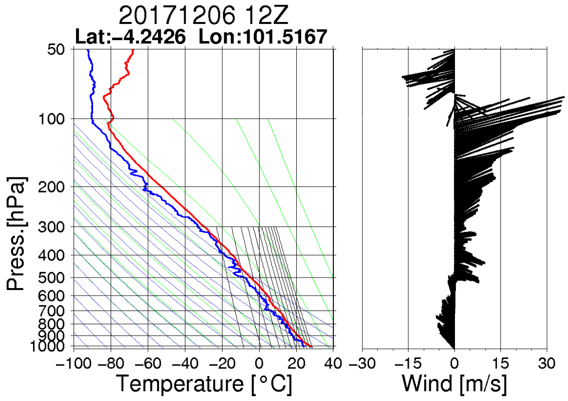
20171205 18Z
Lat:−4.2363 Lon:101.5067

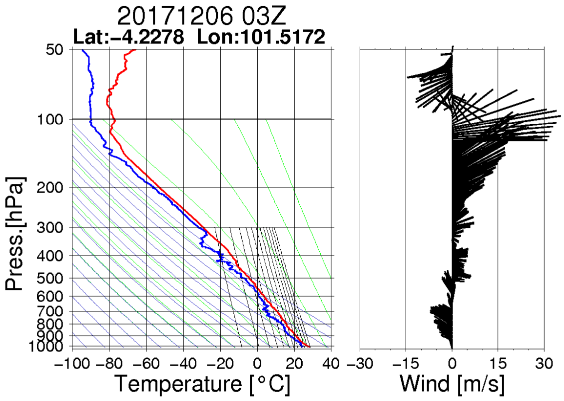


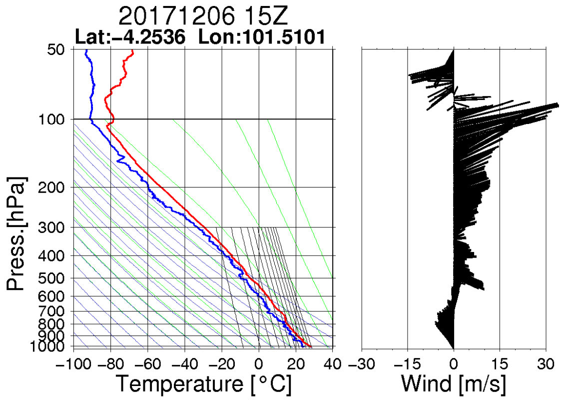
20171205 21Z
Lat:−4.2311 Lon:101.5033

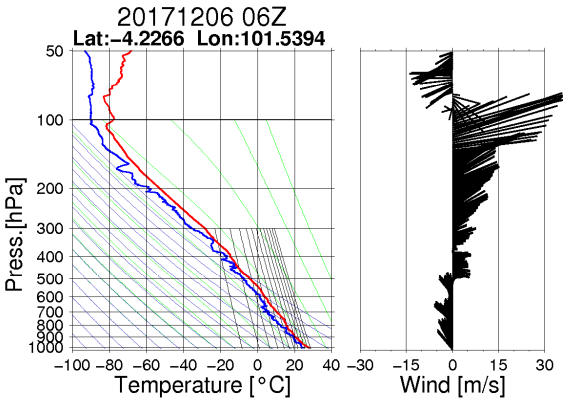


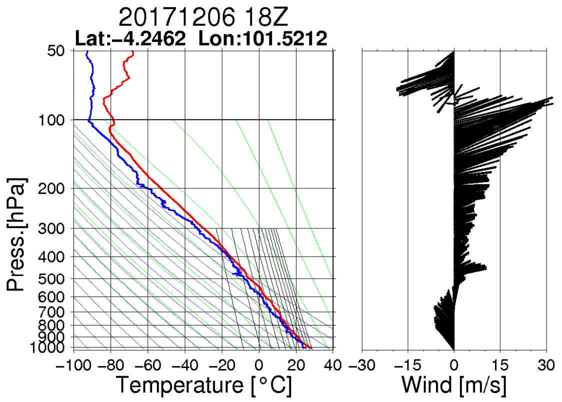

20171206 00Z
Lat:−4.2263 Lon:101.5142
Press.[hPa]
Temperature [°C]
Wind [m/s]

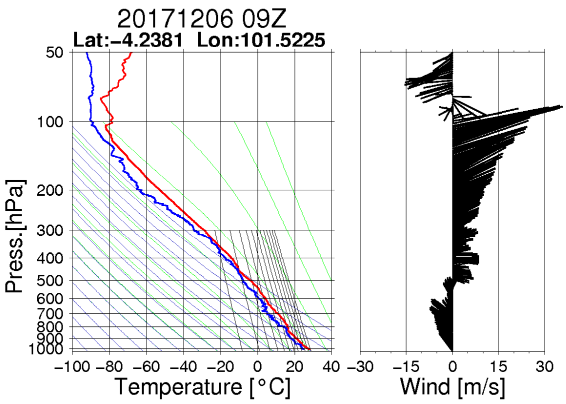

20171206 12Z
Lat:−4.2426 Lon:101.5167
Press.[hPa]
Temperature [°C]
Wind [m/s]

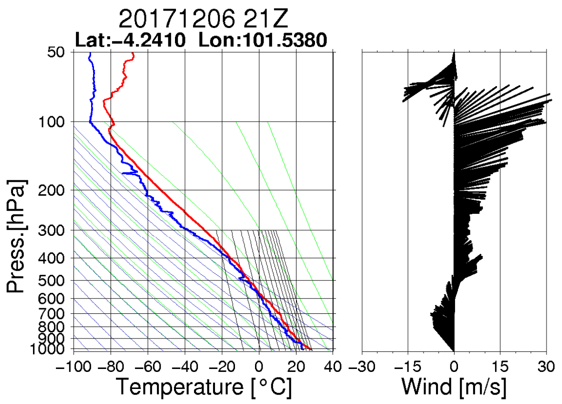

20171206 03Z
Lat:−4.2278 Lon:101.5172
Press.[hPa]
Temperature [°C]
Wind [m/s]

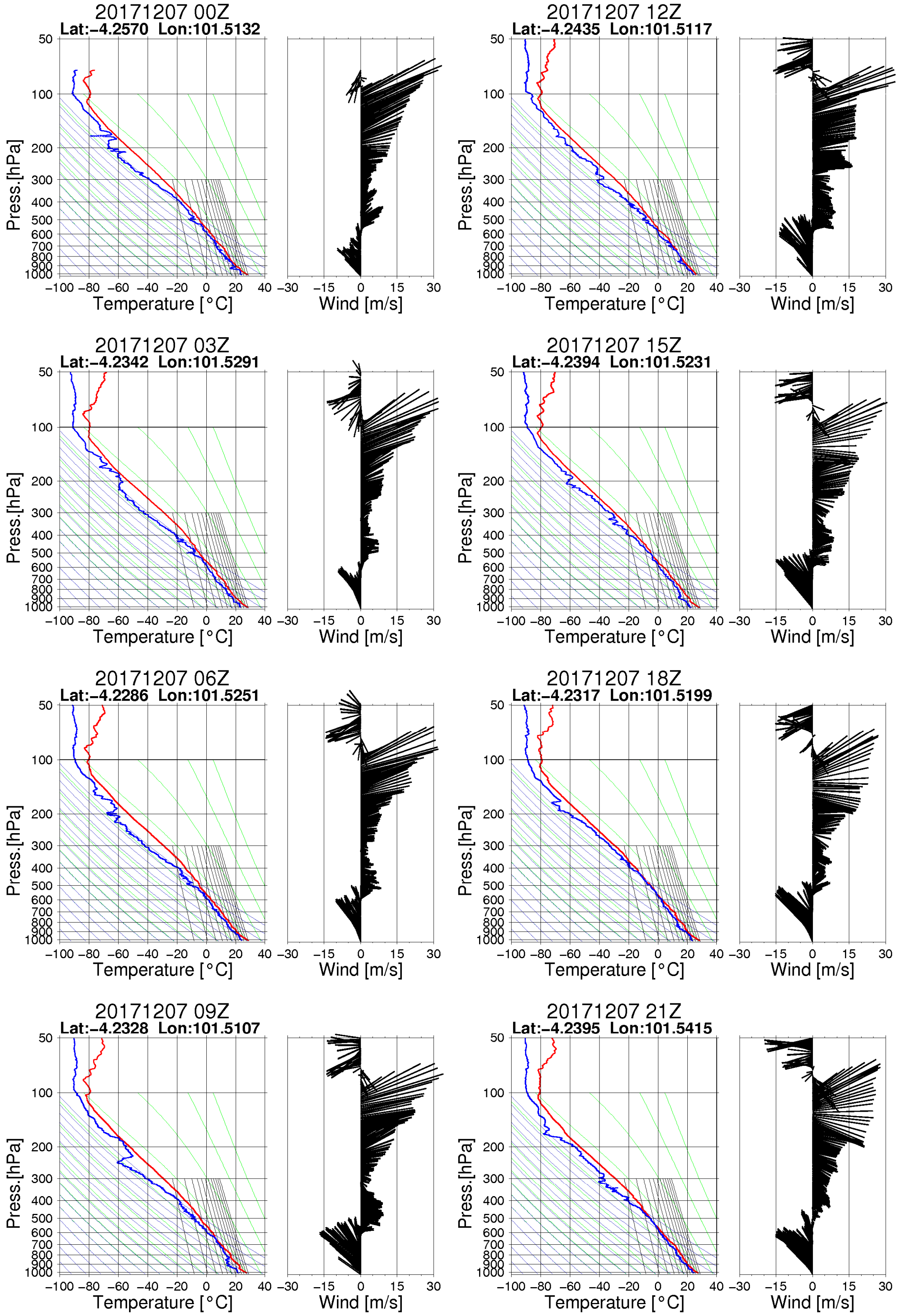

20171206 15Z
Lat:−4.2536 Lon:101.5101
Press.[hPa]
Temperature [°C]
Wind [m/s]

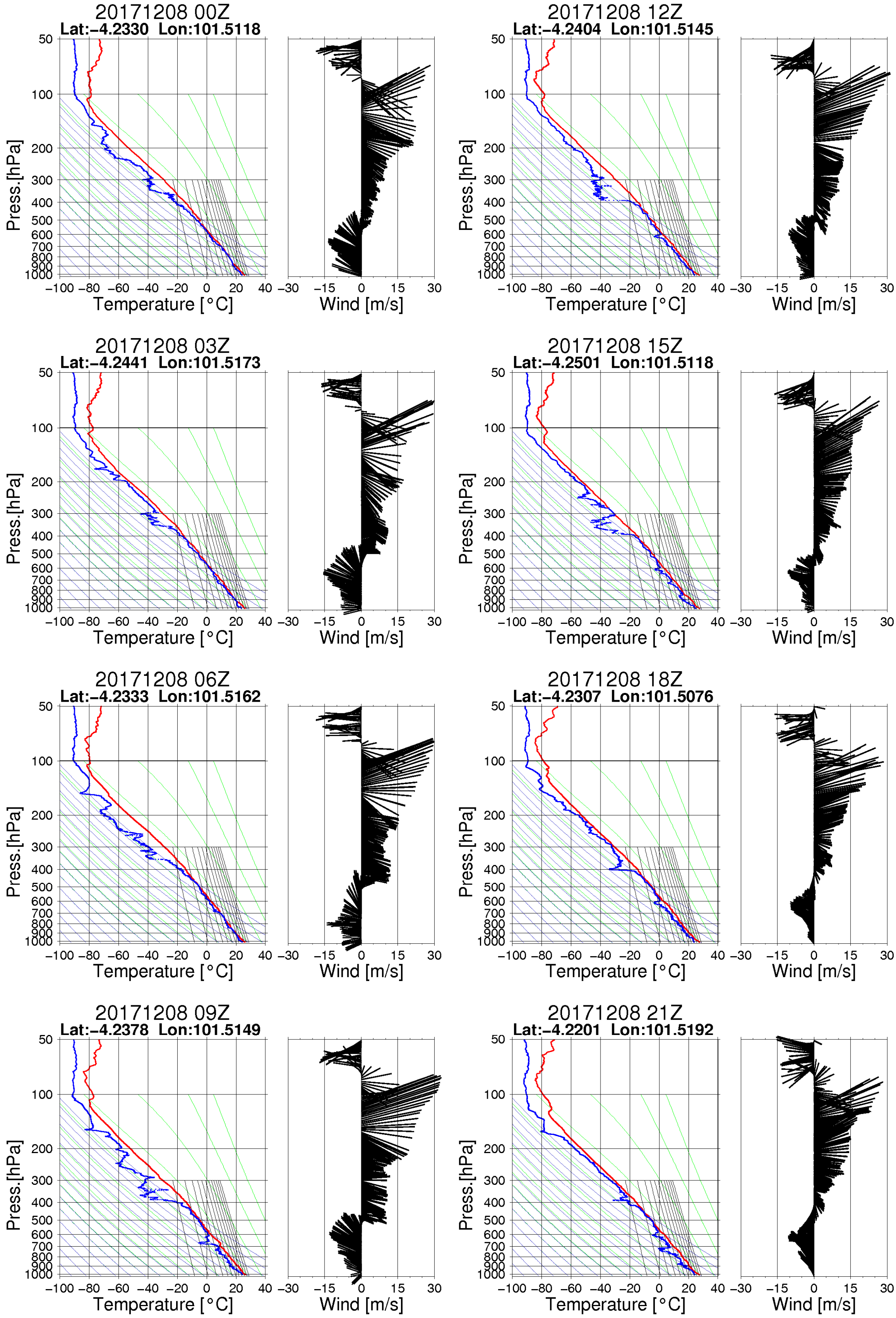

20171206 06Z
Lat:−4.2266 Lon:101.5394
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171206 18Z
Lat:−4.2462 Lon:101.5212
Press.[hPa]
Temperature [°C]
Wind [m/s]

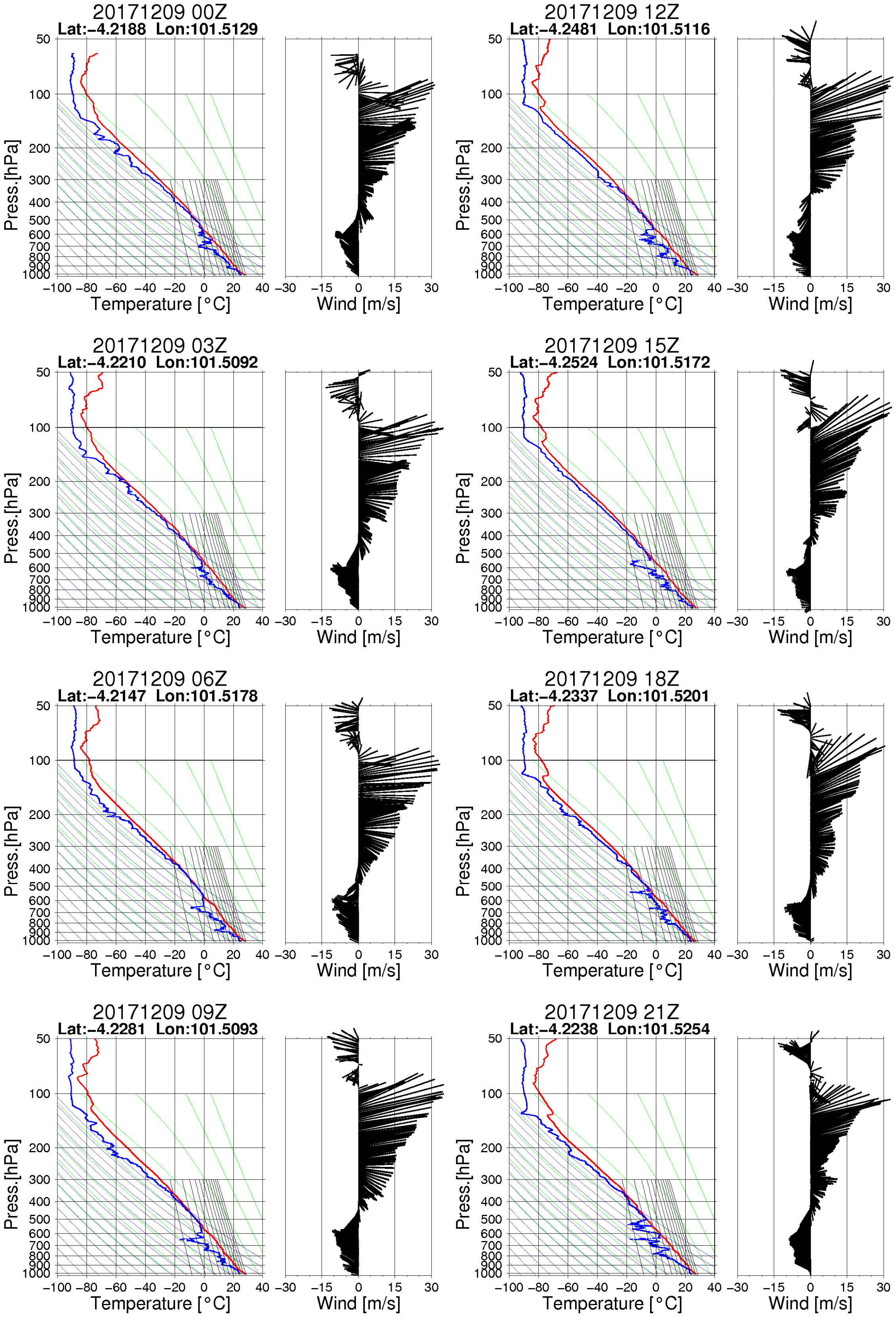

20171206 09Z
Lat:−4.2381 Lon:101.5225
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171206 21Z
Lat:−4.2410 Lon:101.5380
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171207 00Z
Lat:−4.2570 Lon:101.5132
20171207 12Z
Lat:−4.2435 Lon:101.5117
20171207 03Z
Lat:−4.2342 Lon:101.5291
20171207 15Z
Lat:−4.2394 Lon:101.5231
20171207 06Z
Lat:−4.2286 Lon:101.5251
20171207 18Z
Lat:−4.2317 Lon:101.5199
20171207 09Z
Lat:−4.2328 Lon:101.5107
20171207 21Z
Lat:−4.2395 Lon:101.5415
Press.[hPa]
Temperature [°C]
Wind [m/s]

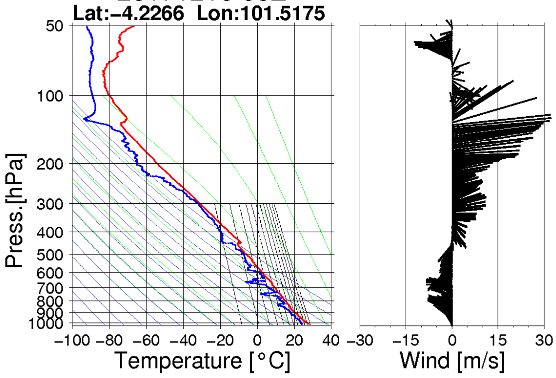


20171208 00Z
Lat:−4.2330 Lon:101.5118
20171208 12Z
Lat:−4.2404 Lon:101.5145
20171208 03Z
Lat:−4.2441 Lon:101.5173
20171208 15Z
Lat:−4.2501 Lon:101.5118
20171208 06Z
Lat:−4.2333 Lon:101.5162
20171208 18Z
Lat:−4.2307 Lon:101.5076
20171208 09Z
Lat:−4.2378 Lon:101.5149
20171208 21Z
Lat:−4.2201 Lon:101.5192
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171209 00Z
Lat:−4.2188 Lon:101.5129
20171209 12Z
Lat:−4.2481 Lon:101.5116
20171209 03Z
Lat:−4.2210 Lon:101.5092
20171209 15Z
Lat:−4.2524 Lon:101.5172
20171209 06Z
Lat:−4.2147 Lon:101.5178
20171209 18Z
Lat:−4.2337 Lon:101.5201
20171209 09Z
Lat:−4.2281 Lon:101.5093
20171209 21Z
Lat:−4.2238 Lon:101.5254
Press.[hPa]
Temperature [°C]
Wind [m/s]

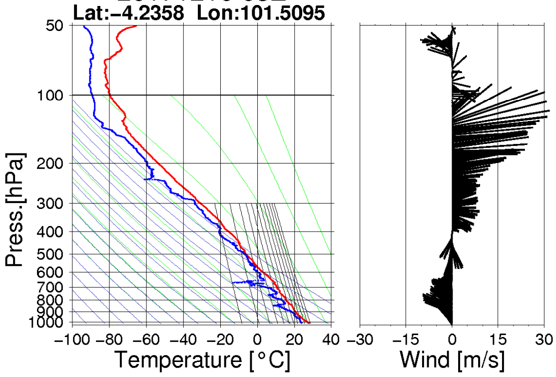
20171210 00Z

Lat:-4.2266 Lon:101.5175



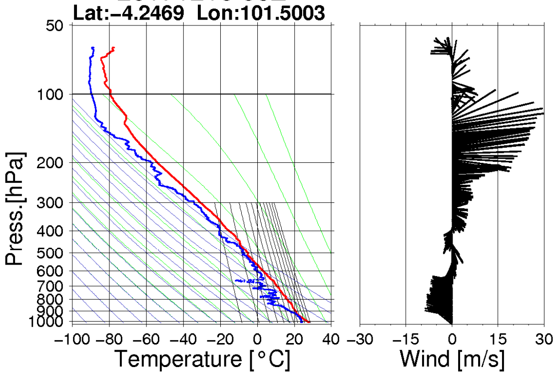
20171210 03Z

Lat:-4.2358 Lon:101.5095



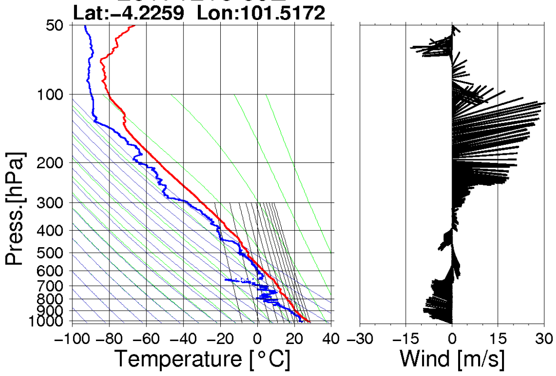
20171210 06Z

Lat:-4.2469 Lon:101.5003



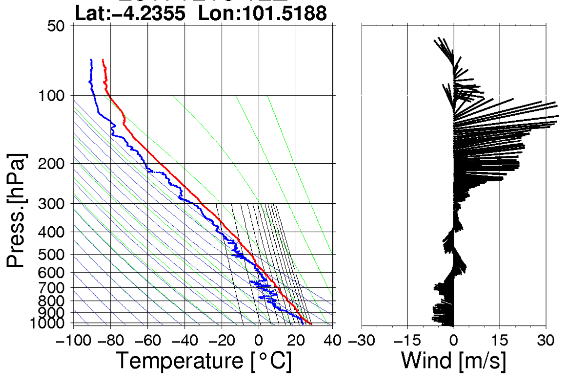
20171210 09Z

Lat:-4.2259 Lon:101.5172



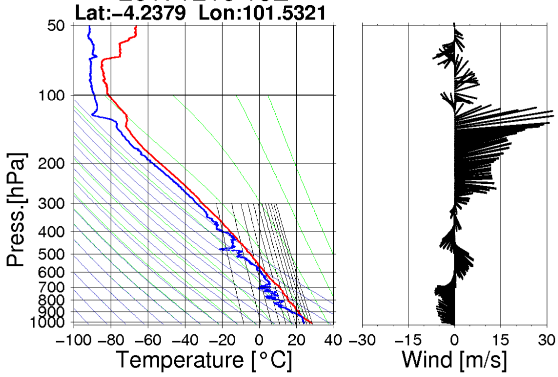
20171210 12Z

Lat:-4.2355 Lon:101.5188



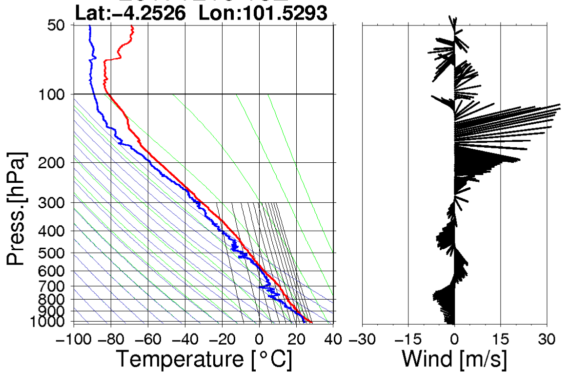
20171210 15Z

Lat:-4.2379 Lon:101.5321



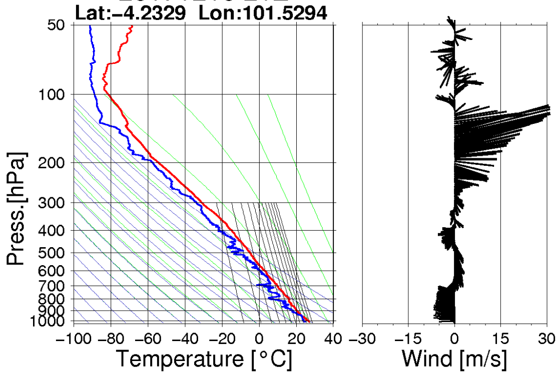
20171210 18Z

Lat:-4.2526 Lon:101.5293

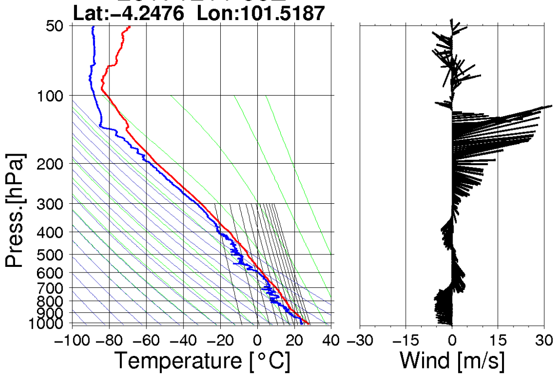


20171210 21Z

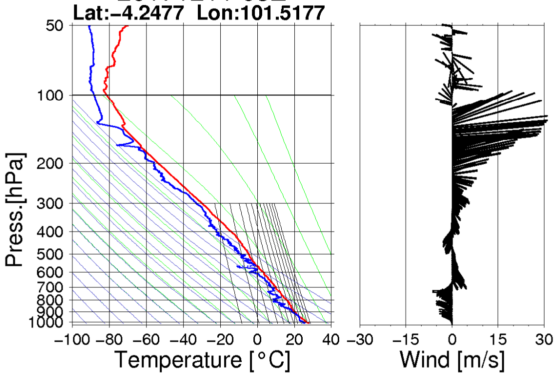
Lat:-4.2329 Lon:101.5294



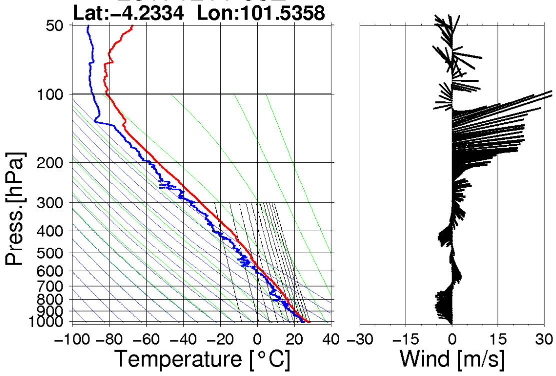
20171211 00Z
Lat:-4.2476 Lon:101.5187



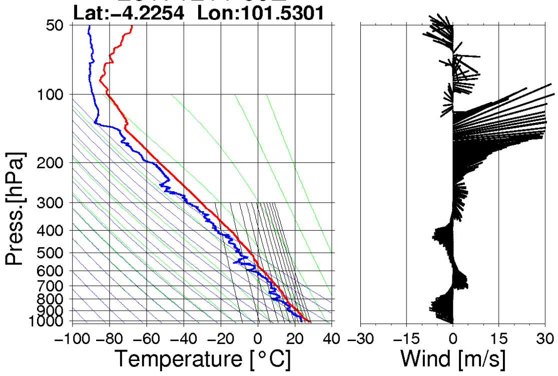
20171211 03Z
Lat:-4.2477 Lon:101.5177



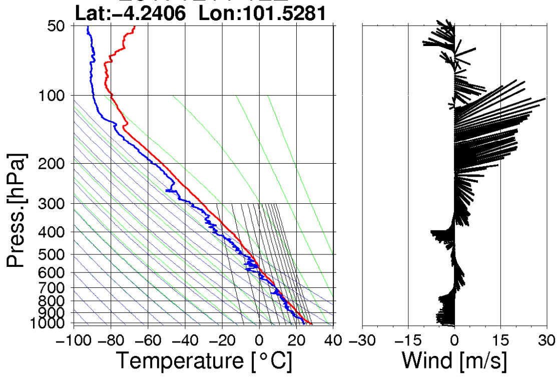
20171211 06Z
Lat:-4.2334 Lon:101.5358



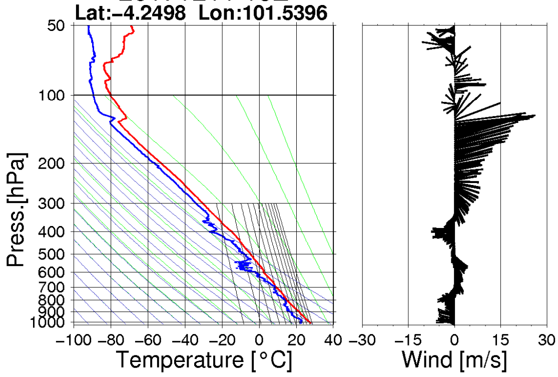
20171211 09Z
Lat:-4.2254 Lon:101.5301



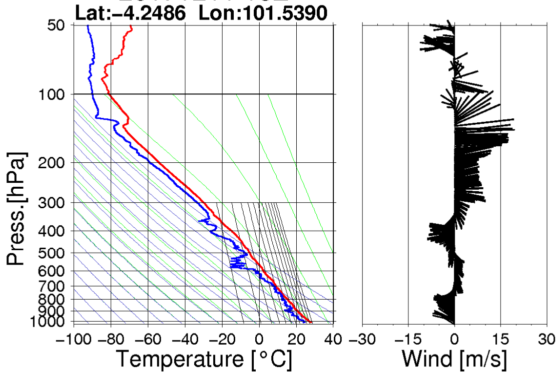
20171211 12Z
Lat:-4.2406 Lon:101.5281



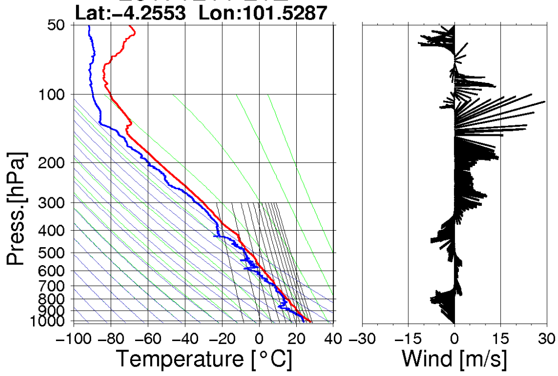
20171211 15Z
Lat:-4.2498 Lon:101.5396



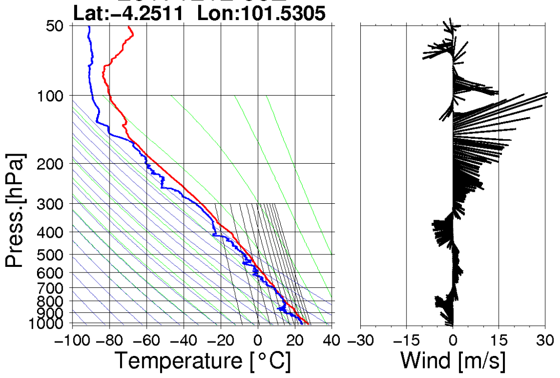
20171211 18Z
Lat:-4.2486 Lon:101.5390



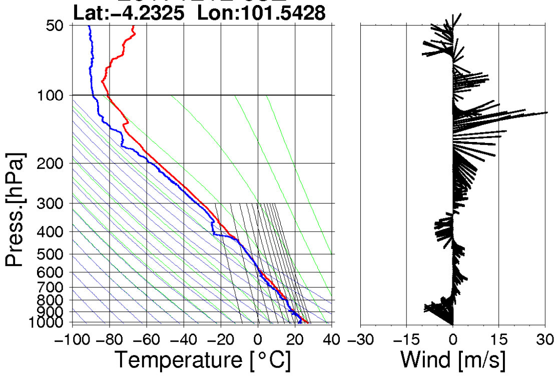
20171211 21Z
Lat:-4.2553 Lon:101.5287



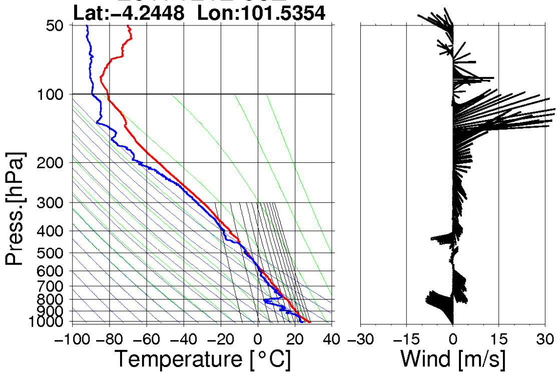
20171212 00Z
Lat:−4.2511 Lon:101.5305



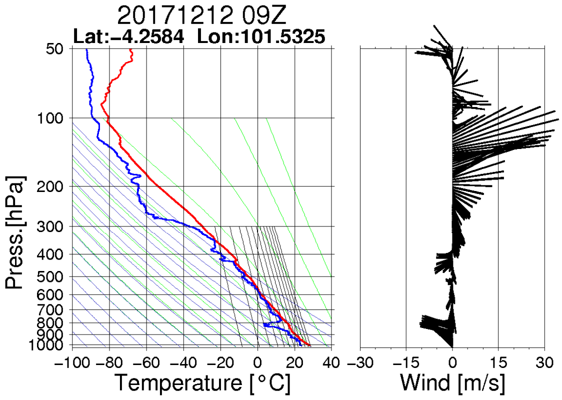
20171212 03Z
Lat:−4.2325 Lon:101.5428



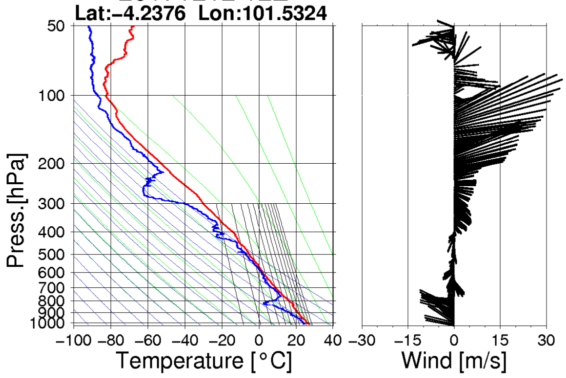
20171212 06Z
Lat:−4.2448 Lon:101.5354



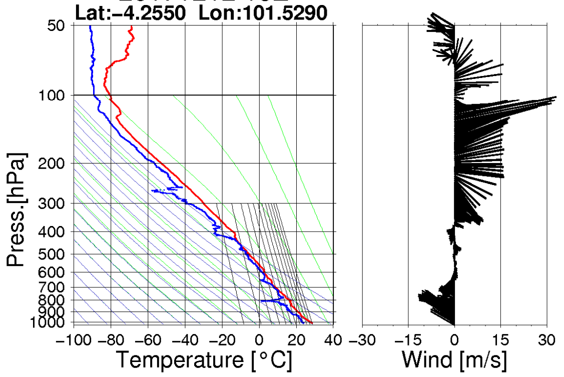
20171212 09Z
Lat:−4.2584 Lon:101.5325



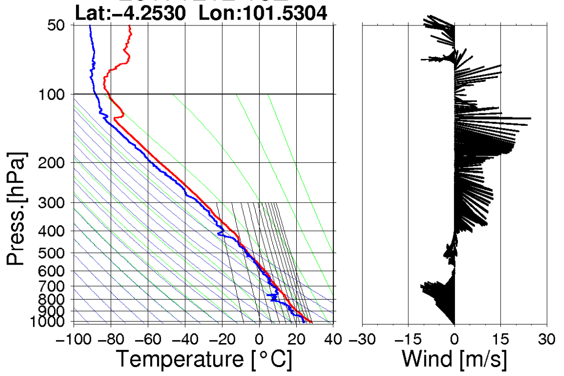
20171212 12Z
Lat:−4.2376 Lon:101.5324



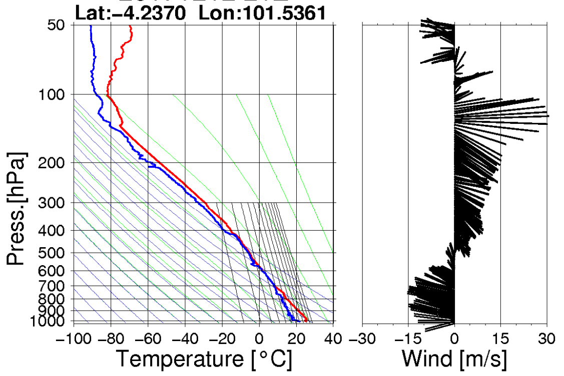
20171212 15Z
Lat:−4.2550 Lon:101.5290



20171212 18Z
Lat:−4.2530 Lon:101.5304

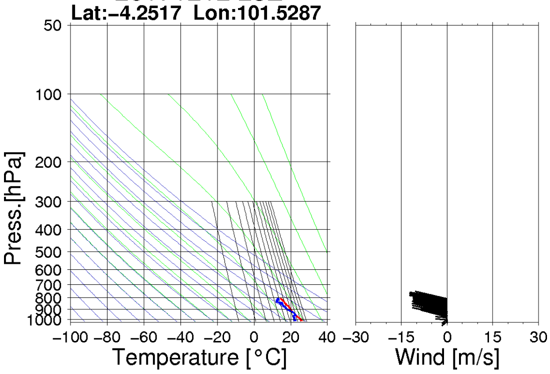


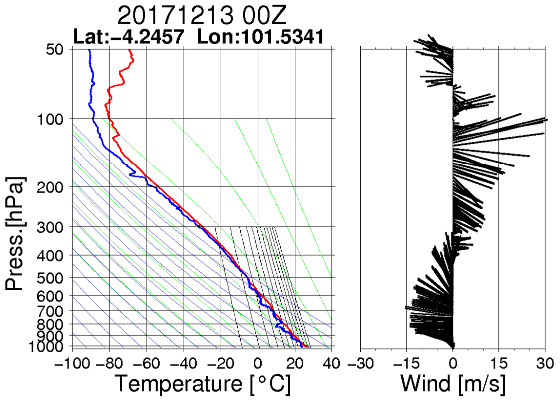
20171212 21Z
Lat:−4.2370 Lon:101.5361

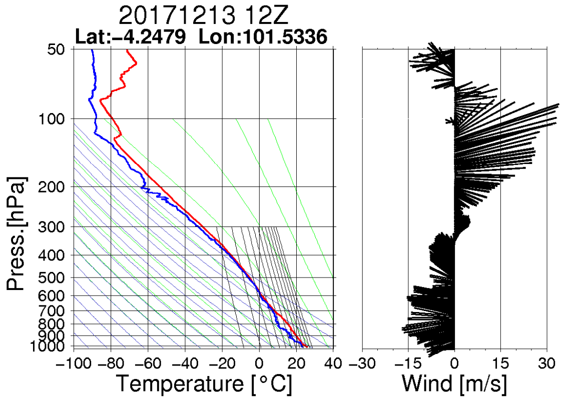


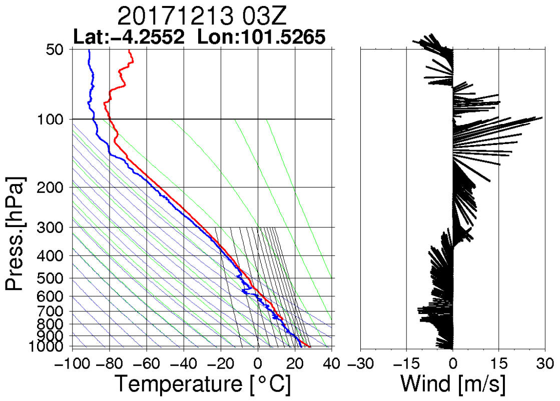
20171212 23Z

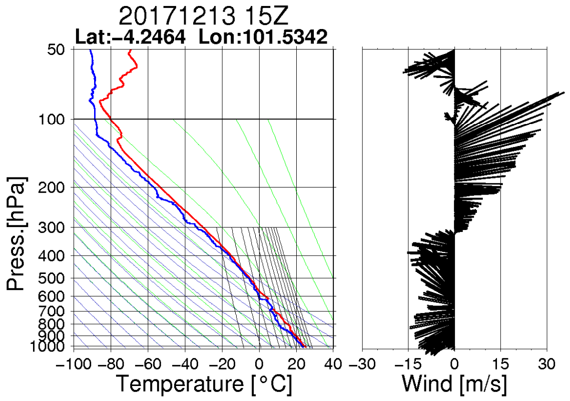
Lat:−4.2517 Lon:101.5287

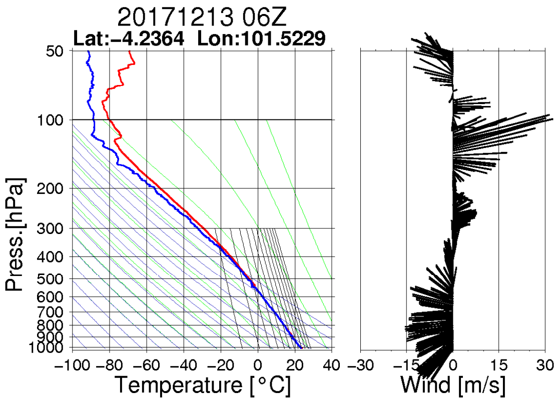


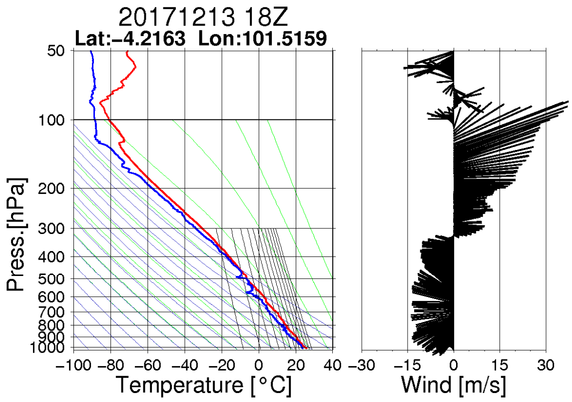

20171213 00Z
Lat:−4.2457 Lon:101.5341
Press.[hPa]
Temperature [°C]
Wind [m/s]

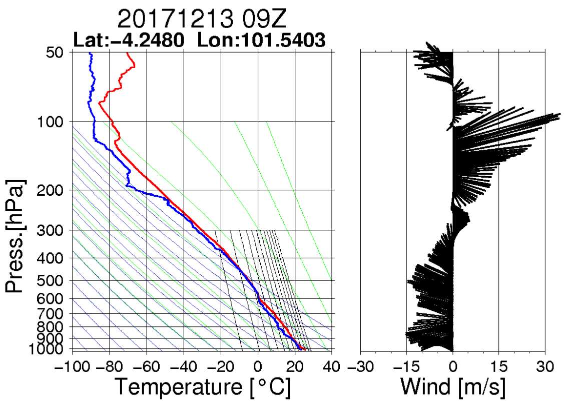

20171213 12Z
Lat:−4.2479 Lon:101.5336
Press.[hPa]
Temperature [°C]
Wind [m/s]

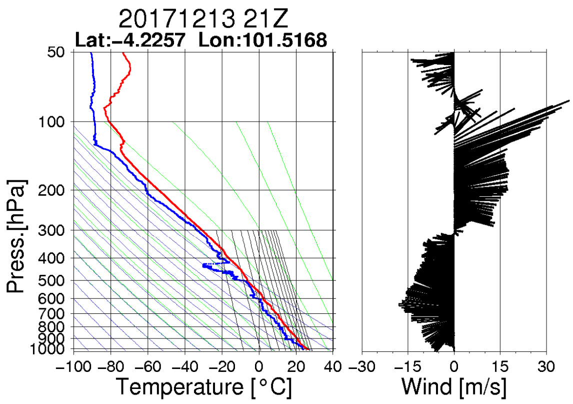

20171213 03Z
Lat:−4.2552 Lon:101.5265
Press.[hPa]
Temperature [°C]
Wind [m/s]

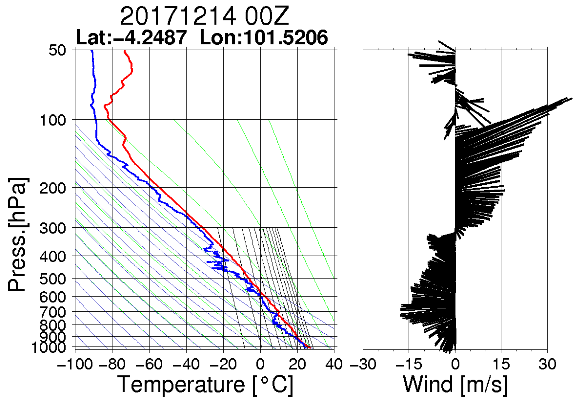

20171213 15Z
Lat:−4.2464 Lon:101.5342
Press.[hPa]
Temperature [°C]
Wind [m/s]

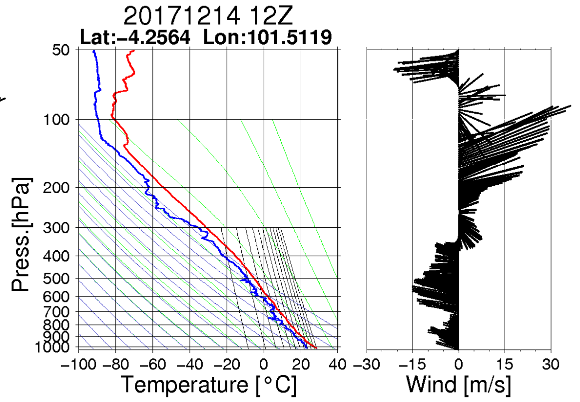

20171213 06Z
Lat:−4.2364 Lon:101.5229
Press.[hPa]
Temperature [°C]
Wind [m/s]

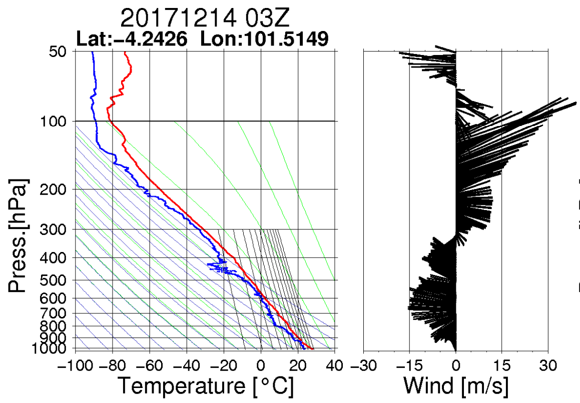

20171213 18Z
Lat:−4.2163 Lon:101.5159
Press.[hPa]
Temperature [°C]
Wind [m/s]

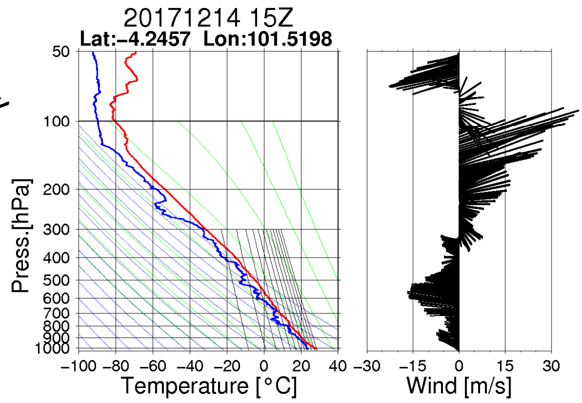

20171213 09Z
Lat:−4.2480 Lon:101.5403
Press.[hPa]
Temperature [°C]
Wind [m/s]

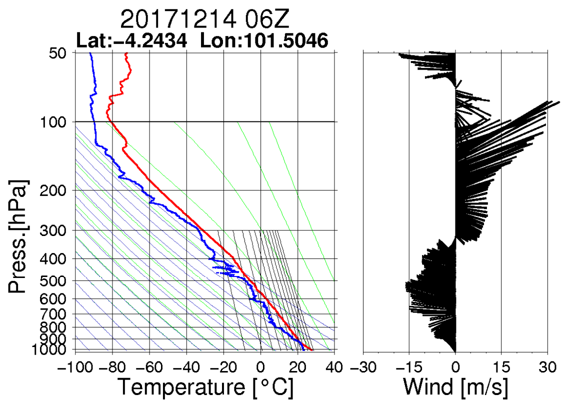

20171213 21Z
Lat:−4.2257 Lon:101.5168
Press.[hPa]
Temperature [°C]
Wind [m/s]

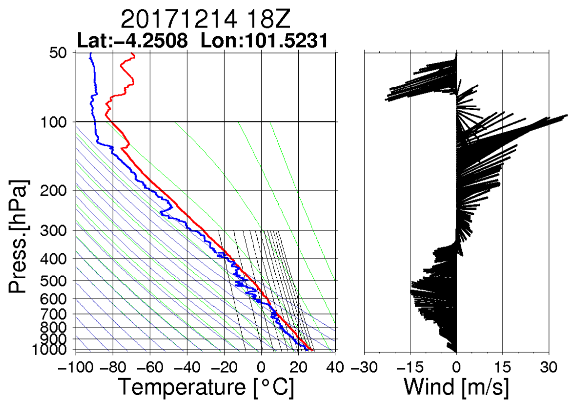

20171214 00Z
Lat:−4.2487 Lon:101.5206
Press.[hPa]
Temperature [°C]
Wind [m/s]

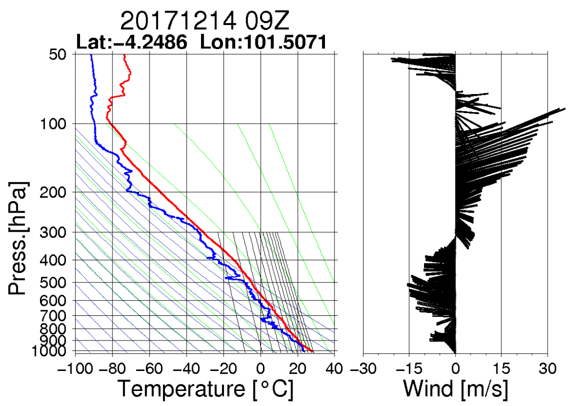

20171214 12Z
Lat:−4.2564 Lon:101.5119
Press.[hPa]
Temperature [°C]
Wind [m/s]

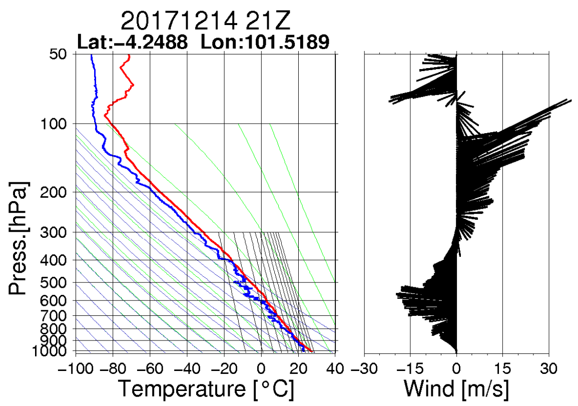

20171214 03Z
Lat:−4.2426 Lon:101.5149
Press.[hPa]
Temperature [°C]
Wind [m/s]

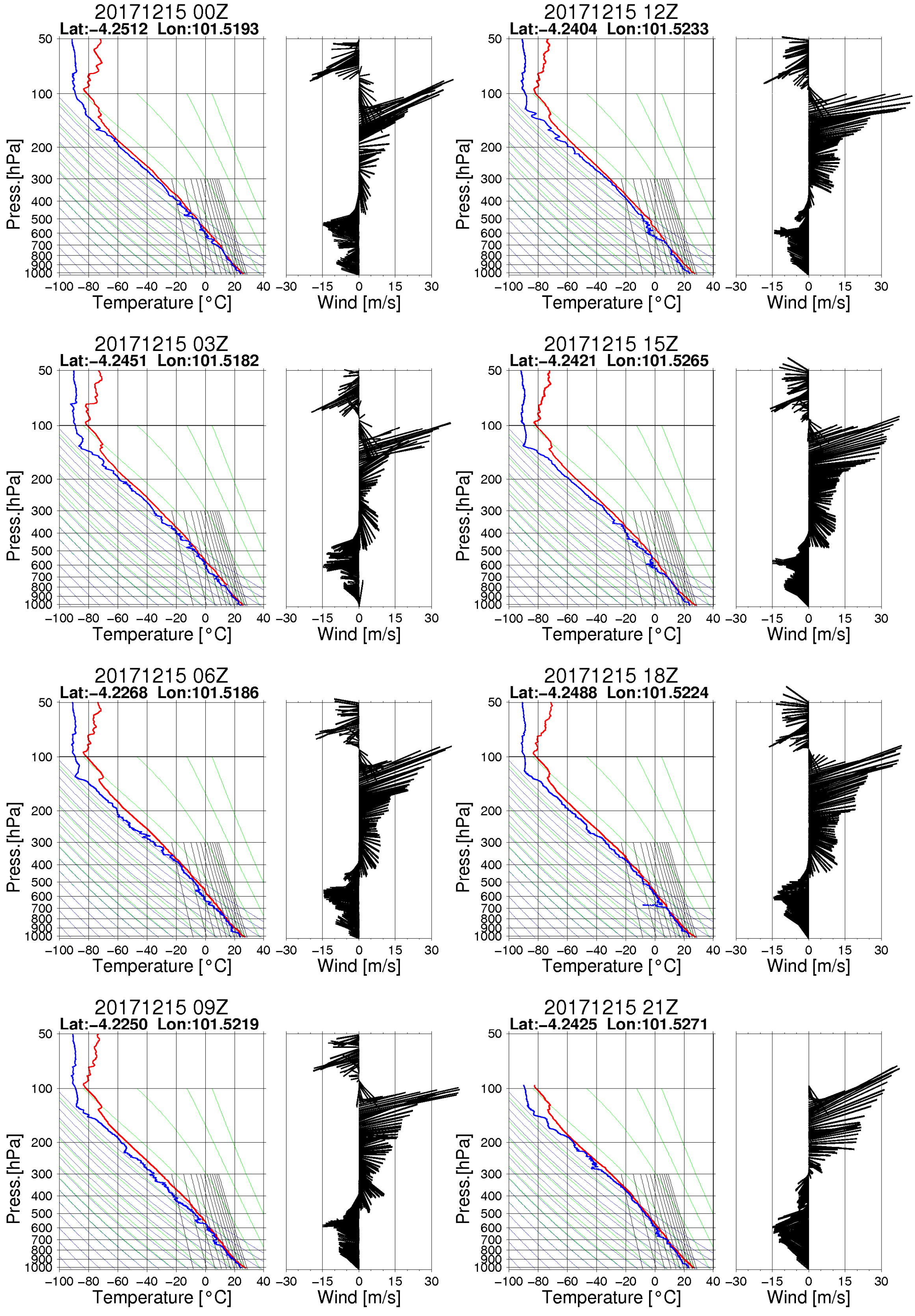

20171214 15Z
Lat:−4.2457 Lon:101.5198
Press.[hPa]
Temperature [°C]
Wind [m/s]

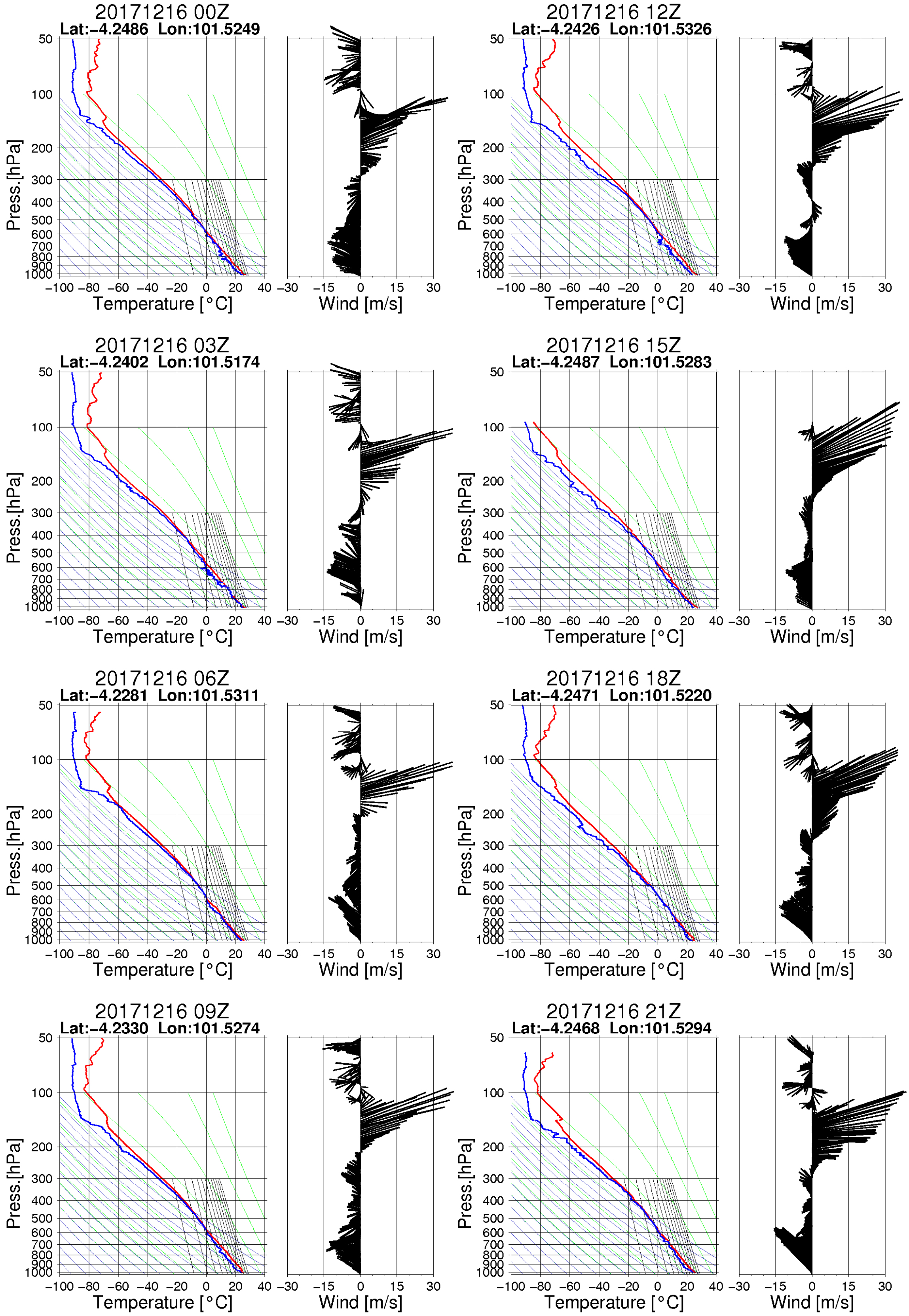

20171214 06Z
Lat:−4.2434 Lon:101.5046
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171214 18Z
Lat:−4.2508 Lon:101.5231
Press.[hPa]
Temperature [°C]
Wind [m/s]

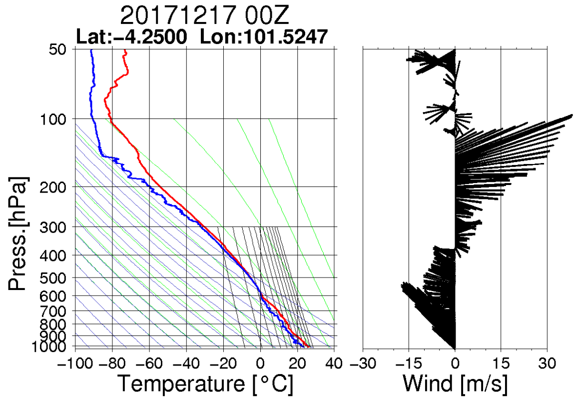

20171214 09Z
Lat:−4.2486 Lon:101.5071
Press.[hPa]
Temperature [°C]
Wind [m/s]

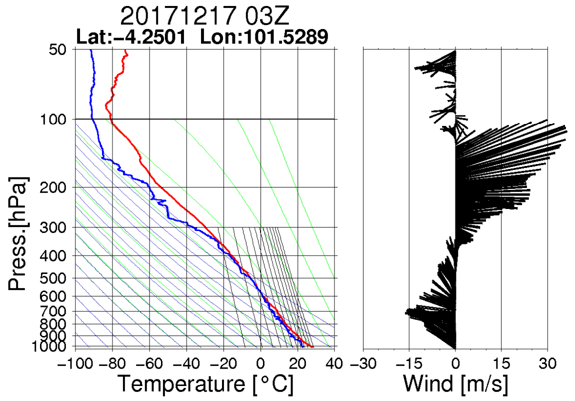

20171214 21Z
Lat:−4.2488 Lon:101.5189
Press.[hPa]
Temperature [°C]
Wind [m/s]

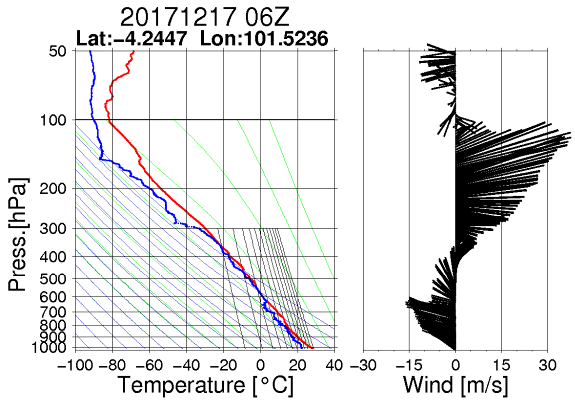

20171215 00Z
Lat:−4.2512 Lon:101.5193
20171215 12Z
Lat:−4.2404 Lon:101.5233
20171215 03Z
Lat:−4.2451 Lon:101.5182
20171215 15Z
Lat:−4.2421 Lon:101.5265
20171215 06Z
Lat:−4.2268 Lon:101.5186
20171215 18Z
Lat:−4.2488 Lon:101.5224
20171215 09Z
Lat:−4.2250 Lon:101.5219
20171215 21Z
Lat:−4.2425 Lon:101.5271
Press.[hPa]
Temperature [°C]
Wind [m/s]

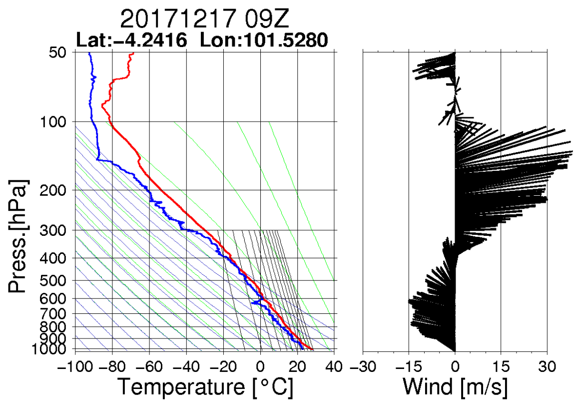


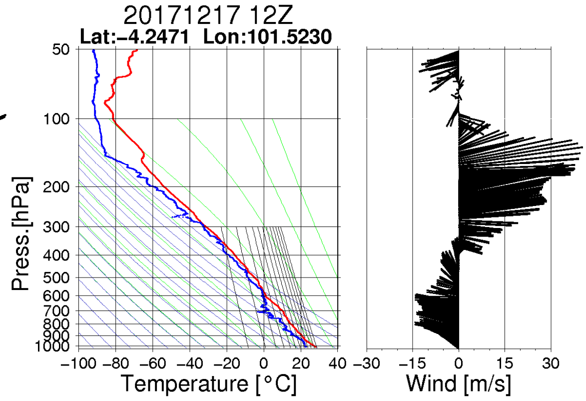
20171216 00Z
Lat:−4.2486 Lon:101.5249
20171216 12Z
Lat:−4.2426 Lon:101.5326
20171216 03Z
Lat:−4.2402 Lon:101.5174
20171216 15Z
Lat:−4.2487 Lon:101.5283
20171216 06Z
Lat:−4.2281 Lon:101.5311
20171216 18Z
Lat:−4.2471 Lon:101.5220
20171216 09Z
Lat:−4.2330 Lon:101.5274
20171216 21Z
Lat:−4.2468 Lon:101.5294
Press.[hPa]
50
100
200
300
400
500
600
700
800
900
1000
−100 −80 −60 −40 −20 0 20 40
Temperature [°C]
−30 −15 0 15 30
Wind [m/s]

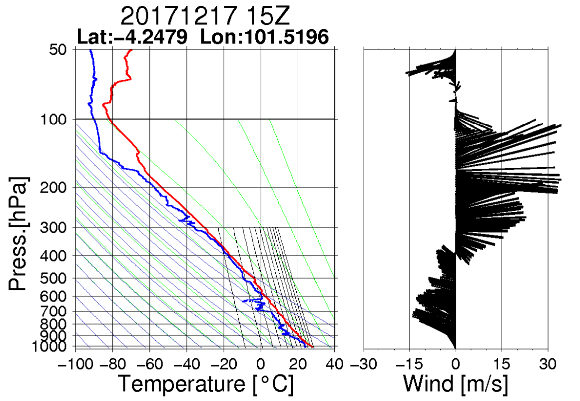

20171217 00Z
Lat:−4.2500 Lon:101.5247
Press.[hPa]
Temperature [°C]
Wind [m/s]

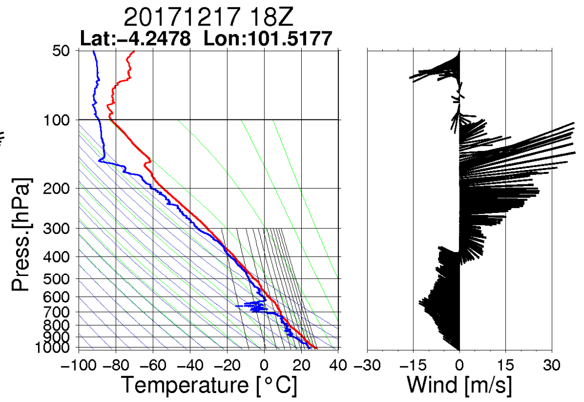

20171217 03Z
Lat:−4.2501 Lon:101.5289
Press.[hPa]
Temperature [°C]
Wind [m/s]

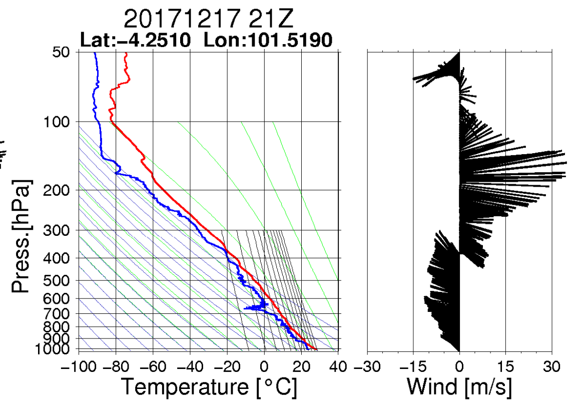

20171217 06Z
Lat:−4.2447 Lon:101.5236
Press.[hPa]
Temperature [°C]
Wind [m/s]

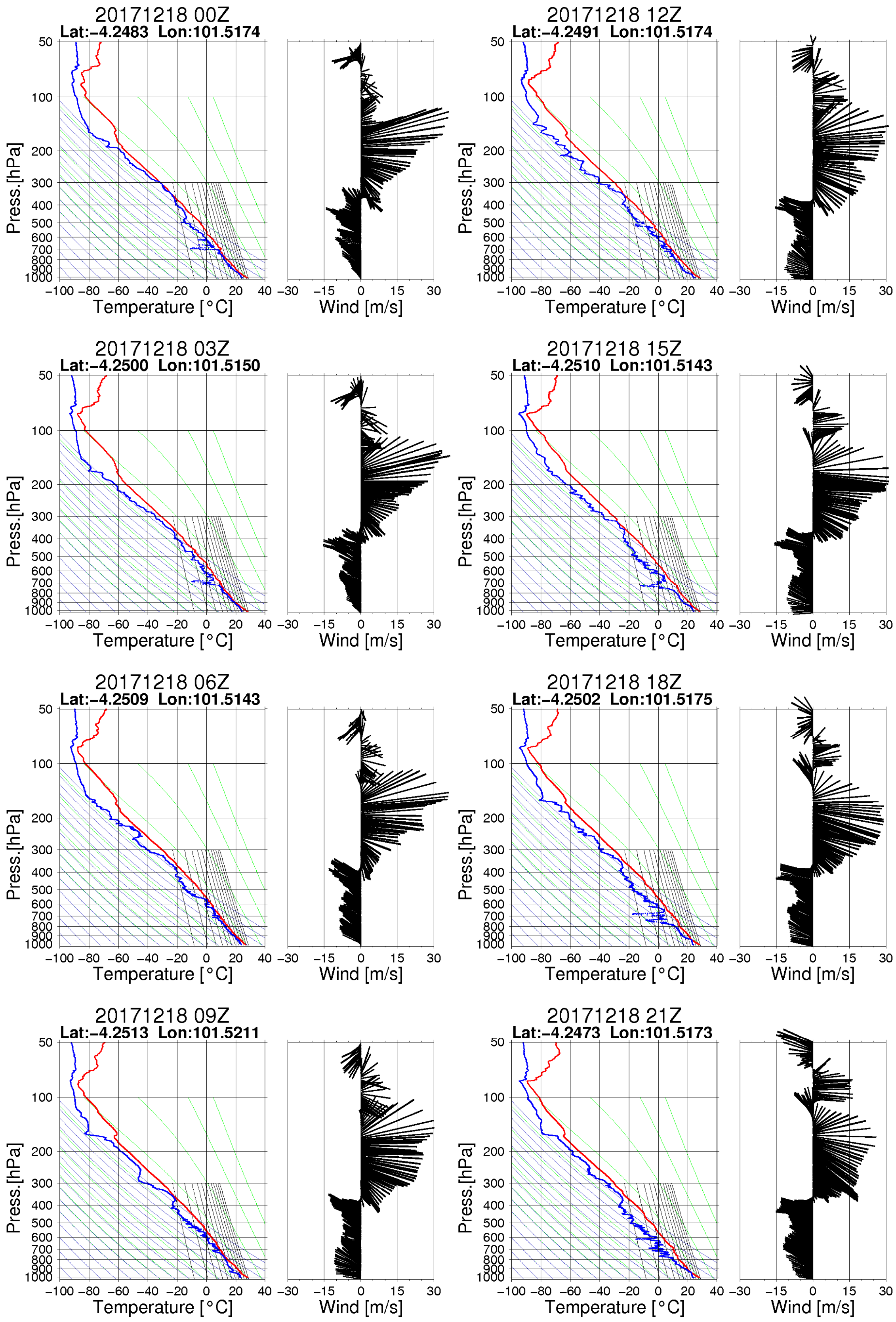

20171217 09Z
Lat:−4.2416 Lon:101.5280
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171217 12Z
Lat:−4.2471 Lon:101.5230
Press.[hPa]
Temperature [°C]
Wind [m/s]

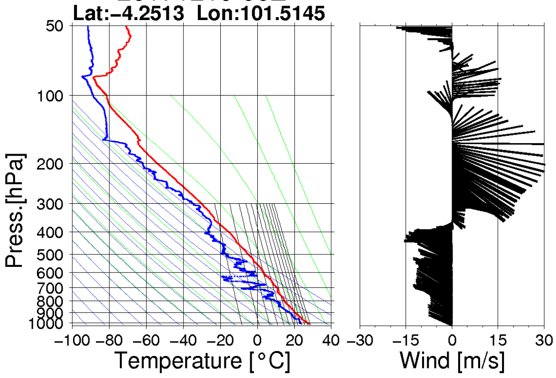

20171217 15Z
Lat:−4.2479 Lon:101.5196
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171217 18Z
Lat:−4.2478 Lon:101.5177
Press.[hPa]
Temperature [°C]
Wind [m/s]

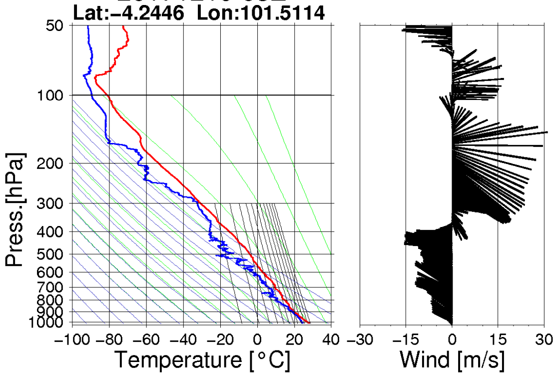

20171217 21Z
Lat:−4.2510 Lon:101.5190
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171218 00Z
Lat:−4.2483 Lon:101.5174
20171218 12Z
Lat:−4.2491 Lon:101.5174
20171218 03Z
Lat:−4.2500 Lon:101.5150
20171218 15Z
Lat:−4.2510 Lon:101.5143
20171218 06Z
Lat:−4.2509 Lon:101.5143
20171218 18Z
Lat:−4.2502 Lon:101.5175
20171218 09Z
Lat:−4.2513 Lon:101.5211
20171218 21Z
Lat:−4.2473 Lon:101.5173
Press.[hPa]
Temperature [°C]
Wind [m/s]

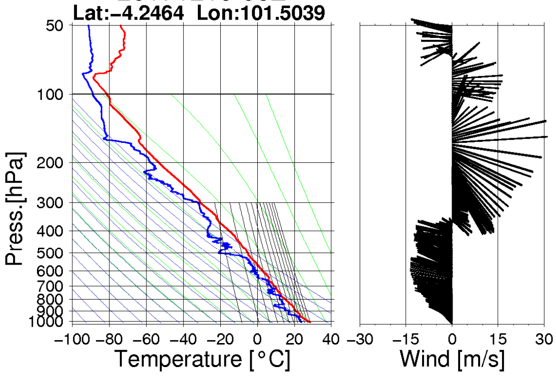
20171219 00Z
Lat:−4.2513 Lon:101.5145



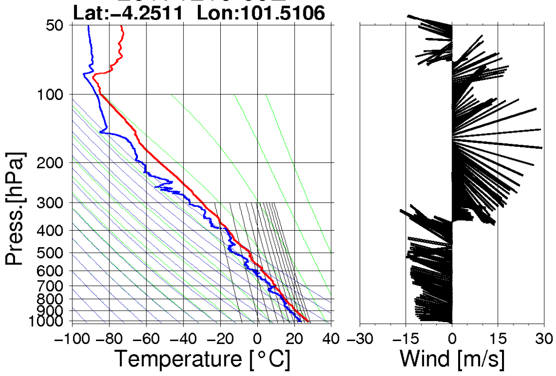
20171219 03Z
Lat:−4.2446 Lon:101.5114



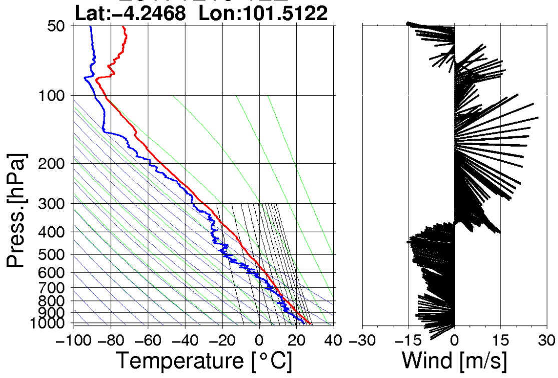
20171219 06Z
Lat:−4.2464 Lon:101.5039



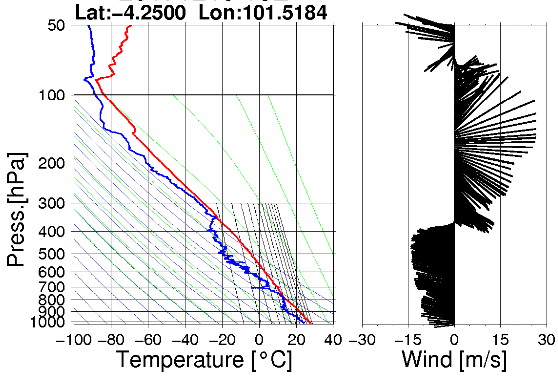
20171219 09Z
Lat:−4.2511 Lon:101.5106



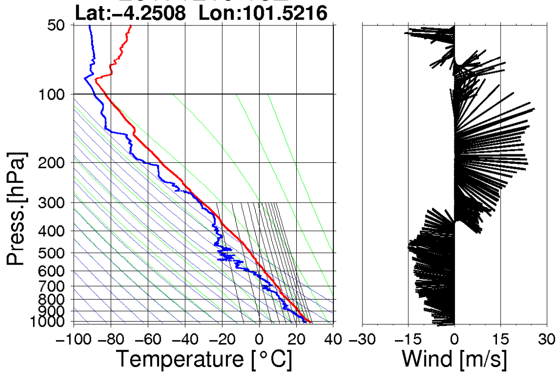
20171219 12Z
Lat:−4.2468 Lon:101.5122



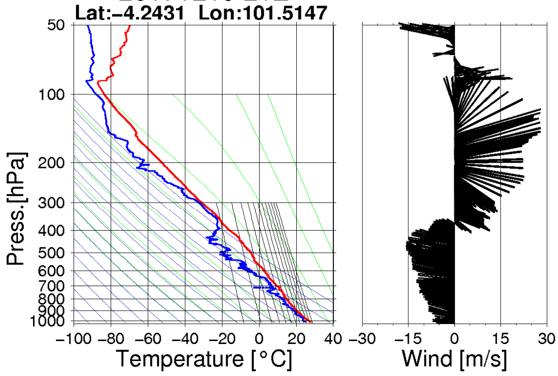
20171219 15Z
Lat:−4.2500 Lon:101.5184



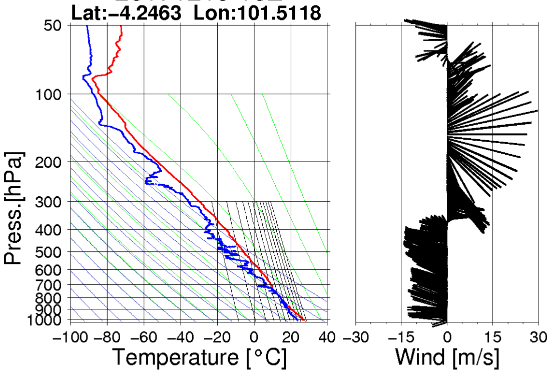
20171219 18Z
Lat:−4.2508 Lon:101.5216



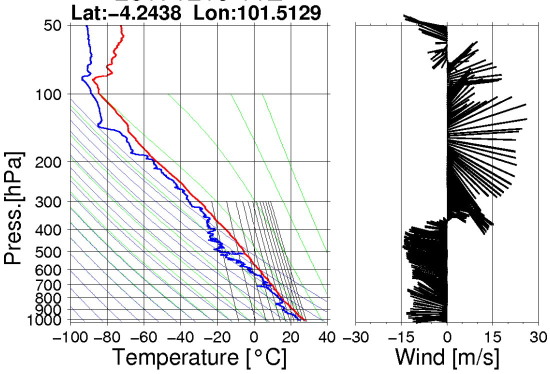
20171219 21Z
Lat:−4.2431 Lon:101.5147



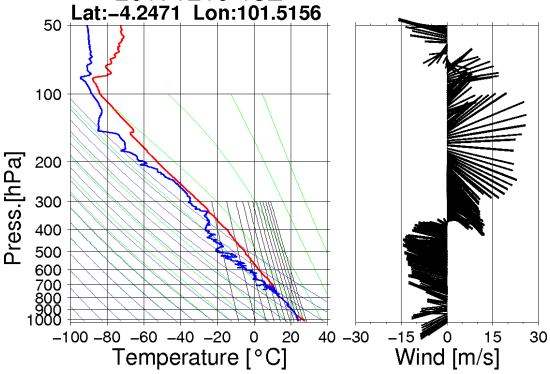
20171219 10Z
Lat:-4.2463 Lon:101.5118



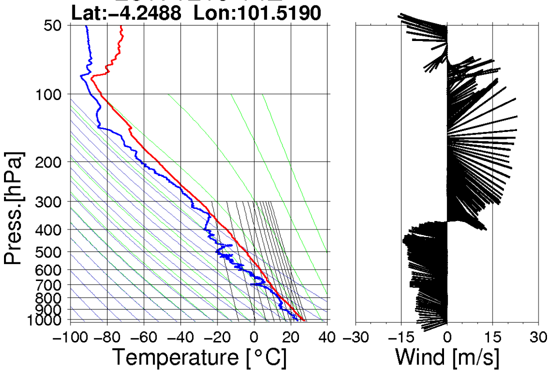
20171219 11Z
Lat:-4.2438 Lon:101.5129



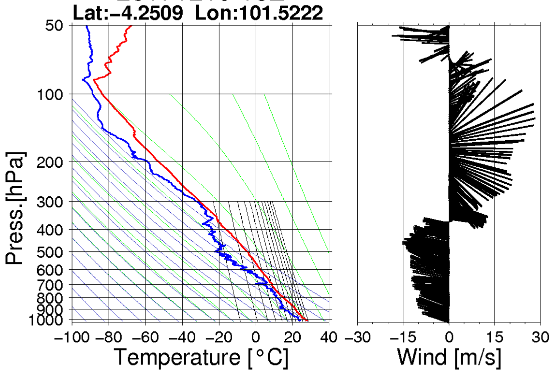
20171219 13Z
Lat:-4.2471 Lon:101.5156



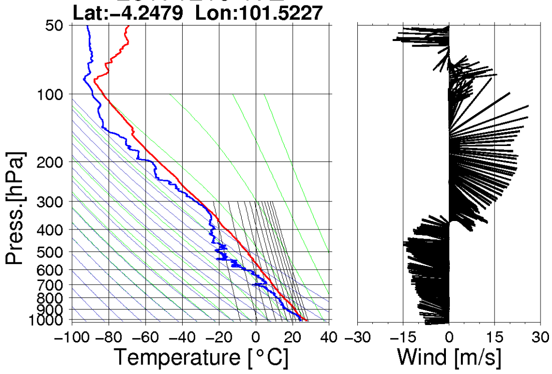
20171219 14Z
Lat:-4.2488 Lon:101.5190

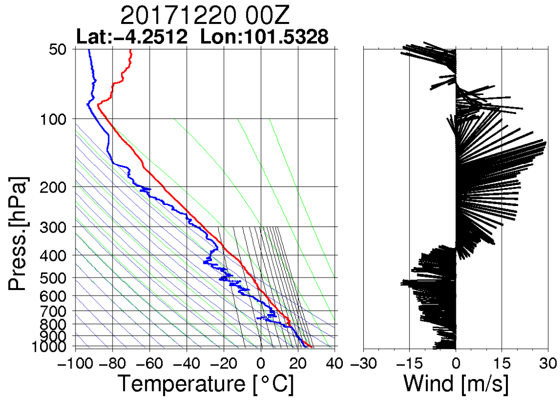


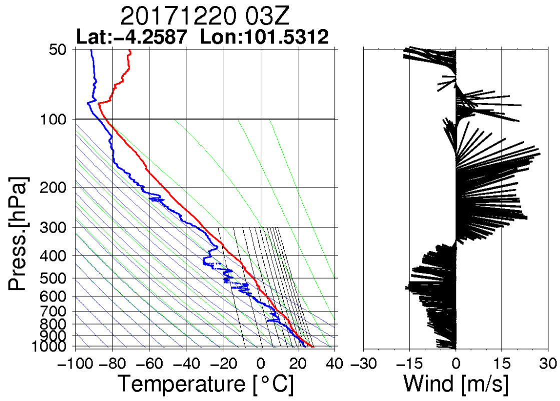
20171219 16Z
Lat:-4.2509 Lon:101.5222

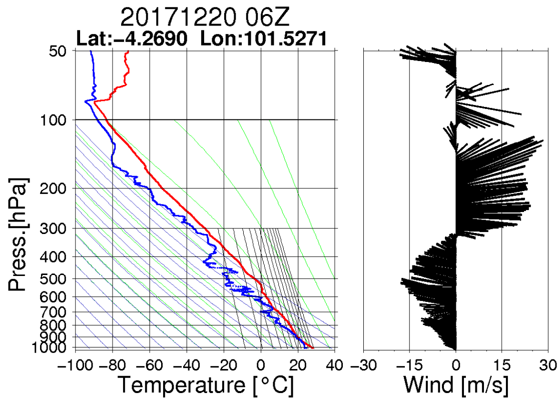


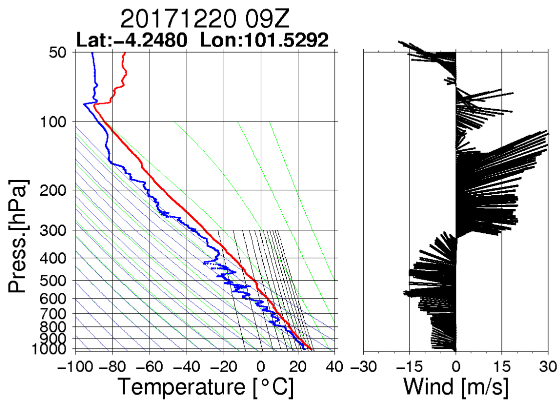
20171219 17Z
Lat:-4.2479 Lon:101.5227

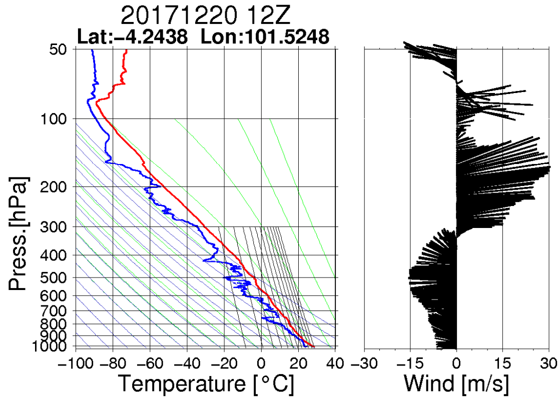


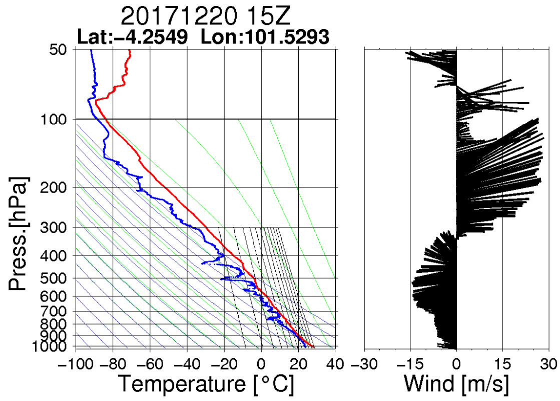

20171220 00Z
Lat:-4.2512 Lon:101.5328
Press.[hPa]
Temperature [°C]
Wind [m/s]

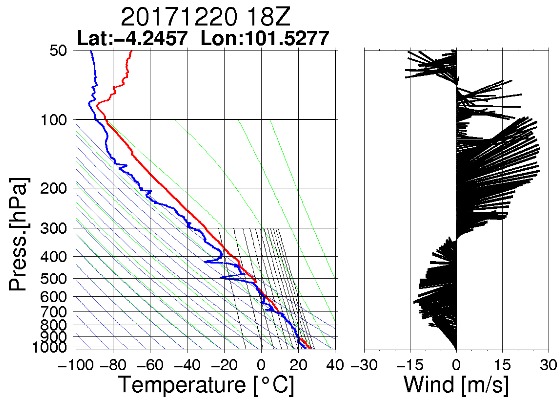

20171220 03Z
Lat:-4.2587 Lon:101.5312
Press.[hPa]
Temperature [°C]
Wind [m/s]

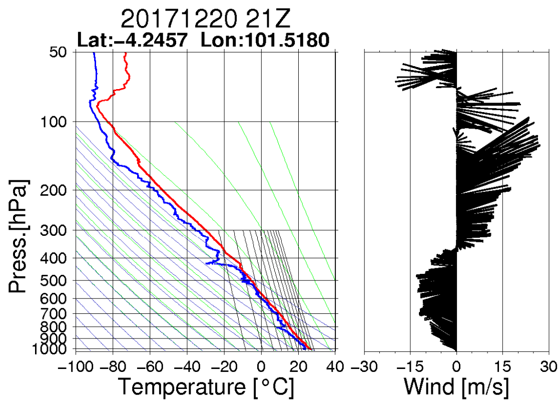

20171220 06Z
Lat:-4.2690 Lon:101.5271
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171220 09Z
Lat:-4.2480 Lon:101.5292
Press.[hPa]
Temperature [°C]
Wind [m/s]

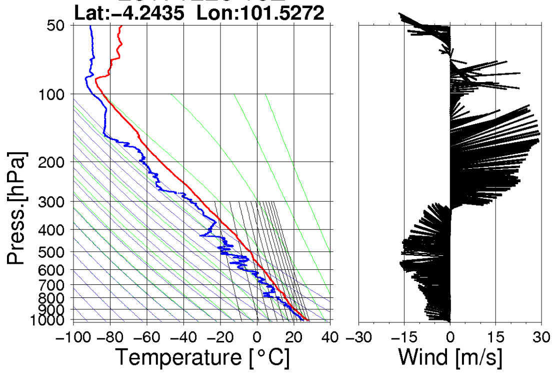

20171220 12Z
Lat:-4.2438 Lon:101.5248
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171220 15Z
Lat:-4.2549 Lon:101.5293
Press.[hPa]
Temperature [°C]
Wind [m/s]

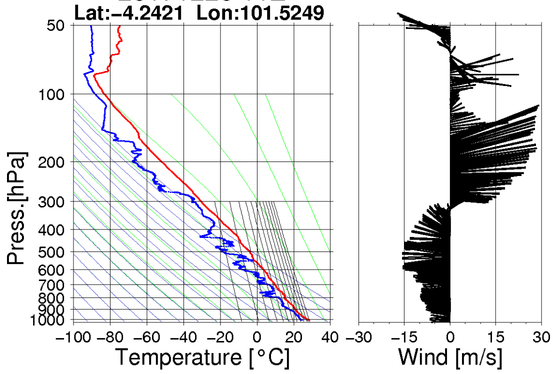

20171220 18Z
Lat:-4.2457 Lon:101.5277
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171220 21Z
Lat:-4.2457 Lon:101.5180
Press.[hPa]
Temperature [°C]
Wind [m/s]

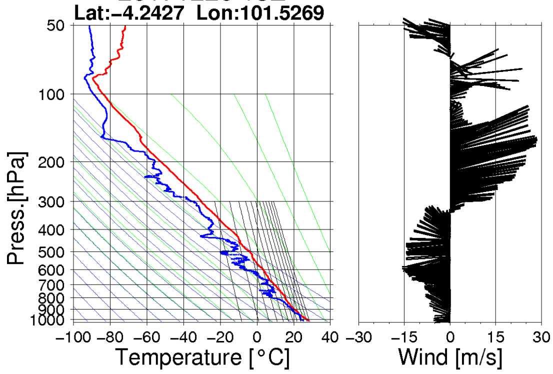
20171220 10Z
Lat:-4.2435 Lon:101.5272



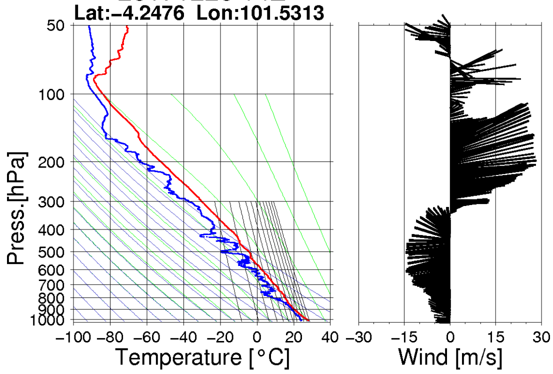
20171220 11Z
Lat:-4.2421 Lon:101.5249



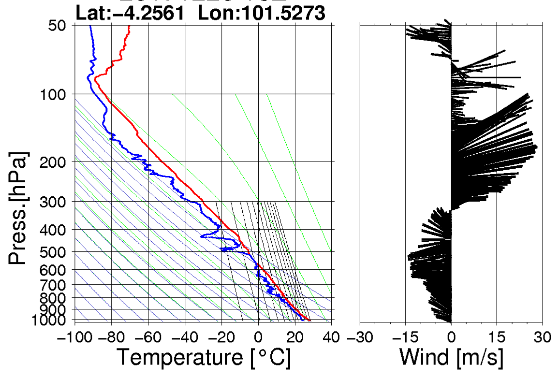
20171220 13Z
Lat:-4.2427 Lon:101.5269



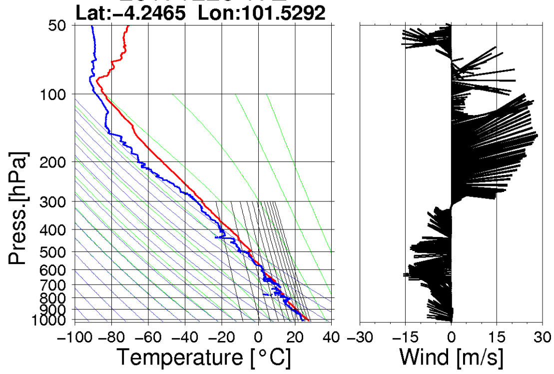
20171220 14Z
Lat:-4.2476 Lon:101.5313

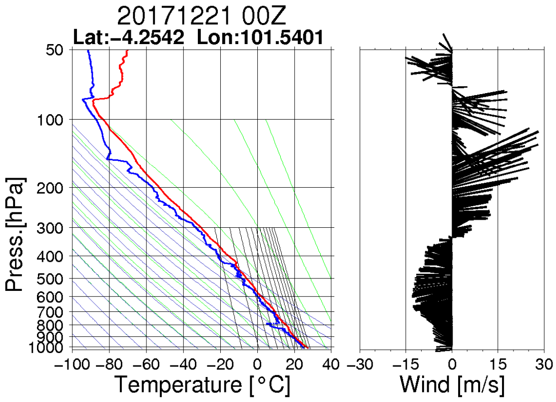


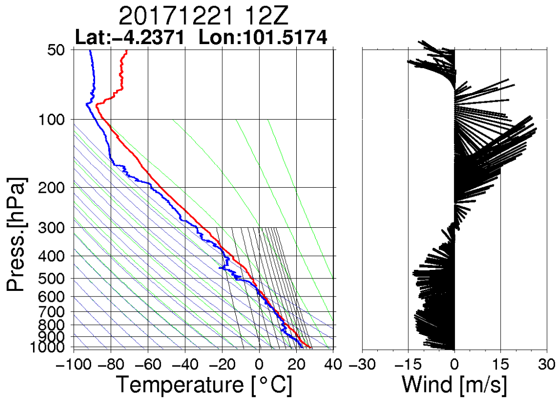
20171220 16Z
Lat:-4.2561 Lon:101.5273

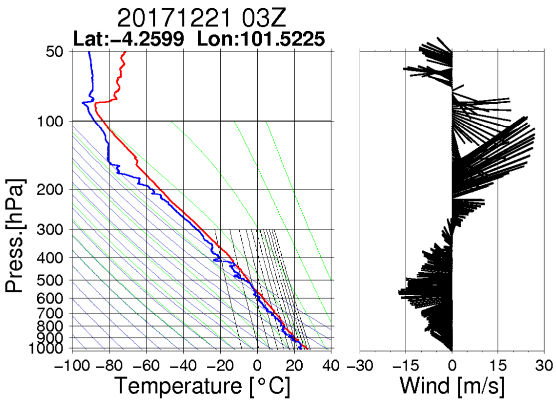


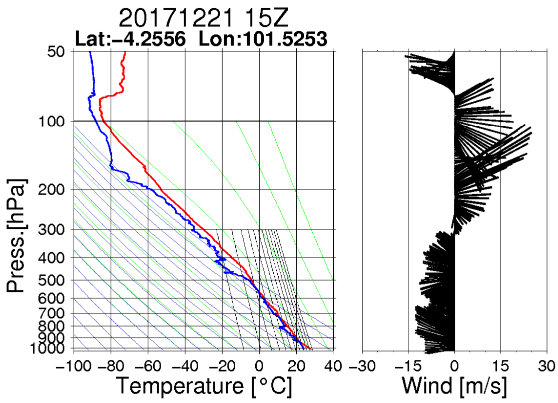
20171220 17Z
Lat:-4.2465 Lon:101.5292

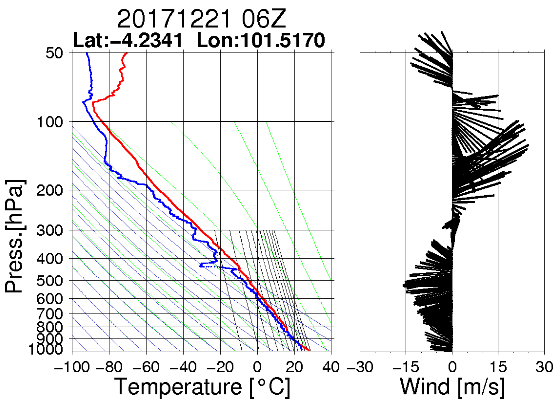


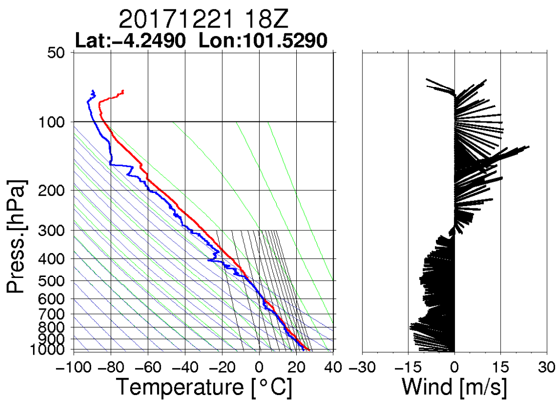

20171221 00Z
Lat:−4.2542 Lon:101.5401
Press.[hPa]
Temperature [°C]
Wind [m/s]

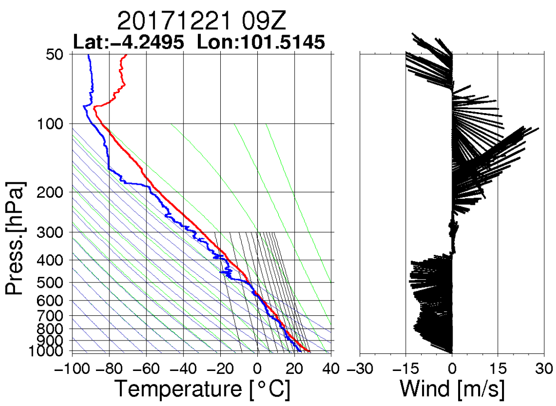

20171221 12Z
Lat:−4.2371 Lon:101.5174
Press.[hPa]
Temperature [°C]
Wind [m/s]

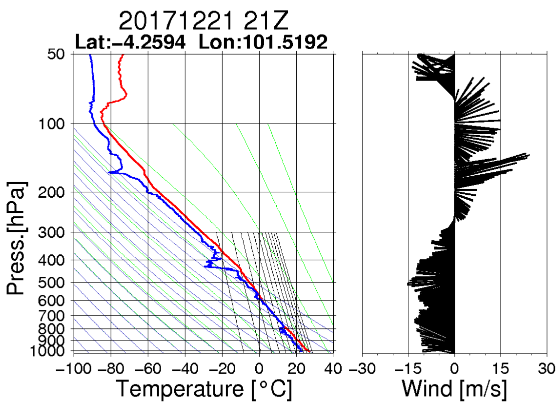

20171221 03Z
Lat:−4.2599 Lon:101.5225
Press.[hPa]
Temperature [°C]
Wind [m/s]

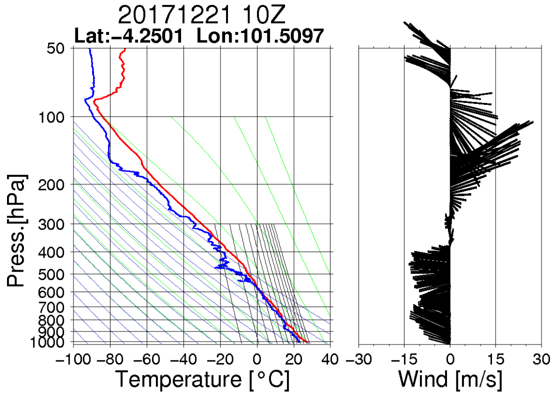

20171221 15Z
Lat:−4.2556 Lon:101.5253
Press.[hPa]
Temperature [°C]
Wind [m/s]

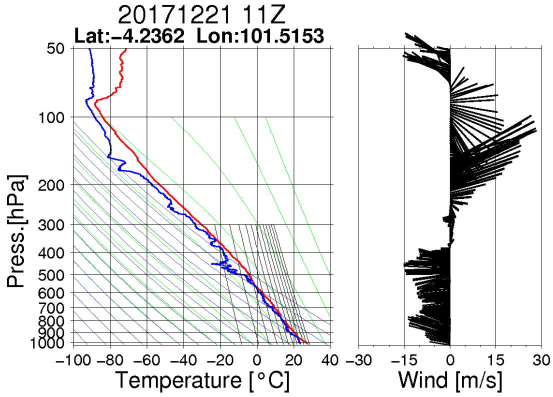

20171221 06Z
Lat:−4.2341 Lon:101.5170
Press.[hPa]
Temperature [°C]
Wind [m/s]

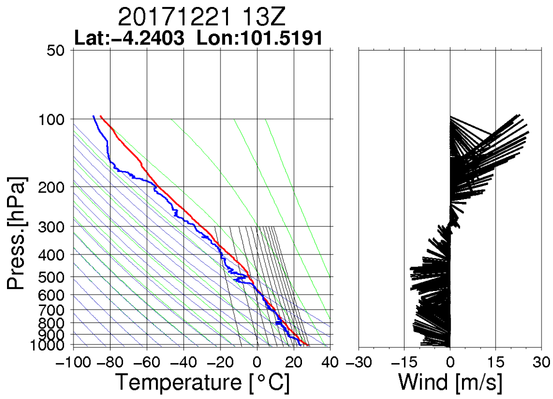

20171221 18Z
Lat:−4.2490 Lon:101.5290
Press.[hPa]
Temperature [°C]
Wind [m/s]

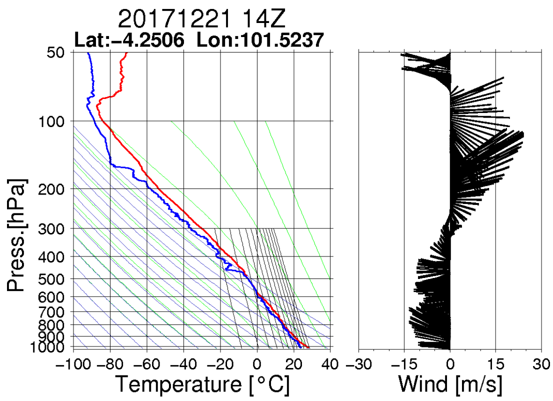

20171221 09Z
Lat:−4.2495 Lon:101.5145
Press.[hPa]
Temperature [°C]
Wind [m/s]

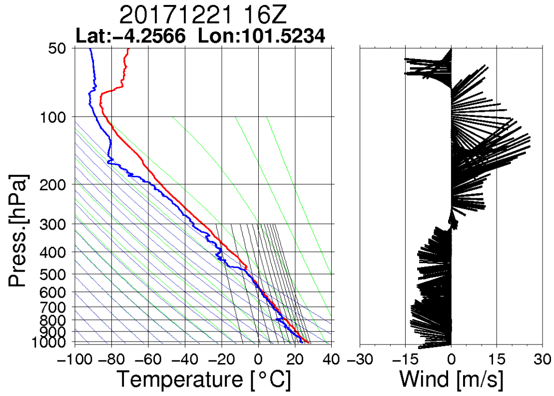

20171221 21Z
Lat:−4.2594 Lon:101.5192
Press.[hPa]
Temperature [°C]
Wind [m/s]

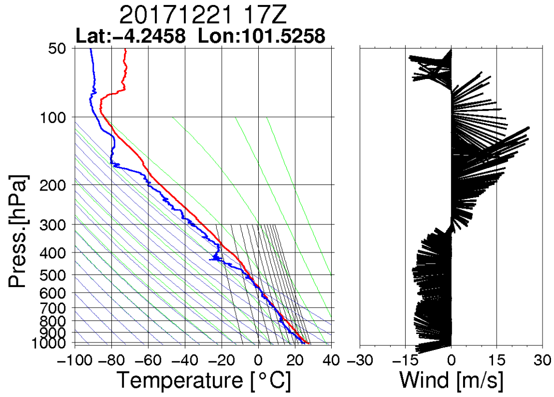

20171221 10Z
Lat:-4.2501 Lon:101.5097
Press.[hPa]
Temperature [°C]
Wind [m/s]

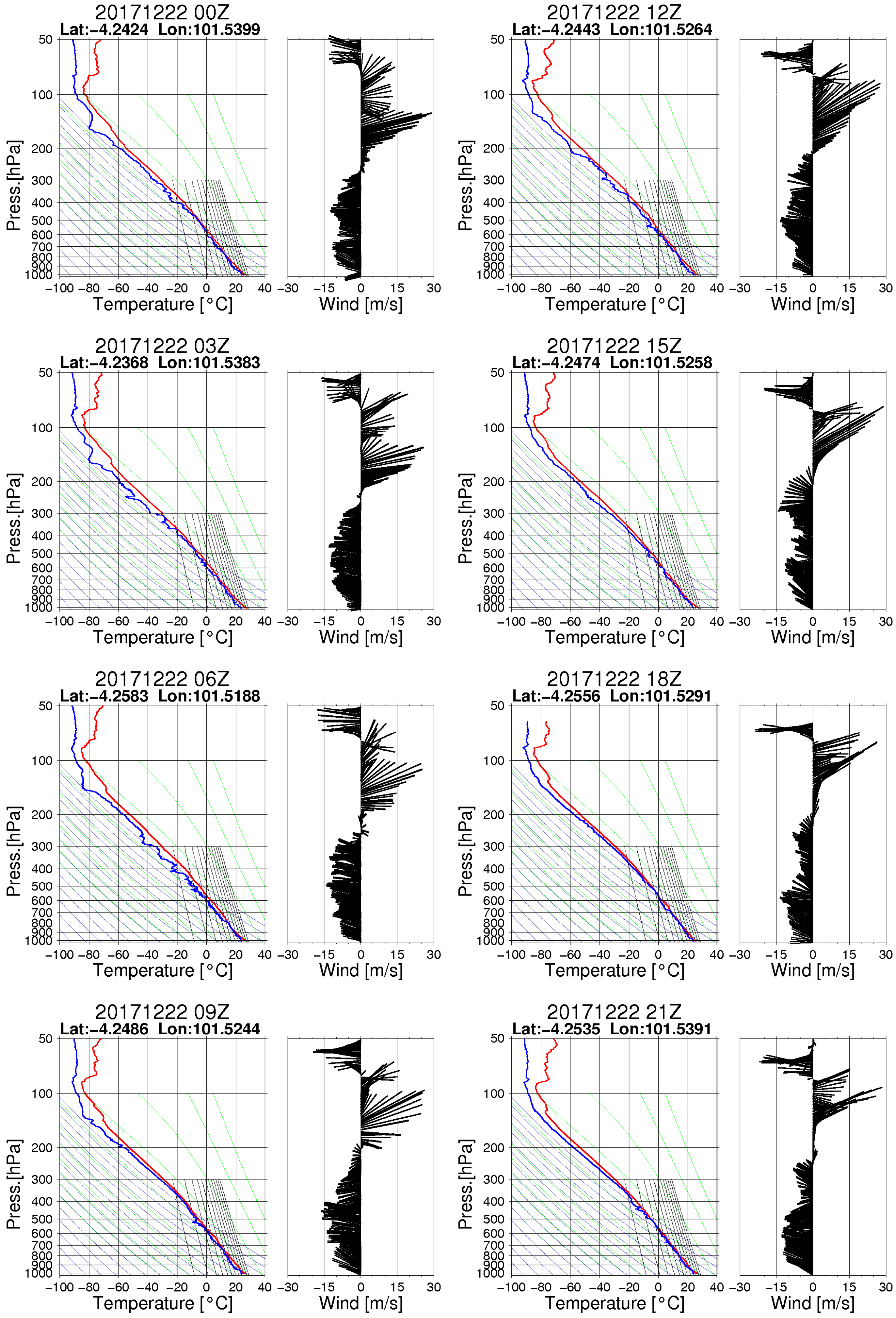

20171221 11Z
Lat:-4.2362 Lon:101.5153
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171221 13Z
Lat:-4.2403 Lon:101.5191
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171221 14Z
Lat:-4.2506 Lon:101.5237
Press.[hPa]
Temperature [°C]
Wind [m/s]

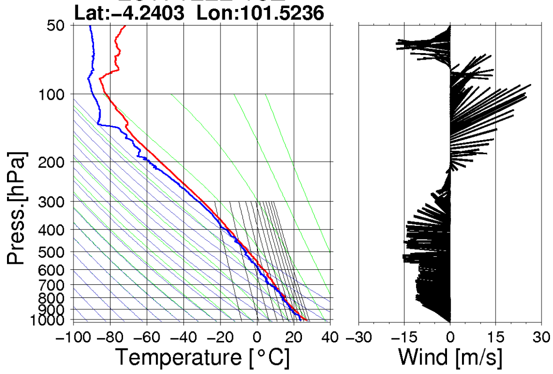

20171221 16Z
Lat:-4.2566 Lon:101.5234
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171221 17Z
Lat:-4.2458 Lon:101.5258
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171222 00Z
Lat:−4.2424 Lon:101.5399
20171222 12Z
Lat:−4.2443 Lon:101.5264
20171222 03Z
Lat:−4.2368 Lon:101.5383
20171222 15Z
Lat:−4.2474 Lon:101.5258
20171222 06Z
Lat:−4.2583 Lon:101.5188
20171222 18Z
Lat:−4.2556 Lon:101.5291
20171222 09Z
Lat:−4.2486 Lon:101.5244
20171222 21Z
Lat:−4.2535 Lon:101.5391
Press.[hPa]
Temperature [°C]
Wind [m/s]

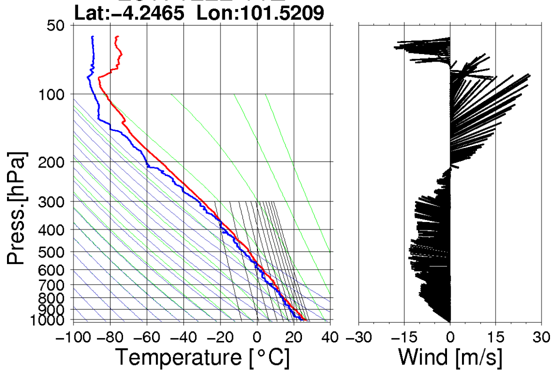
20171222 10Z

Lat:-4.2403 Lon:101.5236



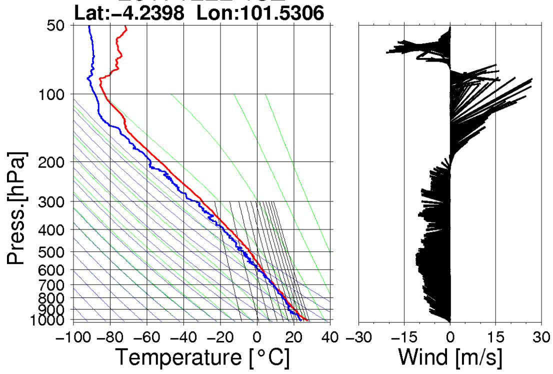
20171222 11Z

Lat:-4.2465 Lon:101.5209



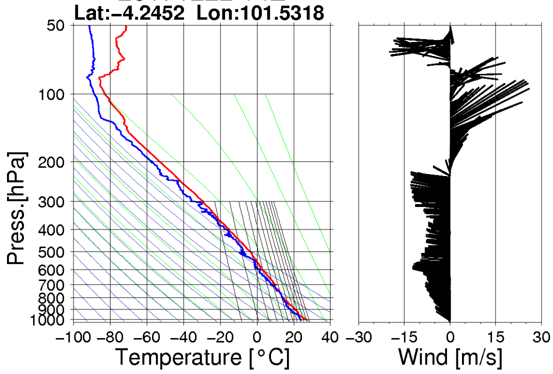
20171222 13Z

Lat:-4.2398 Lon:101.5306



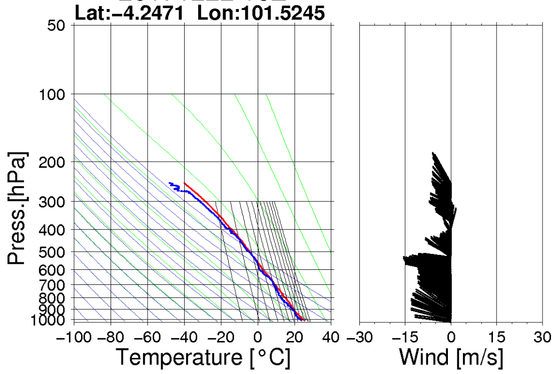
20171222 14Z

Lat:-4.2452 Lon:101.5318



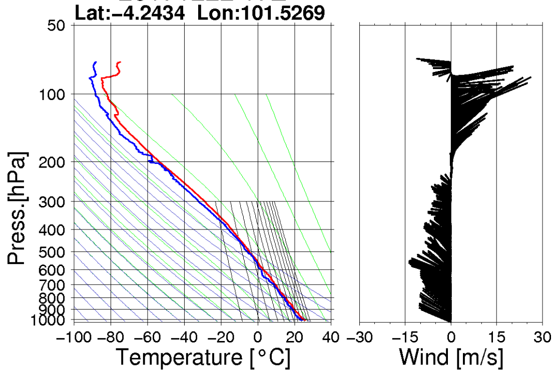
20171222 16Z

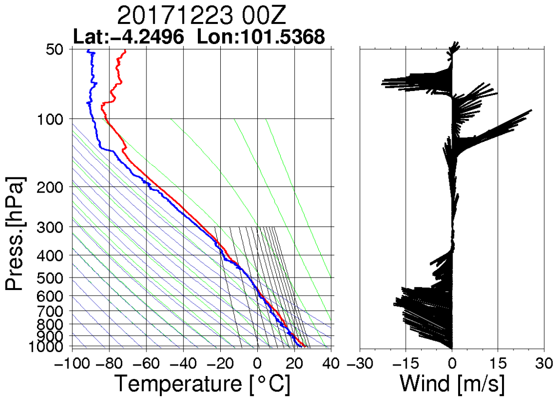
Lat:-4.2471 Lon:101.5245

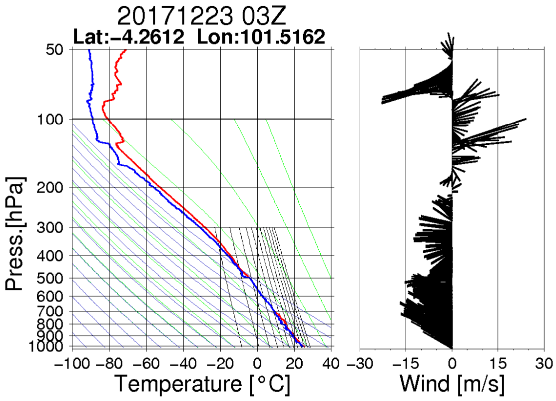


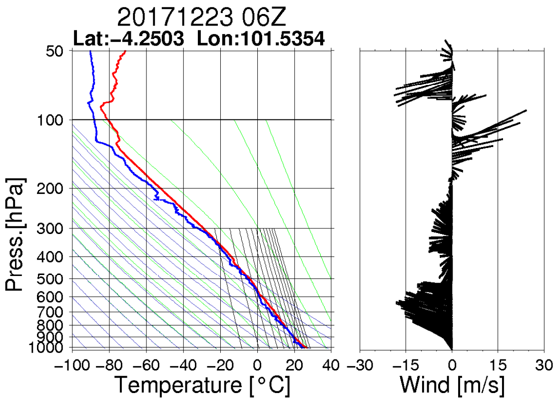
20171222 17Z

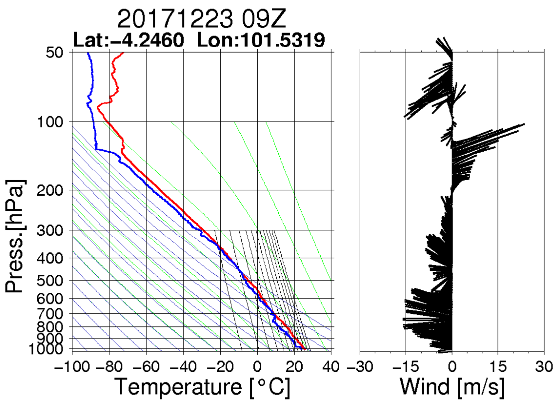
Lat:-4.2434 Lon:101.5269

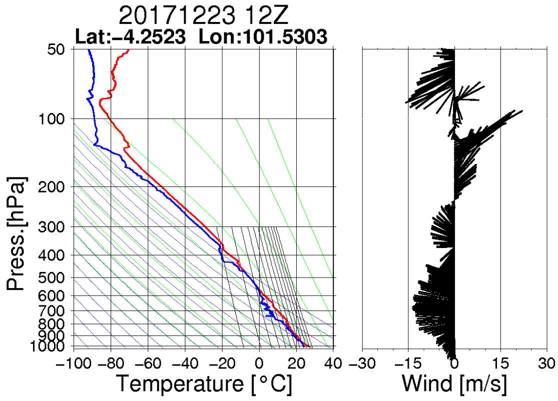


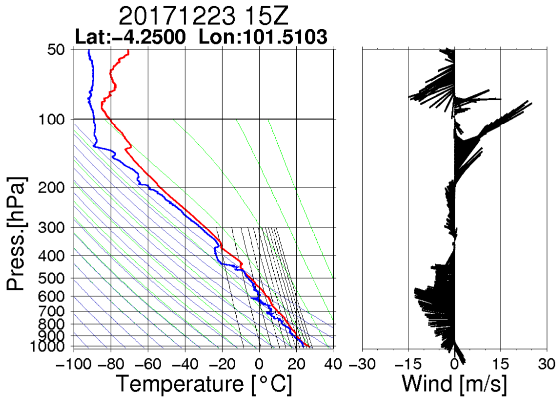

20171223 00Z
Lat:−4.2496 Lon:101.5368
Press.[hPa]
Temperature [°C]
Wind [m/s]

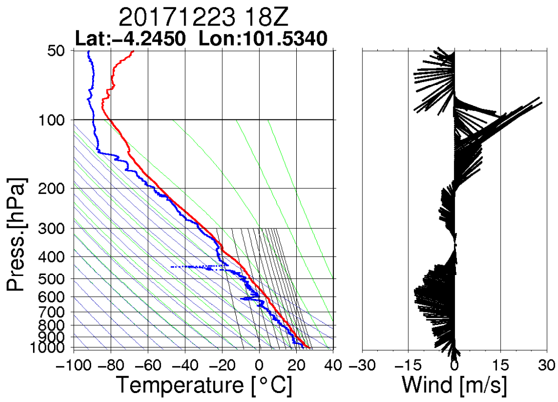

20171223 03Z
Lat:−4.2612 Lon:101.5162
Press.[hPa]
Temperature [°C]
Wind [m/s]

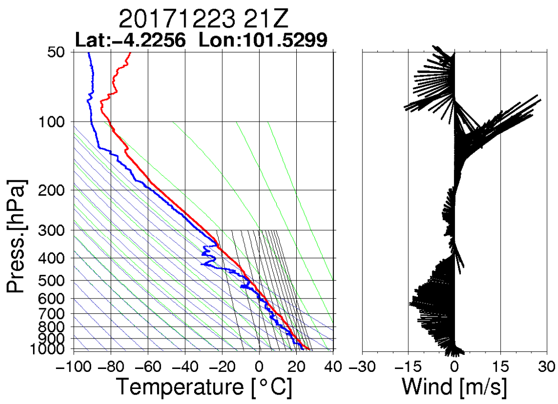

20171223 06Z
Lat:−4.2503 Lon:101.5354
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171223 09Z
Lat:−4.2460 Lon:101.5319
Press.[hPa]
Temperature [°C]
Wind [m/s]

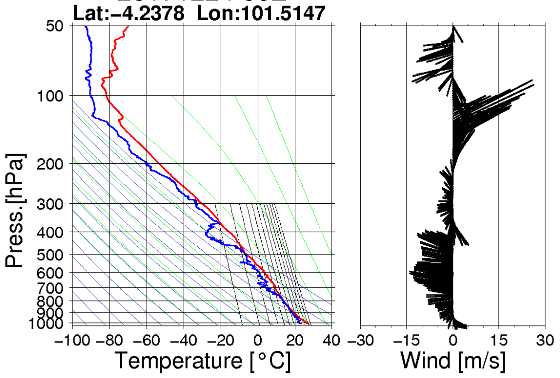

20171223 12Z
Lat:−4.2523 Lon:101.5303
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171223 15Z
Lat:−4.2500 Lon:101.5103
Press.[hPa]
Temperature [°C]
Wind [m/s]

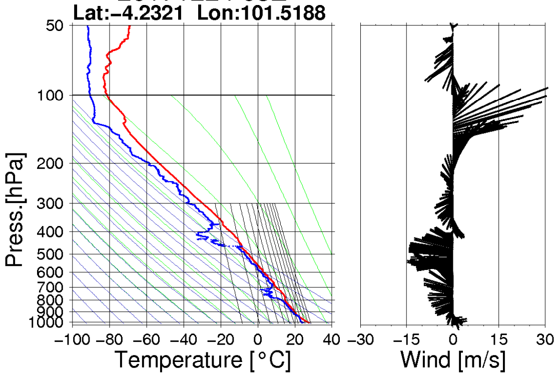

20171223 18Z
Lat:−4.2450 Lon:101.5340
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171223 21Z
Lat:−4.2256 Lon:101.5299
Press.[hPa]
Temperature [°C]
Wind [m/s]

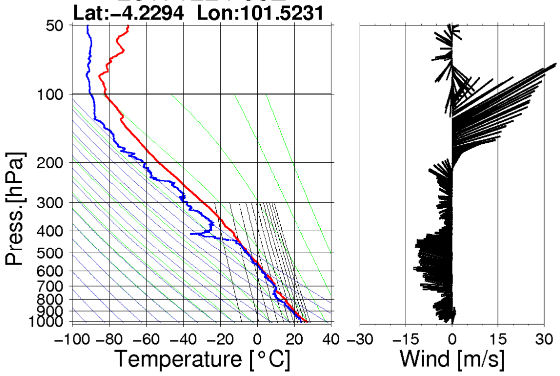
20171224 00Z
Lat:-4.2378 Lon:101.5147



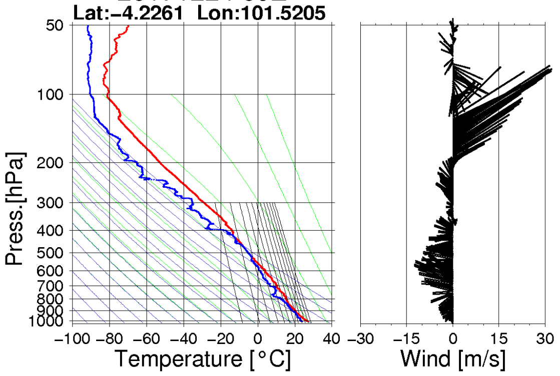
20171224 03Z
Lat:-4.2321 Lon:101.5188



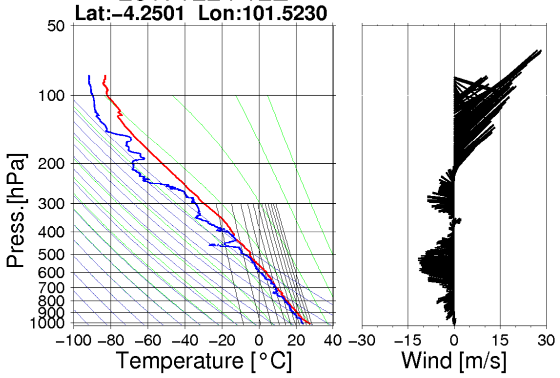
20171224 06Z
Lat:-4.2294 Lon:101.5231



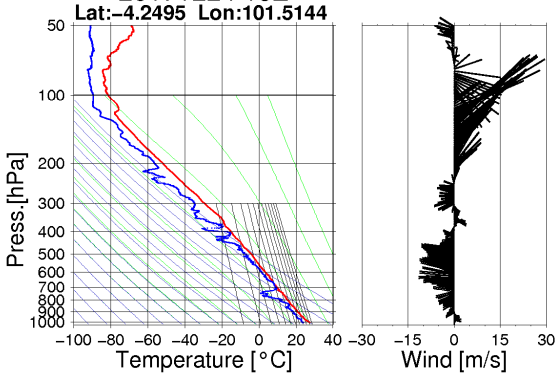
20171224 09Z
Lat:-4.2261 Lon:101.5205



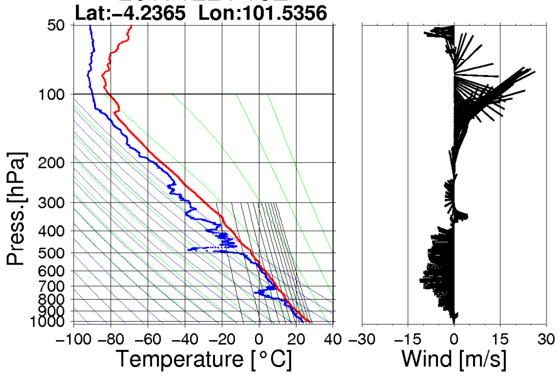
20171224 12Z
Lat:-4.2501 Lon:101.5230



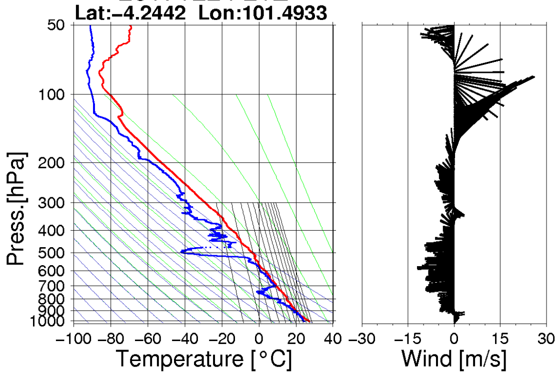
20171224 15Z
Lat:-4.2495 Lon:101.5144

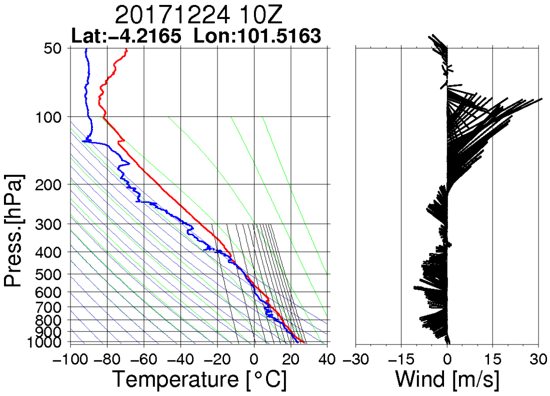


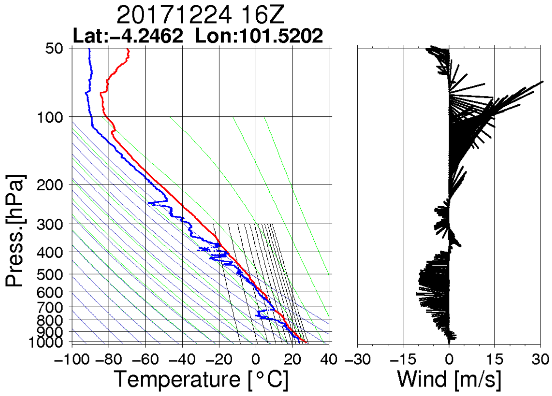
20171224 18Z
Lat:-4.2365 Lon:101.5356

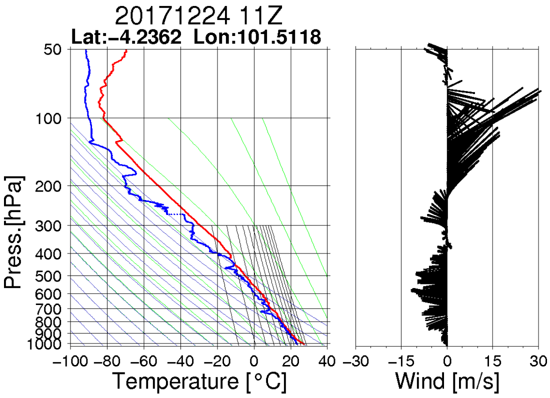


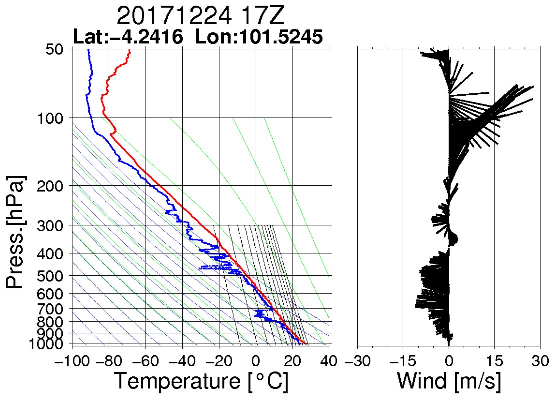
20171224 21Z
Lat:-4.2442 Lon:101.4933

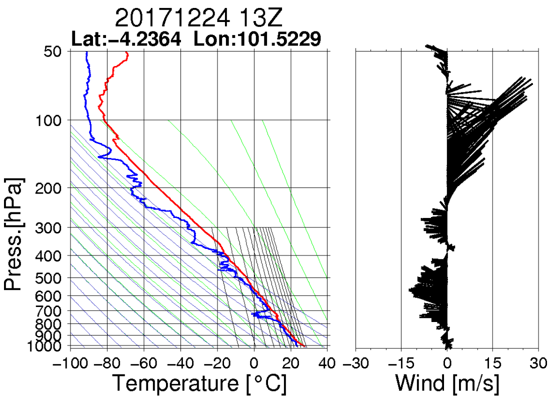


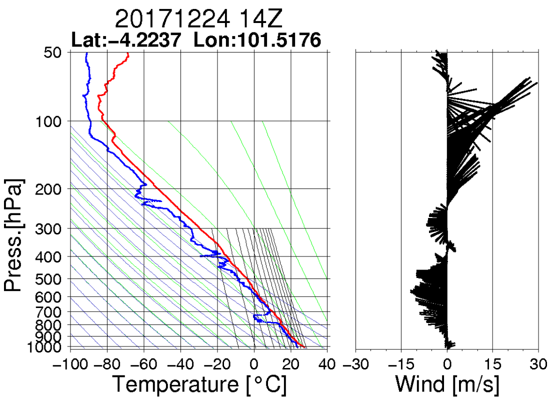

20171224 10Z
Lat:-4.2165 Lon:101.5163
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171224 16Z
Lat:-4.2462 Lon:101.5202
Press.[hPa]
Temperature [°C]
Wind [m/s]

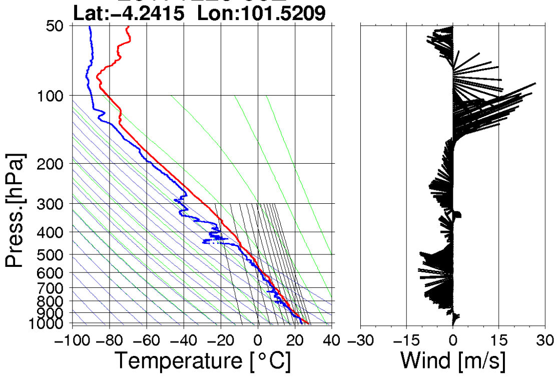

20171224 11Z
Lat:-4.2362 Lon:101.5118
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171224 17Z
Lat:-4.2416 Lon:101.5245
Press.[hPa]
Temperature [°C]
Wind [m/s]

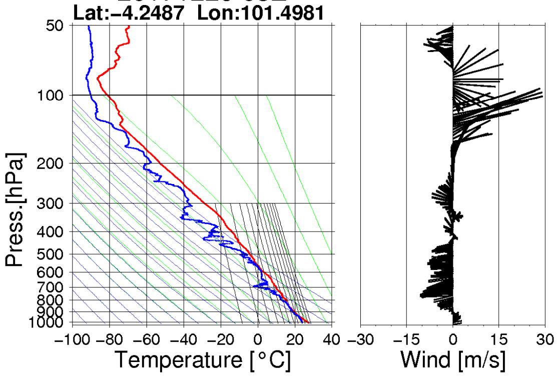

20171224 13Z
Lat:-4.2364 Lon:101.5229
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171224 14Z
Lat:-4.2237 Lon:101.5176
Press.[hPa]
Temperature [°C]
Wind [m/s]

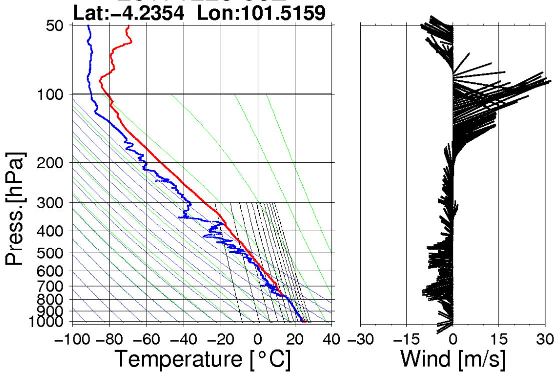
20171225 00Z
Lat:-4.2415 Lon:101.5209



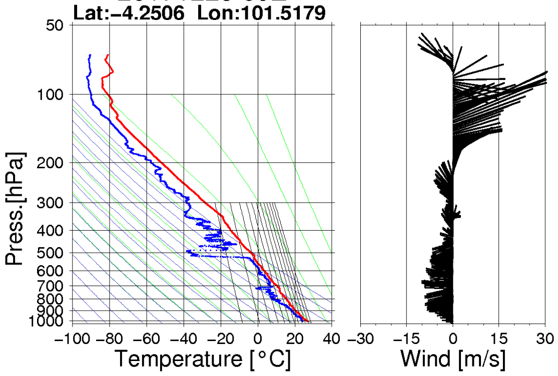
20171225 03Z
Lat:-4.2487 Lon:101.4981



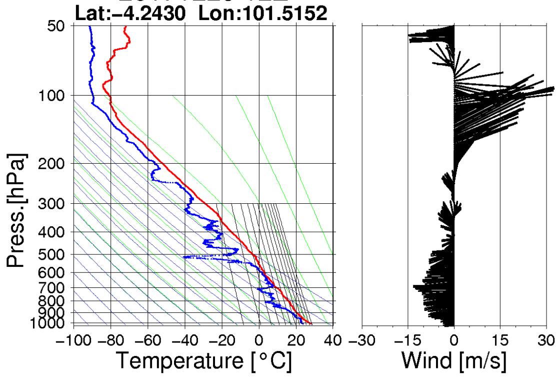
20171225 06Z
Lat:-4.2354 Lon:101.5159



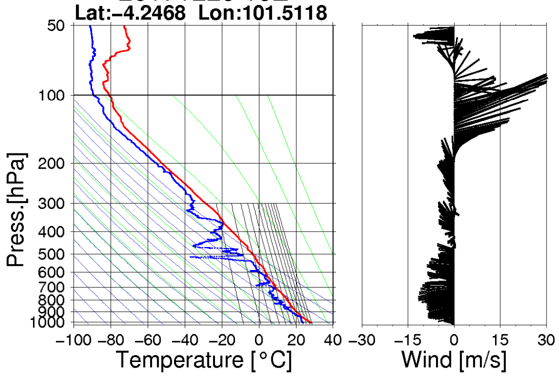
20171225 09Z
Lat:-4.2506 Lon:101.5179



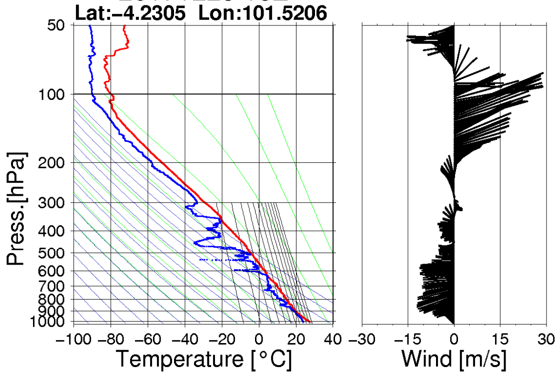
20171225 12Z
Lat:-4.2430 Lon:101.5152



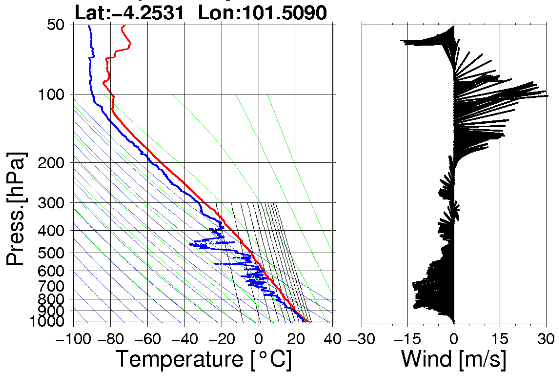
20171225 15Z
Lat:-4.2468 Lon:101.5118



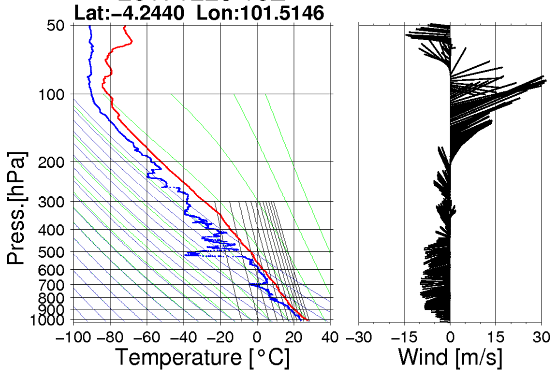
20171225 18Z
Lat:-4.2305 Lon:101.5206



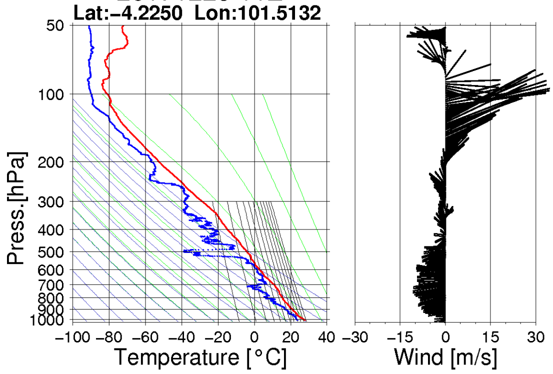
20171225 21Z
Lat:-4.2531 Lon:101.5090



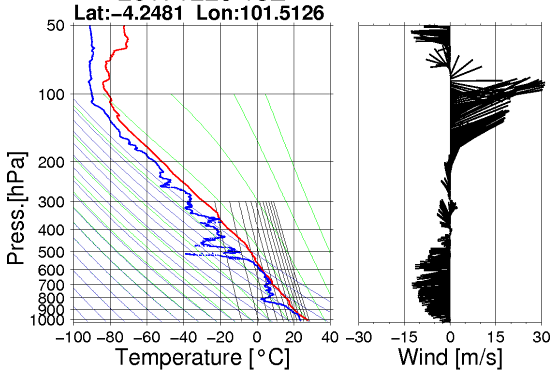
20171225 10Z
Lat:−4.2440 Lon:101.5146



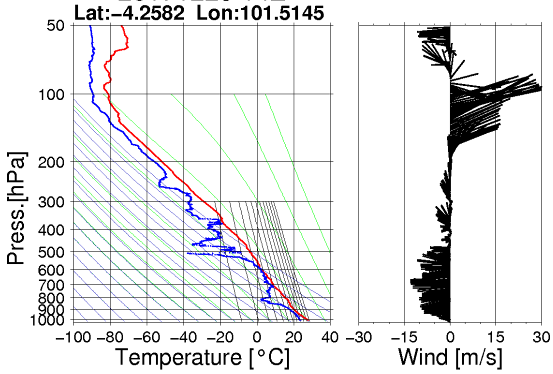
20171225 11Z
Lat:−4.2250 Lon:101.5132



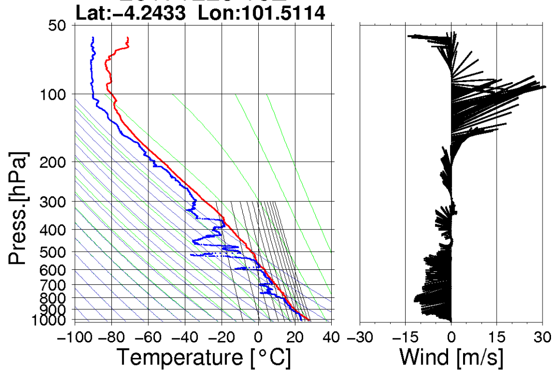
20171225 13Z
Lat:−4.2481 Lon:101.5126



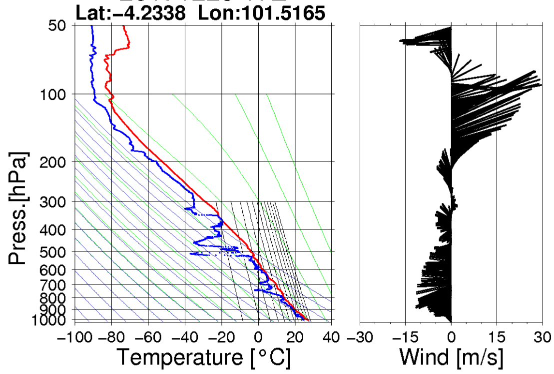
20171225 14Z
Lat:−4.2582 Lon:101.5145

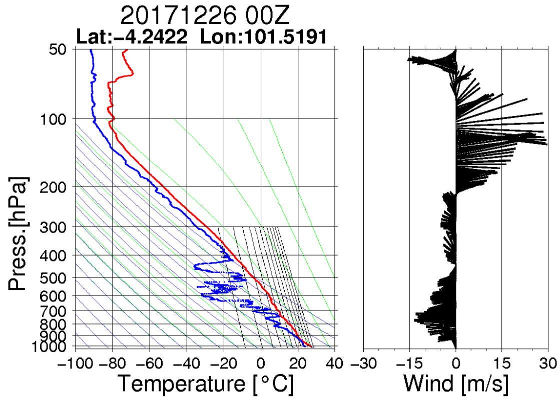


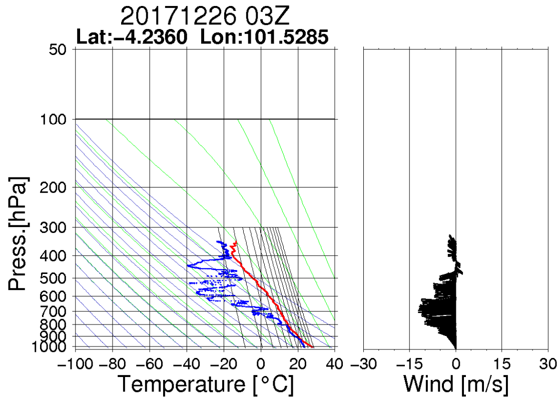
20171225 16Z
Lat:−4.2433 Lon:101.5114

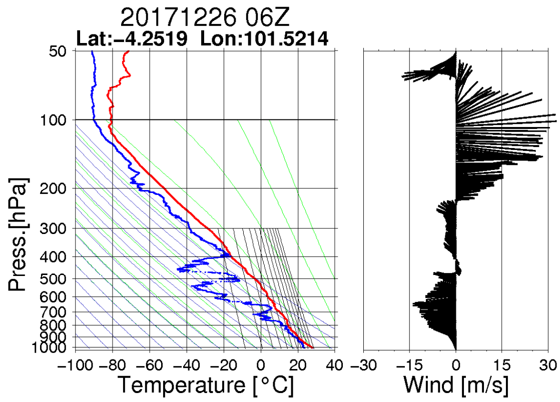


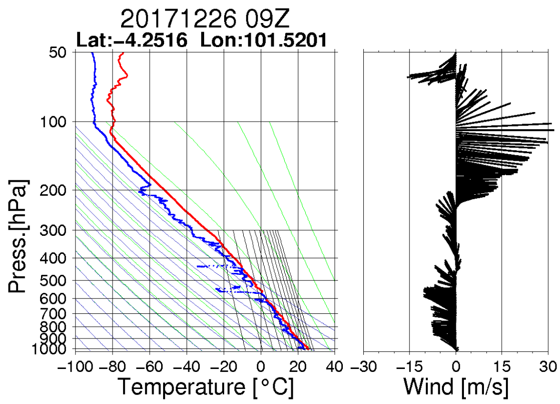
20171225 17Z
Lat:−4.2338 Lon:101.5165

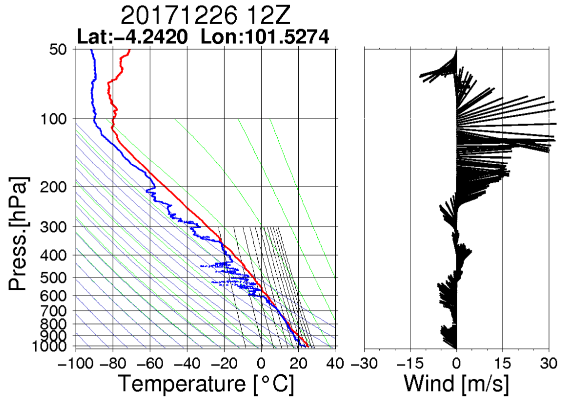


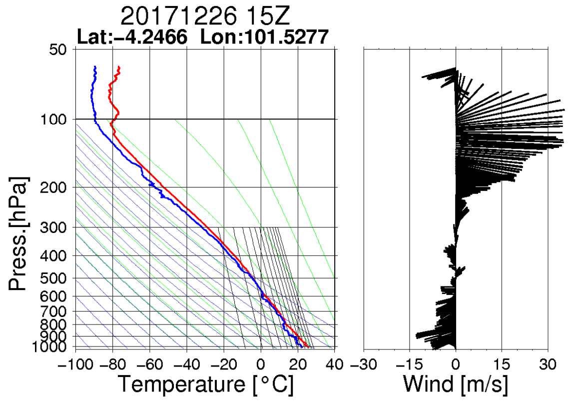

20171226 00Z
Lat:−4.2422 Lon:101.5191
Press.[hPa]
Temperature [°C]
Wind [m/s]

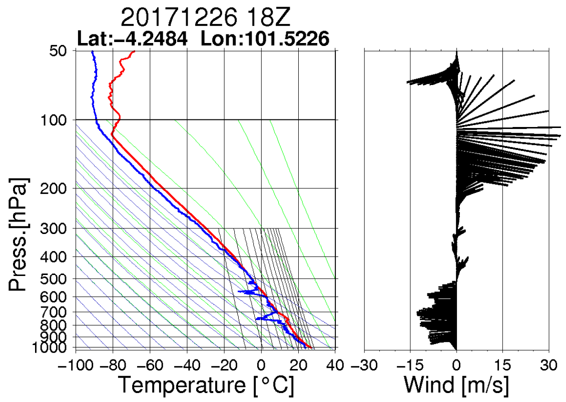

20171226 03Z
Lat:−4.2360 Lon:101.5285
Press.[hPa]
Temperature [°C]
Wind [m/s]

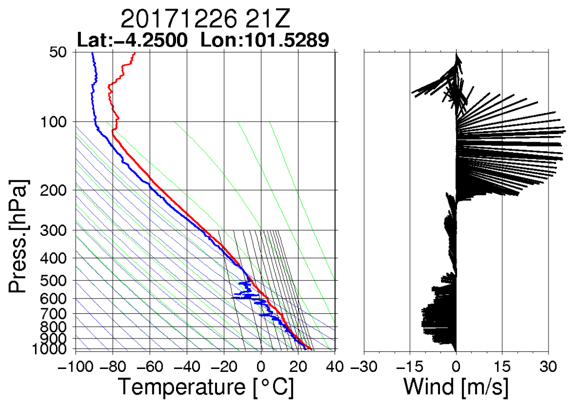

20171226 06Z
Lat:−4.2519 Lon:101.5214
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171226 09Z
Lat:−4.2516 Lon:101.5201
Press.[hPa]
Temperature [°C]
Wind [m/s]

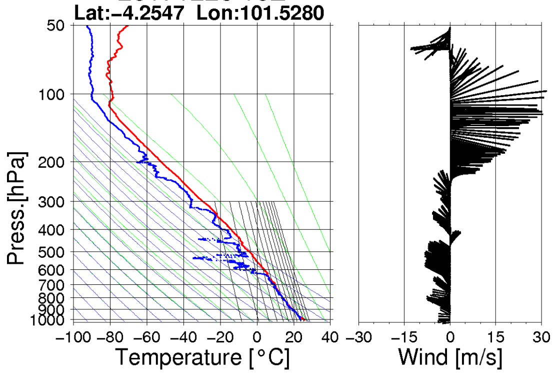

20171226 12Z
Lat:−4.2420 Lon:101.5274
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171226 15Z
Lat:−4.2466 Lon:101.5277
Press.[hPa]
Temperature [°C]
Wind [m/s]

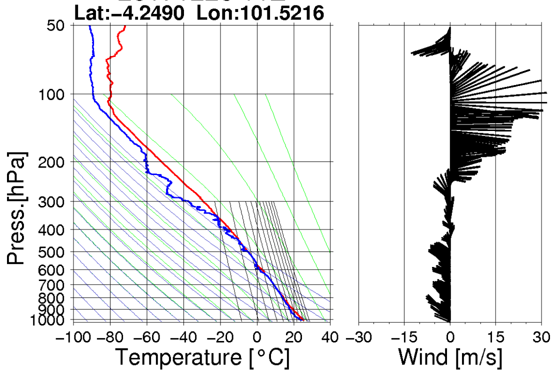

20171226 18Z
Lat:−4.2484 Lon:101.5226
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171226 21Z
Lat:−4.2500 Lon:101.5289
Press.[hPa]
Temperature [°C]
Wind [m/s]

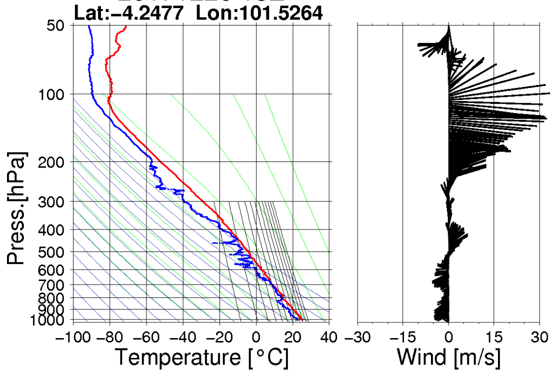
20171226 10Z
Lat:-4.2547 Lon:101.5280



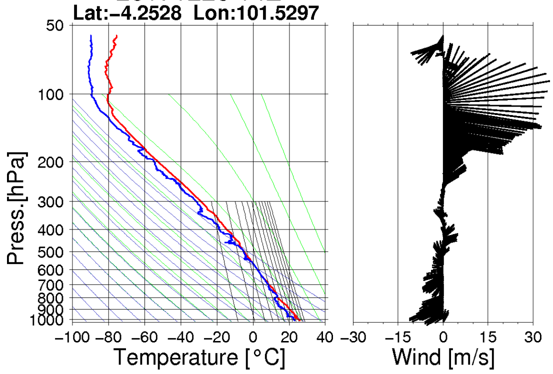
20171226 11Z
Lat:-4.2490 Lon:101.5216



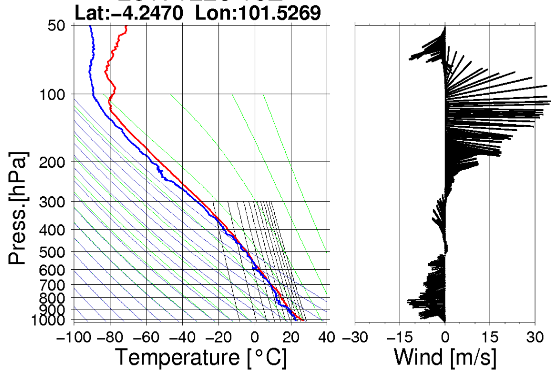
20171226 13Z
Lat:-4.2477 Lon:101.5264



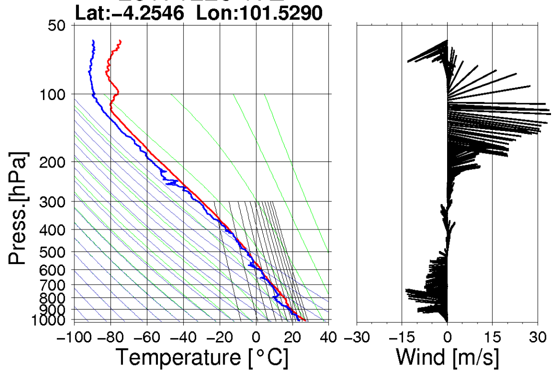
20171226 14Z
Lat:-4.2528 Lon:101.5297



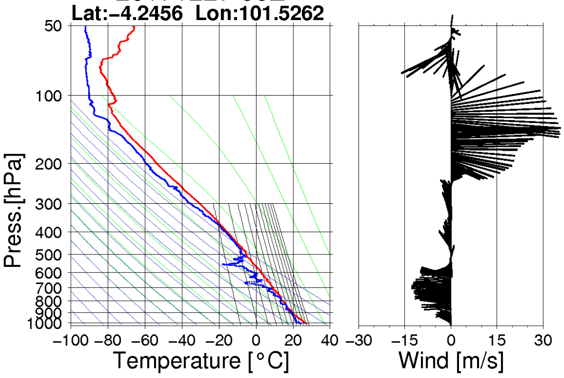
20171226 16Z
Lat:-4.2470 Lon:101.5269



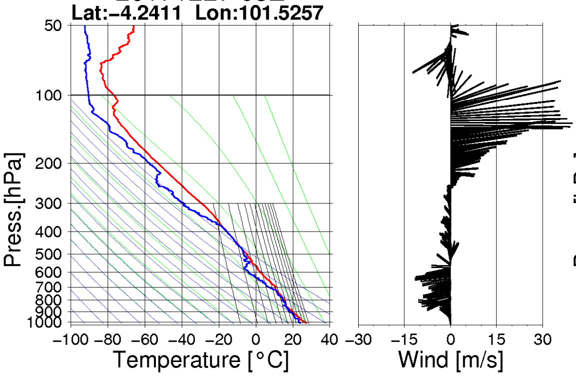
20171226 17Z
Lat:-4.2546 Lon:101.5290



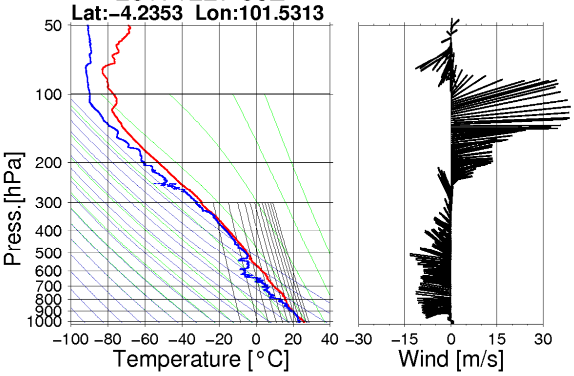
20171227 00Z
Lat:−4.2456 Lon:101.5262



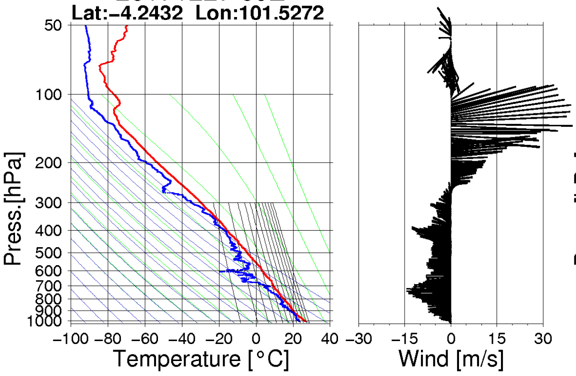
20171227 03Z
Lat:−4.2411 Lon:101.5257



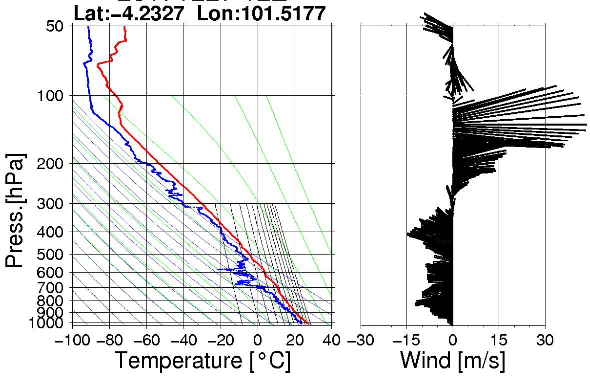
20171227 06Z
Lat:−4.2353 Lon:101.5313



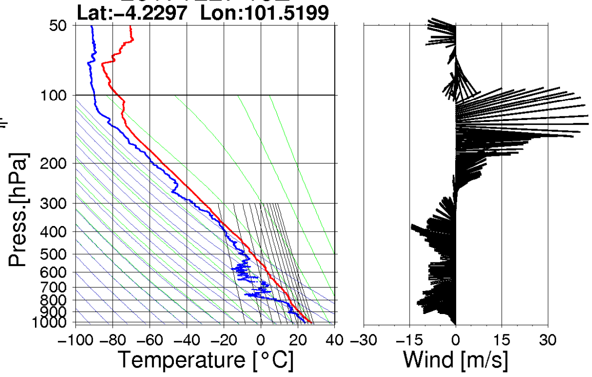
20171227 09Z
Lat:−4.2432 Lon:101.5272



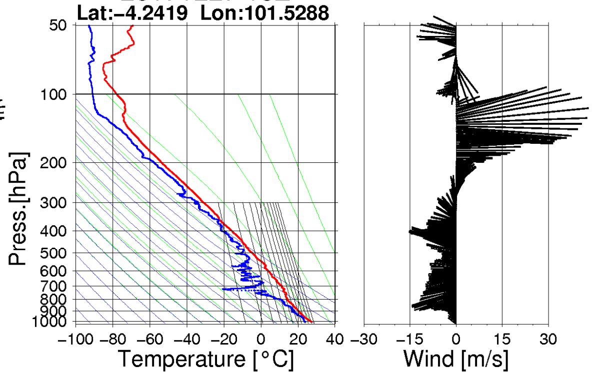
20171227 12Z
Lat:−4.2327 Lon:101.5177



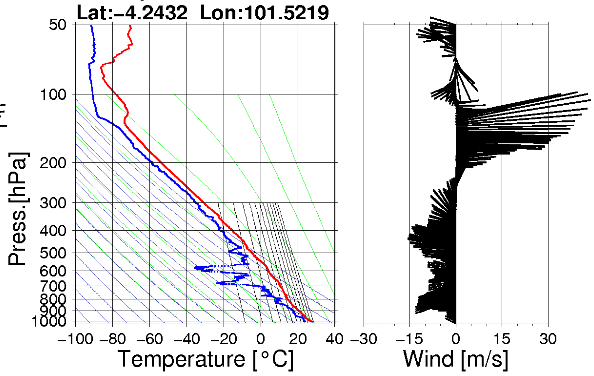
20171227 15Z
Lat:−4.2297 Lon:101.5199

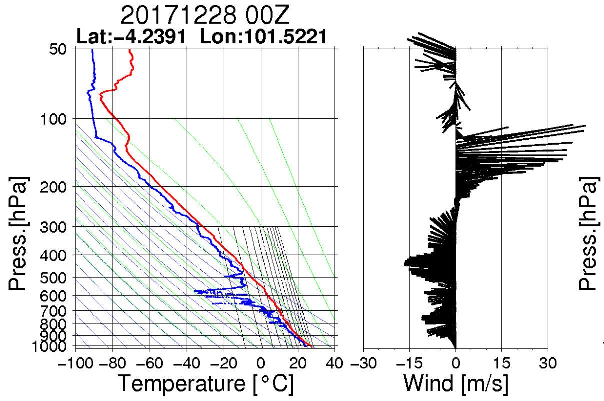


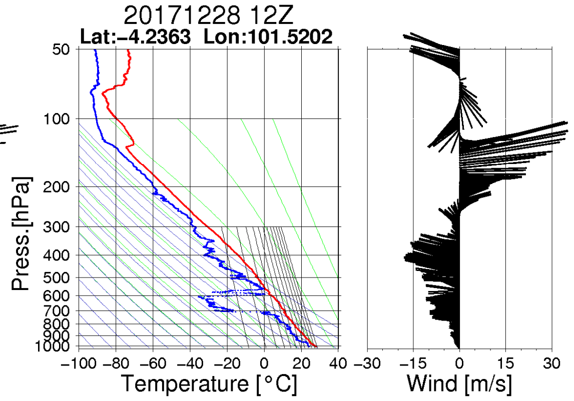
20171227 18Z
Lat:−4.2419 Lon:101.5288

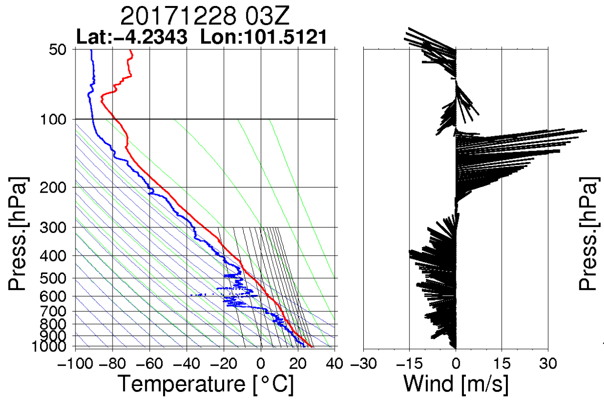


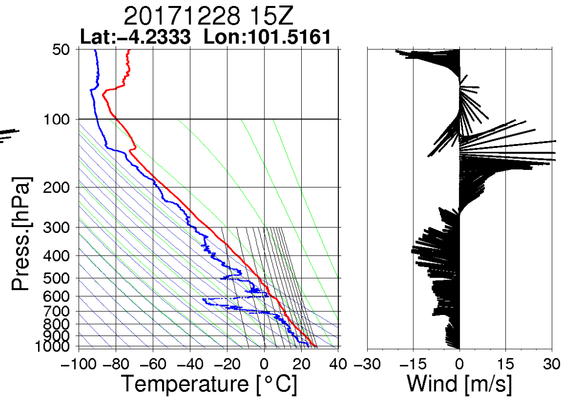
20171227 21Z
Lat:−4.2432 Lon:101.5219

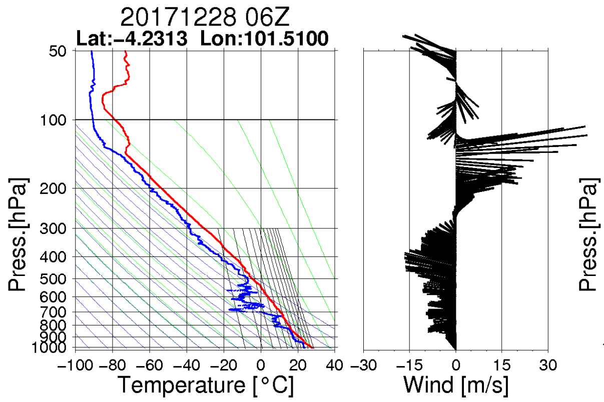


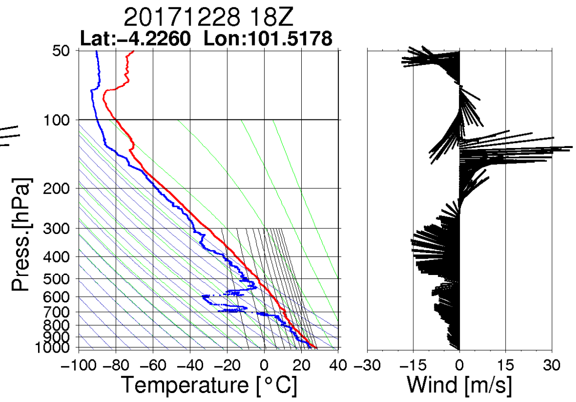

20171228 00Z
Lat:−4.2391 Lon:101.5221
Press.[hPa]
Temperature [°C]
Wind [m/s]

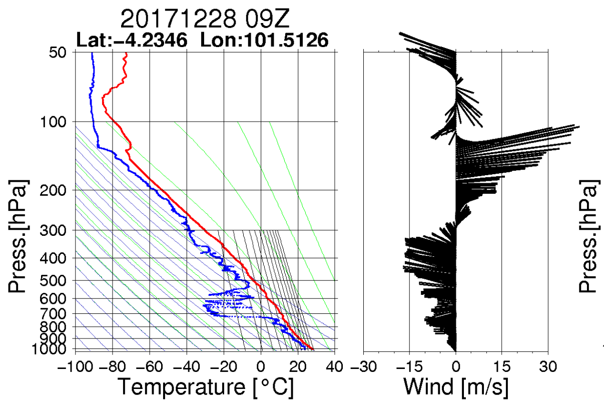

20171228 12Z
Lat:−4.2363 Lon:101.5202
Press.[hPa]
Temperature [°C]
Wind [m/s]

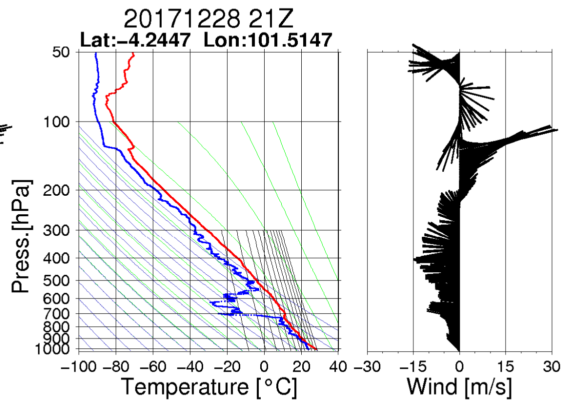

20171228 03Z
Lat:−4.2343 Lon:101.5121
Press.[hPa]
Temperature [°C]
Wind [m/s]

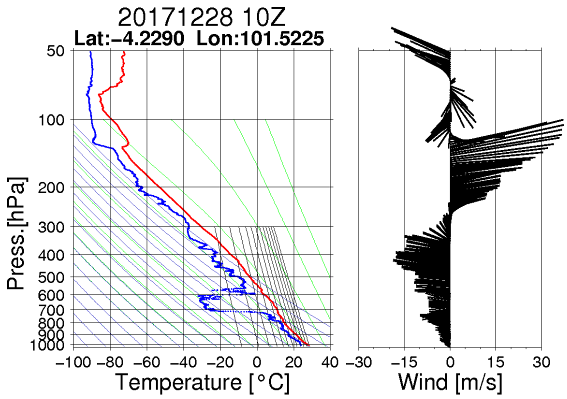

20171228 15Z
Lat:−4.2333 Lon:101.5161
Press.[hPa]
Temperature [°C]
Wind [m/s]

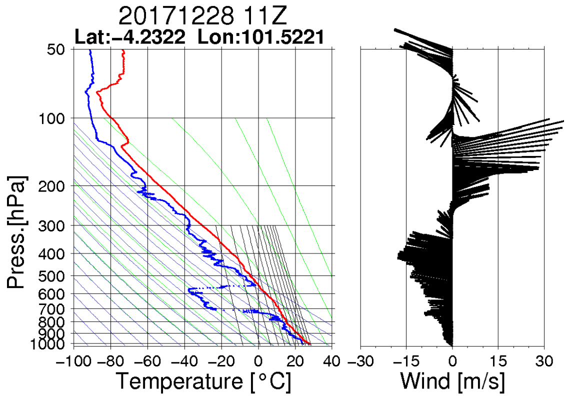

20171228 06Z
Lat:−4.2313 Lon:101.5100
Press.[hPa]
Temperature [°C]
Wind [m/s]

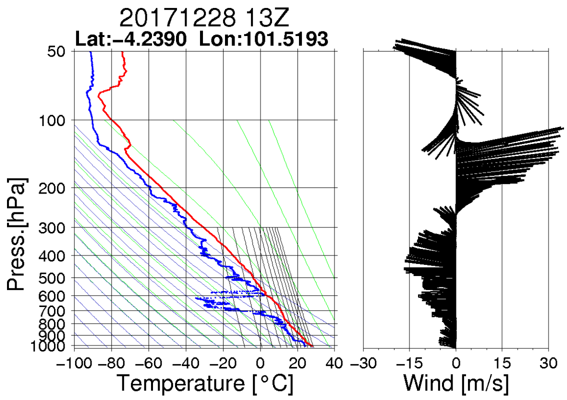

20171228 18Z
Lat:−4.2260 Lon:101.5178
Press.[hPa]
Temperature [°C]
Wind [m/s]

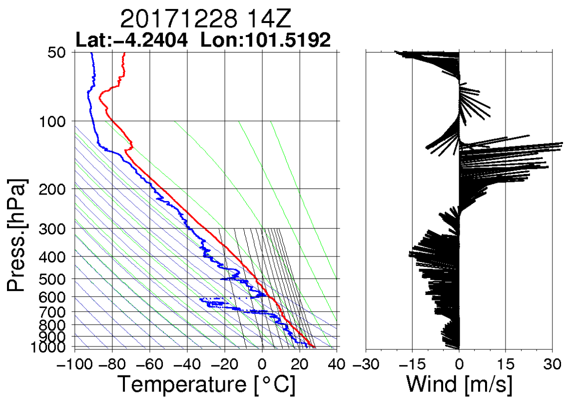

20171228 09Z
Lat:−4.2346 Lon:101.5126
Press.[hPa]
Temperature [°C]
Wind [m/s]

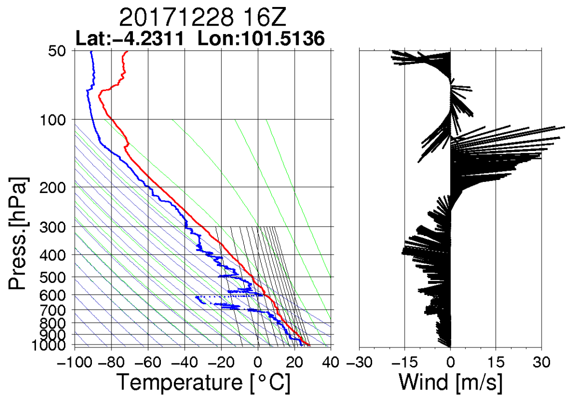

20171228 21Z
Lat:−4.2447 Lon:101.5147
Press.[hPa]
Temperature [°C]
Wind [m/s]

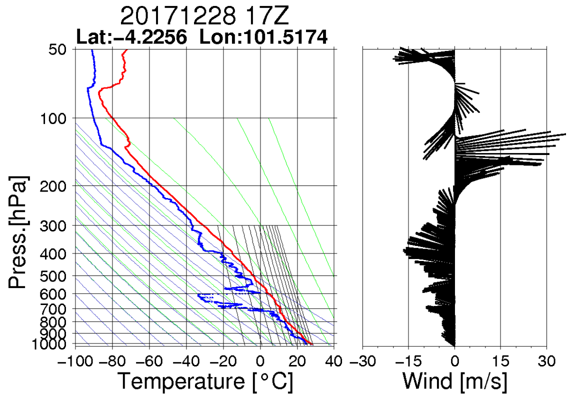

20171228 10Z
Lat:−4.2290 Lon:101.5225
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171228 11Z
Lat:−4.2322 Lon:101.5221
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171228 13Z
Lat:−4.2390 Lon:101.5193
Press.[hPa]
Temperature [°C]
Wind [m/s]

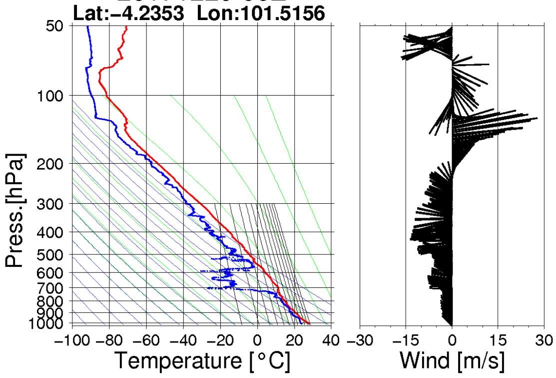

20171228 14Z
Lat:−4.2404 Lon:101.5192
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171228 16Z
Lat:−4.2311 Lon:101.5136
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171228 17Z
Lat:−4.2256 Lon:101.5174
Press.[hPa]
Temperature [°C]
Wind [m/s]

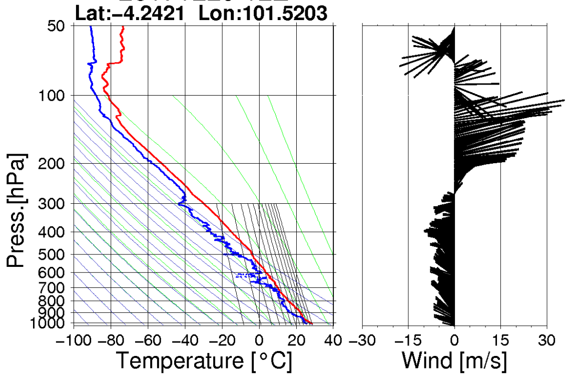
20171229 00Z

Lat:-4.2353 Lon:101.5156



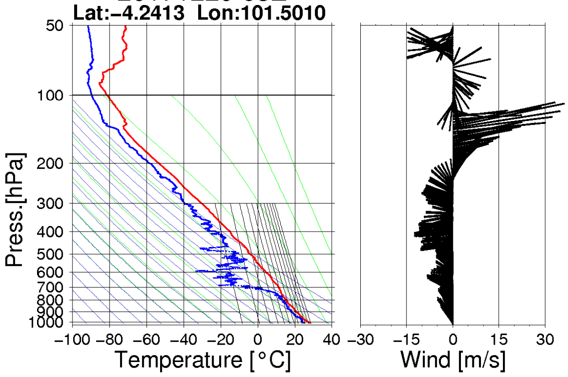
20171229 12Z

Lat:-4.2421 Lon:101.5203



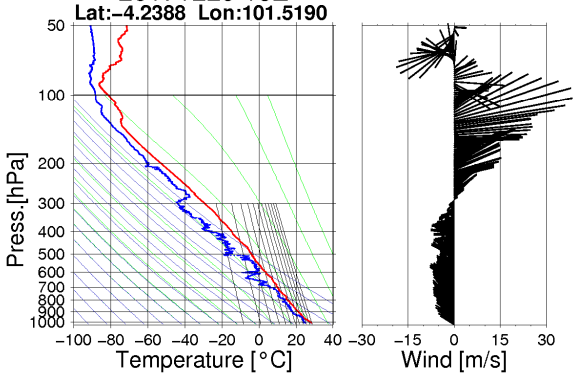
20171229 03Z

Lat:-4.2413 Lon:101.5010



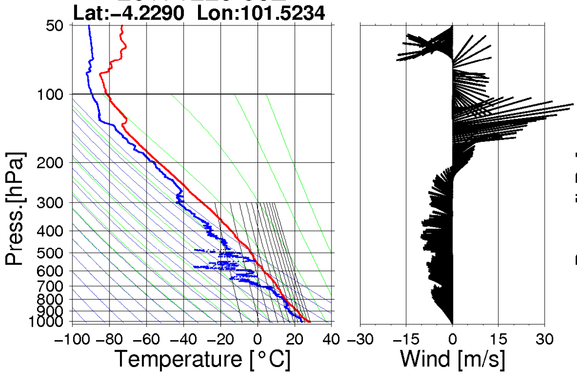
20171229 15Z

Lat:-4.2388 Lon:101.5190



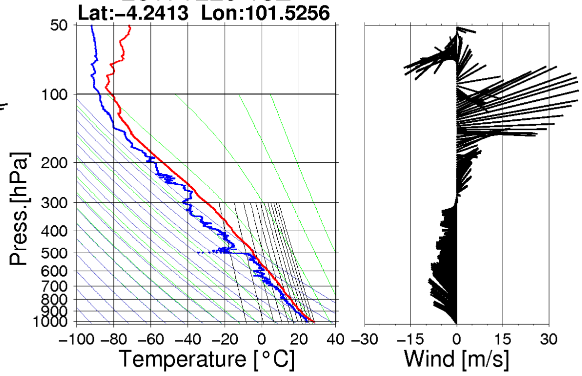
20171229 06Z

Lat:-4.2290 Lon:101.5234



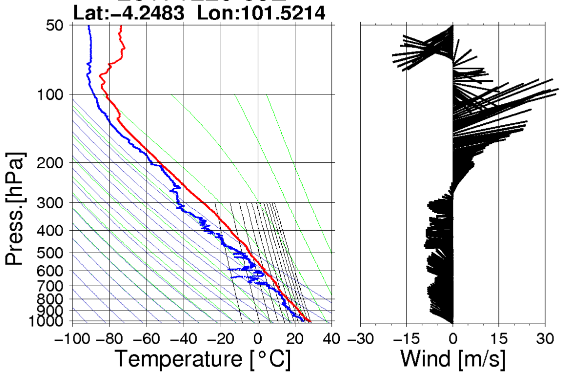
20171229 18Z

Lat:-4.2413 Lon:101.5256



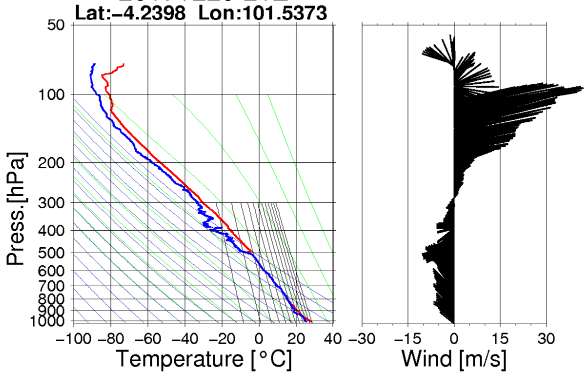
20171229 09Z

Lat:-4.2483 Lon:101.5214



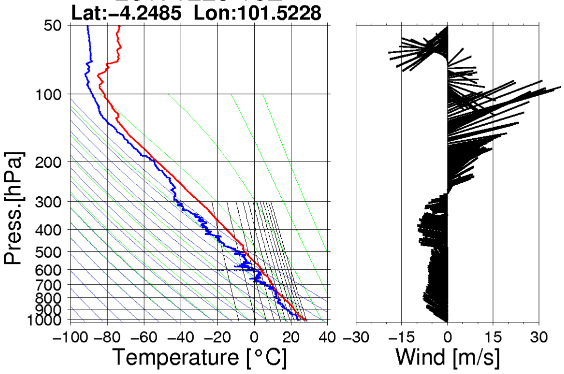
20171229 21Z

Lat:-4.2398 Lon:101.5373



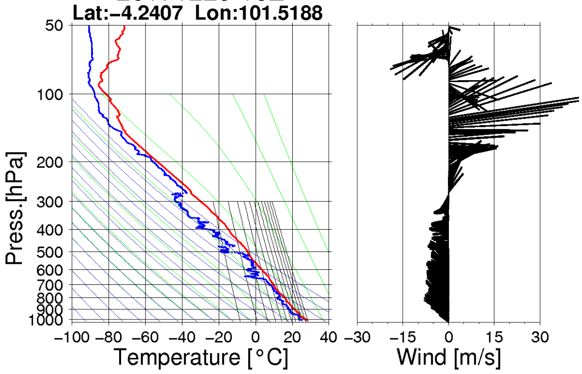
20171229 10Z

Lat:-4.2485 Lon:101.5228



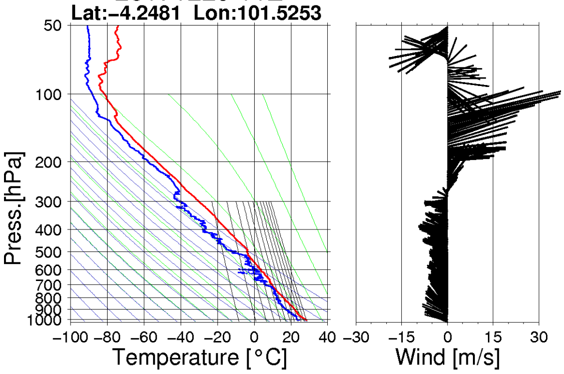
20171229 16Z

Lat:-4.2407 Lon:101.5188



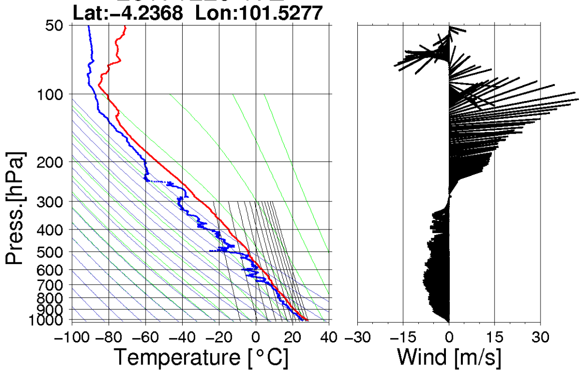
20171229 11Z

Lat:-4.2481 Lon:101.5253



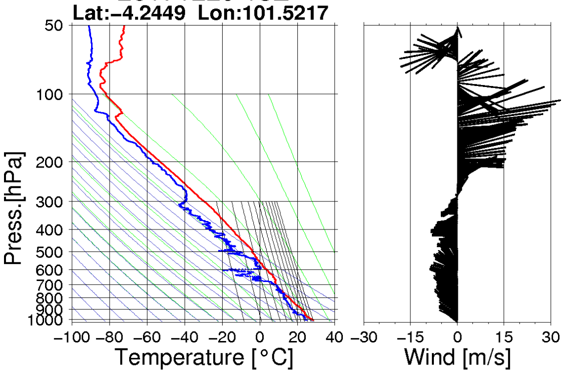
20171229 17Z

Lat:-4.2368 Lon:101.5277



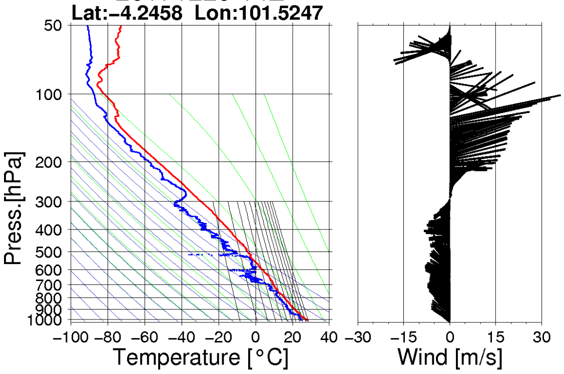
20171229 13Z

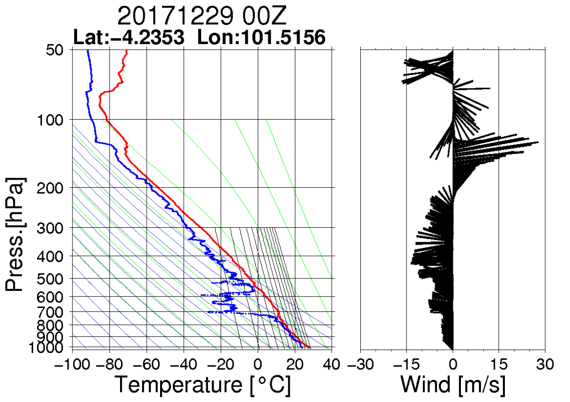
Lat:-4.2449 Lon:101.5217

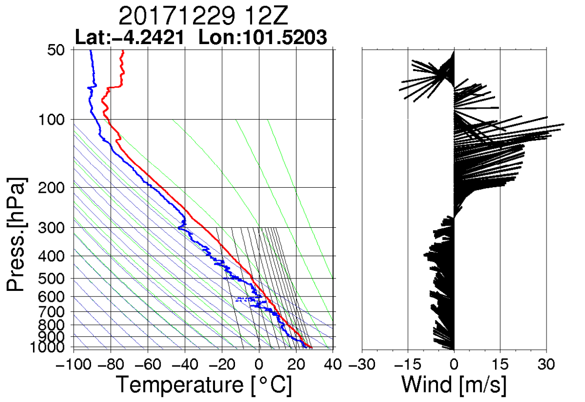


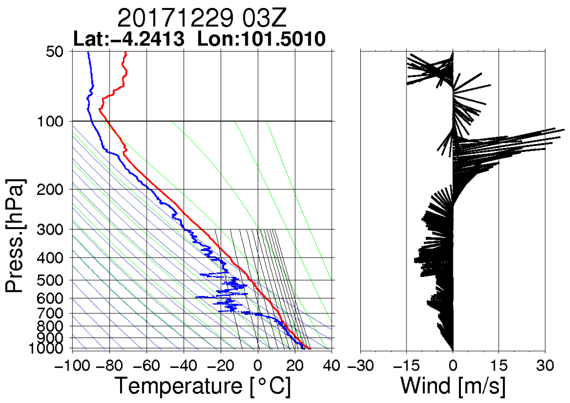
20171229 14Z

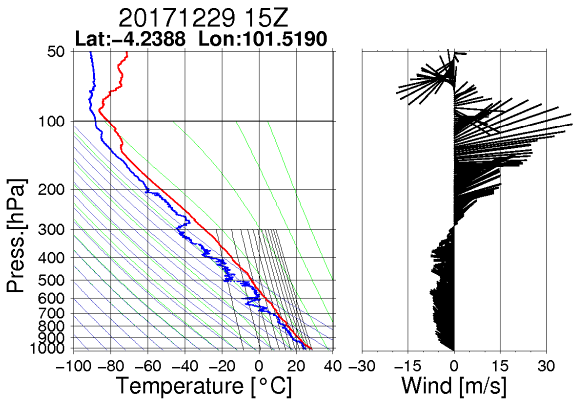
Lat:-4.2458 Lon:101.5247

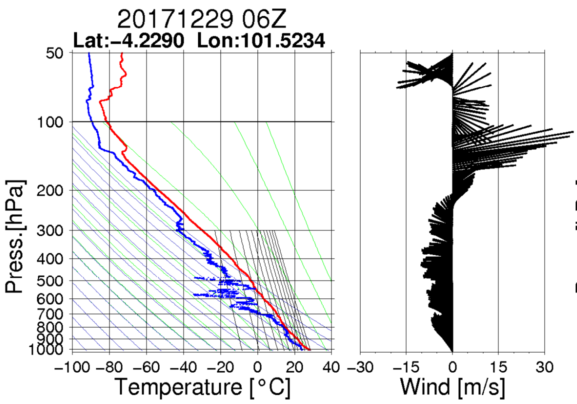


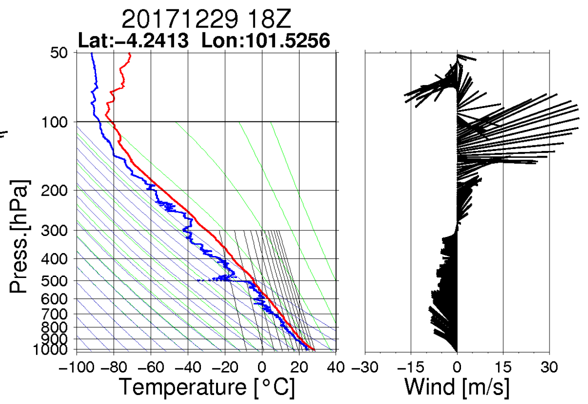

20171229 00Z
Lat:-4.2353 Lon:101.5156
Press.[hPa]
Temperature [°C]
Wind [m/s]

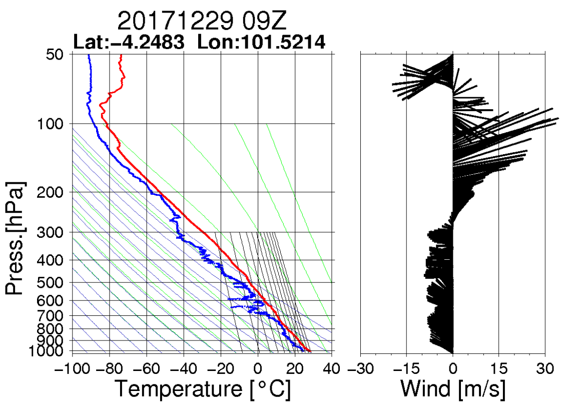

20171229 12Z
Lat:-4.2421 Lon:101.5203
Press.[hPa]
Temperature [°C]
Wind [m/s]

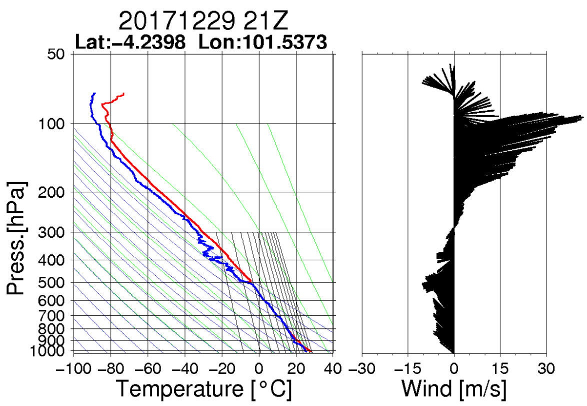

20171229 03Z
Lat:-4.2413 Lon:101.5010
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171229 15Z
Lat:-4.2388 Lon:101.5190
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171229 06Z
Lat:-4.2290 Lon:101.5234
Press.[hPa]
Temperature [°C]
Wind [m/s]

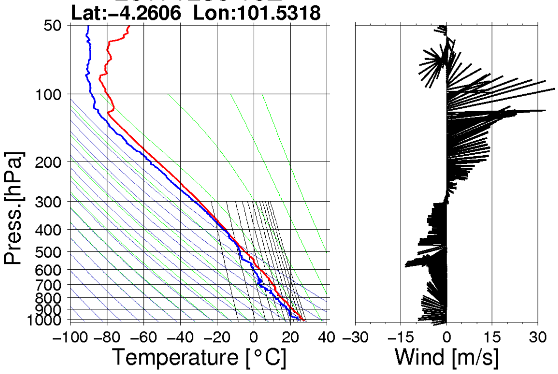

20171229 18Z
Lat:-4.2413 Lon:101.5256
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171229 09Z
Lat:-4.2483 Lon:101.5214
Press.[hPa]
Temperature [°C]
Wind [m/s]


20171229 21Z
Lat:-4.2398 Lon:101.5373
Press.[hPa]
Temperature [°C]
Wind [m/s]

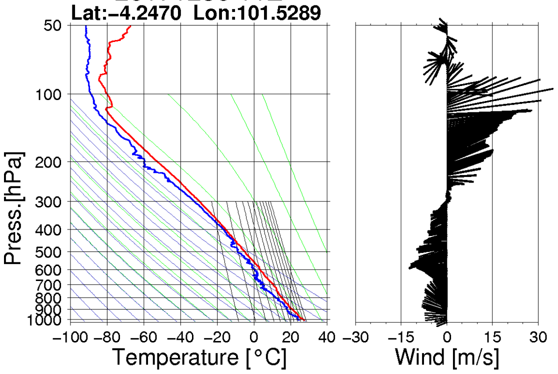
20171230 10Z

Lat:−4.2606 Lon:101.5318



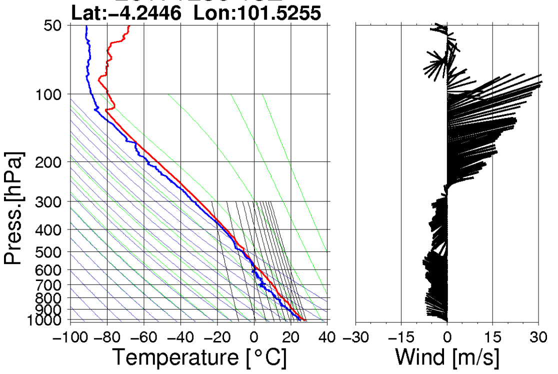
20171230 11Z

Lat:−4.2470 Lon:101.5289



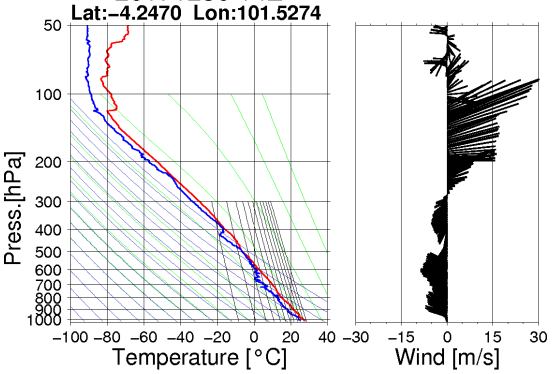
20171230 13Z

Lat:−4.2446 Lon:101.5255



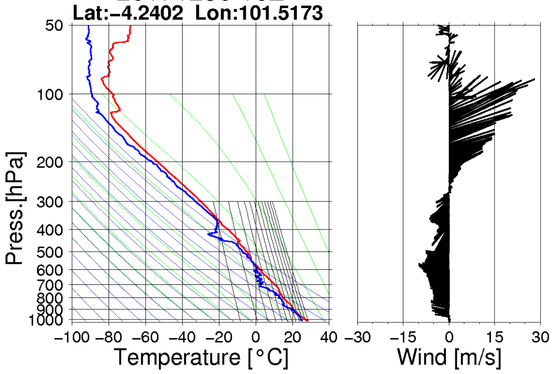
20171230 14Z

Lat:−4.2470 Lon:101.5274



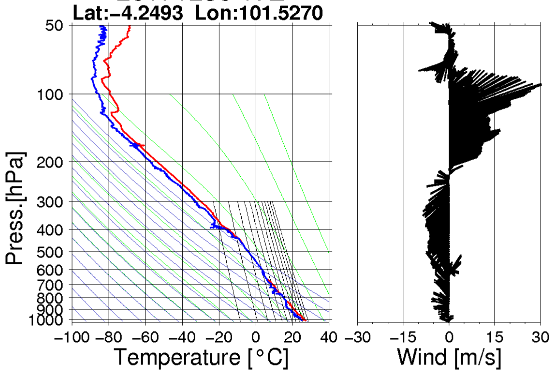
20171230 16Z

Lat:−4.2402 Lon:101.5173



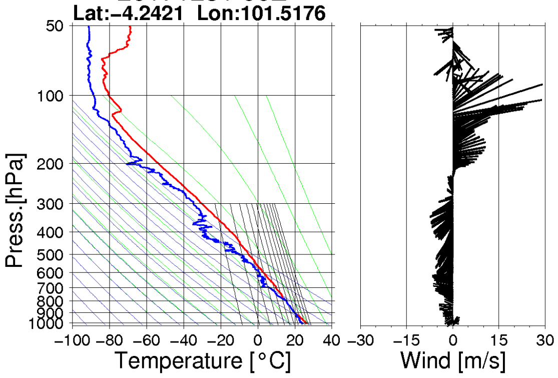
20171230 17Z

Lat:−4.2493 Lon:101.5270



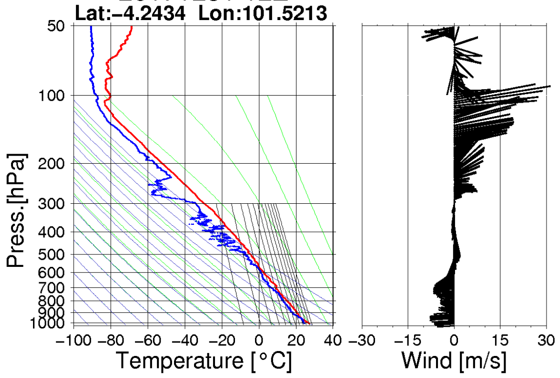
20171231 00Z

Lat:-4.2421 Lon:101.5176



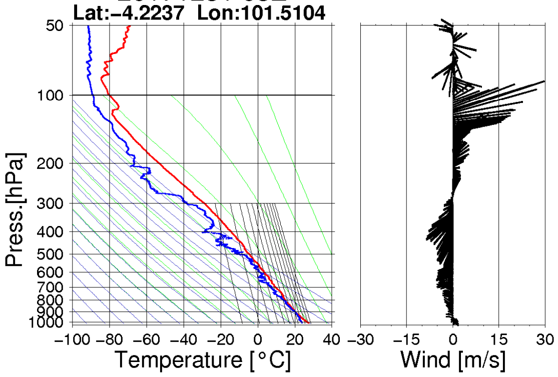
20171231 12Z

Lat:-4.2434 Lon:101.5213



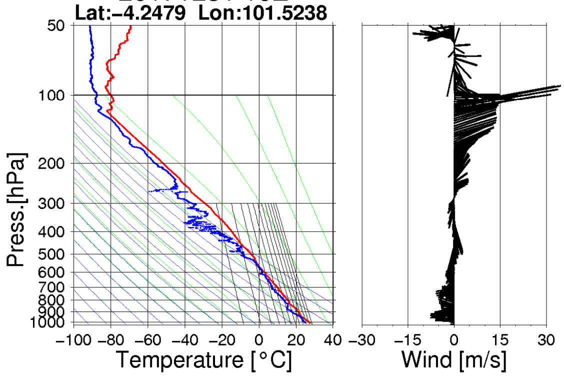
20171231 03Z

Lat:-4.2237 Lon:101.5104



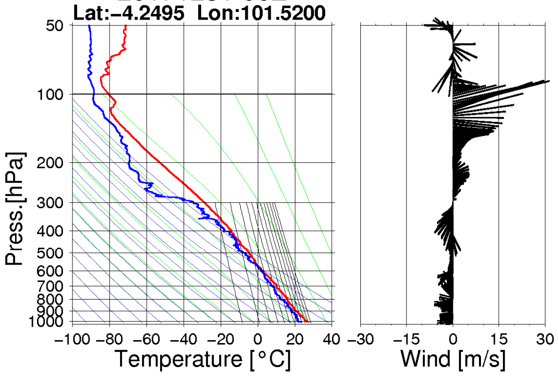
20171231 15Z

Lat:-4.2479 Lon:101.5238



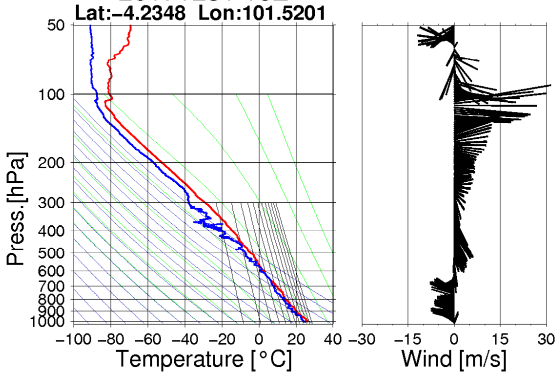
20171231 06Z

Lat:-4.2495 Lon:101.5200



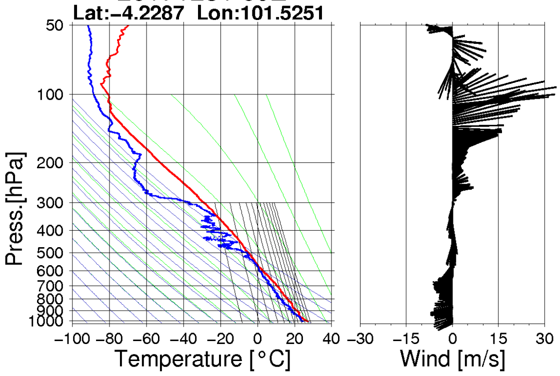
20171231 18Z

Lat:-4.2348 Lon:101.5201



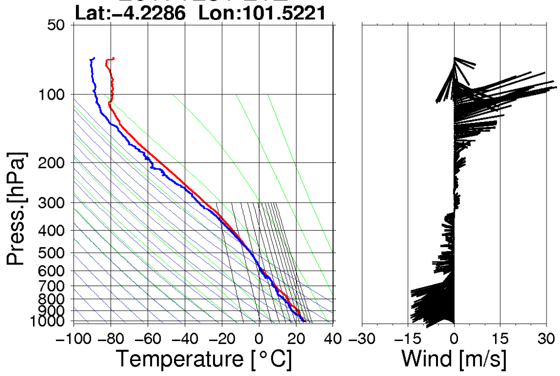
20171231 09Z

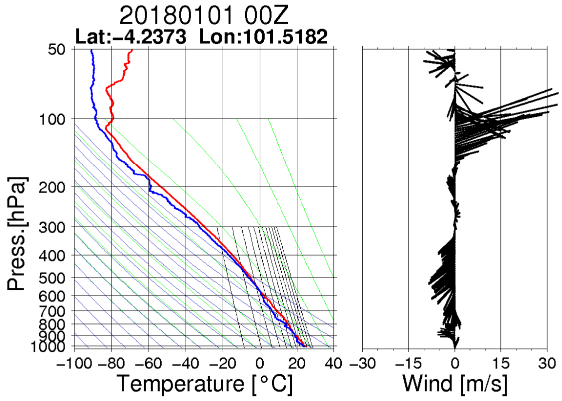
Lat:-4.2287 Lon:101.5251

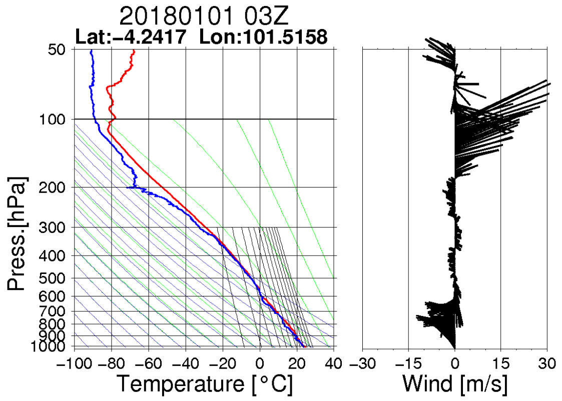


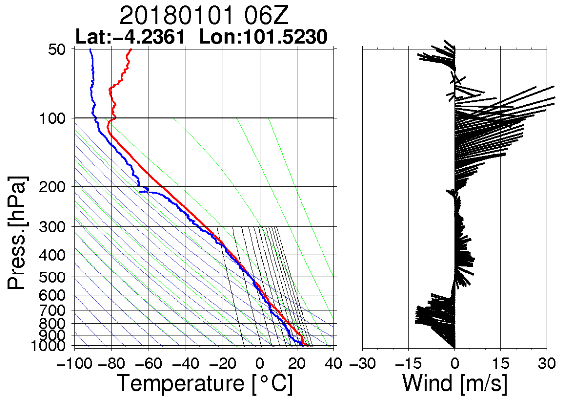
20171231 21Z

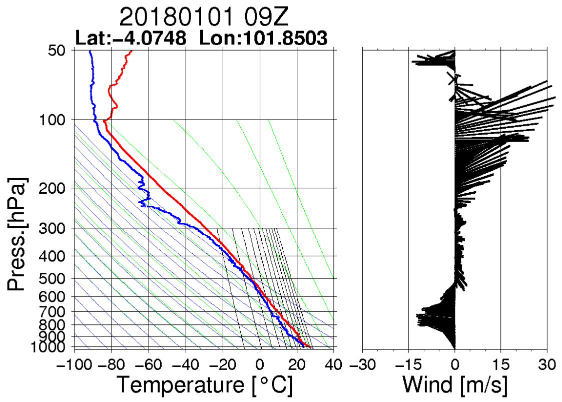
Lat:-4.2286 Lon:101.5221

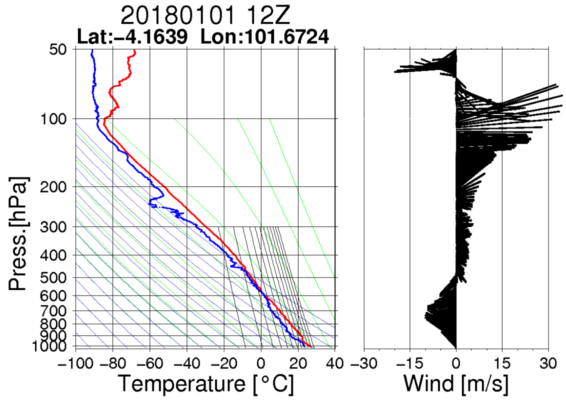


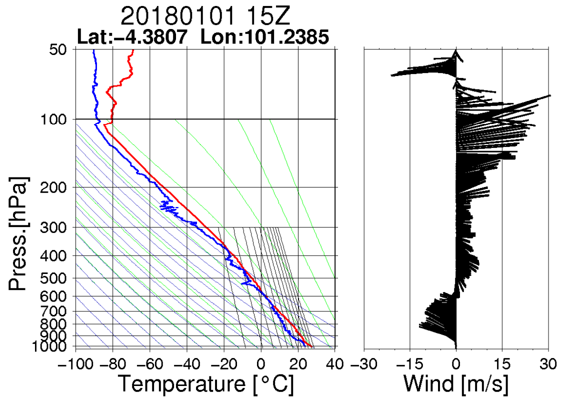

20180101 00Z
Lat:−4.2373 Lon:101.5182
Press.[hPa]
Temperature [°C]
Wind [m/s]

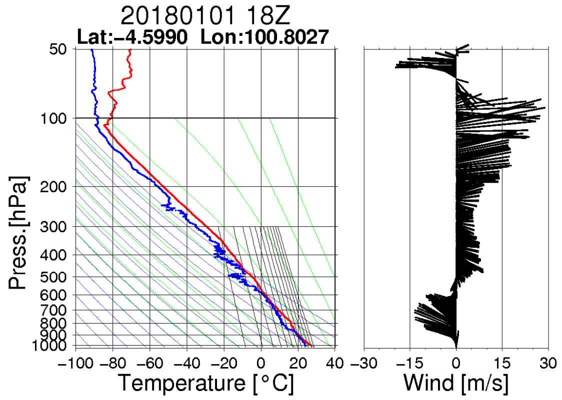

20180101 03Z
Lat:−4.2417 Lon:101.5158
Press.[hPa]
Temperature [°C]
Wind [m/s]

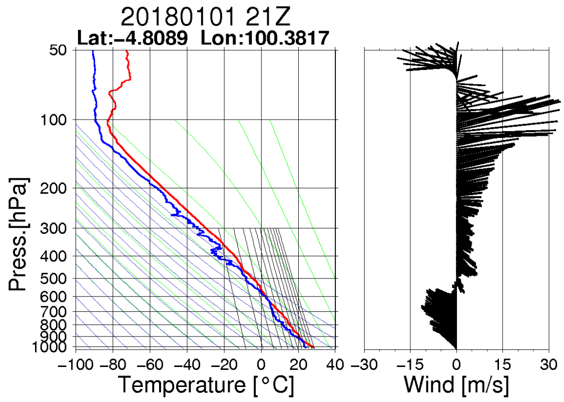

20180101 06Z
Lat:−4.2361 Lon:101.5230
Press.[hPa]
Temperature [°C]
Wind [m/s]


20180101 09Z
Lat:−4.0748 Lon:101.8503
Press.[hPa]
Temperature [°C]
Wind [m/s]

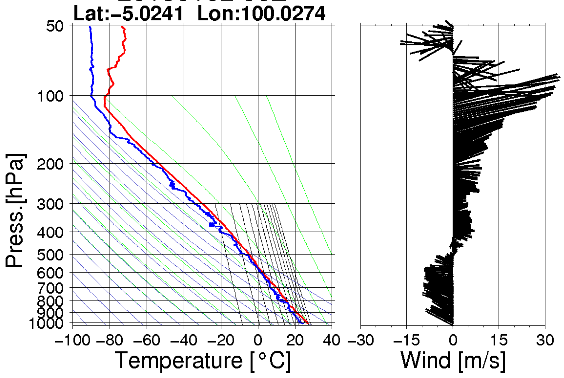

20180101 12Z
Lat:−4.1639 Lon:101.6724
Press.[hPa]
Temperature [°C]
Wind [m/s]


20180101 15Z
Lat:−4.3807 Lon:101.2385
Press.[hPa]
Temperature [°C]
Wind [m/s]

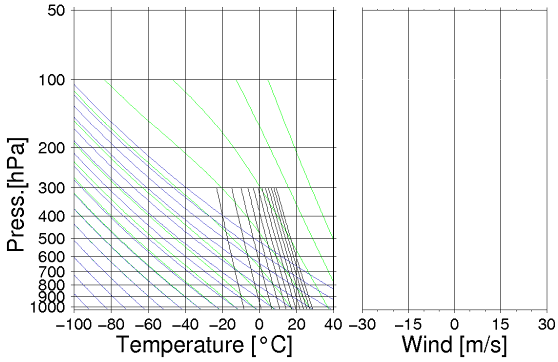

20180101 18Z
Lat:−4.5990 Lon:100.8027
Press.[hPa]
Temperature [°C]
Wind [m/s]


20180101 21Z
Lat:−4.8089 Lon:100.3817
Press.[hPa]
Temperature [°C]
Wind [m/s]

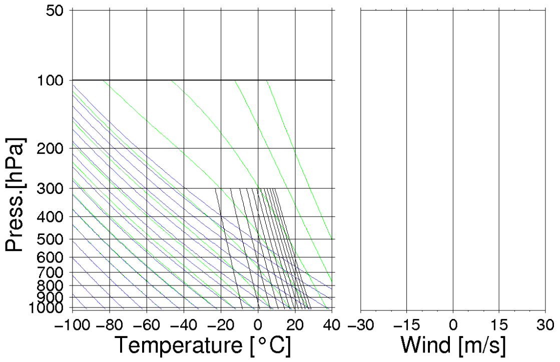
20180102 00Z



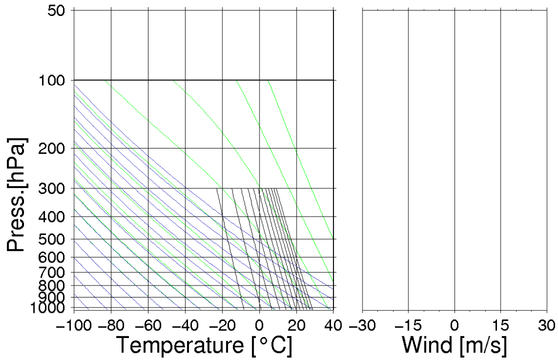
20180102 12Z



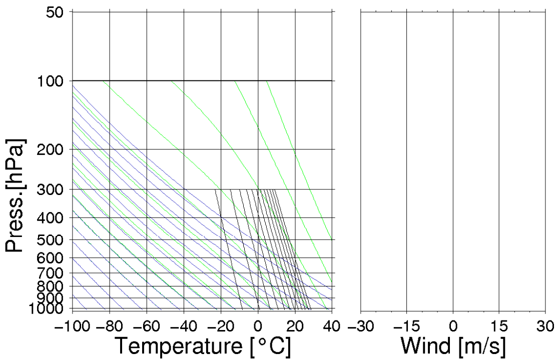
20180102 03Z



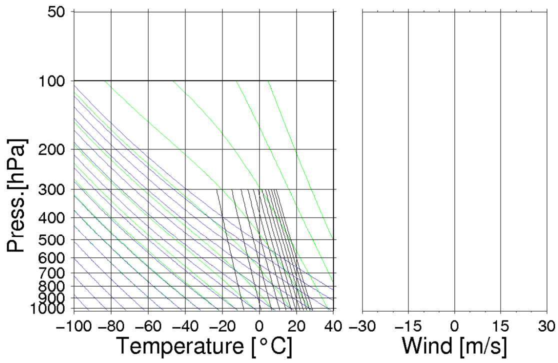
20180102 15Z



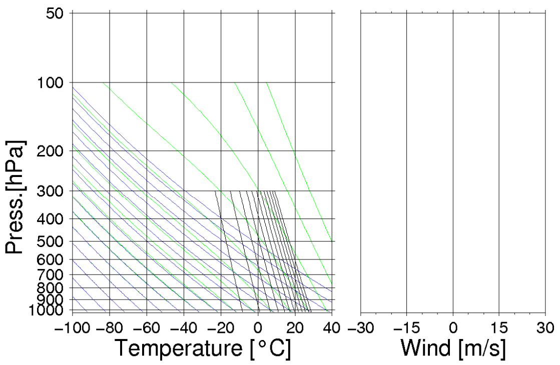
20180102 06Z



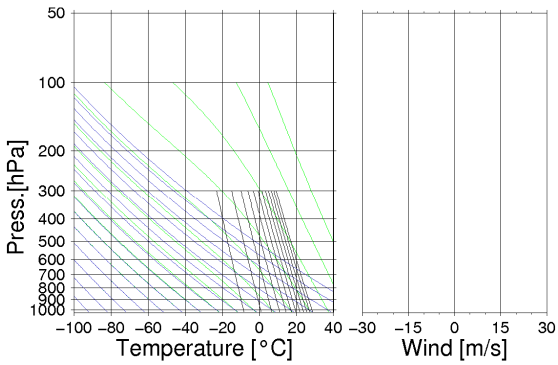
20180102 18Z



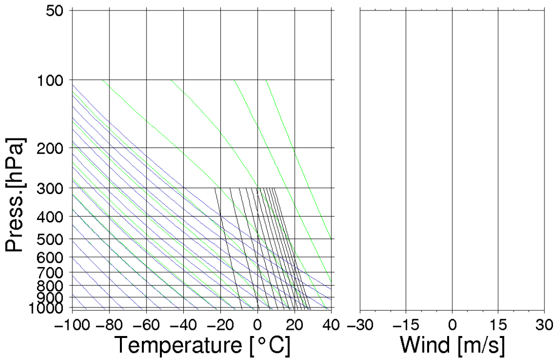
20180102 09Z



20180102 21Z

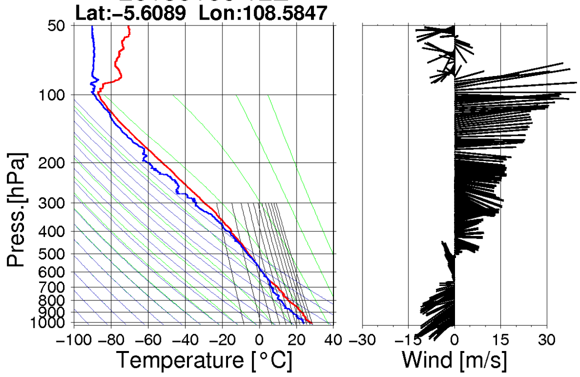


20180106 00Z

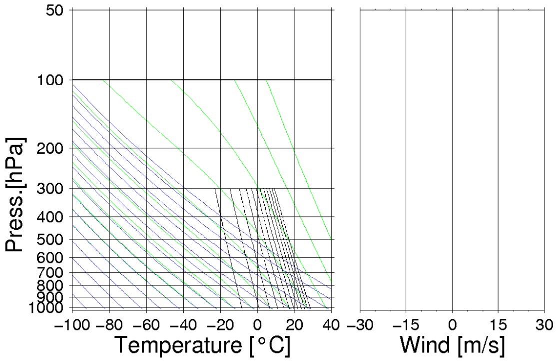


20180106 12Z

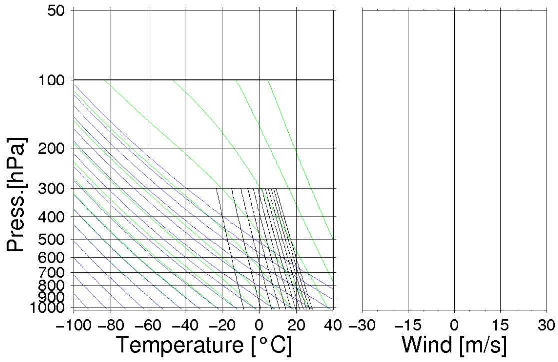
Lat:−5.6089 Lon:108.5847



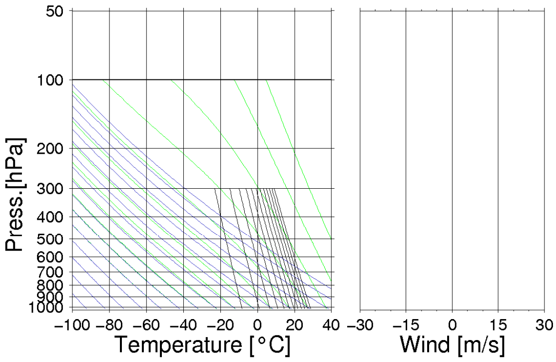
20180106 03Z



20180106 15Z

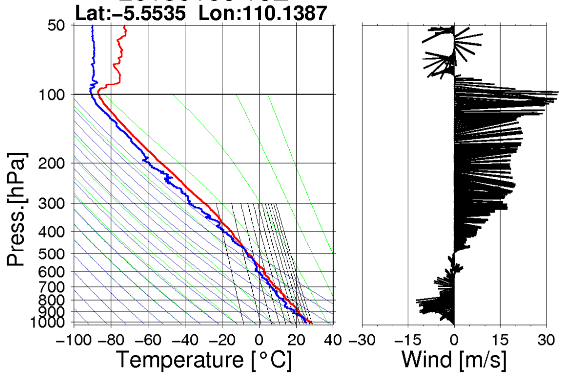


20180106 06Z

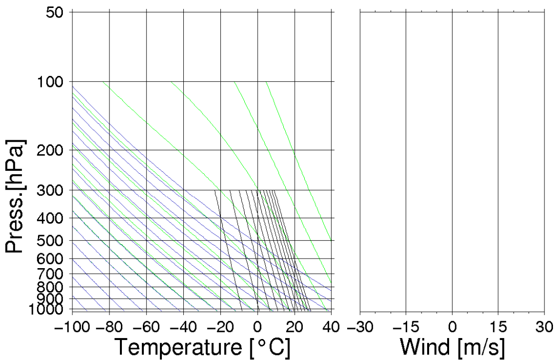


20180106 18Z

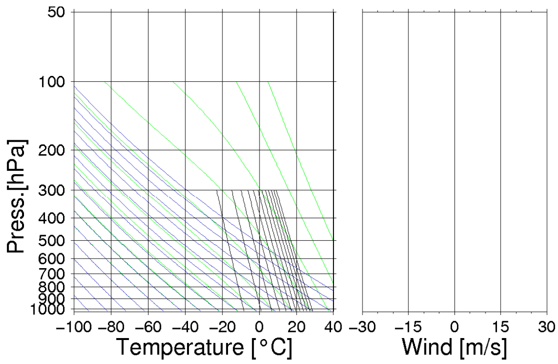
Lat:−5.5535 Lon:110.1387

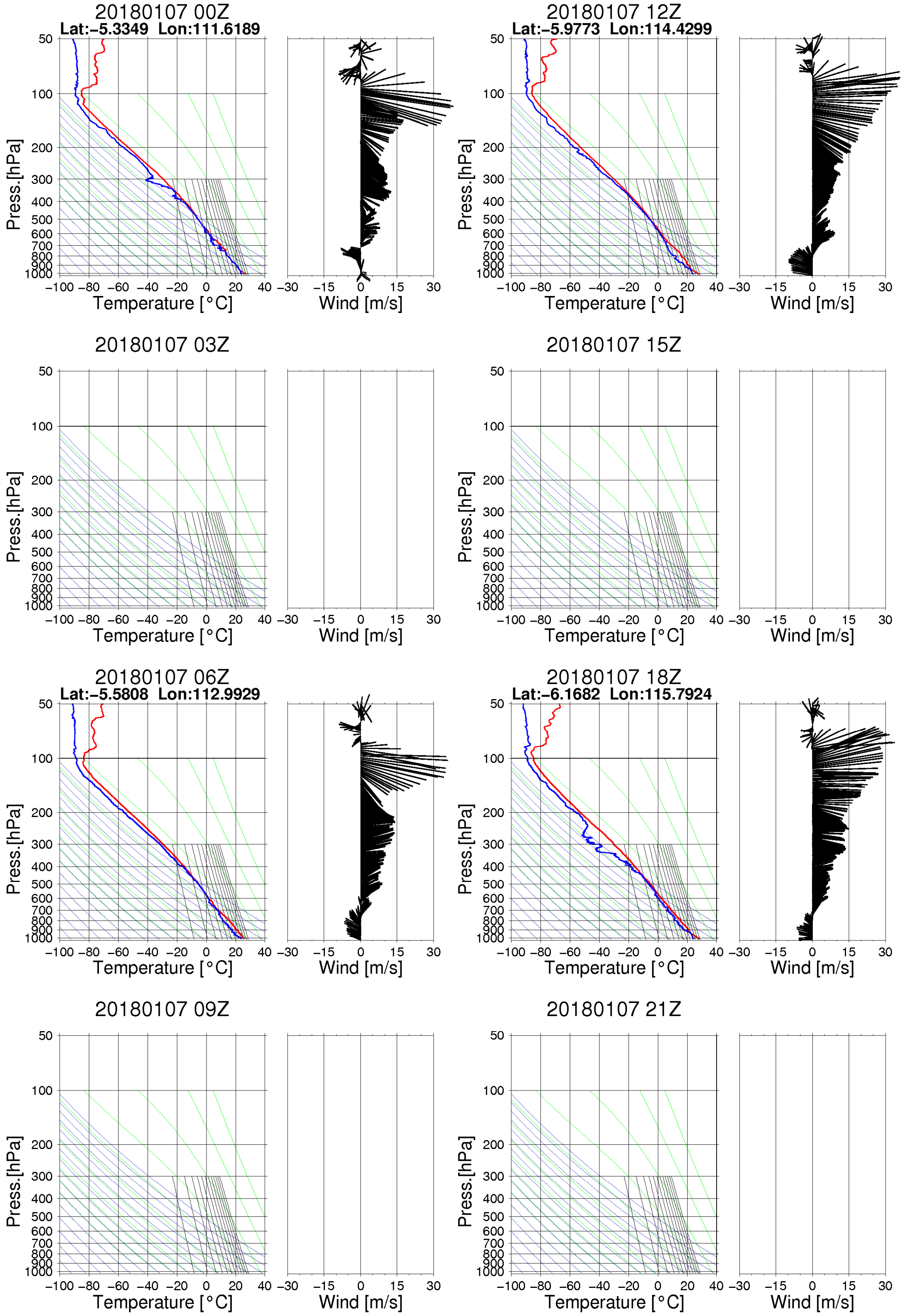


20180106 09Z

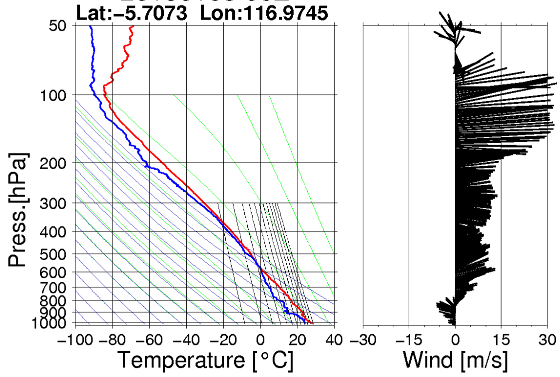


20180106 21Z

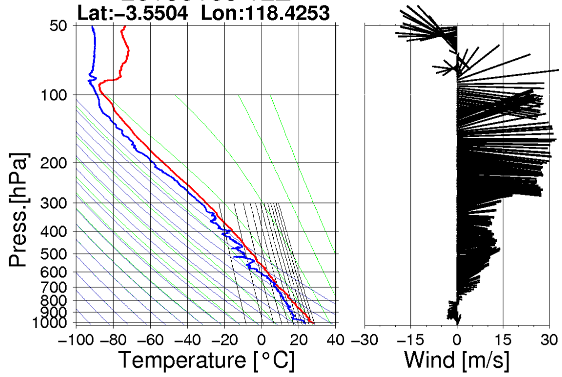



20180107 00Z
Lat:−5.3349 Lon:111.6189
20180107 12Z
Lat:−5.9773 Lon:114.4299
20180107 03Z
20180107 15Z
20180107 06Z
Lat:−5.5808 Lon:112.9929
20180107 18Z
Lat:−6.1682 Lon:115.7924
20180107 09Z
20180107 21Z
Press.[hPa]
50
100
200
300
400
500
600
700
800
900
1000
−100 −80 −60 −40 −20 0 20 40
Temperature [°C]
−30 −15 0 15 30
Wind [m/s]

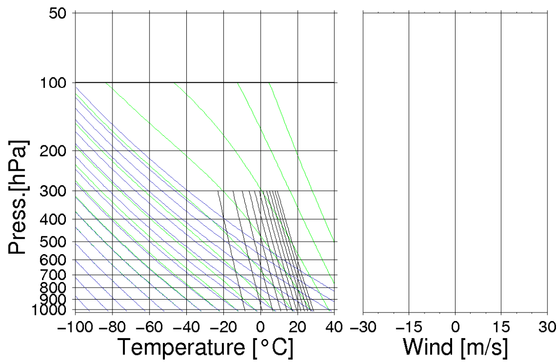
20180108 00Z
Lat:-5.7073 Lon:116.9745



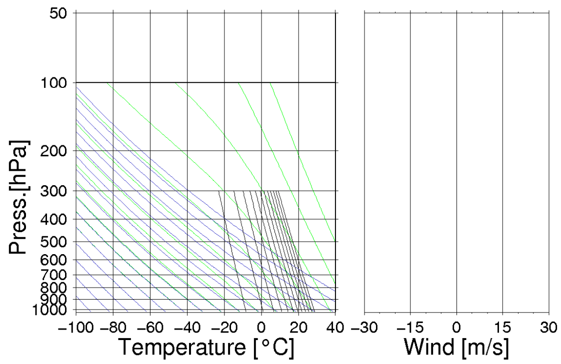
20180108 12Z
Lat:-3.5504 Lon:118.4253



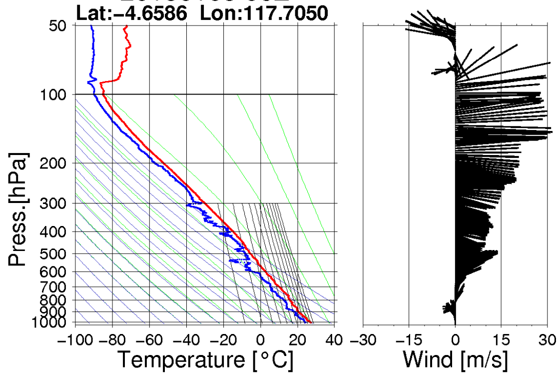
20180108 03Z



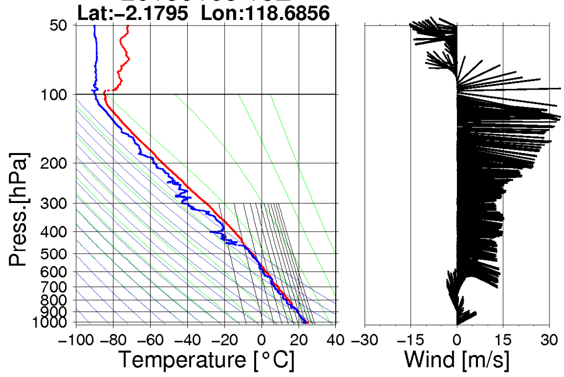
20180108 15Z



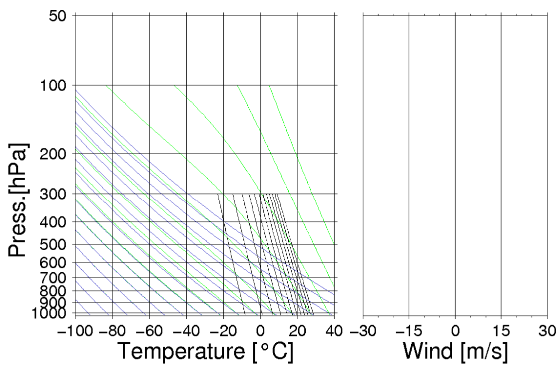
20180108 06Z
Lat:-4.6586 Lon:117.7050



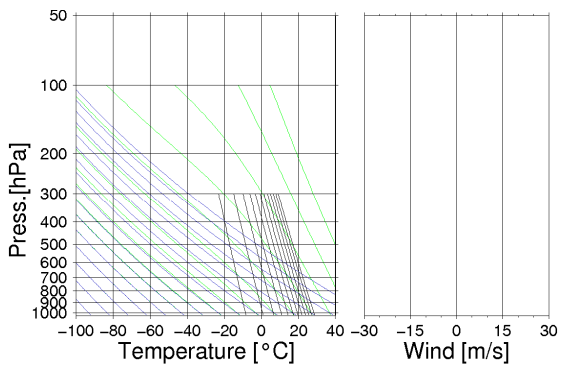
20180108 18Z
Lat:-2.1795 Lon:118.6856



20180108 09Z

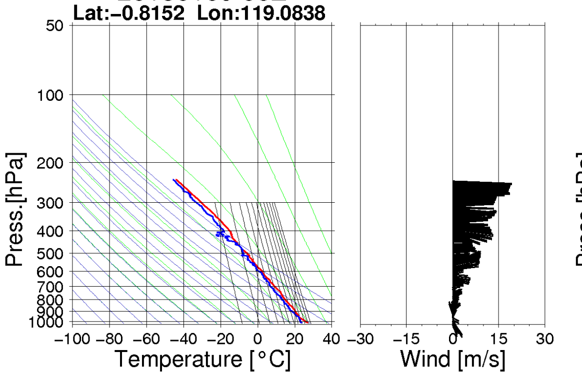


20180108 21Z



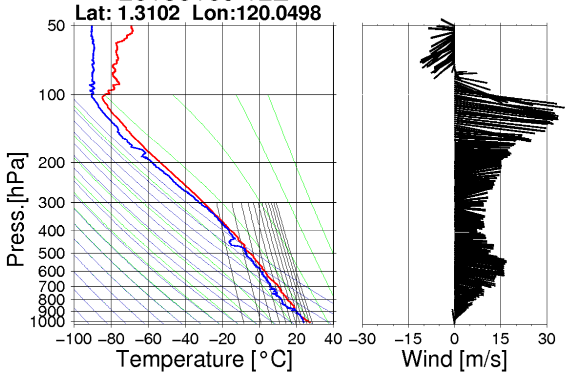
20180109 00Z

Lat:-0.8152 Lon:119.0838

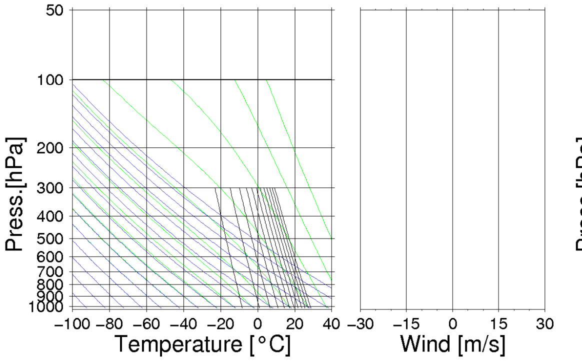


20180109 12Z

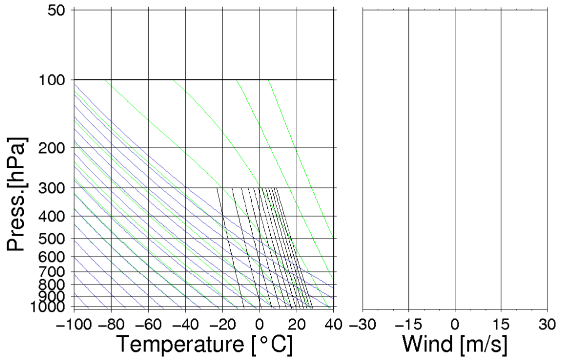
Lat: 1.3102 Lon:120.0498



20180109 03Z

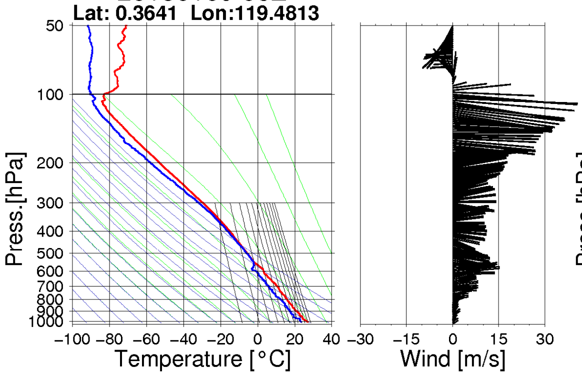


20180109 15Z



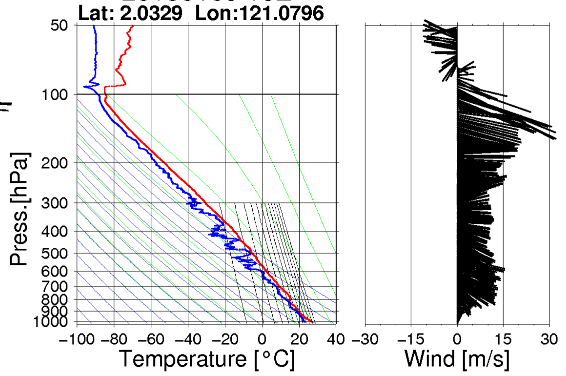
20180109 06Z

Lat: 0.3641 Lon:119.4813

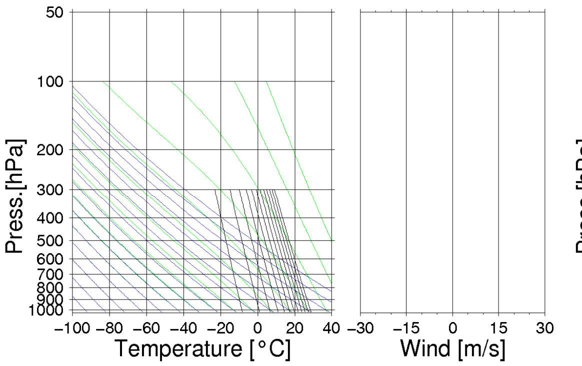


20180109 18Z

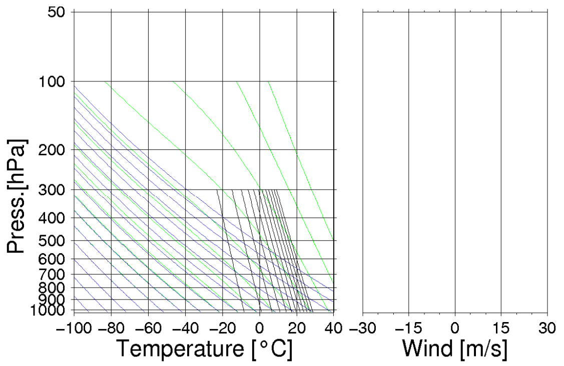
Lat: 2.0329 Lon:121.0796

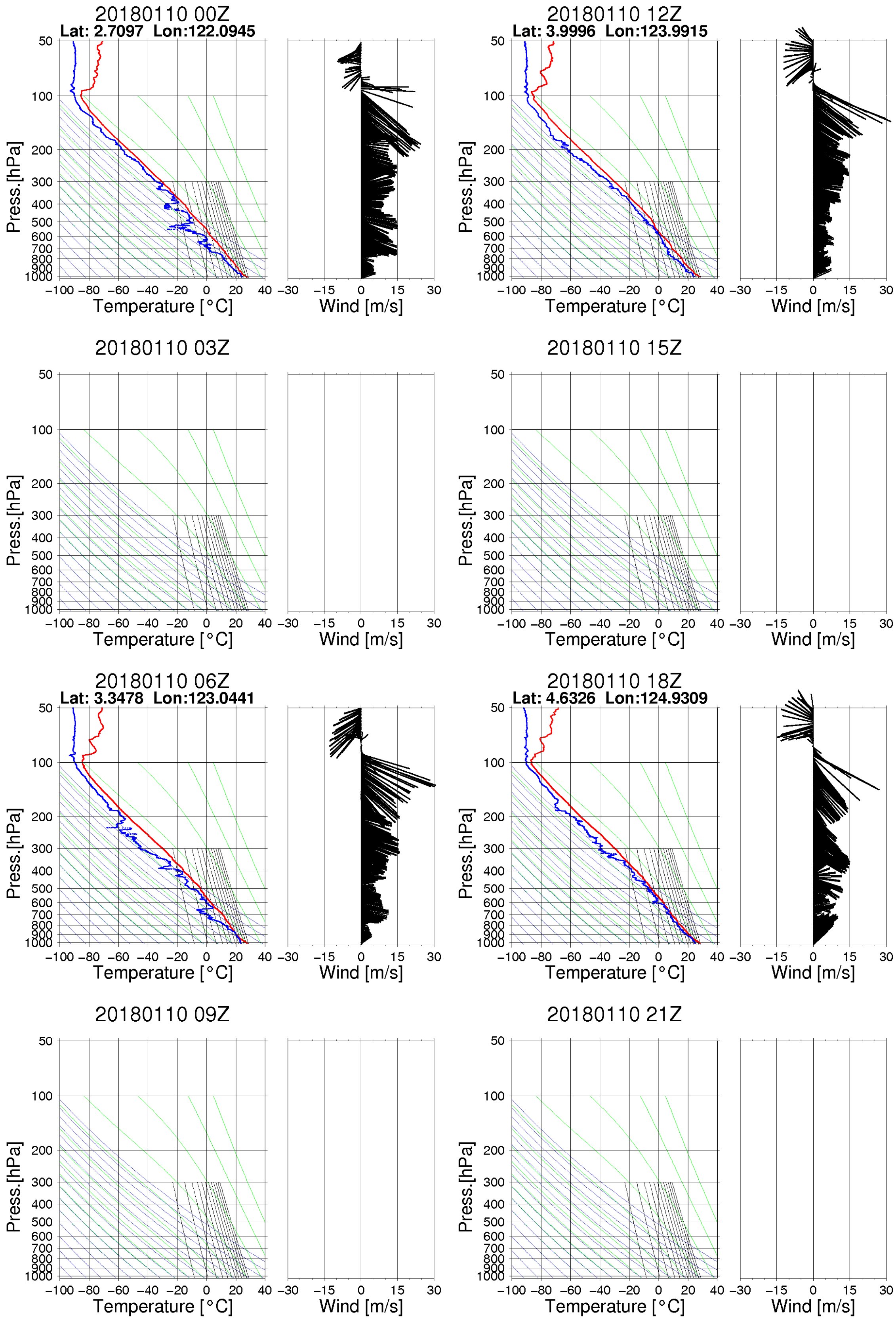


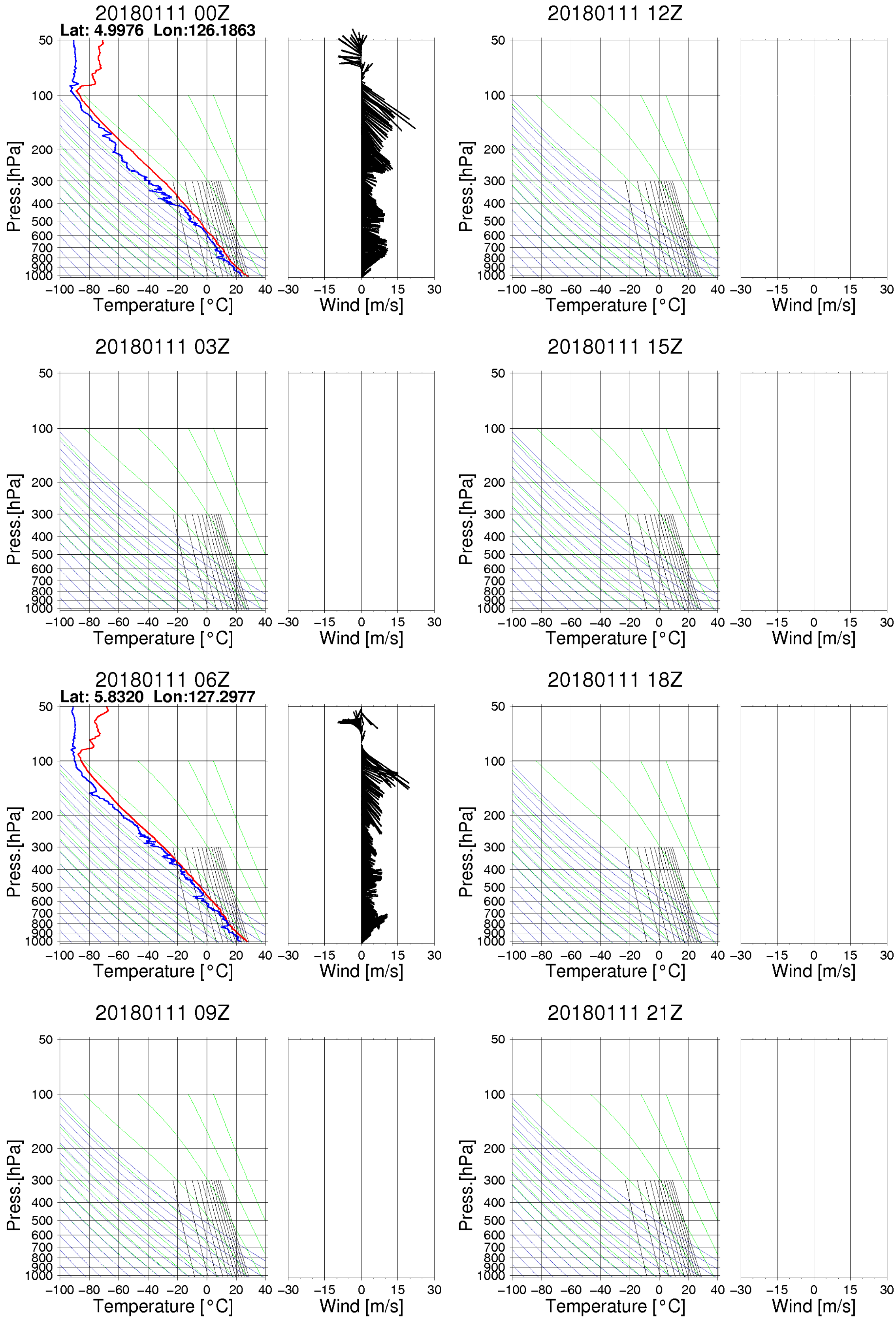
20180109 09Z



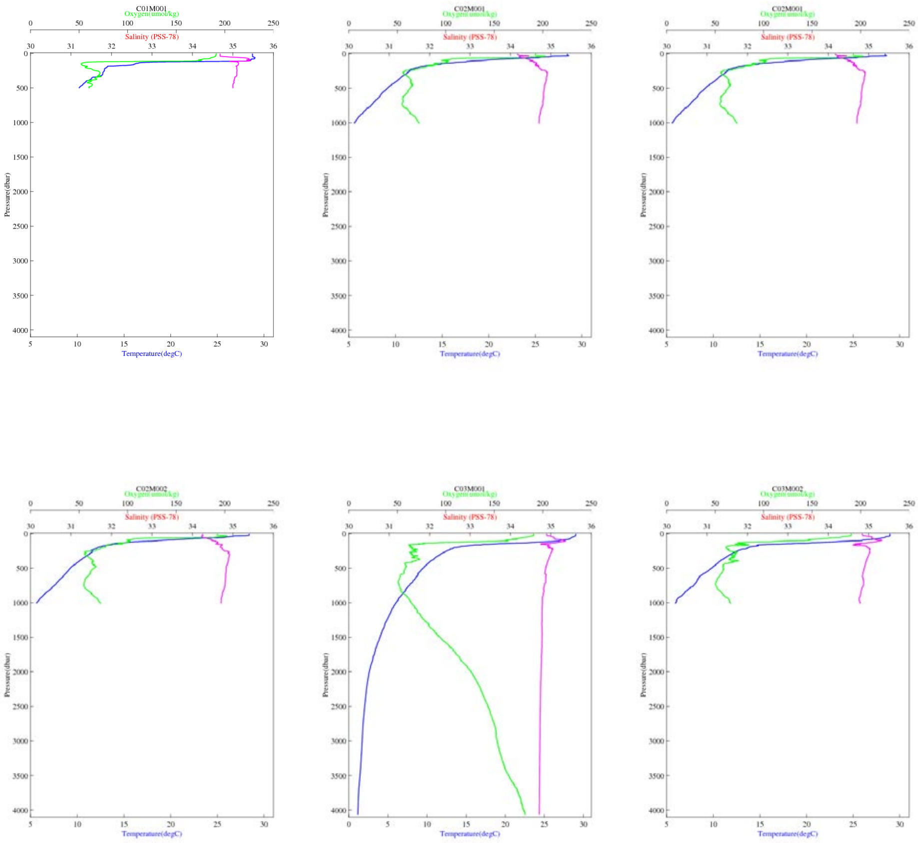
20180109 21Z



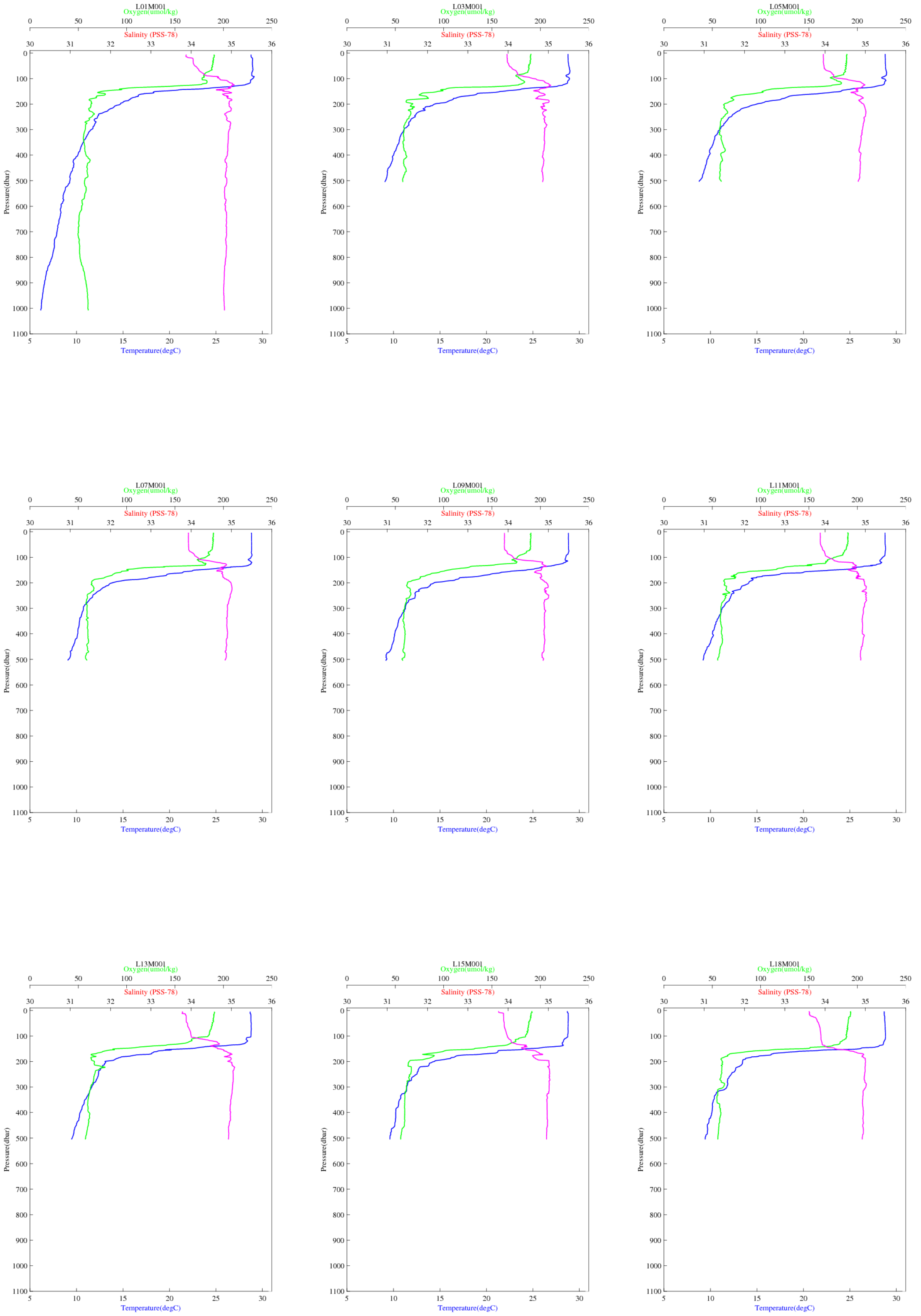

20180110 00Z
Lat: 2.7097 Lon:122.0945
20180110 12Z
Lat: 3.9996 Lon:123.9915
20180110 03Z
20180110 15Z
20180110 06Z
Lat: 3.3478 Lon:123.0441
20180110 18Z
Lat: 4.6326 Lon:124.9309
20180110 09Z
20180110 21Z
Press.[hPa]
Temperature [°C]
Wind [m/s]


20180111 00Z
Lat: 4.9976 Lon:126.1863
20180111 12Z
20180111 03Z
20180111 15Z
20180111 06Z
Lat: 5.8320 Lon:127.2977
20180111 18Z
20180111 09Z
20180111 21Z
Press.[hPa]
Temperature [°C]
Wind [m/s]

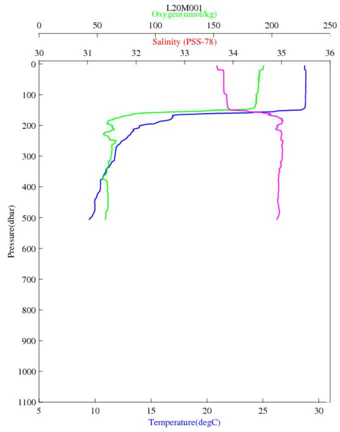
Appendix B: Oceanic profiles by the CTDO observations

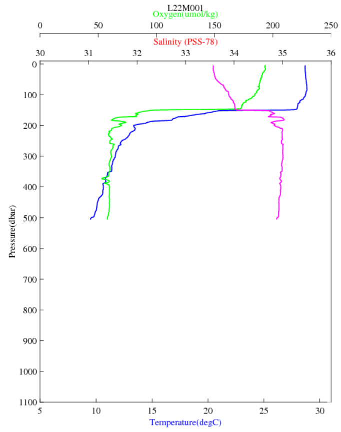


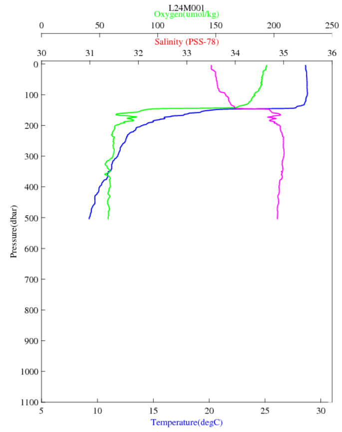
CTD profile (Buoy 25 Nov. 2017 – 30 Nov. 2017 C01M001, C02M001, C02M002, C03M001 and C03M002)

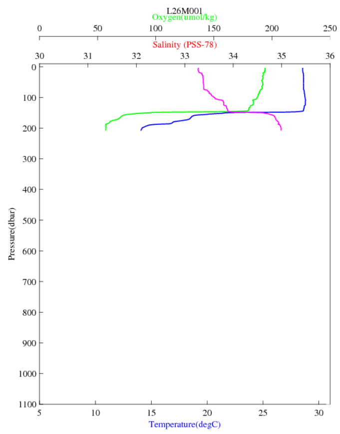


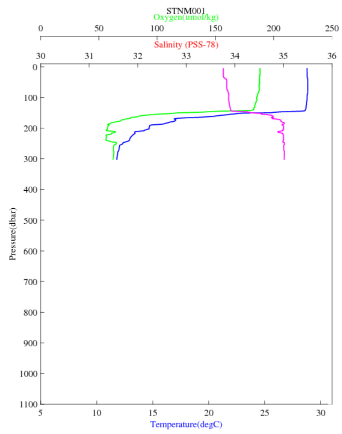
CTD profile (Line 03 Dec. 2017 – 04 Dec. 2017 L01M001, L03M001, L05M001, L07M001, L09M001, L11M001, L13M001, L15M001,and L18M001)



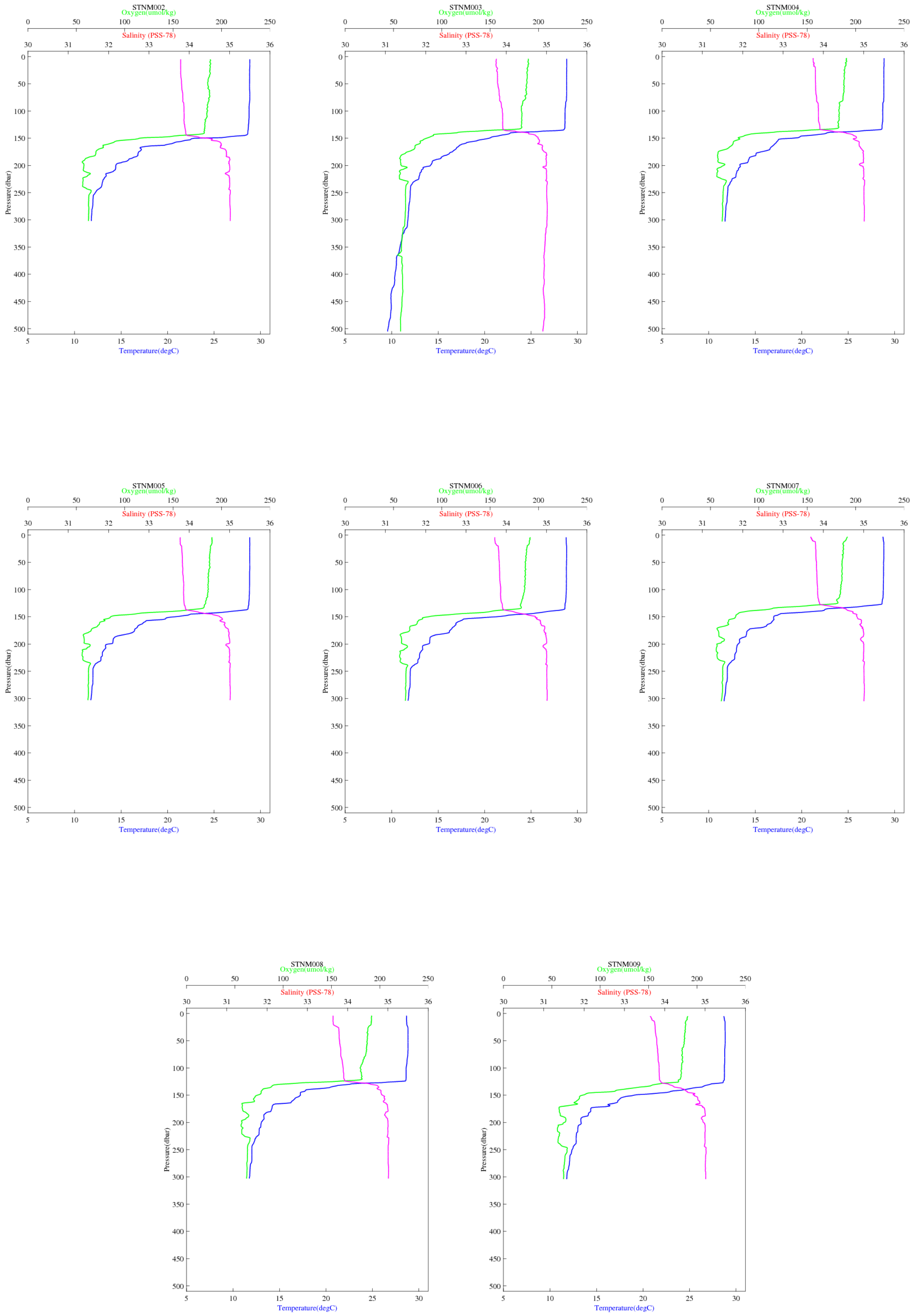




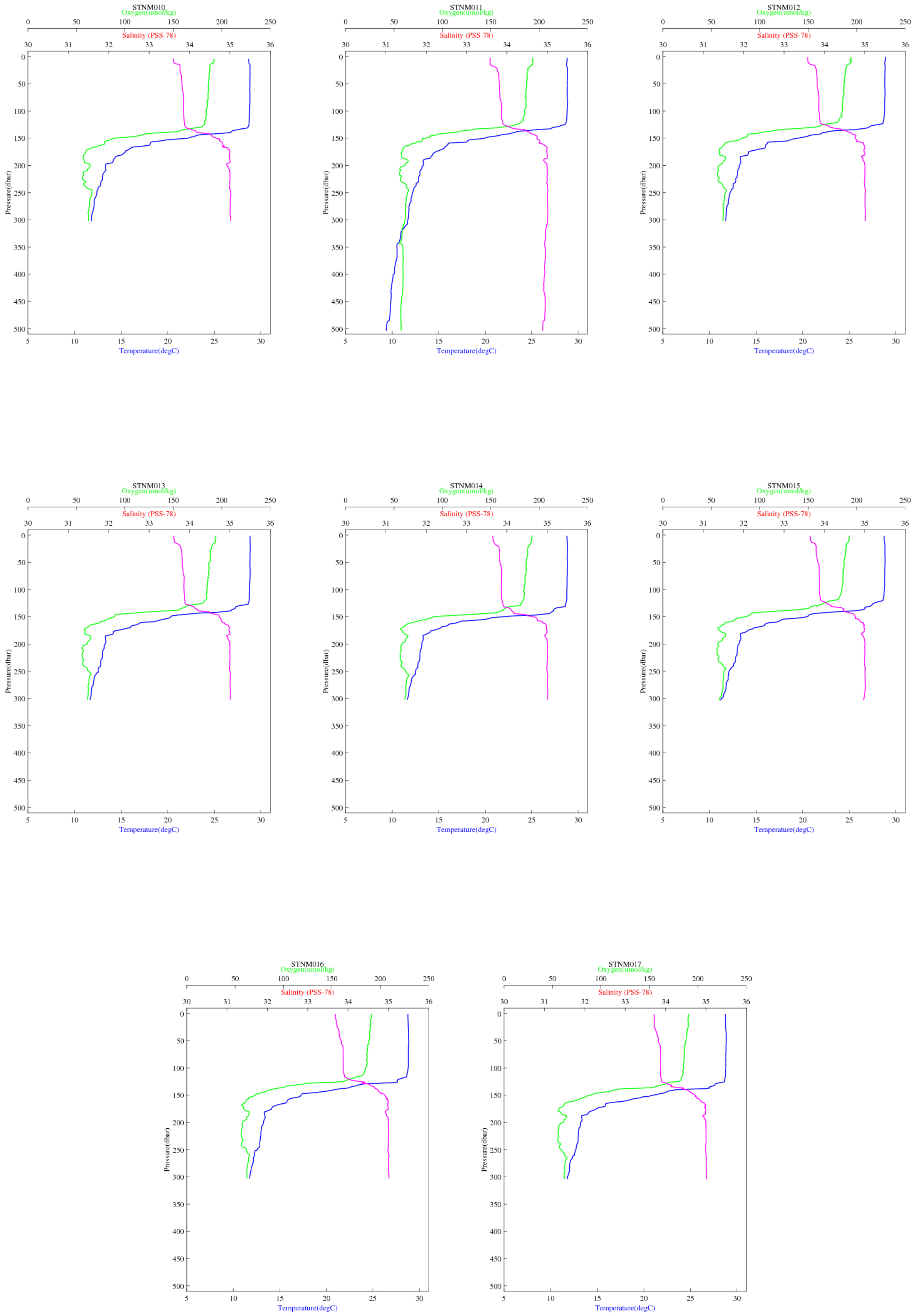




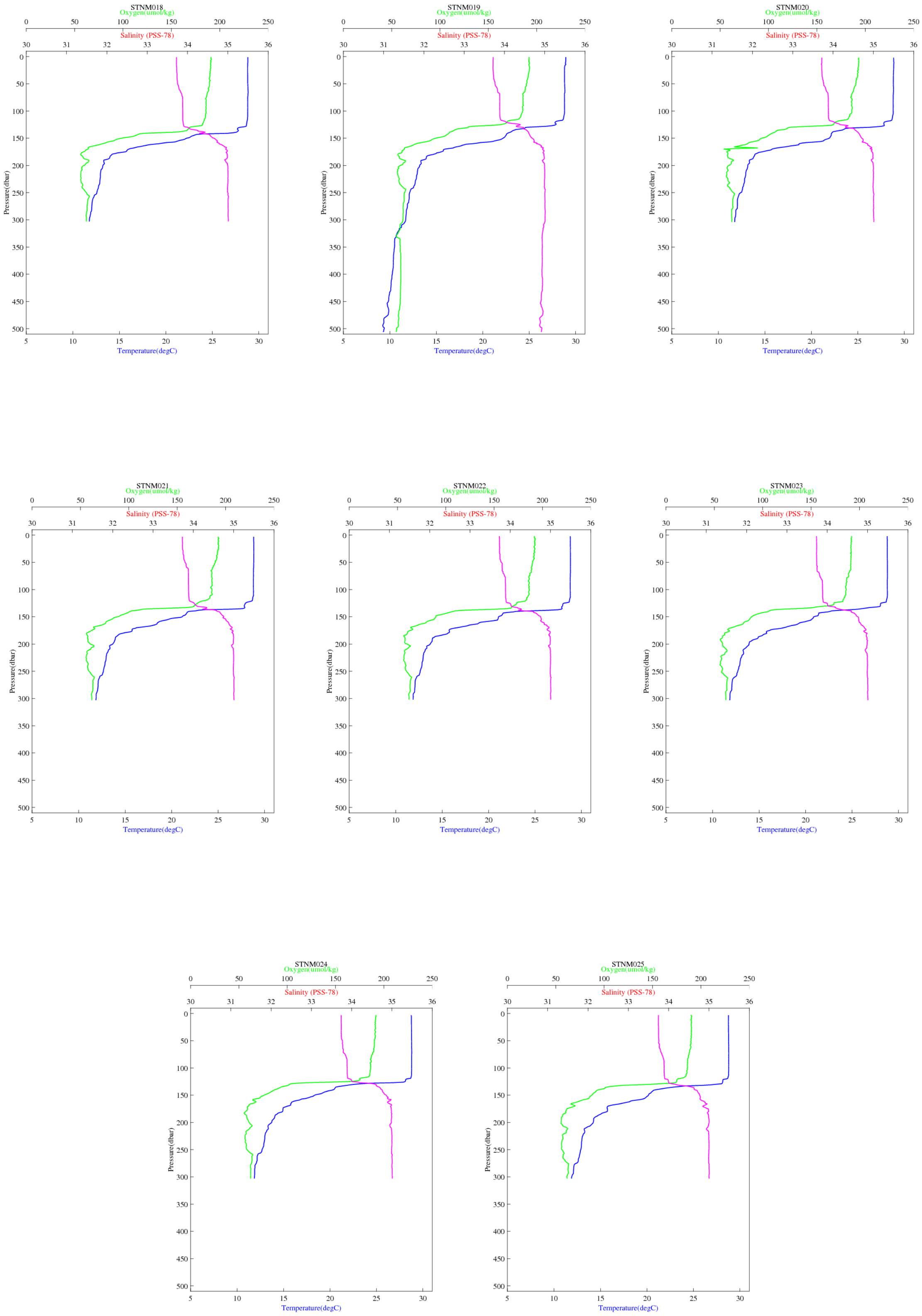
CTD profile (Line 04 Dec. 2017 L20M001, L22M001, L24M001, L26M001 and STNM001)



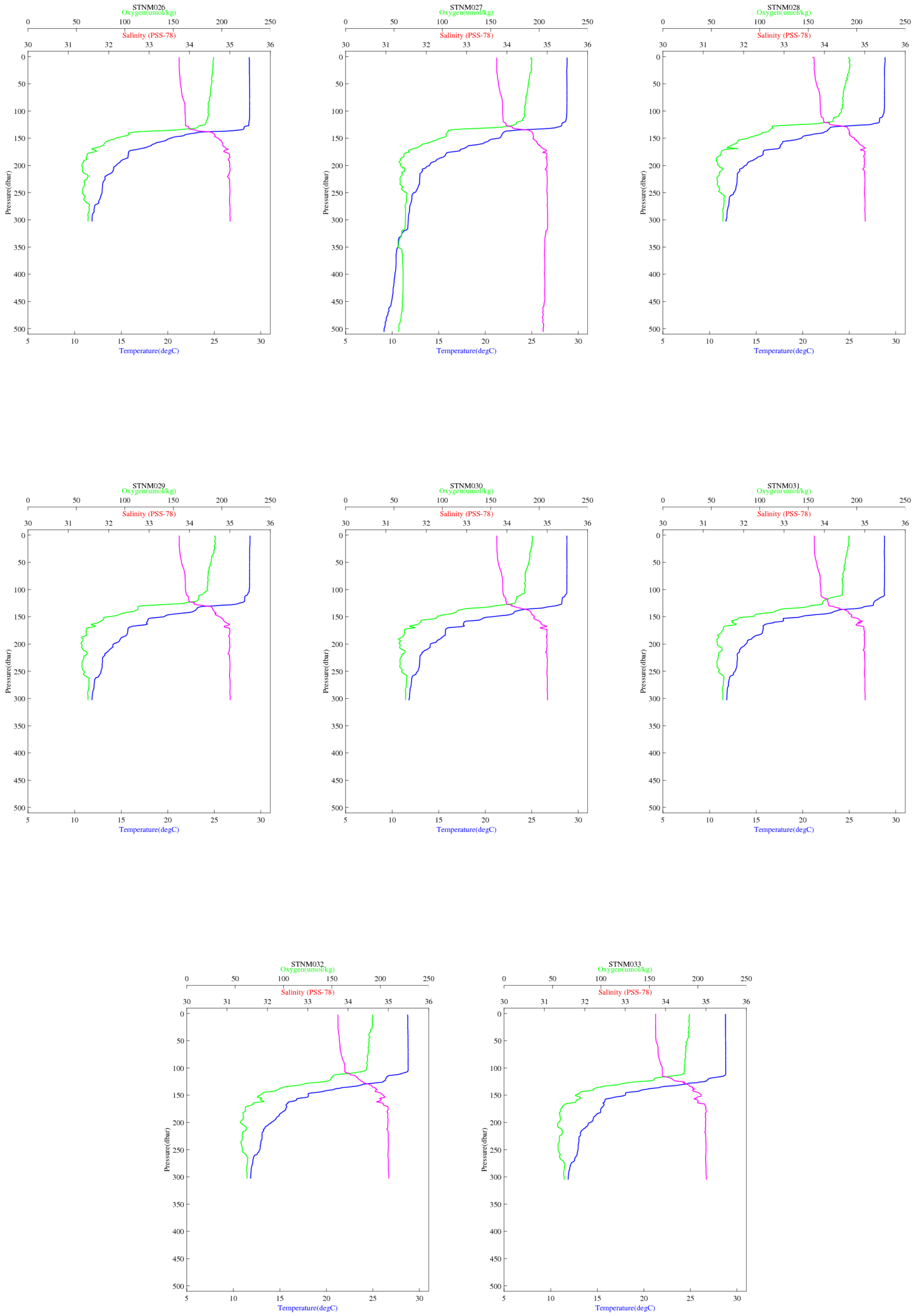
CTD profile (Fixed point 05 Dec. 2017 STNM002 – STNM009)



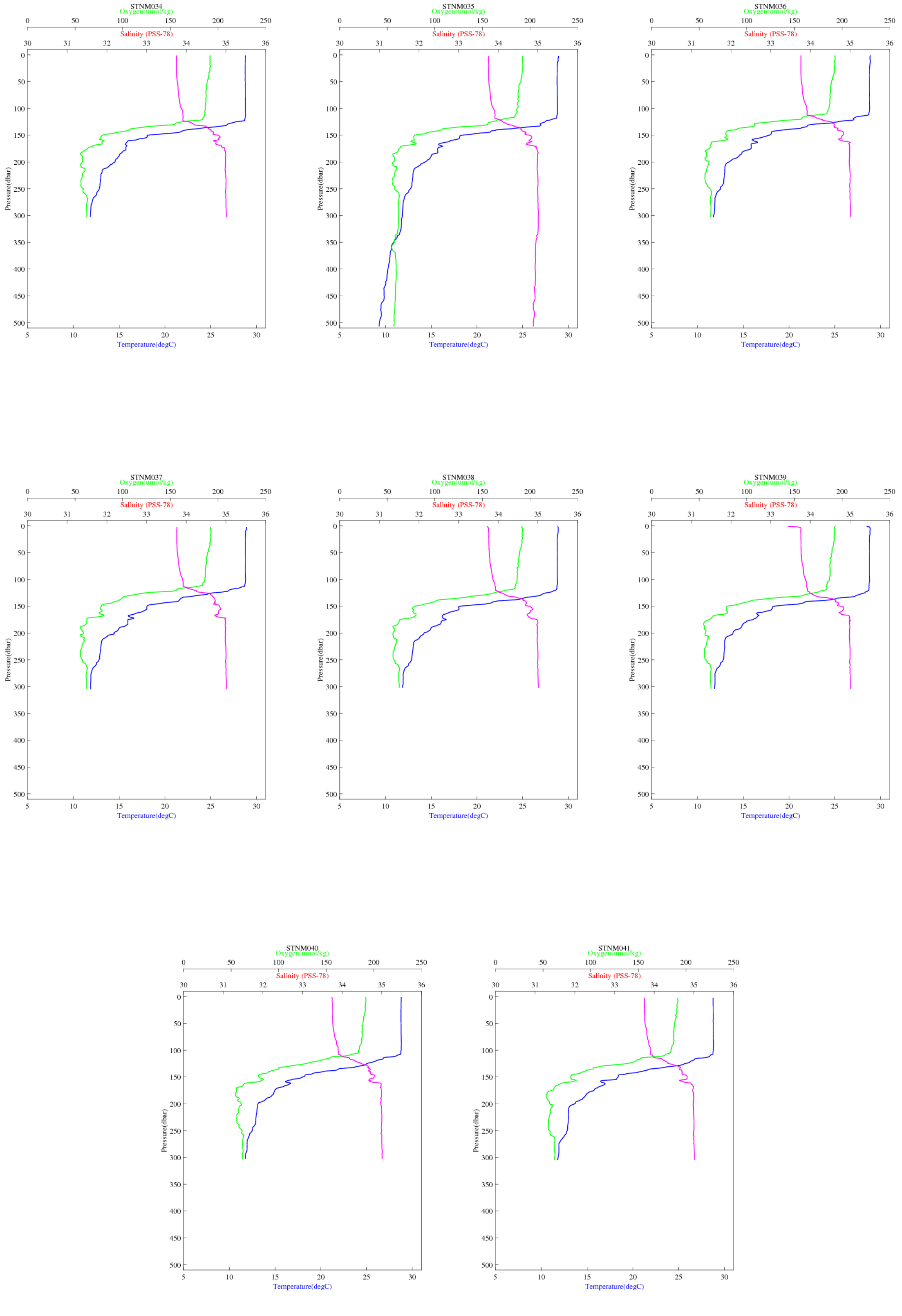
CTD profile (Fixed point 06 Dec. 2017 STNM010 – STNM017)



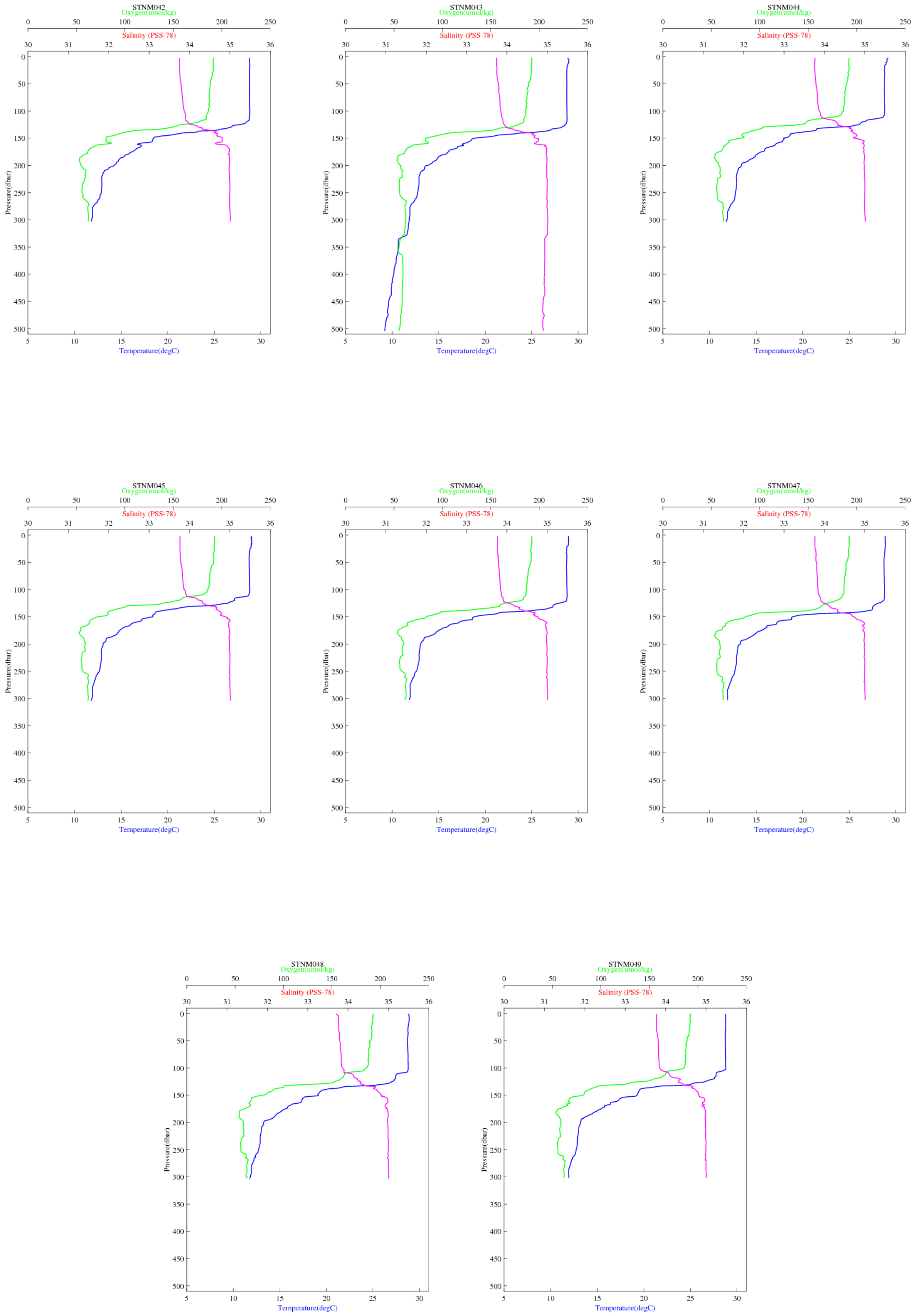
CTD profile (Fixed point 07 Dec. 2017 STNM018 - STNM025)



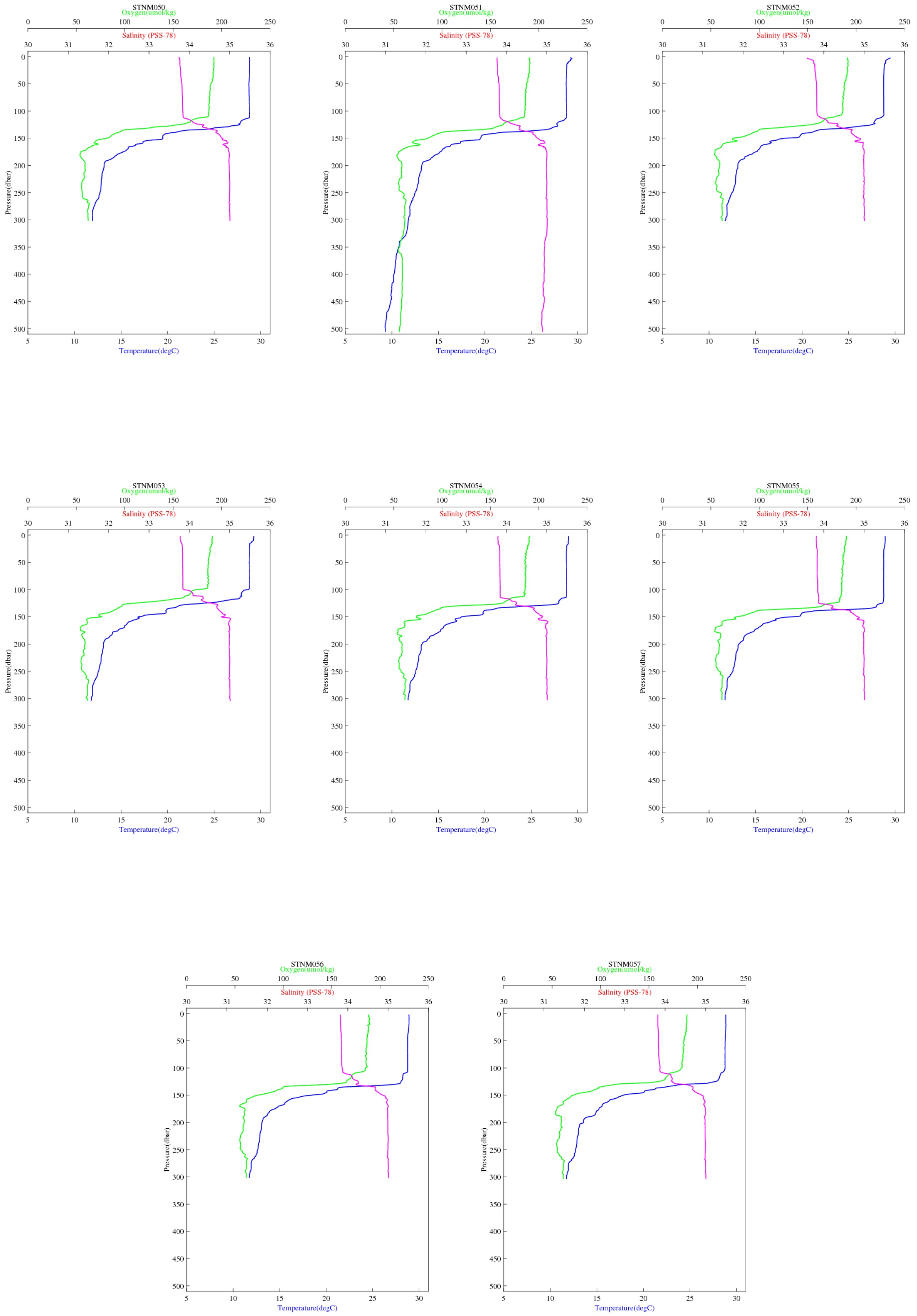
CTD profile (Fixed point 08 Dec. 2017 STNM026 - STNM033)



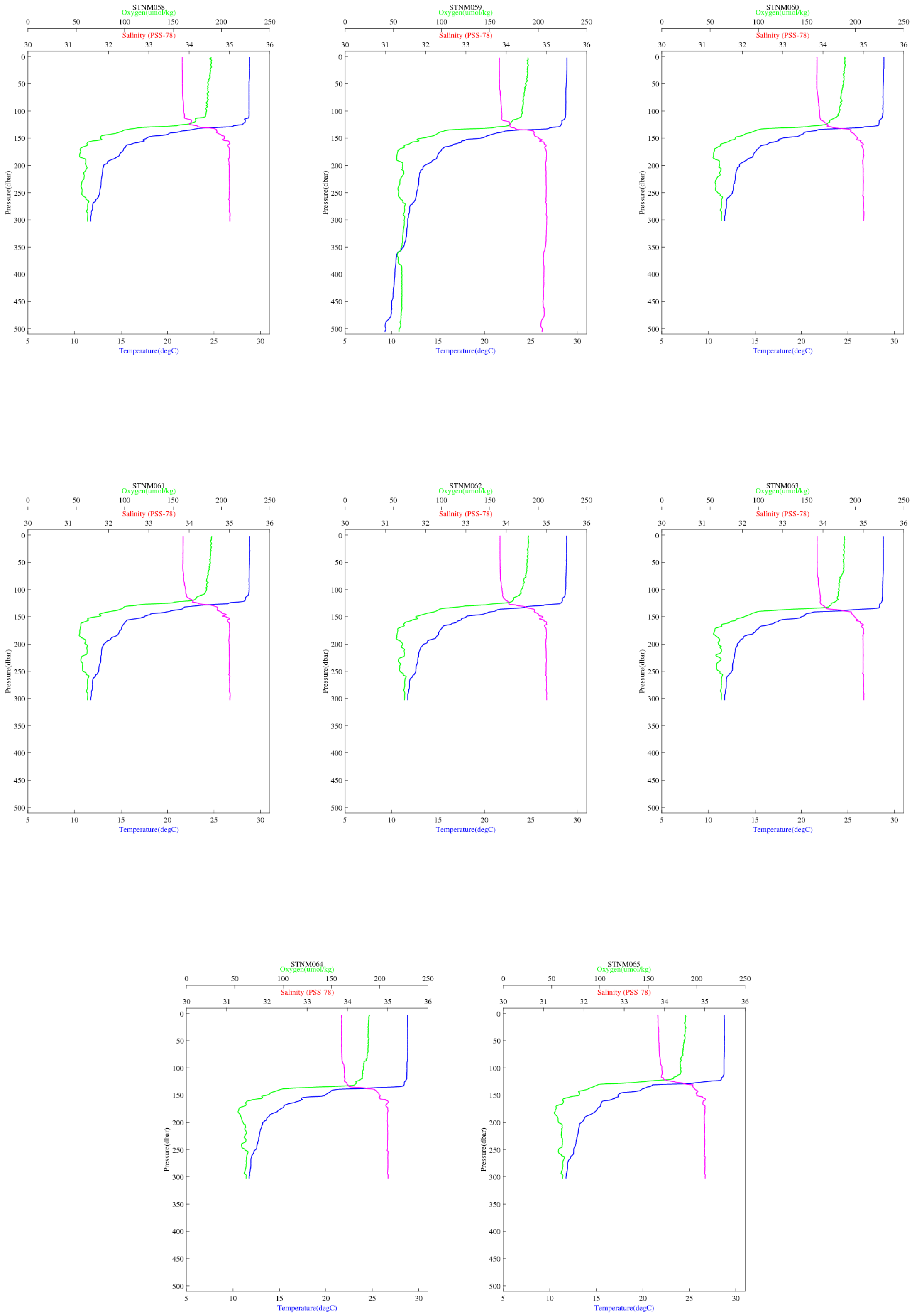
CTD profile (Fixed point 09 Dec. 2017 STNM034 - STNM041)



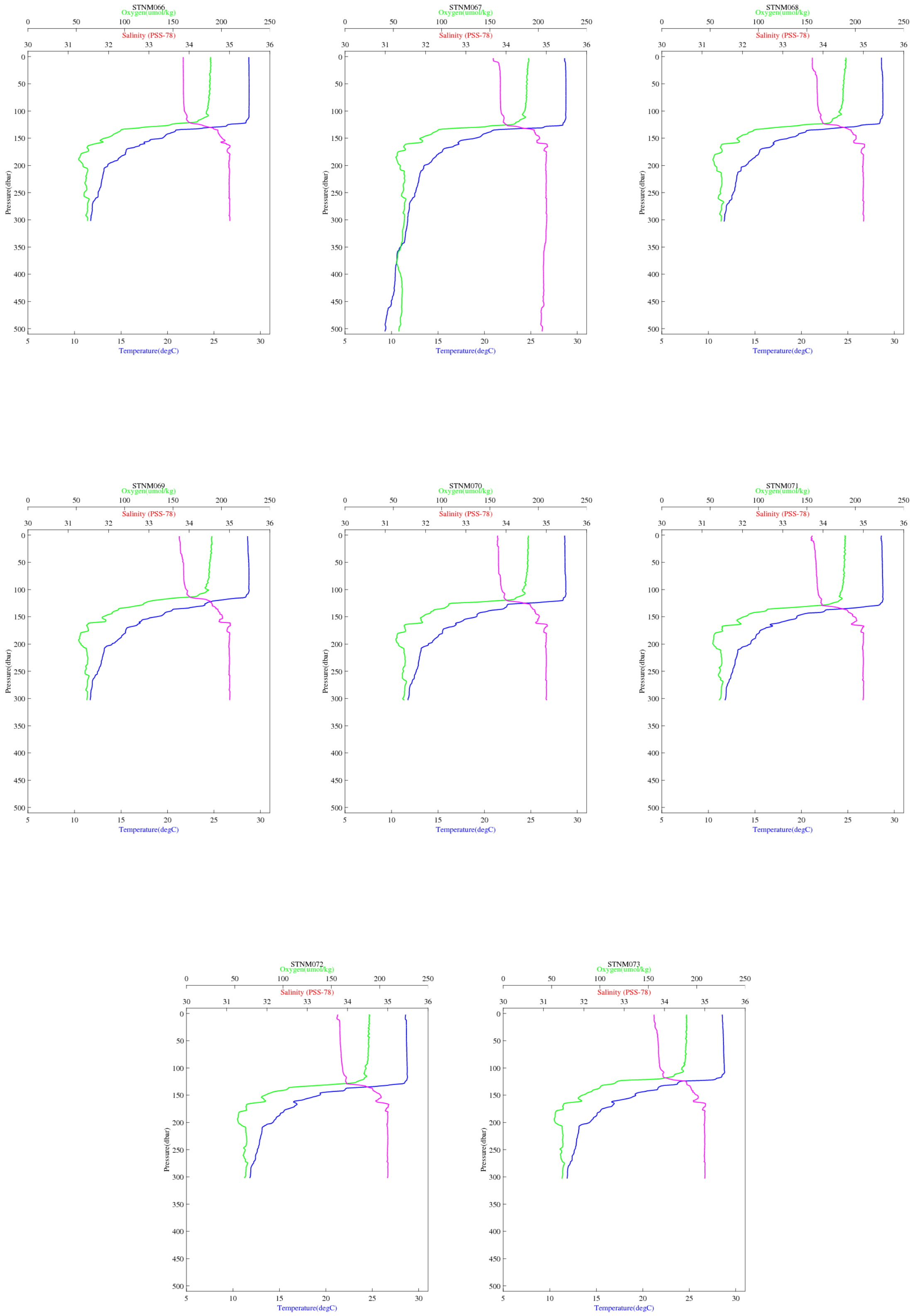
CTD profile (Fixed point 10 Dec. 2017 STNM042 - STNM049)



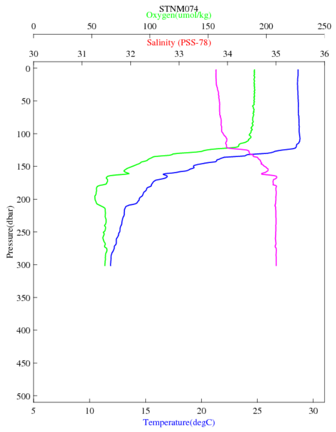
CTD profile (Fixed point 11 Dec. 2017 STNM50 - STNM057)

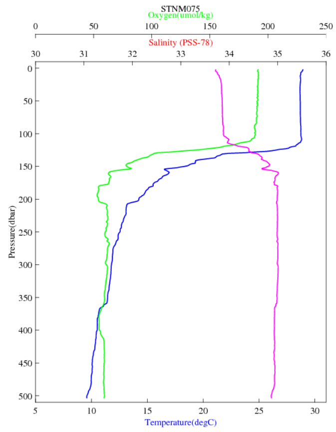


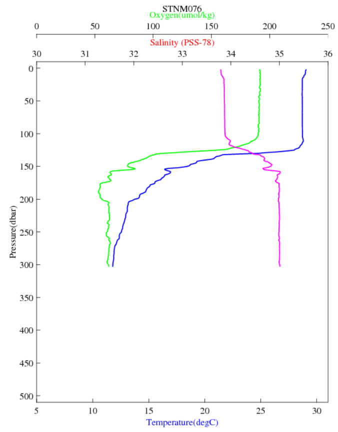
CTD profile (Fixed point 12 Dec. 2017 STNM058 - STNM065)

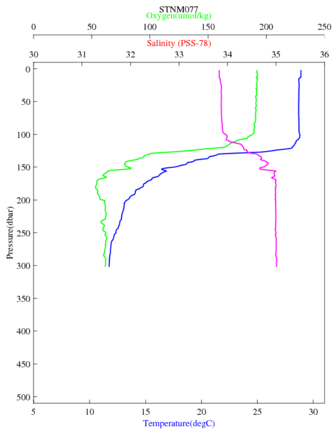


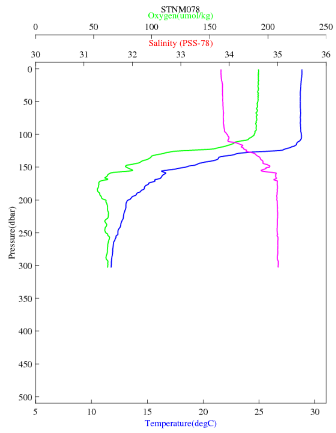
CTD profile (Fixed point 13 Dec. 2017 STNM066 - STNM073)

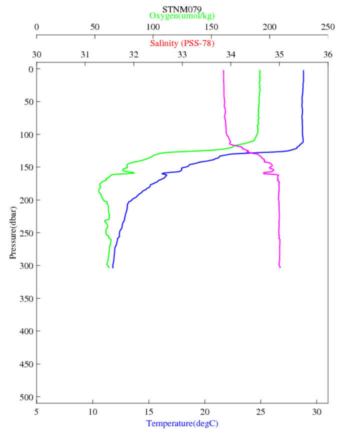


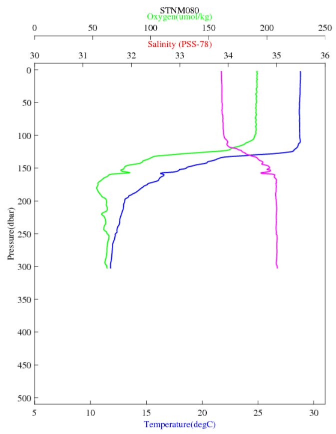


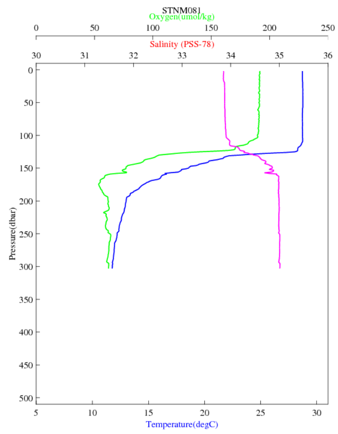




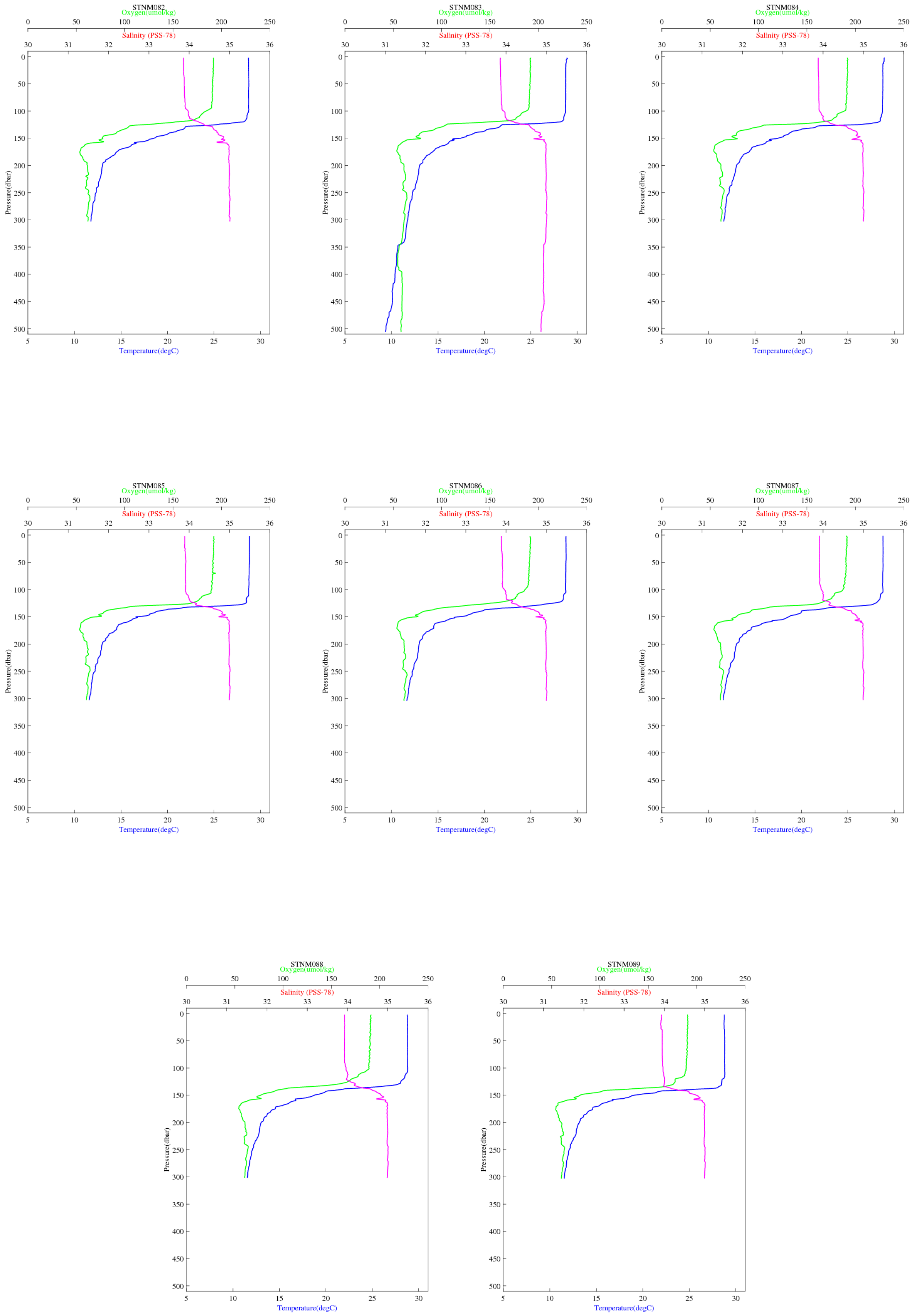




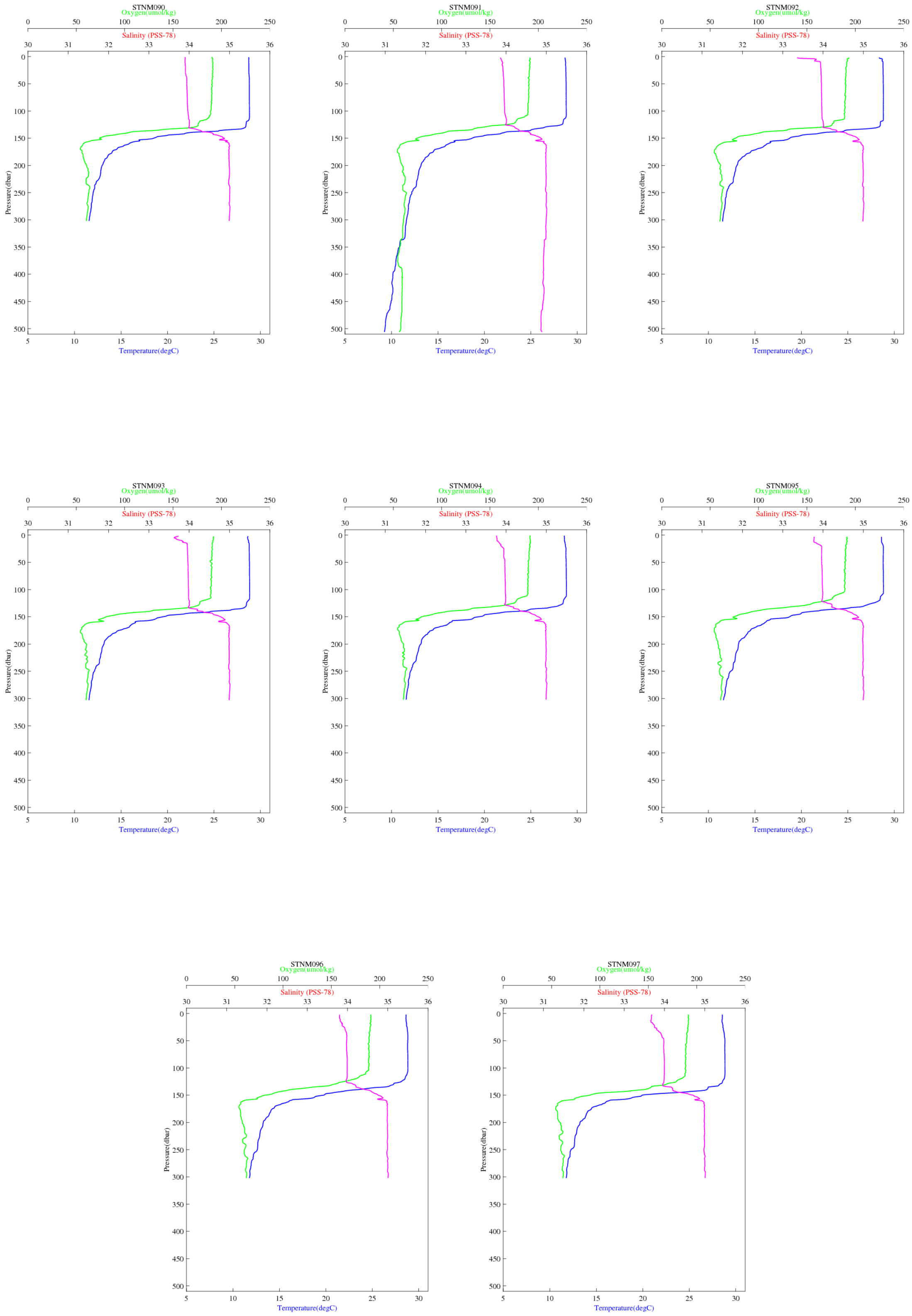




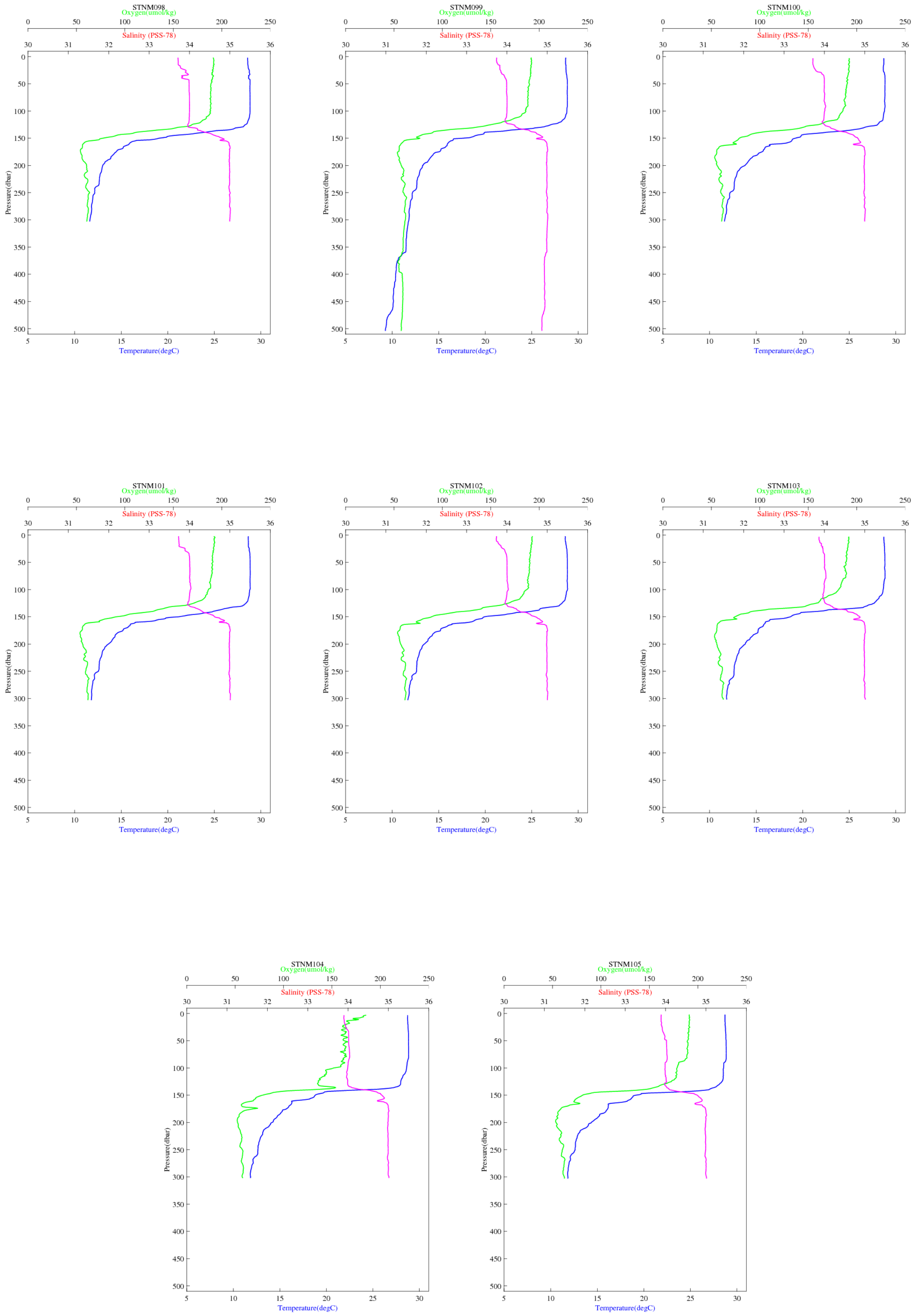
CTD profile (Fixed point 14 Dec. 2017 STNM074 - STNM081)



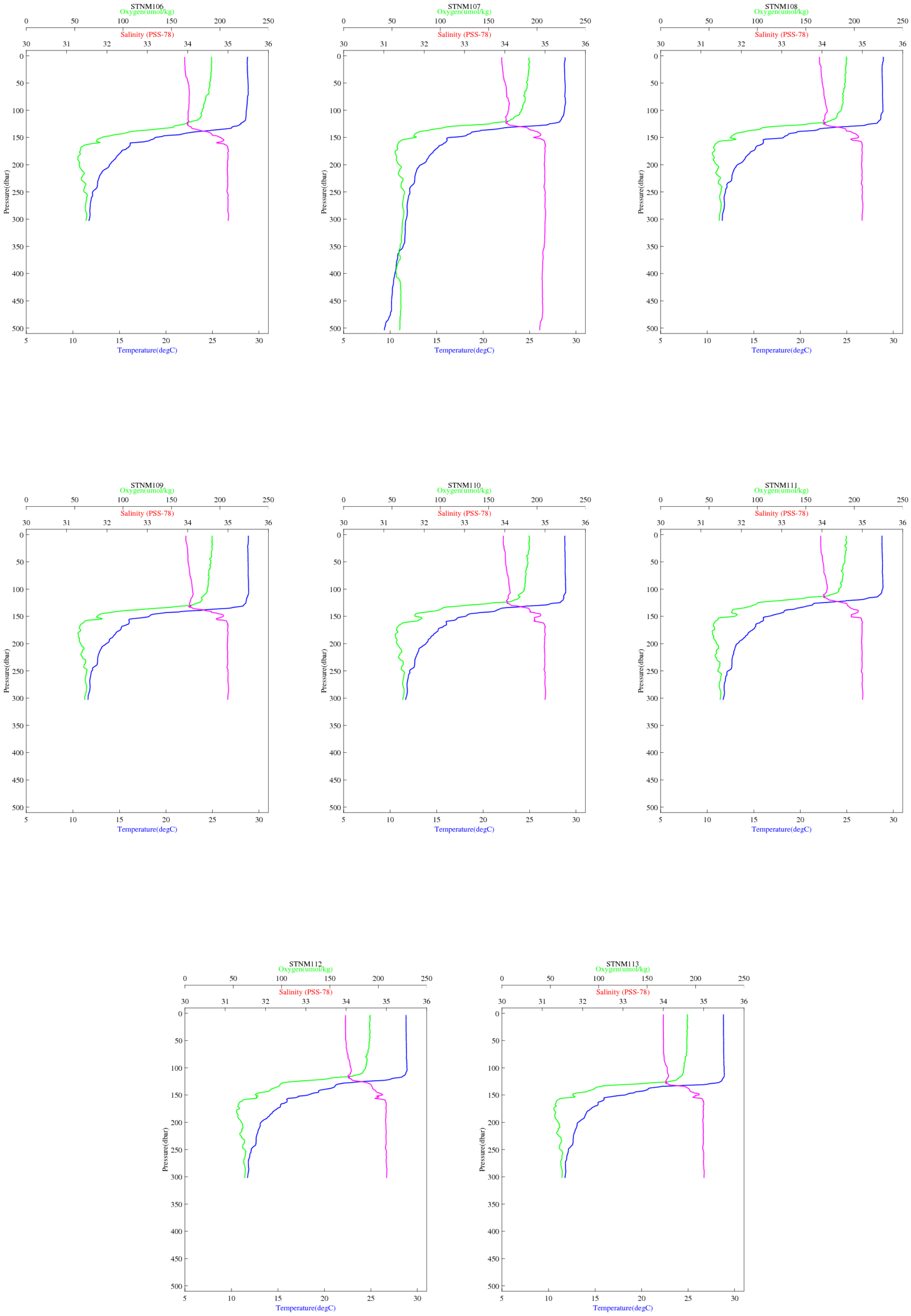
CTD profile (Fixed point 15 Dec. 2017 STNM082 - STNM089)



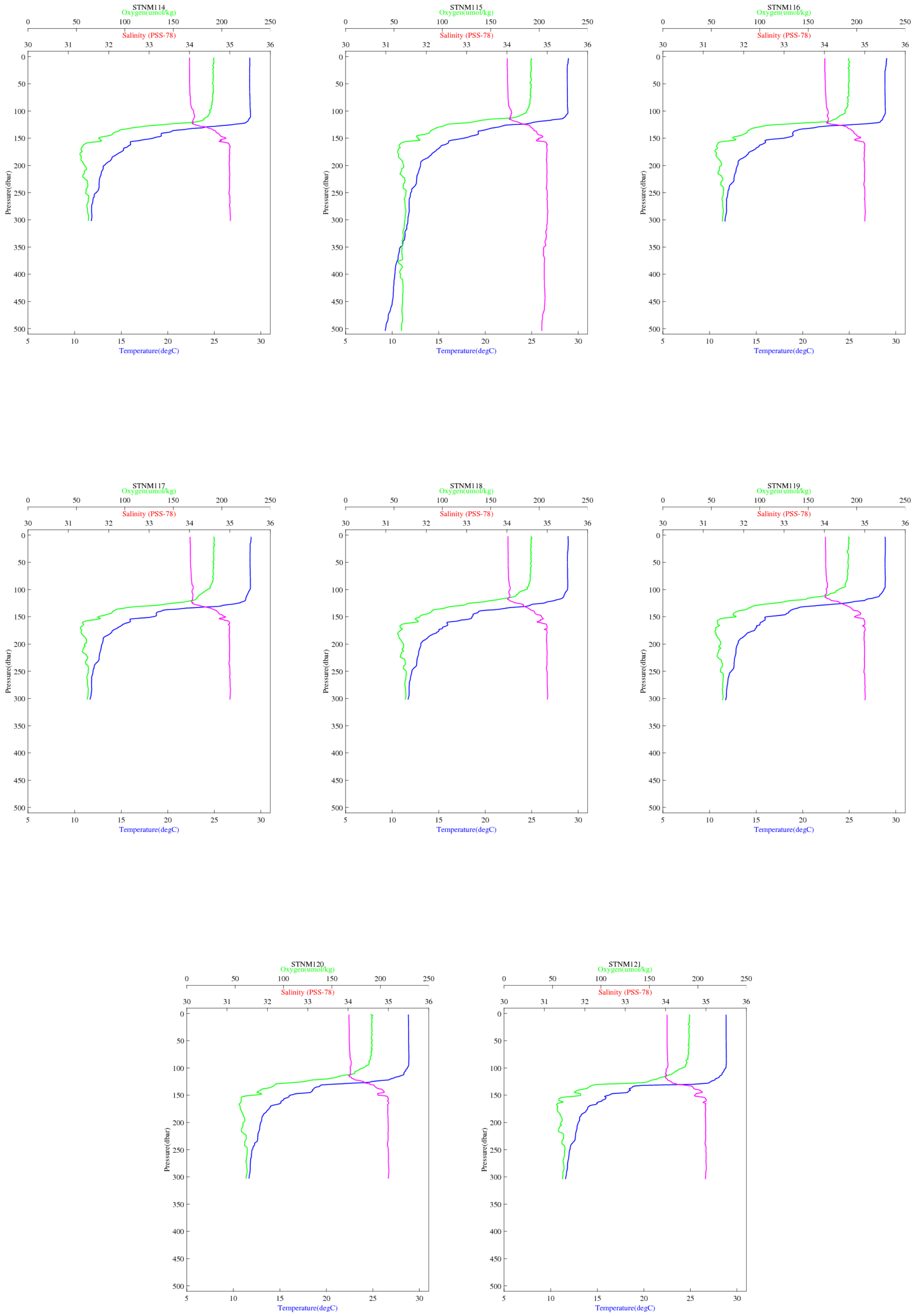
CTD profile (Fixed point 16 Dec. 2017 STNM090 - STNM097)



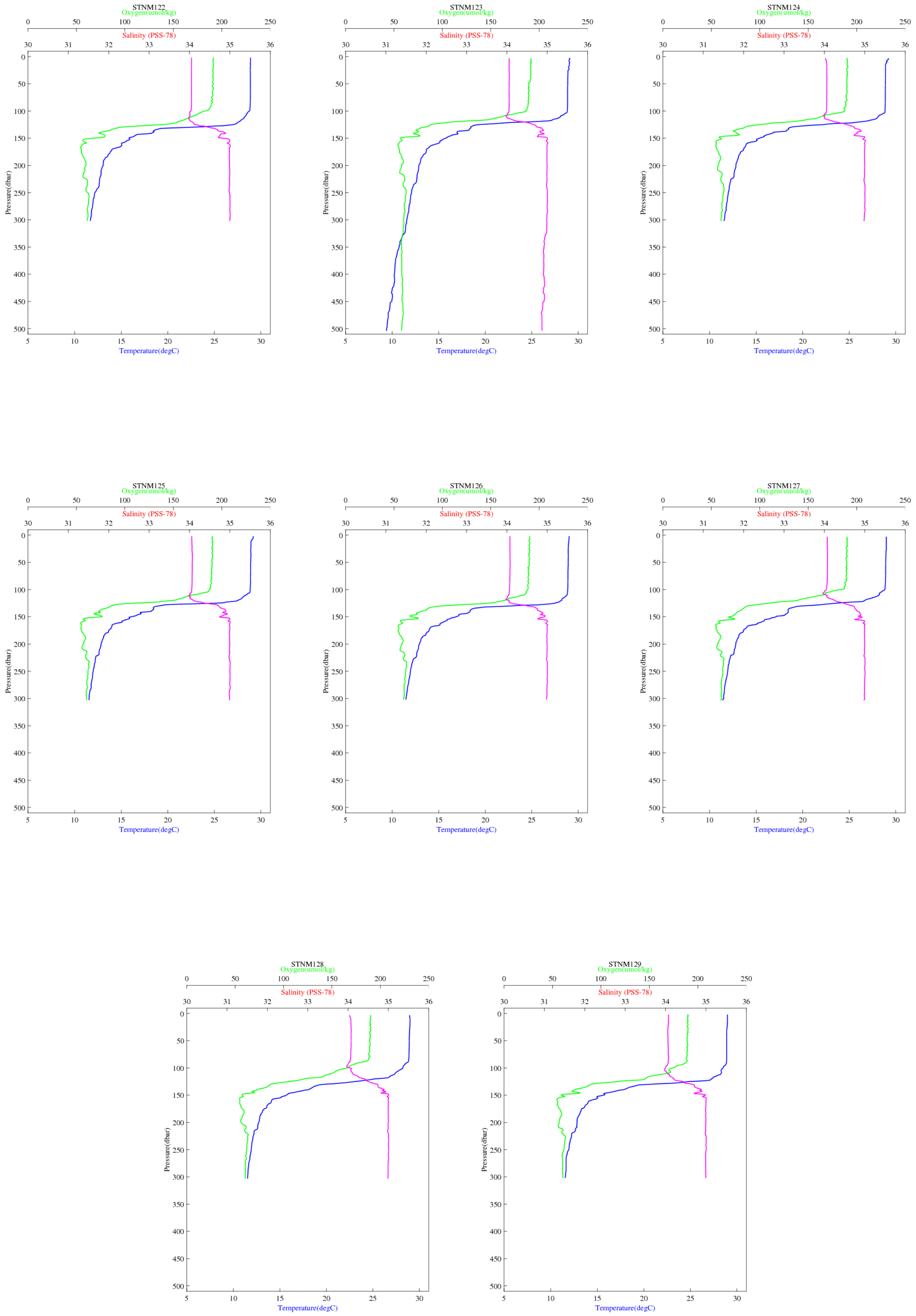
CTD profile (Fixed point 17 Dec. 2017 STNM098 – STNM105)



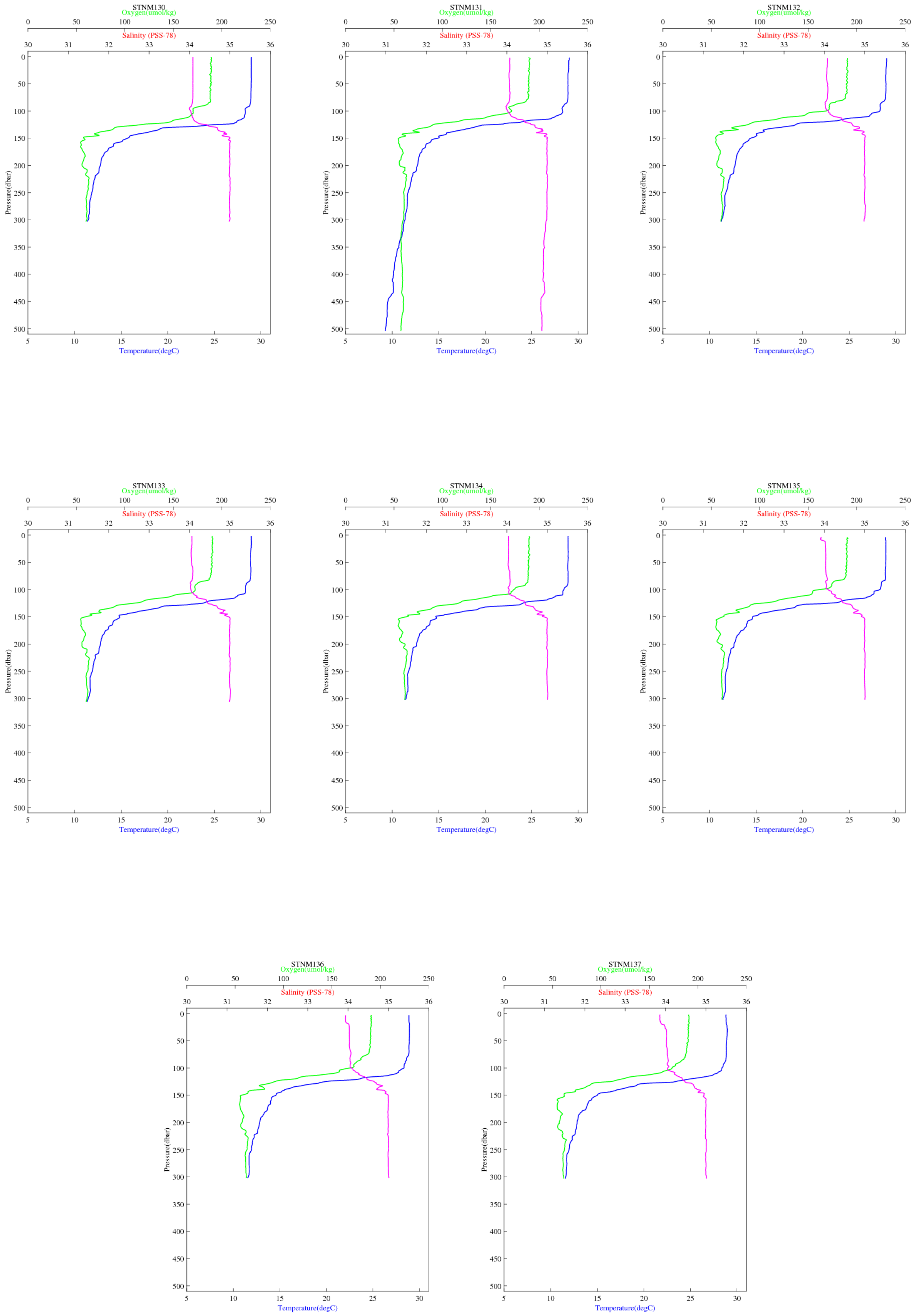
CTD profile (Fixed point 18 Dec. 2017 STNM106 – STNM113)



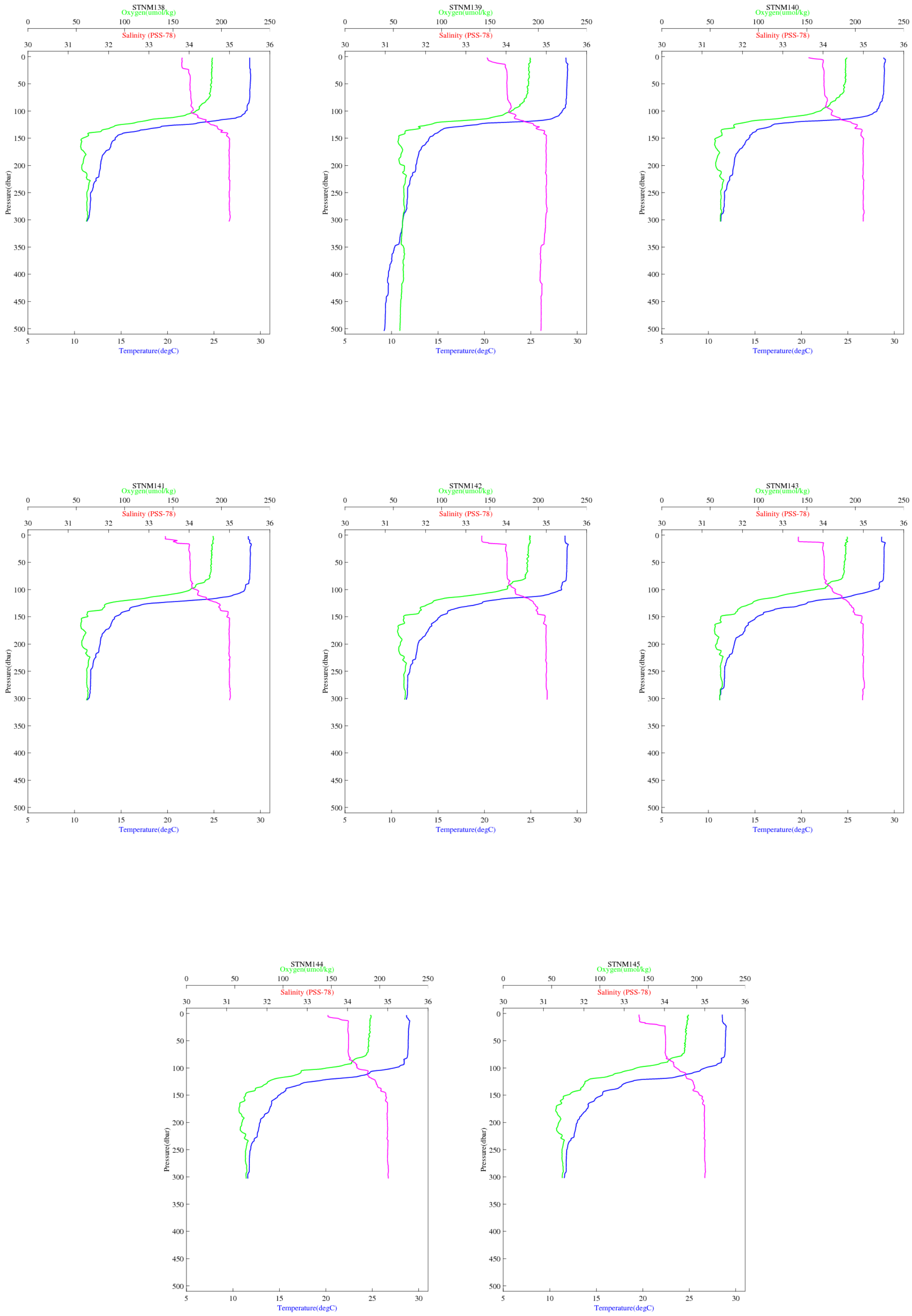
CTD profile (Fixed point 19 Dec. 2017 STNM114 – STNM121)



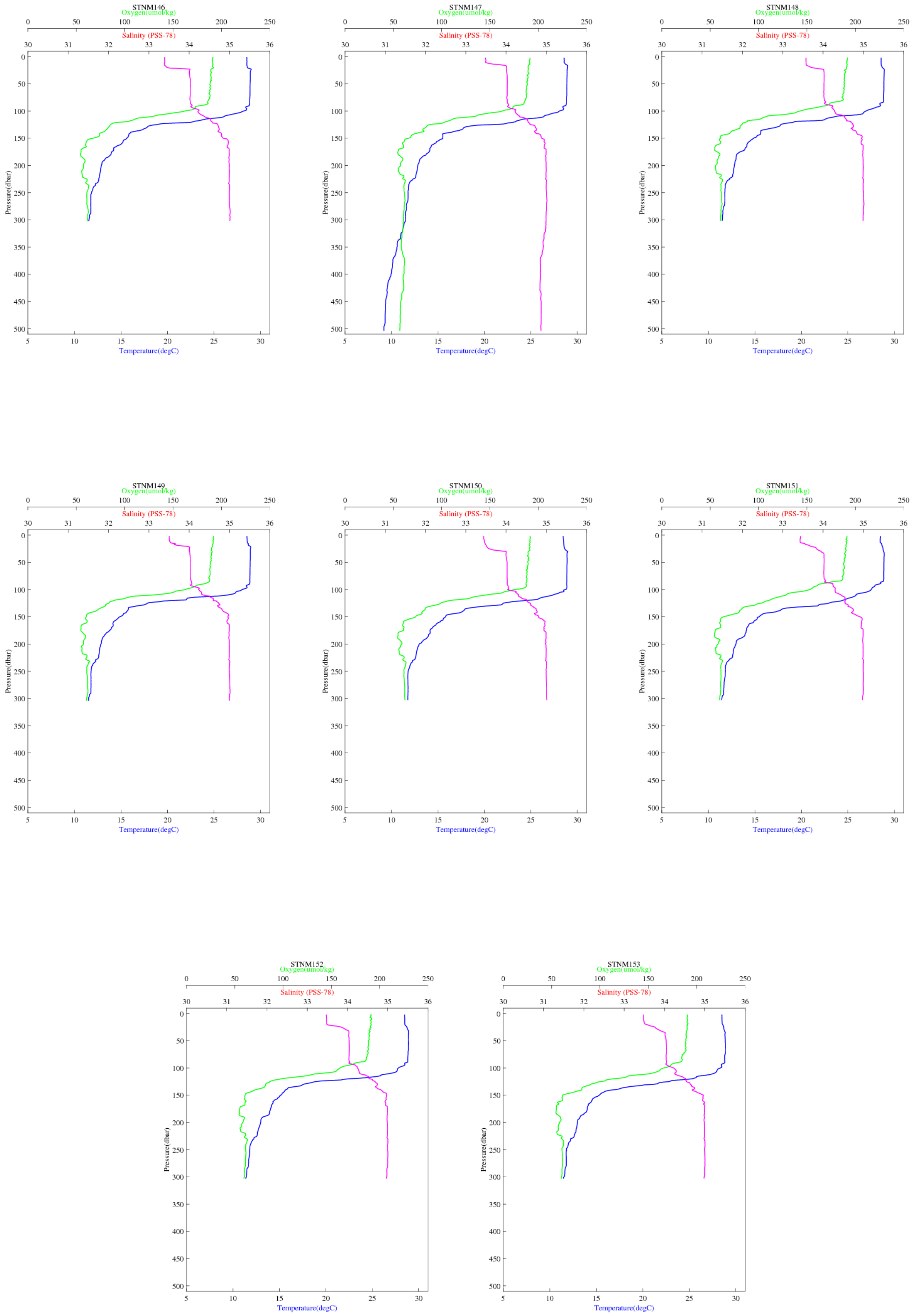
CTD profile (Fixed point 20 Dec. 2017 STNM122 – STNM129)



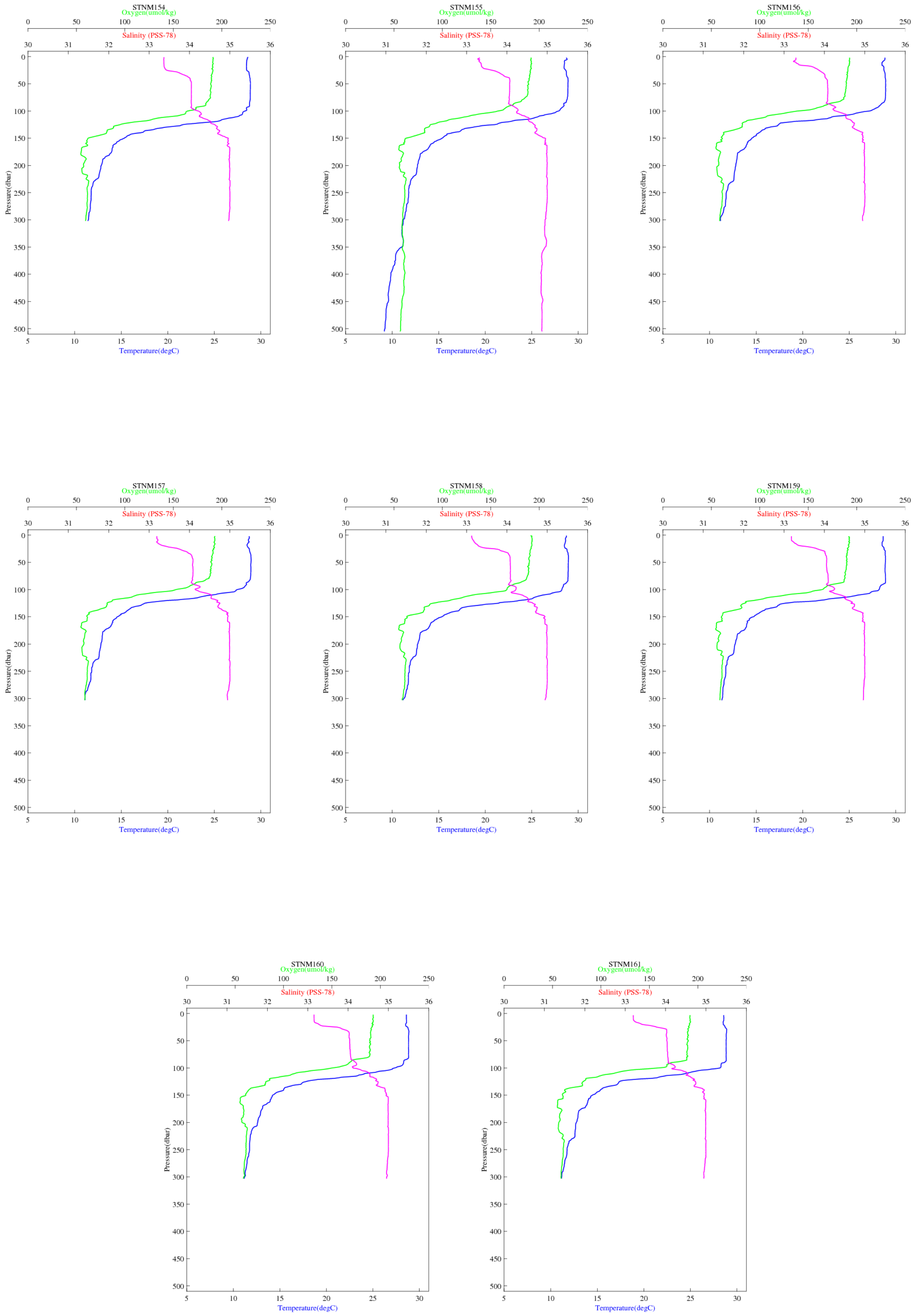
CTD profile (Fixed point 21 Dec. 2017 STNM130 – STNM137)



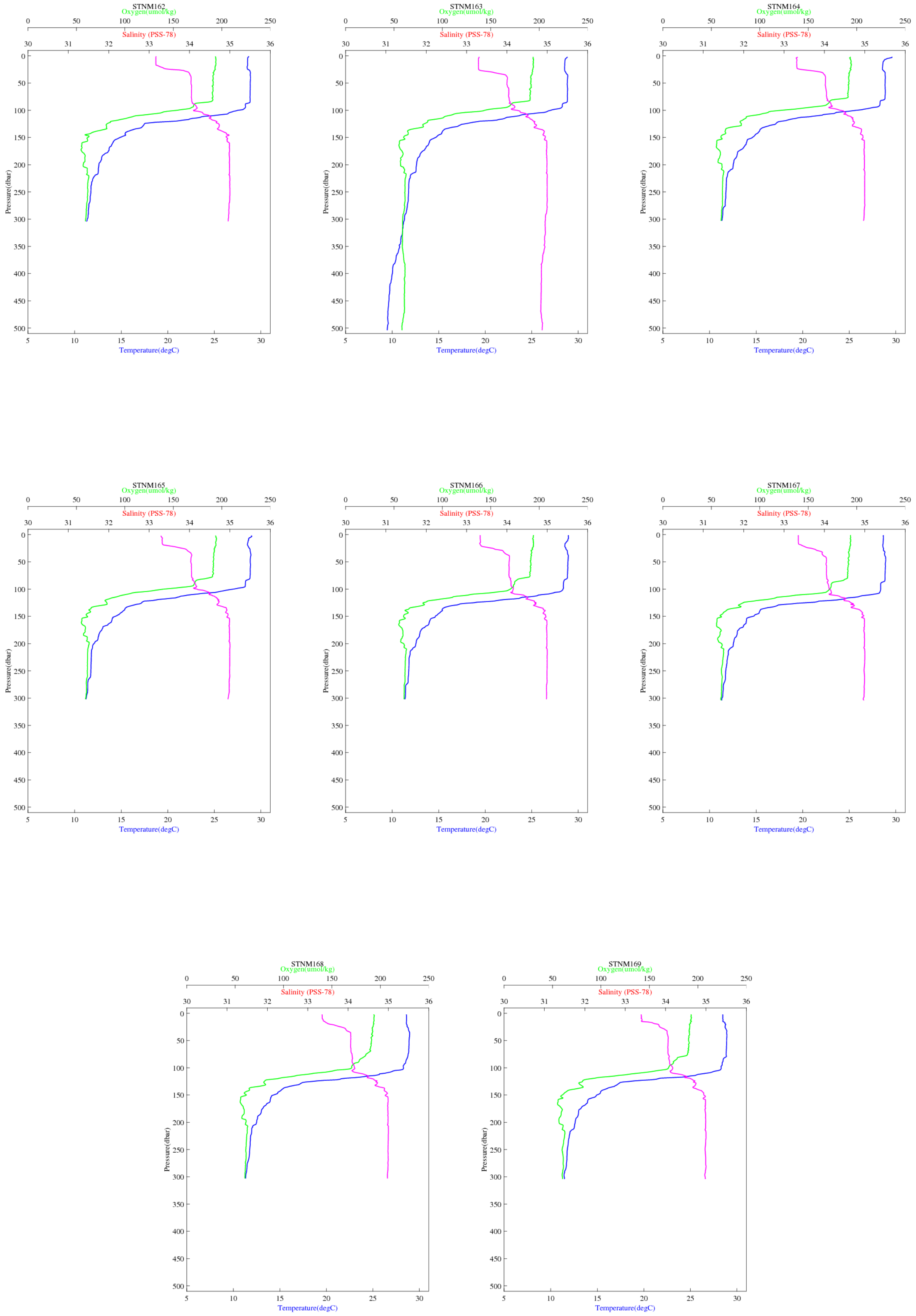
CTD profile (Fixed point 22 Dec. 2017 STNM138 – STNM145)



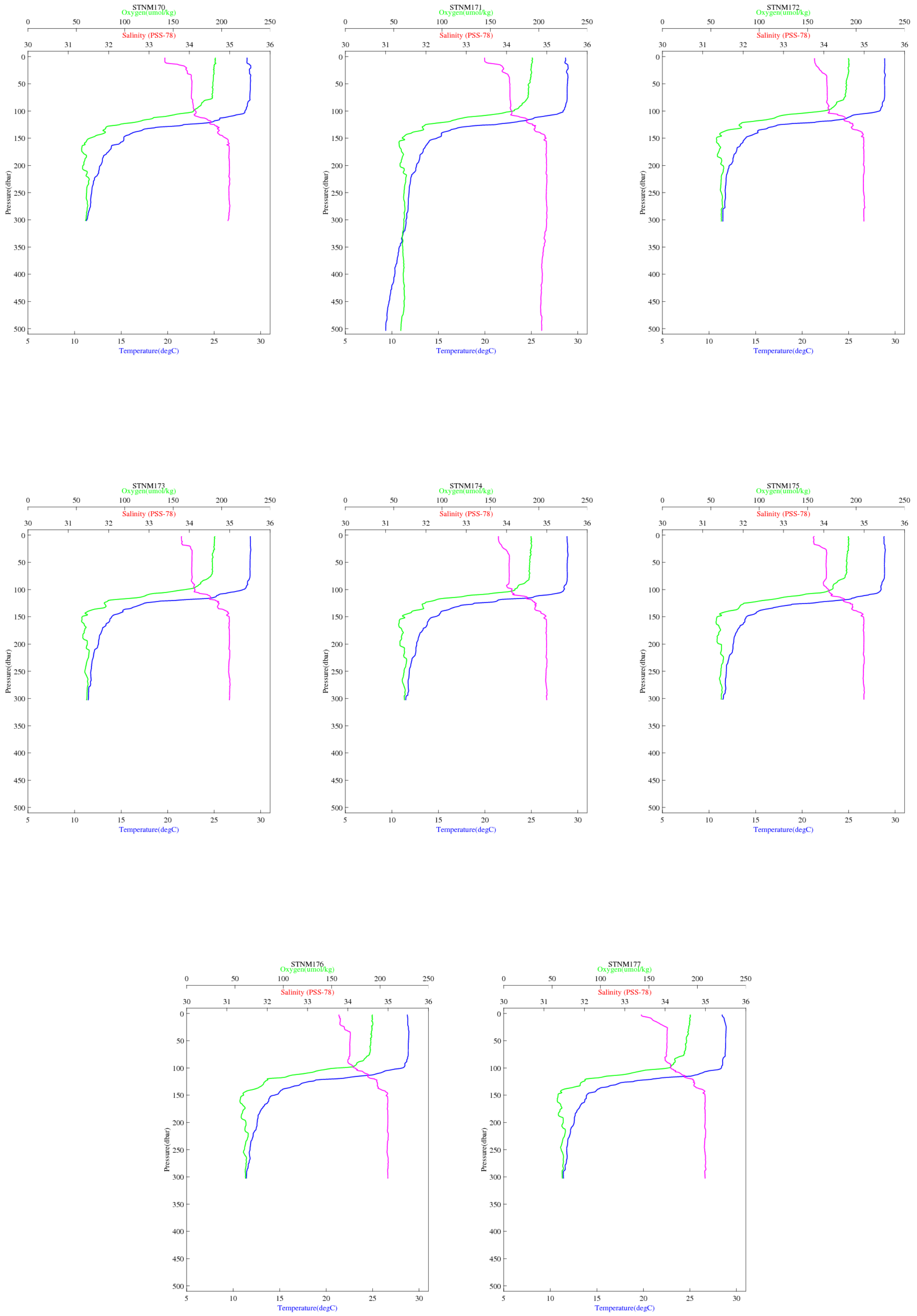
CTD profile (Fixed point 23 Dec. 2017 STNM146 – STNM153)



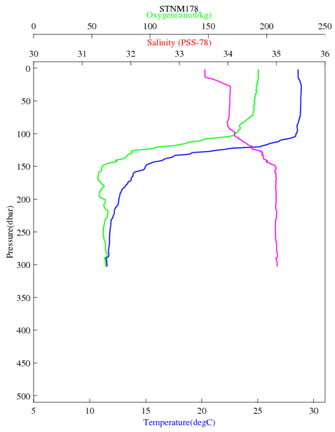
CTD profile (Fixed point 24 Dec. 2017 STNM154 – STNM161)

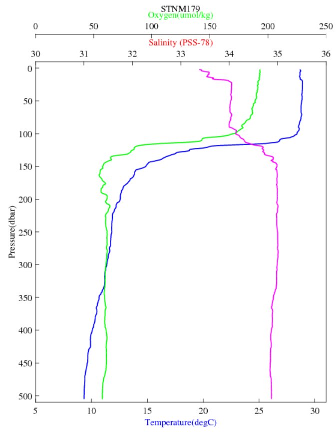


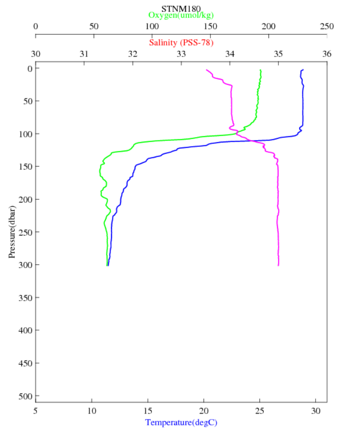
CTD profile (Fixed point 25 Dec. 2017 STNM162 – STNM169)

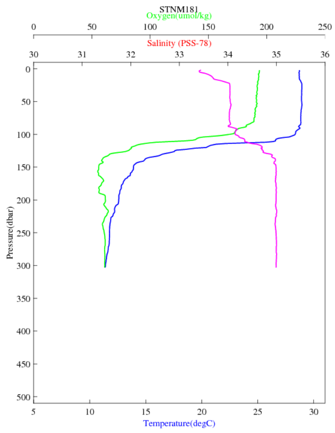


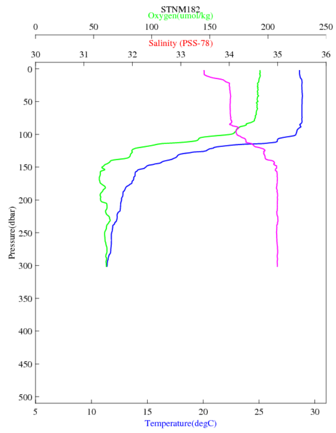
CTD profile (Fixed point 26 Dec. 2017 STNM170 – STNM177)

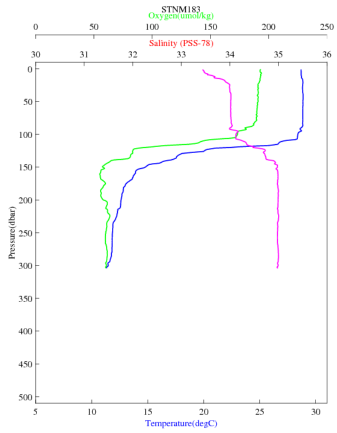


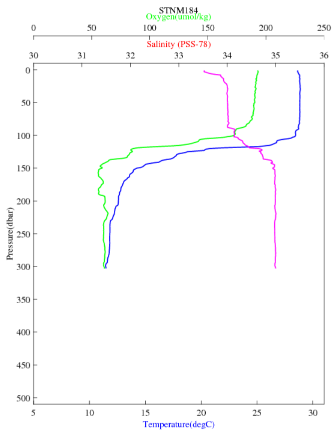


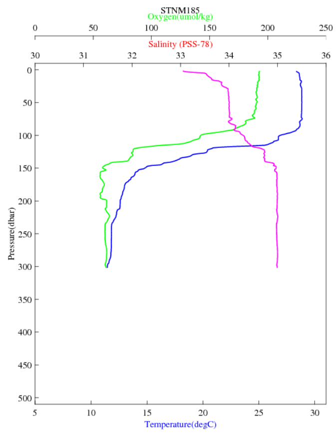




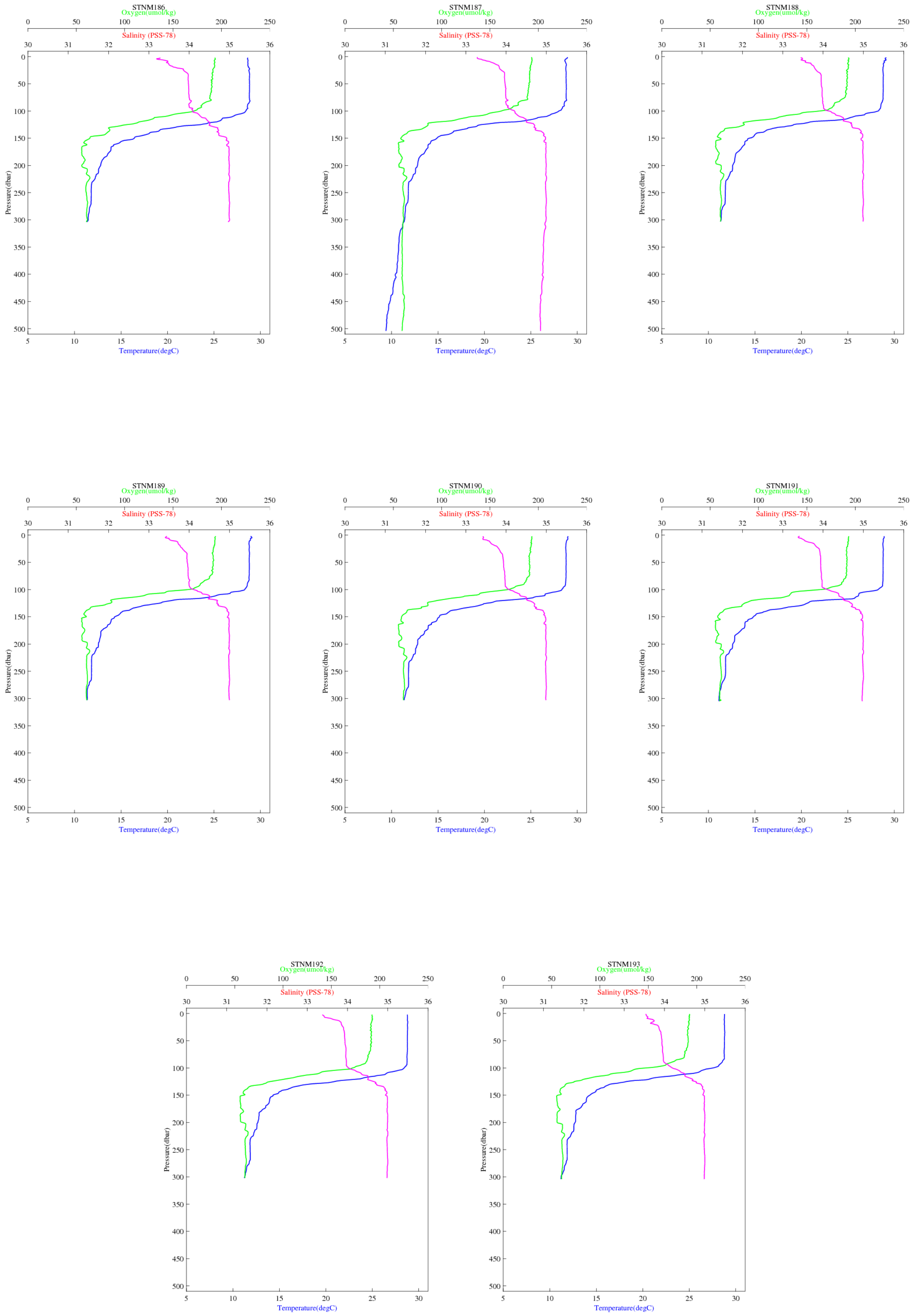




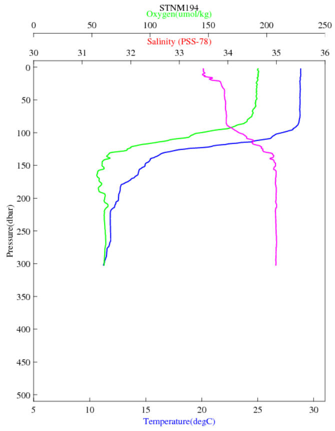


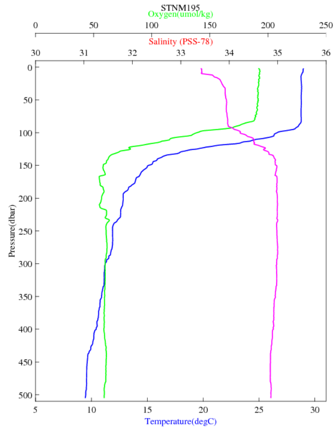


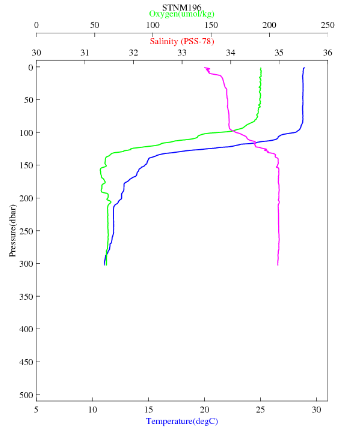
CTD profile (Fixed point 27 Dec. 2017 STNM178 – STNM185)

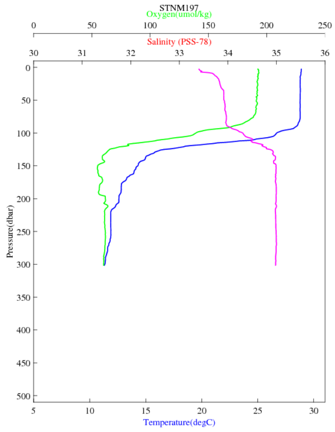


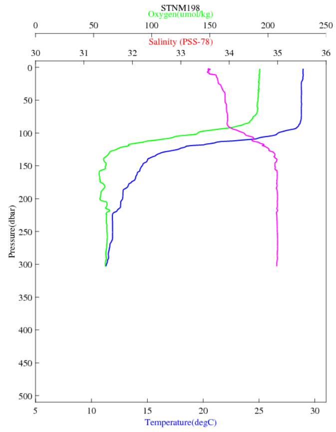
CTD profile (Fixed point 28 Dec. 2017 STNM186 – STNM193)

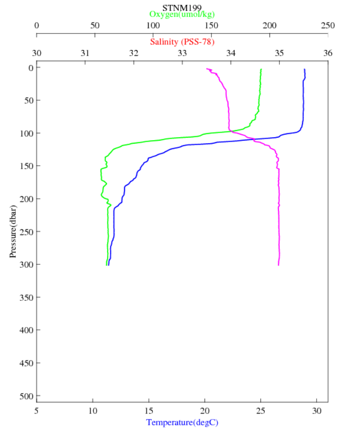


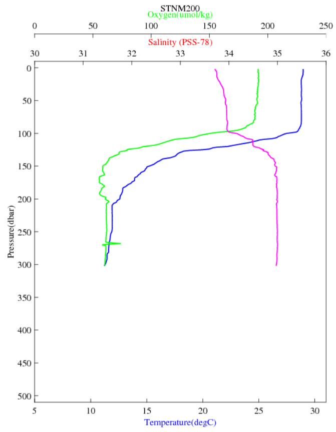


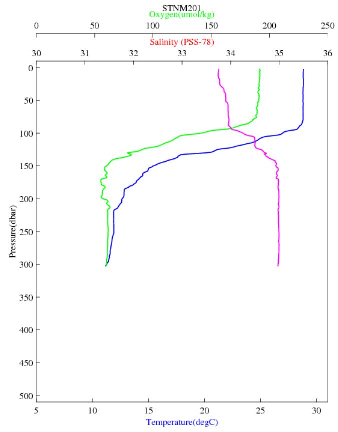




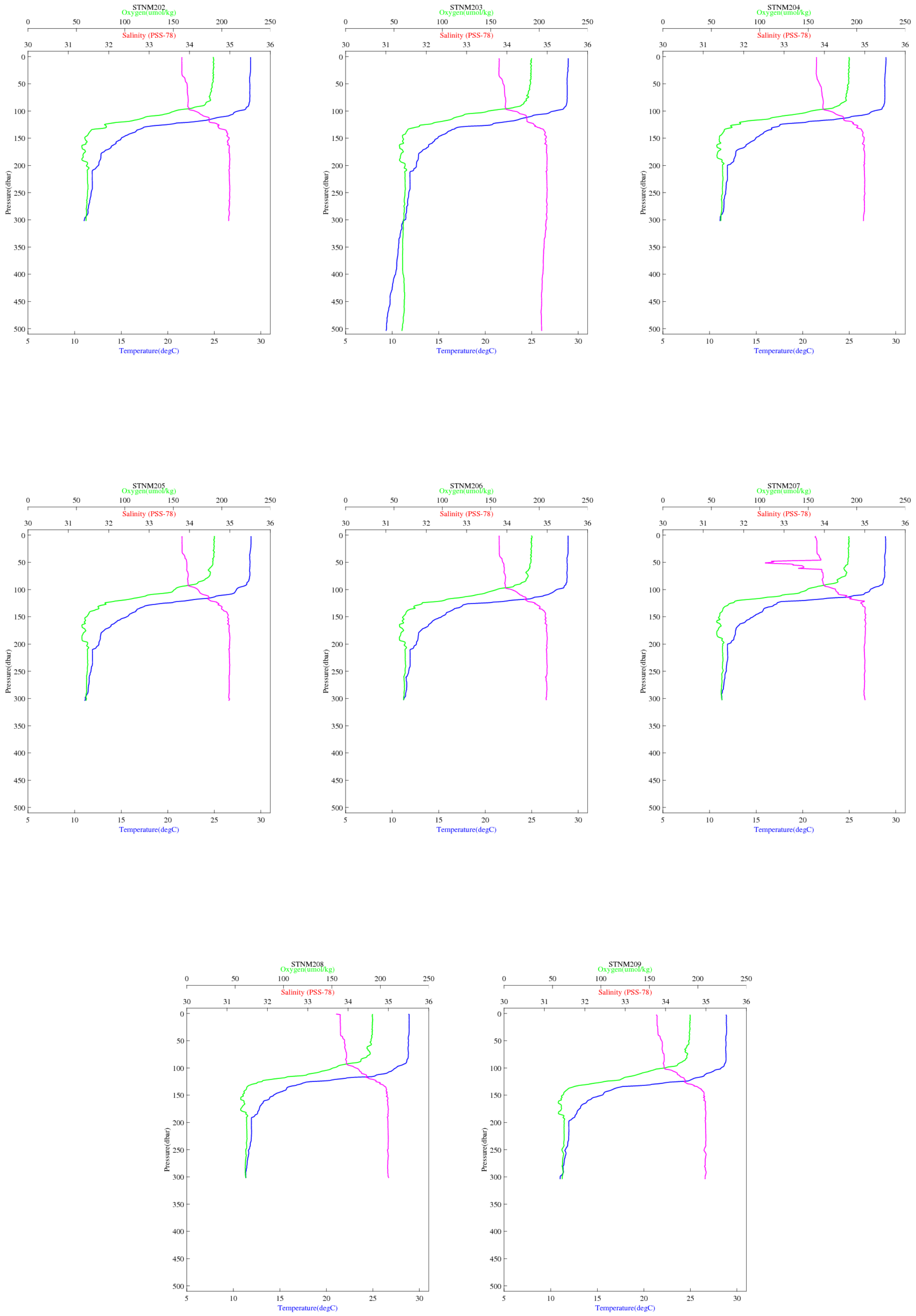




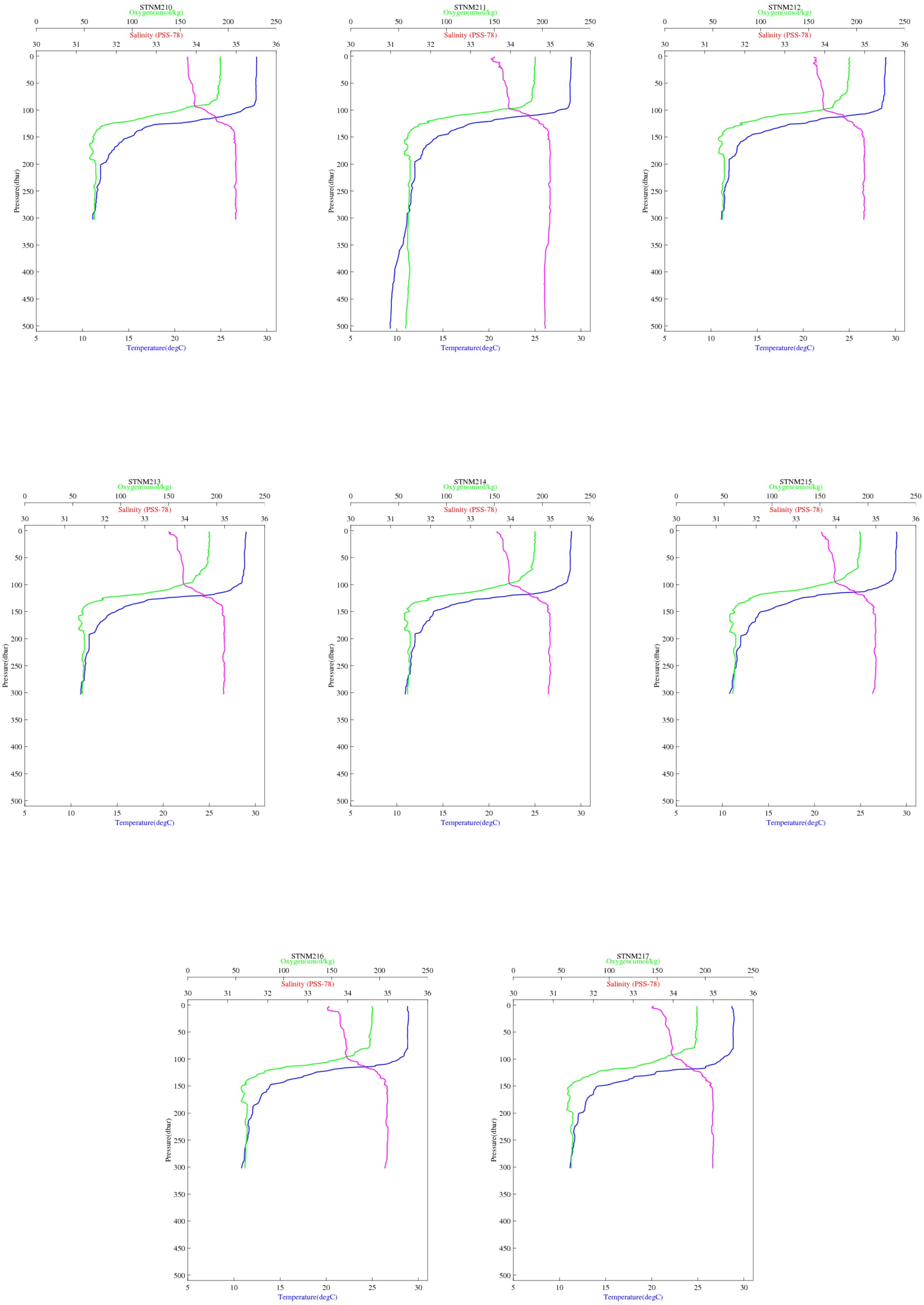




CTD profile (Fixed point 29 Dec. 2017 STNM194 – STNM201)



CTD profile (Fixed point 30 Dec. 2017 STNM202 – STNM209)



CTD profile (Fixed point 31 Dec. 2017 STNM210 – STNM217)