doi : 10.17596/0002581

R/V *Mirai* Cruise Report MR20-E01

Study on air-sea interaction
associated with northward-propagating boreal summer intraseasonal oscillation

Tropical Western Pacific

August 1 – September 13, 2020

Japan Agency for Marine-Earth Science and Technology
(JAMSTEC)

MR20-E01 Cruise Report

Table of contents

1. Introduction

The Boreal Summer Intra-Seasonal Oscillation (BSISO) is one of the large-scale atmospheric disturbances that play dominant roles in precipitation variability over the tropical western Pacific. The BSISO has its typical time scale of 30-60 days, and is characterized by a band-like area of vigorous cumulus convective activity whose long axis is oriented from the northwest to southeast direction with several thousand kilometers length. While the BSISO tends to migrate northward, physical processes that cause the northward migration are still elusive. In order to deepen our understanding of the BSISO behavior, we conduct a field campaign over the tropical western Pacific and neighboring islands, which is named "Years of the Maritime Continent – Boreal Summer Monsoon study 2020 (YMC-BSM 2020)". In particular, this field campaign attempts to test the hypothesis that near-surface thermodynamic structure of the ocean plays a central role in the existence and northward migration of the BSISO.

As the main component of the YMC-BSM 2020 field campaign, we conducted shipborne observation activity using the Research Vessel *Mirai* and collected observational data of the atmosphere and ocean over the tropical western Pacific. We performed station observation at (12-00N, 135-00E) for the period from August 9 to September 7, 2020. Observational items include 3-hourly radiosonde and conductivity-temperature-depth (CTD) observations and surface drifter observation, in addition to a series of continuous observations. We also deployed an m-TRITON mooring system at (11-38N, 134-59E) and three Wave Gliders just before the start of the station observation, which were then recovered just before sailing back to Japan. In addition, three ARGO floats were deployed on the way from Japan to the station observation point.

This cruise report summarizes the observational items and preliminary results during the R/V *Mirai* MR20-E01 cruise. First several sections describe the basic information such as cruise track and on-board personnel list. Details of the 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 × B × D	128.6m × 19.0m × 13.2m
Gross Tonnage	8,706 tons
Call Sign	JNSR
Home Port	Mutsu, Aomori Prefecture, Japan

2.2 Cruise Code

MR20-E01

2.3 Project Name (Main mission)

"Study on air-sea interaction associated with northward-propagating boreal summer intraseasonal oscillation"

2.4 Undertaking Institute

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
2-15, Natsushima-cho, Yokosuka, Kanagawa 237-0061, Japan

2.5 Chief Scientist

Satoru YOKOI
Dynamic Coupling of Ocean-Atmosphere-Land Processes Research Program (DCOP),
Research Institute for Global Change (RIGC), JAMSTEC

2.6 Periods and Port Call

Aug 1., 2020:	departed Shimizu, Japan
Sep. 13, 2020:	arrived Shimizu, Japan

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

(1) Observational study on variation of precipitation and vapor isotope ratio associated with MJO (PI: Kei YOSHIMURA of Univ. Tokyo)
(2) Observational study for upper-ocean stratification: Case of tropical western Pacific (PI: Gilles REVERDIN of LOCEAN)
(3) Observation of aerosol optical characteristics over the ocean (PI: Kazuma AOKI of Univ. Toyama)
(4) Measurement of column-integrated CO2 density in the atmosphere (PI: Yutaka MATSUMI of Nagoya Univ.)
(5) Continuous observation of precipitable water vapor using microwave radiometer (PI: Akira KUWANO-YOSHIDA of Kyoto Univ.)
(6) Study on impacts of aerosols on precipitation and lightning (PI: Kazuaki YASUNAGA of Univ. Toyama)
(7) Study on mechanisms for convective clustering associated with northward-propagating intraseasonal oscillation (PI: Tetsuya TAKEMI of Kyoto Univ.)
(8) Analysis of fine vertical structure of oceanographic parameters over the tropical western Pacific (PI: Kelvin RICHARDS of IPRC)

2.8 Observation Summary

GPS radiosonde	288 times	Aug. 4 to Sep. 10
GNSS precipitable water	continuous	Aug. 1 to Sep. 13
C-band weather radar	continuous	Aug. 1 to Sep. 12
Micro rain radar	continuous	Aug. 1 to Sep. 13
Disdrometer	continuous	Aug. 1 to Sep. 13
Lidar	continuous	Aug. 1 to Sep. 13
Ceilometer	continuous	Aug. 1 to Sep. 13
Ship-borne sky radiometer	continuous	Aug. 1 to Sep. 13
Aerosol and gas observations	continuous	Aug. 1 to Sep. 13
Stable isotope measurement	continuous	Aug. 1 to Sep. 13
Microwave radiometer	continuous	Aug. 1 to Sep. 13
Column CO_2 measurement	continuous	Aug. 1 to Sep. 13
Surface meteorological observations	continuous	Aug. 1 to Sep. 13
Continuous monitoring of surface seawater	continuous	Aug. 1 to Sep. 12
CTD profiling	224 profiles	Aug. 4 to Sep. 7
LADCP	224 profiles	Aug. 4 to Sep. 7
RINKO Profiler	246 profiles	Aug. 4 to Sep. 7
Sea water sampling	36 times	Aug. 2 to Sep. 11
Shipboard ADCP	continuous	Aug. 1 to Sep. 13
XCTD	17 profiles	Aug. 17 to Sep. 7
Deployment of ARGO floats	3 floats	(21N, 135E), (18N, 135E), and (15N, 135E)
Deployment of m-TRITON mooring	1system	Aug. 7 to Sep. 8
Deployment of Wave Gliders	3 systems	Aug. 7 to Sep. 4
Deployment of surface drifters	5 times	Aug. 16-18, Aug. 20-22, Aug. 31-Sep. 2, Sep. 6-7, and Sep. 9
Underway geophysics	continuous	Aug. 1 to Sep. 13

2.9 Overview

In order to investigate atmospheric and oceanic variations over the tropical western Pacific, intensive observations with the use of R/V *Mirai* were carried out at the station observation point (12N, 135E) and its surrounding area, which is the main purpose of this cruise.

On the way from Shimizu to the station observation point, three ARGO floats were deployed at (21N, 135E), (18N, 135E), and (15N, 135E).

Just before the start of the station observation, we deployed an m-TRITON mooring at (11-38N, 134-59E) on August 7 and three Wave Gliders on August 8. Then the R/V *Mirai* moved to the station observation point and stayed there for 30 days from August 9 to September 7 to perform the station observation, including 3-hourly radiosonde launch, RINKO Profiler casts, and CTD casts. Furthermore, the surface drifters were deployed and recovered 4 times. The three Wave Gliders were recovered on September 4, while the m-TRITON mooring was recovered on September 8, just before start sailing back to Shimizu.

On the way to Shimizu, we deployed the surface drifters at (17-00N, 135-50E).

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 several events of active cumulus convective systems with large amount of precipitation and calm and sunny days in between. The observed data collected during this cruise will be fruitful for deepening our understanding of the air-sea interaction processes regarding the cumulus convective activity and the scale interaction processes between the cumulus convective systems and large-scale disturbances such as BSISO.

2.10 Acknowledgements

We would like to express our sincere thanks to Master Haruhiko INOUE.

3. Cruise track and log

3.1 Cruise track

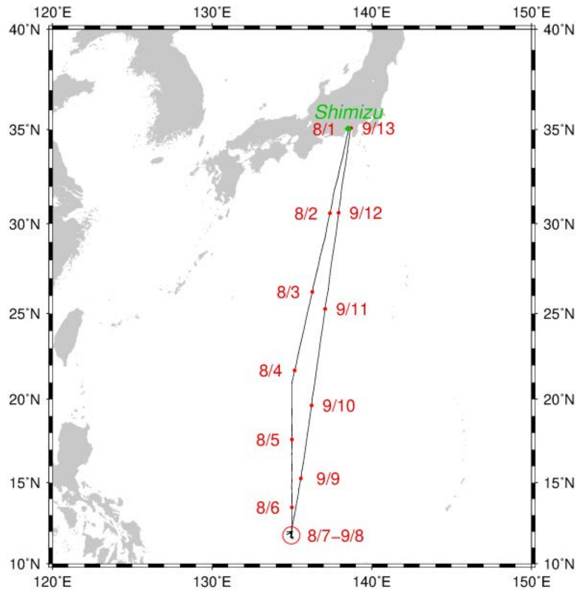


Figure 3.1-1: Cruise track for all the period.

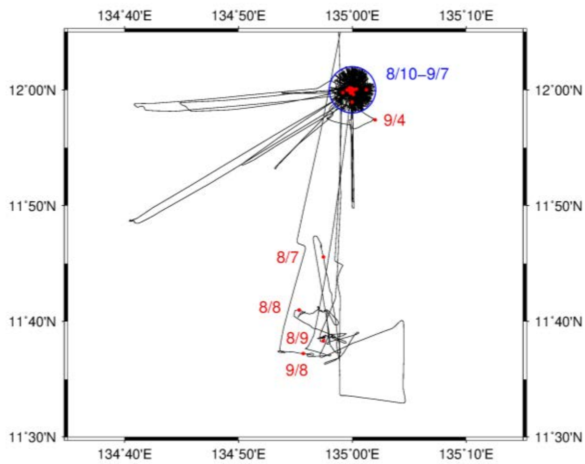


Figure 3.1-2: Cruise track in an area that covers the station observation point and m-TRITON mooring site.

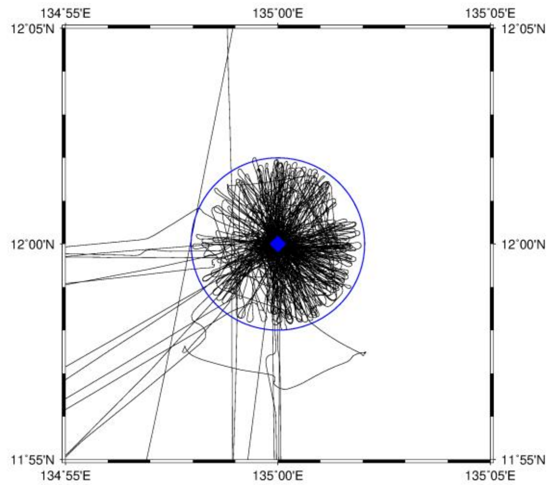


Figure 3.1-3: Cruise track just around the station observation point.

3.2 Cruise log

Date and time (in UTC)		SMT	Location	Event
Aug. 1	0000	0900		Departure from Shimizu, Japan
	0715	1615		Start sea surface water monitoring
	1300	0100		Start Doppler radar observation
Aug. 4	0422	1322	(21-00N, 135-00E)	CTD (C01M001); 1,000 m with water sampling
	0437	1337	(21-00N, 135-00E)	RINKO Profiler (C01M001)
	0523	1423	(21-00N, 135-00E)	Deployment of ARGO float (#1)
	0531	1431		Calibration for magnetometer
	2121	0621	(18-00N, 135-00E)	CTD (C02M001); 1,000 m with water sampling
	2219	0719	(18-00N, 135-00E)	Deployment of ARGO float (#2)
	2330	0830	(17-47N, 134-59E)	Radiosonde (#001)
Aug. 5	0230	1130	(17-20N, 135-00E)	Radiosonde (#002)
	0530	1430	(16-45N, 134-54E)	Radiosonde (#003)
	1130	2030	(15-42N, 135-00E)	Radiosonde (#004)
	1530	0030	(15-00N, 135-00E)	CTD (C03M001); 1,000 m with water sampling
	1626	0126	(15-00N, 135-00E)	Deployment of ARGO float (#3)
	1730	0230	(14-49N, 134-58E)	Radiosonde (#005)
	2330	0830	(13-43N, 135-00E)	Radiosonde (#006)
Aug. 6	0230	1130	(13-01N, 134-59E)	Radiosonde (#007)
	0530	1430	(12-21N, 134-59E)	Radiosonde (#008)
	0830	1730	(11-44N, 134-59E)	Radiosonde (#009)
	1130	2030	(11-40N, 135-04E)	Radiosonde (#010)
	1430	2330	(11-39N, 134-59E)	Radiosonde (#011)
	1730	0230	(11-37N, 134-58E)	Radiosonde (#012)
	2030	0530	(11-38N, 134-58E)	Radiosonde (#013)
	2328 -0454	0828 -1354	(11-38N, 134-59E)	Deployment of m-TRITON mooring
	2330	0830	(11-46N, 134-57E)	Radiosonde (#014)
Aug. 7	0230	1130	(11-43N, 134-58E)	Radiosonde (#015)
	0530	1430	(11-38N, 134-58E)	Radiosonde (#016)
	0605	1505	(11-41N, 134-58E)	CTD (C04M001); 500 m with water sampling attached with RINKO Profiler
	0830	1730	(11-41N, 134-58E)	Radiosonde (#017)
	1130	2030	(11-41N, 134-57E)	Radiosonde (#018)
	1430	2330	(11-41N, 134-57E)	Radiosonde (#019)
	1730	0230	(11-41N, 134-57E)	Radiosonde (#020)
	2030	0530	(11-41N, 134-57E)	Radiosonde (#021)
	2330	0830	(11-41N, 134-55E)	Radiosonde (#022)
	2332	0832	(11-40N, 134-55E)	Deployment of Wave Glider (SV3-196)
Aug. 8	0008	0908	(11-41N, 134-55E)	Deployment of Wave Glider (SV3-248)
	0045	0945	(11-41N, 134-55E)	Deployment of Wave Glider (SV3-252)
	0230	1130	(11-39N, 134-58E)	Radiosonde (#023)
	0300	1200	(11-39N, 134-59E)	RINKO Profiler (C04M002)
	0435	1335	(11-39N, 134-58E)	Deployment of Sea Snake thermistor

	0530	1430	(11-39N, 134-58E)	Radiosonde (#024)
	0600	1500	(11-39N, 134-58E)	RINKO Profiler (C04M003)
	0830	1730	(11-39N, 134-58E)	Radiosonde (#025)
	0900	1800	(11-39N, 134-58E)	RINKO Profiler (C04M004)
	1130	2030	(11-39N, 134-58E)	Radiosonde (#026)
	1200	2100	(11-39N, 134-58E)	RINKO Profiler (C04M005)
	1430	2330	(11-39N, 134-58E)	Radiosonde (#027)
	1500	0000	(11-39N, 134-57E)	RINKO Profiler (C04M006)
	1730	0230	(11-39N, 134-57E)	Radiosonde (#028)
	1800	0300	(11-39N, 134-57E)	RINKO Profiler (C04M007)
	2030	0530	(11-39N, 134-57E)	Radiosonde (#029)
	2100	0600	(11-39N, 134-57E)	RINKO Profiler (C04M008)
	2330	0830	(11-38N, 134-57E)	Radiosonde (#030)
Aug. 9	0000	0900	(11-38N, 134-57E)	RINKO Profiler (C04M009)
	0200	1100	(11-38N, 134-57E)	Recovery of Sea Snake thermistor
	0230	1130	(11-38N, 134-57E)	Radiosonde (#031)
	0236	1136		Leave from m-TRITON mooring point
	0424	1324		Arrive at the station point (12-00N, 135-00E)
	0524	1424	(12-00N, 135-00E)	Radiosonde (#032)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM001)
	0612	1512	(12-00N, 135-00E)	CTD (STNM001); 500 m
	0653	1553	(12-00N, 135-00E)	Deployment of Sea Snake thermistor
	0838	1738	(12-00N, 135-00E)	Radiosonde (#033)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM002)
	0912	1812	(12-00N, 135-00E)	CTD (STNM002); 500 m
	1130	2030	(11-59N, 135-00E)	Radiosonde (#034)
	1200	2100	(11-59N, 135-00E)	RINKO Profiler (STNM003)
	1213	2113	(11-59N, 135-00E)	CTD (STNM003); 500 m
	1430	2330	(12-01N, 135-01E)	Radiosonde (#035)
	1500	0000	(12-01N, 135-01E)	RINKO Profiler (STNM004)
	1513	0013	(12-01N, 135-01E)	CTD (STNM004); 500 m
	1731	0231	(12-00N, 135-00E)	Radiosonde (#036)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM005)
	1820	0320	(12-00N, 135-00E)	CTD (STNM005); 500 m
	2030	0530	(11-59N, 135-00E)	Radiosonde (#037)
	2100	0600	(11-59N, 135-00E)	RINKO Profiler (STNM006)
	2115	0615	(11-59N, 135-00E)	CTD (STNM006); 500 m
	2341	0841	(12-00N, 135-01E)	Radiosonde (#038)
Aug. 10	0000	0900	(12-00N, 135-02E)	RINKO Profiler (STNM007)
	0012	0912	(12-00N, 135-01E)	CTD (STNM007); 1,000 m with water sampling
	0230	1130	(12-00N, 135-01E)	Radiosonde (#039)
	0300	1200	(12-00N, 135-01E)	RINKO Profiler (STNM008)
	0310	1210	(12-00N, 135-01E)	CTD (STNM008); 500 m
	0530	1430	(12-00N, 135-01E)	Radiosonde (#040)
	0600	1500	(12-00N, 135-01E)	RINKO Profiler (STNM009)
	0615	1515	(12-00N, 135-00E)	CTD (STNM009); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#041)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM010)

	0910	1810	(12-00N, 135-00E)	CTD (STNM010); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#042)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM011)
	1215	2115	(12-00N, 134-59E)	CTD (STNM011); 500 m
	1430	2330	(12-00N, 134-59E)	Radiosonde (#043)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM012)
	1511	0011	(12-00N, 135-00E)	CTD (STNM012); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#044)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM013)
	1812	0312	(12-00N, 135-00E)	CTD (STNM013); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#045)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM014)
	2114	0614	(12-00N, 135-00E)	CTD (STNM014); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#046)
Aug. 11	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM015)
	0013	0913	(12-00N, 135-00E)	CTD (STNM015); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#047)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM016)
	0310	1210	(12-00N, 135-00E)	CTD (STNM016); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#048)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM017)
	0610	1510	(12-00N, 135-00E)	CTD (STNM017); 500 m
	0830	1730	(12-01N, 135-00E)	Radiosonde (#049)
	0900	1800	(12-01N, 135-00E)	RINKO Profiler (STNM018)
	0910	1810	(12-01N, 134-59E)	CTD (STNM018); 500 m
	1130	2030	(11-59N, 135-00E)	Radiosonde (#050)
	1200	2100	(11-59N, 135-00E)	RINKO Profiler (STNM019)
	1211	2111	(11-59N, 135-00E)	CTD (STNM019); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#051)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM020)
	1511	0011	(12-00N, 135-00E)	CTD (STNM020); 500 m
	1730	0230	(11-59N, 135-00E)	Radiosonde (#052)
	1800	0200	(12-00N, 135-00E)	RINKO Profiler (STNM021)
	1813	0213	(12-00N, 135-00E)	CTD (STNM021); 500 m
	2030	0530	(11-59N, 135-00E)	Radiosonde (#053)
	2100	0600	(11-59N, 135-00E)	RINKO Profiler (STNM022)
	2111	0611	(11-59N, 135-00E)	CTD (STNM022); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#054)
Aug.12	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM023)
	0011	0911	(12-00N, 135-00E)	CTD (STNM023); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#055)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM024)
	0308	1208	(12-00N, 135-00E)	CTD (STNM024); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#056)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM025)
	0610	1510	(12-00N, 135-00E)	CTD (STNM025); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#057)
	0900	1800	(12-01N, 135-00E)	RINKO Profiler (STNM026)

	0909	1809	(12-00N, 135-00E)	CTD (STNM026); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#058)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM027)
	1211	2111	(12-00N, 135-00E)	CTD (STNM027); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#059)
	1500	0000	(12-00N, 134-59E)	RINKO Profiler (STNM028)
	1514	0014	(12-00N, 134-59E)	CTD (STNM028); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#060)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM029)
	1811	0311	(12-00N, 135-00E)	CTD (STNM029); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#061)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM030)
	2112	0612	(12-00N, 135-00E)	CTD (STNM030); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#062)
Aug. 13	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM031)
	0010	0910	(12-00N, 135-00E)	CTD (STNM031); 1,000 m with water sampling
	0234	1134	(12-00N, 135-00E)	Radiosonde (#063)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM032)
	0306	1206	(12-00N, 135-00E)	CTD (STNM032); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#064)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM033)
	0610	1510	(12-00N, 135-00E)	CTD (STNM033); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#065)
	0900	1300	(12-00N, 135-00E)	RINKO Profiler (STNM034)
	0913	1813	(12-00N, 135-00E)	CTD (STNM034); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#066)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM035)
	1211	2111	(12-00N, 135-00E)	CTD (STNM035); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#067)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM036)
	1511	0011	(12-00N, 135-00E)	CTD (STNM036); 500 m
	1731	0231	(12-00N, 135-01E)	Radiosonde (#068)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM037)
	1812	0312	(12-00N, 135-00E)	CTD (STNM037); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#069)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM038)
	2111	0611	(12-00N, 135-00E)	CTD (STNM038); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#070)
Aug. 14	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM039)
	0010	0910	(12-00N, 135-00E)	CTD (STNM039); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#071)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM040)
	0308	1208	(12-00N, 135-00E)	CTD (STNM040); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#072)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM041)
	0608	1508	(12-00N, 135-00E)	CTD (STNM041); 500 m
	0827	1727	(12-00N, 135-00E)	Radiosonde (#073)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM042)

	0910	1810	(12-00N, 135-00E)	CTD (STNM042); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#074)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM043)
	1213	2113	(12-00N, 135-00E)	CTD (STNM043); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#075)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM044)
	1511	0011	(12-00N, 135-00E)	CTD (STNM044); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#076)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM045)
	1811	0311	(12-00N, 135-00E)	CTD (STNM045); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#077)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM046)
	2113	0613	(12-00N, 135-00E)	CTD (STNM046); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#078)
Aug. 15	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM047)
	0010	0910	(12-00N, 135-01E)	CTD (STNM047); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#079)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM048)
	0308	1208	(12-00N, 135-00E)	CTD (STNM048); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#080)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM049)
	0609	1509	(12-00N, 135-00E)	CTD (STNM049); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#081)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM050)
	0911	1811	(12-00N, 135-00E)	CTD (STNM050); 500 m
	1131	2031	(12-00N, 135-00E)	Radiosonde (#082)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM051)
	1211	2111	(12-00N, 135-00E)	CTD (STNM051); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#083)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM052)
	1511	0011	(12-00N, 135-00E)	CTD (STNM052); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#084)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM053)
	1811	0311	(12-00N, 135-00E)	CTD (STNM053); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#085)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM054)
	2111	0611	(12-00N, 135-00E)	CTD (STNM054); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#086)
Aug. 16	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM055)
	0012	0912	(12-00N, 135-00E)	CTD (STNM055); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#087)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM056)
	0307	1207	(12-00N, 135-00E)	CTD (STNM056); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#088)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM057)
	0608	1508	(12-00N, 135-00E)	CTD (STNM057); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#089)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM058)

	0910	1810	(12-00N, 135-00E)	CTD (STNM058); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#090)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM059)
	1212	2112	(12-00N, 135-00E)	CTD (STNM059); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#091)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM060)
	1510	0010	(12-01N, 135-00E)	CTD (STNM060); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#092)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM061)
	1810	0310	(12-00N, 135-00E)	CTD (STNM061); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#093)
	2100	0600	(11-59N, 135-00E)	RINKO Profiler (STNM062)
	2111	0611	(11-59N, 135-00E)	CTD (STNM062); 500 m
	2150	0650	(11-59N, 135-00E)	Recovery of Sea Snake thermistor
	2245	0745	(11-50N, 135-00E)	Deployment of drifting buoys (#1-1, #1-2)
	2330	0830	(11-58N, 135-00E)	Radiosonde (#094)
	2344	0844	(11-59N, 135-00E)	Deployment of Sea Snake thermistor
Aug. 17	0000	0900	(11-59N, 135-00E)	RINKO Profiler (STNM063)
	0009	0909	(12-00N, 135-00E)	CTD (STNM063); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#095)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM064)
	0308	1208	(12-00N, 135-00E)	CTD (STNM064); 500 m
	0531	1431	(12-00N, 135-00E)	Radiosonde (#096)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM065)
	0637	1537	(12-00N, 135-00E)	XCTD (#01)
	0830	1730	(12-00N, 135-00E)	Radiosonde (#097)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM066)
	0911	1811	(12-00N, 135-00E)	CTD (STNM066); 500 m
	1130	2030	(11-59N, 135-01E)	Radiosonde (#098)
	1200	2100	(11-59N, 135-01E)	RINKO Profiler (STNM067)
	1211	2111	(12-00N, 135-01E)	CTD (STNM067); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#099)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM068)
	1511	0011	(12-00N, 135-00E)	CTD (STNM068); 500 m
	1731	0231	(12-00N, 135-00E)	Radiosonde (#100)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM069)
	1810	0310	(12-00N, 135-00E)	CTD (STNM069); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#101)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM070)
	2110	0610	(12-00N, 135-00E)	CTD (STNM070); 500 m
	2345	0845	(12-00N, 135-00E)	Radiosonde (#102)
Aug. 18	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM071)
	0009	0909	(12-00N, 135-00E)	CTD (STNM071); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#103)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM072)
	0309	1209	(12-00N, 135-00E)	CTD (STNM072); 500 m
	0350	1250	(12-00N, 135-00E)	Recovery of Sea Snake thermistor
	0518	1418	(11-59N, 134-45E)	Recovery of drifting buoys (#1-1, #1-2)

	0526	1426	(11-59N, 134-45E)	Radiosonde (#104)
	0538	1438	(11-59N, 134-45E)	RINKO Profiler (DBRM001)
	0600	1500	(11-59N, 134-47E)	XCTD (#02)
	0709	1609	(12-00N, 135-00E)	Deployment of Sea Snake thermistor
	0830	1730	(12-00N, 135-00E)	Radiosonde (#105)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM073)
	0908	1808	(12-00N, 135-00E)	XCTD (#03)
	1130	2030	(12-01N, 135-00E)	Radiosonde (#106)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM074)
	1211	2111	(12-00N, 135-00E)	CTD (STNM074); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#107)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM075)
	1509	0009	(12-00N, 135-00E)	CTD (STNM075); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#108)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM076)
	1810	0310	(12-00N, 135-00E)	CTD (STNM076); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#109)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM077)
	2110	0610	(12-00N, 135-00E)	CTD (STNM077); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#110)
Aug. 19	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM078)
	0009	0909	(12-00N, 135-00E)	CTD (STNM078); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#111)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM079)
	0309	1209	(12-00N, 135-00E)	CTD (STNM079); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#112)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM080)
	0609	1509	(12-00N, 135-00E)	CTD (STNM080); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#113)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM081)
	0909	1809	(12-00N, 135-00E)	CTD (STNM081); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#114)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM082)
	1211	2111	(12-00N, 135-00E)	CTD (STNM082); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#115)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM083)
	1510	0010	(12-00N, 135-00E)	CTD (STNM083); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#116)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM084)
	1810	0310	(12-00N, 135-00E)	CTD (STNM084); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#117)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM085)
	2110	0610	(12-00N, 135-00E)	CTD (STNM085); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#118)
Aug. 20	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM086)
	0010	0910	(12-00N, 135-00E)	CTD (STNM086); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#119)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM087)

	0308	1208	(12-00N, 135-00E)	CTD (STNM087); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#120)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM088)
	0609	1509	(12-00N, 135-00E)	CTD (STNM088); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#121)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM089)
	0910	1810	(12-00N, 135-00E)	CTD (STNM089); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#122)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM090)
	1209	2109	(12-00N, 135-00E)	CTD (STNM090); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#123)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM091)
	1511	0011	(12-00N, 135-00E)	CTD (STNM091); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#124)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM092)
	1809	0309	(12-00N, 135-00E)	CTD (STNM092); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#125)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM093)
	2110	0610	(12-00N, 135-00E)	CTD (STNM093); 500 m
	2148	0648	(12-00N, 135-00E)	Recovery of Sea Snake thermistor
	2245	0745	(11-50N, 135-00E)	Deployment of drifting buoys (#2-1, #2-2)
	2330	0830	(11-57N, 135-00E)	Radiosonde (#126)
	2345	0845	(11-59N, 135-00E)	Deployment of Sea Snake thermistor
Aug. 21	0000	0900	(11-59N, 135-00E)	RINKO Profiler (STNM094)
	0008	0908	(11-59N, 135-00E)	CTD (STNM094); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#127)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM095)
	0309	1209	(12-00N, 135-00E)	CTD (STNM095); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#128)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM096)
	0609	1509	(12-00N, 135-00E)	CTD (STNM096); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#129)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM097)
	0910	1810	(12-00N, 135-00E)	CTD (STNM097); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#130)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM098)
	1209	2109	(12-00N, 135-00E)	CTD (STNM098); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#131)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM099)
	1509	0009	(12-00N, 135-00E)	CTD (STNM099); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#132)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM100)
	1809	0309	(12-00N, 135-00E)	CTD (STNM100); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#133)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM101)
	2110	0610	(12-00N, 135-00E)	CTD (STNM101); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#134)
Aug. 22	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM102)

	0009	0909	(12-00N, 135-00E)	CTD (STNM102); 1,000 m with water sampling
	0230	1130	(11-59N, 134-59E)	Radiosonde (#135)
	0300	1200	(11-59N, 134-59E)	RINKO Profiler (STNM103)
	0301	1201	(11-59N, 134-59E)	Recovery of Sea Snake thermistor
	0304	1204	(11-59N, 134-59E)	XCTD (#04)
	0515	1415	(11-49N, 134-41E)	Recovery of drifting buoys (#2-1, #2-2)
	0530	1430	(11-49N, 134-41E)	Radiosonde (#136)
	0546	1446	(11-49N, 134-40E)	RINKO Profiler (DBRM002)
	0559	1459	(11-49N, 134-41E)	XCTD (#05)
	0756	1656	(12-00N, 135-00E)	Deployment of Sea Snake thermistor
	0830	1730	(12-00N, 135-00E)	Radiosonde (#137)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM104)
	0908	1808	(12-00N, 135-00E)	XCTD (#06)
	1130	2030	(12-00N, 135-00E)	Radiosonde (#138)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM105)
	1214	2114	(12-00N, 135-00E)	CTD (STNM105); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#139)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM106)
	1510	0010	(12-00N, 135-00E)	CTD (STNM106); 500 m
	1731	0231	(12-00N, 135-00E)	Radiosonde (#140)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM107)
	1809	0309	(12-00N, 135-00E)	CTD (STNM107); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#141)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM108)
	2109	0609	(12-00N, 135-00E)	CTD (STNM108); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#142)
Aug. 23	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM109)
	0008	0908	(12-00N, 135-00E)	CTD (STNM109); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#143)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM110)
	0308	1208	(12-00N, 135-00E)	CTD (STNM110); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#144)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM111)
	0608	1508	(12-00N, 135-00E)	CTD (STNM111); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#145)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM112)
	0909	1809	(12-00N, 135-00E)	CTD (STNM112); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#146)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM113)
	1211	2111	(12-00N, 135-00E)	CTD (STNM113); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#147)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM114)
	1508	0008	(12-00N, 135-00E)	CTD (STNM114); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#148)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM115)
	1808	0308	(12-00N, 135-00E)	CTD (STNM115); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#149)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM116)

	2110	0610	(12-00N, 135-00E)	CTD (STNM116); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#150)
Aug. 24	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM117)
	0012	0912	(12-00N, 135-00E)	CTD (STNM117); 1,000 m with water sampling
	0230	1130	(12-00N, 134-59E)	Radiosonde (#151)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM118)
	0308	1208	(12-00N, 135-00E)	CTD (STNM118); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#152)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM119)
	0609	1509	(12-00N, 135-00E)	CTD (STNM119); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#153)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM120)
	0909	1809	(12-00N, 135-00E)	CTD (STNM120); 500 m
	1130	2030	(12-00N, 135-01E)	Radiosonde (#154)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM121)
	1213	2113	(12-00N, 135-00E)	CTD (STNM121); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#155)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM122)
	1509	0009	(12-00N, 135-00E)	CTD (STNM122); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#156)
	1800	0300	(11-59N, 135-00E)	RINKO Profiler (STNM123)
	1811	0311	(12-00N, 135-00E)	CTD (STNM123); 500 m
	2028	0528	(12-00N, 135-00E)	Radiosonde (#157)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM124)
	2112	0612	(12-00N, 135-00E)	CTD (STNM124); 500 m
	2325	0825	(12-00N, 135-00E)	Radiosonde (#158)
Aug. 25	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM125)
	0013	0913	(12-00N, 135-00E)	CTD (STNM125); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#159)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM126)
	0309	1209	(12-00N, 135-00E)	CTD (STNM126); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#160)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM127)
	0608	1508	(12-00N, 135-00E)	CTD (STNM127); 500 m
	0751	1651	(11-59N, 135-00E)	Recovery of Sea Snake thermistor
	0830	1730	(12-01N, 135-00E)	Radiosonde (#161)
	0900	1800	(12-01N, 135-00E)	RINKO Profiler (STNM128)
	0907	1807	(12-01N, 135-00E)	CTD (STNM128); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#162)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM129)
	1211	2111	(12-01N, 135-00E)	CTD (STNM129); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#163)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM130)
	1509	0009	(12-00N, 135-00E)	CTD (STNM130); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#164)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM131)
	1812	0312	(12-00N, 135-00E)	CTD (STNM131); 500 m
	2027	0527	(12-00N, 135-00E)	Radiosonde (#165)

	2100	0600	(12-00N, 135-01E)	RINKO Profiler (STNM132)
	2111	0611	(12-00N, 135-01E)	CTD (STNM132); 500 m
	2204	0704	(12-00N, 135-00E)	Deployment of Sea Snake thermistor
	2325	0825	(12-00N, 135-00E)	Radiosonde (#166)
Aug. 26	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM133)
	0010	0910	(12-00N, 135-00E)	CTD (STNM133); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#167)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM134)
	0309	1209	(12-00N, 135-00E)	CTD (STNM134); 500 m
	0530	1430	(12-00N, 134-59E)	Radiosonde (#168)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM135)
	0609	1509	(12-00N, 135-00E)	CTD (STNM135); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#169)
	0900	1800	(12-00N, 134-59E)	RINKO Profiler (STNM136)
	0909	1809	(12-00N, 134-59E)	CTD (STNM136); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#170)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM137)
	1212	2112	(12-00N, 135-00E)	CTD (STNM137); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#171)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM138)
	1509	0009	(12-00N, 135-00E)	CTD (STNM138); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#172)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM139)
	1811	0311	(12-01N, 135-00E)	CTD (STNM139); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#173)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM140)
	2111	0611	(12-00N, 135-00E)	CTD (STNM140); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#174)
Aug.27	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM141)
	0012	0912	(12-00N, 135-00E)	CTD (STNM141); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#175)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM142)
	0309	1209	(12-00N, 135-00E)	CTD (STNM142); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#176)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM143)
	0609	1509	(12-00N, 135-00E)	CTD (STNM143); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#177)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM144)
	0908	1808	(12-00N, 135-00E)	CTD (STNM144); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#178)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM145)
	1212	2112	(12-00N, 135-00E)	CTD (STNM145); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#179)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM146)
	1508	0008	(12-00N, 135-00E)	CTD (STNM146); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#180)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM147)
	1811	0311	(12-00N, 135-00E)	CTD (STNM147); 500 m

	2030	0530	(12-00N, 135-00E)	Radiosonde (#181)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM148)
	2110	0610	(12-00N, 135-00E)	CTD (STNM148); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#182)
Aug. 28	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM149)
	0012	0912	(12-00N, 135-00E)	CTD (STNM149); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#183)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM150)
	0310	1210	(12-00N, 135-00E)	CTD (STNM150); 500 m
	0537	1437	(12-00N, 135-00E)	Radiosonde (#184)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM151)
	0608	1508	(12-00N, 135-00E)	CTD (STNM151); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#185)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM152)
	0908	1808	(12-00N, 135-00E)	CTD (STNM152); 500 m
	1130	2030	(12-00N, 135-59E)	Radiosonde (#186)
	1200	2100	(12-00N, 135-59E)	RINKO Profiler (STNM153)
	1209	2109	(12-00N, 135-58E)	CTD (STNM153); 500 m
	1430	2330	(11-59N, 135-00E)	Radiosonde (#187)
	1500	0000	(11-59N, 134-59E)	RINKO Profiler (STNM154)
	1508	0008	(11-59N, 134-59E)	CTD (STNM154); 500 m
	1730	0230	(12-01N, 135-01E)	Radiosonde (#188)
	1800	0300	(12-01N, 135-01E)	RINKO Profiler (STNM155)
	1811	0311	(12-01N, 135-01E)	CTD (STNM155); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#189)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM156)
	2109	0609	(12-00N, 135-00E)	CTD (STNM156); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#190)
Aug. 29	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM157)
	0009	0909	(12-00N, 135-00E)	CTD (STNM157); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#191)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM158)
	0308	1208	(12-00N, 135-00E)	CTD (STNM158); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#192)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM159)
	0609	1509	(12-00N, 135-00E)	CTD (STNM159); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#193)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM160)
	0908	1808	(12-00N, 135-00E)	CTD (STNM160); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#194)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM161)
	1209	2109	(12-00N, 135-00E)	CTD (STNM161); 500 m
	1425	2325	(12-00N, 135-00E)	Radiosonde (#195)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM162)
	1508	0008	(12-00N, 135-00E)	CTD (STNM162); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#196)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM163)
	1811	0311	(12-00N, 135-00E)	CTD (STNM163); 500 m

	2030	0530	(12-00N, 135-00E)	Radiosonde (#197)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM164)
	2111	0611	(12-00N, 135-00E)	CTD (STNM164); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#198)
Aug. 30	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM165)
	0012	0912	(12-00N, 135-00E)	CTD (STNM165); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#199)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM166)
	0311	1211	(12-00N, 135-00E)	CTD (STNM166); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#200)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM167)
	0609	1509	(12-00N, 135-00E)	CTD (STNM167); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#201)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM168)
	0908	1808	(12-00N, 135-00E)	CTD (STNM168); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#202)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM169)
	1209	2109	(12-00N, 135-00E)	CTD (STNM169); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#203)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM170)
	1508	0008	(12-00N, 135-00E)	CTD (STNM170); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#204)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM171)
	1811	0311	(12-00N, 135-00E)	CTD (STNM171); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#205)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM172)
	2110	0610	(12-00N, 135-00E)	CTD (STNM172); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#206)
Aug. 31	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM173)
	0010	0910	(12-00N, 135-00E)	CTD (STNM173); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#207)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM174)
	0309	1209	(12-00N, 135-00E)	CTD (STNM174); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#208)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM175)
	0610	1510	(12-00N, 135-00E)	CTD (STNM175); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#209)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM176)
	0908	1808	(12-00N, 135-00E)	CTD (STNM176); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#210)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM177)
	1209	2109	(12-00N, 135-00E)	CTD (STNM177); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#211)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM178)
	1508	0008	(12-00N, 135-00E)	CTD (STNM178); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#212)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM179)
	1811	0311	(12-00N, 135-00E)	CTD (STNM179); 500 m

	2030	0530	(12-00N, 135-00E)	Radiosonde (#213)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM180)
	2110	0610	(12-00N, 135-00E)	CTD (STNM180); 500 m
	2145	0645	(12-00N, 135-00E)	Recovery of Sea Snake thermistor
	2246	0746	(11-53N, 134-53E)	Deployment of drifting buoys (#3-1, #3-2)
	2330	0830	(11-58N, 134-58E)	Radiosonde (#214)
	2347	0847	(11-59N, 134-59E)	Deployment of Sea Snake thermistor
Sep. 1	0000	0900	(12-00N, 134-59E)	RINKO Profiler (STNM181)
	0010	0910	(12-00N, 134-59E)	CTD (STNM181); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#215)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM182)
	0309	1209	(12-00N, 135-00E)	CTD (STNM182); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#216)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM183)
	0608	1508	(12-00N, 135-00E)	CTD (STNM183); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#217)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM184)
	0908	1808	(12-00N, 135-00E)	CTD (STNM184); 500 m
	1125	2025	(12-00N, 135-00E)	Radiosonde (#218)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM185)
	1209	2109	(12-00N, 135-00E)	CTD (STNM185); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#219)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM186)
	1508	0008	(12-00N, 135-00E)	CTD (STNM186); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#220)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM187)
	1811	0311	(12-00N, 135-00E)	CTD (STNM187); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#221)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM188)
	2110	0610	(12-00N, 135-00E)	CTD (STNM188); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#222)
Sep. 2	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM189)
	0009	0909	(12-00N, 135-00E)	CTD (STNM189); 1,000 m with water sampling
	0230	1130	(12-00N, 134-59E)	Radiosonde (#223)
	0300	1200	(12-00N, 134-58E)	RINKO Profiler (STNM190)
	0308	1208	(12-00N, 134-59E)	CTD (STNM190); 500 m
	0345	1245	(11-59N, 134-58E)	Recovery of Sea Snake thermistor
	0519	1419	(11-58N, 134-42E)	Recovery of drifting buoys (#3-1, #3-2)
	0530	1430	(11-59N, 134-41E)	Radiosonde (#224)
	0545	1445	(11-59N, 134-41E)	RINKO Profiler (DBRM003)
	0600	1500	(11-59N, 134-42E)	XCTD (#07)
	0731	1631	(12-01N, 134-58E)	Deployment of Sea Snake thermistor
	0830	1730	(12-00N, 135-00E)	Radiosonde (#225)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM191)
	0906	1806	(12-00N, 135-00E)	XCTD (#08)
	1130	2030	(12-00N, 135-00E)	Radiosonde (#226)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM192)
	1209	2109	(12-00N, 135-00E)	CTD (STNM192); 500 m

	1430	2330	(12-00N, 135-00E)	Radiosonde (#227)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM193)
	1508	0008	(12-00N, 135-00E)	CTD (STNM193); 500 m
	1731	0231	(12-00N, 135-00E)	Radiosonde (#228)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM194)
	1811	0311	(12-00N, 135-00E)	CTD (STNM194); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#229)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM195)
	2110	0610	(12-00N, 134-59E)	CTD (STNM195); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#230)
Sep. 3	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM196)
	0010	0910	(12-00N, 135-00E)	CTD (STNM196); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#231)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM197)
	0308	1208	(12-00N, 135-00E)	CTD (STNM197); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#232)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM198)
	0608	1508	(12-00N, 135-00E)	CTD (STNM198); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#233)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM199)
	0909	1809	(12-00N, 135-00E)	CTD (STNM199); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#234)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM200)
	1209	2109	(12-00N, 135-00E)	CTD (STNM200); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#235)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM201)
	1507	0007	(12-00N, 135-00E)	XCTD (#09)
	1730	0230	(12-00N, 135-00E)	Radiosonde (#236)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM202)
	1808	0308	(12-00N, 135-00E)	XCTD (#10)
	2030	0530	(12-00N, 135-01E)	Radiosonde (#237)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM203)
	2105	0605	(12-00N, 135-00E)	XCTD (#11)
	2300	0800	(11-59N, 135-01E)	Recovery of Sea Snake thermistor
	2330	0830	(11-59N, 135-01E)	Radiosonde (#238)
Sep. 4	0000	0900	(11-59N, 135-01E)	RINKO Profiler (STNM204)
	0005	0905	(11-58N, 135-01E)	XCTD (#12)
	0049	0949	(11-57N, 135-02E)	Recovery of Wave Glider (SV-252)
	0053	0953	(11-57N, 135-02E)	Water sampling with bucket (WGRM001)
	0141	1041	(11-57N, 135-00E)	Recovery of Wave Glider (SV-248)
	0143	1043	(11-57N, 135-00E)	Water sampling with bucket (WGRM002)
	0228	1128	(11-58N, 134-58E)	Recovery of Wave Glider (SV-196)
	0229	1129	(11-58N, 134-58E)	Water sampling with bucket (WGRM003)
	0230	1130	(11-58N, 134-58E)	Radiosonde (#239)
	0246	1146	(11-58N, 134-59E)	Deployment of Sea Snake thermistor
	0300	1200	(11-59N, 134-59E)	RINKO Profiler (STNM205)
	0306	1206	(11-59N, 134-59E)	XCTD (#13)
	0530	1430	(12-00N, 135-00E)	Radiosonde (#240)

	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM206)
	0605	1505	(12-00N, 135-00E)	XCTD (#14)
	0830	1730	(12-00N, 135-01E)	Radiosonde (#241)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM207)
	0909	1809	(12-00N, 135-00E)	CTD (STNM207); 500 m
	1130	2030	(12-00N, 135-01E)	Radiosonde (#242)
	1200	2100	(12-00N, 135-01E)	RINKO Profiler (STNM208)
	1209	2109	(12-00N, 135-00E)	CTD (STNM208); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#243)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM209)
	1510	0010	(12-00N, 135-00E)	CTD (STNM209); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#244)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM210)
	1811	0311	(12-00N, 135-00E)	CTD (STNM210); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#245)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM211)
	2110	0610	(12-00N, 135-00E)	CTD (STNM211); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#246)
Sep. 5	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM212)
	0009	0909	(12-00N, 135-00E)	CTD (STNM212); 1,000 m with water sampling
	0230	1130	(12-00N, 135-00E)	Radiosonde (#247)
	0300	1200	(12-00N, 135-00E)	RINKO Profiler (STNM213)
	0309	1209	(12-00N, 135-00E)	CTD (STNM213); 500 m
	0530	1430	(12-00N, 135-00E)	Radiosonde (#248)
	0600	1500	(12-00N, 135-00E)	RINKO Profiler (STNM214)
	0611	1511	(12-00N, 135-00E)	CTD (STNM214); 500 m
	0830	1730	(12-01N, 135-00E)	Radiosonde (#249)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM215)
	0909	1809	(12-00N, 135-00E)	CTD (STNM215); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#250)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM216)
	1207	2107	(12-00N, 135-00E)	CTD (STNM216); 500 m
	1430	2330	(12-00N, 135-00E)	Radiosonde (#251)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM217)
	1508	0008	(12-00N, 135-00E)	CTD (STNM217); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#252)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM218)
	1811	0311	(12-00N, 135-00E)	CTD (STNM218); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#253)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM219)
	2110	0610	(12-00N, 135-00E)	CTD (STNM219); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#254)
Sep. 6	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM220)
	0009	0909	(12-00N, 135-00E)	CTD (STNM220); 1,000 m with water sampling
	0230	1130	(12-00N, 134-59E)	Radiosonde (#255)
	0300	1200	(12-00N, 134-59E)	RINKO Profiler (STNM221)
	0309	1209	(12-00N, 134-59E)	CTD (STNM221); 500 m
	0444	1344	(12-00N, 134-54E)	Deployment of drifting buoys (#4-1, #4-2)

	0530	1430	(12-00N, 134-57E)	Radiosonde (#256)
	0600	1500	(12-00N, 134-59E)	RINKO Profiler (STNM222)
	0610	1510	(12-00N, 134-59E)	CTD (STNM222); 500 m
	0830	1730	(12-00N, 135-00E)	Radiosonde (#257)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM223)
	0908	1808	(12-00N, 135-00E)	CTD (STNM223); 500 m
	1130	2030	(12-00N, 135-00E)	Radiosonde (#258)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM224)
	1209	2109	(12-00N, 135-00E)	CTD (STNM224); 500 m
	1430	2330	(12-00N, 135-01E)	Radiosonde (#259)
	1500	0000	(12-00N, 135-00E)	RINKO Profiler (STNM225)
	1508	0008	(12-00N, 135-00E)	CTD (STNM225); 500 m
	1730	0230	(12-00N, 135-00E)	Radiosonde (#260)
	1800	0300	(12-00N, 135-00E)	RINKO Profiler (STNM226)
	1811	0311	(12-00N, 135-00E)	CTD (STNM226); 500 m
	2030	0530	(12-00N, 135-00E)	Radiosonde (#261)
	2100	0600	(12-00N, 135-00E)	RINKO Profiler (STNM227)
	2111	0611	(12-00N, 135-00E)	CTD (STNM227); 500 m
	2330	0830	(12-00N, 135-00E)	Radiosonde (#262)
Sep. 7	0000	0900	(12-00N, 135-00E)	RINKO Profiler (STNM228)
	0010	0910	(12-00N, 135-00E)	CTD (STNM228); 1,000 m with water sampling
	0230	1130	(11-59N, 135-00E)	Radiosonde (#263)
	0300	1200	(11-58N, 135-00E)	RINKO Profiler (STNM229)
	0308	1208	(11-59N, 135-00E)	CTD (STNM229); 500 m
	0348	1248	(11-59N, 134-59E)	Recovery of Sea Snake thermistor
	0456	1356	(11-54N, 134-51E)	Recovery of drifting buoys (#4-1, #4-2)
	0508	1408	(11-54N, 134-50E)	RINKO Profiler (DBRM004)
	0530	1430	(11-55N, 134-52E)	Radiosonde (#264)
	0600	1500	(11-58N, 134-57E)	XCTD (#15)
	0830	1730	(12-00N, 135-00E)	Radiosonde (#265)
	0900	1800	(12-00N, 135-00E)	RINKO Profiler (STNM230)
	0907	1807	(12-00N, 135-00E)	XCTD (#16)
	1130	2030	(12-00N, 135-00E)	Radiosonde (#266)
	1200	2100	(12-00N, 135-00E)	RINKO Profiler (STNM231)
	1209	2109	(12-00N, 135-00E)	XCTD (#17)
	1430	2330	(12-00N, 135-00E)	Radiosonde (#267)
	1730	0230	(12-01N, 135-01E)	Radiosonde (#268)
	1736	0236		Calibration for magnetometer
	1800	0300		Leave from the station point (12N, 135E)
	2012	0512		Arrive at the m-TRITON mooring point
	2030	0530	(11-38N, 134-56E)	Radiosonde (#269)
	2100	0600	(12-00N, 135-00E)	CTD (C04M010); 500 m with water sampling attached with RINKO Profiler
	2219 -0435	0719 -1335		Recovery of m-TRITON mooring
	2330	0830	(11-37N, 134-57E)	Radiosonde (#270)
Sep. 8	0230	1130	(11-37N, 134-54E)	Radiosonde (#271)
	0530	1430	(11-47N, 134-55E)	Radiosonde (#272)

	0830	1730	(12-20N, 135-01E)	Radiosonde (#273)
	1130	2030	(12-54N, 135-08E)	Radiosonde (#274)
	1430	2330	(13-30N, 135-15E)	Radiosonde (#275)
	1729	0229	(14-01N, 135-21E)	Radiosonde (#276)
	2030	0530	(14-31N, 135-25E)	Radiosonde (#277)
	2330	0830	(15-03N, 134-57E)	Radiosonde (#278)
Sep. 9	0230	1130	(11-37N, 134-57E)	Radiosonde (#279)
	0530	1430	(11-37N, 134-57E)	Radiosonde (#280)
	0830	1730	(11-37N, 134-57E)	Radiosonde (#281)
	1006	1906	(17-00N, 135-50E)	Deployment of surface drifters (#5-1, #5-2)
	1130	2030	(11-37N, 134-57E)	Radiosonde (#282)
	1430	2330	(11-37N, 134-57E)	Radiosonde (#283)
	1730	0230	(11-37N, 134-57E)	Radiosonde (#284)
	2030	0530	(11-37N, 134-57E)	Radiosonde (#285)
	2330	0830	(11-37N, 134-57E)	Radiosonde (#286)
Sep. 10	0230	1130	(11-37N, 134-57E)	Radiosonde (#287)
	0530	1430	(11-37N, 134-57E)	Radiosonde (#288)
Sep. 11	2312	0812		Calibration for magnetometer
Sep. 12	0700	1600		Stop sea surface water monitoring
	0900	1800		Stop Doppler radar observation
Sep. 13	2300	0800		Arrival at Shimizu, Japan

4. List of participants

4.1 Participants (on board)

Name	Affiliation	Theme number*
Satoru YOKOI	JAMSTEC	M
Masaki KATSUMATA	JAMSTEC	M, 2, 5
Biao GENG	JAMSTEC	M
Kyoko TANIGUCHI	JAMSTEC	M
Kenta IRIE	JAMSTEC	M
Kei KAMIYA	JAMSTEC	M
Akira TAKESHIMA	Univ. Tokyo	1
Satoru SHOJI	Univ. Tokyo	1
Kazuho YOSHIDA	Nippon Marine Enterprise Inc. (NME)	T
Satomi OGAWA	NME	T
Yutaro MURAKAMI	NME	T
Masanori ENOKI	Marine Works Japan Ltd. (MWJ)	T
Akira WATANABE	MWJ	T
Rei ITO	MWJ	T
Masaki YAMADA	MWJ	T
Katsunori SAGISHIMA	MWJ	T
Tun Htet Aung	MWJ	T
Shiori ARIGA	MWJ	T
Keita HAYASHI	MWJ	T
Daiki KAWATA	MWJ	T

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

4.2 Participants (Not on board)

Name	Affiliation	Theme number*
Kunio YONEYAMA	JAMSTEC	M, 8
Fumikazu TAKETANI	JAMSTEC	M, 3, 4
Kei YOSHIMURA	Univ. Tokyo	1
Gilles REVERDIN	LOCEAN	2
Kazuma AOKI	Univ. Toyama	3
Yutaka MATSUMI	Nagoya Univ.	4
Akira YOSHIDA-KUWANO	Kyoto Univ.	5
Kazuaki YASUNAGA	Univ. Toyama	6
Tetsuya TAKEMI	Kyoto Univ.	7
Kelvin RICHARDS	IPRC / Univ. Hawai'i	8

4.3 Ship Crew

Name	Occupation
Haruhiko INOUE	Master
Tatsuo ADACHI	Chief Officer
Kanto ASAJI	2nd Officer
Tomoyuki TAKAHASHI	Jr. 2nd Officer
Shoma ABE	3rd Officer
Daisuke MORIYA	Jr. 3rd Officer
Tadashi ABE	Chief Engineer
Hiroki TANAKA	1st Engineer
Kota FUJII	2nd Engineer
Shintaro NONAKA	3rd Engineer
Yoichi INOUE	Chief Radio Operator
Kazuyoshi KUDO	Boatswain
Tsuyoshi SATO	Quarter Master
Yukito ISHII	Quarter Master
Yoshiaki MATSUO	Quarter Master
Masaya TANIKAWA	Quarter Master
Shohei UEHARA	Quarter Master
Takuya YAJIMA	Sailor
Takuma TOKUNAGA	Sailor
Keisuke ISOBE	Sailor
Shin ITO	Sailor
Manato KIMURA	Sailor
Iori TERASAKI	Sailor
Kazuya ANDO	No. 1 Oiler
Takuya WATANABE	Oiler
Masashi OE	Assistant Oiler
Tsuyoshi UCHIYAMA	Assistant Oiler
Shodai KAYABA	Assistant Oiler
Yuta WAKUGAWA	Assistant Oiler
Kyotaro MARUYAMA	Assistant Oiler
Toru WADA	Chief Steward
Hiroyuki OHBA	Steward
Kanjuro MURAKAMI	Steward
Mizuki NAKANO	Steward
Koki SHINOHARA	Steward

5. Summary of observations

5.1 GPS radiosonde

(1) Personnel

Satoru YOKOI	(JAMSTEC)	- Principal Investigator
Biao GENG	(JAMSTEC)	
Kyoko TANIGUCHI	(JAMSTEC)	
Kenta IRIE	(JAMSTEC)	
Kei KAMIYA	(JAMSTEC)	
Akira TAKESHIMA	(Univ. Tokyo)	
Satoru SHOJI	(Univ. Tokyo)	
Kazuho YOSHIDA	(NME)	- Operation Leader
Satomi OGAWA	(NME)	
Yutaro MURAKAMI	(NME)	
Yoichi INOUE	(Ship 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 used, which consists of processor (SPS-311), processing and recording software (MW41, ver. 2.11.0), 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). In case the relative wind to the ship is not appropriate for the launch using ASAP, handy launch was selected.

After 5 times of training launches, the radiosondes were launched every 3 hours from 00 UTC on 6 August to 06 UTC on 10 September 2020 (nominal time). In total, 288 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 the period averages, relative humidity, zonal wind, and meridional wind. Several basic parameters are derived from the sounding data and plotted in Fig. 5.1-2, such as column-integrated water vapor (CWV), convectively available potential temperature (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 ascent and decent (partially). 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 Mirai website at http://www.jamstec.go.jp/cruisedata/mirai/e/ .

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

ID	SN	Nominal time:	Launch location		Surface values						Max height	Clouds	
			Lat	Lon	P	T	RH	WD	WS	SST			
		YYYYMMDDHH	degN	degE	hPa	degC	%	deg	m/s	degC	m	Amount	Type
RS001	S0430752	2020080500	17.884	134.998	1009.3	30.3	75	98	12.5	30.390	25994.24	6	Cu, Ac, Cc
RS002	S0430751	2020080503	17.350	134.999	1009.2	29.9	78	104	11.0	30.440	23877.52	10	Cu, Sc As
RS003	S0430753	2020080506	16.786	135.005	1007.8	30.0	80	91	6.7	30.270	28046.74	7	Cu, Ci, As
RS004	S0410867	2020080512	15.775	134.997	1008.3	29.6	85	64	6.8	29.910	25078.26	unknown	Cu,As
RS005	S0410868	2020080518	14.893	134.980	1006.6	27.9	81	85	12.2	29.940	20077.44	10	unknown
RS006	S0520611	2020080600	13.800	134.999	1008.2	27.3	89	15	6.2	29.680	25342.02	10	Sc, As
RS007	S0370664	2020080603	13.121	134.988	1007.1	28.5	82	66	7.5	29.830	26509.28	8	St,As
RS008	S0410869	2020080606	12.439	135.010	1005.5	29.3	79	94	7.8	30.050	25952.35	4	Sc,Cu,Cc
RS009	S0420709	2020080609	11.783	134.976	1005.7	29.2	78	93	7.2	30.090	24174.26	8	Nb,Cu,As
RS010	S0420711	2020080612	11.624	135.075	1007.7	26.7	88	96	2.5	29.960	20982.96	unknown	unknown
RS011	S0370690	2020080615	11.649	134.989	1007.7	27.0	89	170	5.6	29.970	22610	10	Ns, Cu
RS012	S0440248	2020080618	11.618	134.979	1005.9	28.2	84	154	6.4	30.050	24013.61	4	Cu, As
RS013	S0430754	2020080621	11.640	134.975	1006.0	28.4	80	167	6.7	29.990	25396.04	7	Cu, Ci
RS014	S0370663	2020080700	11.774	134.954	1006.7	28.7	76	177	7.4	29.930	25230.66	8	Cu, As, Nb
RS015	S0370660	2020080703	11.729	134.964	1006.8	28.0	82	207	10.4	29.960	22869.55	8	Cu,Sc,Ns,Nb
RS016	S0420945	2020080706	11.622	134.976	1006.3	29.1	78	215	6.0	30.210	25594.5	4	Sc,Nb,Cs
RS017	S0440244	2020080709	11.682	134.961	1006.8	29.3	77	202	5.2	30.110	24280.97	3	Cu,Cs,As
RS018	S0370687	2020080712	11.682	134.954	1008.5	29.2	76	207	6.3	30.020	24544.28	2	unknown
RS019	S0420947	2020080715	11.683	134.951	1008.9	29.0	75	206	5.1	29.990	25592.05	6	Cu, As
RS020	S0370681	2020080718	11.685	134.952	1007.3	28.7	79	201	1.9	29.980	24688	2	Cu, As
RS021	S0420714	2020080721	11.682	134.946	1008.1	28.6	78	156	2.1	29.970	25640	5	Cu, St
RS022	S0370661	2020080800	11.678	134.928	1009.2	29.1	77	87	1.3	30.020	26352.8	3	Cu, Cs, Ci
RS023	S0420713	2020080803	11.645	134.974	1008.2	29.2	77	108	4.1	30.100	25317.29	2	St,As,Cs
RS024	S0410866	2020080806	11.638	134.988	1006.6	29.5	75	102	2.5	30.210	25416.61	2	St,As
RS025	S0420716	2020080809	11.644	134.971	1007.1	29.6	72	76	4.0	30.590	24731.05	4	Cu,As,Nb
RS026	S0370689	2020080812	11.647	134.965	1009.1	28.0	81	58	4.8	30.200	23446	2	As
RS027	S0370665	2020080815	11.664	134.961	1009.3	29.3	81	98	9.5	30.050	23448.96	7	Cu, Ac, As
RS028	S0420710	2020080818	11.644	134.960	1008.6	27.0	88	105	11.7	30.020	21193.9	10	unknown
RS029	S0370662	2020080821	11.644	134.959	1008.6	28.6	78	124	8.9	29.960	25429.23	6	St, Ac
RS030	S0430756	2020080900	11.641	134.959	1008.1	29.2	79	120	7.8	29.980	25625.79	7	Ci, St
RS031	S0370688	2020080903	11.638	134.957	1008.8	29.6	77	136	6.4	30.180	25768.36	6	Sc,Cc
RS032	S0370679	2020080906	12.002	134.994	1009.0	29.7	79	96	7.1	30.220	24076.39	8	Ac,Cu,Sc
RS033	S0370549	2020080909	12.006	135.001	1009.5	29.4	77	96	7.4	30.100	22918.02	8	Nb,Cu,As
RS034	S0370498	2020080912	11.989	135.002	1010.9	27.6	81	145	0.1	30.080	24791.28	unknown	unknown
RS035	S0410533	2020080915	12.017	135.018	1011.3	28.8	75	85	1.5	30.060	24688.23	7	Cu, As, Ac
RS036	S0420712	2020080918	12.000	134.998	1010.5	26.5	81	171	1.1	30.010	4713.65	10	unknown
RS037	S0520628	2020080921	11.986	135.008	1009.9	26.8	89	90	2.4	29.860	23676.41	5	Ns, St, As

RS038	S0370680	2020081000	12.005	135.017	1010.6	28.9	80	59	6.9	30.030	20773.39	3	St, Ci, Cu
RS039	S0420946	2020081003	12.012	135.022	1010.5	29.3	80	57	4.0	30.190	25840.39	6	Cu,Sc,Cc
RS040	S0440245	2020081006	12.017	135.013	1009.4	29.8	77	73	7.9	30.310	23588.06	9	Cu,As,Nb
RS041	S0410531	2020081009	11.989	135.009	1009.5	28.9	78	40	4.1	30.140	23084.28	9	Cu,Nb,As,Ci,Cs
RS042	S0370611	2020081012	12.005	134.998	1010.5	29.6	82	56	6.9	30.090	23283.79	unknown	unknown
RS043	S0410905	2020081015	12.009	134.996	1010.6	28.7	82	49	7.0	30.060	23964.38	8	Sc
RS044	S0370581	2020081018	12.007	134.998	1008.2	29.0	81	50	6.4	30.040	24276.41	3	Cu, Sc, As
RS045	S0370580	2020081021	11.998	135.009	1009.2	29.0	82	68	5.2	30.020	25707.19	4	Cu, St, Ac
RS046	S0430002	2020081100	12.010	134.997	1009.8	29.5	81	79	6.6	30.020	25462.04	9	Cu,Sc,As
RS047	S0430017	2020081103	11.993	134.999	1009.0	29.6	80	65	6.5	30.130	24237.88	7	As,Sc,Cu
RS048	S0430001	2020081106	11.995	135.003	1007.7	29.5	79	44	7.6	30.260	25096.95	7	St,Cu,Ci
RS049	S0430004	2020081109	12.006	135.001	1007.9	29.7	83	37	7.7	30.180	22612.68	8	Cu,Cc,As,Cs
RS050	S0430006	2020081112	11.983	134.996	1009.0	29.5	82	56	9.9	30.100	23174.08	unknown	unknown
RS051	S0430015	2020081115	11.992	134.993	1009.3	29.3	85	75	6.4	30.130	24337.37	10	unknown
RS052	S0420967	2020081118	11.992	135.000	1008.1	28.2	79	43	2.6	30.050	22675.94	8	unknown
RS053	S0430003	2020081121	11.980	135.014	1007.6	29.1	82	36	6.4	30.080	24405.88	8	Cu, St, Nb, Ns
RS054	S0410838	2020081200	12.013	135.002	1009.3	29.7	78	93	9.1	30.090	25741.9	10	Cu, Ns, Sc
RS055	S0410836	2020081203	12.011	135.007	1008.0	27.6	83	139	10.3	30.050	25382.31	10	St,Cu,As
RS056	S0410840	2020081206	11.991	135.003	1006.7	28.0	81	124	4.0	30.040	26239.14	10	St,As
RS057	S0410833	2020081209	12.011	135.011	1007.9	28.7	81	96	6.0	30.040	24311.14	9	As,Sc,Cu,Nb
RS058	S0410837	2020081212	12.006	135.007	1008.1	26.7	92	192	0.6	29.990	23298.02	unknown	unknown
RS059	S0410835	2020081215	11.985	134.995	1009.1	28.2	77	209	0.8	30.000	25181.71	10	unknown
RS060	S0410839	2020081218	11.999	135.004	1007.3	28.4	76	236	1.9	30.010	25215.83	9	As
RS061	S0410538	2020081221	11.990	135.003	1006.9	28.5	75	210	1.4	30.000	24845.29	7	As, Cu, St
RS062	S0410904	2020081300	11.995	134.988	1008.9	28.8	75	320	1.2	30.000	26114.42	9	Cu, As, Ac
RS063	S0410539	2020081303	12.000	134.994	1008.5	29.5	73	124	0.3	30.140	25802.76	8	Cu,Ci,Cs
RS064	S0410540	2020081306	11.999	135.002	1006.8	29.1	79	96	4.3	30.420	25879.66	8	Cu,Cs,As
RS065	S0641251	2020081309	11.991	134.996	1007.0	29.0	77	132	3.3	30.310	25294.69	9	Cu,As
RS066	S0370683	2020081312	12.004	135.004	1008.4	27.9	84	127	3.0	30.250	23277.36	unknown	unknown
RS067	S0410854	2020081315	11.999	135.007	1008.6	26.5	90	244	5.8	30.160	22384.68	10	unknown
RS068	S0410853	2020081318	11.997	135.016	1004.8	27.5	82	209	3.8	30.100	23296.5	5	Cu, As
RS069	S0410843	2020081321	11.993	135.001	1004.9	28.0	83	246	4.4	30.000	26018.64	5	Cu, As, St
RS070	S0410870	2020081400	11.985	134.998	1007.3	28.6	82	311	0.6	29.970	25574.38	7	Cu, As
RS071	S0410844	2020081403	12.005	135.014	1007.4	28.7	78	217	1.4	30.040	25519.19	5	Cu,Sc,Cs
RS072	S0410842	2020081406	11.985	135.005	1005.7	29.4	73	242	2.4	30.100	24618.7	4	Cu,Sc,Ci
RS073	S0410834	2020081409	11.987	134.994	1006.3	26.3	90	317	4.6	30.320	21983.1	7	Cu,As
RS074	S0410846	2020081412	12.005	135.001	1007.9	27.9	83	31	5.0	30.150	23845.36	unknown	unknown
RS075	S0410537	2020081415	12.010	134.995	1007.5	27.9	80	74	3.6	30.060	22221.82	unknown	unknown
RS076	S0410865	2020081418	12.004	135.001	1005.9	28.3	81	171	2.4	30.070	23775.59	3	unknown
RS077	S0370684	2020081421	11.995	135.020	1005.5	28.3	81	162	4.0	30.140	25281.15	3	Cu, As
RS078	S0370607	2020081500	11.997	135.013	1006.4	29.0	78	175	4.2	30.100	26366.04	3	Cu
RS079	S0370577	2020081503	11.996	135.013	1006.0	29.3	76	186	4.0	30.380	24830.65	2	Cu

RS080	S0370578	2020081506	11.995	135.009	1004.7	29.2	78	211	3.0	30.460	25736.5	5	Cu,Cc
RS081	S0370608	2020081509	11.987	135.005	1005.4	27.8	88	38	5.3	30.490	23640.02	7	Cu,St,Ci,Cs,As
RS082	S0410841	2020081512	12.003	134.997	1007.1	28.6	81	0	1.2	30.330	23772.57	3	unknown
RS083	S0410845	2020081515	12.011	134.998	1007.5	28.8	78	240	0.3	30.310	25465.9	unknown	unknown
RS084	S0410536	2020081518	12.007	135.000	1006.3	28.7	78	145	0.1	30.270	25632.24	unknown	unknown
RS085	S0420510	2020081521	12.001	134.998	1006.3	28.6	77	110	3.0	30.180	25519.69	2	Cu, Ac, Ci
RS086	S0420502	2020081600	12.005	135.003	1007.0	28.9	78	128	2.7	30.050	26289.22	3	Cu
RS087	S0420507	2020081603	11.996	134.990	1005.7	29.3	78	151	4.1	30.380	25650.8	5	Cu
RS088	S0420414	2020081606	12.006	135.008	1004.3	29.4	76	149	3.0	30.390	25018.95	3	Cu
RS089	S0410886	2020081609	12.004	135.006	1004.3	29.5	76	104	1.9	30.790	26341.85	3	Cu,Ci,Cs
RS090	S0410847	2020081612	12.013	135.003	1006.0	29.4	75	88	2.8	30.670	25660.39	unknown	unknown
RS091	S0420500	2020081615	12.019	134.999	1006.3	29.3	75	122	3.8	30.450	25449.15	unknown	unknown
RS092	S0370579	2020081618	11.996	134.995	1004.8	29.0	76	93	1.8	30.330	25287.9	1	Cu, As
RS093	S0410848	2020081621	11.992	134.993	1004.9	28.9	79	104	3.4	30.310	24973.15	3	Cu
RS094	S0410882	2020081700	11.872	135.002	1006.6	29.8	73	89	8.3	30.350	22659.12	3	Cu, Sc, Nb
RS095	S0430702	2020081703	12.006	135.019	1004.7	29.0	80	177	6.0	30.530	24941.21	7	Cu,Sc,Ci
RS096	S0370612	2020081706	12.001	135.007	1003.8	29.7	71	154	4.0	30.660	25833.89	6	Cu,Ci,Nb
RS097	S0410850	2020081709	12.009	135.004	1003.9	29.5	72	74	1.2	30.680	23136.59	8	Cu,As,Ac,Nb
RS098	S0410884	2020081712	11.990	134.998	1005.4	27.1	85	319	2.2	30.530	24940.63	unknown	unknown
RS099	S0410885	2020081715	12.000	135.006	1005.7	28.6	83	106	7.5	30.450	23463.95	unknown	unknown
RS100	S0370682	2020081718	11.998	135.001	1004.0	27.1	83	69	2.7	30.300	24220.58	unknown	unknown
RS101	S0410880	2020081721	11.995	134.994	1003.5	28.2	75	89	5.9	30.110	25920.69	9	Sc, St, As
RS102	S0420413	2020081800	12.000	134.996	1004.7	29.0	76	83	6.7	30.150	23052.03	5	Cu, As, Sc
RS103	S0420508	2020081803	12.008	134.988	1005.1	28.9	77	97	6.9	30.200	25540.36	9	Cu,As,Ci
RS104	S0420505	2020081806	11.972	134.760	1003.5	27.4	87	154	8.3	30.310	21617.88	10	Cu,As
RS105	S0420506	2020081809	11.994	135.015	1003.6	27.2	79	223	11.8	30.300	22620.46	9	As,Cu,St
RS106	S0410849	2020081812	11.992	135.012	1005.0	27.9	75	217	4.1	30.240	26287.99	unknown	unknown
RS107	S0410851	2020081815	11.986	134.998	1006.0	28.1	77	260	2.3	30.190	23972.28	unknown	unknown
RS108	S0410852	2020081818	11.994	134.996	1004.8	28.2	78	279	0.9	30.170	24661.18	unknown	Cu
RS109	S0420501	2020081821	11.998	135.015	1004.0	28.1	80	154	1.0	30.140	26217.48	9	Ac, As, St, Cu
RS110	S0420442	2020081900	12.011	135.011	1005.5	28.7	78	128	3.5	30.160	26537.12	5	As, Sc
RS111	S0420411	2020081903	12.007	135.010	1005.0	29.1	75	137	2.9	30.460	23193.2	2	Cu,St
RS112	S0370569	2020081906	12.004	135.020	1004.3	29.4	74	161	5.7	30.560	25315.46	2	Cu,St
RS113	S0370652	2020081909	12.001	135.008	1004.7	29.6	75	145	4.1	30.460	26129.9	2	Cu,Cs
RS114	S0430019	2020081912	12.003	135.010	1007.1	29.3	76	197	2.4	30.280	24243.44	unknown	Nb
RS115	S0370570	2020081915	11.988	135.015	1007.7	29.2	76	243	1.9	30.330	25911.37	unknown	unknown
RS116	S0370643	2020081918	11.988	135.014	1006.1	28.9	77	183	2.9	30.310	25582.1	1	As, St
RS117	S0370563	2020081921	11.998	135.006	1005.8	28.9	77	109	4.1	30.250	25597.1	2	As, Sc
RS118	S0430746	2020082000	12.010	135.011	1007.7	29.4	76	152	3.8	30.230	25822.95	1	Sc, Cu, Ci
RS119	S0420444	2020082003	12.004	135.019	1007.9	29.6	73	183	4.1	30.540	26053	3	Cu,Ci
RS120	S0420513	2020082006	11.989	135.025	1006.9	30.0	73	202	3.7	30.770	24335.34	3	Cu,Ci

RS121	S0420440	2020082009	11.993	135.010	1007.2	29.1	81	184	2.7	30.550	25421.97	5	Cu,Ci
RS122	S0420516	2020082012	11.986	135.006	1008.7	29.6	75	232	3.3	30.630	26252.56	unknown	unknown
RS123	S0410529	2020082015	12.018	135.000	1008.6	29.5	81	290	4.2	30.510	25693.59	unknown	unknown
RS124	S0370561	2020082018	11.988	134.983	1008.1	29.3	80	300	4.3	30.370	24337.39	3	unknown
RS125	S0430747	2020082021	11.993	134.987	1008.4	28.3	82	342	5.8	30.410	24228.46	2	Cu, Sc, Nb
RS126	S0370588	2020082100	11.923	134.999	1009.5	29.4	79	11	2.7	30.440	24916.17	2	Cu, Sc, Ci, As
RS127	S0430022	2020082103	12.001	134.987	1009.4	29.6	78	37	3.1	30.650	24659.63	6	Cu,As,Ci
RS128	S0370566	2020082106	12.010	134.990	1007.7	29.9	75	16	2.3	30.770	25588.93	8	As, Cu, Sc
RS129	S0370646	2020082109	12.001	134.992	1007.8	29.8	76	337	2.0	30.800	23206.27	8	As,Cu
RS130	S0420410	2020082112	12.001	134.984	1009.7	29.0	77	347	4.8	30.730	24495.25	unknown	unknown
RS131	S0430750	2020082115	12.001	134.987	1009.6	29.2	79	33	0.2	30.740	23638.46	unknown	unknown
RS132	S0430749	2020082118	12.002	134.996	1008.4	29.0	81	87	0.4	30.600	24966.23	unknown	Nb
RS133	S0420441	2020082121	12.000	135.008	1008.7	27.7	85	180	2.0	30.450	25169.24	2	Cu, Nb, Sc, As
RS134	S0420511	2020082200	11.994	135.001	1010.0	28.6	78	176	2.3	30.500	24585.62	1	Cu, Sc
RS135	S0370650	2020082203	12.005	134.977	1009.2	29.3	78	213	4.7	30.920	26734.94	1	Sc, Cu, Ci, St
RS136	S0420443	2020082206	11.812	134.681	1008.3	29.0	80	254	4.2	30.950	25337.51	5	Cu, Ci
RS137	S0420933	2020082209	12.002	135.000	1008.1	29.9	77	225	4.7	30.960	24256.03	6	Cu,As
RS138	S0370653	2020082212	11.988	135.004	1009.5	29.4	78	254	5.9	30.700	21386.94	6	Cu
RS139	S0370375	2020082215	11.984	135.002	1009.6	29.5	79	276	3.8	30.580	26023.85	unknown	unknown
RS140	S0370374	2020082218	11.976	135.003	1009.6	27.6	80	134	0.4	30.470	25387.12	unknown	unknown
RS141	S0420514	2020082221	11.985	135.005	1009.1	28.6	83	248	3.0	30.490	23913.59	2	Cu, Sc, Nb, As
RS142	S0370644	2020082300	11.985	135.005	1009.0	29.4	77	242	3.1	30.540	26656.24	2	Cu, Sc
RS143	S0370562	2020082303	11.976	135.007	1008.1	28.8	79	246	3.3	30.780	25447.57	6	Cu, Ns, Ci
RS144	S0370568	2020082306	11.997	135.000	1006.7	30.0	71	266	6.6	31.000	24152.61	3	Cu, Ns
RS145	S0410923	2020082309	12.005	135.002	1008.0	30.3	69	271	4.4	30.750	25129.85	7	Cu,Sc,Ci
RS146	S0420515	2020082312	11.999	135.005	1008.8	29.5	77	296	5.4	30.700	24623.31	4	Cu,As
RS147	S0430748	2020083215	11.998	135.004	1008.4	28.9	84	294	7.6	30.620	24234.4	unknown	unknown
RS148	S0420512	2020082318	11.998	135.004	1007.3	29.3	78	270	5.3	30.520	25651.03	unknown	unknown
RS149	S0370625	2020082321	12.000	135.003	1007.5	28.8	81	274	5.8	30.480	25731.64	3	Nb, Sc, Cu, St
RS150	S0430032	2020082400	11.994	134.998	1008.2	29.1	84	253	4.8	30.530	25536.6	4	Nb, Cu, Sc
RS151	S0420465	2020082403	11.987	134.983	1007.3	29.9	78	287	8.7	30.720	25757.84	6	Cu, Ns, Ci
RS152	S0420943	2020082406	12.002	134.992	1005.6	30.1	77	302	7.7	30.780	25691.57	7	Cu, Cg, Nb, Ci
RS153	S0410534	2020082409	12.000	135.003	1006.4	29.6	77	314	4.0	30.650	18202.6	7	Cu,Sc,Ci
RS154	S0370565	2020082412	11.996	135.008	1006.3	29.9	80	294	8.6	30.590	24593.42	4	Cu,Ci
RS155	S0430731	2020082415	11.997	135.003	1006.4	29.1	82	281	6.9	30.530	24337.39	3	Cu
RS156	S0420944	2020082418	12.000	135.000	1004.7	29.5	78	298	6.8	30.480	23800.71	10	unknown
RS157	S0420472	2020082421	12.003	134.997	1005.1	27.4	90	304	3.6	30.470	22877.31	10	Nb, Ns
RS158	S0430027	2020082500	12.004	135.007	1007.6	25.5	94	269	5.5	30.480	21874.1	10	Nb, Ns
RS159	S0420412	2020082503	12.001	134.998	1006.7	26.4	90	231	13.0	30.370	24966.57	10	Ns, Cu
RS160	S0420466	2020082506	11.995	135.005	1005.1	27.6	87	239	14.4	30.350	26695.71	10	Ns
RS161	S0430041	2020082509	11.986	135.003	1004.9	27.9	81	261	15.8	30.300	22558.84	10	St,Ns

RS162	S0430040	2020082512	11.979	134.986	1006.0	28.4	78	278	13.1	30.230	22456.71	10	unknown
RS163	S0430025	2020082515	11.980	134.982	1006.0	28.4	78	298	11.8	30.230	22512.03	10	unknown
RS164	S0641254	2020082518	11.985	134.982	1005.0	28.9	78	287	8.7	30.220	23197.63	10	unknown
RS165	S0430727	2020082521	11.994	135.015	1004.9	26.5	90	199	8.1	30.190	23179.76	10	Nb, Ns
RS166	S0370373	2020082600	11.999	134.999	1005.8	26.2	91	271	10.9	30.090	26021.5	10	Nb, Ns
RS167	S0430730	2020082603	11.986	134.999	1004.8	26.9	89	223	8.1	30.070	26558.19	9	As, Cu, Ci
RS168	S0430733	2020082606	11.980	134.995	1003.4	27.8	87	242	10.2	30.190	26037.37	10	Ns, As
RS169	S0420470	2020082609	12.002	135.000	1003.9	28.5	80	217	10.3	30.190	24232.44	9	Cu,Ac,Sc,Ns
RS170	S0420468	2020082612	12.001	135.006	1005.4	28.6	81	215	7.8	30.180	24777.96	8	Cu,St
RS171	S0420463	2020082615	11.999	135.023	1005.6	28.5	81	207	9.2	30.160	23502.63	7	Ns,St,Cu
RS172	S0420474	2020082618	12.003	135.005	1003.3	27.8	84	240	10.1	30.130	23430.26	5	unknown
RS173	S0420473	2020082621	12.002	135.001	1004.5	26.9	88	251	6.5	30.090	22660.96	10	Nb, Ns
RS174	S0350980	2020082700	11.991	135.012	1005.7	29.3	77	207	9.5	30.090	25659.79	8	Cu, Sc, St, As, Ac
RS175	S0430016	2020082703	11.994	135.015	1005.0	29.4	76	216	11.4	30.140	25880.21	8	Cu, Cg, Ci
RS176	S0430018	2020082706	12.004	134.998	1002.6	29.9	73	222	13.5	30.160	25048.86	9	Ns, Cg, Cu, Ci
RS177	S0360489	2020082709	11.996	135.014	1003.2	28.9	77	248	12.4	30.140	22482.65	10	St,Sc,As
RS178	S0360490	2020082712	11.992	135.002	1004.6	29.2	76	238	11.6	30.130	23782.36	10	St,As
RS179	S0430745	2020082715	11.984	135.008	1004.6	29.4	75	233	9.7	30.100	24814.11	10	St,As
RS180	S0420469	2020082718	12.005	135.000	1003.7	29.3	77	237	9.0	30.100	21719.22	10	unknown
RS181	S0420453	2020082721	12.000	135.001	1003.9	29.1	75	227	8.6	30.100	25828.45	7	St, Cu, As
RS182	S0420452	2020082800	11.989	135.006	1005.5	29.6	76	222	7.8	30.090	24843.8	9	Cu, St, Ac, As
RS183	S0360494	2020082803	11.990	134.999	1004.9	27.0	84	203	3.4	30.070	25417.64	10	Ns, Cu, As
RS184	S0430012	2020082806	11.992	135.010	1003.2	25.9	93	281	4.7	30.040	25921.76	10	Ns, Cu, As, Ci
RS185	S0420879	2020082809	12.001	134.996	1003.9	27.3	83	274	13.3	30.000	23271.82	10	Sc,As,Ns
RS186	S0430039	2020082812	11.983	134.990	1004.9	28.6	76	231	11.0	30.000	23403.27	10	unknown
RS187	S0420464	2020082815	11.980	135.004	1003.7	28.4	79	220	7.7	29.970	23760.57	10	unknown
RS188	S0430728	2020082818	12.008	135.020	1002.3	28.9	77	219	10.5	30.000	24926.33	9	unknown
RS189	S0420467	2020082821	12.001	135.017	1002.3	29.3	78	216	10.9	30.000	24874	2	Cu, St, As
RS190	S0430007	2020082900	11.992	135.008	1004.3	30.0	76	214	8.5	30.000	24426.04	4	Cu, Sc, As, Ac
RS191	S0430043	2020082903	11.985	135.019	1003.7	30.1	74	210	11.9	30.070	25676.92	2	Cu, Ns, Ac
RS192	S0430013	2020082906	11.999	135.021	1001.7	30.3	71	211	11.0	30.110	25790.53	5	Cs, Cu, Ci
RS193	S0430021	2020082909	11.999	135.013	1002.7	29.9	75	187	10.7	30.080	23576.36	9	Cu,Ci,Cg
RS194	S0430047	2020082912	11.999	135.016	1004.9	27.8	87	188	11.3	30.040	24723.01	8	Cu,As,Sc,Ci
RS195	S0360496	2020082915	11.989	135.018	1005.5	28.5	81	197	8.1	30.010	22929.45	7	Cu,Cs
RS196	S0430046	2020082918	11.996	135.021	1003.4	29.0	79	193	11.4	30.010	24283	5	As,Cu
RS197	S0360497	2020082921	12.000	135.017	1004.1	29.5	78	198	10.3	30.000	25022.09	4	Cu, St, As, Sc
RS198	S0420455	2020083000	12.003	135.014	1005.8	29.1	78	195	14.0	30.000	25975.98	6	Cu, As, St
RS199	S0430014	2020083003	11.992	135.016	1005.2	29.2	77	206	13.8	30.020	25819.31	4	Cu, Ci
RS200	S0430020	2020083006	11.997	135.011	1003.2	29.6	76	215	9.8	30.660	23289.87	6	Cs, Cu, Ci
RS201	S0420450	2020083009	11.992	135.012	1004.4	29.5	72	197	8.1	30.050	24399.04	5	St,Cu,Cs
RS202	S0420969	2020083012	11.993	135.012	1007.0	29.4	78	192	6.8	30.030	24545.65	3	Cu,Cg,Ci

RS203	S0360491	2020083015	12.014	135.005	1007.1	29.3	80	174	6.6	30.020	23479.14	3	Cu
RS204	S0360498	2020083018	12.002	135.011	1005.6	28.9	82	163	3.7	30.030	24575.54	3	Cu
RS205	S0430009	2020083021	11.999	135.017	1006.0	29.0	80	210	1.8	30.030	25178.49	3	Cu, St, As
RS206	S0430045	2020083100	12.011	134.991	1007.6	29.2	77	199	2.3	30.070	24980.29	2	As, Ci, Sc, Cu
RS207	S0420456	2020083103	11.999	135.019	1008.0	29.5	75	198	1.4	30.340	26750.86	6	Cs, Ci, Cc, Cu
RS208	S0430044	2020083106	11.996	134.986	1006.4	29.9	76	125	4.9	30.860	25129.36	7	Cs, Ci, Cu
RS209	S0360488	2020083109	12.010	135.007	1007.1	29.7	73	114	2.2	30.340	23567.42	8	As, Cu, Nb, Ci
RS210	S0370422	2020083112	12.017	135.000	1008.5	26.3	88	136	9.1	30.340	23946.6	7	Cu,Ac,Ci
RS211	S0420970	2020083115	12.019	135.001	1008.1	28.1	80	130	3.1	30.140	25312.02	7	As,Ac
RS212	S0350981	2020083118	12.015	135.002	1006.0	28.5	75	110	3.3	30.080	25323.85	4	Cs,Cc
RS213	S0440251	2020083121	12.003	134.997	1006.0	28.6	79	44	4.4	30.060	25853.33	2	Cu, Sc, As, Ci
RS214	S0440259	2020090100	11.914	134.913	1006.8	28.6	85	42	7.7	30.050	26304.13	9	Cu, As, Ac, Sc, Ci
RS215	S0420504	2020090103	12.013	134.984	1006.6	29.6	77	44	8.5	30.190	26764.81	3	Cc, Ci, St, Cu, Ns
RS216	S0360495	2020090106	12.011	135.000	1005.2	29.6	77	40	6.3	30.250	26251.34	9	Ns, Cg, Cu, As
RS217	S0370526	2020090109	12.016	134.998	1005.3	28.5	84	20	5.7	30.120	25033.76	6	Ns, Ci, Nb, Cu
RS218	S0540241	2020090112	12.011	134.994	1006.6	28.9	76	88	9.6	30.030	25001.8	4	Cu, Ci
RS219	S0360493	2020090115	12.019	135.000	1007.1	29.5	80	81	9.3	30.020	25764	2	Cu,St
RS220	S0420972	2020090118	12.013	134.995	1006.0	29.4	80	287	7.0	30.020	25390.03	2	Cu,Ci,As
RS221	S0420451	2020090121	12.015	134.999	1006.8	29.3	79	96	6.5	30.000	25629.14	10	Ac, Sc, As
RS222	S0360742	2020090200	12.011	135.003	1007.6	29.5	79	127	5.0	29.990	25699.44	9	Ac, As, Sc, Cu
RS223	S0440247	2020090203	11.999	134.995	1006.9	29.8	78	157	4.5	30.200	25459.3	7	Ac, Cu, Cg, Ci
RS224	S0370527	2020090206	11.970	134.703	1006.1	29.4	81	148	3.6	30.410	26347.1	4	Cg, Cu, St, Ac, Ci
RS225	S0420503	2020090209	12.004	134.989	1006.4	29.5	78	208	3.3	30.280	24870.23	8	Cg, Cu, St, As, Cs, Ci
RS226	S0420973	2020090212	12.012	134.988	1007.7	29.6	76	163	1.9	30.240	25741.58	6	St, Ac, As, Ci
RS227	S0420974	2020090215	12.004	135.019	1008.2	29.5	80	151	2.4	30.230	22912.9	5	Cu,Cs
RS228	S0440252	2020090218	12.002	135.026	1007.5	29.2	80	203	3.4	30.110	25575.33	9	Ac,As,Cu
RS229	S0440264	2020090221	11.985	135.015	1007.6	29.3	79	203	5.4	30.080	25621.17	2	As, Sc, Cu
RS230	S0440262	2020090300	11.999	135.009	1008.7	29.7	77	239	4.3	30.110	24378.33	5	As, Cu, Sc
RS231	S0440261	2020090303	11.985	135.015	1007.8	29.8	76	228	4.1	30.380	27070.45	5	Cs, Ci, Cu, Cg
RS232	S0370523	2020090306	11.983	135.009	1006.3	29.8	78	236	5.1	30.510	26683.05	3	Cc, Ci, Cu, Nb
RS233	S0420448	2020090309	11.984	135.008	1006.6	29.9	78	247	4.0	30.610	25432.16	8	Cc, Cu, Sc
RS234	S0420962	2020090312	11.980	135.006	1008.0	29.8	78	263	5.0	30.430	24904.23	8	Cu, Cc
RS235	S0420981	2020090315	11.983	135.001	1007.8	29.3	81	257	4.1	30.290	23623.83	2	Cu,Cs
RS236	S0440263	2020090318	11.994	134.998	1007.0	29.1	81	259	4.2	30.240	24690.58	6	Cu,Cs
RS237	S0420984	2020090321	11.982	135.018	1006.6	29.1	81	278	3.2	30.140	22068.94	5	Cu, Sc, St, As
RS238	S0430028	2020090400	11.976	135.015	1007.6	29.2	78	249	1.4	30.180	25665.04	9	As, Cu, Sc
RS239	S0370524	2020090403	11.956	134.968	1006.9	29.6	77	294	2.2	30.450	27172.33	8	Cs, Ci, Cu
RS240	S0420499	2020090406	11.989	135.023	1005.2	29.9	74	273	0.9	30.570	26327.88	4	As, Cs, Ci, Cu

RS241	S0440250	2020090409	11.999	135.016	1004.8	29.9	73	225	2.3	30.860	23025.84	8	St, Cg, Ci
RS242	S0440260	2020090412	12.004	135.020	1006.1	29.9	72	194	2.0	30.820	23117.87	unknown	Ci, Cu
RS243	S0420976	2020090415	11.995	135.021	1005.9	29.8	75	192	4.4	31.000	24218.16	9	Cs,Cu
RS244	S0370628	2020090418	11.996	135.016	1004.4	29.5	78	211	3.8	30.480	25369.22	8	Cs,Cu
RS245	S0430029	2020090421	11.977	135.011	1004.5	29.1	79	284	3.3	30.290	26899.88	8	As, Cu, Sc
RS246	S0420975	2020090500	11.985	135.011	1005.6	29.4	77	208	1.4	30.290	24955.71	5	As, Sc, Cu
RS247	S0440243	2020090503	11.997	135.020	1005.0	29.9	73	228	2.2	30.620	26149.23	8	Cs, Ci, Cu
RS248	S0420977	2020090506	11.982	135.017	1003.7	30.1	73	203	0.9	30.790	24686.63	8	Cs, Ci, Cu
RS249	S0420841	2020090509	12.017	135.000	1004.6	29.9	74	144	1.2	30.970	24037.36	7	Cu, Nb, Ci
RS250	S0420983	2020090512	12.020	135.002	1005.9	28.2	84	206	7.5	31.060	22784.87	5	Cu, Ci, Nb, Cg
RS251	S0420978	2020090515	12.015	135.001	1006.0	28.8	77	143	2.1	30.860	25925.64	6	Cs,Cu,St
RS252	S0430010	2020090518	12.012	135.007	1004.4	28.8	81	158	6.1	30.580	25030.12	3	Cu,Ci
RS253	S0420982	2020090521	12.002	135.022	1005.1	29.0	81	176	5.8	30.420	21488.81	3	Cu, Sc
RS254	S0420964	2020090600	11.997	135.016	1007.0	29.6	77	173	5.4	30.440	23651.07	3	As, Cu, Sc
RS255	S0440249	2020090603	11.991	135.000	1006.6	29.7	77	209	3.2	30.590	27080.22	1	Cu, Ci, Cs
RS256	S0430024	2020090606	11.996	134.913	1004.4	29.9	75	291	2.5	31.050	25518.97	2	Cu, Cs, Ci
RS257	S0440242	2020090609	12.006	135.011	1005.2	30.0	70	84	0.9	31.000	25463.31	5	Cu, Ci, Nb
RS258	S0440241	2020090612	12.019	134.995	1007.4	30.0	74	80	3.9	31.400	24239.48	unknown	unknown
RS259	S0420986	2020090615	12.016	135.007	1007.9	29.7	80	91	2.5	31.150	24557.85	6	Ci,Cu,Ci
RS260	S0420985	2020090618	12.008	135.005	1007.1	29.6	77	68	4.3	31.050	25177.2	6	Cs,Cu
RS261	S0420961	2020090621	12.015	134.991	1007.8	28.8	81	76	3.0	30.470	25226.4	3	Cu, Sc, As
RS262	S0420445	2020090700	12.005	134.991	1008.1	29.9	77	85	5.7	30.320	25716.43	3	Cu, Sc, As, Ci
RS263	S0421008	2020090703	11.994	135.001	1007.5	30.1	71	76	6.5	30.620	22799.65	2	Cu, Cs
RS264	S0420988	2020090706	11.892	134.841	1006.1	29.9	78	88	4.3	31.010	26297.64	4	Nb, Cu, Cs
RS265	S0420989	2020090709	12.000	134.977	1006.9	29.4	77	41	5.7	30.700	24335.89	6	Nb, Cu, Ns, As, Ci, Cs
RS266	S0421004	2020090712	11.996	134.983	1008.8	28.2	85	42	3.8	30.600	22499.09	unknown	unknown
RS267	S0420987	2020090715	12.013	135.007	1008.5	29.1	81	63	4.3	30.620	24276.21	9	Cu,Cs
RS268	S0370391	2020090718	12.012	135.000	1008.1	27.8	82	184	5.5	30.500	22908.46	9	Ns,Cg,Cu
RS269	S0370392	2020090721	11.639	134.940	1008.6	25.2	90	83	3.4	30.320	22448.23	9	Ns, Nb
RS270	S0370364	2020090800	11.618	134.933	1009.3	27.6	83	120	5.5	30.450	24300.2	10	Cu, Sc, Ns, Nb
RS271	S0370366	2020090803	11.623	134.900	1009.0	29.0	76	120	4.4	30.310	26417.33	9	Ns, Cu, As, Ac, Cs, Sc, St
RS272	S0370384	2020090806	11.702	134.912	1007.1	29.2	75	151	2.0	30.760	27292.26	9	Ns, Cu, Ci, Cc
RS273	S0440312	2020090809	12.262	135.015	1007.5	27.9	78	148	1.4	30.430	25214.35	10	Cu, As, Sc
RS274	S0410855	2020090812	12.855	135.114	1008.7	28.0	83	308	2.2	30.480	24382.86	unknown	unknown
RS275	S0370341	2020090815	13.425	135.239	1008.0	28.8	77	71	2.7	30.500	23979.51	8	Ns,As,Cu
RS276	S0370423	2020090818	13.955	135.328	1006.2	27.4	86	61	8.2	30.290	23920.01	10	Ns,As,Cu
RS277	S0370361	2020090821	14.452	135.417	1006.8	26.0	86	110	3.9	30.220	22646.35	10	Sc, Ns
RS278	S0370394	2020090900	14.979	135.506	1007.0	28.9	79	127	9.3	30.310	27084.82	5	Cu, Sc, As, Ci
RS279	S0440310	2020090903	15.546	135.600	1006.3	26.3	89	175	11.1	30.350	26328.41	10	Ns, Sc, Cu
RS280	S0440311	2020090906	16.100	135.698	1005.3	28.7	79	76	2.9	30.010	26241.76	10	Ns, Cu, As
RS281	S0410856	2020090909	16.644	135.783	1005.1	27.5	82	261	1.3	29.980	21830.99	10	Ns, Cu, As
RS282	S0440309	2020090912	17.171	135.859	1006.1	28.0	79	46	1.0	30.050	24756.2	unknown	unknown
RS283	S0370393	2020090915	17.759	135.946	1005.6	28.1	82	80	1.3	30.040	24912.65	10	Nb,As

RS284	S0370362	2020090918	18.321	136.033	1004.2	28.0	82	282	1.5	29.920	25230.67	9	As,Ac
RS285	S0370382	2020090921	18.884	136.115	1004.4	27.8	85	56	1.6	29.620	25812.62	4	Cu, Sc, As, Ac
RS286	S0370383	2020091000	19.416	136.192	1006.0	28.5	80	77	3.1	29.190	25574.05	3	Cu, Sc, As
RS287	S0370421	2020091003	19.926	136.264	1005.2	27.9	83	34	5.9	29.140	27014.41	7	As, Ci, Cu, Ns
RS288	S0370395	2020091006	20.468	136.346	1004.3	28.6	77	347	2.2	30.600	26497.94	2	Cs, Ci, Cu

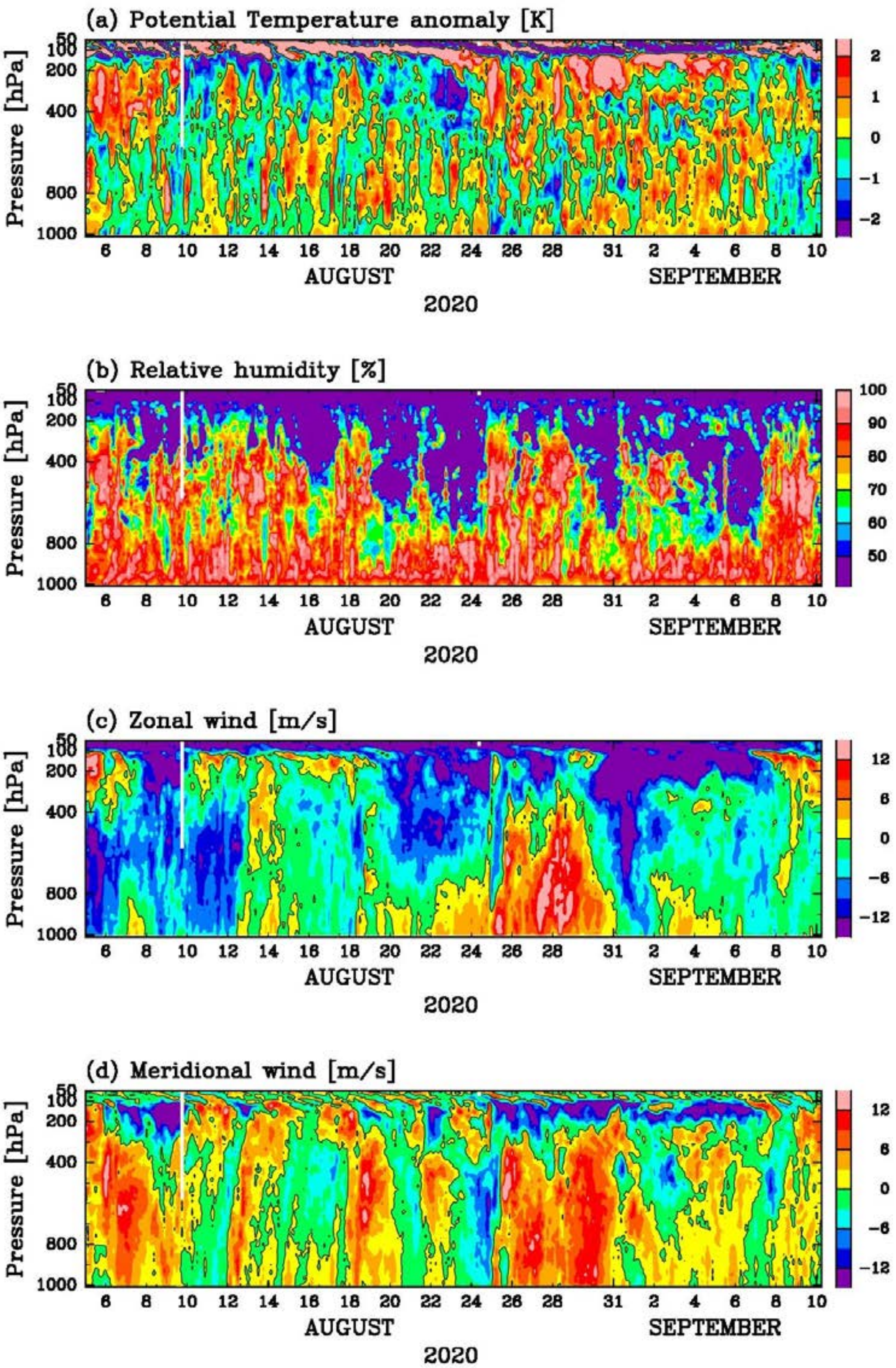


Fig. 5.1-1: Time-height cross sections of (a) potential temperature anomaly from the period average, (b) relative humidity, (c) zonal wind, and (d) meridional wind.

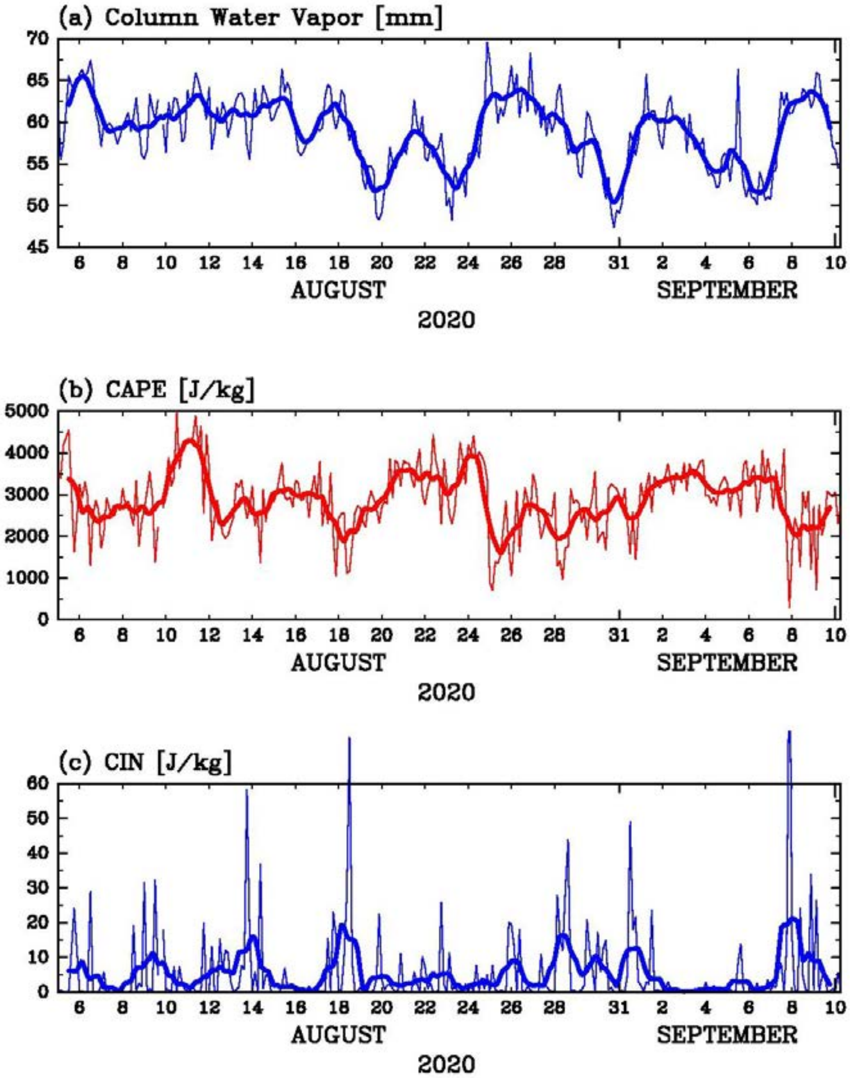


Fig. 5.1-2: Time series of (a) column-integrated water vapor (CWV), (b) convective available potential energy (CAPE), and (c) convective inhibition (CIN). Thin lines show the 3-hourly time series, while thick lines represent diurnal running averages.

5.2 GNSS precipitable water

(1) Personnel

Mikiko FUJITA (JAMSTEC) (not on board)
Masaki KATSUMATA (JAMSTEC)

(2) Objectives

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

(3) Instruments and Methods

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 through the cruise.

(4) Preliminary Results

We will calculate the total column integrated water from observed GNSS satellite data after the cruise.

(5) Data Archive

Raw data is recorded as T02 format and stream data every 5 seconds. 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)	
Kazuho YOSHIDA	(NME)	Operation Leader
Satomi OGAWA	(NME)	
Yutaro MURAKAMI	(NME)	

(2) Objective

The objective of weather radar observations in this cruise is to investigate the structure and evolution of precipitating systems over the tropical ocean.

(3) Radar specifications

The C-band weather 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
Inertial Navigation Unit:	PHINS (IXBLUE SAS France)

(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 navigation unit. 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 peak output power and the pulse width of the radar are checked every day.

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

(6) Data

The C-band weather radar observations were conducted from Aug. 1 to Sep. 12, 2020. Figure 5.3-1 shows the time series of the areal coverage of radar echoes observed by the radar. During the observational period, various precipitating systems have been observed, including those that later evolved into Typhoon No. 9 and No. 10 of 2020. These precipitation systems developed in various time and space scales. It should be noted that, due to the data transfer problem and the maintenance of the radar system, some or all data of a volume scan are missing very occasionally, which is shown in Table 5.3-2. Detailed analyses of the data observed by the radar will be performed after the cruise.

(7) Data archive

The C-band weather radar 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)" on the JAMSTEC website (http://www.godac.jamstec.go.jp/darwin/e).

Table 5.3-1 Scan modes of C-band weather radar

	Surveillance PPI Scan	Volume Scan						RHI Scan
Repeated Cycle (min.)	30	6						6
Times in One Cycle	1	1						3
PRF(s) (Hz)	400	dual PRF (ray alternative)						1250
		667	833	938	1250	1333	2000	
Azimuth (deg)	Full Circle							Option
Bin Spacing (m)	150							
Max. Range (km)	300	150		100		60		100
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

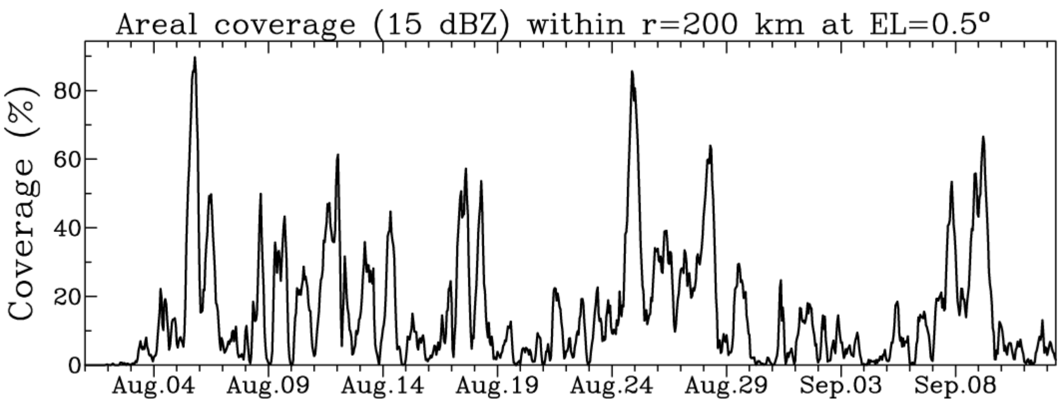


Figure 5.3-1. Time series of the areal coverage of radar echoes (≥15 dBZ) within a radius of 200 km from the radar during the observational period.

Table 5.3-2 Times when some or all data of a volume scan are missing

YYMMDD	HHMMSS	Data Missing Status
20200820	014200	Some data of a volume scan
20200820	030000	Some data of a volume scan
20200820	031200~033000	All data of 3 volume scans
20200826	001200	Some data of a volume scan
20200901	161800	Some data of a volume scan
20200904	151200	Some data of a volume scan
20200907	154200	Some data of a volume scan
20200908	040000	Some data of a volume scan
20200910	121200	Some data of a volume scan
20200912	070000	Some data of a volume scan

5.4 Micro rain radar

(1) Personnel

Masaki KATSUMATA (JAMSTEC) - Principle 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 100 meters in range distance (i.e. height) up to 3100 meters. 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

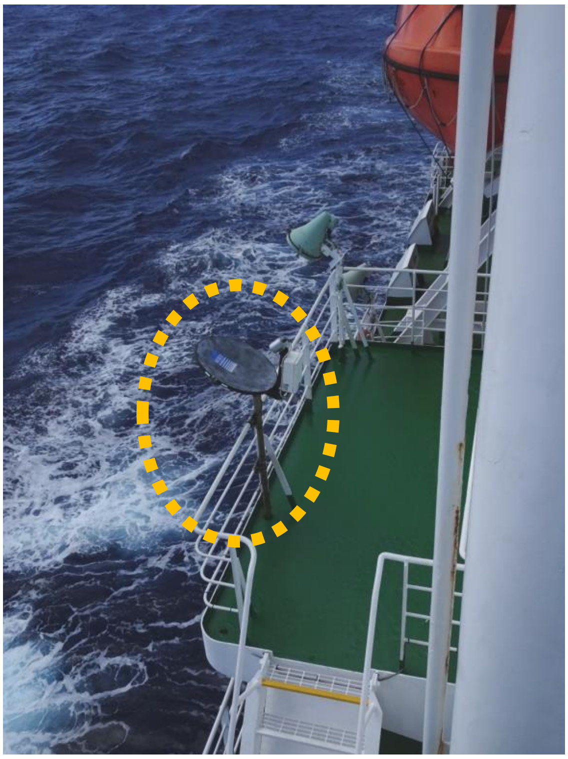


Table 5.4-1: Specifications of the MRR-2.

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 non-permitted territorial waters and EEZs. The further analyses will be 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).

5.5 Disdrometer

(1) Personnel

Masaki KATSUMATA (JAMSTEC) - Principle 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 C-band radar in Section 5.3) to the rainfall amount, and (c) to validate the algorithms and the products of the satellite-borne precipitation radars; TRMM/PR and GPM/DPR.

(3) Instrumentations and Methods

Two “Laser Precipitation Monitor (LPM)” (Adolf Thies GmbH & Co) are utilized. It 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 5.5-1.

The LPMs are installed on the top (roof) of the anti-rolling system, as shown in Fig. 5.5-1. Both are installed at the corner at the bow side and the starboard side. One (in aft) equipped the "wind protection element" to reduce the effect of the wind on the measurement, and to estimate the effectiveness of the "element" by comparing data from two sensors.

(4) Preliminary Results

The data have been obtained all through the cruise, except non-permitted territorial waters and EEZs. 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).

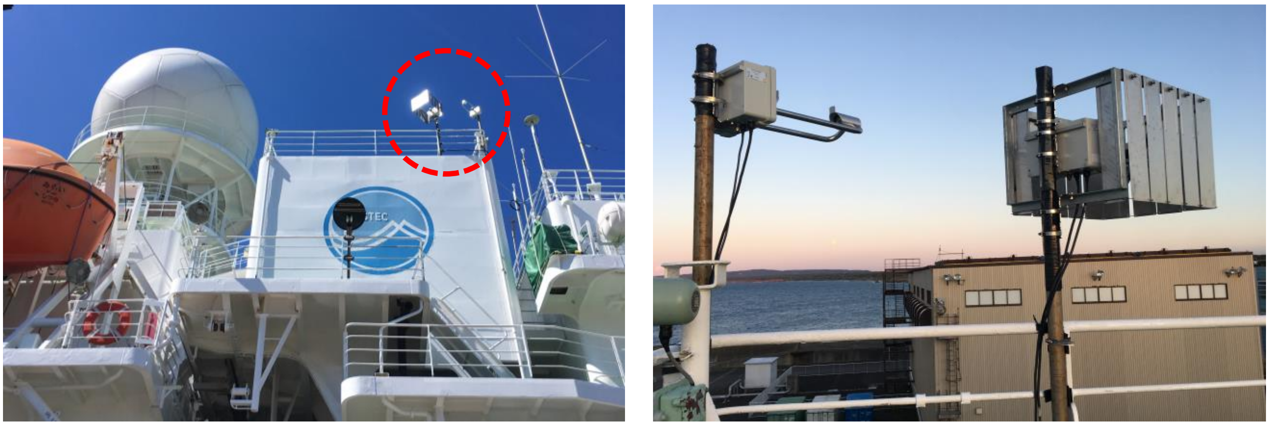


Fig. 5.5-1: Onboard LPM sensors. (Left) The location of the sensors, as designated by the red broken circle. (Right) The sensors. Right one (aft one) equipped wind protection element to reduce the effect of the wind, while left one (fore one) did not.

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

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

5.6 Lidar

(1) Personnel

Masaki KATSUMATA (JAMSTEC) Principle Investigator
Kyoko TANIGUCHI (JAMSTEC)

(2) Objective

The objective of this observation is to capture the vertical distribution of clouds, aerosols, and water vapor in high spatio-temporal resolution.

(3) Methods

The Mirai Lidar system transmits a 10-Hz pulse laser in three wavelengths: 1064nm, 532nm, 355nm. For cloud and aerosol observation, the system detects Mie scattering at these wavelengths. The separate detections of polarization components at 532 nm and 355 nm obtain additional characteristics of the targets. The system also detects Raman water vapor signals at 660 nm and 408nm, Raman nitrogen signals at 607 nm and 387nm at nighttime. Based on the signal ratio of Raman water vapor to Raman nitrogen, the system offers water vapor mixing ratio profiles.

(4) Preliminary Results

The lidar system observed the lower atmosphere throughout the cruise, except on EEZs and territorial waters without permission. All data will be reviewed after the cruise to maintain data quality.

(5) Data Archive

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

5.7 Ceilometer

(1) Personnel

Satoru YOKOI	(JAMSTEC)	-Principal Investigator
Kazuho YOSHIDA	(NME)	- Operation Leader
Satomi OGAWA	(NME)	
Yutaro MURAKAMI	(NME)	
Yoichi INOUE	(MIRAI Crew)	

(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 MR20-E01 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

08:45UTC 08 Aug. 2020
05:29UTC 15 Aug. 2020
05:15UTC 23 Aug. 2020
05:31UTC 29 Aug. 2020
07:46UTC 06 Sep. 2020

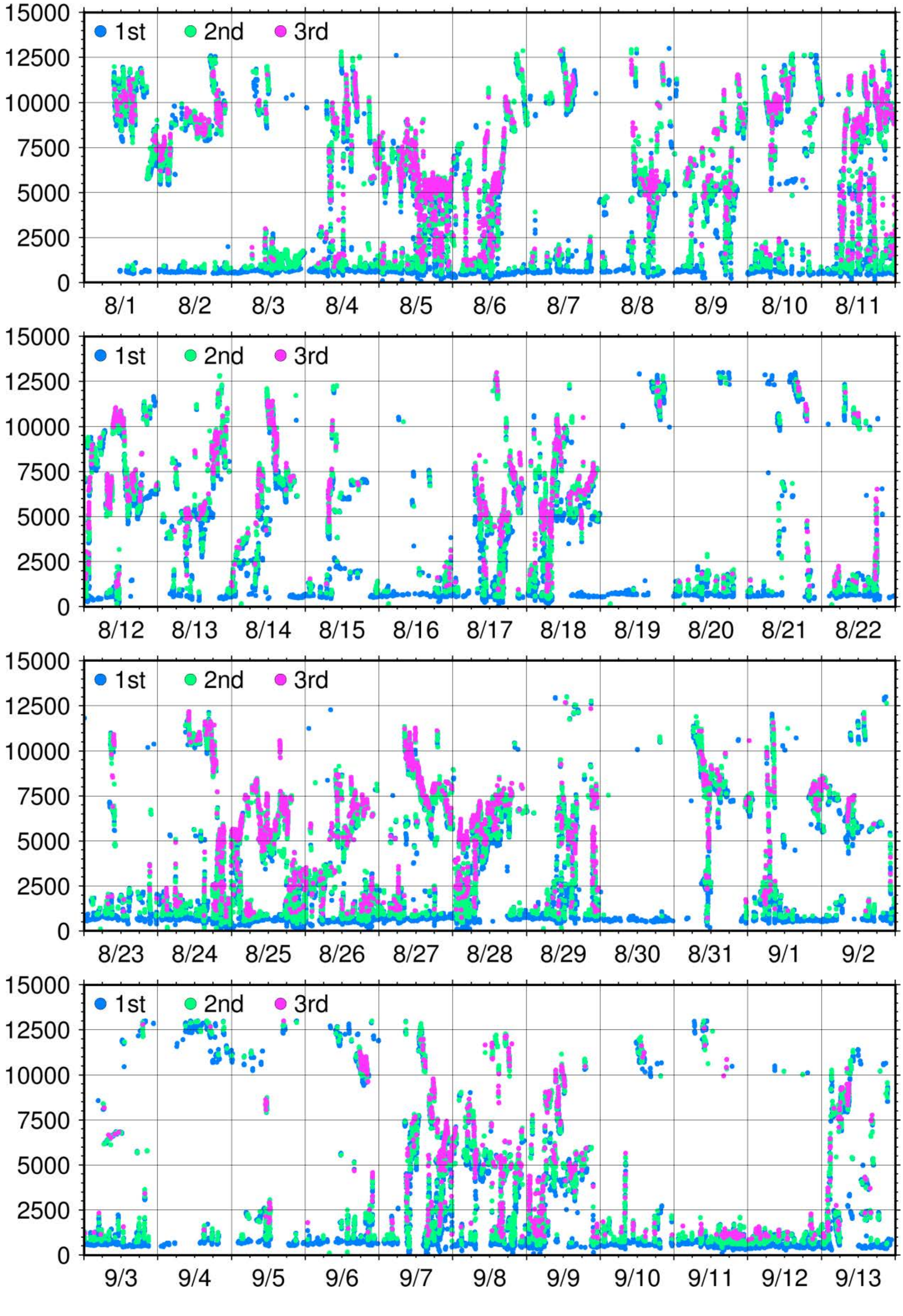


Fig. 5.7-1 First (Blue), 2nd (Green) and 3rd (Red) lowest cloud base height during the cruise.

5.8 Aerosol optical characteristics measured by ship-borne sky radiometer

(1) Personnel

Kazuma Aoki (University of Toyama) not onboard
Katsumata Masaki (JAMSTEC)
Fumikazu Taketani (JAMSTEC) 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

Fumikazu TAKETANI	(JAMSTEC)	- Principal Investigator	- not on board
Takuma MIYAKAWA	(JAMSTEC)		- not on board
Yugo KANAYA	(JAMSTEC)		- not on board
Chunmao ZHU	(JAMSTEC)		- not on board
Hisahiro TAKASHIMA	(JAMSTEC/Fukuoka Univ.)		- not on board

Operation for all instruments was supported by Nippon Marine Enterprises, Ltd

(2) Objectives

To investigate roles of aerosols in the marine atmosphere in relation to climate change
To investigate processes of biogeochemical cycles between the atmosphere and the ocean.

(3) Methods

(3-1) CO and O_3 observations

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 48C, Thermo Fisher Scientific) and a UV photometric ozone analyzer (Model 205, 2B Tech), located in the Research Information Center. The data will be used for characterizing air mass origins.

(3-2) Particle number concentration and size distribution

The number concentration of ament particles was measured by mixing condensation particle counter (MCPC) (Model 1720, Brechtel). The size distribution of particles was measured by a scanning mobility particle sizer (SMPS) (Nano Scan model 3910, TSI)

(3-3) Fluorescent property

Fluorescent properties of aerosol particles were measured by a single particle fluorescence sensor, Waveband Integrated bioaerosol sensor (WIBS4) (WIBS-4A, Droplet Measurement Technologies). Two pulsed xenon lamps emitting UV light (280 nm and 370 nm) were used for excitation. Fluorescence emitted from a single particle within 310–400 nm and 420–650 nm wavelength windows was recorded.

(3-4) Aerosol extinction coefficient (AEC)

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 scanned elevation angles were 1.5, 3, 5, 10, 20, 30, 90 degrees in the 30-min cycle. The roll motion of the ship was measured to autonomously compensate additional motion of the prism, employed for scanning the elevation angle. For the selected spectra recorded with elevation angles with good accuracy, DOAS spectral fitting was performed to quantify the slant column density (SCD) of NO2 (and other gases) and O4 (O2-O2, collision complex of oxygen) for each elevation angle. Then, the O4 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 NO2 and other gases were made.

(3-5) Rain sampling

Rain sample was corrected using a hand-made sampler installed on compass deck. These sampling logs are listed in Table 5.9-1. To investigate the nutrients concentration in the rain, these samples are going to be analyzed in laboratory.

(3-6) PM2.5 sampling

PM2.5 samplings were carried out by air samplers installed at compass deck. Ambient particles were collected on the quartz filter (Φ=110) along cruise track to analyze their composition using a high-volume air sampler (HV-700F, SIBATA) operated at flow rate of 500L/min. These sampling logs are listed in Table 5.9-2.

For MCPC, SMPS, and WIBS-4 instruments, the ambient air was commonly sampled from the compass deck by a 3-m-long conductive tube through the dryer to dry up the particles, and then introduced to each instrument installed at the environmental research room. MAXDOAS were installed at the deck above stabilizer of ship.

(4) Observation log

Table 5.9-1: Logs of Rain sampling by rain sampler

Table 5.9-2: Logs of $PM_{2.5}$ sampling on the quartz filter by HV sampler

(5) 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>

(6) Acknowledgments

We thank the crew of the R/V Mirai, and staff of Nippon Marine Enterprises, Ltd. for their support with observations throughout the cruise.

Table 5.9-1

	date/time sampling(UTC)				latitude			longitude		
ID	yyyy	mm	dd	hh:mm	deg	min	N-S	deg	min	E-W
R20E01-R003	2020	8	4	2:49	21	15.71	N	135	3.76	E
R20E01-R004	2020	9	11	5:00	26	21.09	N	137	16.64	E
R20E01-R005	2020	9	12	4:31	31	27.97	N	138	3.42	E
R20E01-R006	2020	9	13	4:09	35	3.05	N	138	48.89	E

Table 5.9-2

	date/timesampling(UTC)				latitude			longitude		
ID	yyyy	mm	dd	op (hh:m	deg	min	N-S	deg	min	E-W
	2020	8	1		34	41.2	N	137	27.45	E
MR20-E01-HV-001	2020	8	2	2:09	30	14.8	N	137	17.22	E
MR20-E01-HV-002	2020	8	3	2:28	25	49.45	N	136	10.31	E
MR20-E01-HV-003	2020	8	4	2:28	21	19.22	N	135	4.62	E
MR20-E01-HV-004	2020	9	11	4:29	26	13.3	N	137	14.89	E
MR20-E01-HV-005	2020	9	12	4:31	31	27.97	N	138	3.42	E
MR20-E01-HV-006	2020	9	13	4:07	35	3.05	N	138	48.89	E

5.10 Stable isotope in the vapor and rainwater

(1) Personnel

Kei YOSHIMURA	(Univ. Tokyo)	(Not on board)	- Principal Investigator
Akira TAKESHIMA	(Univ. Tokyo)		
Masahiro KOIKE	(Univ. Tokyo)	(Not on board)	
Satoru SHOJI	(Univ. Tokyo)		

(2) Objectives

By using the stable isotopic ratios of water (δ^{18}O and δ D) 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 laboratory 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 ratios of the rain samples were analyzed.

(4) Results

The time series of stable isotopic ratios of water vapor measured by the laser spectroscopic analyzer is shown in Figure 5.10-1. Note that these intermittent spikes are due to measurements of the two standard waters to calibrate the measurement of ambient moisture. The rainwater samples data (66 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

Data of stable isotopic ratios of water vapor for about six hours on 11th August are missing due to some troubles. Log data of five rainwater samples are missing due to malfunction of the automatic rain collector.

Fig. 5.10-1: The time series of the stable isotopic ratios of water vapor.

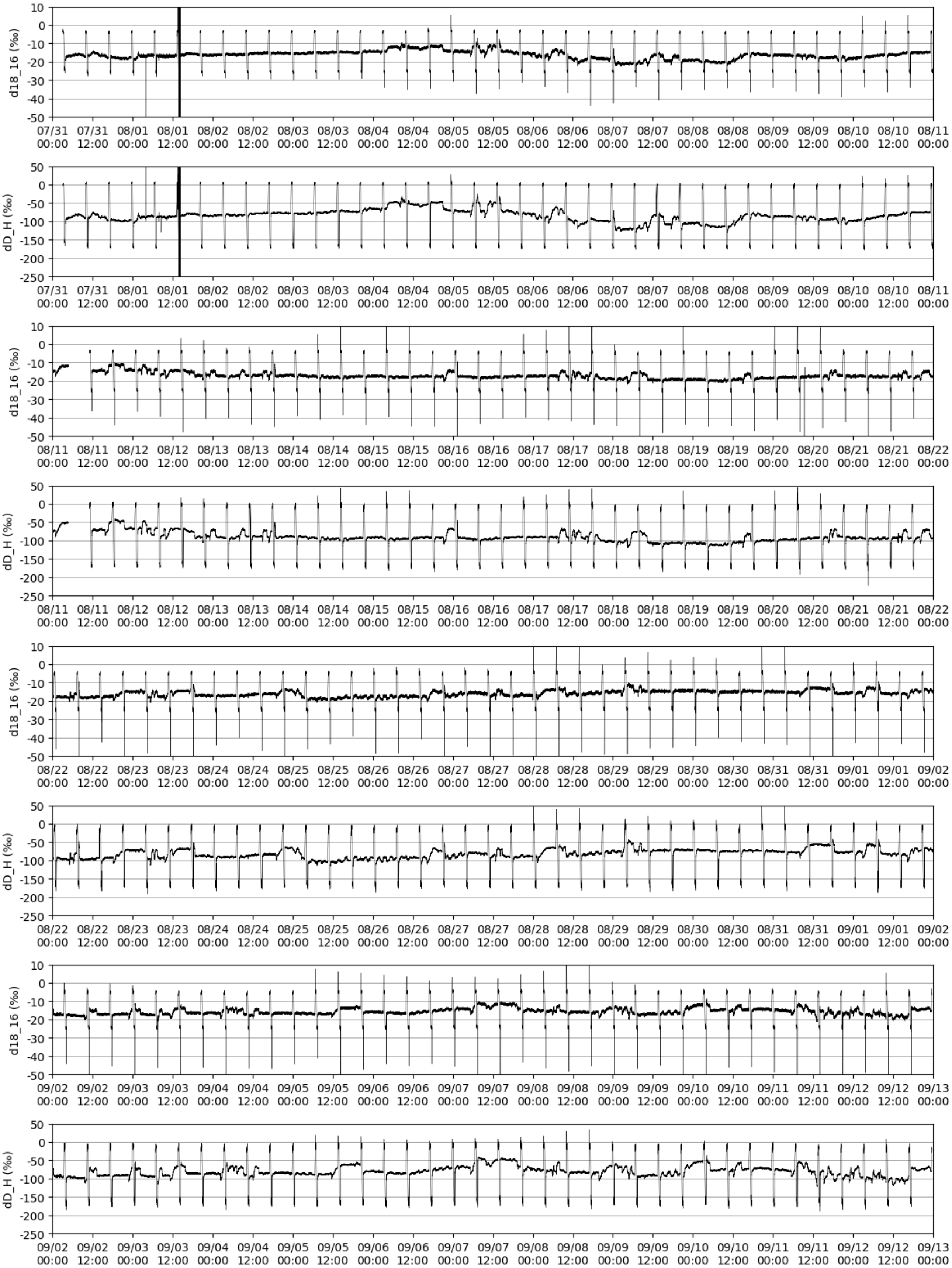


Table 5.10-1: Summary of rainwater samples. Note that “Amount” column shows water level of the sampling bottle, not rainfall amount.

No.	Start	JST	Stop	JST	Latitude	Longitude	Bottle No.	Amount (cm)	Remarks
1	2020/8/4	8:47	2020/8/4	22:06	19-33.72380N	134-59.95520E	1	3.1	
2	2020/8/4	22:06	2020/8/5	4:09	18-24.26949N	134-59.74359E	2	small	
3	2020/8/5	9:25	2020/8/5	15:26	17,16-36.4551	134-59.15174E	1	2.3	
4	2020/8/5	15:26	2020/8/5	22:10	15-23.29447N	135-00.41356E	2	1.8	
5	2020/8/5	22:10	2020/8/6	4:14	14-30.36948N	134-58.94795E	3	full	
6	2020/8/6	4:14	2020/8/6	11:33	13-00.62248N	134-59.13189E	4	1.4	
7	2020/8/6	13:23	2020/8/6	23:34	11-38.69355N	134-58.79858E	1	7.6	
8	2020/8/6	23:34	2020/8/7	6:01	11-38.39229N	134-57.99907E	2	small	
9	2020/8/8	21:28	2020/8/9	3:28	11-38.71111N	134-57.45793E	1	6	
10	2020/8/9	3:28	2020/8/9	10:12	11-38.29453N	134-57.44320E	2	small	
11	2020/8/9	13:21	2020/8/9	20:18	11-59.03420N	135-00.26648E	1	1.4	
12	2020/8/9	20:18	2020/8/10	3:48	12-00.20277N	135-00.06842E	2	9	
13	2020/8/10	3:48	2020/8/10	10:36	12-00.71964N	135-01.16484E	3	small	
14	2020/8/10	13:22	2020/8/10	22:00	12-00.12616N	134-59.26955E	1	0.7	
15	2020/8/11	-	2020/8/12	-	-	-	1	full	Log data missing
16	2020/8/11	-	2020/8/12	-	-	-	2	3.8	Log data missing
17	2020/8/11	-	2020/8/12	-	-	-	3	6	Log data missing
18	2020/8/12	-	2020/8/13	-	-	-	1	full	Log data missing
19	2020/8/13	17:44	2020/8/13	23:44	12-00.10304N	135-00.17475E	1	3.8	
20	2020/8/13	23:44	2020/8/14	6:27	11-59.71623N	134-59.64750E	2	small	
21	2020/8/14	6:27	2020/8/14	9:16	11-59.99063N	134-59.61994E	3	0.7	
22	2020/8/14	13:25	2020/8/14	22:54	12-00.83016N	134-59.55444E	1	small	
23	2020/8/17	13:15	2020/8/17	23:37	12-00.05940N	135-00.37367E	1	3	
24	2020/8/17	23:37	2020/8/18	5:38	11-59.92246N	134-59.86013E	2	full	
25	2020/8/18	5:38	2020/8/18	13:17	11-58.97293N	134-54.56317E	3	1.65	
26	2020/8/18	13:19	2020/8/18	19:41	11-59.18533N	135-01.29909E	1	7	
27	2020/8/19	-	2020/8/22	-	-	-	3	1.7	Log data missing
28	2020/8/22	13:14	2020/8/22	19:40	11-58.35864N	135-00.58427E	1	0.7	
29	2020/8/22	19:40	2020/8/23	1:48	11-58.34786N	135-00.31509E	2	0.7	
30	2020/8/23	1:48	2020/8/23	7:59	11-58.96014N	135-00.34062E	3	1.75	
31	2020/8/23	7:59	2020/8/23	13:15	11-58.68577N	134-59.97847E	4	0.5	
32	2020/8/24	13:06	2020/8/24	20:24	11-59.66642N	135-00.68150E	1	0.9	
33	2020/8/24	20:24	2020/8/25	5:45	12-00.24356N	135-00.13439E	2	full	
34	2020/8/25	5:45	2020/8/25	11:48	12-00.16069N	134-59.89236E	3	full	
35	2020/8/25	11:48	2020/8/25	13:11	12-00.36401N	134-59.88528E	4	0.5	
36	2020/8/25	13:14	2020/8/25	19:21	12-00.39225N	134-59.55274E	1	0.7	
37	2020/8/26	1:22	2020/8/26	7:42	11-59.85686N	134-59.98574E	3	full	
38	2020/8/26	7:42	2020/8/26	11:29	11-59.85338N	134-59.55668E	4	3.1	
39	2020/8/26	13:05	2020/8/26	19:37	11-59.98622N	134-59.99299E	1	1.8	
40	2020/8/27	2:44	2020/8/27	8:58	11-59.97780N	135-00.06176E	3	6.8	
41	2020/8/27	8:58	2020/8/27	11:18	11-59.52354N	135-00.44848E	4	1.9	
42	2020/8/27	13:05	2020/8/27	19:56	11-59.38000N	135-00.32182E	1	small	
43	2020/8/28	7:58	2020/8/28	13:04	11-59.12420N	135-00.67899E	4	full	
44	2020/8/28	13:08	2020/8/28	19:11	11-59.06518N	134-59.44282E	1	11.2	
45	2020/8/29	7:55	2020/8/29	7:58	11-59.37723N	11-59.37723N	4	small	
46	2020/8/29	13:02	2020/8/29	21:51	11-59.84764N	135-00.08824E	1	4.9	
47	2020/8/29	21:51	2020/8/30	4:15	12-00.13881N	135-00.87243E	2	4.1	
48	2020/8/31	13:06	2020/8/31	22:27	12-01.69757N	134-59.89917E	1	0.7	
49	2020/9/1	13:22	2020/9/1	20:28	11-59.97879N	134-58.89140E	1	1.1	
50	2020/9/5	13:20	2020/9/6	1:03	12-00.53641N	135-00.27735E	1	2.8	
51	2020/9/6	13:13	2020/9/7	4:23	12-00.87050N	134-59.38274E	1	4.7	
52	2020/9/7	4:23	2020/9/7	10:28	12-00.52258N	135-00.17698E	2	0.8	
53	2020/9/7	13:03	2020/9/7	19:04	11-59.53058N	135-01.28590E	1	full	
54	2020/9/7	19:04	2020/9/8	1:15	12-01.41175N	134-59.74636E	2	full	
55	2020/9/8	1:15	2020/9/8	7:44	11-36.98965N	134-57.14800E	3	5.1	
56	2020/9/8	7:44	2020/9/8	11:40	11-37.39201N	134-53.46082E	4	small	
57	2020/9/8	21:56	2020/9/9	5:49	14-33.62721N	135-24.61585E	2	full	
58	2020/9/9	5:49	2020/9/9	14:40	16-10.76748N	135-42.71250E	3	full	
59	2020/9/9	14:43	2020/9/9	23:46	17-52.29850N	135-57.10576E	1	small	
60	2020/9/9	23:46	2020/9/10	12:26	20-10.19864N	136-17.33776E	2	5	
61	2020/9/10	12:26	2020/9/10	12:26	20-10.19864N	136-17.33776E	3	small	
62	2020/9/10	13:12	2020/9/10	22:39	22-33.59188N	136-39.81968E	1	3.3	
63	2020/9/11	13:30	2020/9/11	23:22	28-33.41371N	137-36.10998E	1	0.9	
64	2020/9/11	23:22	2020/9/12	5:44	29-48.85559N	137-49.01107E	2	1.4	
65	2020/9/12	5:44	2020/9/12	12:01	31-08.70646N	138-00.89048E	3	2.2	
66	2020/9/12	12:01	2020/9/12	13:28	31-26.97658N	138-03.29461E	4	small	

5.11 Microwave radiometer

(1) Personnel

Akira KUWANO-YOSHIDA	(Kyoto Univ.)	(not on board)
Masahiro MINOWA	(Furuno Electric Co., Ltd.)	(not on board)
Masaki KATSUMATA	(JAMSTEC)	

(2) Objective

To retrieve total column integrated water vapor content of the atmosphere.

(3) Method

The microwave radiometer (hereafter MWR; manufactured by Furuno Electric Co., Ltd.) is used. The MWR received natural microwave within the angle of 20 deg. from zenith, at the frequencies around 22 GHz. The received signal can be converted to the column integrated water vapor (or precipitable water). The observation was made every 60 seconds. The rain sensor is equipped to identify the period of rainfall.

In addition to the MWR, the whole sky camera was installed beside the MWR. This is to monitor cloud cover, which also affects the microwave signals. The camera obtained the whole-sky image every 60 seconds.

Both instruments were installed at the top of the roof of aft wheelhouse, as in Fig. 5.11-1. The data were continuously obtained all through the cruise period.

(4) Results

The time series of the obtained column integrated water vapor is shown in Fig. 5.11-2. Diurnal cycle can be found, especially in the dry period. The variation with several-days cycle are also found, with the increased precipitable water when frequent rain were detected. A sample of the whole sky image is shown in Fig. 5.11-3.

(5) Data archive

The data will be submitted to the JAMSTEC Data Management Group (DMG).

(6) Acknowledgment

The observation was supported by the JSPS KAKENHI Grant 20H04306.

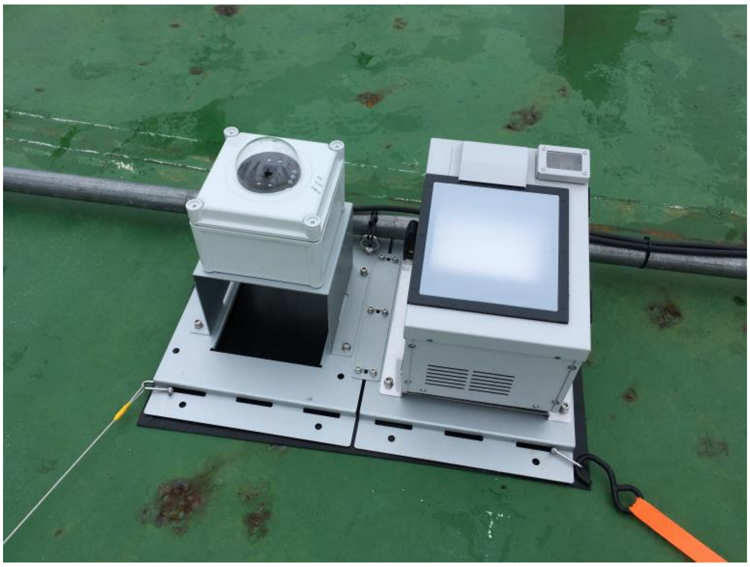


Fig. 5.11-1: Outlook of the microwave radiometer (right) and the whole-sky camera (left) installed at the roof of the aft wheelhouse.

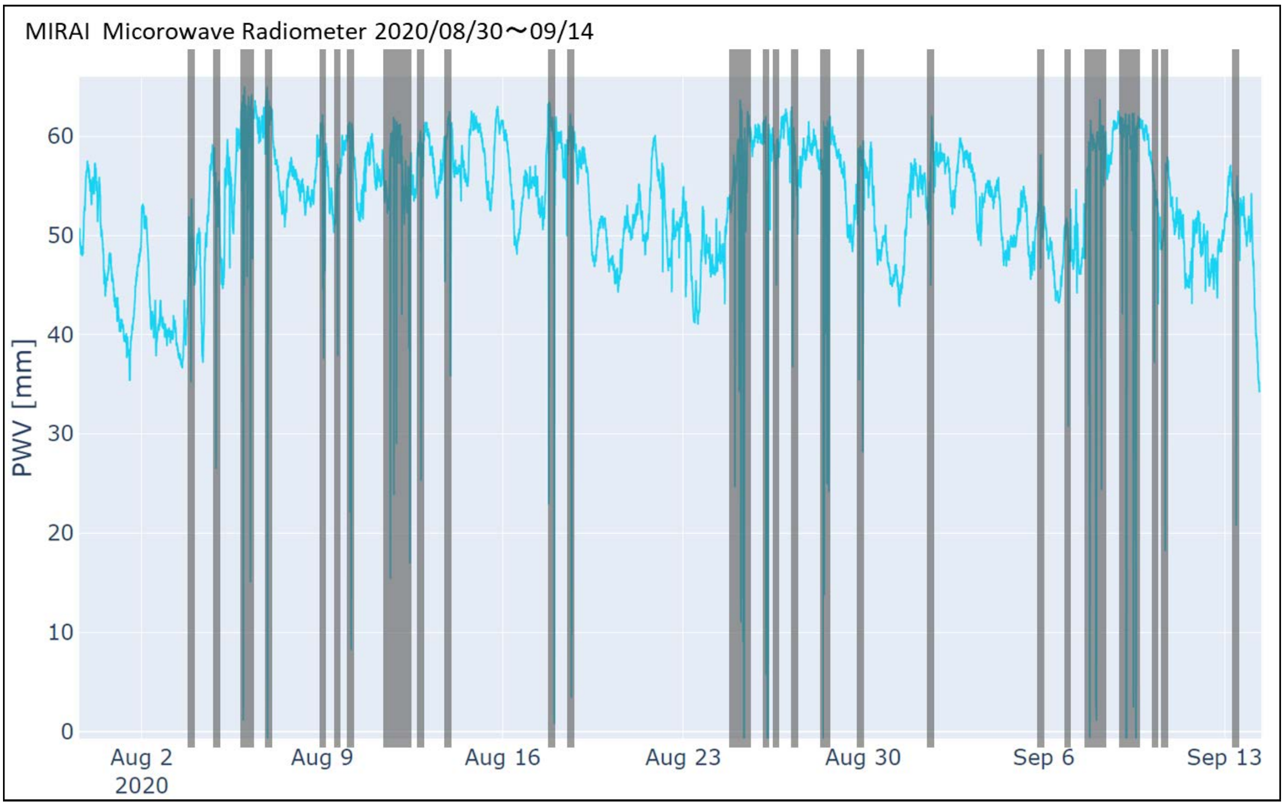


Fig. 5.11-2: Time series of the estimated precipitable water. Note that gray-shaded periods are when rainfall was detected by the rain sensor.

Fig. 5.11-3: Examples of the image from the whole-sky camera, at (left) a sunny moment, (center) a partly-cloudy moment, and (right) a raining moment.

5.12 Measurement of column-integrated CO_2 density in the atmosphere

(1) Personnel

Yutaka MATSUMI	(Nagoya University)	- Principal Investigator	- not on board
Ryoichi IMASU	(Tokyo University)		- not on board
Tomoo NAGAHAMA	(Nagoya University)		- not on board
Fumikazu TAKETANI	(JAMSTEC)		- not on board

Operation for the l instrument was supported by Nippon Marine Enterprises, Ltd

(2) Objectives

To investigate CO_2 concentrations in the marine atmosphere

(3) Methods

The ground-based observation of CO2 column concentration which is performed by near-infrared spectroscopy of solar light is very important. To obtain the CO_2 column concentration, The TCCON uses a large FTS (wavenumber resolution ~ 0.01 cm^{-1}), some groups uses a small FTS (resolution 0.2 cm^{-1}). Both of them had highly cost. In previous research, we used OSA (Optical Spectrum Analyzer wavelength swept type spectrometer, resolution 0.1 cm^{-1}) to obtain the CO_2 column concentration with lower cost. FTS and OSA take several seconds to several minutes to interferometer drive and wavelength sweep, and disturbance due to the passage of thin clouds there between may cause distortion of the spectrum.

We use a small size fiber spectrometer of a commercially available array type infrared sensor (Ocean Optics, NIR Quest, 1557-1625 nm resolution 1.0 cm^{-1}) and an equatorial mount which was originally made by our group. This system uses an array type sensor, there is an advantage in that the entire wavelength area can be measured instantaneously. It can be observed even in cloudy weather. The sun tracking device is simple and easy to observe even in unstable places such as ships and automobiles.

(4) Preliminary Results

The originally-designed sun-tracker of the system worked well during the cruse, althogh there was some problems. The solar spectra onserved during the cruse were recorded in the computer. we are now analysing the spectra to calculate the CO_2 column concnetrations from the spectra.

(5) 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>

(6) Acknowledgments

We thank the crew of the R/V Mirai, and staff of Nippon Marine Enterprises, Ltd. for their support with observations throughout the cruise.

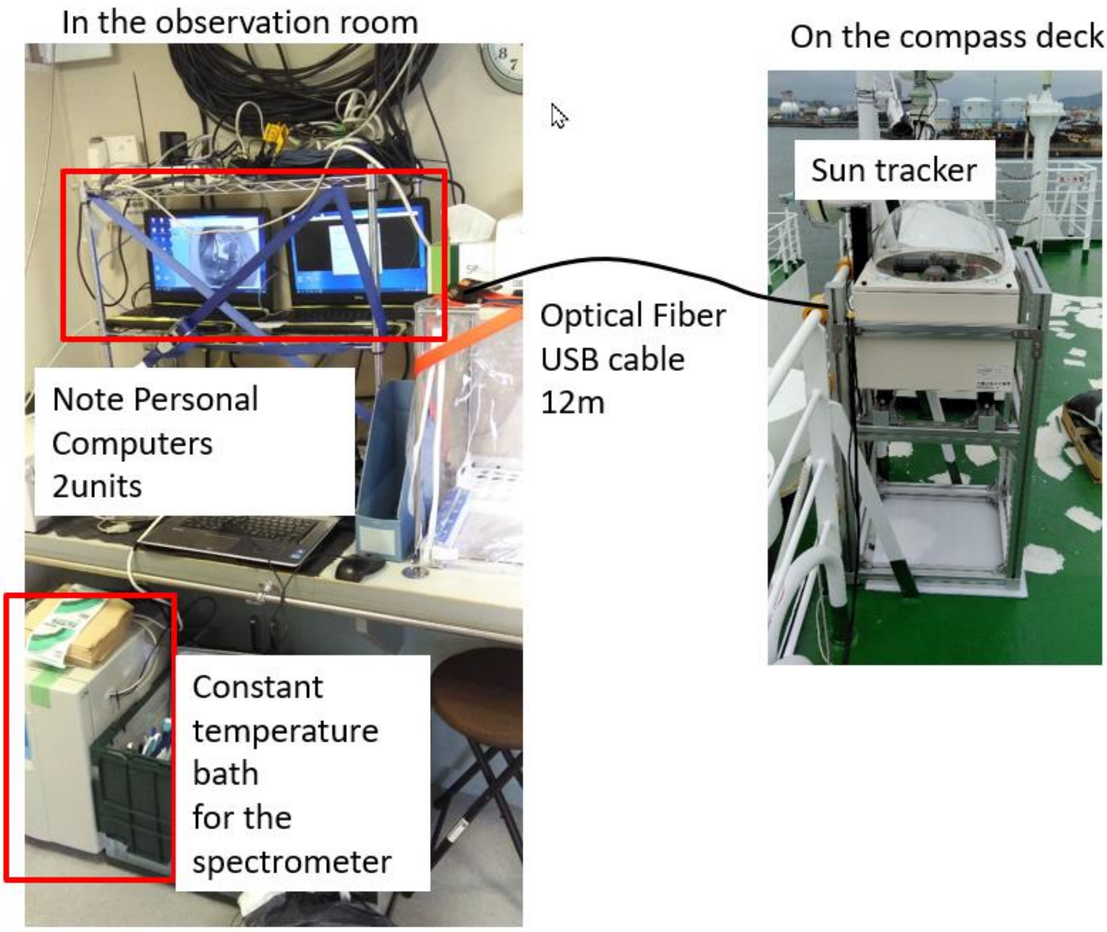


Fig. 1 CO_2 column measurement instrument mounted in R/V Mirai

5.13 Surface meteorological observations

(1) Personnel

Satoru YOKOI	(JAMSTEC)	- Principal Investigator
Kazuho YOSHIDA	(NME)	- Operation Leader
Satomi OGAWA	(NME)	
Yutaro MURAKAMI	(NME)	
Yoichi INOUE	(NME)	- MIRAI Crew

(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 MR20-E01 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 5.13-1 and measured parameters are listed in Table 5.13-2. 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) Analog meteorological data sampling with CR1000 logger manufactured by Campbell Inc., Canada – wind, pressure, and rainfall (by a capacitive rain gauge(CRG)) measurement.
b) Digital meteorological data sampling from individual sensors －air temperature, relative humidity and rainfall (by optical rain gauge (ORG)) measurement.
c) Radiation data sampling with CR1000X logger manufactured by Campbell Inc., Radiometers designed by Hukseflux Thermal Sensors B.V. Netherlands. – short and long wave downward radiation 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 Radiation, air temperature, relative humidity, CR1000, ORG and PAR 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 5.13-3 and measured parameters are listed in Table 5.13-4.

SeaSnake has two thermistor probes (5cm and 100cm from the cable respectively) and output voltage was converted to SSST by Steinhart-Hart equation with the following coefficients "a", "b" and "c", which were led from the calibration data.

Sensor	a	b	c
SSST-005	8.74350E-04	-2.04952E-04	-8.29560E-08
SSST-100	9.48760E-04	-1.93418E-04	-1.18144E-07

$y = a + b * x + c * x^3$
$x = \log (1 / ((V_{ref} / V - 1) * R_2 - R_1))$
$T = 1 / y - 273.15$

V_{ref} = 2500 [mV]
R_1 = 249000 [Ω]
R_2 = 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 probes were calibrated by the bath equipped with SBE-3 plus, Sea-Bird Electronics, Inc.

(4) Preliminary Results

Figure 5.13-1 shows the time series of the following parameters;
Wind (SOAR)
Air temperature (SMet)
Relative humidity (SMet)
Precipitation (SOAR, CRG)
Short/long wave radiation (SOAR)
Barometric Pressure (SMet)
Sea surface temperature (SMet)
Significant wave height (SMet)

Figure 5.13-2 shows the time series of SSST compared to sea surface temperature (TSG).

(5) 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

(6) Remarks

1. The following periods, SST data of SMET was available.

07:15UTC 01 Aug. 2020 - 05:00UTC 12 Sep. 2020

2. The following period, PAR and Ultraviolet radiation data were invalid due to the sensor trouble.

11:21UTC 12 Aug. 2020 - 00:58UTC 13 Aug. 2020

3. SeaSnake (SSST)

(1) The following period, SSST data was available.

05:00UTC 08 Aug. 2020 – 03:46UTC 07 Sep. 2020

(2) The following periods, SSST observation was suspended.

02:00UTC 09 Aug. 2020 - 07:24UTC 09 Aug. 2020
21:47UTC 16 Aug. 2020 - 23:42UTC 16 Aug. 2020
03:48UTC 18 Aug. 2020 - 07:15UTC 18 Aug. 2020
21:45UTC 20 Aug. 2020 - 23:46UTC 20 Aug. 2020
03:00UTC 22 Aug. 2020 - 07:55UTC 22 Aug. 2020
07:49UTC 25 Aug. 2020 - 22:03UTC 25 Aug. 2020
21:45UTC 31 Aug. 2020 - 23:46UTC 31 Aug. 2020
03:44UTC 02 Sep. 2020 - 07:34UTC 02 Sep. 2020
23:00UTC 03 Sep. 2020 - 02:48UTC 04 Sep. 2020

(3) The following periods, SSST data were invalid due to maintenance.

01:23UTC 10 Aug. 2020 - 01:24UTC 10 Aug. 2020
23:45UTC 10 Aug. 2020 - 23:46UTC 10 Aug. 2020
01:24UTC 11 Aug. 2020 - 01:58UTC 11 Aug. 2020
23:47UTC 11 Aug. 2020 - 23:48UTC 11 Aug. 2020
23:45UTC 12 Aug. 2020 - 23:47UTC 12 Aug. 2020
23:51UTC 14 Aug. 2020 - 23:56UTC 14 Aug. 2020
23:44UTC 15 Aug. 2020 - 23:48UTC 15 Aug. 2020
23:47UTC 18 Aug. 2020 - 23:57UTC 18 Aug. 2020
23:42UTC 22 Aug. 2020 - 23:43UTC 22 Aug. 2020
23:45UTC 28 Aug. 2020 - 23:52UTC 28 Aug. 2020
23:46UTC 29 Aug. 2020 - 23:51UTC 29 Aug. 2020
23:45UTC 30 Aug. 2020 - 23:52UTC 30 Aug. 2020
01:30UTC 31 Aug. 2020 - 01:44UTC 31 Aug. 2020
23:44UTC 01 Sep. 2020 - 23:49UTC 01 Sep. 2020
23:45UTC 02 Sep. 2020 - 23:52UTC 02 Sep. 2020

Table 5.13-1: Instruments and installation locations of MIRAI Surface Meteorological observation system

Sensors	Type	Manufacturer	Location (altitude from surface)
Anemometer	KS-5900	Koshin Denki, Japan	Foremast (25 m)
Tair/RH	HMP155	Vaisala, Finland	Compass deck (21 m)
with aspirated radiation shield	43408 Gill	R.M. Young, U.S.A.	starboard and port side
Thermometer: SST	RFN2-0	Koshin Denki, Japan	4th deck (-1m, inlet -5m)
Barometer	Model-370	Setra System, U.S.A.	Captain deck (13 m) Weather observation room
Capacitive rain gauge	50202	R. M. Young, U.S.A.	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) Stern (8m)

Table 5.13-2: 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)	degC	6sec. averaged
11 Air temperature (port)	degC	6sec. averaged
12 Dewpoint temperature (starboard)	degC	6sec. averaged
13 Dewpoint temperature (port)	degC	6sec. averaged
14 Relative humidity (starboard)	%	6sec. averaged
15 Relative humidity (port)	%	6sec. averaged
16 Sea surface temperature	degC	6sec. averaged
17 Precipitation intensity (optical rain gauge)	mm/hr	hourly accumulation
18 Precipitation (capacitive rain gauge)	mm/hr	hourly accumulation
19 Downwelling shortwave radiation	W/m^2	6sec. averaged
20 Downwelling infra-red radiation	W/m^2	6sec. averaged
21 Significant wave height (bow)	m	hourly
22 Significant wave height (stern)	m	hourly
23 Significant wave period (bow)	second	hourly
24 Significant wave period (stern)	second	hourly

Table 5.13-3: Instruments and installation locations of SOAR system

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

Sensors (Radiation)	Type	Manufacturer	Location *
Radiometer (short wave)	SR20	Hukseflux Thermal Sensors B.V., Netherlands	Foremast (25 m)
Radiometer (long wave)	IR20	Hukseflux Thermal Sensors B.V., Netherlands	Foremast (25 m)

Sensor (PAR&UV)	Type	Manufacturer	Location *
PAR&UV sensor	PUV-510	Biospherical Instruments Inc., USA	Navigation deck (18m)

Sensor (SeaSnake)	Type	Manufacturer	Location *
Thermistor	107	Campbell Scientific, USA	Bow, 5m extension (0 m)

*Location : Altitude from surface

Table 5.13-4: 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 Precipitation intensity (optical rain gauge)	mm/hr	
11 Precipitation (capacitive rain gauge)	mm/hr	reset at 50 mm
12 Down welling shortwave radiation	W/m^2	
13 Down welling infrared radiation	W/m^2	
14 "SeaSnake" raw data	mV	
15 SSST (SeaSnake)	degC	
16 PAR	$microE/cm^2/sec$	
17 UV 305 nm	$microW/cm^2/nm$	
18 UV 320 nm	$microW/cm^2/nm$	
19 UV 340 nm	$microW/cm^2/nm$	
20 UV 380 nm	$microW/cm^2/nm$	

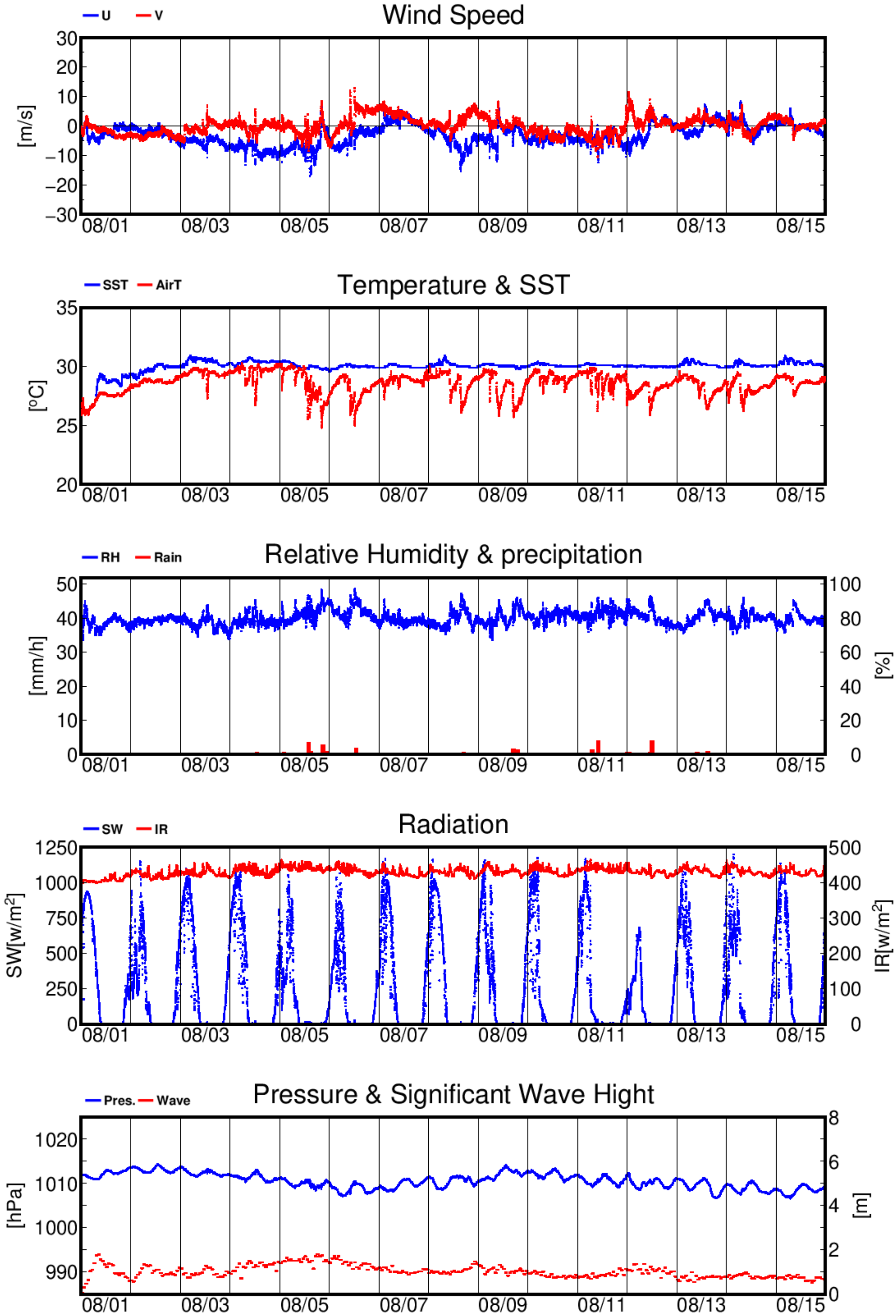


Fig. 5.13-1: Time-height cross sections of potential temperature anomaly from the period average.

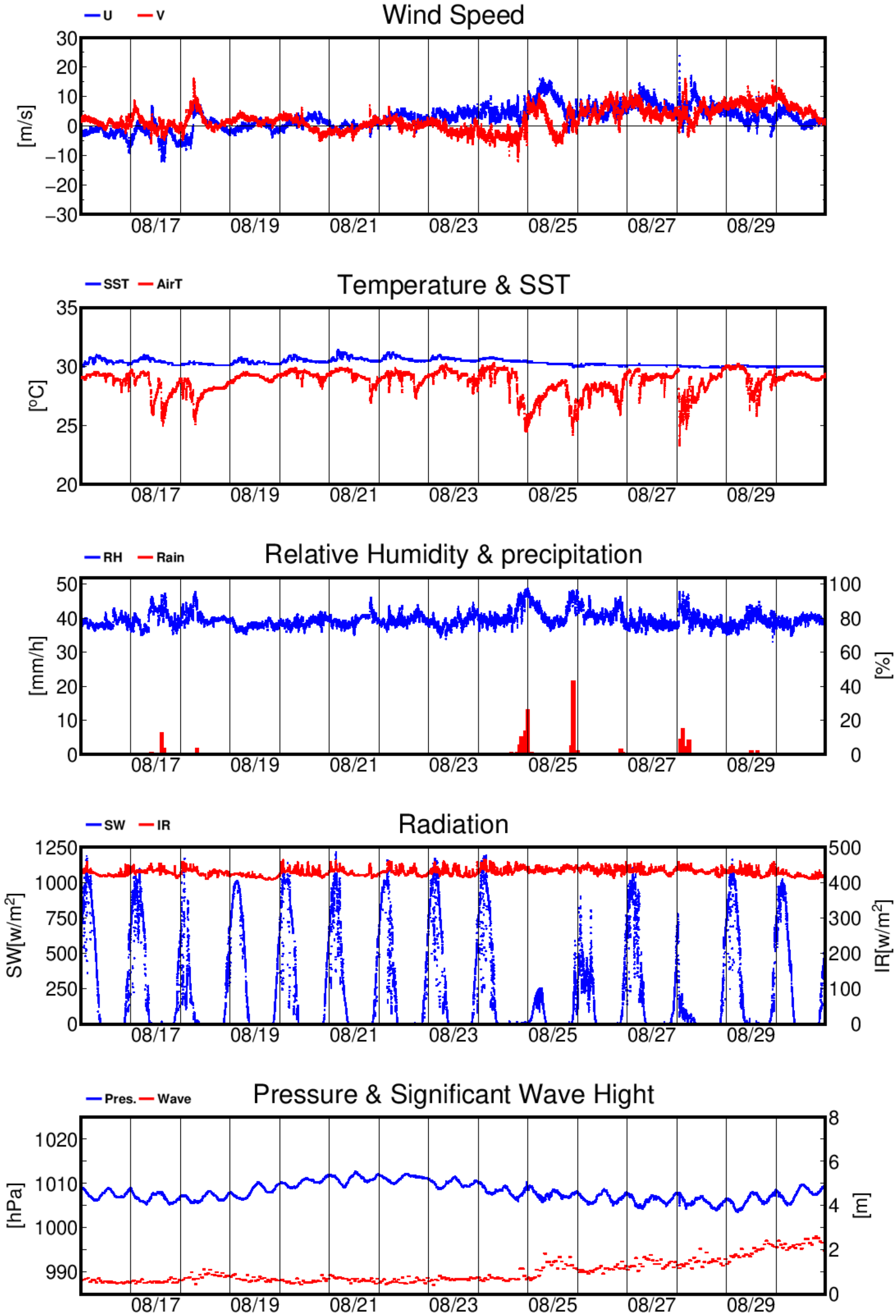


Fig. 5.13-1 (Continued)

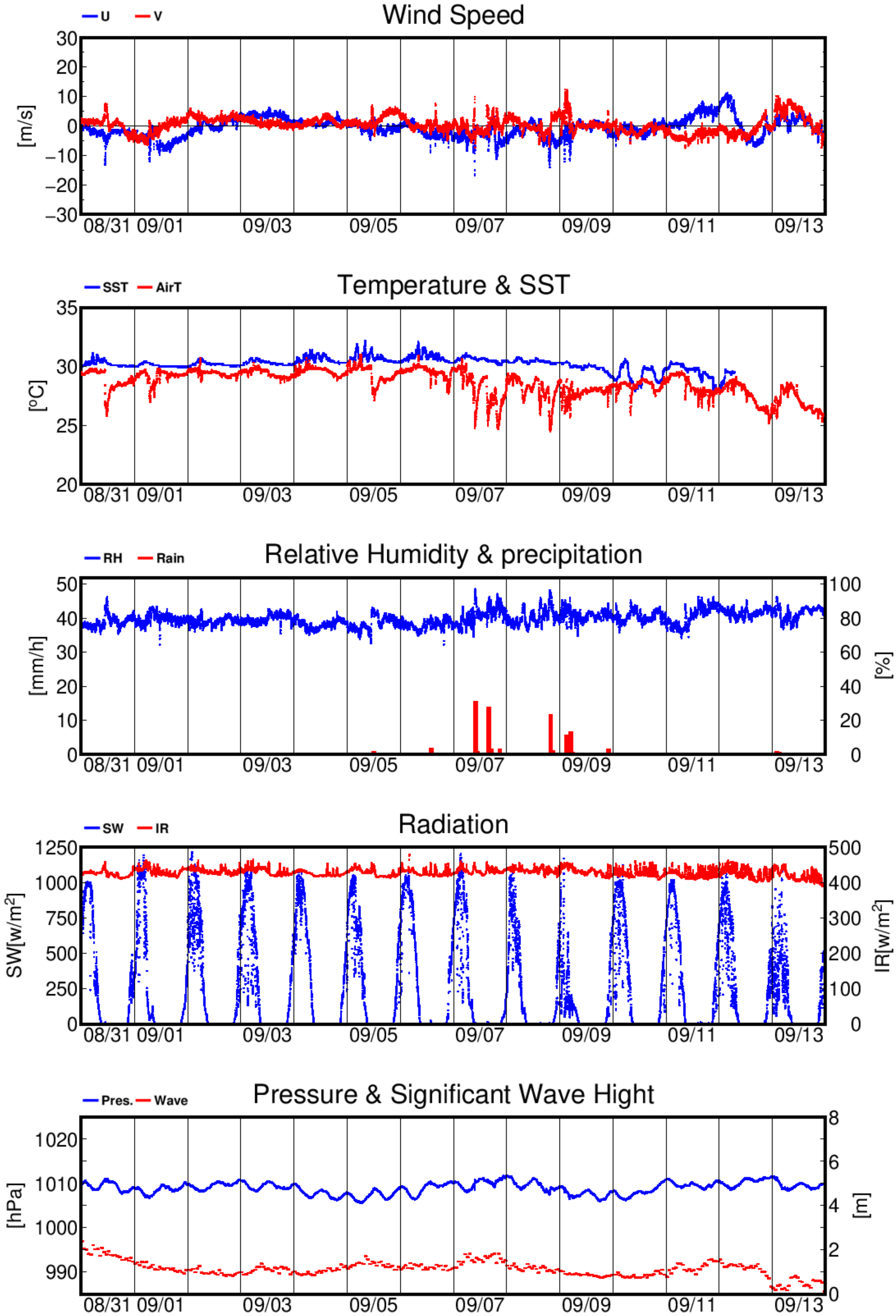


Fig. 5.13-1 (Continued)

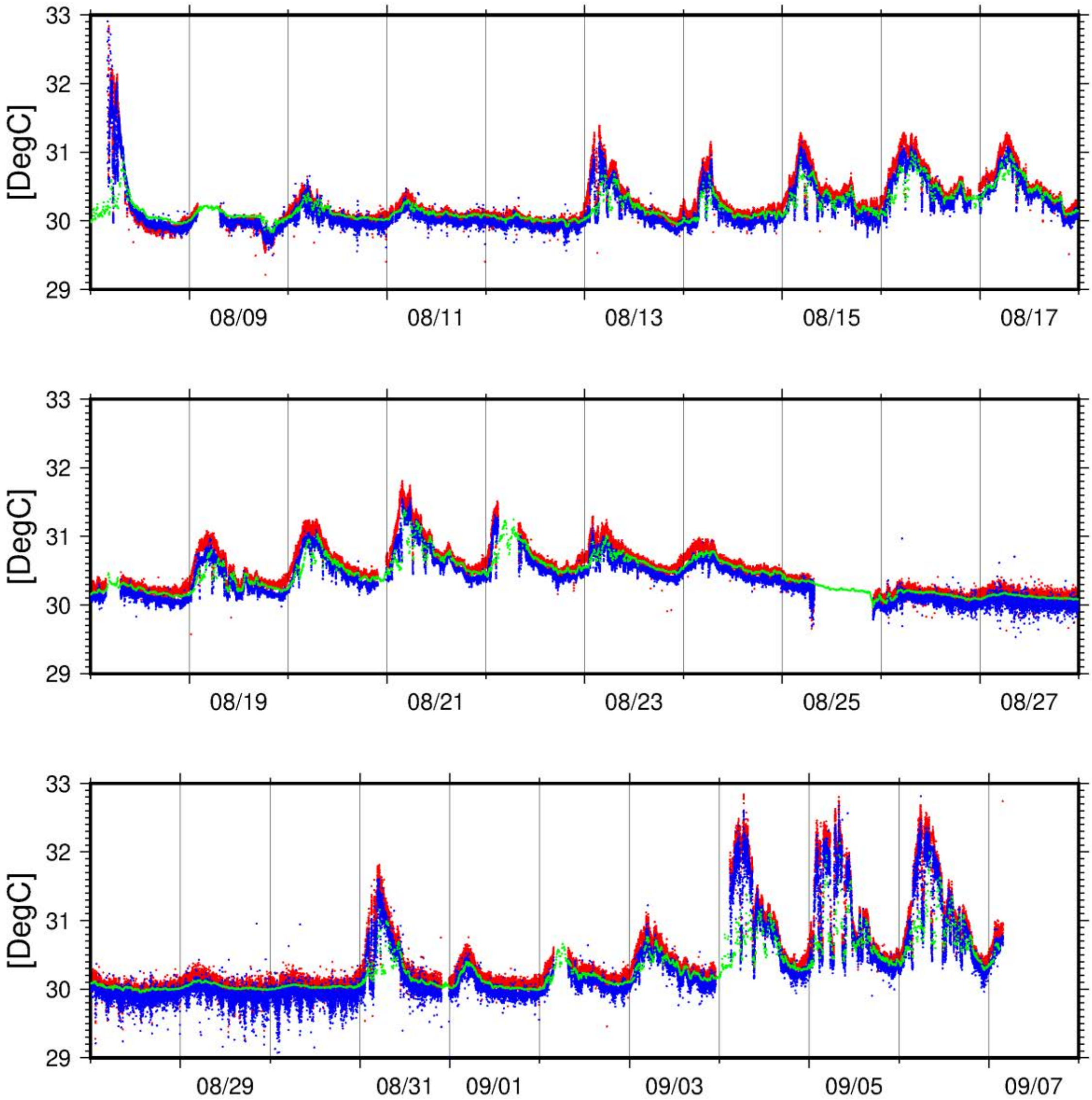


Fig. 5.13-2 Time series of Skin Sea Surface Temperature (SSST; 5cm:Red 100cm:Blue) and Sea Surface Temperature (TSG:Grean).

5.14. Continuous monitoring of surface seawater

(1) Personnel

Satoru YOKOI	(JAMSTEC)	- Principal Investigator
Katsunori SAGISHIMA	(MWJ)	- Operation leader
Shiori ARIGA	(MWJ)	

(2) Objective

Our 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 six sensors and automatically measures temperature, salinity, dissolved oxygen, fluorescence, turbidity, and total dissolved gas pressure 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 12 dm^3 min^{-1}.

a. Instruments

Software

Seamoni Ver.1.2.0.0

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:	4563325-0362

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:	3857820-0540
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:	0035 / 0013
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:	2300707
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 5.14-1.

Table 5.14-1 Events list of the Sea surface water monitoring during MR20-E01

System Date [UTC]	System Time [UTC]	Events	Remarks
2020/08/01	10:45	All the measurements started and data was available.	Logging Start
2020/08/12	18:49	The measurements stopped.	Exchanged Dissolved Oxygen Sensor (S/N:0035 → S/N:0013)
2020/08/12	07:31	The measurements started.	Logging restart
2020/09/12	07:00	All the measurements stopped.	Logging 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. 5.14-2. All the salinity samples were analyzed by the Model 8400B “AUTOSAL” manufactured by Guildline Instruments Ltd. (see 5.18), and dissolve oxygen samples were analyzed by Winkler method (see 5.19), chlorophyll a were analyzed by 10-AU manufactured by Turner Designs. (see 5.20).

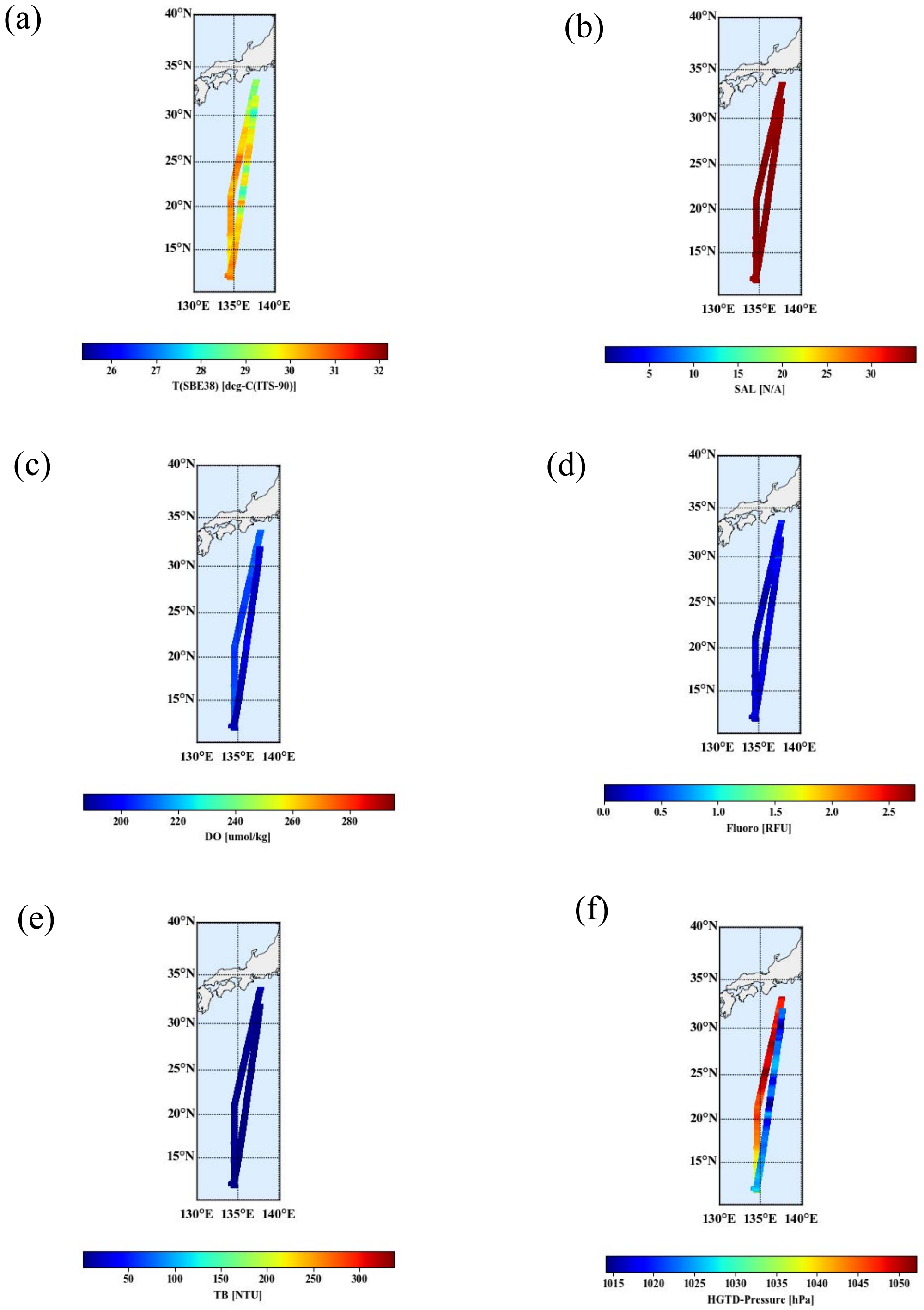


Figure 5.14-1 Spatial and temporal distribution of (a) temperature, (b) salinity, (c) dissolved oxygen, (d) fluorescence, (e) turbidity and (f) total dissolved gas pressure in MR20-E01 cruise.

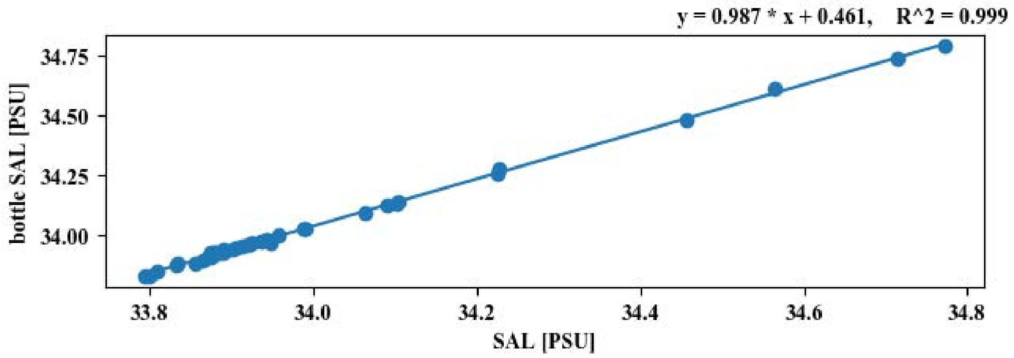


Figure 5.14-2-1 Correlation of salinity between sensor data and bottle data.

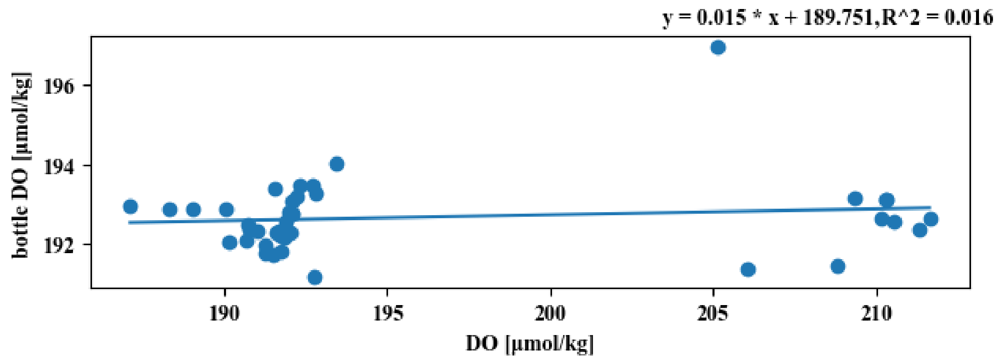


Figure 5.14-2-2 Correlation of dissolved oxygen between sensor data and bottle data.

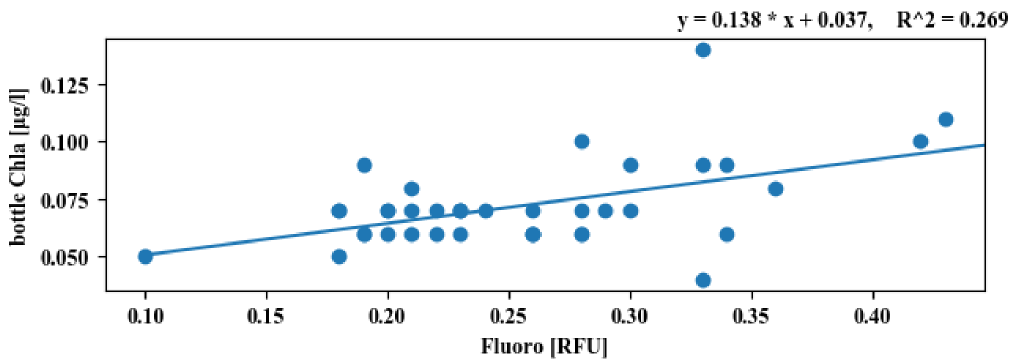


Figure 5.14-2-3 Correlation of fluorescence between sensor data and bottle data.

(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>

5.15 CTD profiling

(1) Personnel

Satoru YOKOI	(JAMSTEC)	*Principal investigator
Masanori ENOKI	(MWJ)	*Operation leader
Rei ITO	(MWJ)	
Tun Htet Aung	(MWJ)	
Akira WATANABE	(MWJ)	
Katsunori SAGISHIMA	(MWJ)	
Shiori ARIGA	(MWJ)	
Masaki YAMADA	(MWJ)	
Keita HAYASHI	(MWJ)	
Daiki KAWATA	(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 SBE43)
Dissolved Oxygen voltage (RINKO III)
Fluorescence
Photosynthetically Active Radiation

(4) Instruments and Methods

CTD/Carousel Water Sampling System, which is a 36-position Carousel Water Sampler (CWS) with Sea-Bird Electronics, Inc. CTD (SBE9plus), was used during this cruise. 12-liter sample Bottles were used for sampling seawater. The sensors attached on the CTD were temperature (primary and secondary), conductivity (primary and secondary), pressure, dissolved oxygen (primary and secondary), RINKO III (dissolved oxygen sensor), fluorescence, photosynthetically active radiation. 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: SBE911plus CTD system
Under water unit:
SBE9plus (S/N: 09P21746-0575, Sea-Bird Electronics, Inc.)
Pressure sensor: Digiquartz pressure sensor (S/N: 79492)
Calibrated Date: 10-Jul-2020
Carousel water sampler:
SBE32 (S/N: 3227443-0391, Sea-Bird Electronics, Inc.)

Temperature sensors:
Primary: SBE03-04/F (S/N: 031464, Sea-Bird Electronics, Inc.)
Calibrated Date: 01-Jun-2019

Secondary: SBE03-04/F (S/N: 03P2453, Sea-Bird Electronics, Inc.)
Calibrated Date: 27-Feb-2019

Conductivity sensors:
Primary: SBE04C (S/N: 041203, Sea-Bird Electronics, Inc.)
Calibrated Date: 04-Oct-2019
Secondary: SBE04C (S/N: 041206, Sea-Bird Electronics, Inc.)
Calibrated Date: 25-Jun-2019

Dissolved oxygen sensor:
Primary: SBE43 (S/N:432211, Sea-Bird Electronics, Inc.)
Calibrated Date: 19-Jun-2019
Secondary: SBE43 (S/N: 430949, Sea-Bird Electronics, Inc.)
Calibrated Date: 20 Oct. 2018

Dissolved oxygen voltage
RINKO III, (S/N: 0278(163010BA), JFE Advantech Co., Ltd.)
Calibrated Date: 12-Jun-2020

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

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

Submersible Pump:
Primary: SBE5T (S/N: 054595, Sea-Bird Electronics, Inc.)
Secondary: SBE5T (S/N: 053293, Sea-Bird Electronics, Inc.)

Deck unit: SBE11plus (S/N 11P54451-0872, Sea-Bird Electronics, Inc.)

Configuration file: MR20E01A.xmlcon
C01M001 – STNM175

MR20E01B.xmlcon
STNM176 –STNM229

MR20E01C.xmlcon
C04M010

The CTD raw data were acquired on real time using the Seasave-Win32 (ver.7.26.7) 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.

The bottle was fired after waiting from the stop for more than 30 seconds below thermocline to stabilize. For depths where vertical gradient of water properties was expected to be large, the bottle was exceptionally fired after waiting 60 seconds from the stop to enhance the exchange of water between inside and outside of the bottle. 223 casts of CTD measurements were conducted (Table 5.15-1).

Data processing procedures and used utilities of SBE Data Processing-Win32 (ver.7.26.7.129) 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 031464 : 7.75293156e-009 (degC/dbar)
S/N 03P2453 : 3.1274e-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 6 seconds advancing to dissolved oxygen sensor (primary and secondary SBE43) output and 1 second advancing to dissolved oxygen voltage (RINKO III) 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 (SBE43) output.

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 density (sigma-theta).

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

(5) Station list

During this cruise, 223 casts of CTD observation were carried out. Date, time and locations of the CTD casts are listed in Table 5.15-1.

(6) Preliminary Results

During this cruise, 223 casts of CTD observation were carried out on buoy observation, ARGO float observation and fixed station observation. Date, time and locations of the CTD casts are listed in Table 5.15.1.

The time series contours of primary temperature, salinity, fluorescence and photosynthetically active radiation with pressure are shown in Figure. 5.15.1. Vertical profile (down cast) of primary temperature, salinity and dissolved oxygen with pressure are shown in the appendix.

During this cruise, we judged noise, spike or shift in the data of some casts.

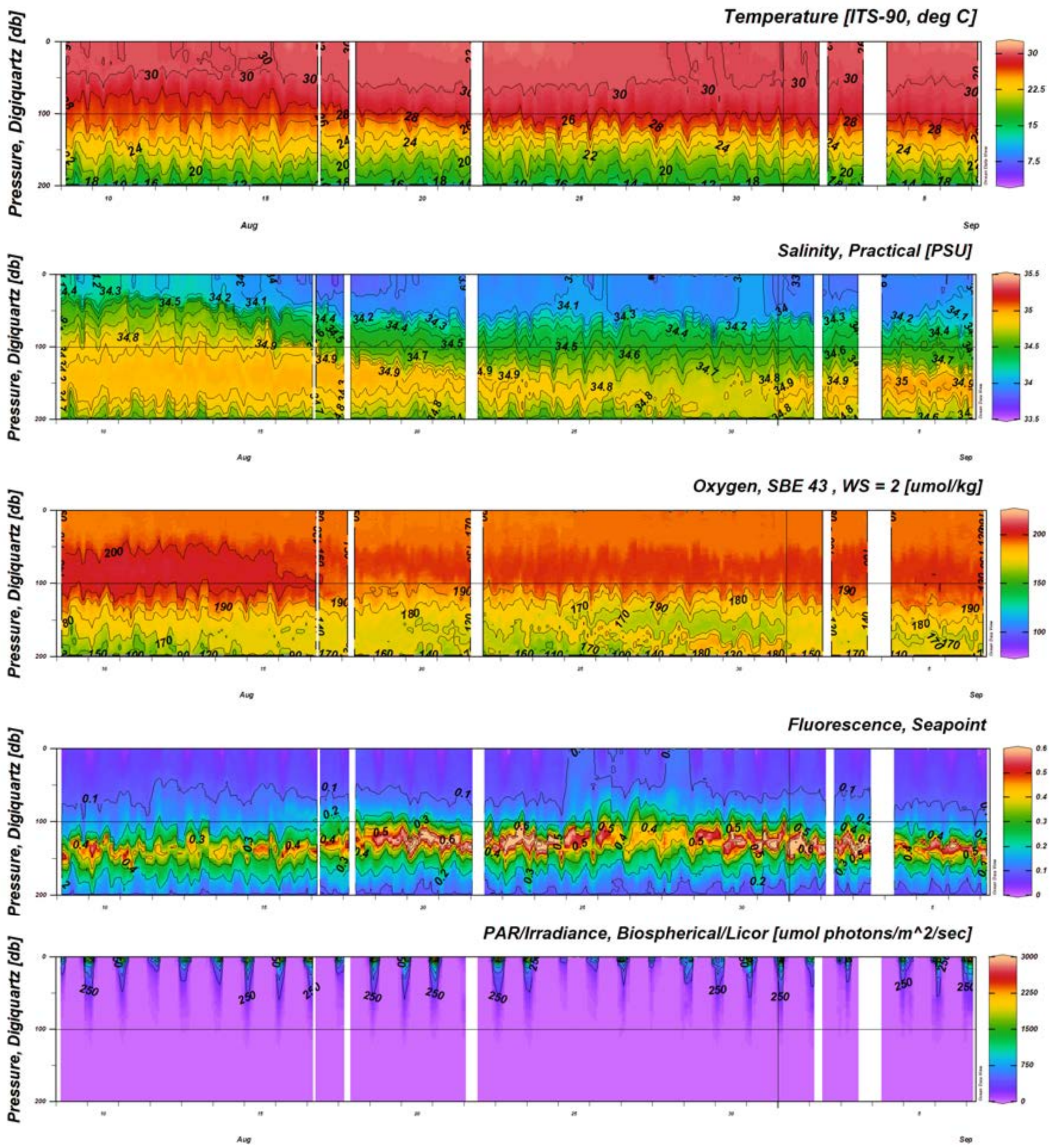


Figure 5.15-1 the time series contours (temperature, salinity oxygen and fluorescence and photosynthetically active radiation) in fixed point measurement (STNM001 ~ STNM229).

(7)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 5.15.1 MR20-E01 CTD cast table

Stnnbr	Castno	Date(UTC)	Time(UTC)		BottomPosition		Depth (m)	Wire Out (m)	HT Above Bottom (m)	Max Depth (m)	Max Pressure (dbar)	CTD Filename	Remark
		(mmddyy)	Start	End	Latitude	Longitude							
C01	1	080420	04:27	05:13	21-00.09N	135-00.08E	5810.0	999.1	-	1001.3	1010.0	C01M001	ARGO
C02	1	080420	21:28	22:09	18-00.01N	134-59.69E	5215.0	1000.4	-	1000.5	1009.0	C02M001	ARGO
C03	1	080520	15:36	16:17	15-00.09N	134-59.82E	4497.0	999.3	-	1001.7	1010.0	C03M001	ARGO
C04	1	080720	06:13	06:40	11-40.86N	134-57.74E	4353.0	500.6	-	501.5	505.0	C04M001	m-TRITON Dep.
STN	1	080920	06:19	06:43	12-00.01N	135-00.03E	4612.0	497.6	-	500.5	504.0	STNM001	
STN	2	080920	09:20	09:44	12-00.47N	134-59.65E	4620.0	499.3	-	502.5	506.0	STNM002	
STN	3	080920	12:19	12:42	11-59.30N	135-00.07E	4621.0	498.2	-	500.5	504.0	STNM003	
STN	4	080920	15:20	15:43	12-01.04N	135-01.11E	4572.0	501.5	-	503.5	507.0	STNM004	
STN	5	080920	18:23	18:46	12-00.20N	135-00.02E	4611.0	499.3	-	500.5	504.0	STNM005	
STN	6	080920	21:19	21:43	11-59.22N	135-00.22E	4615.0	497.8	-	501.5	505.0	STNM006	
STN	7	081020	00:18	01:14	12-00.01N	135-01.21E	4430.0	1001.3	-	1002.8	1011.0	STNM007	
STN	8	081020	03:16	03:41	12-00.29N	135-00.94E	4542.0	505.0	-	500.5	504.0	STNM008	
STN	9	081020	06:16	06:39	11-59.66N	135-00.47E	4575.0	499.6	-	500.5	504.0	STNM009	
STN	10	081020	09:16	09:42	11-59.67N	135-00.04E	4612.0	498.5	-	501.5	505.0	STNM010	
STN	11	081020	12:17	12:40	11-59.92N	134-59.45E	4620.0	499.6	-	501.5	505.0	STNM011	
STN	12	081020	15:17	15:41	12-00.22N	134-59.79E	4617.0	500.6	-	502.5	506.0	STNM012	
STN	13	081020	18:18	18:41	12-00.15N	134-59.80E	4619.0	499.1	-	501.5	505.0	STNM013	
STN	14	081020	21:18	21:41	11-59.93N	135-00.05E	4612.0	499.8	-	502.5	506.0	STNM014	
STN	15	081120	00:16	01:15	12-00.17N	134-59.75E	4617.0	999.8	-	1000.8	1009.0	STNM015	
STN	16	081120	03:15	03:38	11-59.61N	134-59.97E	4612.0	498.5	-	500.5	504.0	STNM016	
STN	17	081120	06:16	06:39	12-00.52N	134-59.82E	4619.0	502.6	-	500.5	504.0	STNM017	
STN	18	081120	09:16	09:39	12-00.86N	134-59.41E	4599.0	498.7	-	500.5	504.0	STNM018	
STN	19	081120	12:17	12:39	11-59.08N	134-59.88E	4625.0	499.4	-	502.5	506.0	STNM019	
STN	20	081120	15:18	15:42	11-59.92N	134-59.52E	4624.0	502.2	-	503.5	507.0	STNM020	
STN	21	081120	18:19	18:43	12-00.01N	134-59.94E	4616.0	504.8	-	502.5	506.0	STNM021	
STN	22	081120	21:17	21:40	11-59.49N	135-00.21E	4600.0	500.4	-	502.5	506.0	STNM022	
STN	23	081220	00:17	01:17	12-00.08N	135-00.05E	4608.0	1000.0	-	1000.8	1009.0	STNM023	
STN	24	081220	03:14	03:37	12-00.14N	135-00.12E	4605.0	499.1	-	500.5	504.0	STNM024	
STN	25	081220	06:15	06:38	11-59.97N	135-00.06E	4603.0	500.4	-	500.5	504.0	STNM025	
STN	26	081220	09:15	09:37	12-00.11N	135-00.23E	4594.0	500.4	-	502.5	506.0	STNM026	
STN	27	081220	12:17	12:40	12-00.13N	135-00.05E	4612.0	500.2	-	502.5	506.0	STNM027	

STN	28	081220	15:17	15:41	11-59.59N	134-59.13E	4617.0	501.3	-	501.5	505.0	STNM028	
STN	29	081220	18:17	18:41	12-00.12N	134-59.80E	4625.0	500.2	-	500.5	504.0	STNM029	
STN	30	081220	21:18	21:41	11-59.71N	134-59.96E	4614.0	500.9	-	501.5	505.0	STNM030	
STN	31	081320	00:16	01:13	11-59.94N	134-59.85E	4619.0	999.3	-	1000.8	1009.0	STNM031	
STN	32	081320	03:22	03:49	11-59.74N	134-59.76E	4616.0	500.2	-	500.5	504.0	STNM032	
STN	33	081320	06:16	06:40	12-00.08N	135-00.05E	4609.0	497.4	-	500.5	504.0	STNM033	
STN	34	081320	09:19	09:42	11-59.87N	134-59.66E	4617.0	497.4	-	501.5	505.0	STNM034	
STN	35	081320	12:17	12:41	12-00.33N	135-00.00E	4613.0	499.1	-	502.5	506.0	STNM035	
STN	36	081320	15:17	15:42	12-00.30N	134-59.98E	4615.0	497.6	-	500.5	504.0	STNM036	
STN	37	081320	18:19	18:42	12-00.06N	135-00.25E	4602.0	500.6	-	502.5	506.0	STNM037	
STN	38	081320	21:17	21:43	11-59.72N	134-59.65E	4619.0	500.4	-	500.5	504.0	STNM038	
STN	39	081420	00:15	01:11	11-59.98N	134-59.50E	4619.0	1003.9	-	1001.8	1010.0	STNM039	
STN	40	081420	03:14	03:37	12-00.38N	135-00.20E	4610.0	499.4	-	500.5	504.0	STNM040	
STN	41	081420	06:14	06:37	11-59.95N	134-59.80E	4618.0	500.0	-	501.5	505.0	STNM041	
STN	42	081420	09:17	09:39	12-00.01N	135-00.01E	4614.0	499.8	-	501.5	505.0	STNM042	
STN	43	081420	12:19	12:41	12-00.27N	134-59.90E	4615.0	500.9	-	503.5	507.0	STNM043	
STN	44	081420	15:18	15:41	12-00.34N	134-59.72E	4626.0	502.6	-	502.5	506.0	STNM044	
STN	45	081420	18:18	18:42	12-00.05N	135-00.10E	4612.0	502.0	-	503.5	507.0	STNM045	
STN	46	081420	21:19	21:42	11-59.80N	135-00.16E	4601.0	497.8	-	500.5	504.0	STNM046	
STN	47	081520	00:15	01:13	11-59.97N	135-00.05E	4612.0	999.6	-	1000.8	1009.0	STNM047	
STN	48	081520	03:14	03:36	12-00.00N	135-00.08E	4610.0	500.4	-	502.5	506.0	STNM048	
STN	49	081520	06:14	06:38	12-00.02N	135-00.10E	4612.0	498.5	-	500.5	504.0	STNM049	
STN	50	081520	09:17	09:40	11-59.84N	134-59.93E	4611.0	499.1	-	500.5	504.0	STNM050	
STN	51	081520	12:17	12:39	11-59.85N	134-59.80E	4620.0	499.8	-	501.5	505.0	STNM051	
STN	52	081520	15:17	15:41	12-00.04N	134-59.63E	4619.0	499.4	-	500.5	504.0	STNM052	
STN	53	081520	18:17	18:40	12-00.13N	134-59.74E	4620.0	499.4	-	500.5	504.0	STNM053	
STN	54	081520	21:16	21:40	12-00.24N	134-59.98E	4617.0	498.5	-	500.5	504.0	STNM054	
STN	55	081620	00:15	01:13	12-00.01N	135-00.10E	4605.0	1000.9	-	1000.8	1009.0	STNM055	
STN	56	081620	03:13	03:35	11-59.98N	134-59.84E	4614.0	500.2	-	502.5	506.0	STNM056	
STN	57	081620	06:14	06:38	12-00.17N	135-00.16E	4609.0	500.6	-	500.5	504.0	STNM057	
STN	58	081620	09:17	09:40	12-00.04N	134-59.92E	4615.0	496.7	-	500.5	504.0	STNM058	
STN	59	081620	12:19	12:43	12-00.09N	134-59.84E	4618.0	499.4	-	500.5	504.0	STNM059	
STN	60	081620	15:17	15:41	12-00.10N	134-59.76E	4623.0	499.3	-	501.5	505.0	STNM060	
STN	61	081620	18:16	18:40	12-00.16N	134-59.79E	4619.0	496.1	-	500.5	504.0	STNM061	
STN	62	081620	21:16	21:40	11-59.32N	135-00.16E	4623.0	500.4	-	501.5	505.0	STNM062	
STN	63	081720	00:15	01:15	11-59.61N	135-00.09E	4613.0	1000.4	-	1000.8	1009.0	STNM063	

STN	64	081720	03:14	03:37	12-00.02N	135-00.07E	4613.0	500.0	-	501.5	505.0	STNM064	
STN	66	081720	09:13	09:36	12-00.09N	135-00.00E	4611.0	499.3	-	501.5	505.0	STNM066	
STN	67	081720	12:18	12:40	11-58.80N	135-00.82E	4490.0	499.6	-	500.5	504.0	STNM067	
STN	68	081720	15:16	15:40	12-00.02N	135-00.07E	4610.0	497.4	-	500.5	504.0	STNM068	
STN	69	081720	18:16	18:40	12-00.04N	134-59.96E	4612.0	500.9	-	501.5	505.0	STNM069	
STN	70	081720	21:15	21:38	12-00.07N	134-59.88E	4614.0	498.7	-	501.5	505.0	STNM070	
STN	71	081820	00:15	01:10	11-59.94N	134-59.75E	4616.0	1002.2	-	1002.8	1011.0	STNM071	
STN	72	081820	03:15	03:39	12-00.07N	134-59.91E	4614.0	497.4	-	500.5	504.0	STNM072	
STN	74	081820	12:17	12:40	12-00.09N	135-00.04E	4613.0	499.6	-	501.5	505.0	STNM074	
STN	75	081820	15:15	15:39	11-59.95N	134-59.90E	4616.0	499.6	-	501.5	505.0	STNM075	
STN	76	081820	18:16	18:40	12-00.09N	135-00.03E	4613.0	500.6	-	501.5	505.0	STNM076	
STN	77	081820	21:16	21:40	12-00.06N	135-00.05E	4613.0	500.7	-	501.5	505.0	STNM077	
STN	78	081920	00:15	01:11	12-00.08N	135-00.38E	4595.0	1001.7	-	1000.8	1009.0	STNM078	
STN	79	081920	03:15	03:38	11-59.92N	135-00.02E	4610.0	499.1	-	500.5	504.0	STNM079	
STN	80	081920	06:15	06:39	11-59.97N	135-00.05E	4614.0	500.0	-	500.5	504.0	STNM080	
STN	81	081920	09:14	09:40	12-00.19N	134-59.88E	4622.0	498.7	-	500.5	504.0	STNM081	
STN	82	081920	12:17	12:40	12-00.02N	134-59.99E	4617.0	499.3	-	501.5	505.0	STNM082	
STN	83	081920	15:17	15:40	11-59.97N	134-59.87E	4615.0	500.4	-	500.5	504.0	STNM083	
STN	84	081920	18:16	18:40	12-00.07N	134-59.93E	4614.0	499.6	-	500.5	504.0	STNM084	
STN	85	081920	21:17	21:40	12-00.02N	134-59.97E	4614.0	500.0	-	501.5	505.0	STNM085	
STN	86	082020	00:16	01:12	11-59.99N	135-00.04E	4610.0	1001.7	-	1000.8	1009.0	STNM086	
STN	87	082020	03:15	03:37	11-59.95N	135-00.05E	4609.0	498.5	-	500.5	504.0	STNM087	
STN	88	082020	06:15	06:38	12-00.00N	134-59.99E	4617.0	499.1	-	500.5	504.0	STNM088	
STN	89	082020	09:15	09:38	12-00.10N	135-00.06E	4613.0	499.1	-	500.5	504.0	STNM089	
STN	90	082020	12:16	12:43	11-59.61N	134-59.88E	4620.0	498.5	-	500.5	504.0	STNM090	
STN	91	082020	15:17	15:40	12-00.19N	134-59.80E	4616.0	499.8	-	500.5	504.0	STNM091	
STN	92	082020	18:16	18:39	12-00.11N	134-59.84E	4620.0	500.9	-	501.5	505.0	STNM092	
STN	93	082020	21:15	21:38	11-59.94N	134-59.95E	4612.0	500.2	-	500.5	504.0	STNM093	
STN	94	082120	00:14	01:11	11-58.95N	134-59.97E	4627.0	1001.3	-	1000.8	1009.0	STNM094	
STN	95	082120	03:15	03:38	11-59.92N	135-00.01E	4614.0	499.1	-	500.5	504.0	STNM095	
STN	96	082120	06:15	06:37	11-59.91N	134-59.73E	4619.0	499.1	-	500.5	504.0	STNM096	
STN	97	082120	09:17	09:41	12-00.28N	134-59.88E	4617.0	499.8	-	501.5	505.0	STNM097	
STN	98	082120	12:15	12:38	12-00.09N	134-59.67E	4621.0	501.3	-	502.5	506.0	STNM098	
STN	99	082120	15:15	15:39	12-00.05N	134-59.82E	4616.0	498.3	-	500.5	504.0	STNM099	
STN	100	082120	18:15	18:39	11-59.99N	134-59.81E	4615.0	500.7	-	502.5	506.0	STNM100	
STN	101	082120	21:15	21:39	11-59.91N	134-59.75E	4621.0	500.0	-	501.5	505.0	STNM101	

STN	102	082220	00:15	01:11	11-59.82N	134-59.97E	4616.0	1002.4	-	1000.8	1009.0	STNM102	
STN	105	082220	12:17	12:39	12-00.12N	134-59.79E	4622.0	500.6	-	502.5	506.0	STNM105	
STN	106	082220	15:15	15:39	11-59.93N	134-59.72E	4626.0	500.2	-	500.5	504.0	STNM106	
STN	107	082220	18:15	18:42	12-00.06N	134-59.91E	4611.0	500.9	-	501.5	505.0	STNM107	
STN	108	082220	21:14	21:38	12-00.00N	135-00.08E	4612.0	499.4	-	501.5	505.0	STNM108	
STN	109	082320	00:14	01:09	11-59.97N	134-59.79E	4628.0	1010.5	-	1000.8	1009.0	STNM109	
STN	110	082320	03:14	03:40	11-59.89N	134-59.97E	4611.0	500.4	-	502.5	506.0	STNM110	
STN	111	082320	06:14	06:38	11-59.92N	134-59.77E	4620.0	502.2	-	500.5	504.0	STNM111	
STN	112	082320	09:15	09:38	12-00.09N	134-59.59E	4618.0	499.6	-	501.5	505.0	STNM112	
STN	113	082320	12:15	12:38	11-59.95N	134-59.84E	4615.0	498.7	-	500.5	504.0	STNM113	
STN	114	082320	15:14	15:37	12-00.02N	134-59.78E	4622.0	500.6	-	500.5	504.0	STNM114	
STN	115	082320	18:14	18:38	11-59.81N	134-59.79E	4620.0	501.3	-	501.5	505.0	STNM115	
STN	116	082320	21:17	21:40	12-00.04N	134-59.96E	4613.0	499.4	-	501.5	505.0	STNM116	
STN	117	082420	00:15	01:11	12-00.13N	134-59.87E	4615.0	1000.6	-	999.8	1008.0	STNM117	
STN	118	082420	03:13	03:35	12-00.01N	134-59.58E	4620.0	497.4	-	499.5	503.0	STNM118	
STN	119	082420	06:15	06:38	11-59.79N	134-59.53E	4619.0	500.2	-	500.5	504.0	STNM119	
STN	120	082420	09:14	09:37	12-00.27N	134-59.53E	4620.0	500.4	-	500.5	504.0	STNM120	
STN	121	082420	12:16	12:38	11-59.82N	134-59.98E	4613.0	500.2	-	502.5	506.0	STNM121	
STN	122	082420	15:14	15:37	12-00.34N	134-59.91E	4618.0	499.8	-	500.5	504.0	STNM122	
STN	123	082420	18:17	18:40	11-59.93N	134-59.61E	4618.0	499.6	-	500.5	504.0	STNM123	
STN	124	082420	21:17	21:41	12-00.23N	134-59.98E	4613.0	500.0	-	500.5	504.0	STNM124	
STN	125	082520	00:15	01:12	12-00.12N	134-59.91E	4618.0	1004.8	-	1000.8	1009.0	STNM125	
STN	126	082520	03:14	03:36	12-00.02N	134-59.84E	4616.0	499.1	-	500.5	504.0	STNM126	
STN	127	082520	06:14	06:36	11-59.88N	134-59.83E	4615.0	500.0	-	500.5	504.0	STNM127	
STN	128	082520	09:21	09:44	12-01.20N	134-59.78E	4623.0	498.3	-	501.5	505.0	STNM128	
STN	129	082520	12:15	12:37	12-00.90N	134-59.71E	4628.0	499.3	-	502.5	506.0	STNM129	
STN	130	082520	15:15	15:38	12-00.34N	134-59.93E	4618.0	500.0	-	502.5	506.0	STNM130	
STN	131	082520	18:18	18:41	12-00.23N	134-59.93E	4617.0	499.4	-	500.5	504.0	STNM131	
STN	132	082520	21:16	21:41	11-59.68N	135-00.57E	4577.0	499.6	-	502.5	506.0	STNM132	
STN	133	082620	00:15	01:11	12-00.00N	134-59.88E	4617.0	1002.6	-	1000.8	1009.0	STNM133	
STN	134	082620	03:14	03:37	11-59.99N	134-59.66E	4620.0	498.9	-	500.5	504.0	STNM134	
STN	135	082620	06:14	06:37	11-59.75N	134-59.80E	4618.0	500.4	-	502.5	506.0	STNM135	
STN	136	082620	09:13	09:36	11-59.89N	134-59.22E	4620.0	497.1	-	500.5	504.0	STNM136	
STN	137	082620	12:14	12:37	12-00.01N	135-00.02E	4612.0	497.6	-	500.5	504.0	STNM137	
STN	138	082620	15:14	15:38	12-00.26N	135-00.13E	4613.0	499.8	-	501.5	505.0	STNM138	
STN	139	082620	18:17	18:40	12-00.51N	134-59.79E	4622.0	499.3	-	500.5	504.0	STNM139	

STN	140	082620	21:16	21:39	12-00.13N	135-00.12E	4608.0	500.7	-	501.5	505.0	STNM140	
STN	141	082720	00:14	01:10	11-59.97N	135-00.09E	4613.0	999.4	-	1000.8	1009.0	STNM141	
STN	142	082720	03:15	03:37	12-00.10N	134-59.99E	4614.0	495.6	-	500.5	504.0	STNM142	
STN	143	082720	06:14	06:36	11-59.92N	135-00.10E	4608.0	497.4	-	500.5	504.0	STNM143	
STN	144	082720	09:13	09:36	11-59.98N	135-00.02E	4611.0	497.2	-	501.5	505.0	STNM144	
STN	145	082720	12:14	12:37	12-00.03N	134-59.76E	4618.0	499.1	-	501.5	505.0	STNM145	
STN	146	082720	15:14	15:37	12-00.22N	135-00.08E	4614.0	498.2	-	500.5	504.0	STNM146	
STN	147	082720	18:17	18:41	12-00.11N	135-00.01E	4614.0	499.8	-	500.5	504.0	STNM147	
STN	148	082720	21:15	21:38	11-59.94N	135-00.02E	4607.0	499.6	-	501.5	505.0	STNM148	
STN	149	082820	00:15	01:10	11-59.97N	134-59.88E	4620.0	1000.4	-	1000.8	1009.0	STNM149	
STN	150	082820	03:15	03:38	11-59.54N	135-00.01E	4623.0	503.7	-	500.5	504.0	STNM150	
STN	151	082820	06:13	06:36	11-59.82N	135-00.04E	4604.0	497.8	-	500.5	504.0	STNM151	
STN	152	082820	09:13	09:35	12-00.02N	134-59.57E	4621.0	497.4	-	501.5	505.0	STNM152	
STN	153	082820	12:14	12:36	11-59.75N	134-58.44E	4602.0	498.5	-	500.5	504.0	STNM153	
STN	154	082820	15:14	15:38	11-59.30N	134-59.05E	4613.0	499.4	-	501.5	505.0	STNM154	
STN	155	082820	18:17	18:40	12-00.60N	135-00.98E	4562.0	496.7	-	500.5	504.0	STNM155	
STN	156	082820	21:14	21:38	11-59.92N	135-00.14E	4602.0	498.7	-	502.5	506.0	STNM156	
STN	157	082920	00:15	01:10	11-59.97N	135-00.04E	4611.0	999.8	-	1001.8	1010.0	STNM157	
STN	158	082920	03:14	03:36	11-59.98N	134-59.88E	4617.0	497.8	-	502.5	506.0	STNM158	
STN	159	082920	06:15	06:37	11-59.99N	135-00.07E	4611.0	496.3	-	500.5	504.0	STNM159	
STN	160	082920	09:13	09:37	12-00.15N	135-00.00E	4612.0	497.4	-	501.5	505.0	STNM160	
STN	161	082920	12:14	12:37	12-00.00N	135-00.05E	4607.0	498.3	-	501.5	505.0	STNM161	
STN	162	082920	15:14	15:38	12-00.10N	135-00.02E	4615.0	497.6	-	501.5	505.0	STNM162	
STN	163	082920	18:17	18:41	12-00.26N	135-00.14E	4612.0	499.6	-	502.5	506.0	STNM163	
STN	164	082920	21:15	21:41	12-00.00N	135-00.05E	4615.0	497.4	-	500.5	504.0	STNM164	
STN	165	083020	00:15	01:11	12-00.00N	135-00.13E	4609.0	999.1	-	1000.8	1009.0	STNM165	
STN	166	083020	03:17	03:39	12-00.01N	135-00.19E	4597.0	496.3	-	500.5	504.0	STNM166	
STN	167	083020	06:15	06:39	11-59.89N	135-00.06E	4609.0	496.0	-	500.5	504.0	STNM167	
STN	168	083020	09:14	09:37	11-59.90N	135-00.09E	4608.0	496.1	-	501.5	505.0	STNM168	
STN	169	083020	12:14	12:38	11-59.57N	135-00.06E	4613.0	496.9	-	500.5	504.0	STNM169	
STN	170	083020	15:14	15:38	12-00.29N	134-59.95E	4616.0	497.4	-	501.5	505.0	STNM170	
STN	171	083020	18:17	18:41	12-00.02N	134-59.93E	4618.0	496.9	-	500.5	504.0	STNM171	
STN	172	083020	21:15	21:37	12-00.07N	135-00.15E	4605.0	498.5	-	501.5	505.0	STNM172	
STN	173	083120	00:16	01:17	12-00.05N	134-59.89E	4615.0	1000.4	-	1001.8	1010.0	STNM173	
STN	174	083120	03:14	03:37	12-00.00N	134-59.90E	4613.0	497.1	-	500.5	504.0	STNM174	
STN	175	083120	06:15	06:38	11-59.99N	135-00.16E	4600.0	496.0	-	500.5	504.0	STNM175	

STN	176	083120	09:13	09:36	12-00.29N	134-59.93E	4618.0	498.5	-	501.5	505.0	STNM176	
STN	177	083120	12:15	12:38	12-00.23N	134-59.76E	4621.0	496.3	-	500.5	504.0	STNM177	
STN	178	083120	15:14	15:37	12-00.30N	134-59.83E	4622.0	498.9	-	501.5	505.0	STNM178	
STN	179	083120	18:18	18:41	12-00.40N	134-59.72E	4621.0	500.0	-	500.5	504.0	STNM179	
STN	180	083120	21:15	21:38	12-00.13N	135-00.05E	4613.0	499.4	-	501.5	505.0	STNM180	
STN	181	090120	00:16	01:13	11-59.75N	134-59.18E	4617.0	999.6	-	1000.8	1009.0	STNM181	
STN	182	090120	03:15	03:38	12-00.11N	135-00.12E	4613.0	499.3	-	500.5	504.0	STNM182	
STN	183	090120	06:14	06:36	12-00.20N	135-00.18E	4609.0	498.5	-	500.5	504.0	STNM183	
STN	184	090120	09:14	09:36	12-00.24N	135-00.24E	4604.0	499.4	-	501.5	505.0	STNM184	
STN	185	090120	12:15	12:38	12-00.26N	135-00.07E	4612.0	499.6	-	500.5	504.0	STNM185	
STN	186	090120	15:14	15:37	12-00.10N	134-59.94E	4616.0	500.0	-	500.5	504.0	STNM186	
STN	187	090120	18:17	18:39	12-00.06N	134-59.86E	4619.0	497.1	-	500.5	504.0	STNM187	
STN	188	090120	21:15	21:38	12-00.06N	134-59.92E	4622.0	502.8	-	502.5	506.0	STNM188	
STN	189	090220	00:14	01:10	12-00.00N	135-00.08E	4608.0	999.6	-	1000.8	1009.0	STNM189	
STN	190	090220	03:14	03:36	11-59.52N	134-58.50E	4598.0	497.8	-	500.5	504.0	STNM190	
STN	192	090220	12:15	12:37	12-00.15N	134-59.94E	4613.0	498.9	-	500.5	504.0	STNM192	
STN	193	090220	15:14	15:37	12-00.05N	134-59.82E	4615.0	500.9	-	500.5	504.0	STNM193	
STN	194	090220	18:17	18:40	12-00.05N	134-59.65E	4628.0	499.6	-	500.5	504.0	STNM194	
STN	195	090220	21:15	21:38	11-59.90N	134-59.46E	4621.0	500.2	-	500.5	504.0	STNM195	
STN	196	090320	00:16	01:12	12-00.04N	134-59.87E	4614.0	1000.2	-	1000.8	1009.0	STNM196	
STN	197	090320	03:14	03:36	11-59.99N	135-00.03E	4612.0	499.4	-	500.5	504.0	STNM197	
STN	198	090320	06:13	06:35	11-59.97N	135-00.10E	4608.0	498.9	-	500.5	504.0	STNM198	
STN	199	090320	09:14	09:36	11-59.90N	135-00.02E	4621.0	497.6	-	501.5	505.0	STNM199	
STN	200	090320	12:15	12:37	12-00.12N	135-00.11E	4609.0	498.5	-	501.5	505.0	STNM200	
STN	207	090420	09:14	09:37	12-00.04N	135-00.15E	4601.0	499.6	-	502.5	506.0	STNM207	
STN	208	090420	12:14	12:37	12-00.20N	135-00.39E	4595.0	499.1	-	501.5	505.0	STNM208	
STN	209	090420	15:16	15:39	12-00.08N	135-00.02E	4615.0	499.3	-	501.5	505.0	STNM209	
STN	210	090420	18:17	18:40	12-00.07N	134-59.90E	4616.0	499.8	-	501.5	505.0	STNM210	
STN	211	090420	21:15	21:39	11-59.89N	135-00.09E	4600.0	502.0	-	502.5	506.0	STNM211	
STN	212	090520	00:14	01:10	11-59.89N	134-59.78E	4620.0	1001.3	-	1001.8	1010.0	STNM212	
STN	213	090520	03:14	03:36	11-59.98N	134-59.89E	4615.0	498.7	-	500.5	504.0	STNM213	
STN	214	090520	06:13	06:36	12-00.03N	134-59.79E	4622.0	498.9	-	500.5	504.0	STNM214	
STN	215	090520	09:13	09:36	12-00.15N	134-59.91E	4614.0	498.0	-	500.5	504.0	STNM215	
STN	216	090520	12:14	12:37	12-00.02N	134-59.97E	4614.0	499.8	-	502.5	506.0	STNM216	
STN	217	090520	15:14	15:36	12-00.06N	134-59.94E	4616.0	498.3	-	501.5	505.0	STNM217	
STN	218	090520	18:16	18:39	11-59.90N	134-59.94E	4611.0	499.1	-	500.5	504.0	STNM218	

STN	219	090520	21:15	21:38	11-59.95N	134-59.97E	4611.0	500.6	-	502.5	506.0	STNM219	
STN	220	090620	00:14	01:10	11-59.74N	134-59.81E	4619.0	1000.0	-	1000.8	1009.0	STNM220	
STN	221	090620	03:13	03:37	11-59.67N	134-58.75E	4606.0	499.8	-	500.5	504.0	STNM221	
STN	222	090620	06:16	06:38	11-59.85N	134-58.63E	4607.0	497.1	-	500.5	504.0	STNM222	
STN	223	090620	09:13	09:35	12-00.04N	135-00.03E	4617.0	498.0	-	502.5	506.0	STNM223	
STN	224	090620	12:15	12:39	12-00.10N	134-59.86E	4615.0	498.9	-	500.5	504.0	STNM224	
STN	225	090620	15:15	15:37	12-00.05N	134-59.91E	4621.0	500.4	-	501.5	505.0	STNM225	
STN	226	090620	18:18	18:40	11-59.98N	135-00.00E	4611.0	499.4	-	500.5	504.0	STNM226	
STN	227	090620	21:16	21:40	11-59.90N	135-00.02E	4608.0	499.4	-	502.5	506.0	STNM227	
STN	228	090720	00:15	01:11	12-00.10N	135-00.00E	4611.0	1001.1	-	1000.8	1009.0	STNM228	
STN	229	090720	03:15	03:38	11-58.61N	134-59.51E	4631.0	500.9	-	500.5	504.0	STNM229	
C04	10	090720	21:08	21:31	11-37.68N	134-55.96E	4099.0	501.1	-	502.5	506.0	C04M010	m-TRITON Rec.

5.16 LADCP

(1) Personnel

Satoru YOKOI	(JAMSTEC)	*Principal investigator
Masanori ENOKI	(MWJ)	*Operation leader
Rei ITO	(MWJ)	
Tun Htet Aung	(MWJ)	
Akira WATANABE	(MWJ)	
Masaki YAMADA	(MWJ)	
Keita HAYASHI	(MWJ)	
Daiki KAWATA	(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 (WHS600-I-UG177, S/N 14557) rated for 1000m depth.

The instrument was attached to the frame of the CTD system using a mount sealed around the instrument and the CTD frame by two bolts on two mounting points (see Figure 5.16-1).

The instrument was self-contained with an internal battery pack. The health of the battery was monitored by the recorded voltage count.

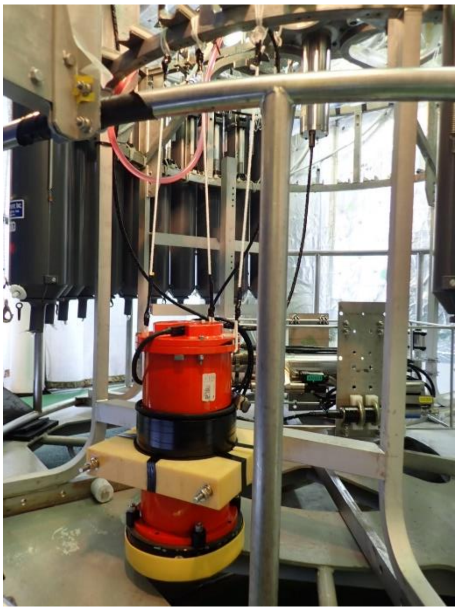


Figure 5.16-1:Mounting of LADCP on CTD System

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.txt. The full list of commands sent to the instrument were:

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.)

(4) Preliminary results

During the cruise, 224 profiles were obtained in total. All the data has to be converted and quality-controlled before the analyses. The further analyses will be in near future.

(5) 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>

5.17 RINKO Profiler

(1) Personnel

Satoru YOKOI	(JAMSTEC)	- Principal Investigator
Masaki KATSUMATA	(JAMSTEC)	
Masanori ENOKI	(MWJ)	
Masaki YAMADA	(MWJ)	
Rei ITO	(MWJ)	

(2) Objectives

To measure vertical profiles of temperature, salinity, etc., in the ocean near-surface layer, the layer from the surface down to typically 10 m depth.

(3) Methods

We used the RINKO Profiler manufactured by JFE Advantech, which weighs 1 kg in the water. The instrument is equipped with sensors for depth, temperature, conductivity, chlorophyll-a, turbidity, and dissolved oxygen. The specification of the sensors is shown in Table 5.17-1. It is pressure-resistant down to 600 meters.

We tied the instrument to the rope of approximately 25 meters in length, and slowly lowered it by hand from the middle of the starboard side of upper deck of the vessel (so-called “muster pad”) down to 15 meters in depth. We performed the measurement just after deployment of an ARGO float (21N, 135E) (C01M001), after the deployment of the m-TRITON mooring (C04M002 – C04M009), just after the recovery of the surface drifters (DBRM001 – DBRM004), and at the station point (STNM001 – STNM231). In total, there are 244 casts. The data interval was set as every 0.1 meter (C01M001, C04M002 – C04M009, and STNM001 – STNM032), or every 0.2 second (DBRM001 – DBRM004 and STNM033 – STNM231). When we lowered it, the vessel was maneuvered to try not to disturb the environmental water. In particular, the bow thruster was suspended from 10 minutes before the measurement if possible.

In addition, we attached the instrument to the CTD frame (Section 5.) at 2 CTD casts (C04M001 and C04M010) to estimate the difference from the precise measurements in the CTD system. On that measurement, we set the data interval as every 1 meter.

(4) Preliminary Results

Figure 5.17-1 is a preliminary result of the measurement, showing time-depth cross section of temperature and salinity profiles from 0000 UTC 14 August to 1200 UTC 7 September 2020, from the surface to 12-meter depth, at the station point (STNM039 – STNM231).

(5) Data archive

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

Table 5.17-1: The specification of the sensors in RINKO Profiler, as described in the instruction manual.

Parameter	Range	Resolution	Precision	Response
Depth	0 to 600 m	0.01 m	± 0.3 %	0.2 s
Temperature	-3 to 45 ℃	0.001 ℃	± 0.01 ℃	0.2 s
Conductivity	0.5 to 70 mS/cm	0.001 mS/cm	± 0.01 mS/cm	0.2 s
(Salinity)	2 to 42 PSU	0.001 PSU	(not described)	0.2 s
Turbidity	0 to 1000 FTU	0.03 FTU	± 0.3 FTU	0.2 s
Chlorophyll	0 to 400 ppb	0.01 ppb	± 1 % FS	0.2 s
Dissolved oxygen	0 to 20 mg/l	0.001 mg/l	± 2 % FS	0.4 s

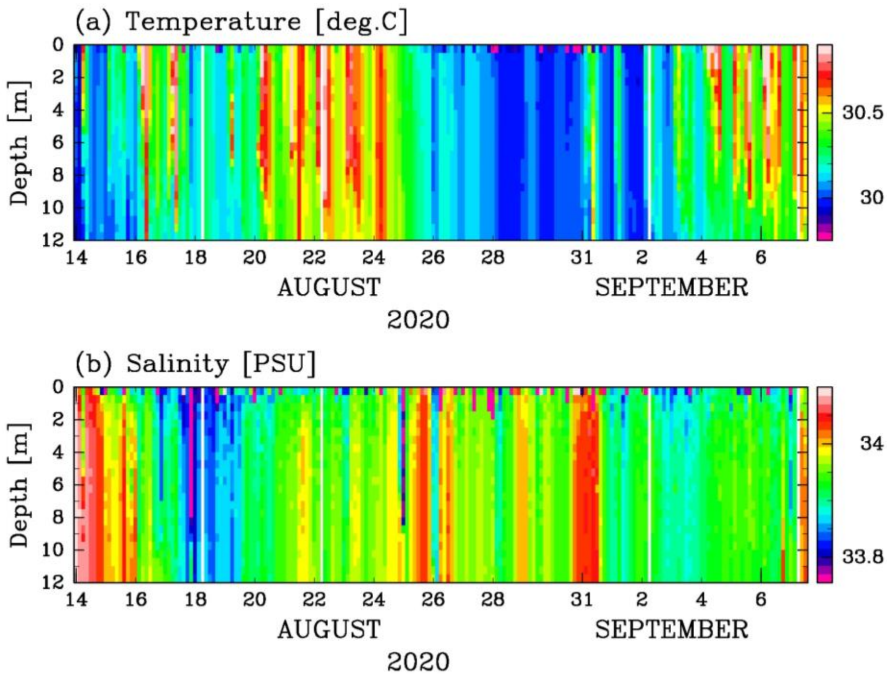


Fig. 5.17-1: Time-depth cross section of observed (a) temperature and (b) salinity profiles from 0000 UTC 14 August to 1200 UTC 7 September 2020 at the station point.

5.18 Salinity of sampled water

(1) Personnel

Satoru Yokoi	(JAMSTEC)	- Principal Investigator
Rei Ito	(MWJ)	- Operation Leader
Katsunori Sagishima	(MWJ)	

(2) Objective

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

(3) Method

a. Salinity Sample Collection

Seawater samples were collected with 12 liter sample 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 5.18.1 Kind and number of samples

Kind of Samples	Number of Samples
Samples for CTD	94
Samples for TSG	39
Total	133

b. Instruments and Method

The salinity analysis was carried out on R/V MIRAI during the cruise of MR20-E01 using the salinometer (Model 8400B “AUTOSAL” ; Guildline Instruments Ltd.: S/N 72874) with an additional peristaltic-type intake pump (Ocean Scientific International, Ltd.). A pair of precision digital thermometers (1502A; FLUKE: S/N B78466 and B81550) 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 (1502A: FLUKE)

Measurement Range	:	16 to 30 deg C
Resolution	:	0.001
Accuracy	:	0.006 deg C (@ 0 deg C)

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 531 and all measurements were done at this setting. The value of STANDBY was 24+5989 ~ 5993 and that of ZERO was 0.0 - 0002. The conductivity ratio of IAPSO Standard Seawater batch P163 was 0.99985 (double conductivity ratio was 1.99970) and was used as the standard for salinity. 12 bottles of P163 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 0.00003 which is equivalent to 0.0006 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 0.0002 in salinity.

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

batch	:	P163
conductivity ratio	:	0.99985
salinity	:	34.994
use by	:	10^{th} Apr. 2022

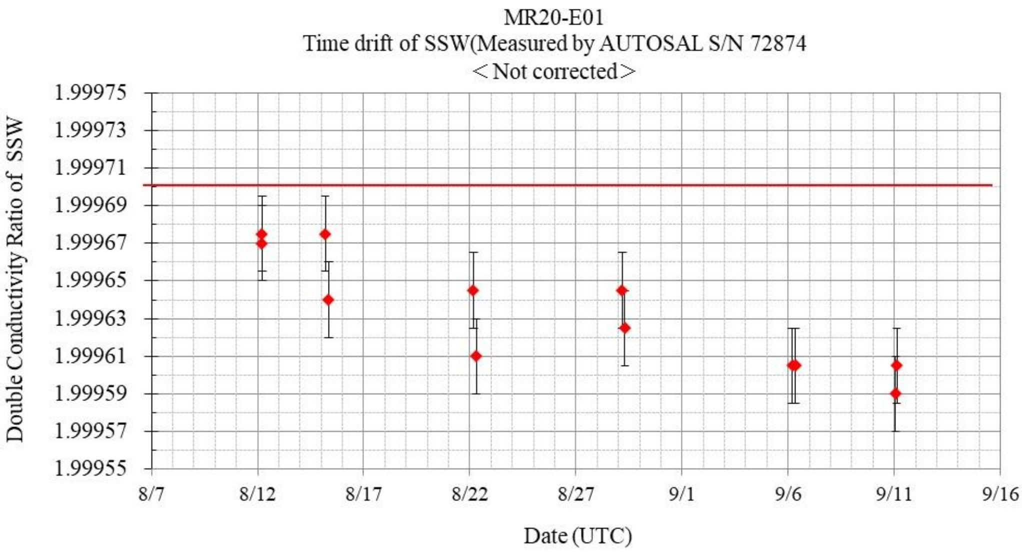


Fig. 5.14-1: Time series of double conductivity ratio for the Standard Seawater batch P163 (before correction)

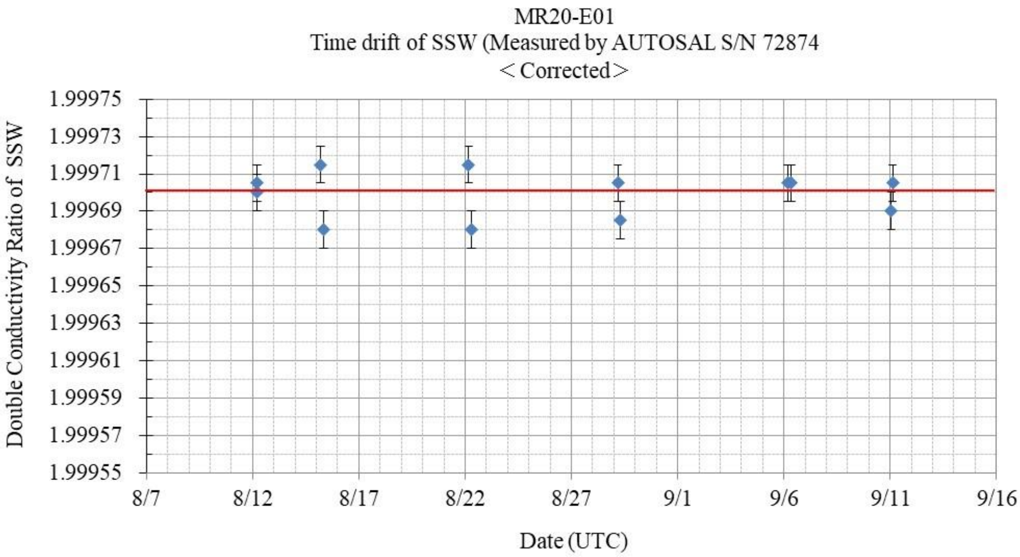


Fig. 5.14-2: Time series of double conductivity ratio for the Standard Seawater batch P163 (after correction)

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 33 pairs of replicate samples taken from the same sample bottle. The average and the standard deviation of absolute difference among 39 pairs of replicate samples were 0.00060 and 0.00059 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

5.19. Dissolved oxygen of sampled water

(1) Personnel

Satoru YOKOI	(JAMSTEC)	- Principal Investigator
Katsunori SAGISHIMA	(MWJ)	- Operation Leader
Shiori ARIGA	(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-620) manufactured by Kyoto Electronics Manufacturing Co., Ltd. / 10 cm^3 of titration vessel

Detector;

Automatic photometric titrator (DOT-15X) 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 dm^{-3})

c. Sampling

Seawater samples were collected with 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.

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. 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 7.6×10^{-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 5.19-1 shows results of the standardization and the blank determination during this cruise.

Table 5.19-1 Results of the standardization and the blank determinations during cruise

Date (yyyy/mm/dd)	Potassium iodate ID	Sodium thiosulfate ID	DOT-01X (No.9)		Stations
			E.P. (cm^3)	Blank (cm^3)	
2020/08/03	K20A01	T-20A	3.931	-0.001	
2020/08/04	K20A02	T-20A	3.950	0.001	Station, STN Cast: 007, 015, 023, 031, 039
2020/08/15	K20A04	T-20A	3.950	0.001	Station, STN Cast: 047, 055, 063, 071, 078, 086, 094, 102, 109, 117, 125
2020/08/25	K20A03	T-20A	3.949	0.001	Station, STN Cast: 133, 141, 149, 157, 165
2020/08/31	K20A05	T-20A	3.954	0.000	Station, STN Cast: 173
2020/09/01	K20A06	T-20A	3.952	0.002	
2020/09/01	K20A06	T20-B	3.958	-0.001	Station, STN Cast: 181, 189, 196, 212, 220, 228
2020/09/12	K20A07	T20-B	3.958	0.004	

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 0.10 μmol kg^{-1} (n=58).

(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>

(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.

5.20. Chlorophyll *a* of sampled water

(1) Personnel

Satoru YOKOI	(JAMSTEC)	- Principal Investigator
Katsunori SAGISHIMA	(MWJ)	- Operation leader
Saori ARIGA	(MWJ)	

(2) Objective

We measured total chlorophyll *a* in seawater by using the fluorometric method.

(3) Parameters

Total chlorophyll *a*

(4) Instruments and methods

We collected samples for total chlorophyll *a* from 10 depths between the surface and 300 m depth including a chlorophyll *a* maximum layer. The chlorophyll *a* maximum layer was determined by a Chlorophyll Fluorometer attached to the CTD system.

Seawater samples for total chlorophyll *a* were vacuum-filtrated (< 0.02 MPa) through Whatman GF/F filter (25mm-in diameter). 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.) (Suzuki and Ishimaru, 1990). The tubes were stored at -20 °C under the dark condition to extract chlorophyll *a* at least for 24 hours.

Chlorophyll *a* concentrations were measured by the fluorometer (10-AU, TURNER DESIGNS), which was previously calibrated against a pure chlorophyll *a* (Sigma-Aldrich Co., LLC). To estimate the chlorophyll *a* concentrations, we applied to the fluorometric “Non-acidification method” (Welschmeyer, 1994).

(5) Preliminary results

At each station, water samples were taken in replicate for water of chlorophyll *a* maximum layer. Results of replicate samples were shown in table 5.20-1.

(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>

(7) Reference

Suzuki, R., & Ishimaru T. (1990). An improved method for the determination of phytoplankton chlorophyll

using N, N-dimethylformamide. *J. Oceanogr. Soc. Japan*, 46, 190-194.
Welschmeyer, N. A. (1994). Fluorometric analysis of chlorophyll *a* in the presence of chlorophyll *b* and pheopigments. *Limnol. Oceanogr.* 39(8), 1985-1992.

Table 5.20-1. Results of the replicate sample measurements.

	All samples
Number of replicate sample pairs	28
Standard deviation ($\mu g\ L^{-1}$)	0.01

5.21 Shipboard ADCP

(1) Personnel

Satoru YOKOI	(JAMSTEC)	- Principal Investigator
Kazuho YOSHIDA	(NME)	- Operation Leader
Yutaro MURAKAMI	(NME)	
Satomi OGAWA	(NME)	
Yoichi INOUE	(MIRAI Crew)	

(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 1.49 (TRDI) for data acquisition.
5. To synchronize time stamp of ping with Computer time, the clock of the logging computer is adjusted to GNSS 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, 15 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 5.21-1.

Table 5.21-1: 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.5.21-1 shows the time series plot of vertical profile of easting and northing current velosity at the station point (near 12N135E).

(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 >

(7) Remarks

1. In this cruise, N1R files sometimes contain NMEA sentences delayed in several seconds a day due to GNSS system output delay.

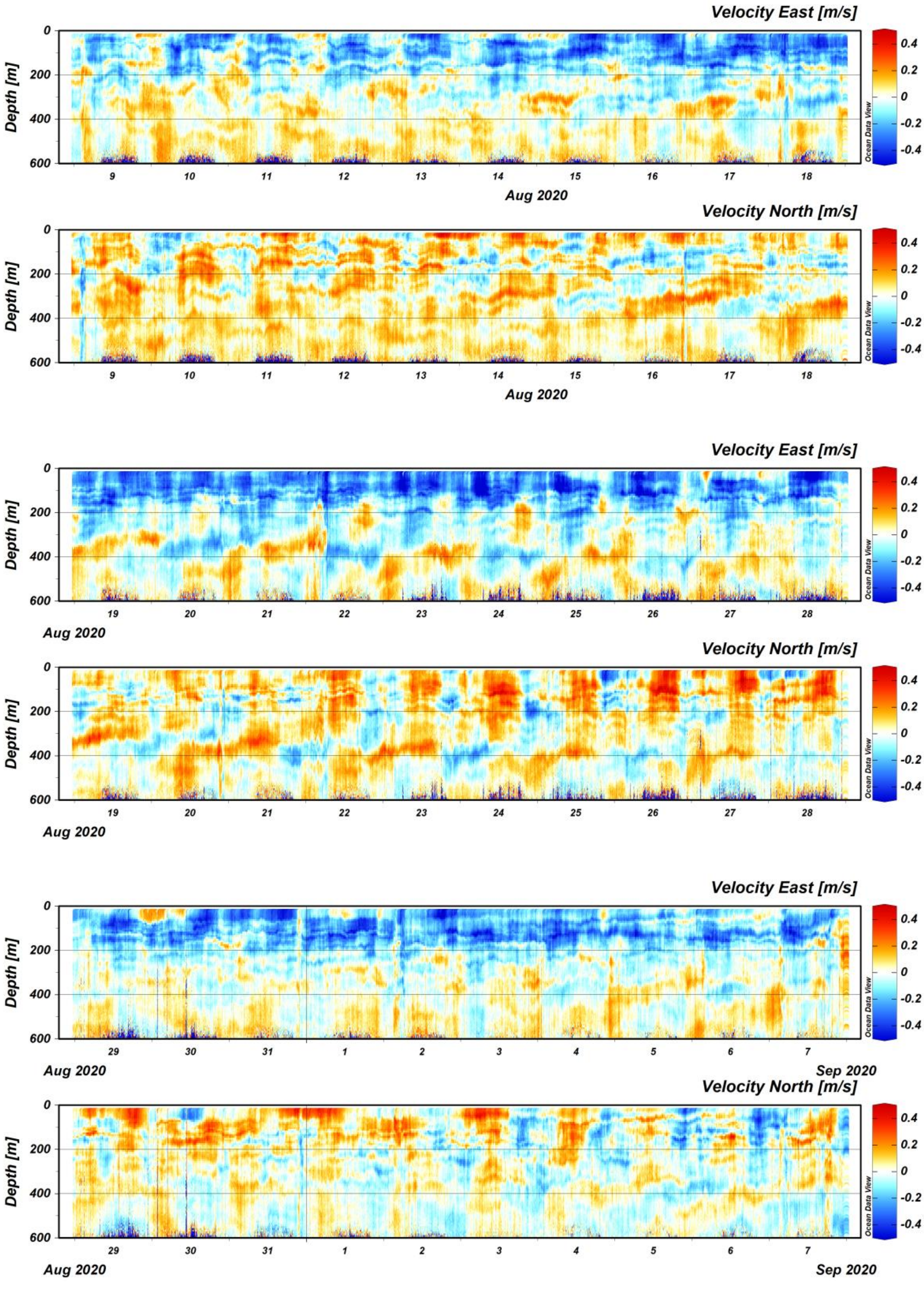


Fig. 5.21-1 current velocity time series at the station point (near 12N135E).

5.22 XCTD

(1) Personnel

Satoru YOKOI	(JAMSTEC)	- Principal Investigator
Kazuho YOSHIDA	(NME)	- Operation Leader
Yutaro MURAKAMI	(NME)	
Satomi OGAWA	(NME)	
Yoichi INOUE	(MIRAI Crew)	

(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.1.1.5; Tsurumi-Seiki Co). The specifications of the measured parameters are as in Table 5.22-1. We launched probes by using automatic launcher during MR20-E01 cruise as listed in Table 5.22-2.

Table 5.22-1: 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 5.22-2: List of XCTD observations. SST (sea surface temperature) and SSS (sea surface salinity).

No.	Date [UTC]	Time [UTC]	Latitude [dd-mm.mmmm N]	Longitude [ddd-mm.mmmm E]	SST [deg-C]	SSS [PSU]	Probe S/N
01	2020/08/17	06:37	12-00.0057	135-00.1832	30.812	33.872	20025871
02	2020/08/18	06:00	11-59.0164	134-47.3700	30.288	33.791	20025873
03	2020/08/18	09:08	12-00.1348	135-00.0320	30.282	33.801	20025872
04	2020/08/22	03:04	11-58.9530	134-58.9338	30.748	33.907	20025874
05	2020/08/22	05:59	11-49.0750	134-41.3570	30.964	33.874	20025876
06	2020/08/22	09:08	12-00.3115	134-59.8979	30.937	33.892	20025875
07	2020/09/02	06:00	11-58.8286	134-42.1385	30.602	33.926	20025878
08	2020/09/02	09:06	11-59.9890	134-59.6263	30.296	33.879	20025877
09	2020/09/03	15:07	11-59.8910	134-59.9849	30.332	33.831	20025884
10	2020/09/03	18:08	11-59.6165	134-59.6062	30.235	33.829	20025885
11	2020/09/03	21:05	11-59.7670	134-59.8713	30.149	33.839	20025879
12	2020/09/04	00:04	11-58.4155	135-00.7784	30.172	33.844	20025880
13	2020/09/04	03:06	11-58.6888	134-58.8680	30.331	33.846	20025883
14	2020/09/04	06:05	11-59.7584	134-59.8894	30.441	33.861	20025881
15	2020/09/07	05:59	11-58.1965	134-57.0870	30.933	33.827	20025886
16	2020/09/07	09:07	12-00.0176	134-59.8762	30.687	33.953	20025882
17	2020/09/07	12:08	12-00.0055	134-59.7887	30.646	33.908	20025887

5.23 ARGO float

(1) Personnel

Satoru YOKOI	(JAMSTEC)	- Principal Investigator
Ayako SEIKI	(JAMSTEC)	(not on board)
Masanori ENOKI	(MWJ)	
Rei ITO	(MWJ)	

(2) Objectives

The objective of the observation is to measure vertical profiles of sea-water temperature and salinity for investigating oceanic mixed layer structure and air-sea interaction.

(3) Methods

Three APEX profiling floats manufactured by Teledyne Webb Research were deployed on the way from Shimizu to the station observation point. Information of the deployment is summarized in Table 5.23-1. These floats measure vertical profile of sea-water temperature and salinity above 500 dbar at about 1000 UTC (1900 Local Time) every day. Note that the floats are equipped with RBRargo CTD sensor.

(4) Preliminary Results

Figure 5.23-1 shows tracks of the floats, while Fig. 5.23-2 shows time-depth cross section of temperature and salinity up to 19 September 2020.

(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/). 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.

Table 5.23-1: Information of the deployment of the floats.

S/N	WMO number	Date and time (UTC)	Latitude	Longitude
8897	5906385	05:23 UTC, 4 August 2020	21-00N	135-00E
8898	5906386	22:19 UTC, 4 August 2020	18-00N	135-00E
8899	5906387	16:26 UTC, 5 August 2020	15-00N	135-00E

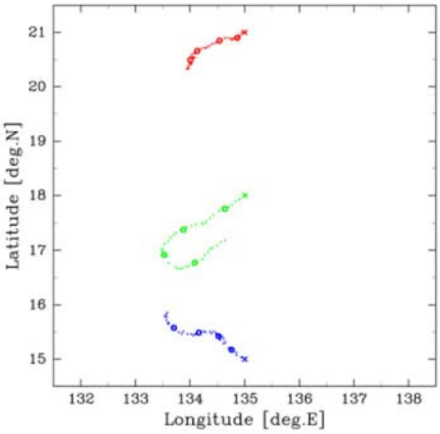


Figure 5.23-1: Tracks of the floats, whose WMO numbers are (red) 5906385, (green) 5906386, and (blue) 5906387. Crosses indicate the location of the deployment, while big circles indicate position of the float on 10, 20, and 30 August, and 10 September 2020.

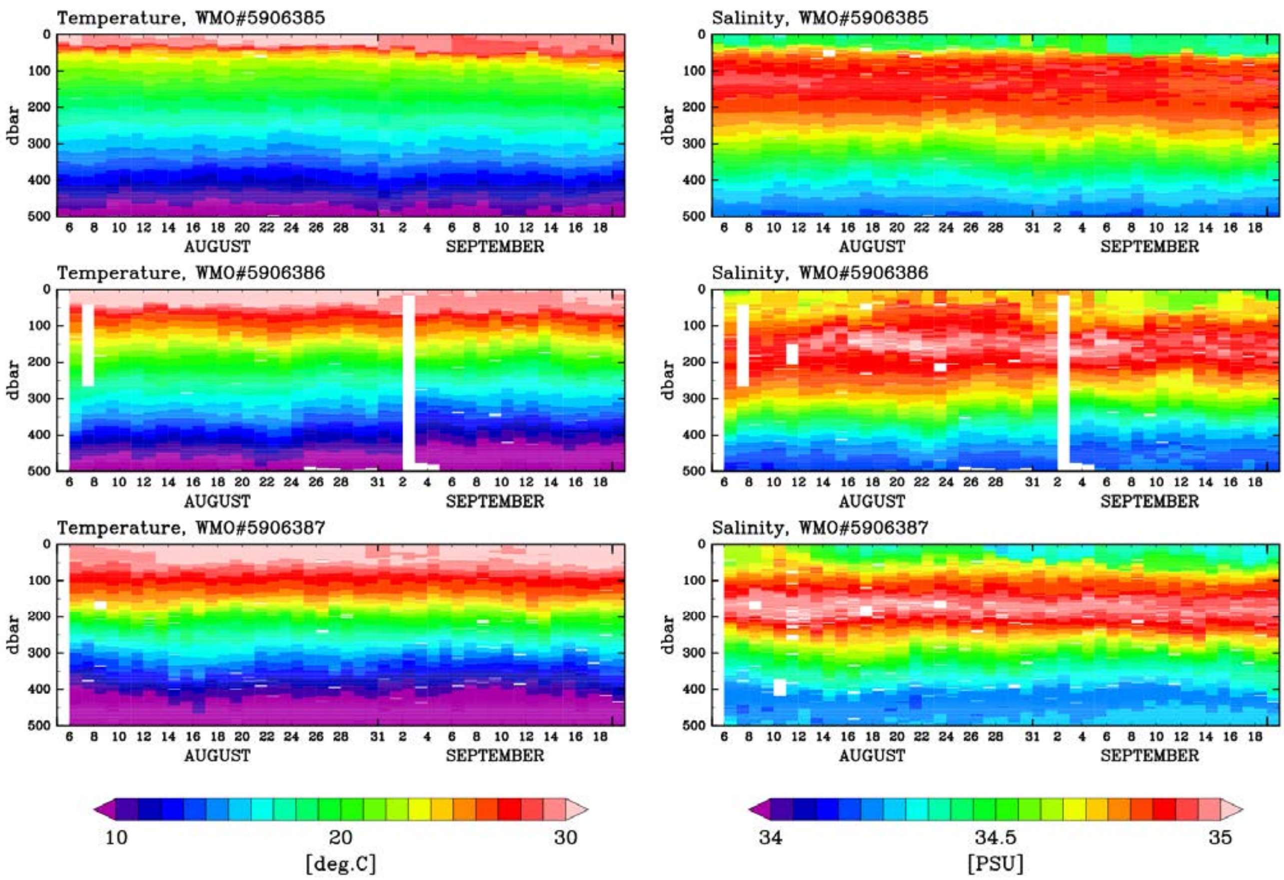


Fig. 5.23-2: Time-depth cross section of (left) temperature and (right) salinity observed by the three floats.

5.24 m-TRITON mooring

(1) Personnel

Kunio YONEYAMA	(JAMSTEC) not on-board
Satoru YOKOI	(JAMSTEC)
Masaki KATSUMATA	(JAMSTEC)
Akira WATANABE	(MWJ): Technical Staff
Masaki YAMADA	(MWJ): Technical Staff
Keita HAYASHI	(MWJ): Technical Staff
Masanori ENOKI	(MWJ): Technical Staff
Rei ITO	(MWJ): Technical Staff
Daiki KAWATA	(MWJ): Technical Staff
Tun Htet Aung	(MWJ): Technical Staff

(2) Objectives

The processes at and near the ocean surface are the key factors in the weather and climate system. The m-TRITON buoy system has been developed to observe the status of sea surface atmosphere as well as in the upper ocean. In this project, we deployed this m-TRITON buoy system for 1-month when the R/V *Mirai* (and Wave Gliders, see Section 5.25) was at the station (12N, 135E), to capture the meso-scale spatiotemporal atmospheric and oceanic variations.

(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,
- precipitable water

Oceanic parameters:
- water temperature and conductivity at
  - 1m,
  - 5m, 10m, 15m, 20m, 25m, 30m, 35m, 40m, 45m, 50m, 55m, 60m, 65m, 70m,
  - 80m, 90m, 100m, 110m, 120m, 130m, 140m, 150m, 160m, 170m, 180m, 190m, 200m,
  - 250m,300m,500m
- pressure at
  - 1m, 25m, 50m, 100m, 150m, 200m, 500m,
- current speed and direction at
  - 10m

(4) Instrument

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

Oceanic sensors

1) CTD and CT (Conductivity-Temperature-Depth meter, Sea Bird Electronics Inc.)

SBE-37 IM MicroCAT

A/D cycles to average :	4
Sampling interval :	600 sec.
Measurement range, Temperature :	-5～+35 deg-C
Measurement range, Conductivity :	0～7 S/m
Measurement range, Pressure :	0～full scale range

2) CRN (Current meter, SonTek)

SonTek Argonaut ADCM

Sensor frequency :	1500 kHz
Sampling interval :	1200 sec.
Average interval :	120 sec.

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 JAMSTEC

Data logger and Thuraya transmitter

1) Data logger

Meteorological sensors are controlled by I/O RS485.

GPS and Inductive modem are controlled by RS232C.

2) Thuraya transmitter

Hourly averaged data are transmitted through Thuraya satellite data transmission system in almost real time.

(5) Locations of m-TRITON buoys deployment and recovered

Nominal location :	11.5N 135E
ID number at JAMSTEC :	96501
Thuraya IMEI number :	35797506-010088-2
ARGOS backup PTT number :	30832
Deployed date :	07 Aug. 2020
Recovered date :	08 Sep. 2020
Exact location :	11°37.6549' N, 134°58.8711' E
Depth :	4,963 m

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

(6) Preliminary results

Hourly data were transmitted to JAMSTEC once a day. Then, initial quality check has been made. Their surface meteorology as well as oceanic profiles are plotted in Figs. 5.24-1 and 5.24-2. The data at the surface well captured, at least qualitatively, characteristics of the atmospheric and oceanic variations such as: Diurnal warming of SST (Fig. 5.24-1 (a)), intermittent drop of air temperature and coincident rise of relative humidity (Figs. 5.24-1 (a) and (b)), sudden drop of salinity ((Fig. 5.24-1 (b)), etc. The gradual deepening of the mixed layer can be also found in the former half of the period, in Fig. 5.24-2.

The full dataset will be retrieved from the data loggers after the cruise. Data evaluation, quality control, and further analyses will be done after the cruise.

(7) Data archive

Quality control will be made at JAMSTEC Mutsu Institute, then data will be archived at JAMSTEC YMC data site at http://www.jamstec.go.jp/ymc/ymc_data.html. In addition, all data will be submitted to JAMSTEC Data Management Group.

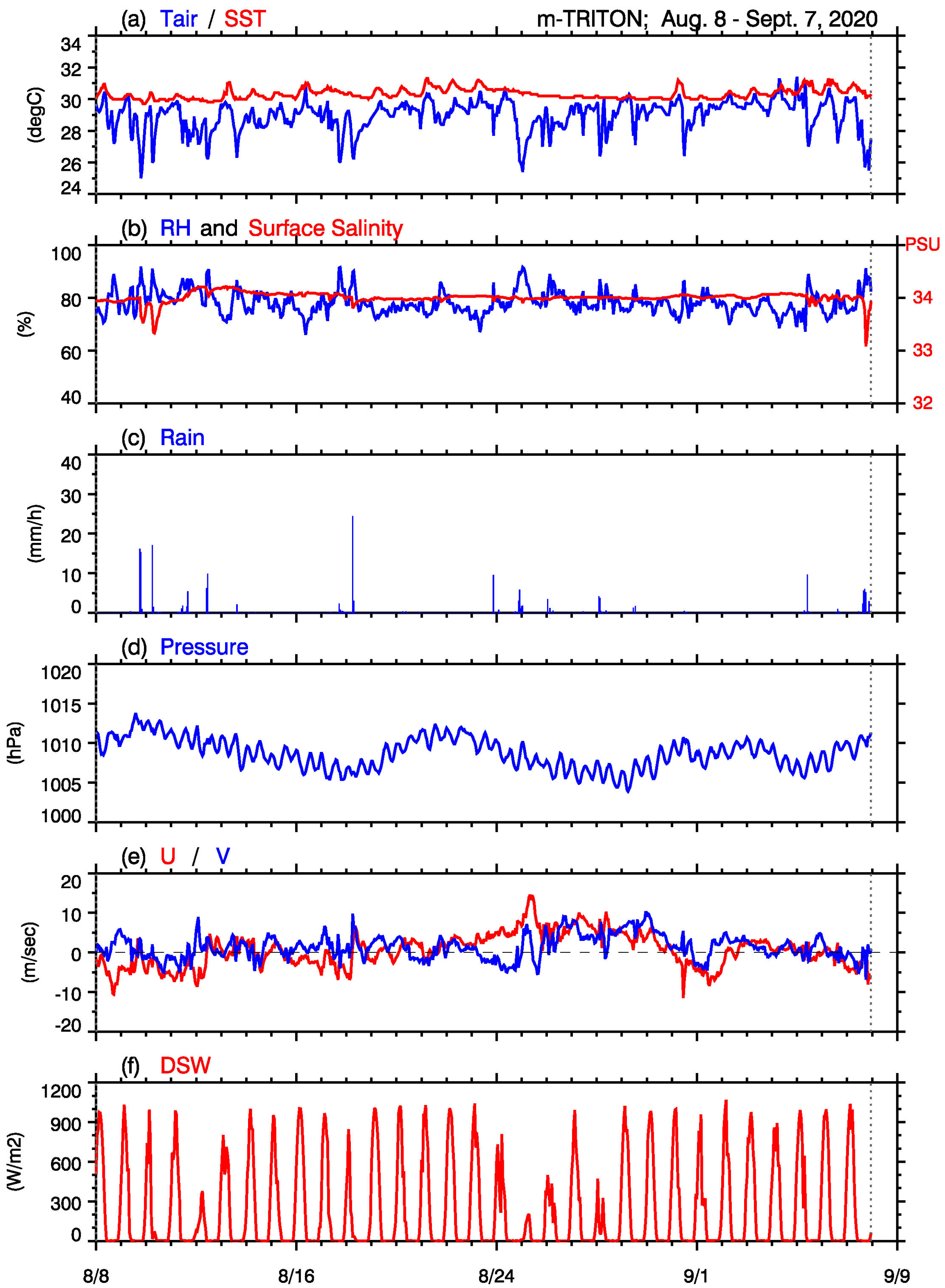


Fig. 5.24-1: Time series of (a) air temperature and sea surface temperature, (b) relative humidity and surface salinity, (c) rain rate, (d) surface pressure, (e) zonal and meridional wind, and (f) short wave radiation.

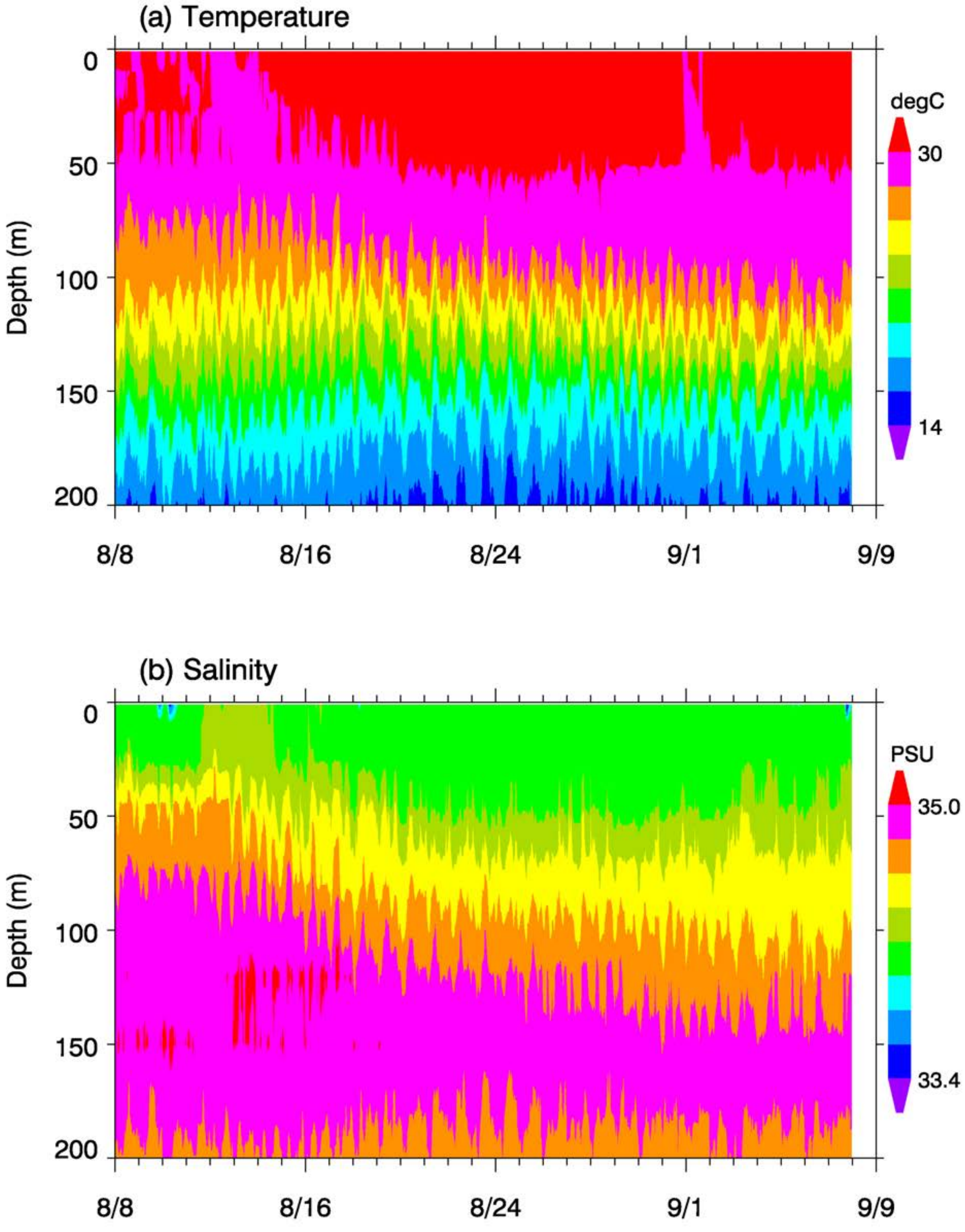


Fig. 5.24-2: Time-depth cross section of (a) sea temperature, and (b) salinity.

5.25 Wave Glider

(1) Personnel

Kunio YONEYAMA	(JAMSTEC)	(not on board)
Satoru YOKOI	(JAMSTEC)	
Mikiko FUJITA	(JAMSTEC)	(not on board)
Masaki KATSUMATA	(JAMSTEC)	
Iwao UEKI	(JAMSTEC)	(not on board)
Tatsuya FUKUDA	(JAMSTEC)	(not on board)
Yasuhisa ISHIHARA	(JAMSTEC)	(not on board)
Akira WATANABE	(MWJ)	
Masaki YAMADA	(MWJ)	
Rei ITO	(MWJ)	
Keita HAYASHI	(MWJ)	
Masanori ENOKI	(MWJ)	
Makito YOKOTA	(MWJ)	(not on board)
Nobuhiro FUJII	(MWJ)	(not on board)
Hiroyuki NAKAJIMA	(MWJ)	(not on board)
Takayuki HASHIMUKAI	(MWJ)	(not on board)
Shino SAKABE	(MWJ)	(not on board)

(2) Objective

The processes at the ocean surface are the key factors in the weather and climate system, through the surface flux (heat, fresh-water, momentum). As a latest successor of the ocean surface platform to observe in-situ surface fluxes, the unmanned ocean-surface vehicle named "Wave Glider" (hereafter WG) has been utilized in recent years. In the present cruise, we deployed three WGs around R/V *Mirai* to obtain meso-scale spatiotemporal distribution of the surface fluxes and related near-surface status of the ocean and atmosphere.

(3) Instrumentation

(3-1) Wave Glider (as a platform)

The Wave Glider (manufactured by Liquid Robotics Inc.) is an autonomous ocean surface vehicle. The WG utilize wave energy for propulsion, with the aid of thruster powered by the solar-charged battery in case. The on-board computing, communications and sensor payloads are also powered by the solar-charged batteries. The real-time communication enables to operate WG to head to the designated locations, real-time monitoring of observed data, status of vehicles, etc.

The WG consists of two-part architecture; surface float and underwater glider. The two parts are connected by umbilical cable. The outline is shown in Fig. 5.25-1.

In the present cruise, we utilized 3 WGs, as listed in Table Fig. 5.25-1. Note that the length of the umbilical cable (i.e. depth of the underwater glider part) differ between vehicles. The configurations are common for SV3-248 and SV3-252, while SV3-198 differ from other two.

Fig. 5.25-1: The schematics of Wave Glider system (quoted from Liquid Robotics 2016)

Table 5.25-1: List of Wave Glider vehicles used in the present cruise.

Name of Vehicle	Dimension of the float	Length of Umbilical Cable	Paint of the float / glider parts
SV3-196	213 x 142 x 21 (cm)	6 meters	Biofauling-resistant coating (color: yellow)
SV3-248	220 x 145 x 33 (cm)	8 meters	Copper anti-biofouling coating
SV3-252			

(3-2) Onboard sensors for oceanic parameters

The WG in the present study equipped sensors for underwater part as listed in Table 5.25-2. The thermistor chain was attached only to the SV3-252 which occupied station-NORTH (see followings for location). Some sensors were connected to the onboard logger system to store the data and transmit a part of the data in real-time, while other sensors stored its data inside the sensor unit itself. All of the stored data will be recovered after the cruise.

(3-3) Onboard sensors for atmospheric parameters

The WG in the present study equipped sensors for atmospheric part as listed in Table 5.25-3. As in the table, several types of the meteorological sensor packages were installed; Weather Station (manufactured by Airmar), Weather Transmitter (manufactured by Vaisala Oyj), and JAMMET (developed and assembled by JAMSTEC). The location of the sensors are shown in Fig. 5.25-2. The data were stored in the onboard logger system, and a part of the data were transmitted in real-time. In addition, the receivers of GNSS signals to estimate the column water vapor were also equipped to store the data. All of the stored data will be recovered after the cruise.

(3-4) Other equipments

To monitor the status of the vehicle, 3 cameras were attached to see upward, forward and downward (underwater).

Table 5.25-2: List of sensors for the underwater measurements.

Attached Part	Name (type) of Sensor	Recorded Parameter	Notes
Float	Aanderaa 5860B	Temperature Conductivity Salinity	Nominal depth of the sensor: 0.2 m
	RBR duet TD	Temperature Pressure	
	WH-Monitor (300kHz)	Vertical profile of current direction and speed	
Thermistor Chain (only on SV3-252)	RBR concert	Temperature profile (every 1 m along wire, down to 11 m in wire length)	
	RBR duet TD	Temperature Pressure	Beside the top T sensor of the thermistor chain
	RBR duet TD	Temperature Pressure	Beside the tail T sensor of the thermistor chain
Glider	SBE 37	Temperature Conductivity Salinity	
	RBR duet TD	Temperature Pressure	

Table 5.25-3: List of sensors for the atmospheric measurements.

Package	Sensor	Recorded Parameter	# in Fig. 2-25.xx	Nominal height ASL [m]	Notes
(Wind sensor)	R.M.Young 86000	Wind direction and speed	a	1.2	
GNSS receiver	Advanced Navigation, Spatial Dual	GNSS signals (for precipitable water)	b	(N/A)	2 antennas
Weather Station	Airmar PB200	Wind direction and speed Temperature Pressure	c	1.2	
Weather Transmitter	Vaisala WXT533	Rain rate Wind direction and speed	d	1.2	
EasyJAMMET	GE Druck RPS8100	Pressure	1	0.8	
	Rotronic MP102H	Temperature Relative humidity	2	0.9	
	Eppley SPP	Downward shortwave radiation	3	1.2	
	Eppley PIR	Downward longwave radiation	4	1.2	

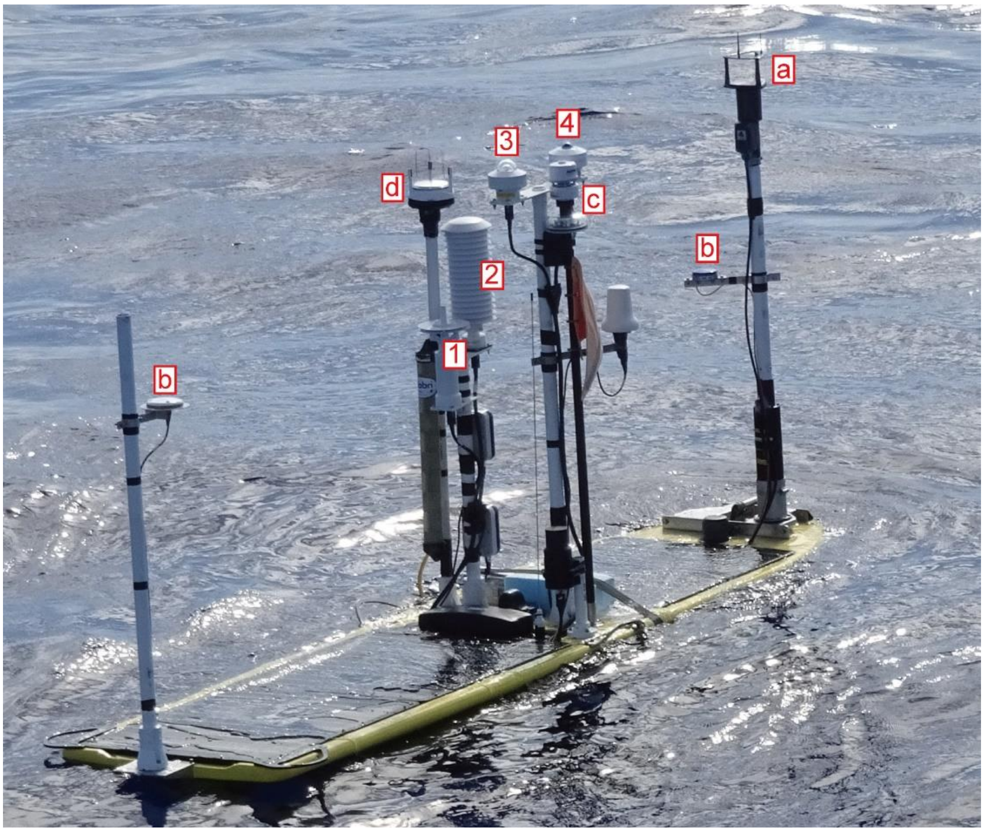


Fig. 5.25-2: Location of the sensors for the atmospheric measurements listed in Table 5.25-3.

(4) Methods

We deployed 3 WGs in total. The WGs were deployed (left it on the water to start observation) from and recovered (to pick it up from the water to end the observation) by the R/V *Mirai*. The operation of the vehicle and the monitoring of the vehicle status and observed data were handled by the member onshore.

The deployment from R/V *Mirai* was on Aug. 08 nearby the m-TRITON buoy. The recovery by R/V *Mirai* was on Sep. 04 nearby the Station (12N, 135E). The period consisted of four stages as follows.

(a) Intercomparison [Aug. 08 (in SMT=UTC+9) to Aug. 09]

The stage was set to compare the data from all WGs, R/V *Mirai*, and m-TRITON buoy (see Section 5.24) each other. This is to evaluate possible bias between data from all platforms. The all WGs were deployed from R/V *Mirai* nearby the m-TRITON buoy before 01UTC on Aug. 08. After the deployment, the all WGs and R/V *Mirai* stayed until 0230 UTC on Aug. 09 (> 24 hours in total) at the designated stations near m-TRITON buoy. The stations for WGs located ~ 8 km apart to the north to west from the anchor location of the m-TRITON buoy. In the same period, R/V *Mirai* stayed northwestern half of the circle within ~ 5.5 km from the anchoring point. On R/V *Mirai*, 3-hourly radiosonde launches (Section 5.1) and 3-hourly profiling by RINKO profiler (Section 5.17), as well as other continous observations, were carried out during the period.

(b) Transition to the stations [Aug. 09 to Aug. 11]

The stage was to transfer the WGs from the stations for (a) to the stations for (c). The WG traveled by themselves.

(c) Networked observation at stations [Aug. 11 to Sep. 02]

During the stage, each WG kept each designated station, to form the observation network. The location of each WG is set 50 km apart to the east, west and north from R/V *Mirai* Station (12N, 135E), as shown in Fig. 5.25-3. Actually, each WG kept on cruising along the designated line around, to better measure the movement of the vehicle to correct the ADCP data.

The WGs arrived the designated stations at or before 00 UTC on Aug. 11. After the networked observation, all the vehicle departed these stations after 07 UTC on Sep. 02. The period for the networked observation can be regarded between these two timestamps.

(d) Transition for recovery [Sep. 02 to Sep. 04]

After 07 UTC on Sep. 02, all the WGs traveled south of R/V *Mirai* to wait for the recovery. All the vehicles were recovered in the morning of Sep. 04 (in SMT), i.e. between 00 UTC and 03UTC on Sep. 04. After each recovery, surface water was sampled by the bucket to measure the salinity as in Section 5.18, to compare to the sensor-observed value.

After the recovery of all WGs, some comparison between sensors were carried out. To examine the salinity sensors, Aanderaa 5860B (attached at the float part) and SBE37 (attached to the glider part) from all 3 WGs were put into one bath filled by the seawater, with the RINKO profiler (see Section 5.17) and obtain the data for > 30 minutes periods, both before and after cleaning of the sensor. To minimize the inhomogeneity of the water in the bath, the water was stirred continuously during the periods. The water were sampled in the beginning and the end of the periods, to measure the salinity as in Section 5.18, to be the reference value. Furthermore to compare the data from sensors for atmospheric measurements, WGs were kept on working and left side-by-side on the deck of R/V *Mirai*. The systems were finally shut down after 06UTC on Sep. 06, to continue the intercomparison > 48 hours.

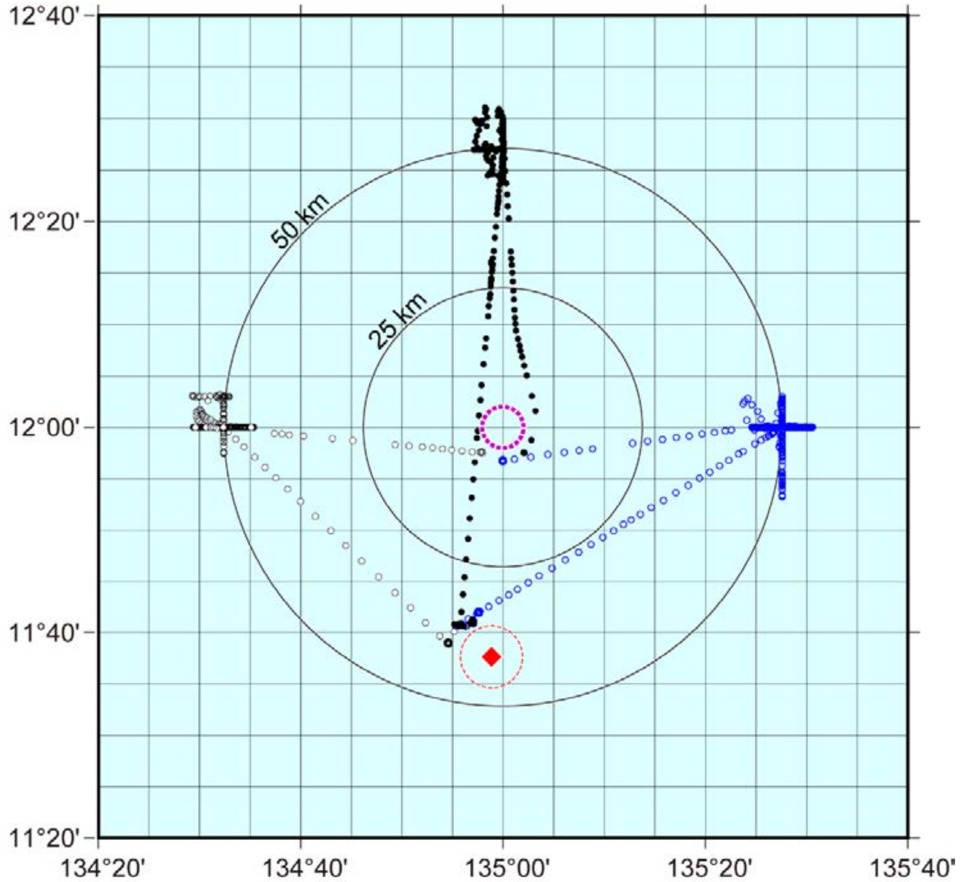


Fig. 5.25-3: Cruise tracks of the Wave Gliders. Blue, white and black circles are the hourly position of SV3-248 (for Station-EAST), SV3-196 (occupied Station-WEST), and SV3-252 (occupied Station-NORTH), respectively. Note that position information were occasionally missed due to failure on real-time data transmission. Red diamond indicates the anchoring location of m-TRITON (see Section 5.24), while the red broken circle indicates the area where the m-TRITON surface buoy possibly drifted (3-miles radius from the anchoring location). Purple broken circle indicates the area of the Station (12N, 135E) for R/V *Mirai* (2-miles radius from the exact (12N, 135E). Black rings indicate the distance from (12N, 135E).

(5) Preliminary Results

We successfully deployed and recovered all three Wave Gliders. A part of the obtained dataset from each vehicle, which was transmitted in real-time, is shown in Figs. 5.25-4, 5.25-5 and 5.25-6 for SV3-196, SV3-248, SV3-252, respectively. The data well captured, at least qualitatively, characteristics of the atmospheric and oceanic variations: Diurnal warming of SST (see panel (a)), intermittent drop of air temperature and coincident rise of relative humidity (see panels (a) and (b)), sudden drop of salinity (see panel (b)), etc. Convectively active period, which started from Aug. 24 and continued several days, was also well captured by intermittent decrease of air temperature (panel (a)), weak / no diurnal warming of SST (panel (a)), rise of relative humidity (panel (b)), decrease of strong wind (panel (e)), downward shortwave radiation (panel (f)), etc.

The full dataset will be retrieved from the data loggers after the cruise. Data evaluation, quality control, and further analyses will be after the cruise.

(6) Data Archive

All data obtained during this cruise will be submitted to the JAMSTEC Data Management Group (DMG) after quality control is made. In addition, all data will be archived and available from YMC data site at http://www.jamstec.go.jp/ymc/ymc_data.html.

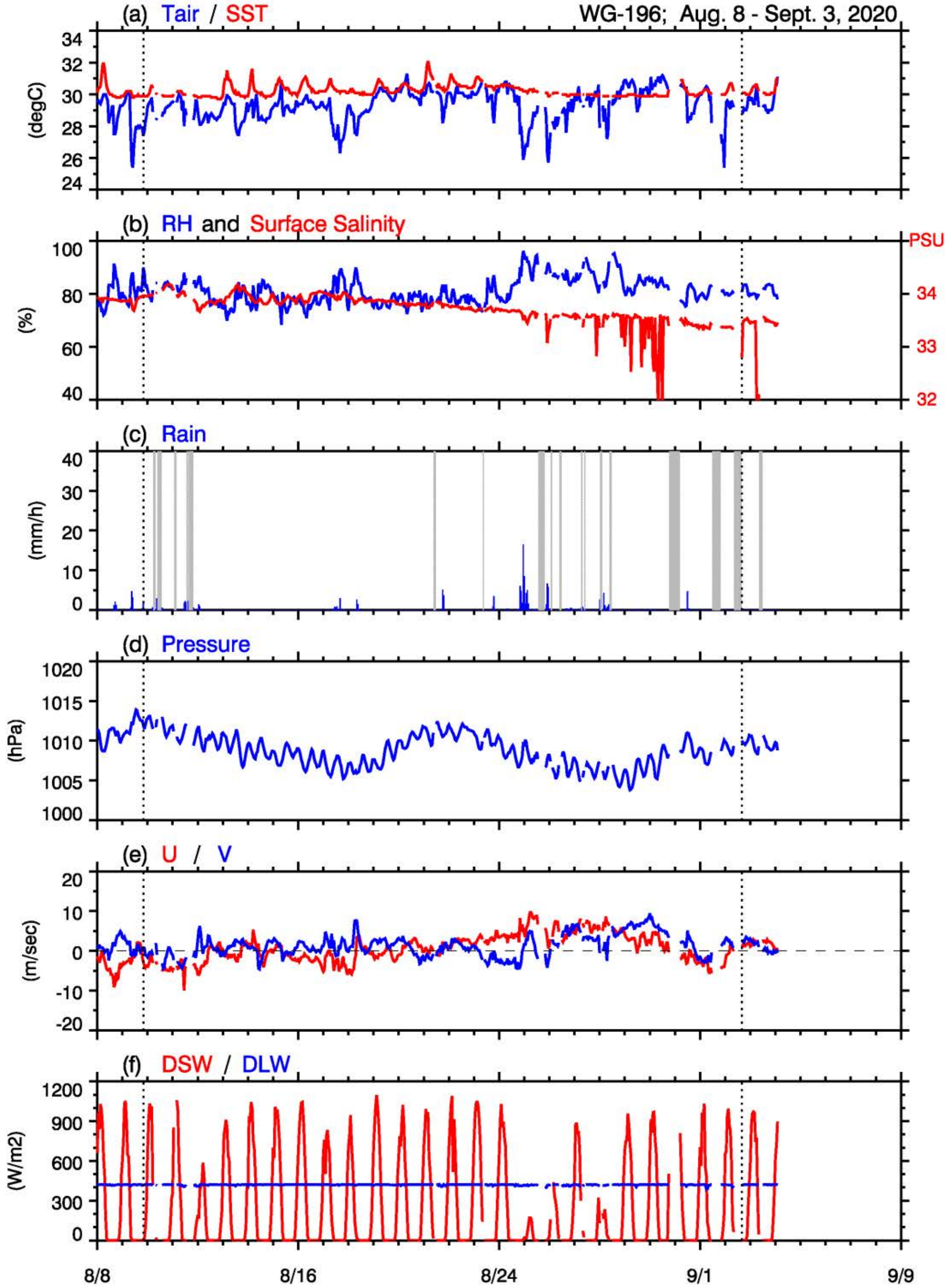


Figure 5.25-4: Time series of a part of the parameters obtained by WaveGlider SV3-196, which occupied "Station-WEST". Vertical broken line indicate the start and the end of the "Networked observation" period. Gray areas in panel (c) indicate the period of data missing. The plot is based on the real-time data, which is uncorrected and possibly missed due to just the failures on the data transmission.

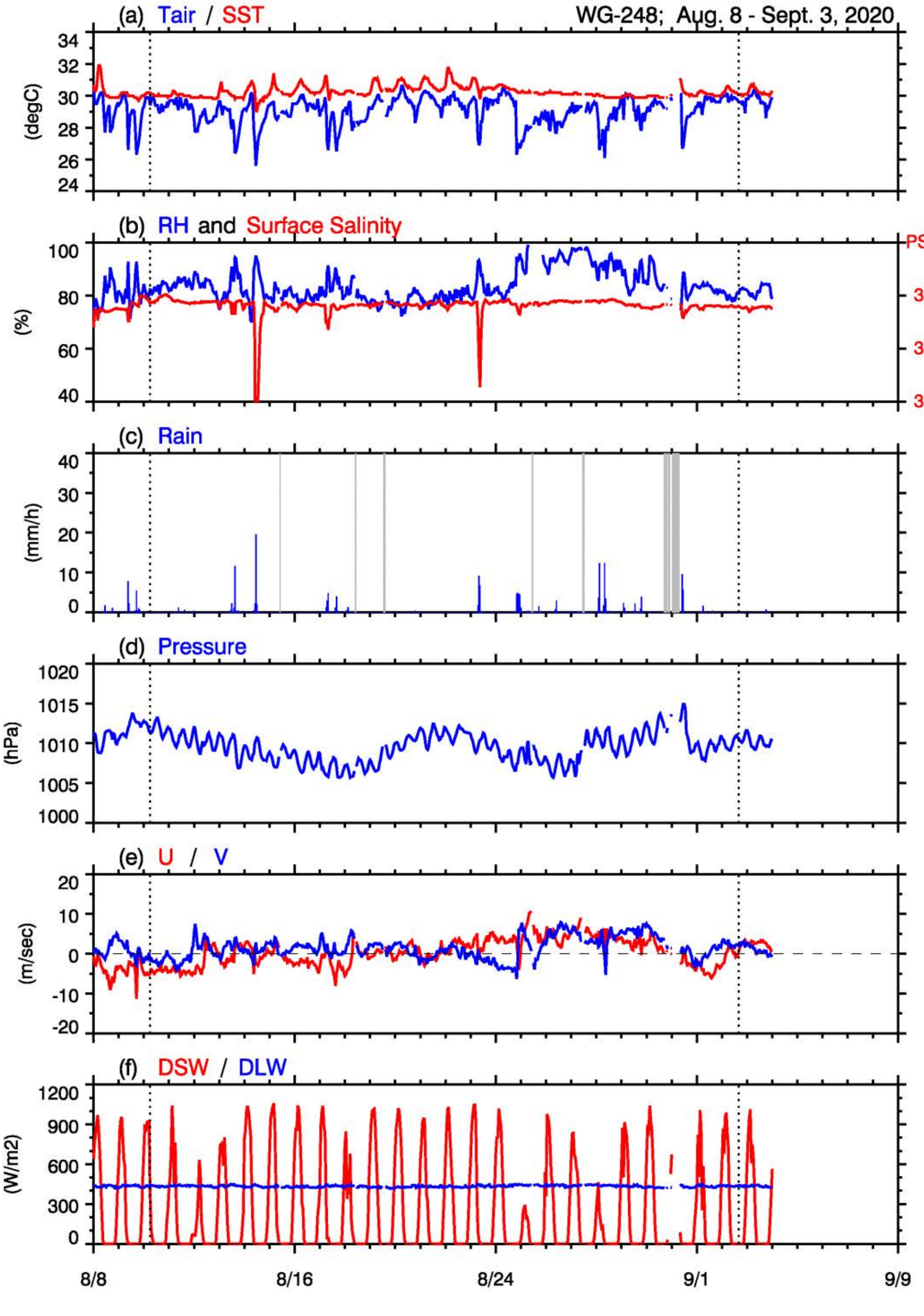


Figure 5.25-5: Same as Fig. 5.25-4, except by WaveGlider SV3-248, which occupied "Station-EAST".

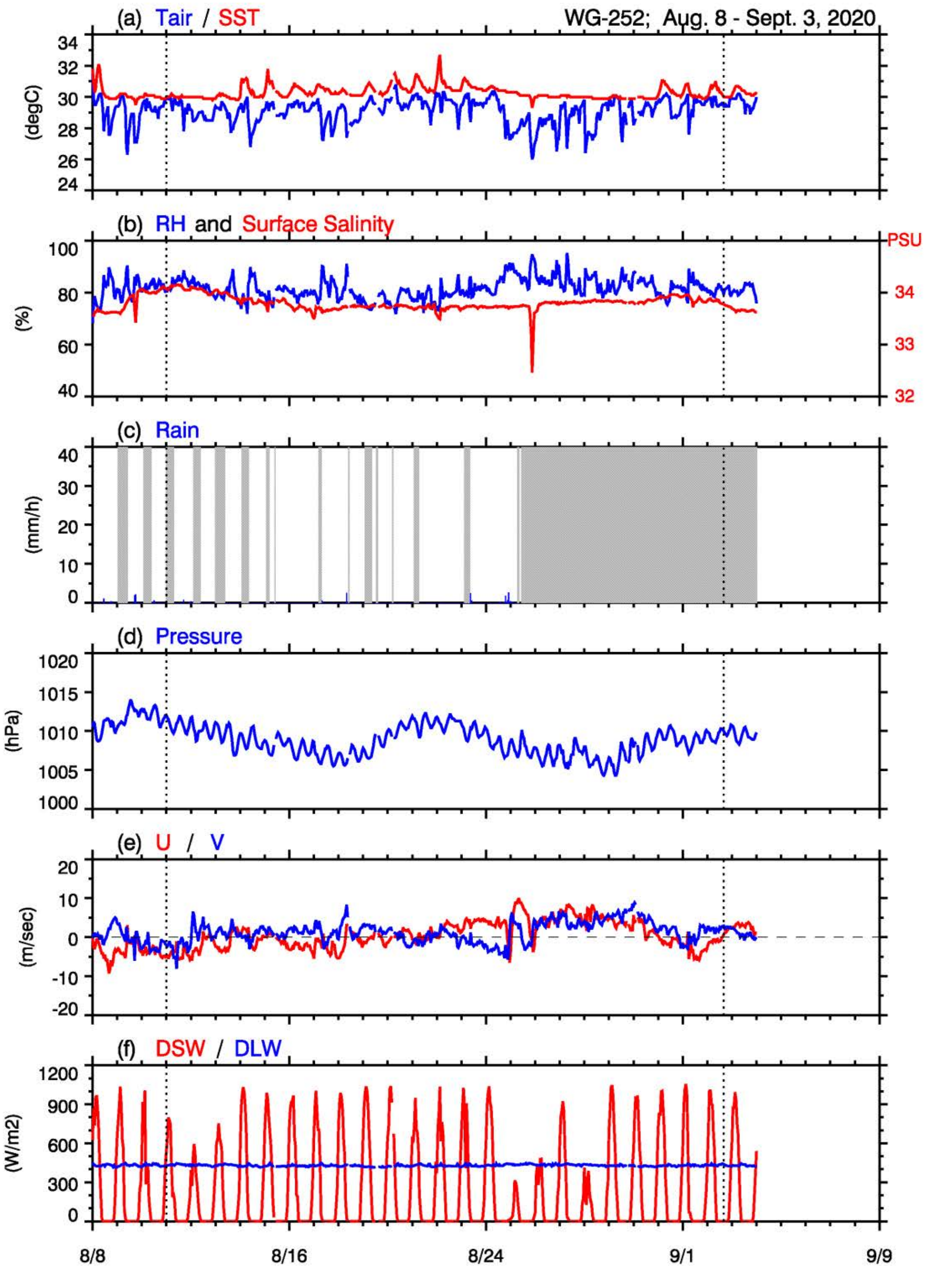


Figure 5.25-6: Same as Fig. 5.25-4, except by WaveGlider SV3-252, which occupied "Station-NORTH".

5.26 Surface drifters for near-surface stratification

(1) Personnel

Gilles REVERDIN	(LOCEAN)	(not on board)
Alexsandre SUPPLY	(LOCEAN)	(not on board)
Christophe NOISEL	(LOCEAN)	(not on board)
Dimitry KHVROSTYANOV	(LOCEAN)	(not on board)
Antonio LOURENÇO	(LOCEAN)	(not on board)
Masaki KATSUMATA	(JAMSTEC)	
Hugo BELLENGER	(CNRS)	(not on board)
Rei ITO	(MWJ)	

(2) Objective

The oceanic near-surface layer is critical to dominate the (latent and sensible) heat flux to the atmosphere, while the layer is severely affected by the atmospheric processes. To investigate the very detailed spatiotemporal structure of the near-surface layer and its relationship to the ocean-atmosphere processes, we deployed multiple set of the drifter buoys, which are capable to retrieve the stratification within top half meters layer with very high temporal resolutions (seconds to minutes).

(3) Instrumentation

(3-1) Surpact

The Surpact (manufactured by SMRU [Sea Mammal Research Unit, University of St. Andrews]), is a small drifter buoy. It is designed to have the sensor for water temperature and conductivity at 5-cm depth. The vertical acceleration is also measured to estimate the wave height. In addition, a multi-frequency microphone placed under a small cupola records sounds that can be spectrally analyzed to estimate rainfall. Obtained data can be stored within the buoy, or be sent by Argos satellite communications. For further detail, see Reverdin et al. (2013).

(3-2) IST micro chain

The IST micro chain (assembled by LOCEAN, using sensors manufactured by IST [Innovative Sensor Technology Co.]) is a small drifter buoy, which quipped tiny (10 x 6 x 1 mm) 5 sensors for water temperature and conductivity along a nadir-oriented cable (with weight at the bottom) to observe vertical profile down to 1 m depth with the interval of 20 cm.

(3-3) CARTHE

The CARTHE (manufactured by Pacific Gyre) is a small drifter buoy to provide the GNSS-based location via GlobalStar telecommunication satellite system. It consists of surface buoy and drogue. The vertical length of the drogue panel is 38 cm, while the top of the drogue is at 25 cm depth.

(3-4) DST-CTD

The DST-CTD (manufactured by Star-ODDI) is a micro-sized (5cm x 1.5cm) package including the battery, memory. controlling microprocessor sensor, and sensors for water temperature, conductivity and pressure, inside the waterproof housing. In the present experiment, we prepared to attach 3 sensors to one CARTHE drifter at the depths of 3 cm, 28 cm, and 61 cm. The sampling interval was set as 10 seconds.

(4) Methods

(4-1) Short deployments

On the "short deployment" experiments, we deployed the drifters for 4 times during the stationary observation period at (12N, 135E). The deployed drifters are grouped in two sets, and the drifters in each group are connected by floating line. Each group are shown in Fig. 5.6-1 as photo, and Table 5.6-1 as name and serial numbers of the instruments.

Set 1 included one CARTHE, one Surpact, and one IST micro chain. CARTHE and Surpact, and Surpact and IST micro chain, were tied by a 8-m long floating line. The Surpact was set to obtain data every 3 seconds that were stored inside the drifter. Three DST-CTD's are attached to CARTHE. Set 2 was identical to Set 1, except not attaching IST micro chain (i.e. Set 2 consisted of one Surpact and one CARTHE with 3 DST-CTD's).

The deployments are listed in Table 5.6-2. We released drifters away from the station (12N, 135E), to (1) avoid collision to *Mirai*, which is cruising around the station, and (2) avoid the short range distance from the vessel where the data from C-band radar (see Section 5.3) degrades. The distance was approximately 10 nm for the 1st to 3rd deployments, while 5 nm for 4th deployment. After the release, the location information was tracked by the reports from CARTHE. Based on the location information, the vessel recovered the drifters in the next day. After each recovery, the observation by RINKO profiler (Section 5.17) was carried out.

Just for notice, the SSST measurement by "Sea Snake" thermistor (see Section 5.13) was paused during the release and recovery ("Sea Snake" can be observable when the ship speed is ≤ 5kt, while we need to steam between the station (12N, 135E) and the point of release / recovery), while the SSST data by "Sea Snake" was available when we released the drifters in 4th deployment.

(4-2) Long deployment

On the "long deployment" experiment, we deployed the drifters at (17° 50' N, 135° 50' E), at 10 UTC on September 09. The two sets prepared as in "short deployment", but without IST micro chain and DST-CTD's, were deployed. The Surpact was set to report the data every 30 minutes via satellite communication.

(5) Preliminary Results

We successfully deployed and recovered the drifters for three deployments. An example of the data obtained is shown in Fig. 5.26-2. The time series well shows diurnal warming of the temperature in the daytime, and drops of salinity between 04 UTC to 08 UTC on Sep. 1. The C-band radar (see Section 5.3) captured the rain signals in the vicinity of the drifters at the time.

Data quality control, including correction of bias between the two Surpact's as seen in Fig. 5.26-2, better understanding and testing of the signals recorded by the IST micro chain prototype, and further analyses will be done after the cruise.

(6) Data Archive

All data obtained during this cruise will be submitted to the JAMSTEC Data Management Group (DMG), as well as will be archived at LOCEAN, France.

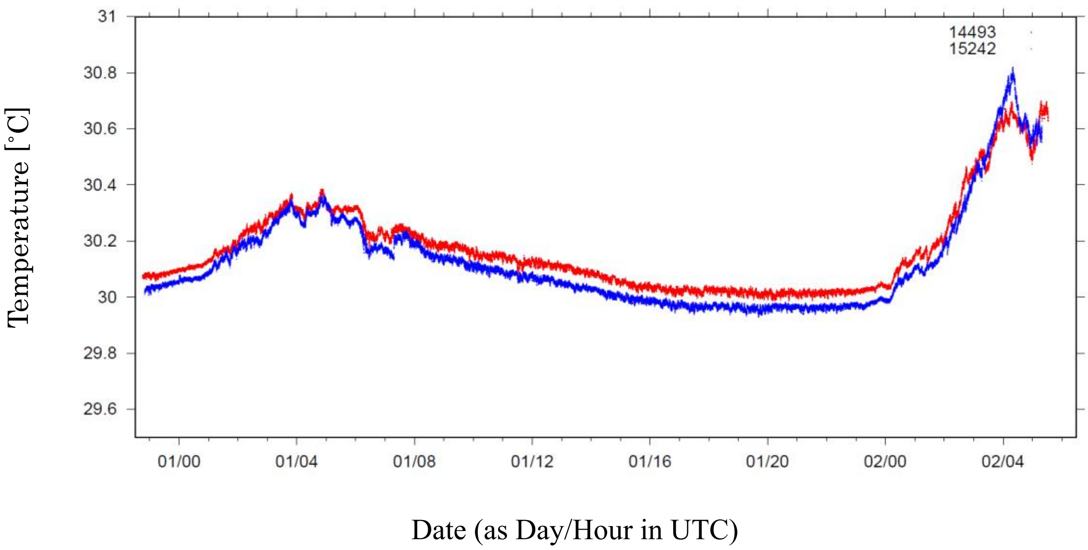
Fig. 5.6-1: The instruments used in the short deployment. Right ones are for Set 1, consisted of (upper) CARTHE, (center) Surpact, and (lower) IST micro chain. Left ones are for Set 2, consisted of (upper-right) CARTHE and (lower-left) Surpact. Note that the sensors of IST micro chain were not attached yet in this figure.

Table 5.6-1: List of the observations. Deployments numbers with 'S' for the short deployments, while 'L' for the long deployment. Note that the locations are those of R/V *Mirai* (not the drifters) when deployed / recovered. The drifters were within several hundred meters from *Mirai* when recovered.

Deployment No.	Set	Deployment		Recovery	
		Time	Location	Time	Location
S1	1	Aug. 16 2245UTC	11-49.79N 135-00.04E	Aug. 18 0518UTC	11-58.62N 134-45.23E
	2	Aug. 16 2248UTC		Aug. 18 0522 UTC	11-58.67N 134-45.08E
S2	1	Aug. 20 2245UTC	11-50.56N 135-00.06E	Aug. 22 0537UTC	11-48.81N 134-40.50E
	2	Aug. 20 2248UTC	11-50.40N 135-00.06E	Aug. 22 0514UTC	11-48.73N 134-40.75E
S3	1	Aug. 31 2245UTC	11-53.25N 134-53.30E	Sep. 02 0532UTC	11-58.50N 134-41.17E
	2	Aug. 31 2250UTC	11-53.40N 134-53.39E	Sep. 02 0520UTC	11-58.46N 134-41.72E
S4	1	Sep. 06 0444UTC	11-59.77N 134-53.89E	Sep. 07 0456UTC	11-53.60N 134-50.63E
	2	Sep. 06 0449UTC	11-59.78N 134-54.08E	Sep. 07 0459UTC	11-53.56N 134-50.51E
L	1	Sep. 09 1006UTC	17-00.05N 135-49.91E	(None)	
	2	Sep. 09 1010UTC	17-00.24N 135-49.92E		

Table 5.6-2: Instruments and its serial numbers used in each deployment.

Set		Set-1					Set-2				
Deployment		S1	S2	S3	S4	L	S1	S2	S3	S4	L
Surpact		14493					15242				
CARTHE		4409630					4407609				
Star-ODDI	Top	9054		8979		None	9053				None
	Middle	9521					9520				
	Bottom	9524					9522				
IST		Attached			None		None				



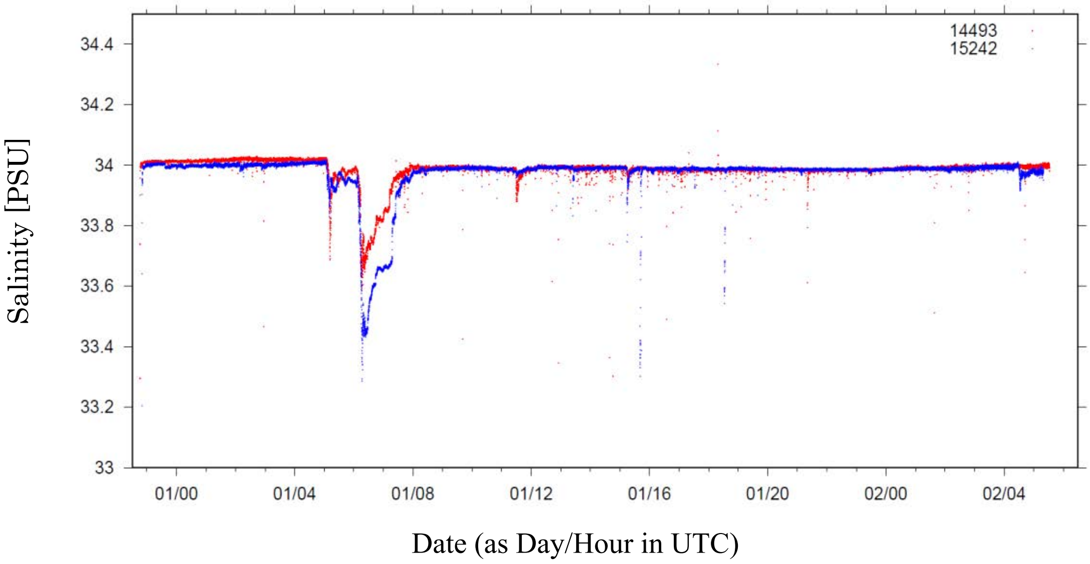


Figure 5.6-2: Time series of the temperature and salinity obtained by Surpact's during the deployment-3. Red and blue dots designate value from #14493 (Set-1) and #15242 (Set-2), respectively. Note that the data are uncorrected.

5.27 Underway geophysics

Personnel

Satoru YOKOI	(JAMSTEC)	-Principal Investigator
Kazuho YOSHIDA	(NME)	- Operation Leader
Satomi OGAWA	(NME)	
Yutaro MURAKAMI	(NME)	
Yoichi INOUE	(MIRAI Crew)	

5.27.1 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 Shimizu as the reference point.

(4) Preliminary Results

Absolute gravity table was shown in Table.5.27.1-1.

Table 5.27.1-1 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	7/29	00:20	Shimizu	979728.977	226	642	979729.92	12011.35
#2	9/14	23:26	Shimizu	979728.977	324	630	979730.00	12010.32

*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>

5.27.2 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:

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

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

$$B * Hob + Hbp = R * P * Y * F \qquad (b)$$

where $B = A^{-1}$, and $Hbp = -B * Hp$. The magnetic field, *F*, can be obtained by measuring *R*, *P*, *Y* and *Hob*, if *B* and *Hbp* are known. Twelve constants in *B* 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 (GNSS) and speed data are taken from LAN every second.

(4) Preliminary Results

The results will be published after primary processing.

(5) Data Archives

The three-component magnetometer 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) 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.
   05:31UTC - 05:54UTC, 04 Aug. 2020 around 20-59N, 135-00E.
   17:36UTC - 17:57UTC, 07 Sep. 2020 around 12-01N, 135-00E.
   23:12UTC - 23:35UTC, 11 Sep. 2020 around 30-23N, 137-53E.

5.27.3 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 the m-TRITON buoy deployment area and drew the bathymetric map. And we measured the estimate depth at the anchor position of the fixed buoy.

(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, XCTD and Argo float data by the equation in Del Grosso (1974) during the cruise. Table 5.27.3-1 shows system configuration and performance of SEABEAM 3012 system.

Table 5.27.3-1 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>

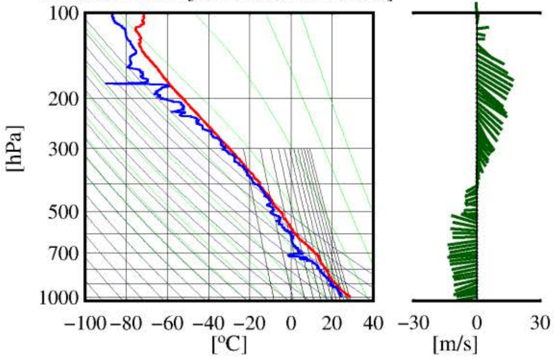
(5) Remarks

1) The following period, data acquisitions were suspended due to the stationary observation.
   04:56UTC 07 Aug. 2020 - 17:51UTC 16 Aug. 2020
   08:18UTC 18 Aug. 2020 - 18:38UTC 20 Aug. 2020
   08:37UTC 22 Aug. 2020 - 20:38UTC 31 Aug. 2020
   07:42UTC 02 Sep. 2020 - 23:35UTC 03 Sep. 2020
   03:38UTC 04 Sep. 2020 - 17:21UTC 07 Sep. 2020

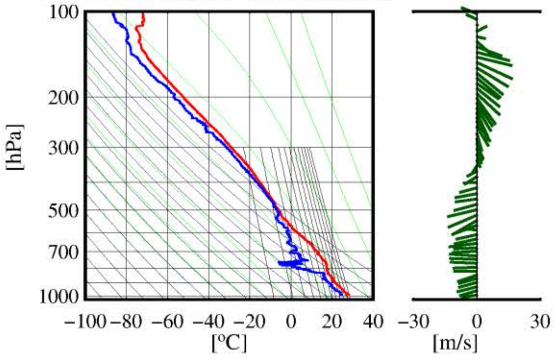
2) The following period, data acquisitions were suspended due to operating ANS system.
   22:20UTC 07 Sep. 2020 - 22:29UTC 07 Sep. 2020

Appendix A: Atmospheric profiles by the radiosonde observations

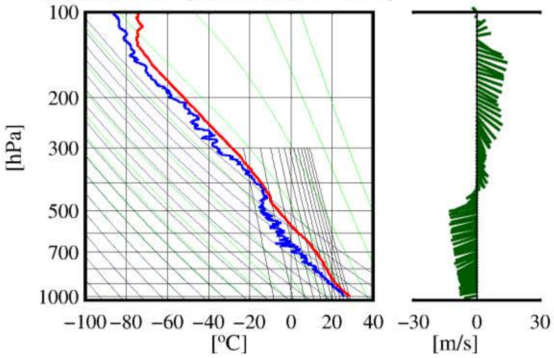
20/08/04 23:30 [134.9873E 17.7860N]



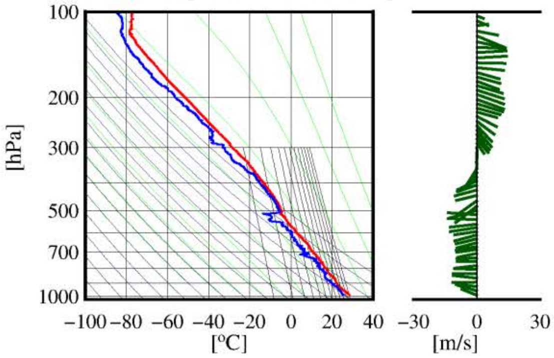
20/08/05 02:30 [134.9920E 17.2439N]



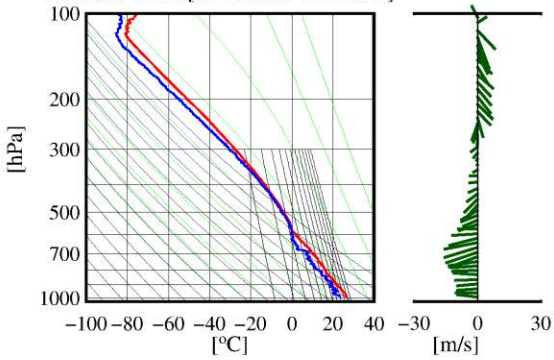
20/08/05 05:29 [134.9882E 16.7463N]

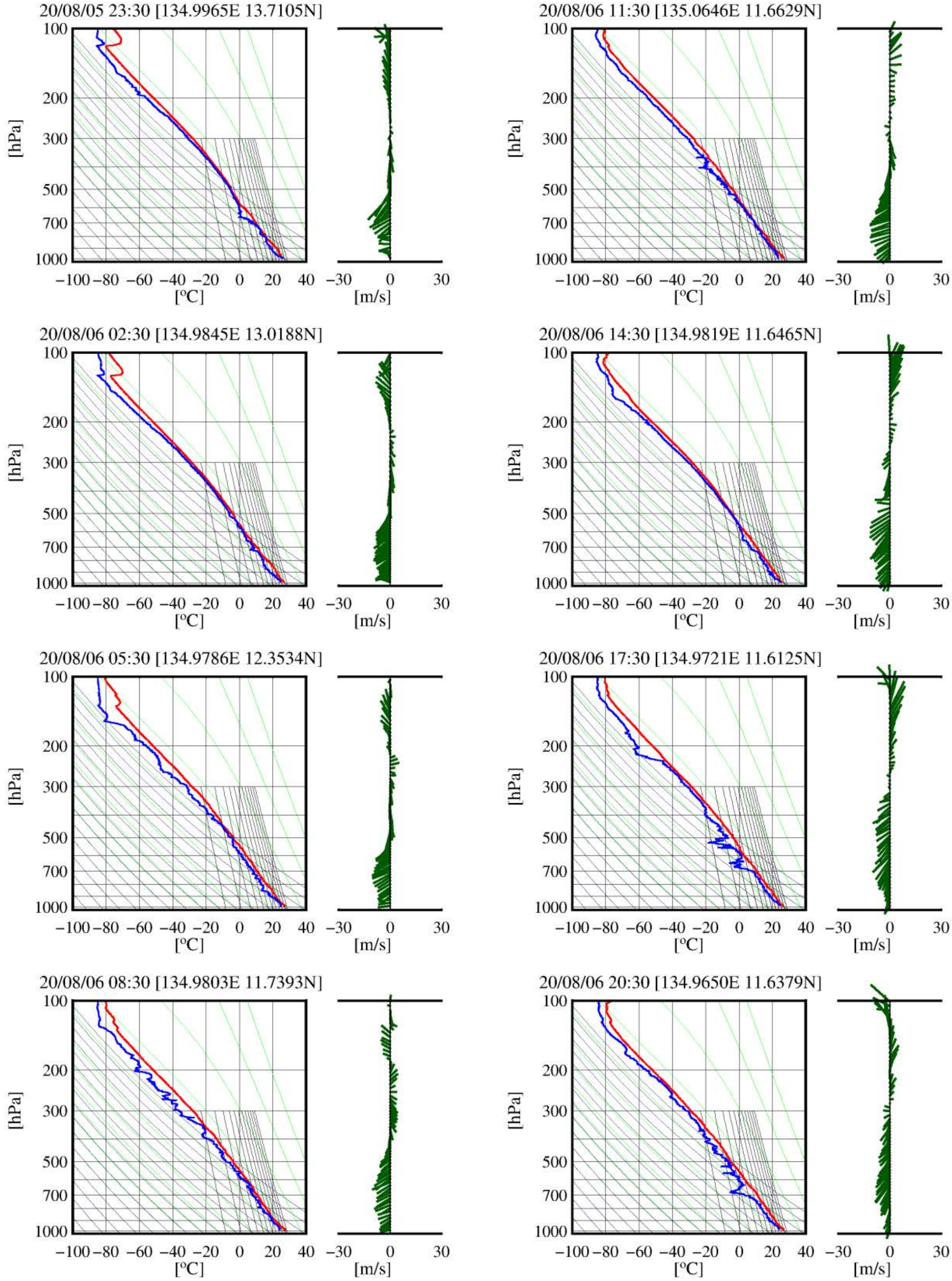


20/08/05 11:30 [134.9992E 15.6963N]

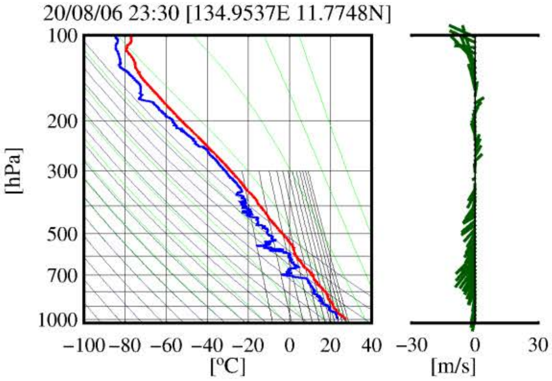


20/08/05 17:30 [134.9706E 14.8207N]

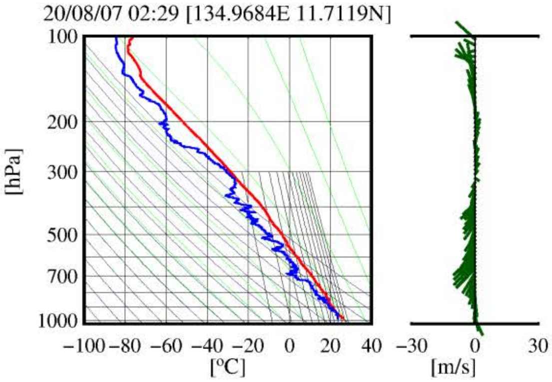



20/08/05 23:30 [134.9965E 13.7105N]
20/08/06 11:30 [135.0646E 11.6629N]
20/08/06 02:30 [134.9845E 13.0188N]
20/08/06 14:30 [134.9819E 11.6465N]
20/08/06 05:30 [134.9786E 12.3534N]
20/08/06 17:30 [134.9721E 11.6125N]
20/08/06 08:30 [134.9803E 11.7393N]
20/08/06 20:30 [134.9650E 11.6379N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[ºC]
−30 0 30
[m/s]

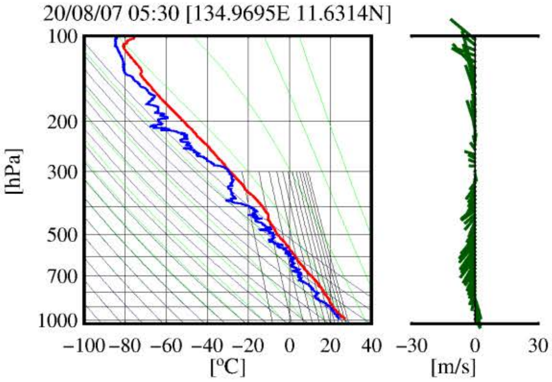
20/08/06 23:30 [134.9537E 11.7748N]



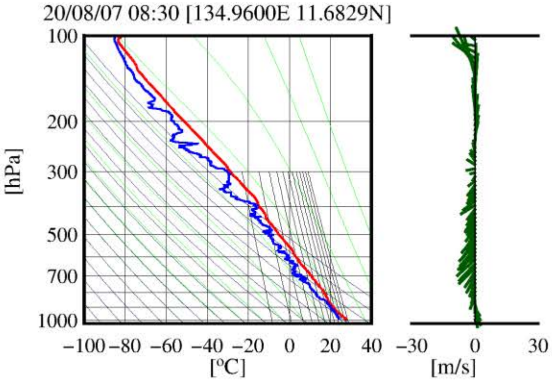
20/08/07 02:29 [134.9684E 11.7119N]



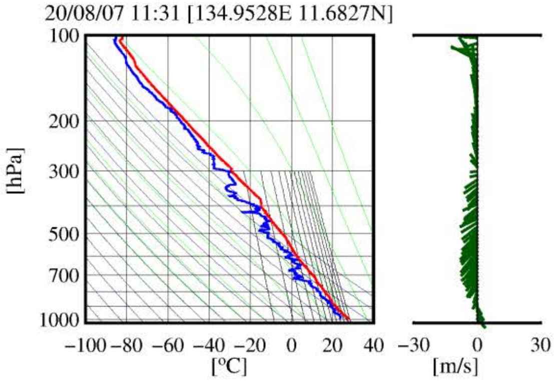
20/08/07 05:30 [134.9695E 11.6314N]



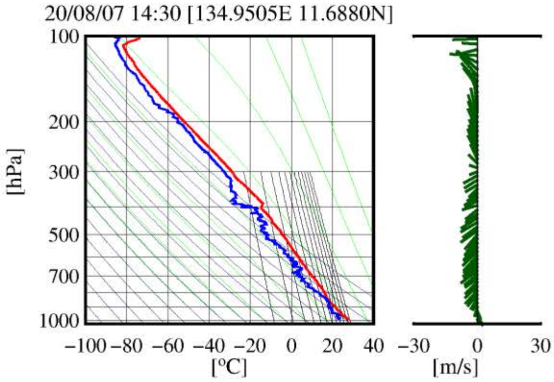
20/08/07 08:30 [134.9600E 11.6829N]



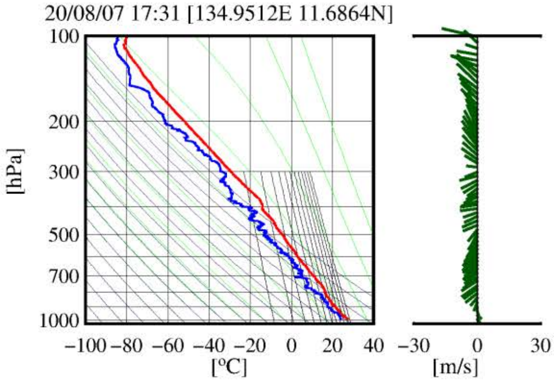
20/08/07 11:31 [134.9528E 11.6827N]



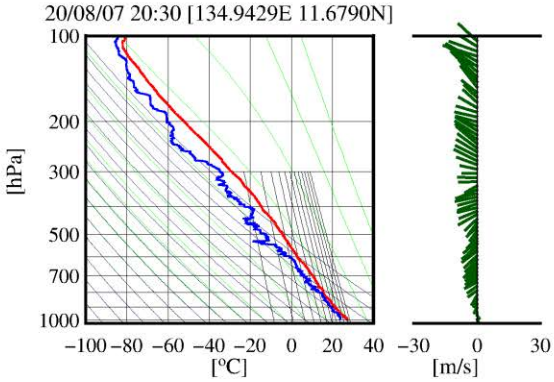
20/08/07 14:30 [134.9505E 11.6880N]

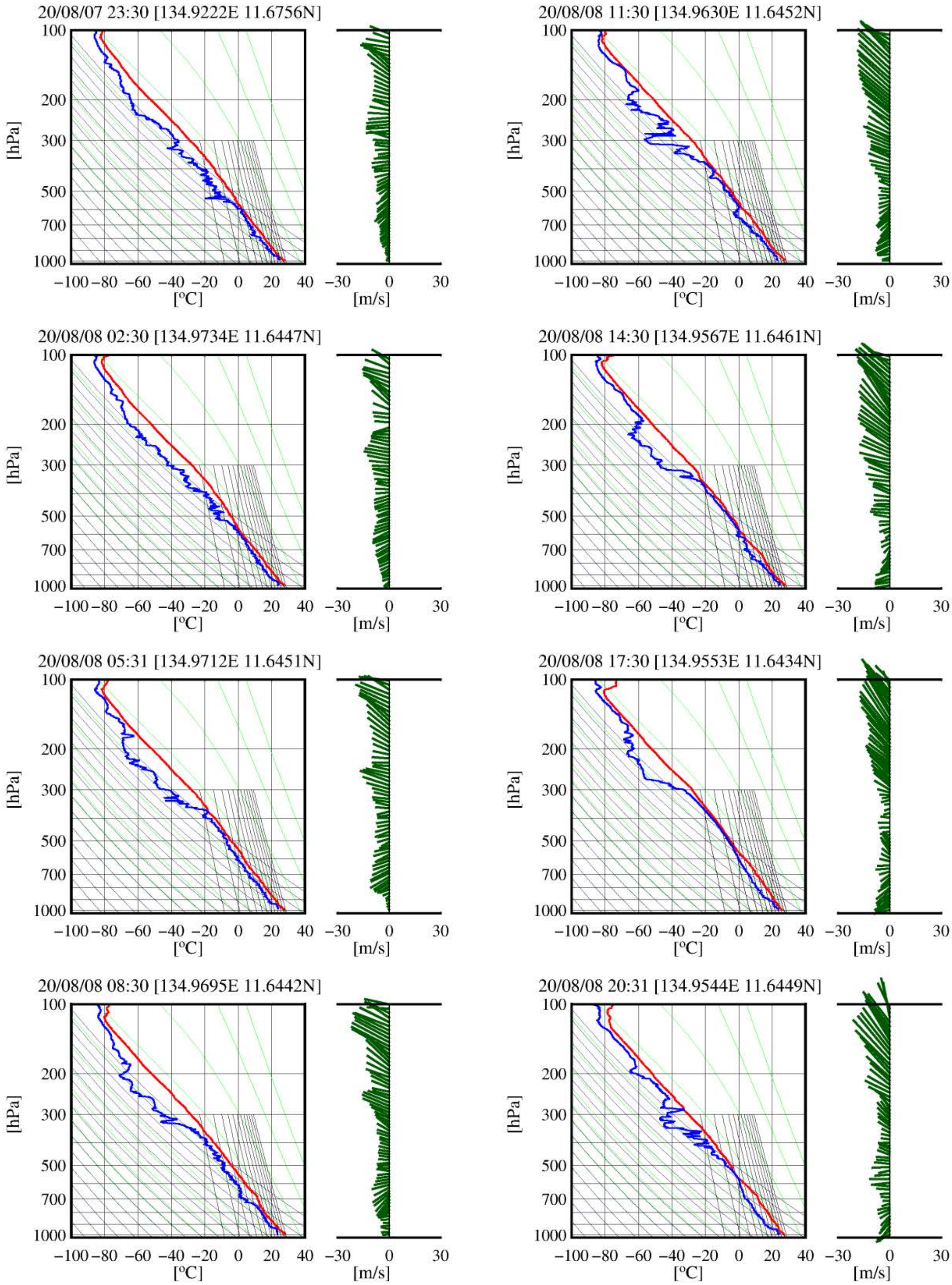


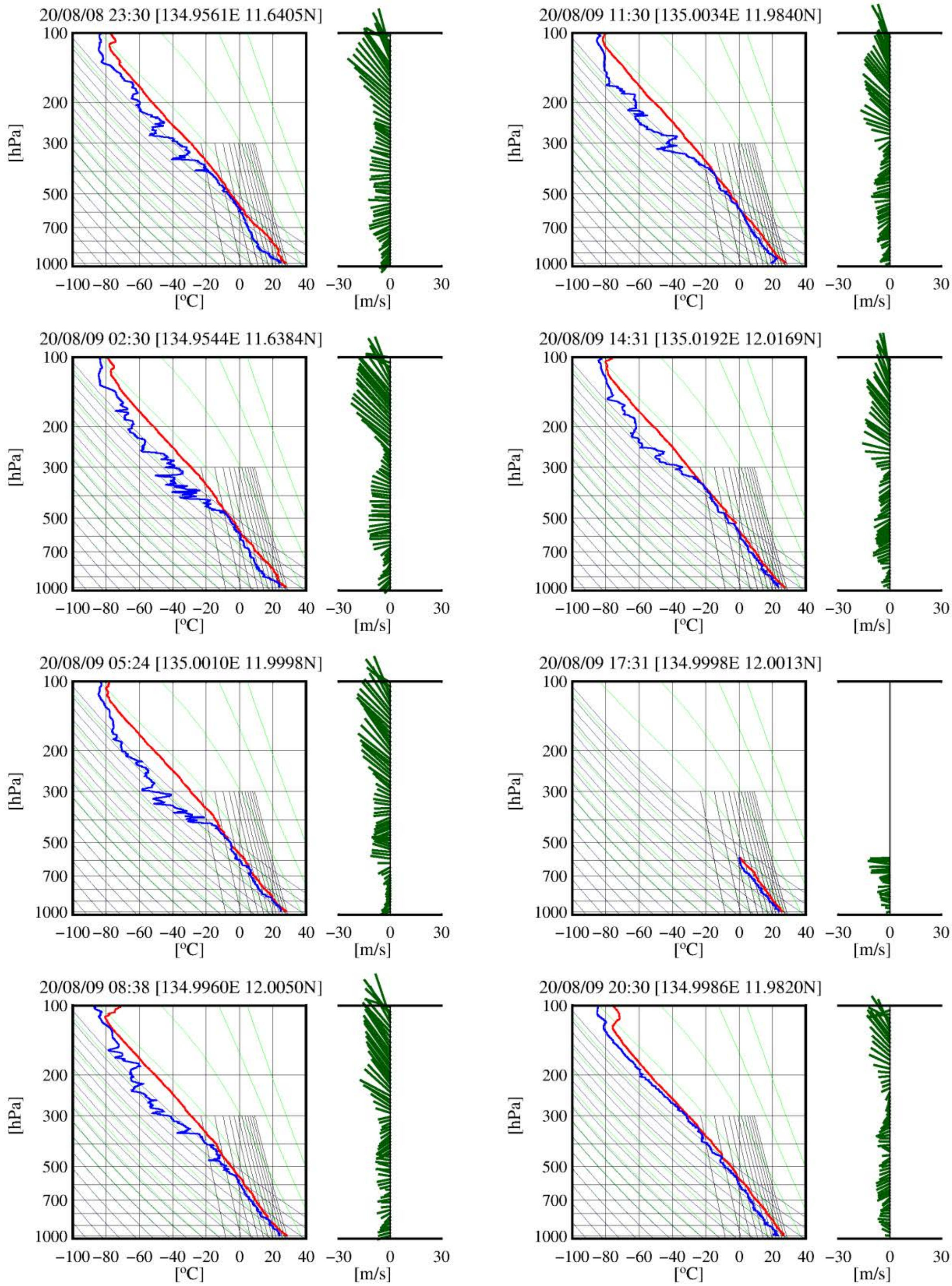
20/08/07 17:31 [134.9512E 11.6864N]

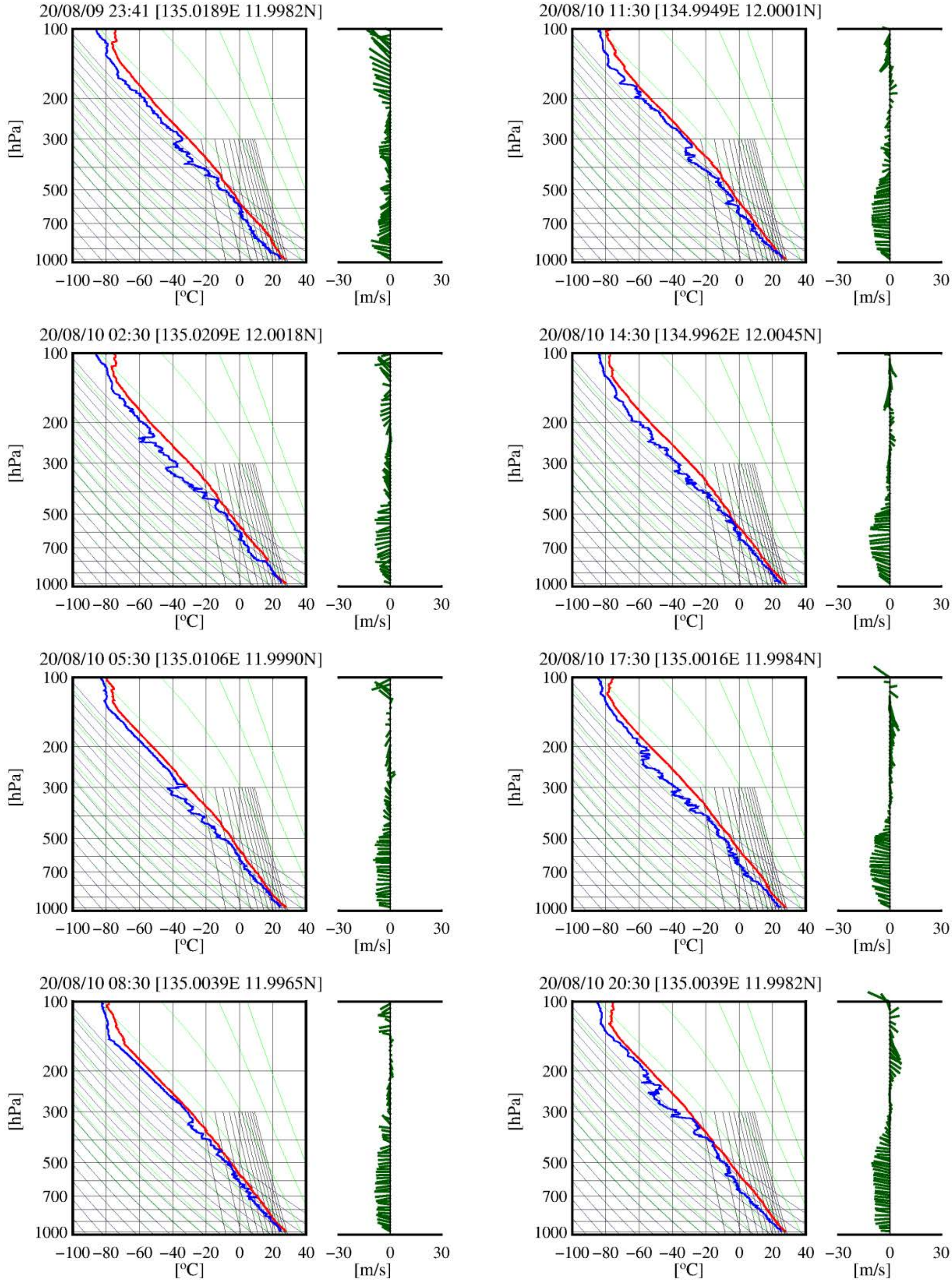


20/08/07 20:30 [134.9429E 11.6790N]

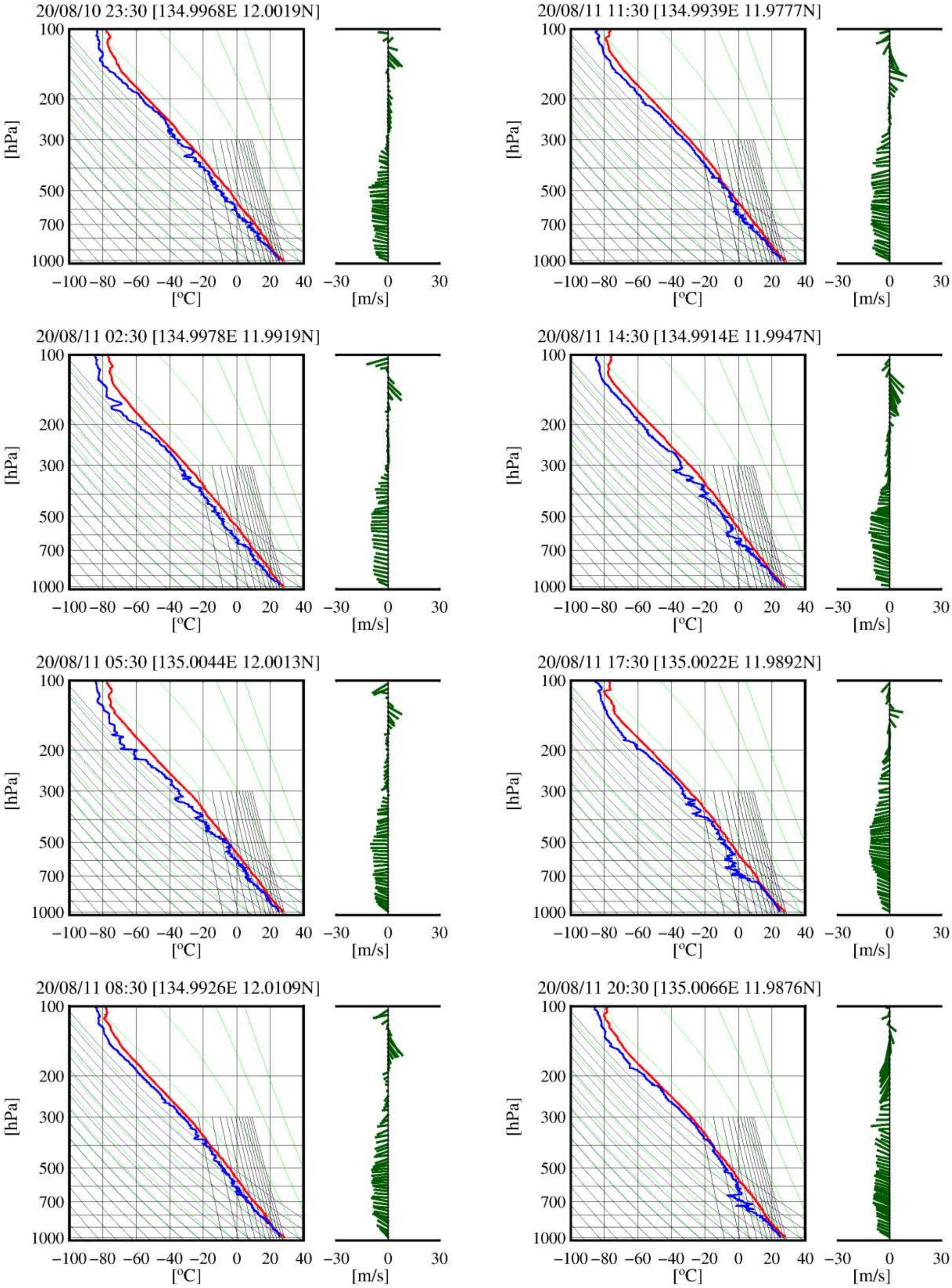


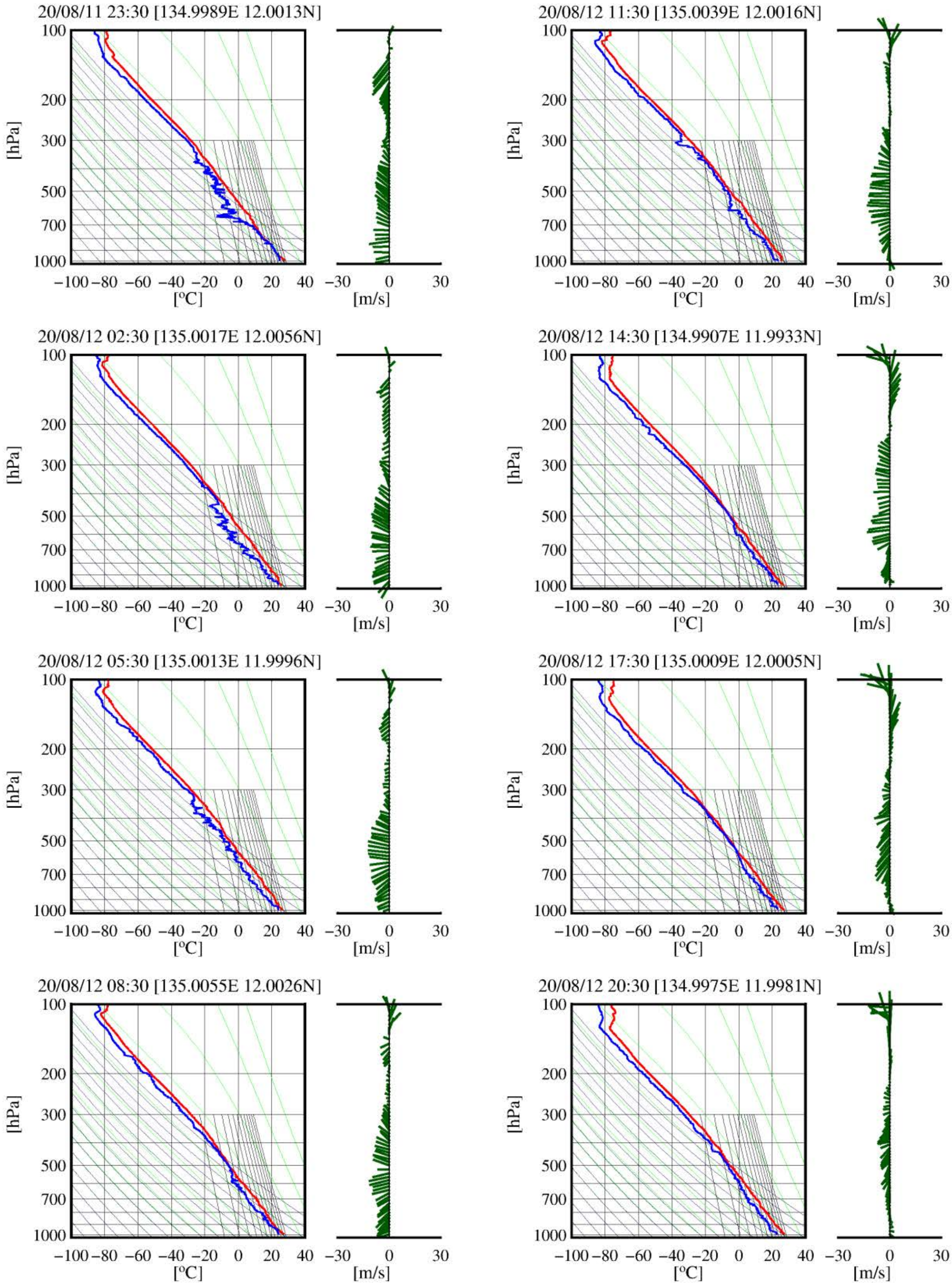

20/08/07 23:30 [134.9222E 11.6756N]
20/08/08 11:30 [134.9630E 11.6452N]
20/08/08 02:30 [134.9734E 11.6447N]
20/08/08 14:30 [134.9567E 11.6461N]
20/08/08 05:31 [134.9712E 11.6451N]
20/08/08 17:30 [134.9553E 11.6434N]
20/08/08 08:30 [134.9695E 11.6442N]
20/08/08 20:31 [134.9544E 11.6449N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[^{o}C]
−30 0 30
[m/s]


20/08/08 23:30 [134.9561E 11.6405N]
20/08/09 02:30 [134.9544E 11.6384N]
20/08/09 05:24 [135.0010E 11.9998N]
20/08/09 08:38 [134.9960E 12.0050N]
20/08/09 11:30 [135.0034E 11.9840N]
20/08/09 14:31 [135.0192E 12.0169N]
20/08/09 17:31 [134.9998E 12.0013N]
20/08/09 20:30 [134.9986E 11.9820N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

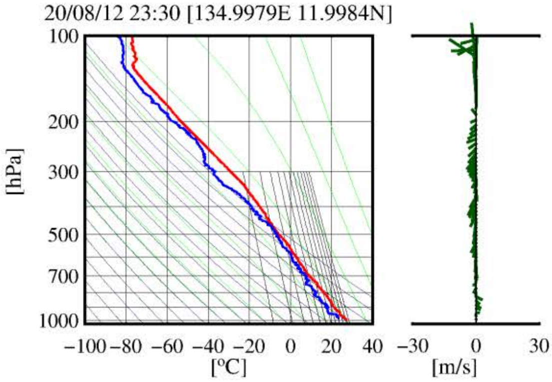


20/08/09 23:41 [135.0189E 11.9982N]
20/08/10 11:30 [134.9949E 12.0001N]
20/08/10 02:30 [135.0209E 12.0018N]
20/08/10 14:30 [134.9962E 12.0045N]
20/08/10 05:30 [135.0106E 11.9990N]
20/08/10 17:30 [135.0016E 11.9984N]
20/08/10 08:30 [135.0039E 11.9965N]
20/08/10 20:30 [135.0039E 11.9982N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

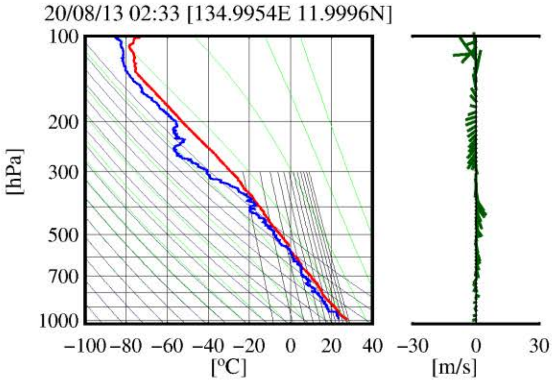

20/08/10 23:30 [134.9968E 12.0019N]
20/08/11 02:30 [134.9978E 11.9919N]
20/08/11 05:30 [135.0044E 12.0013N]
20/08/11 08:30 [134.9926E 12.0109N]
20/08/11 11:30 [134.9939E 11.9777N]
20/08/11 14:30 [134.9914E 11.9947N]
20/08/11 17:30 [135.0022E 11.9892N]
20/08/11 20:30 [135.0066E 11.9876N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]


20/08/11 23:30 [134.9989E 12.0013N]
20/08/12 02:30 [135.0017E 12.0056N]
20/08/12 05:30 [135.0013E 11.9996N]
20/08/12 08:30 [135.0055E 12.0026N]
20/08/12 11:30 [135.0039E 12.0016N]
20/08/12 14:30 [134.9907E 11.9933N]
20/08/12 17:30 [135.0009E 12.0005N]
20/08/12 20:30 [134.9975E 11.9981N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[ºC]
−30 0 30
[m/s]

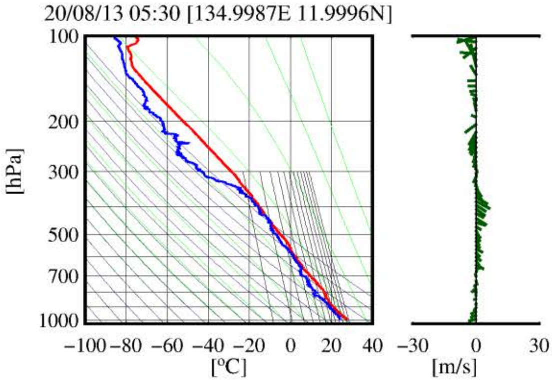
20/08/12 23:30 [134.9979E 11.9984N]



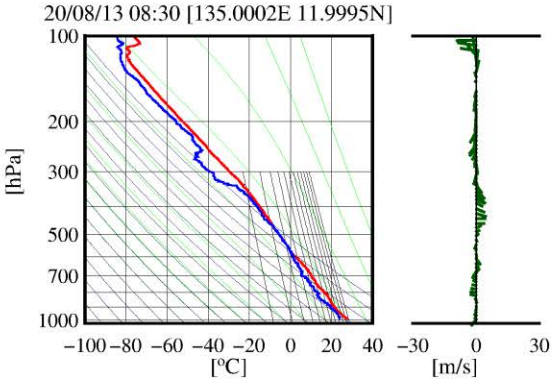
20/08/13 02:33 [134.9954E 11.9996N]



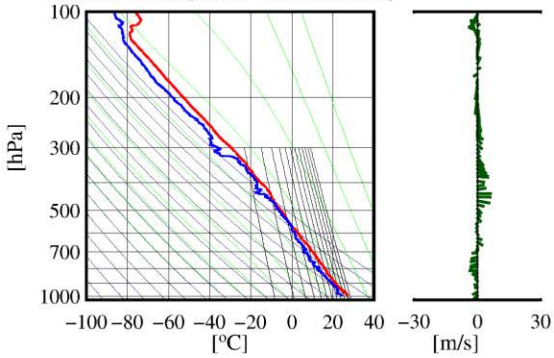
20/08/13 05:30 [134.9987E 11.9996N]



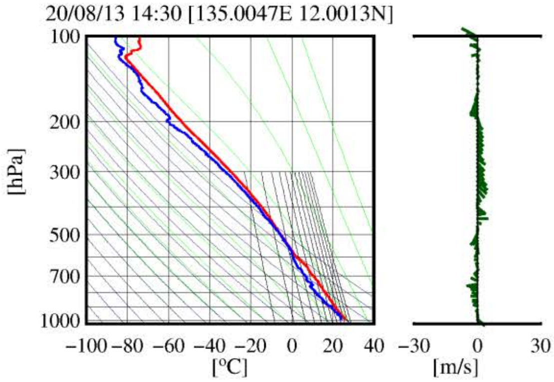
20/08/13 08:30 [135.0002E 11.9995N]



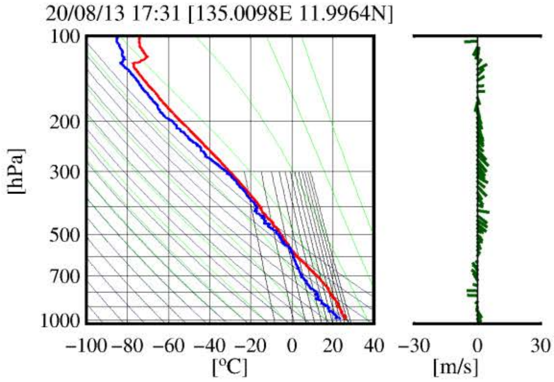
20/08/13 11:30 [135.0046E 12.0053N]



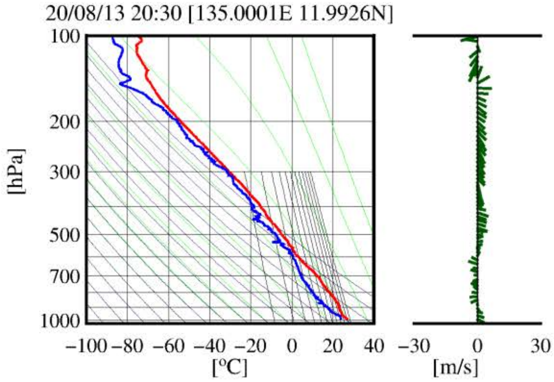
20/08/13 14:30 [135.0047E 12.0013N]



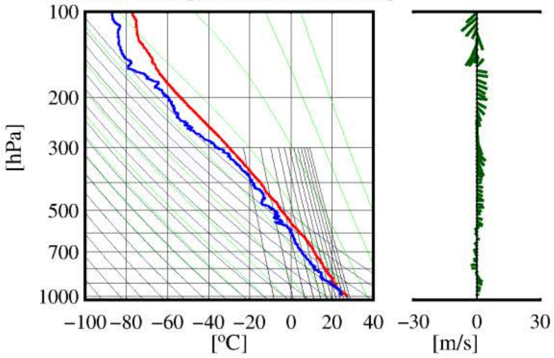
20/08/13 17:31 [135.0098E 11.9964N]



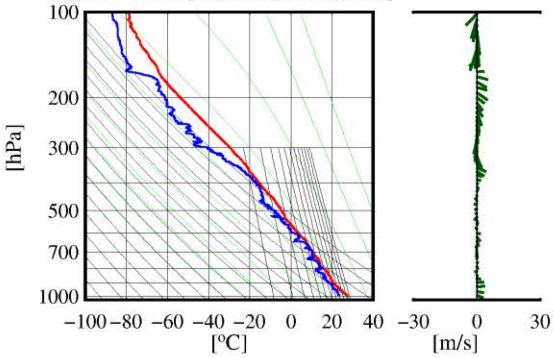
20/08/13 20:30 [135.0001E 11.9926N]



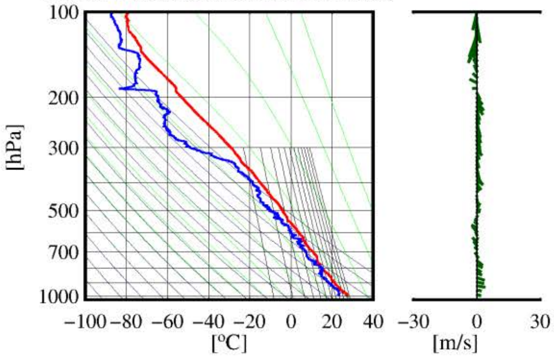
20/08/13 23:30 [134.9989E 11.9957N]



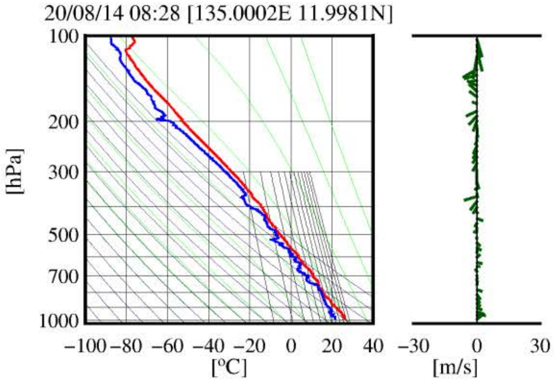
20/08/14 02:30 [135.0086E 12.0013N]



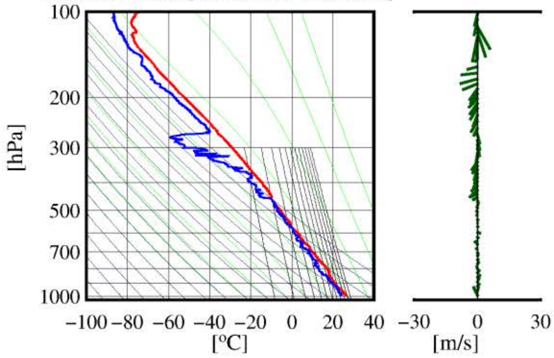
20/08/14 05:30 [135.0006E 11.9973N]



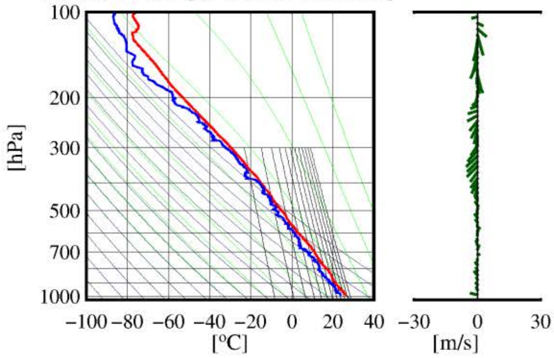
20/08/14 08:28 [135.0002E 11.9981N]



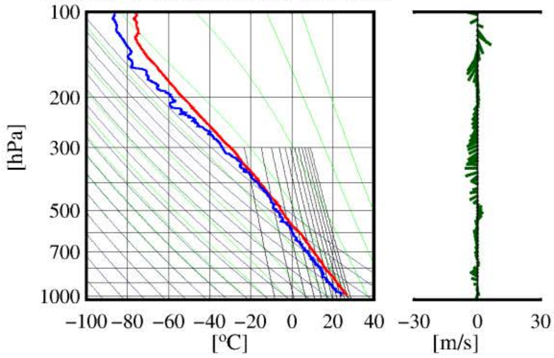
20/08/14 11:30 [135.0023E 12.0017N]



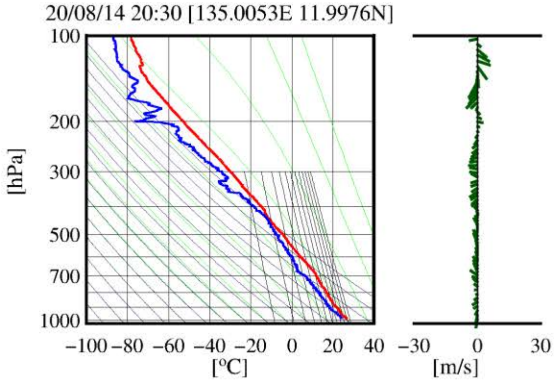
20/08/14 14:31 [134.9961E 12.0011N]



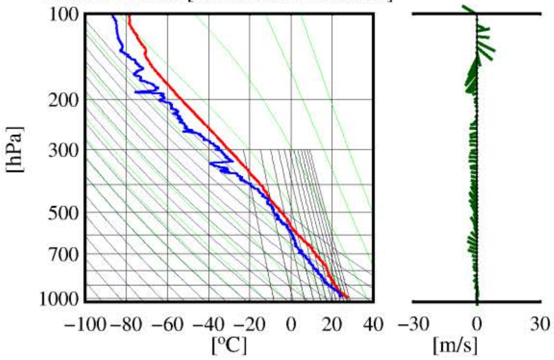
20/08/14 17:30 [135.0030E 11.9981N]



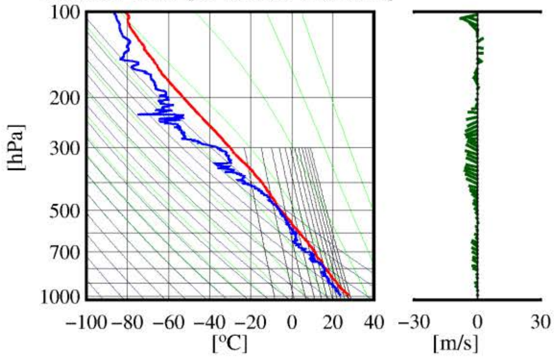
20/08/14 20:30 [135.0053E 11.9976N]



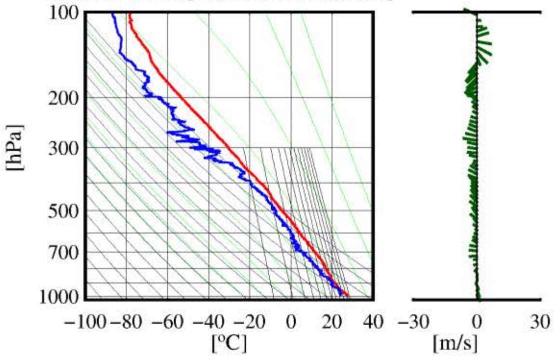
20/08/14 23:30 [135.0005E 12.0008N]



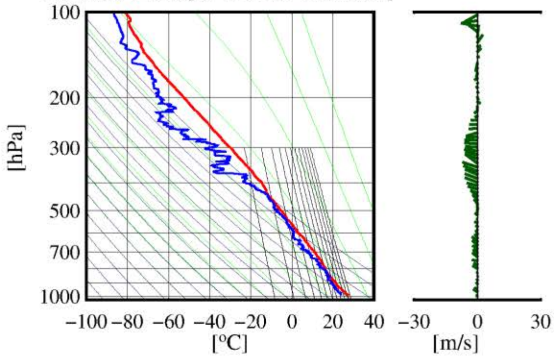
20/08/15 11:31 [134.9997E 12.0004N]



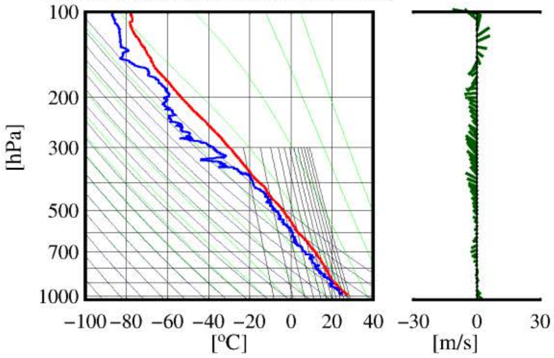
20/08/15 02:30 [135.0021E 12.0003N]



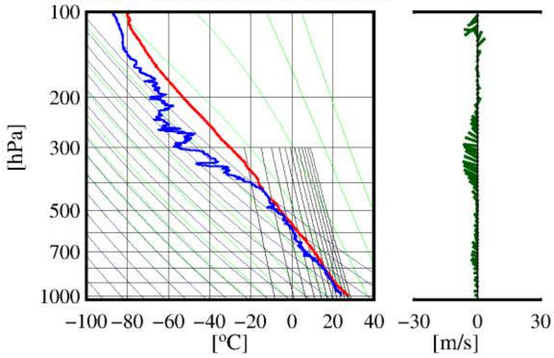
20/08/15 14:30 [134.9976E 12.0005N]



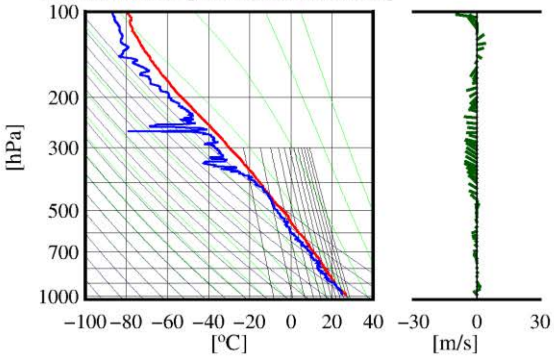
20/08/15 05:30 [135.0016E 12.0016N]



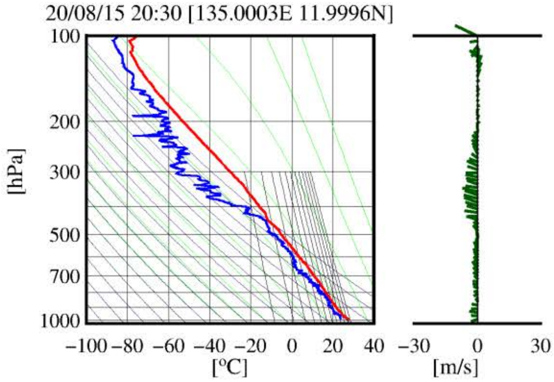
20/08/15 17:30 [135.0015E 12.0004N]



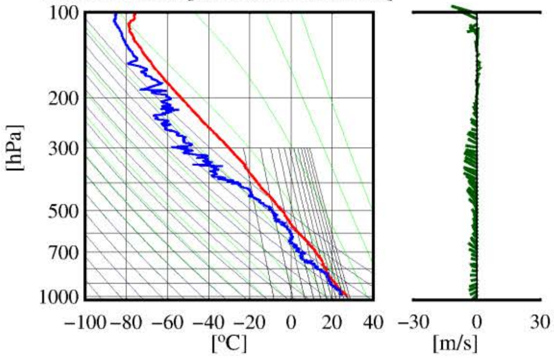
20/08/15 08:31 [134.9987E 11.9951N]



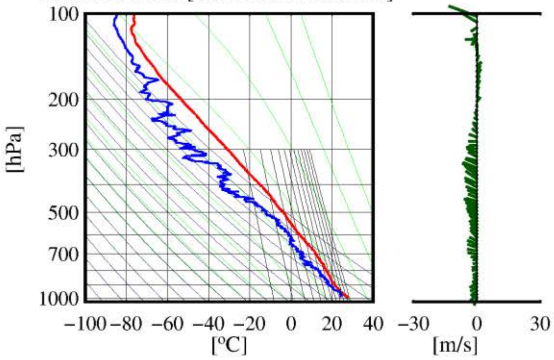
20/08/15 20:30 [135.0003E 11.9996N]



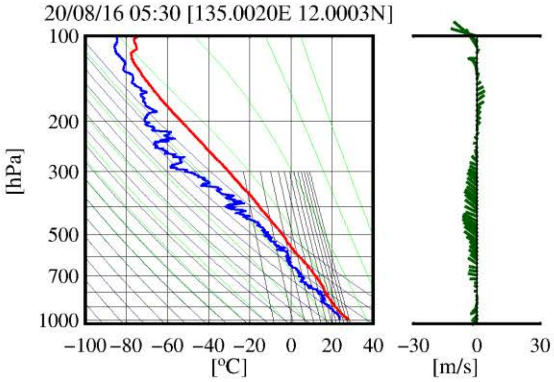
20/08/15 23:30 [134.9999E 12.0012N]



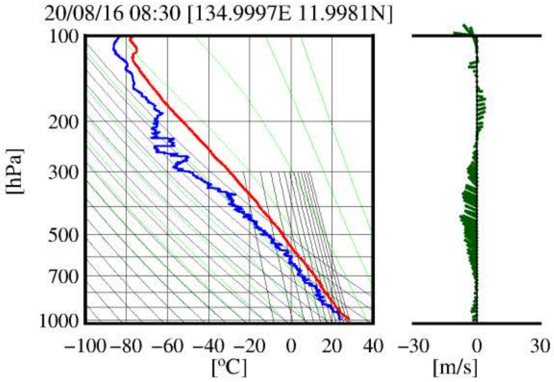
20/08/16 02:30 [134.9966E 12.0012N]



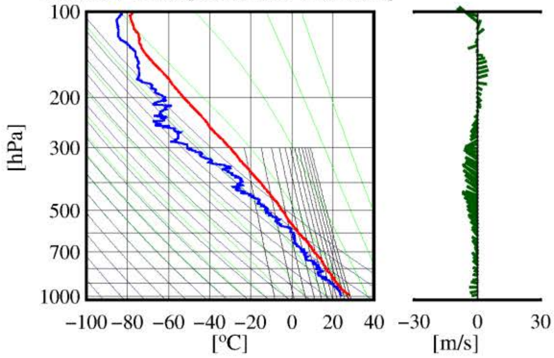
20/08/16 05:30 [135.0020E 12.0003N]



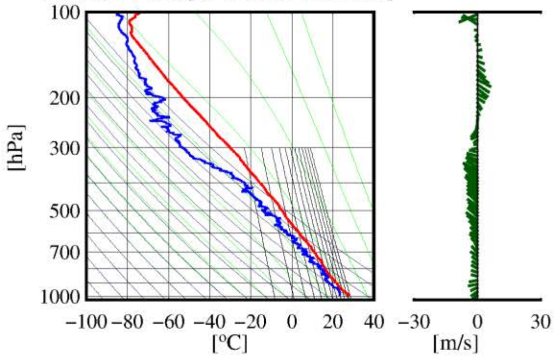
20/08/16 08:30 [134.9997E 11.9981N]



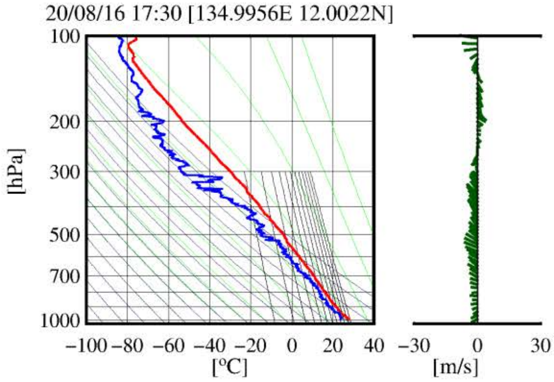
20/08/16 11:30 [135.0008E 12.0005N]



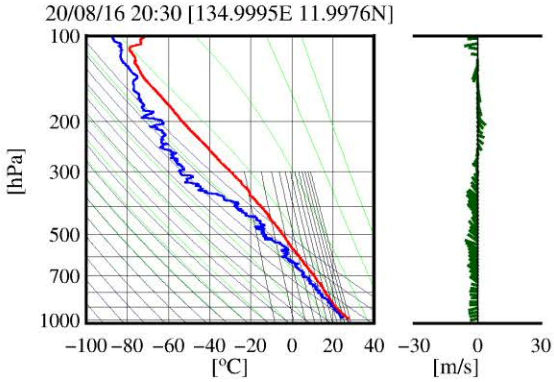
20/08/16 14:30 [134.9997E 12.0020N]



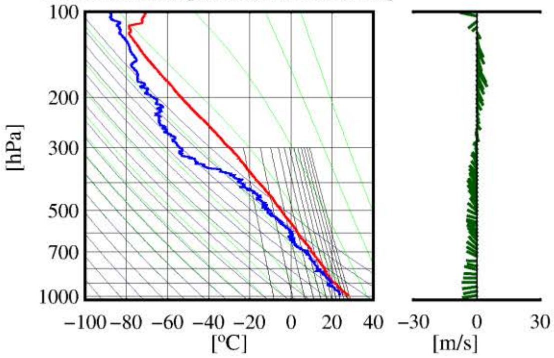
20/08/16 17:30 [134.9956E 12.0022N]



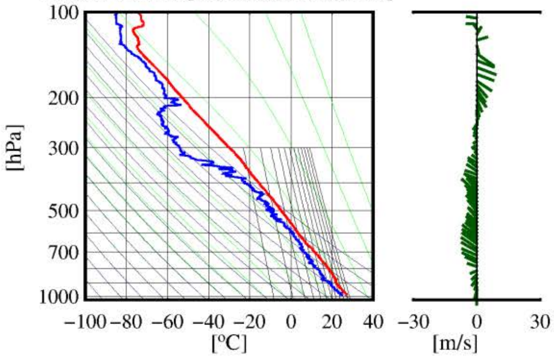
20/08/16 20:30 [134.9995E 11.9976N]



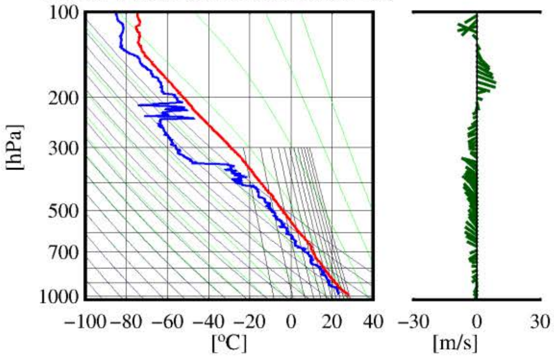
20/08/16 23:30 [134.9990E 11.9557N]



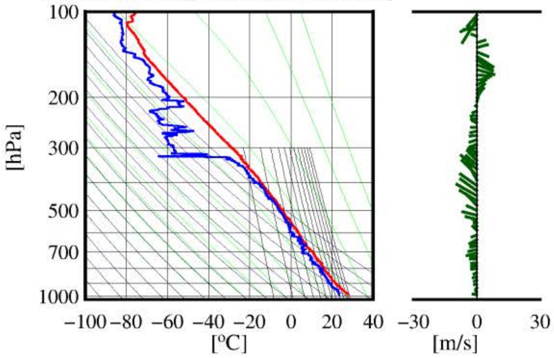
20/08/17 02:30 [135.0008E 12.0010N]



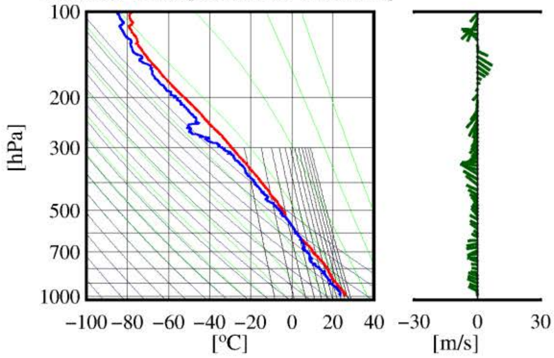
20/08/17 05:31 [134.9993E 12.0014N]



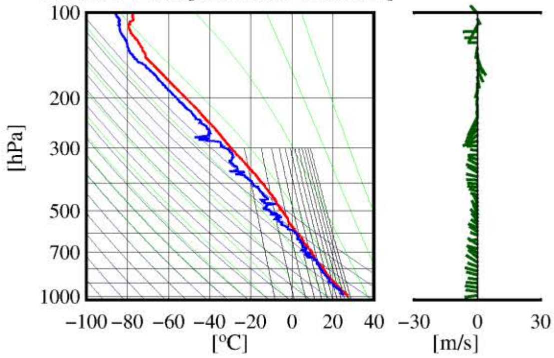
20/08/17 08:30 [135.0018E 11.9994N]



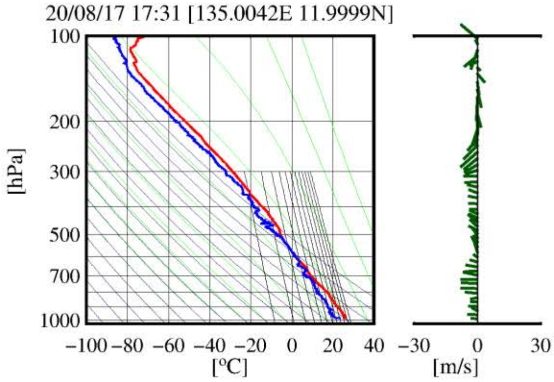
20/08/17 11:30 [135.0190E 11.9804N]



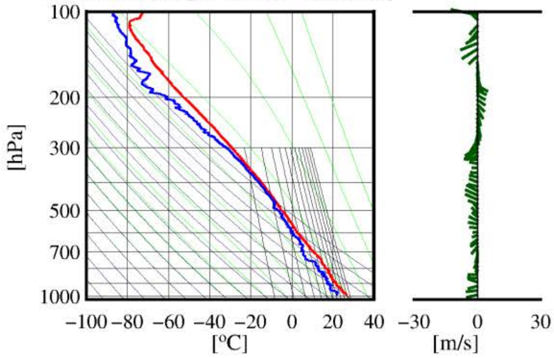
20/08/17 14:30 [135.0053E 12.0024N]

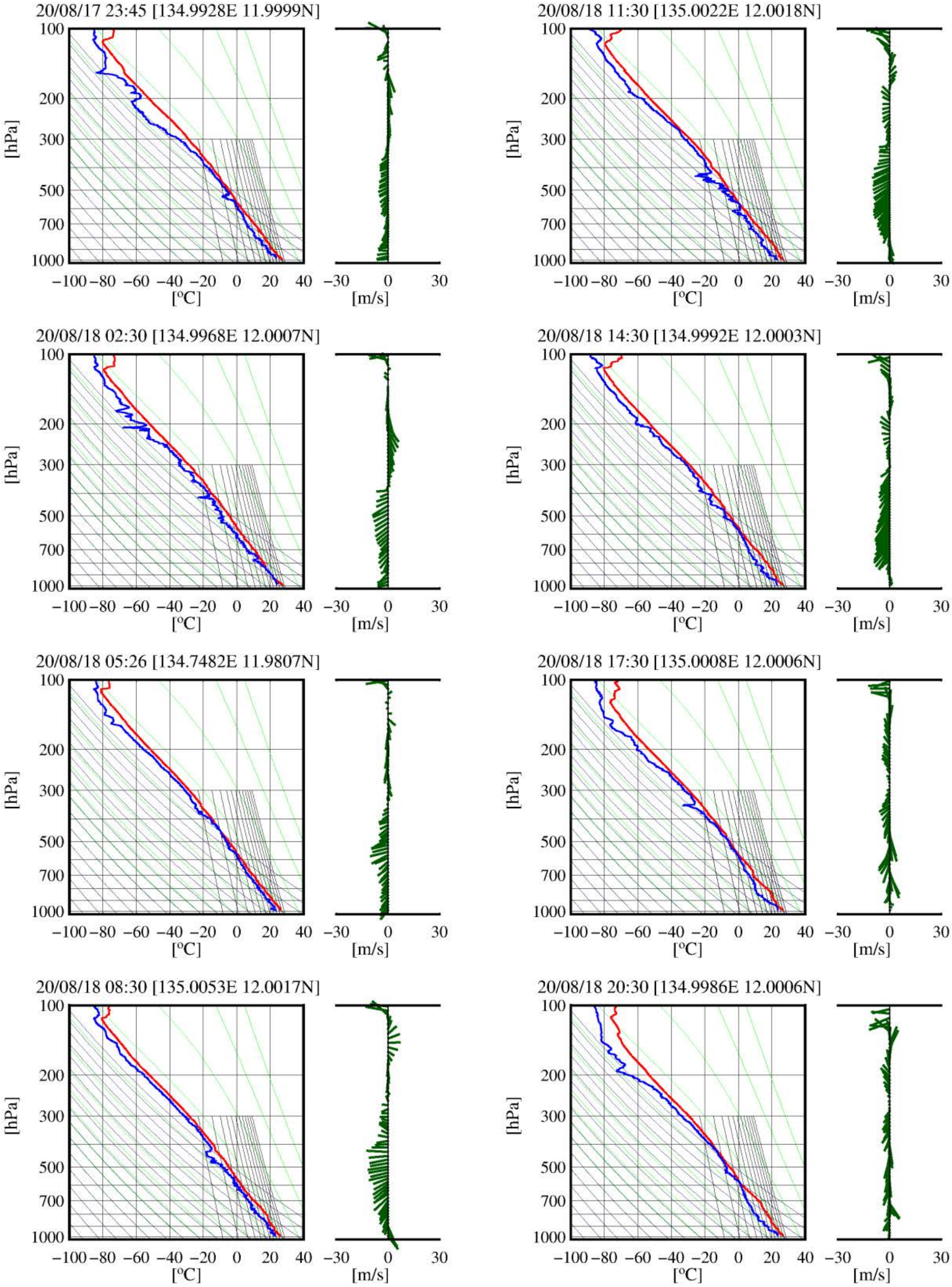


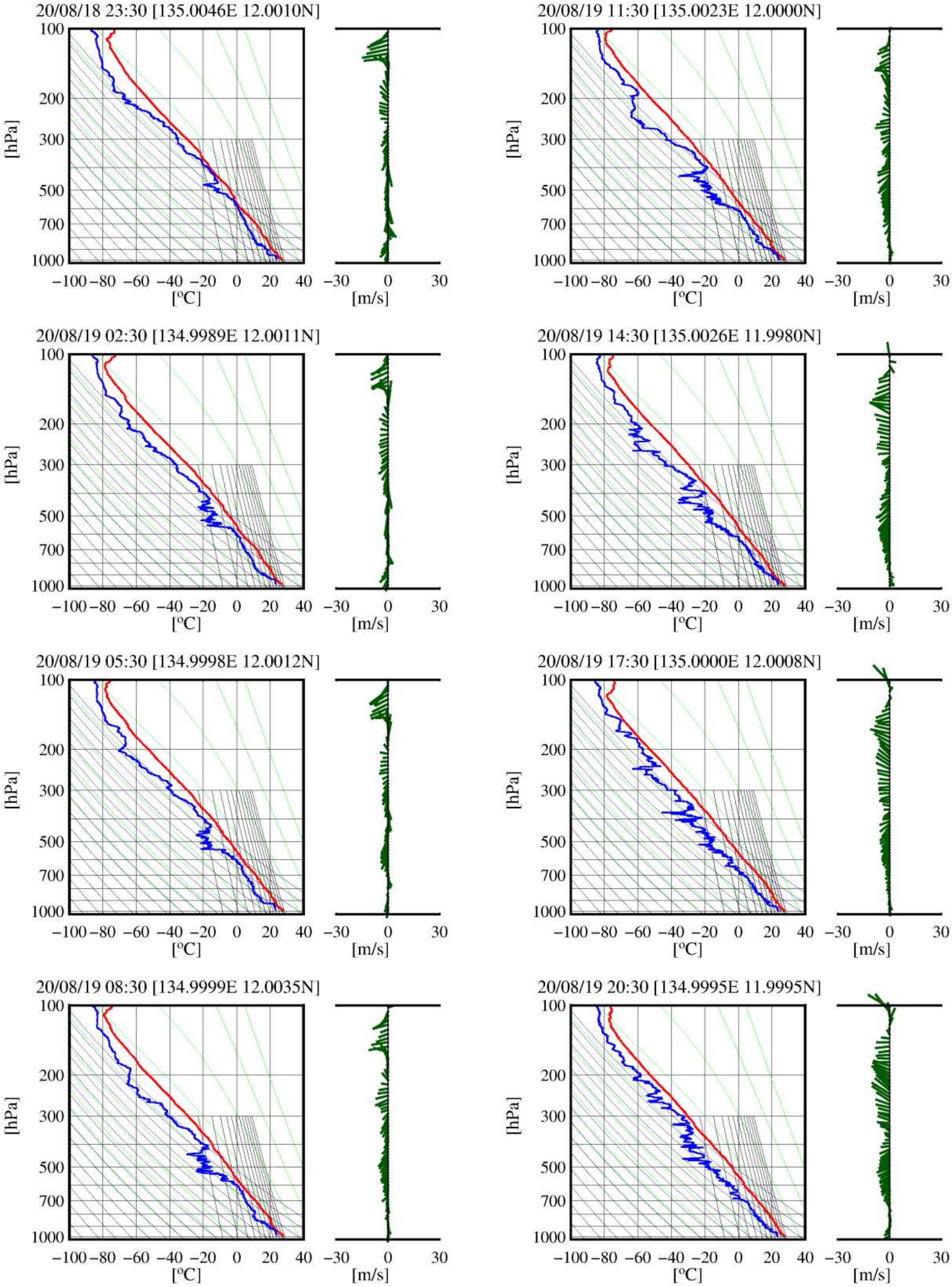
20/08/17 17:31 [135.0042E 11.9999N]

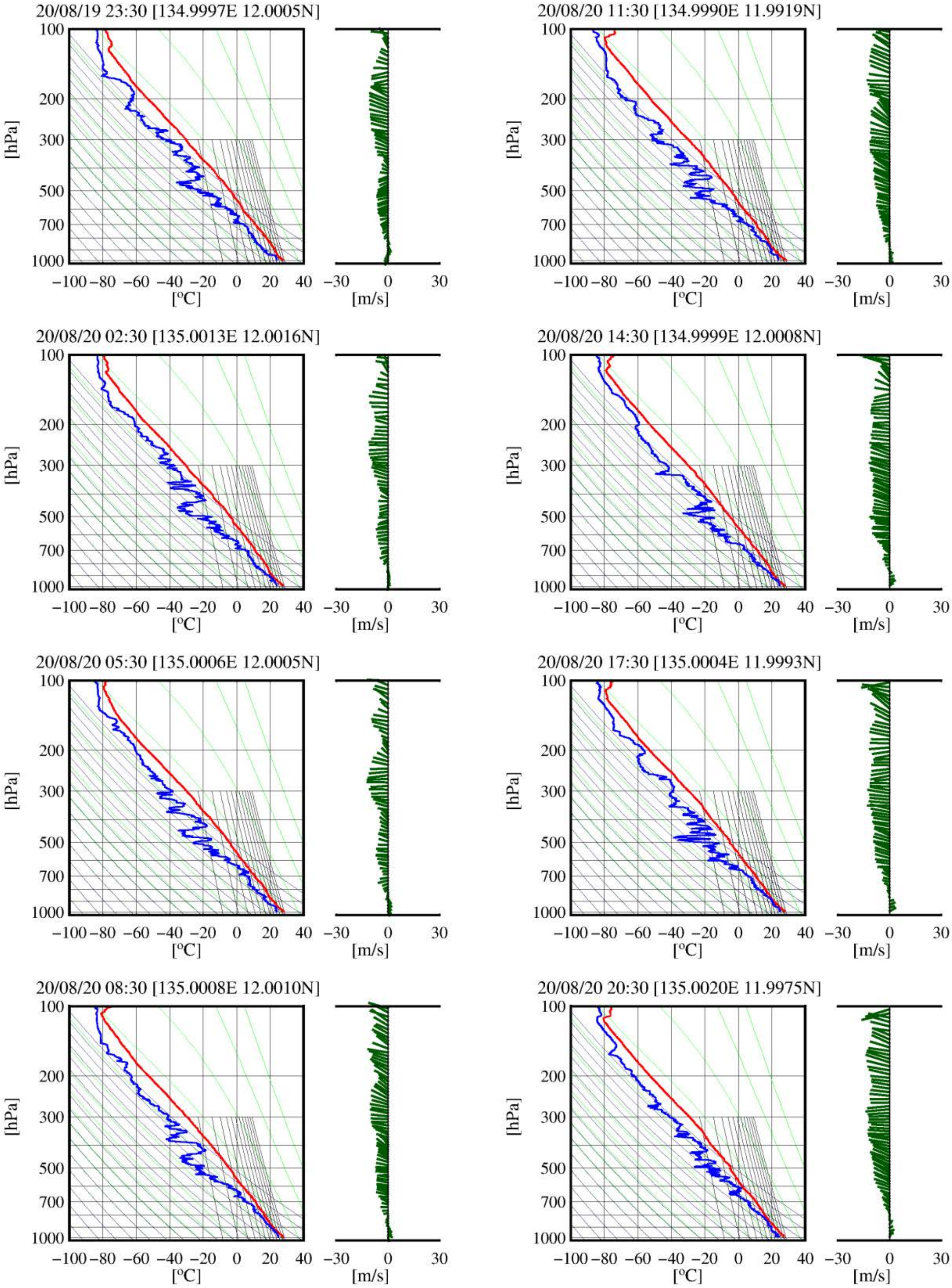


20/08/17 20:30 [134.9981E 11.9994N]



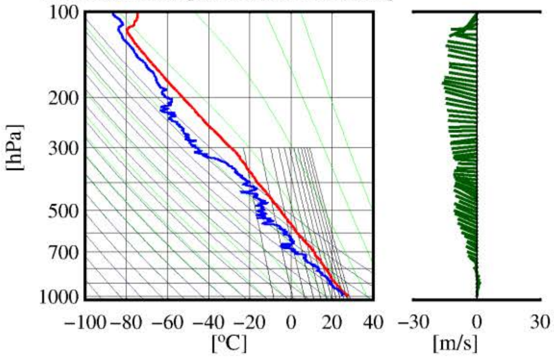

20/08/17 23:45 [134.9928E 11.9999N]
20/08/18 11:30 [135.0022E 12.0018N]
20/08/18 02:30 [134.9968E 12.0007N]
20/08/18 14:30 [134.9992E 12.0003N]
20/08/18 05:26 [134.7482E 11.9807N]
20/08/18 17:30 [135.0008E 12.0006N]
20/08/18 08:30 [135.0053E 12.0017N]
20/08/18 20:30 [134.9986E 12.0006N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]


20/08/18 23:30 [135.0046E 12.0010N]
20/08/19 02:30 [134.9989E 12.0011N]
20/08/19 05:30 [134.9998E 12.0012N]
20/08/19 08:30 [134.9999E 12.0035N]
20/08/19 11:30 [135.0023E 12.0000N]
20/08/19 14:30 [135.0026E 11.9980N]
20/08/19 17:30 [135.0000E 12.0008N]
20/08/19 20:30 [134.9995E 11.9995N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

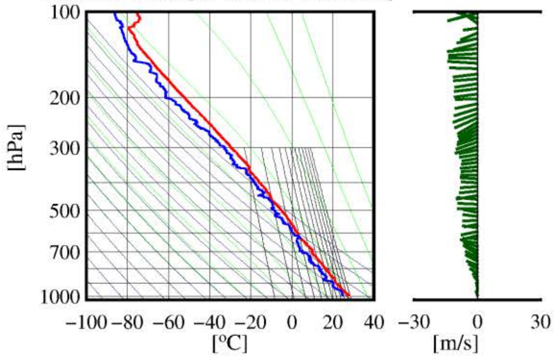


20/08/19 23:30 [134.9997E 12.0005N]
20/08/20 11:30 [134.9990E 11.9919N]
20/08/20 02:30 [135.0013E 12.0016N]
20/08/20 14:30 [134.9999E 12.0008N]
20/08/20 05:30 [135.0006E 12.0005N]
20/08/20 17:30 [135.0004E 11.9993N]
20/08/20 08:30 [135.0008E 12.0010N]
20/08/20 20:30 [135.0020E 11.9975N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

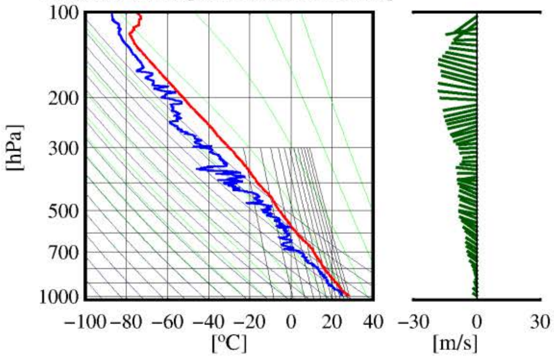
20/08/20 23:30 [134.9968E 11.9566N]



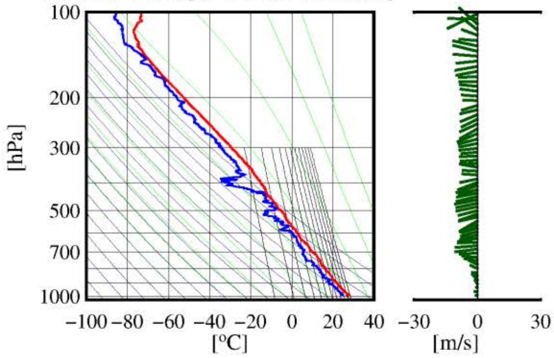
20/08/21 11:30 [134.9971E 11.9996N]



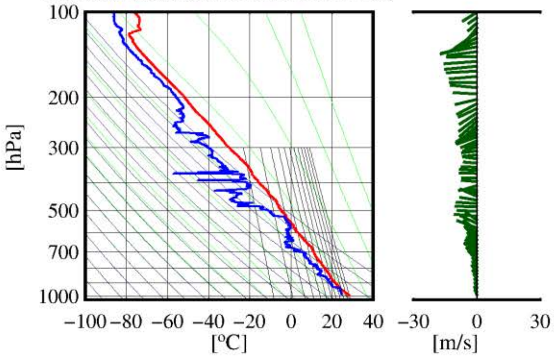
20/08/21 02:30 [134.9986E 11.9992N]



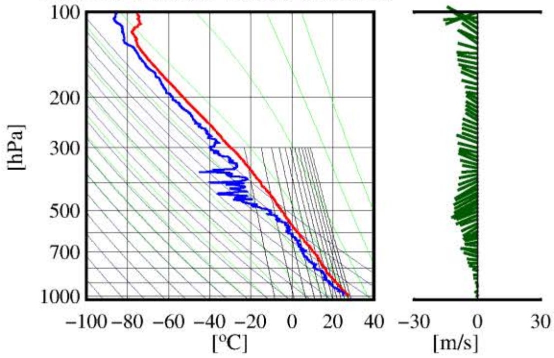
20/08/21 14:30 [134.9968E 12.0005N]



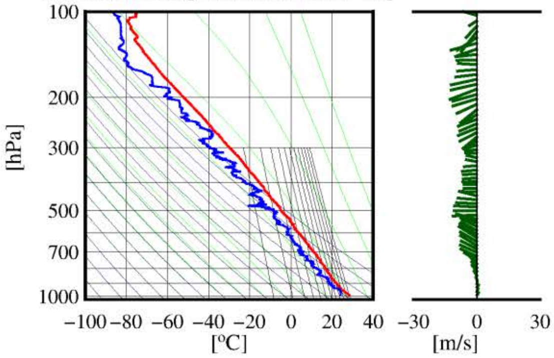
20/08/21 05:30 [134.9995E 11.9994N]



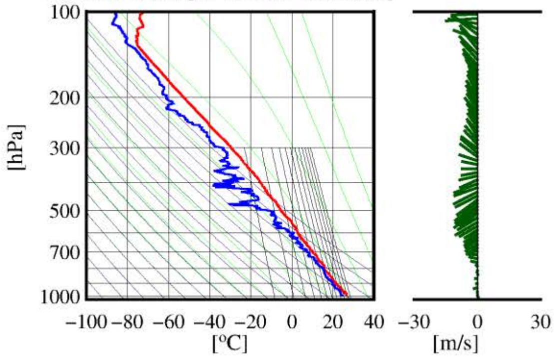
20/08/21 17:30 [134.9999E 12.0004N]



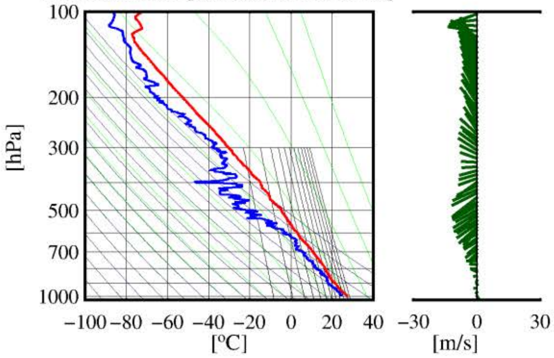
20/08/21 08:30 [135.0002E 12.0017N]



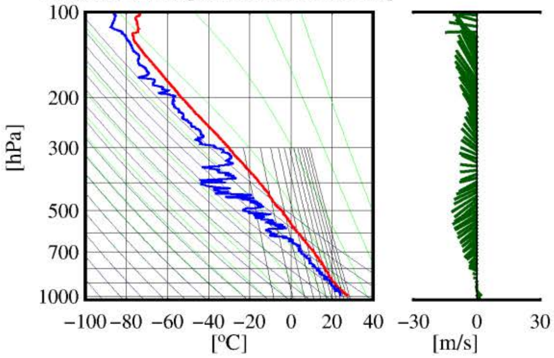
20/08/21 20:30 [134.9978E 12.0007N]



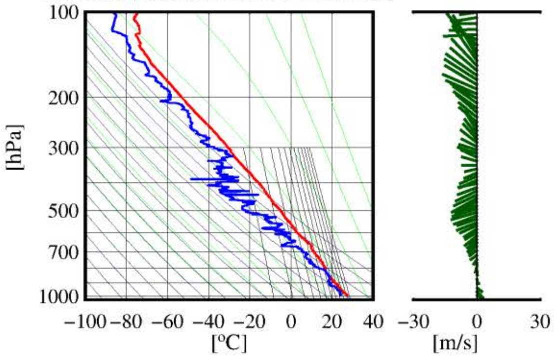
20/08/21 23:31 [135.0010E 11.9991N]



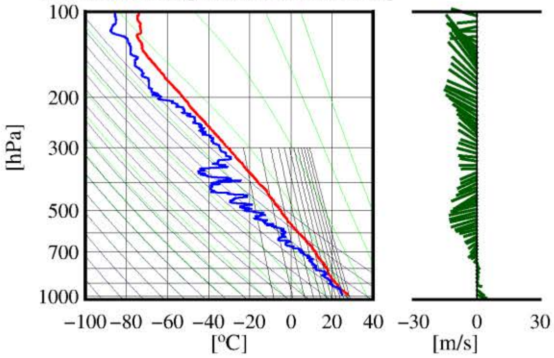
20/08/22 02:30 [134.9838E 11.9837N]



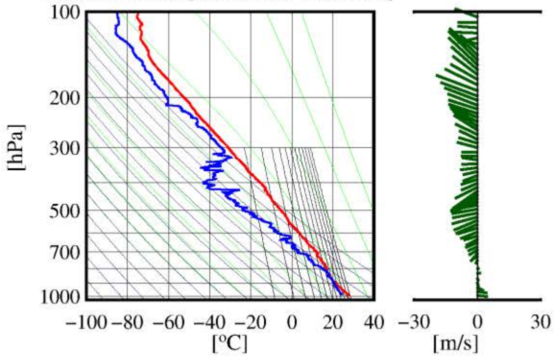
20/08/22 05:30 [134.6757E 11.8137N]



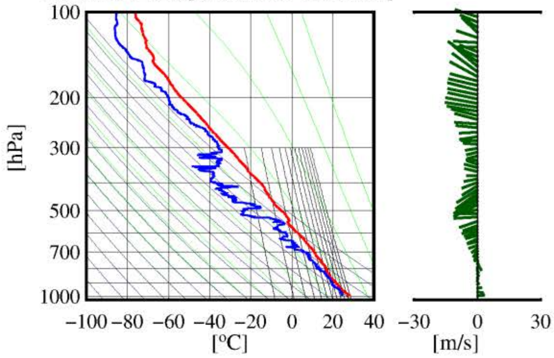
20/08/22 08:30 [135.0012E 12.0029N]



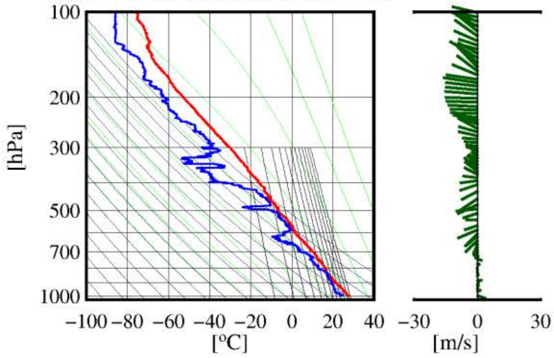
20/08/22 11:30 [135.0037E 11.9992N]



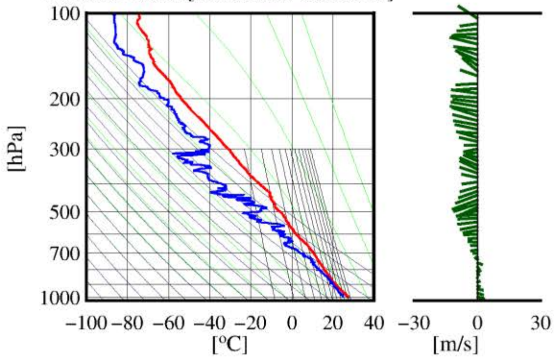
20/08/22 14:30 [135.0020E 11.9978N]



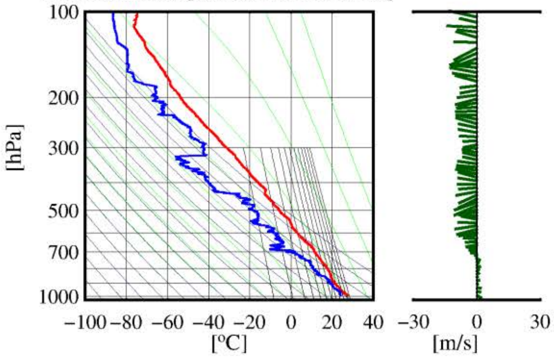
20/08/22 17:31 [135.0003E 11.9944N]



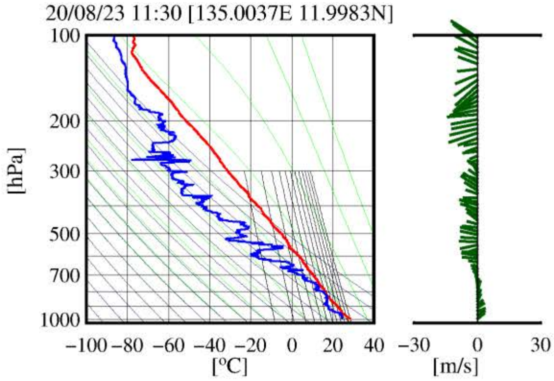
20/08/22 20:30 [135.0053E 11.9982N]



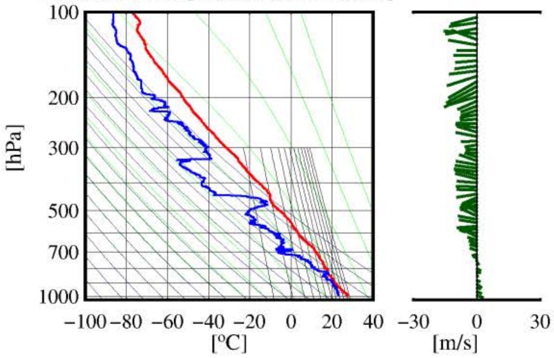
20/08/22 23:30 [135.0040E 11.9979N]



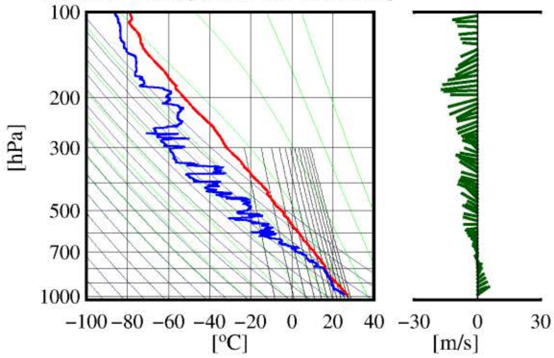
20/08/23 11:30 [135.0037E 11.9983N]



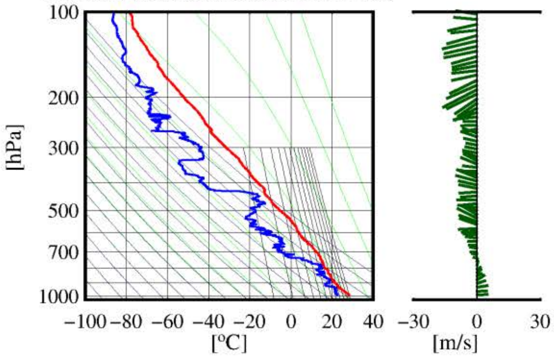
20/08/23 02:30 [135.0016E 11.9986N]



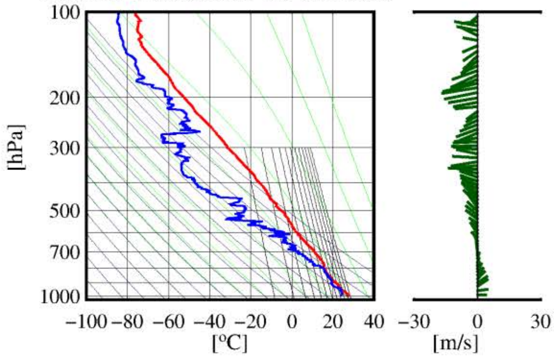
20/08/23 14:30 [135.0048E 11.9975N]



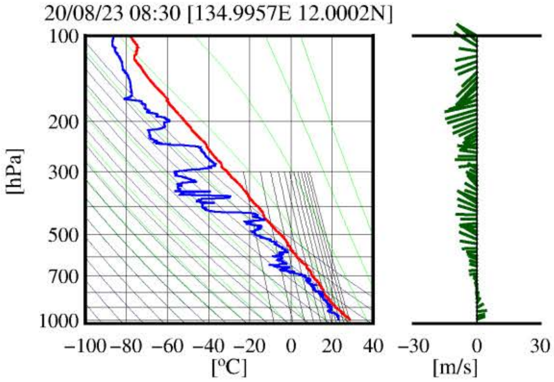
20/08/23 05:30 [135.0013E 11.9997N]



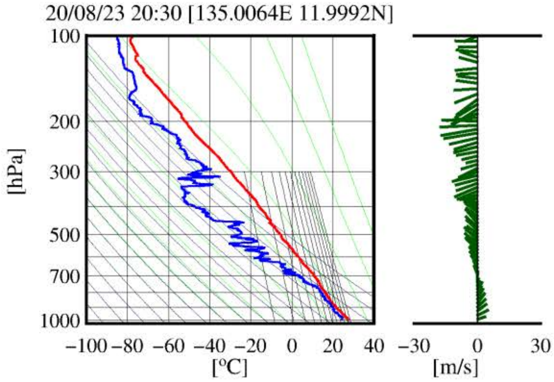
20/08/23 17:30 [135.0045E 11.9957N]

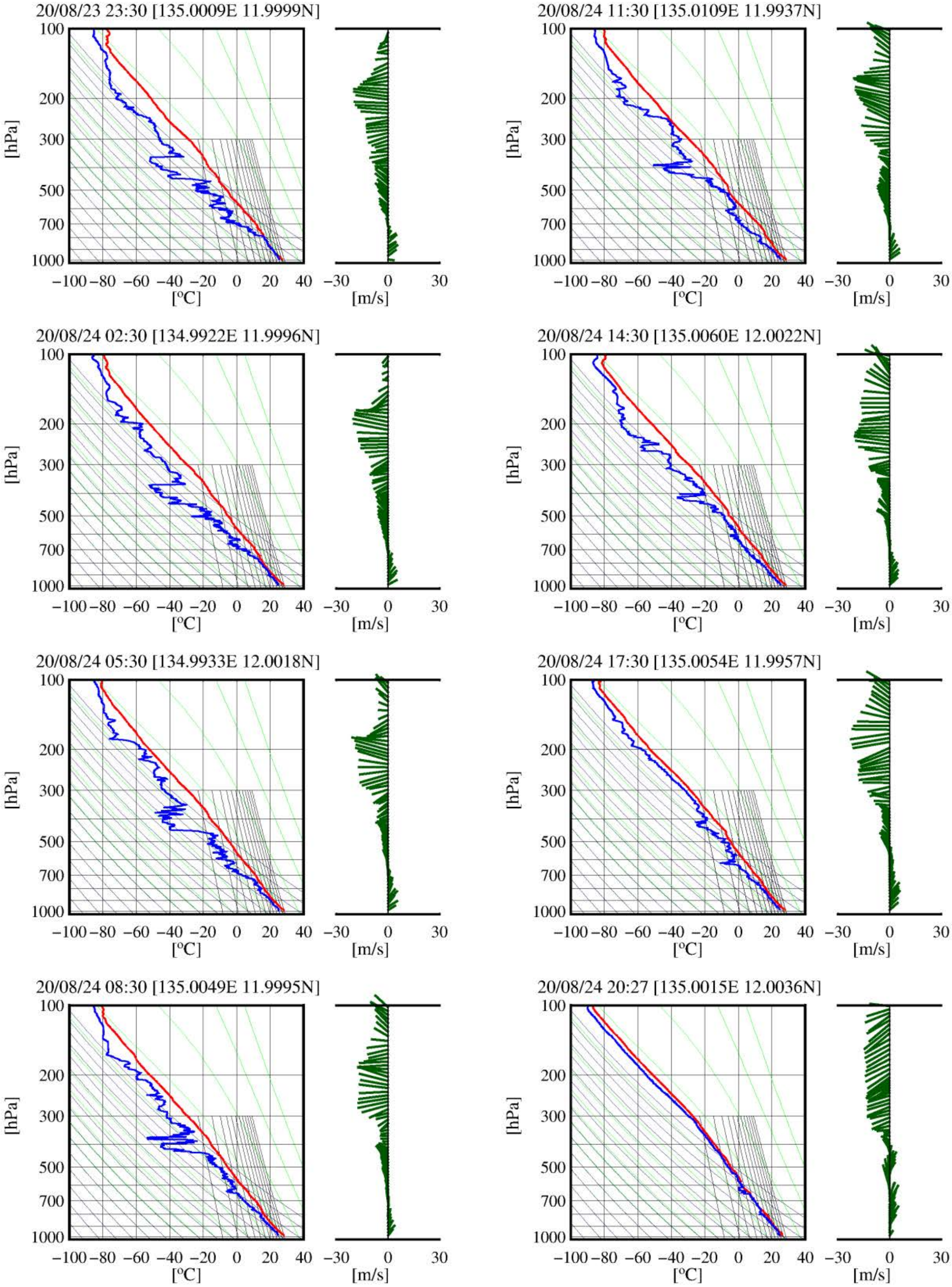


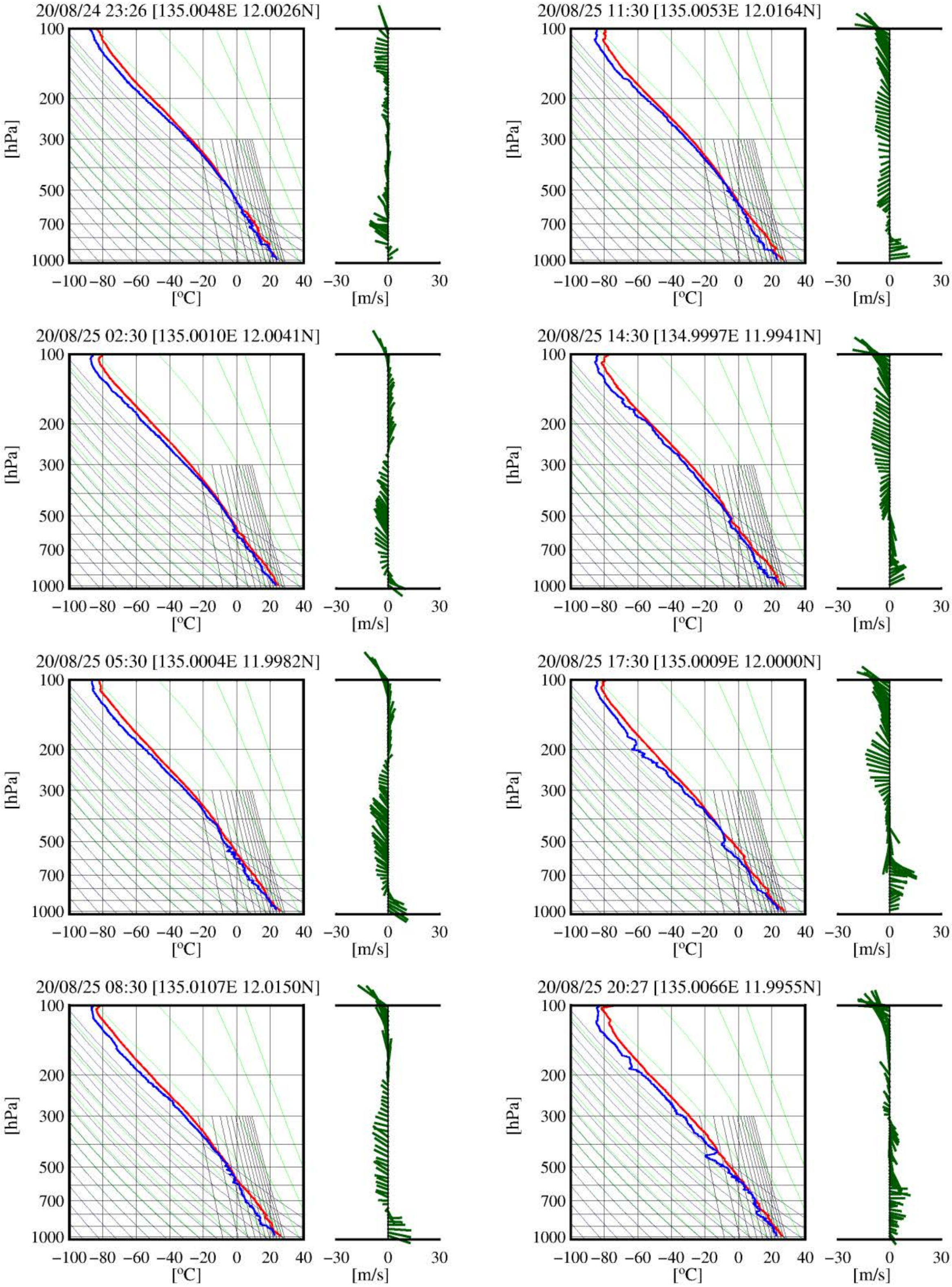
20/08/23 08:30 [134.9957E 12.0002N]



20/08/23 20:30 [135.0064E 11.9992N]

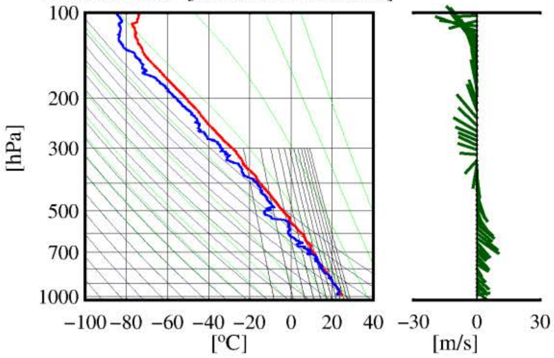



20/08/23 23:30 [135.0009E 11.9999N]
20/08/24 02:30 [134.9922E 11.9996N]
20/08/24 05:30 [134.9933E 12.0018N]
20/08/24 08:30 [135.0049E 11.9995N]
20/08/24 11:30 [135.0109E 11.9937N]
20/08/24 14:30 [135.0060E 12.0022N]
20/08/24 17:30 [135.0054E 11.9957N]
20/08/24 20:27 [135.0015E 12.0036N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

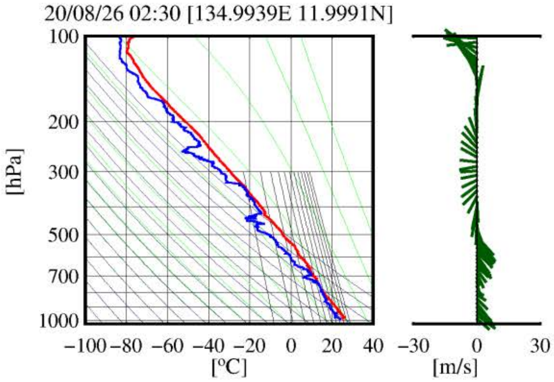


20/08/24 23:26 [135.0048E 12.0026N]
20/08/25 02:30 [135.0010E 12.0041N]
20/08/25 05:30 [135.0004E 11.9982N]
20/08/25 08:30 [135.0107E 12.0150N]
20/08/25 11:30 [135.0053E 12.0164N]
20/08/25 14:30 [134.9997E 11.9941N]
20/08/25 17:30 [135.0009E 12.0000N]
20/08/25 20:27 [135.0066E 11.9955N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

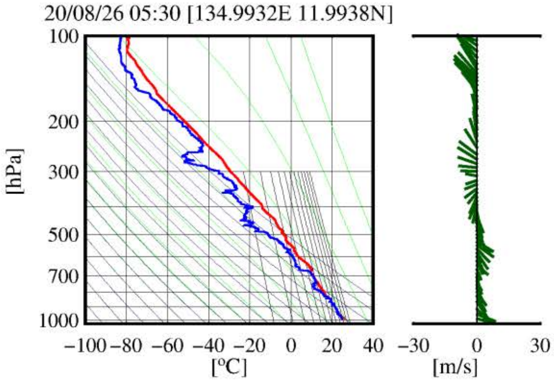
20/08/25 23:24 [135.0010E 12.0000N]



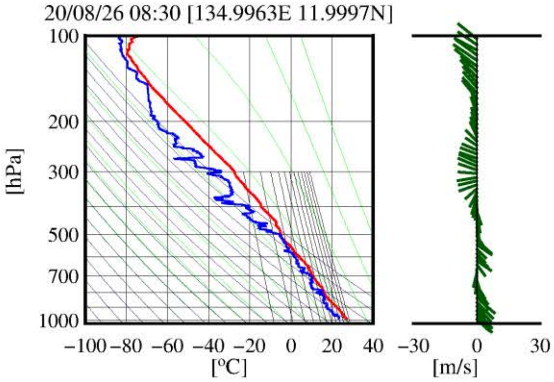
20/08/26 02:30 [134.9939E 11.9991N]



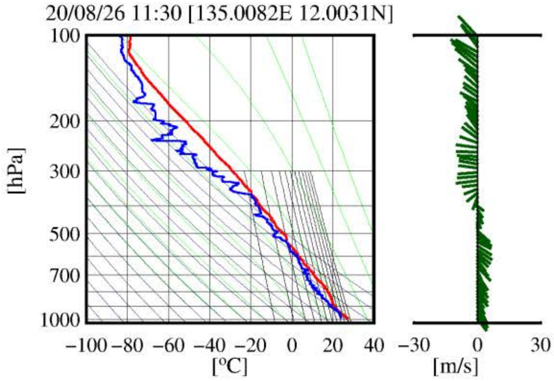
20/08/26 05:30 [134.9932E 11.9938N]



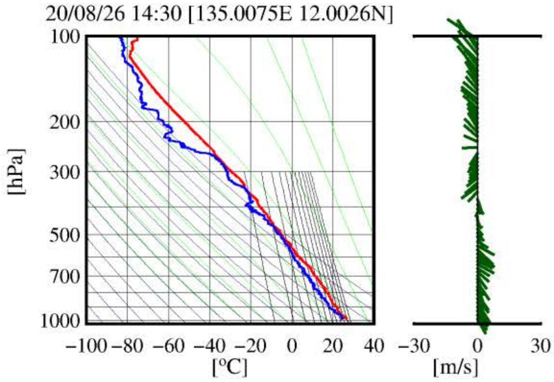
20/08/26 08:30 [134.9963E 11.9997N]



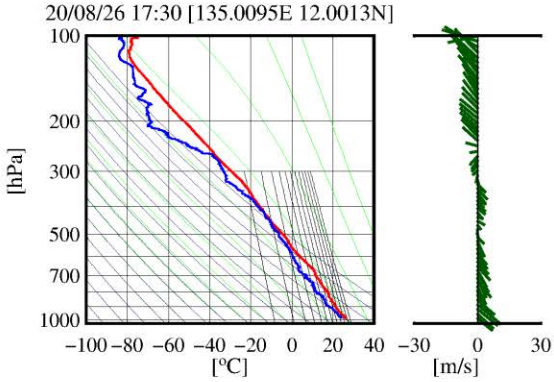
20/08/26 11:30 [135.0082E 12.0031N]



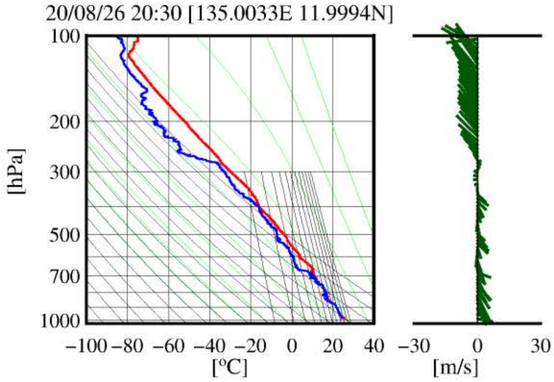
20/08/26 14:30 [135.0075E 12.0026N]



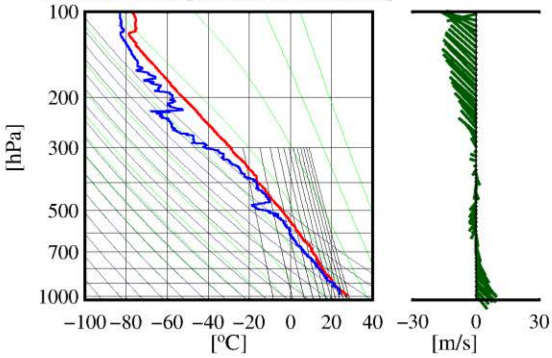
20/08/26 17:30 [135.0095E 12.0013N]



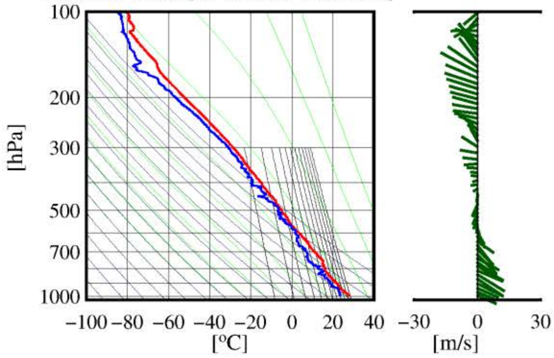
20/08/26 20:30 [135.0033E 11.9994N]



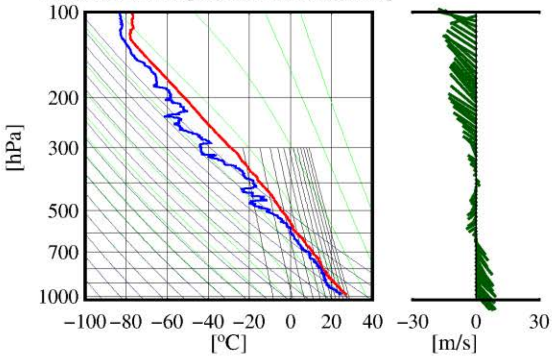
20/08/26 23:30 [135.0028E 12.0004N]



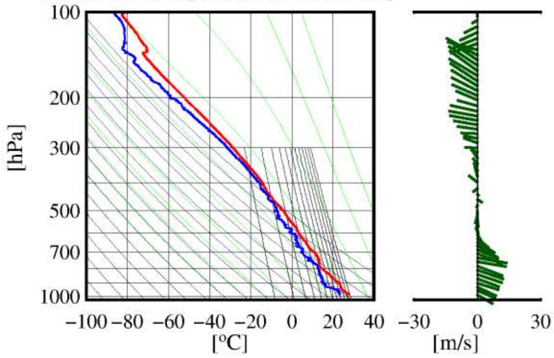
20/08/27 11:30 [134.9996E 11.9994N]



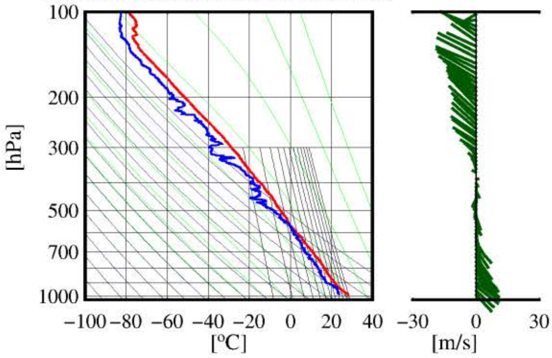
20/08/27 02:30 [135.0037E 12.0004N]



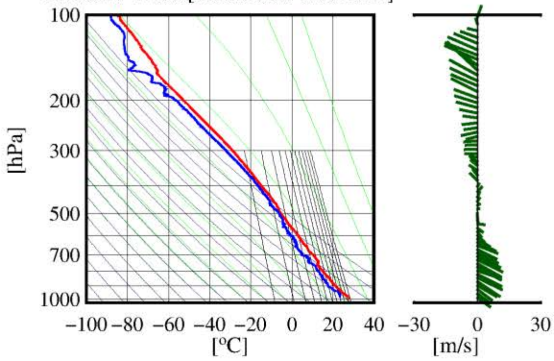
20/08/27 14:30 [135.0033E 11.9993N]



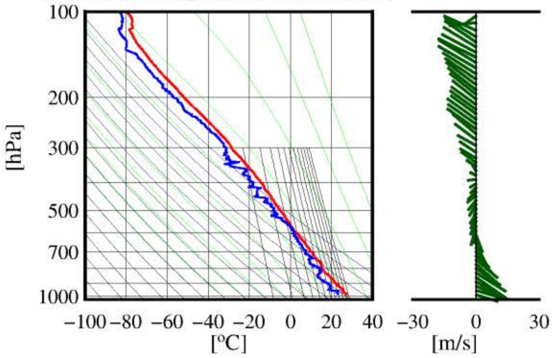
20/08/27 05:30 [135.0015E 12.0011N]



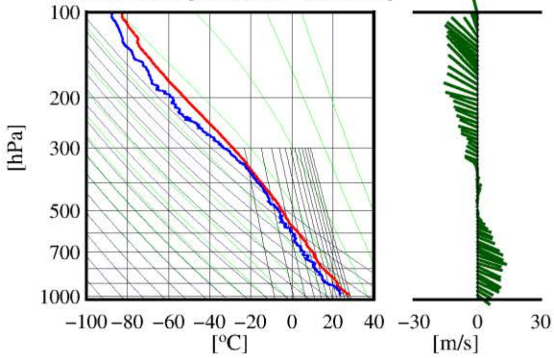
20/08/27 17:30 [135.0030E 12.0031N]

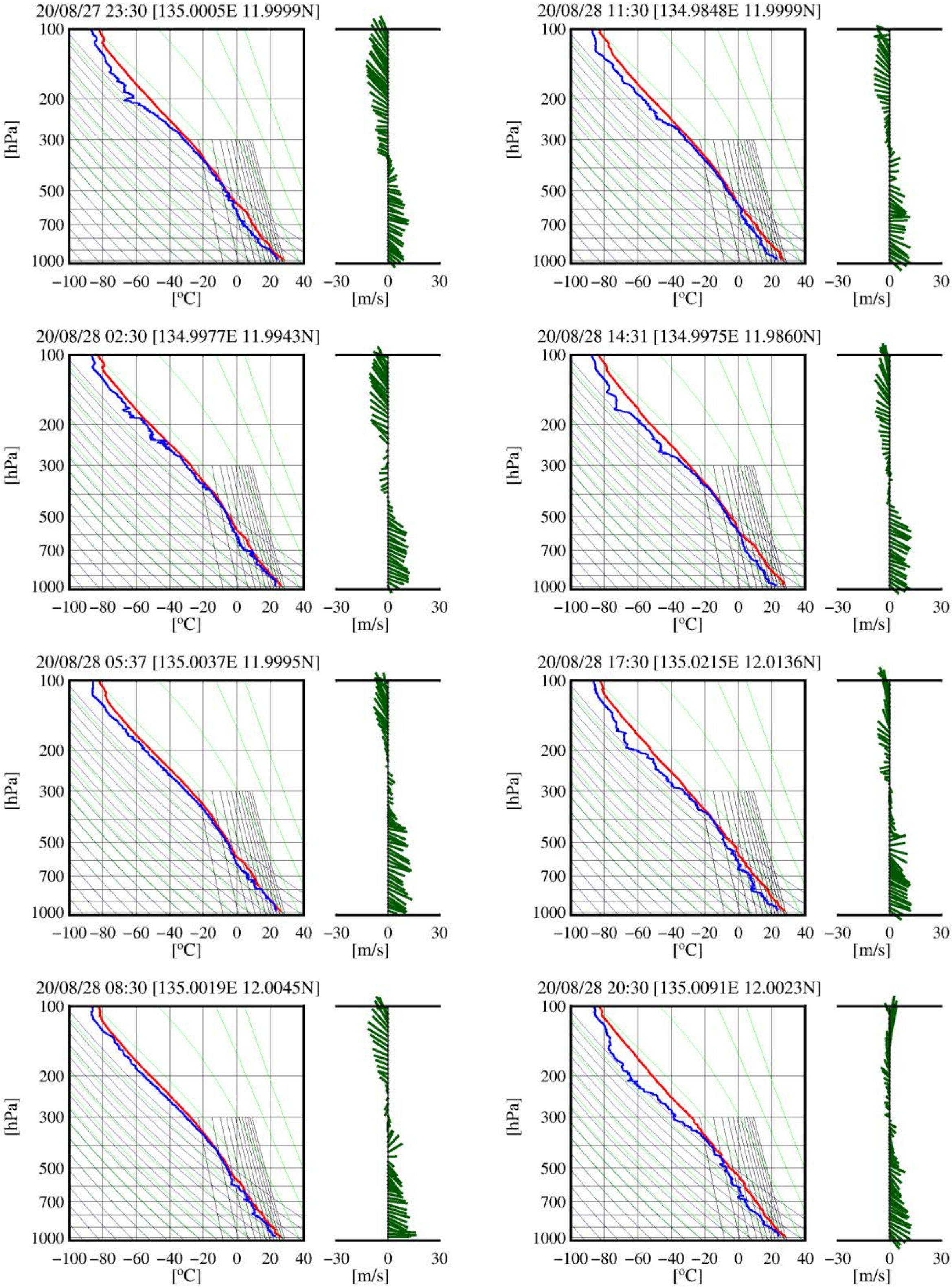


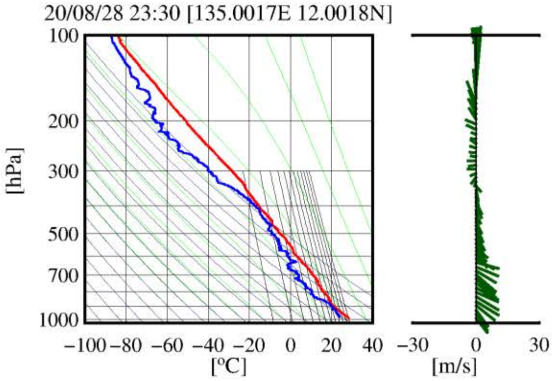
20/08/27 08:30 [135.0093E 12.0003N]

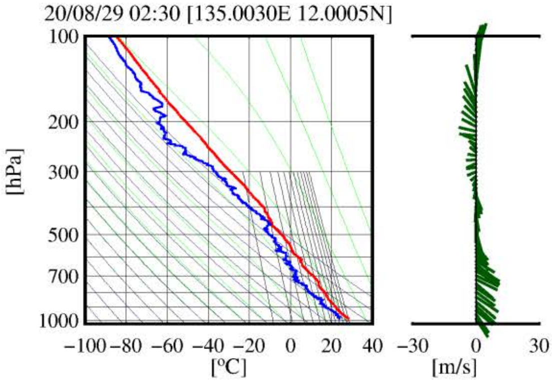


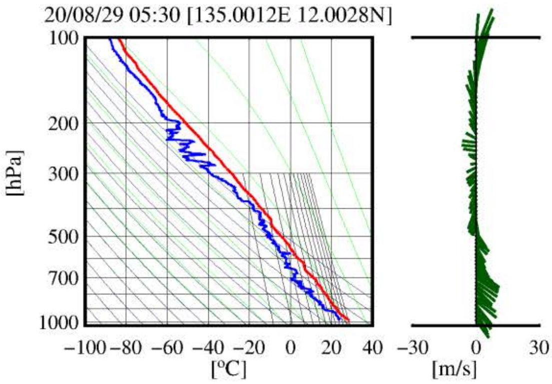
20/08/27 20:30 [135.0022E 12.0006N]

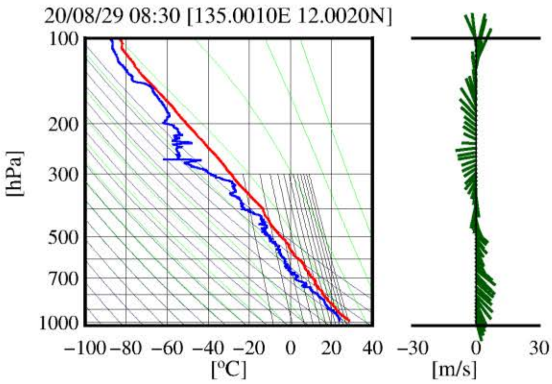


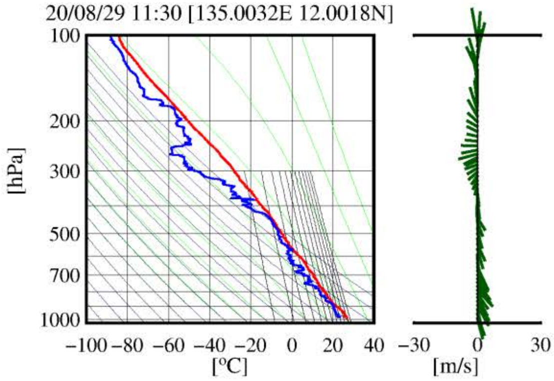

20/08/27 23:30 [135.0005E 11.9999N]
20/08/28 11:30 [134.9848E 11.9999N]
20/08/28 02:30 [134.9977E 11.9943N]
20/08/28 14:31 [134.9975E 11.9860N]
20/08/28 05:37 [135.0037E 11.9995N]
20/08/28 17:30 [135.0215E 12.0136N]
20/08/28 08:30 [135.0019E 12.0045N]
20/08/28 20:30 [135.0091E 12.0023N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[^{o}C]
−30 0 30
[m/s]

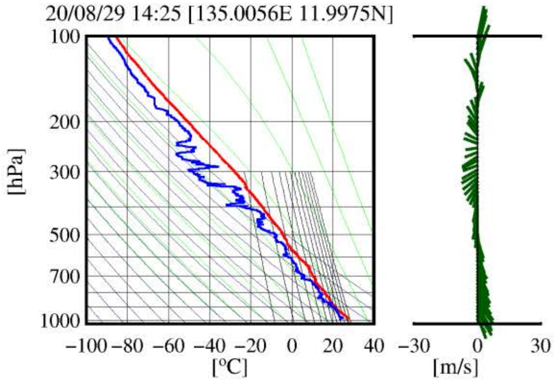

20/08/28 23:30 [135.0017E 12.0018N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

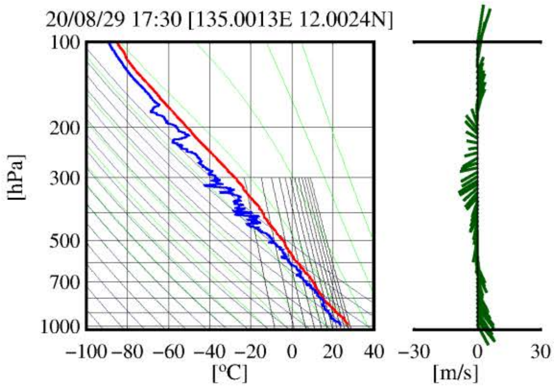

20/08/29 02:30 [135.0030E 12.0005N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

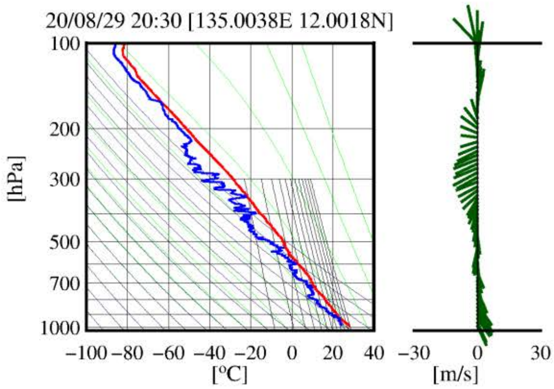

20/08/29 05:30 [135.0012E 12.0028N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

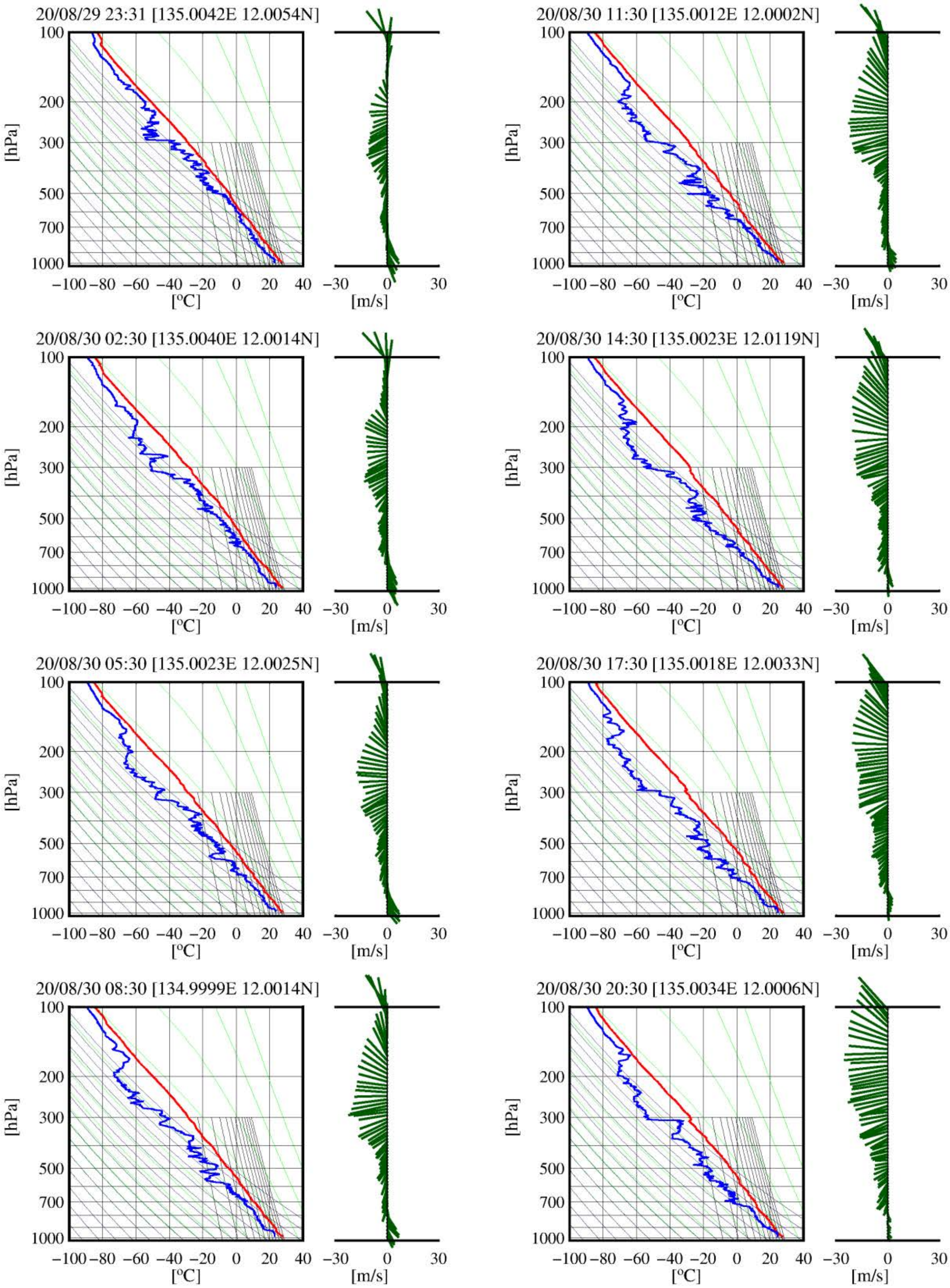

20/08/29 08:30 [135.0010E 12.0020N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

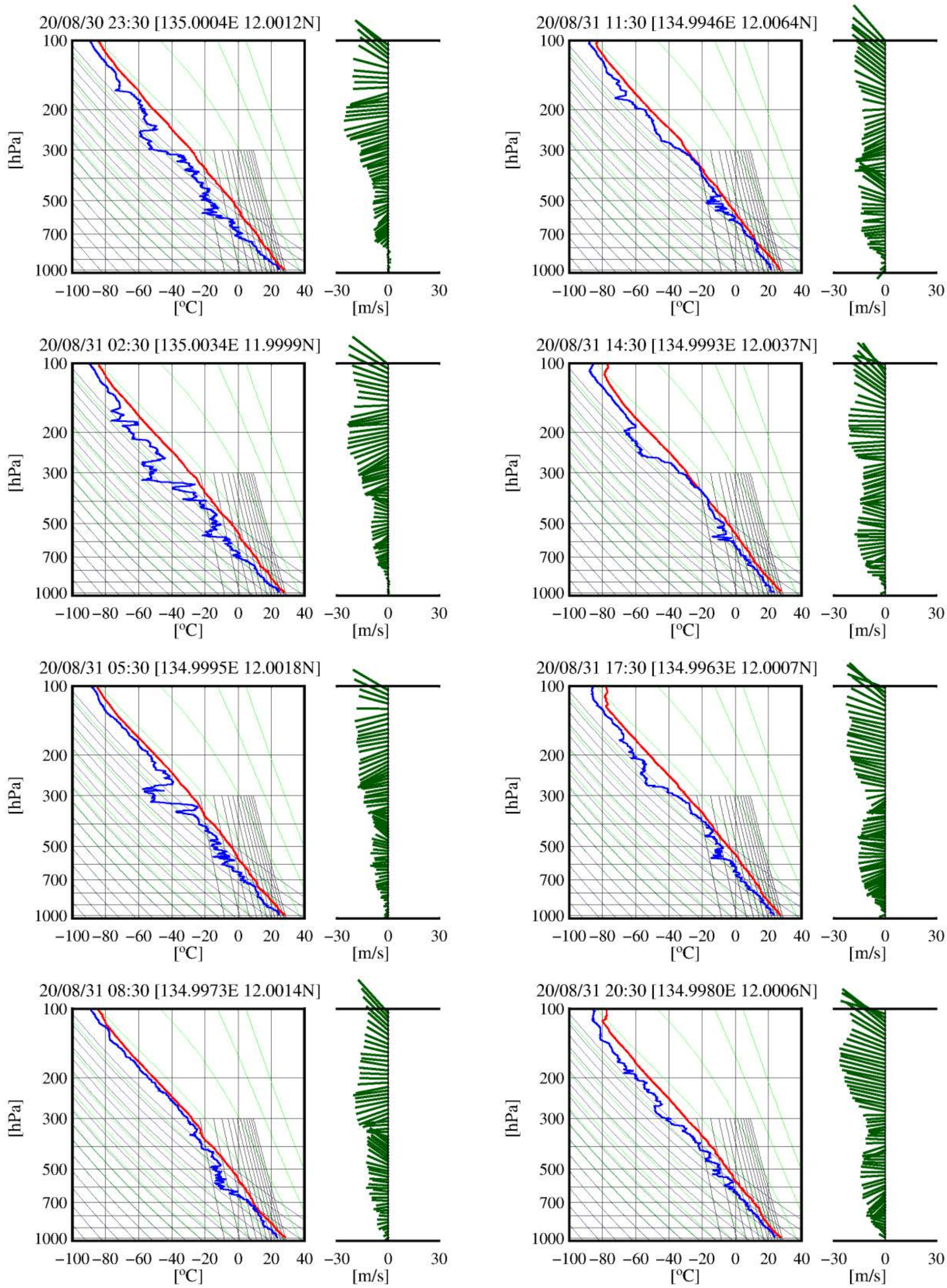

20/08/29 11:30 [135.0032E 12.0018N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

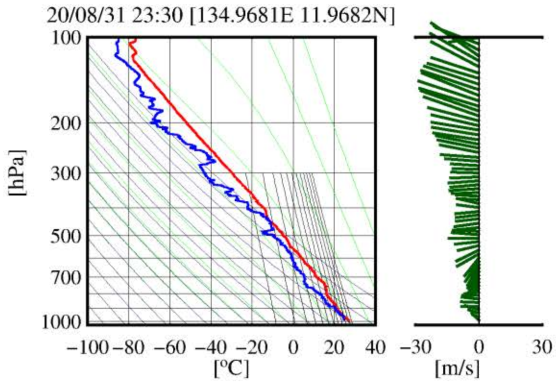

20/08/29 14:25 [135.0056E 11.9975N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

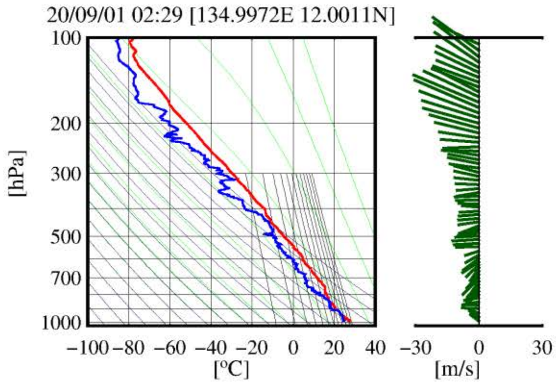

20/08/29 17:30 [135.0013E 12.0024N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

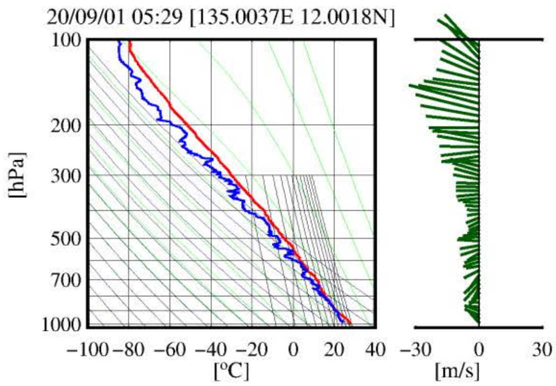

20/08/29 20:30 [135.0038E 12.0018N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

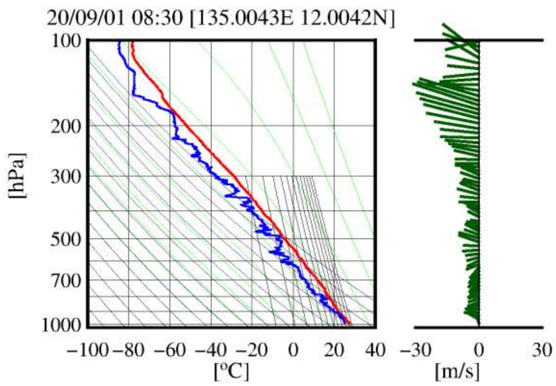

20/08/29 23:31 [135.0042E 12.0054N]
20/08/30 11:30 [135.0012E 12.0002N]
20/08/30 02:30 [135.0040E 12.0014N]
20/08/30 14:30 [135.0023E 12.0119N]
20/08/30 05:30 [135.0023E 12.0025N]
20/08/30 17:30 [135.0018E 12.0033N]
20/08/30 08:30 [134.9999E 12.0014N]
20/08/30 20:30 [135.0034E 12.0006N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[^{o}C]
−30 0 30
[m/s]

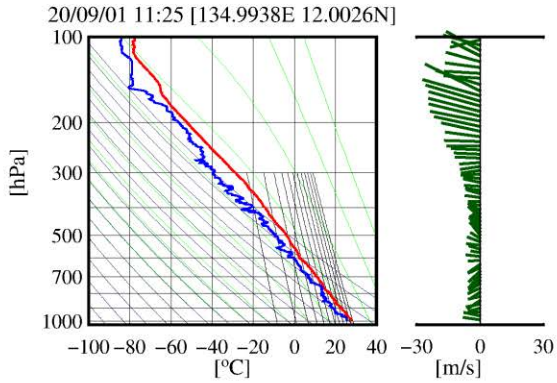

20/08/30 23:30 [135.0004E 12.0012N]
20/08/31 02:30 [135.0034E 11.9999N]
20/08/31 05:30 [134.9995E 12.0018N]
20/08/31 08:30 [134.9973E 12.0014N]
20/08/31 11:30 [134.9946E 12.0064N]
20/08/31 14:30 [134.9993E 12.0037N]
20/08/31 17:30 [134.9963E 12.0007N]
20/08/31 20:30 [134.9980E 12.0006N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

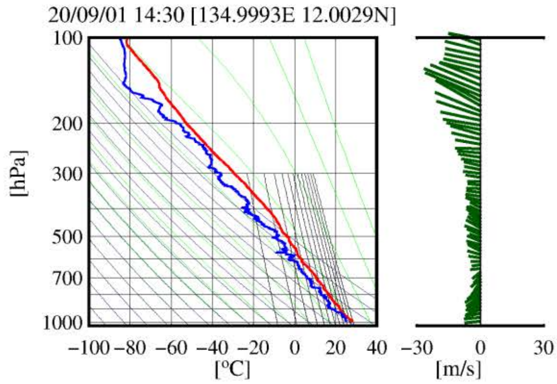

20/08/31 23:30 [134.9681E 11.9682N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

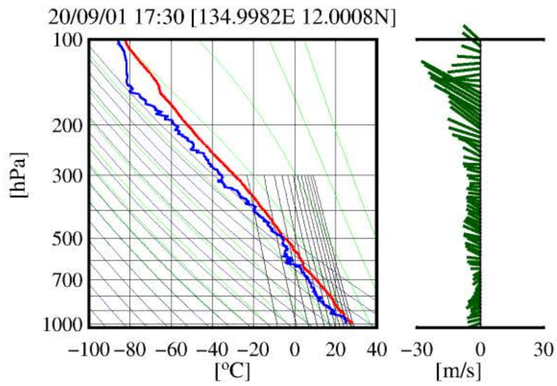

20/09/01 02:29 [134.9972E 12.0011N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

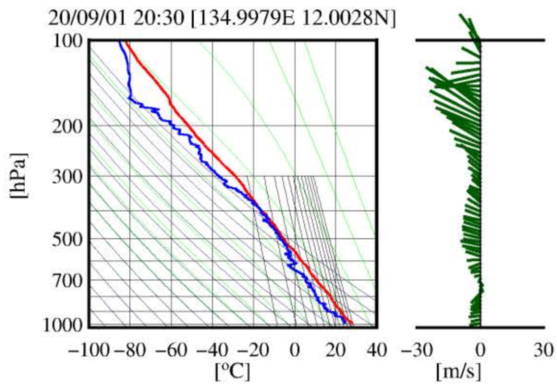

20/09/01 05:29 [135.0037E 12.0018N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]


20/09/01 08:30 [135.0043E 12.0042N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

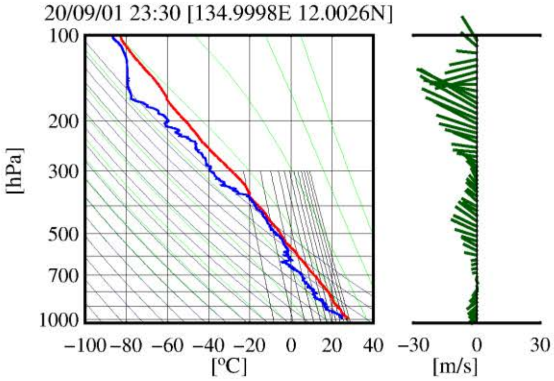

20/09/01 11:25 [134.9938E 12.0026N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]


20/09/01 14:30 [134.9993E 12.0029N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

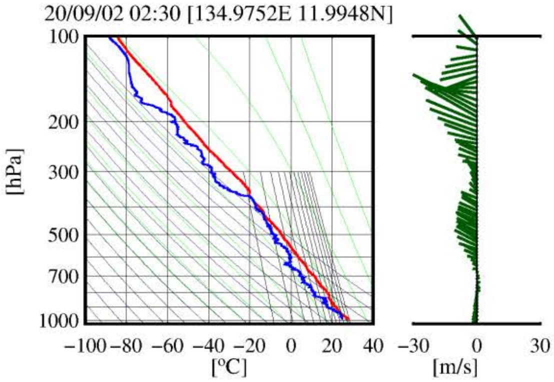

20/09/01 17:30 [134.9982E 12.0008N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]


20/09/01 20:30 [134.9979E 12.0028N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

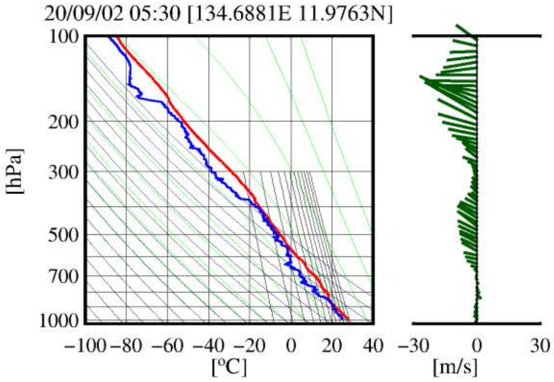
20/09/01 23:30 [134.9998E 12.0026N]



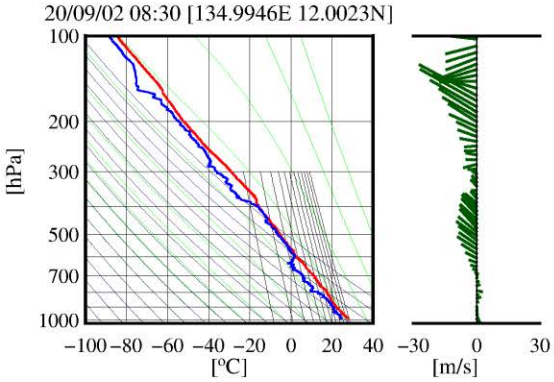
20/09/02 02:30 [134.9752E 11.9948N]



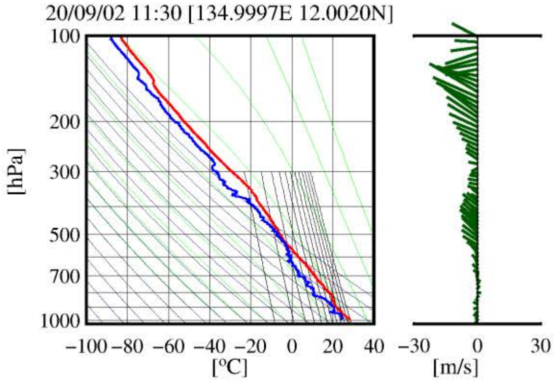
20/09/02 05:30 [134.6881E 11.9763N]



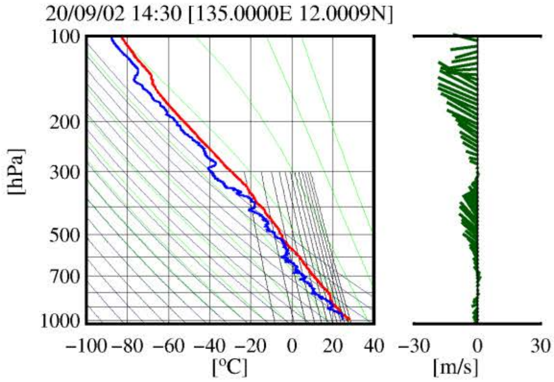
20/09/02 08:30 [134.9946E 12.0023N]



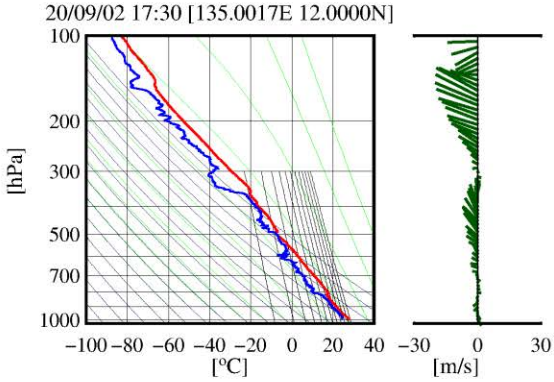
20/09/02 11:30 [134.9997E 12.0020N]



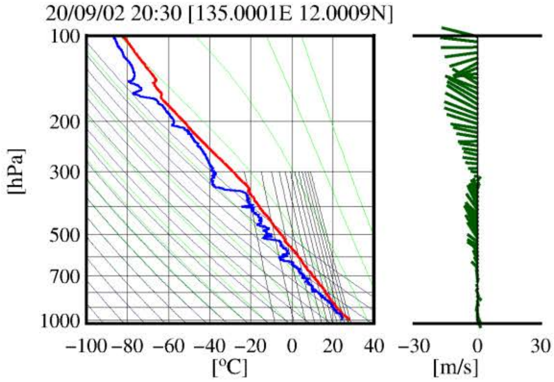
20/09/02 14:30 [135.0000E 12.0009N]



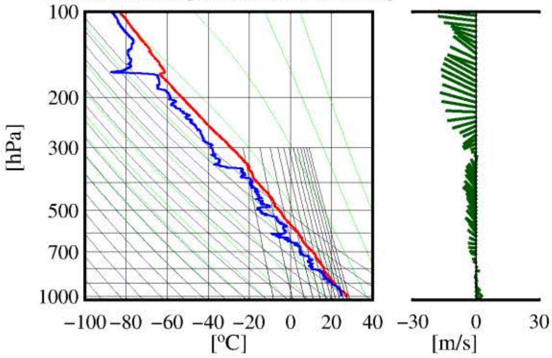
20/09/02 17:30 [135.0017E 12.0000N]



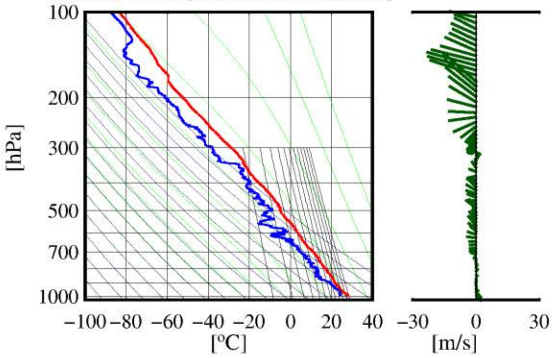
20/09/02 20:30 [135.0001E 12.0009N]



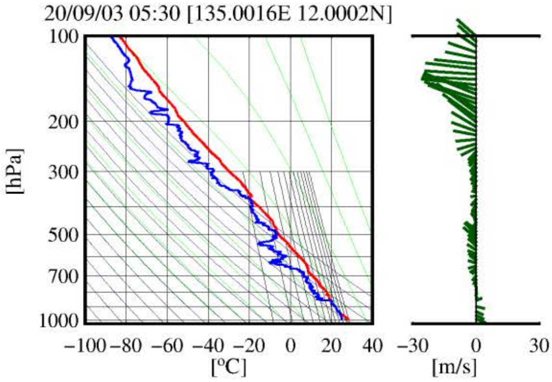
20/09/02 23:30 [135.0013E 11.9999N]



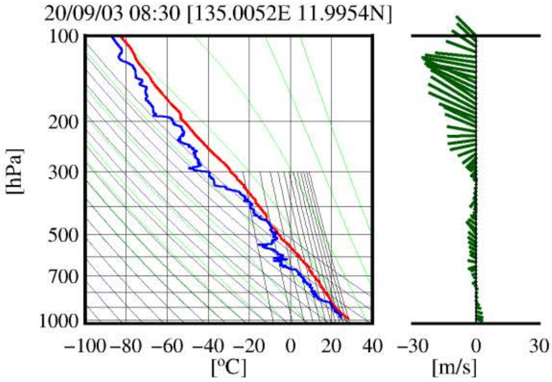
20/09/03 02:30 [135.0009E 12.0003N]



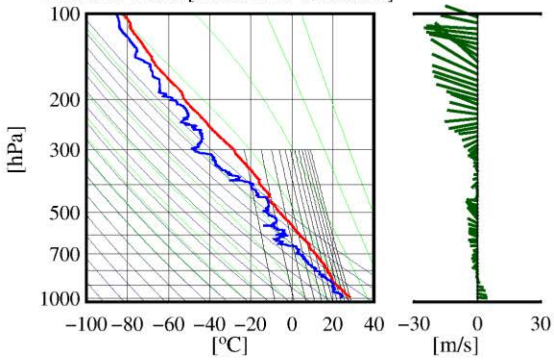
20/09/03 05:30 [135.0016E 12.0002N]



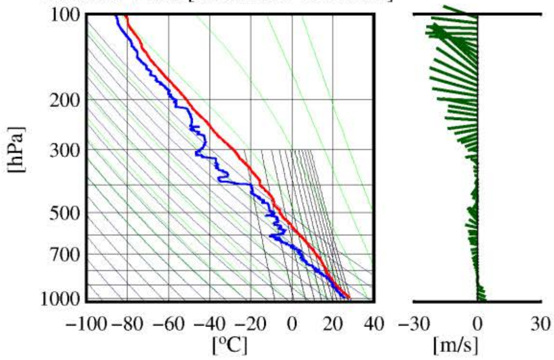
20/09/03 08:30 [135.0052E 11.9954N]



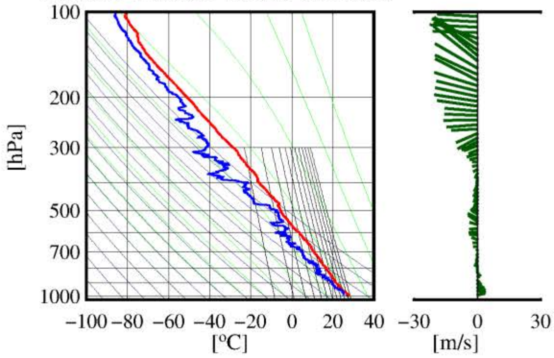
20/09/03 11:30 [135.0024E 11.9985N]



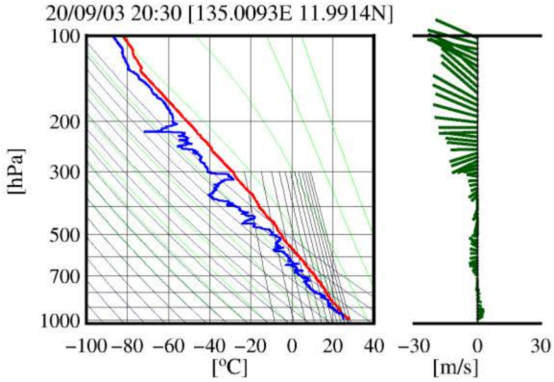
20/09/03 14:30 [135.0030E 11.9995N]

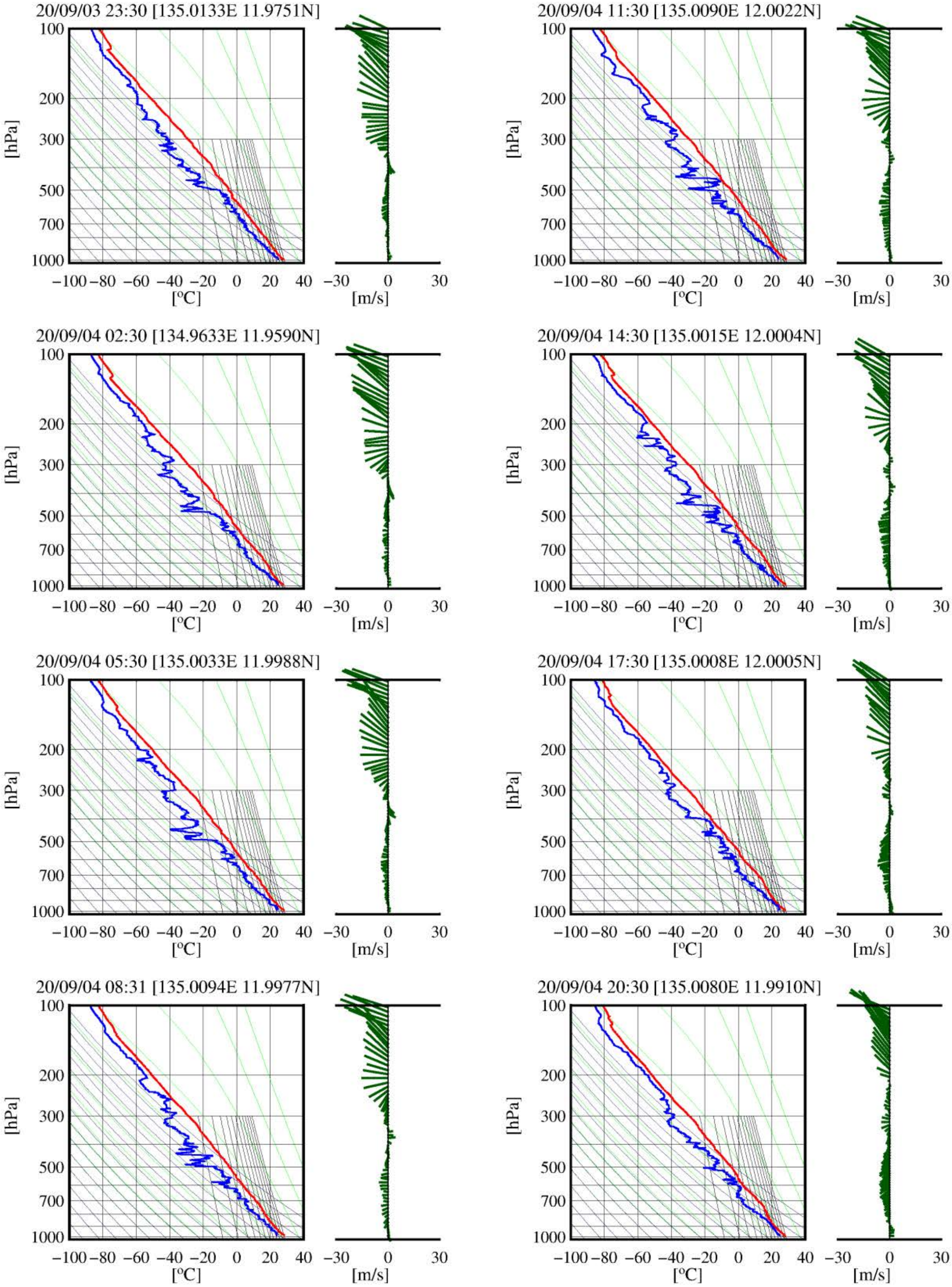


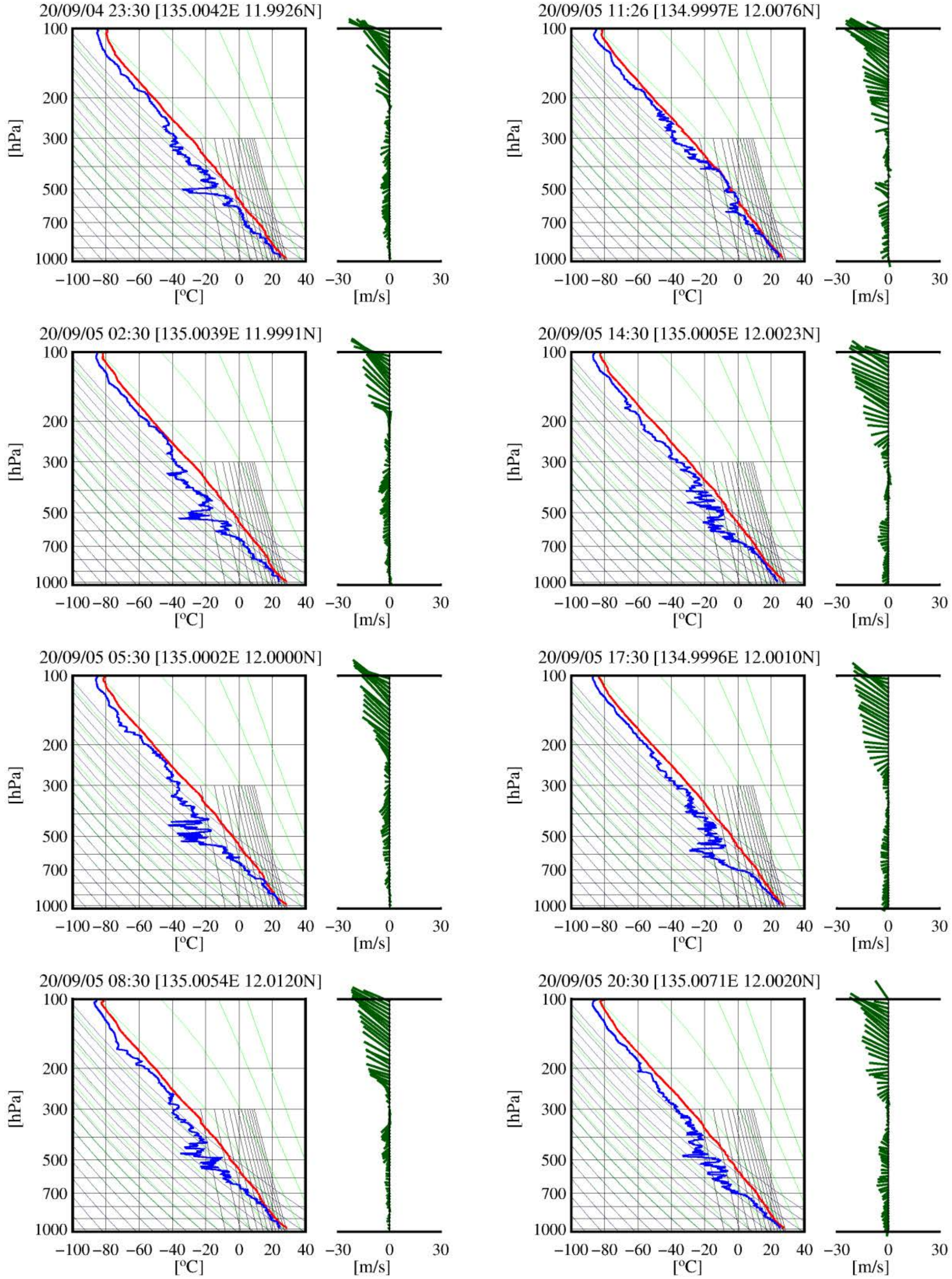
20/09/03 17:30 [134.9980E 11.9987N]

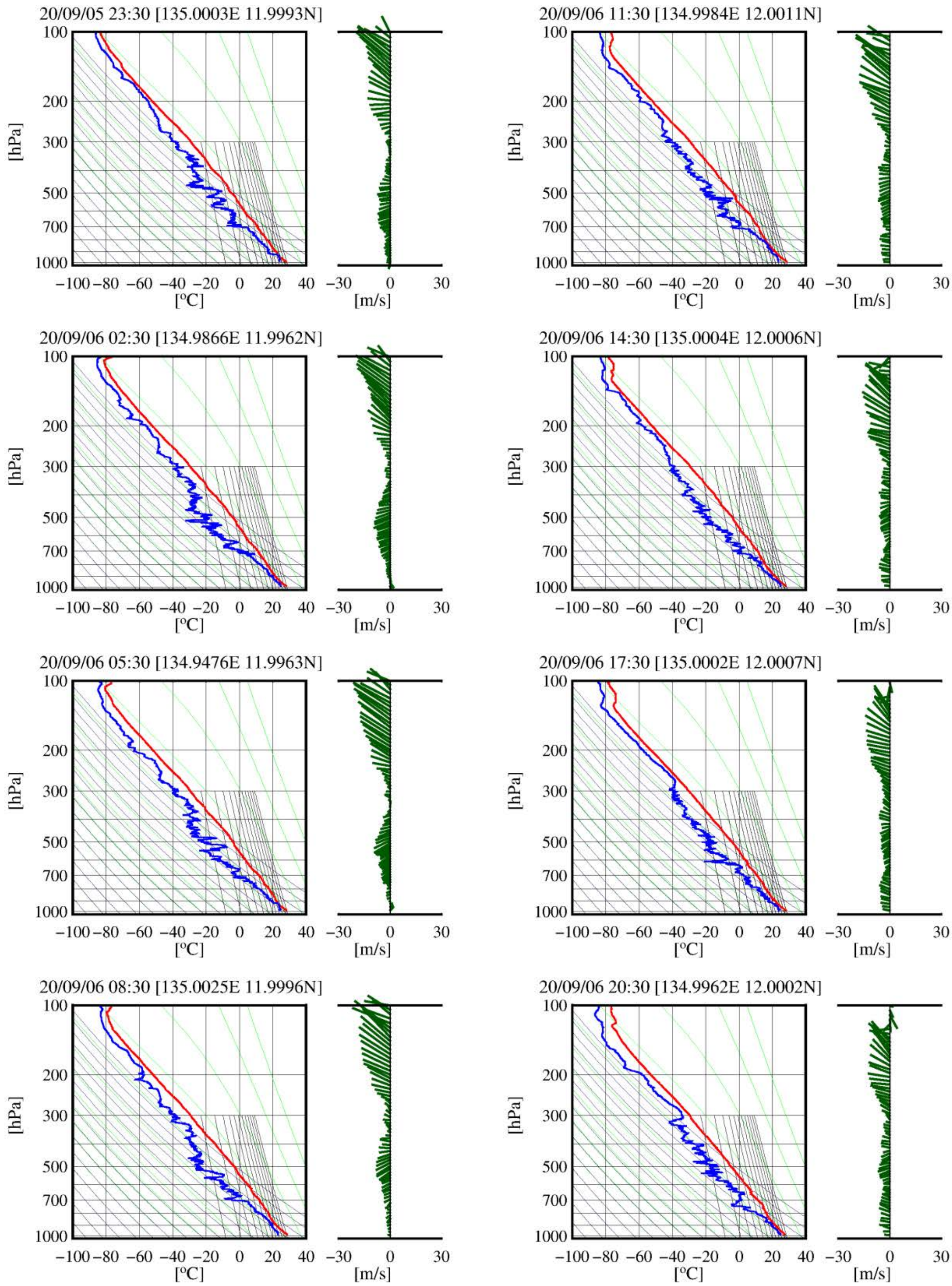


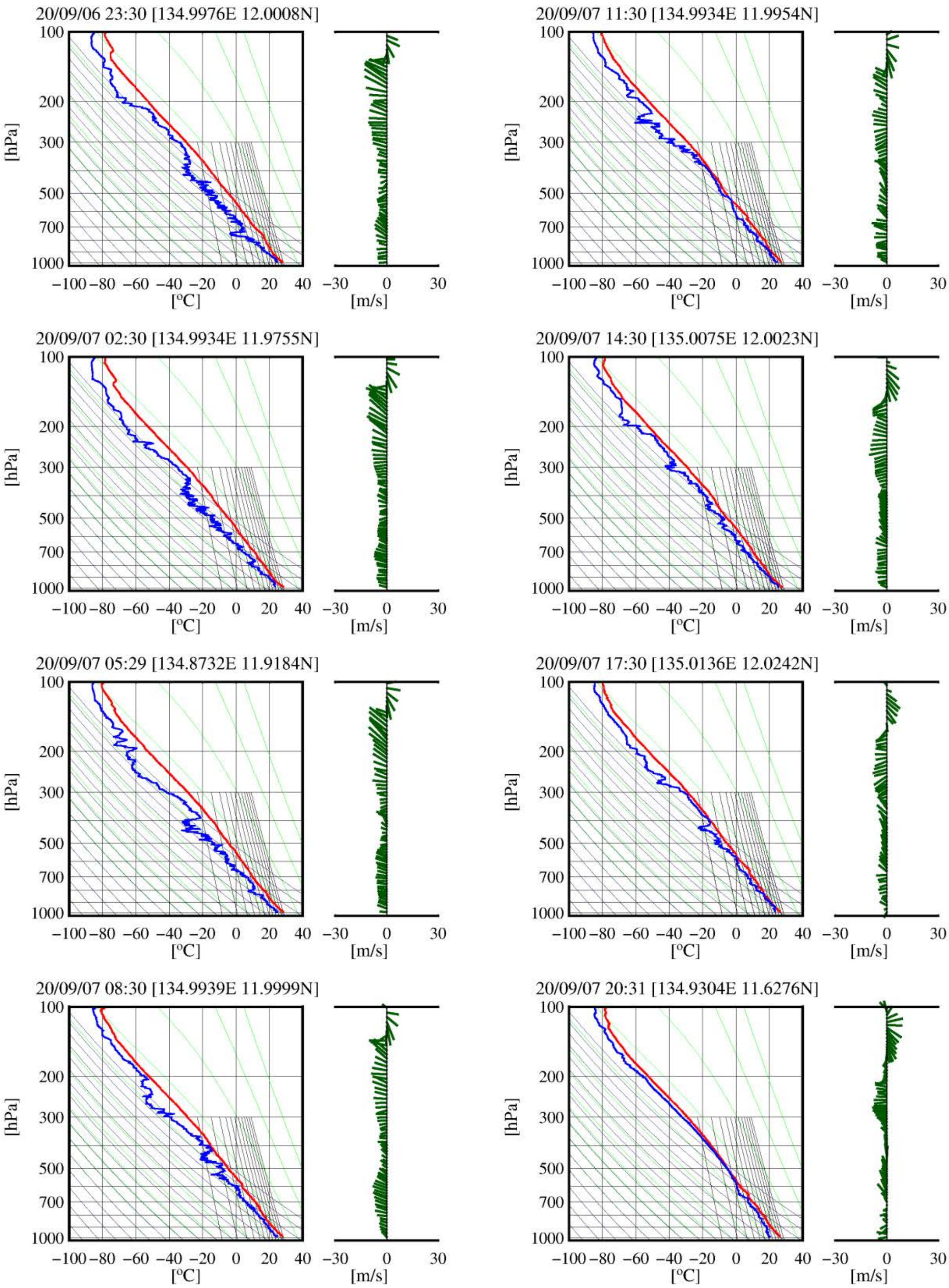
20/09/03 20:30 [135.0093E 11.9914N]



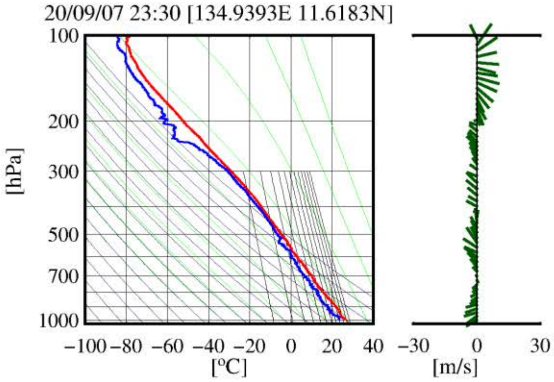

20/09/03 23:30 [135.0133E 11.9751N]
20/09/04 02:30 [134.9633E 11.9590N]
20/09/04 05:30 [135.0033E 11.9988N]
20/09/04 08:31 [135.0094E 11.9977N]
20/09/04 11:30 [135.0090E 12.0022N]
20/09/04 14:30 [135.0015E 12.0004N]
20/09/04 17:30 [135.0008E 12.0005N]
20/09/04 20:30 [135.0080E 11.9910N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]


20/09/04 23:30 [135.0042E 11.9926N]
20/09/05 11:26 [134.9997E 12.0076N]
20/09/05 02:30 [135.0039E 11.9991N]
20/09/05 14:30 [135.0005E 12.0023N]
20/09/05 05:30 [135.0002E 12.0000N]
20/09/05 17:30 [134.9996E 12.0010N]
20/09/05 08:30 [135.0054E 12.0120N]
20/09/05 20:30 [135.0071E 12.0020N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

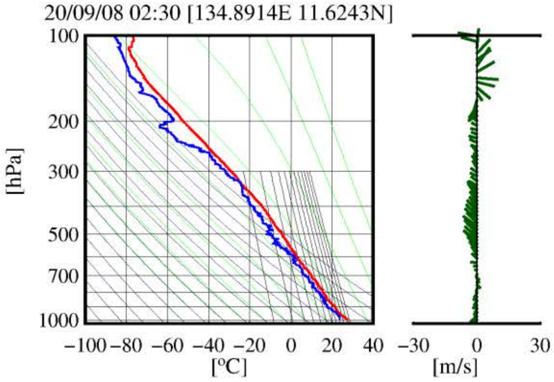

20/09/05 23:30 [135.0003E 11.9993N]
20/09/06 02:30 [134.9866E 11.9962N]
20/09/06 05:30 [134.9476E 11.9963N]
20/09/06 08:30 [135.0025E 11.9996N]
20/09/06 11:30 [134.9984E 12.0011N]
20/09/06 14:30 [135.0004E 12.0006N]
20/09/06 17:30 [135.0002E 12.0007N]
20/09/06 20:30 [134.9962E 12.0002N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]


20/09/06 23:30 [134.9976E 12.0008N]
20/09/07 11:30 [134.9934E 11.9954N]
20/09/07 02:30 [134.9934E 11.9755N]
20/09/07 14:30 [135.0075E 12.0023N]
20/09/07 05:29 [134.8732E 11.9184N]
20/09/07 17:30 [135.0136E 12.0242N]
20/09/07 08:30 [134.9939E 11.9999N]
20/09/07 20:31 [134.9304E 11.6276N]
[hPa]
100
200
300
500
700
1000
−100 −80 −60 −40 −20 0 20 40
[°C]
−30 0 30
[m/s]

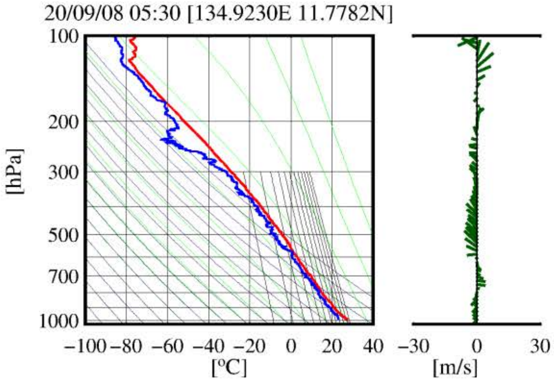
20/09/07 23:30 [134.9393E 11.6183N]



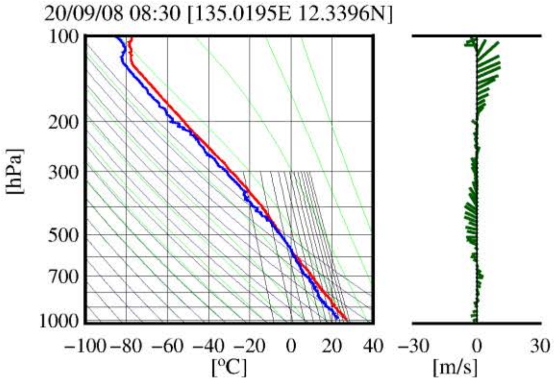
20/09/08 02:30 [134.8914E 11.6243N]



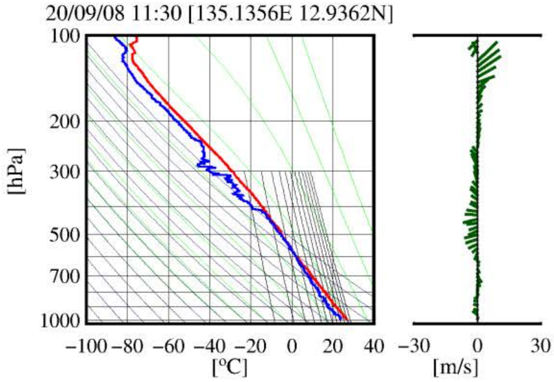
20/09/08 05:30 [134.9230E 11.7782N]



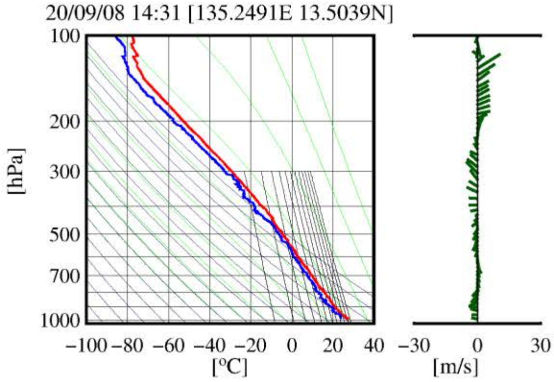
20/09/08 08:30 [135.0195E 12.3396N]



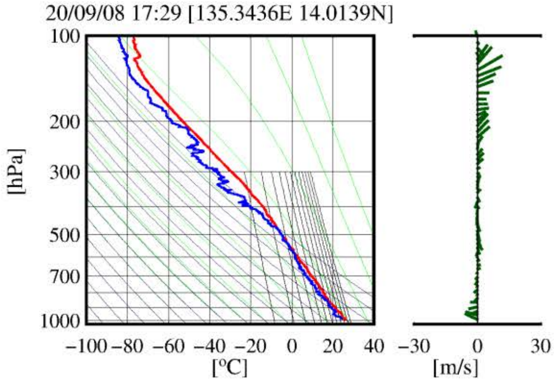
20/09/08 11:30 [135.1356E 12.9362N]



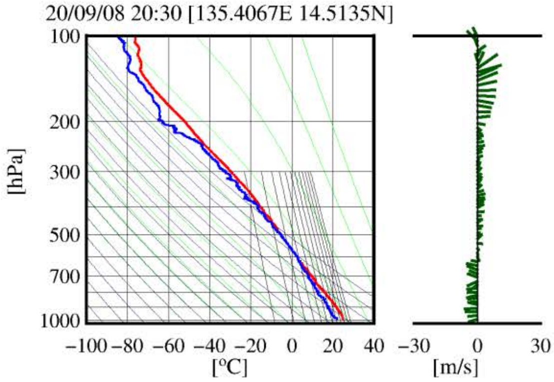
20/09/08 14:31 [135.2491E 13.5039N]

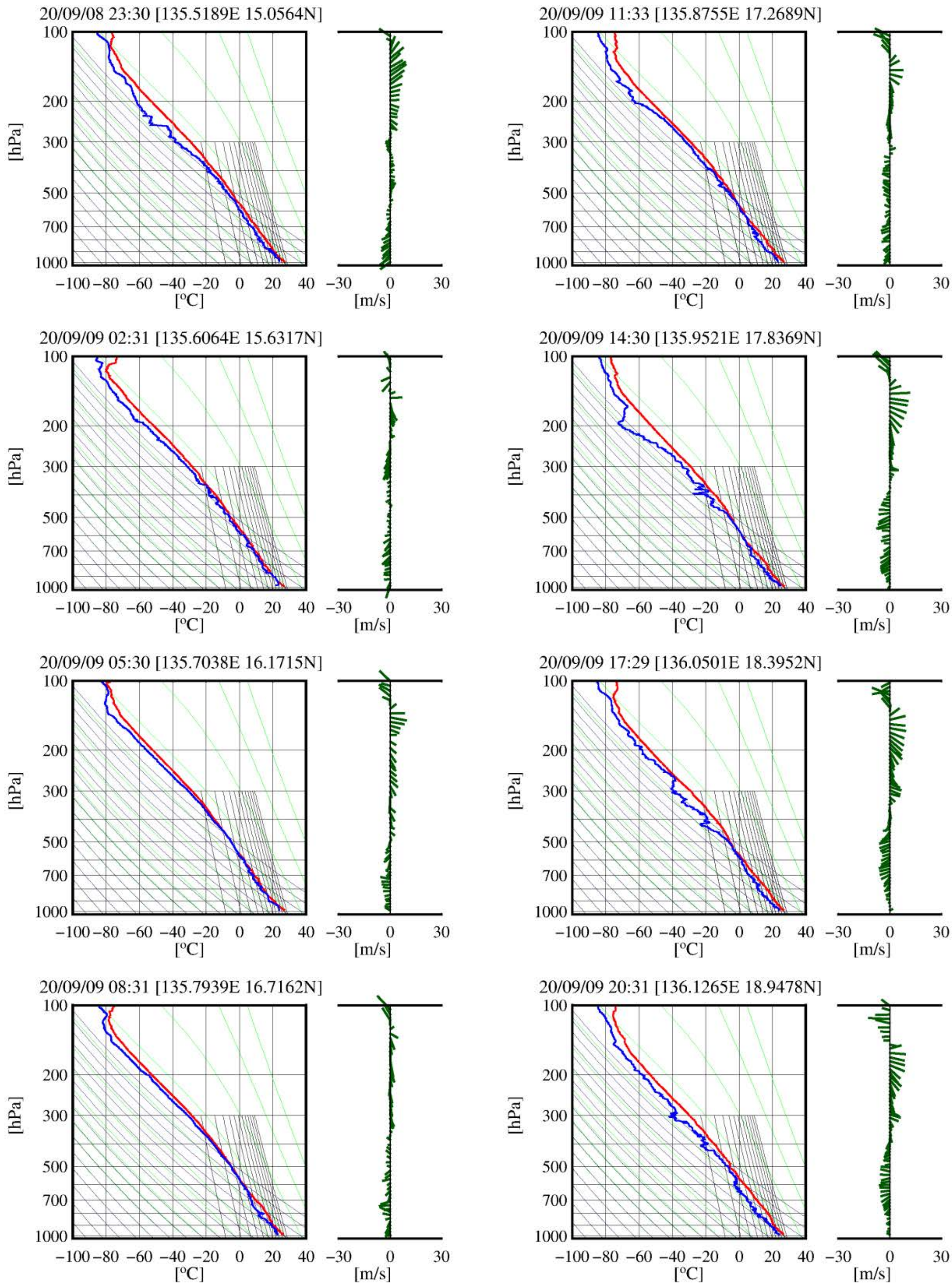


20/09/08 17:29 [135.3436E 14.0139N]

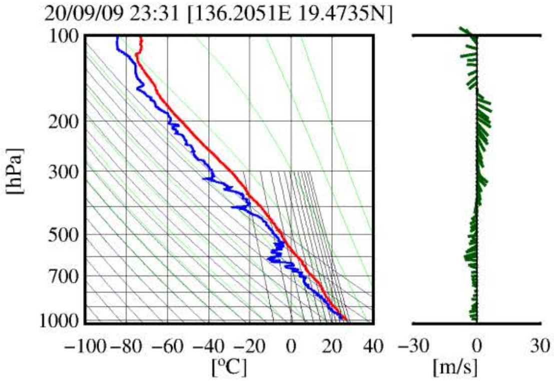


20/09/08 20:30 [135.4067E 14.5135N]

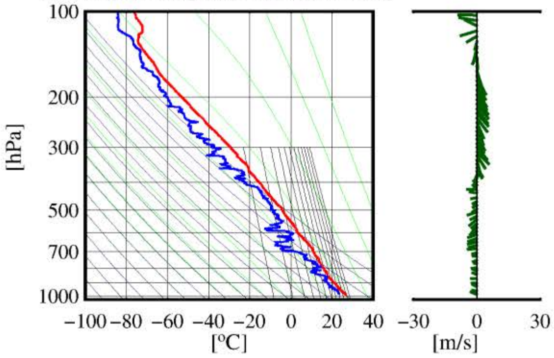



20/09/08 23:30 [135.5189E 15.0564N]
20/09/09 11:33 [135.8755E 17.2689N]
20/09/09 02:31 [135.6064E 15.6317N]
20/09/09 14:30 [135.9521E 17.8369N]
20/09/09 05:30 [135.7038E 16.1715N]
20/09/09 17:29 [136.0501E 18.3952N]
20/09/09 08:31 [135.7939E 16.7162N]
20/09/09 20:31 [136.1265E 18.9478N]
[hPa]
[°C]
[m/s]

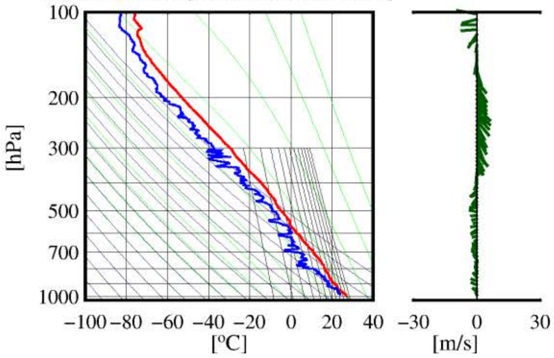
20/09/09 23:31 [136.2051E 19.4735N]



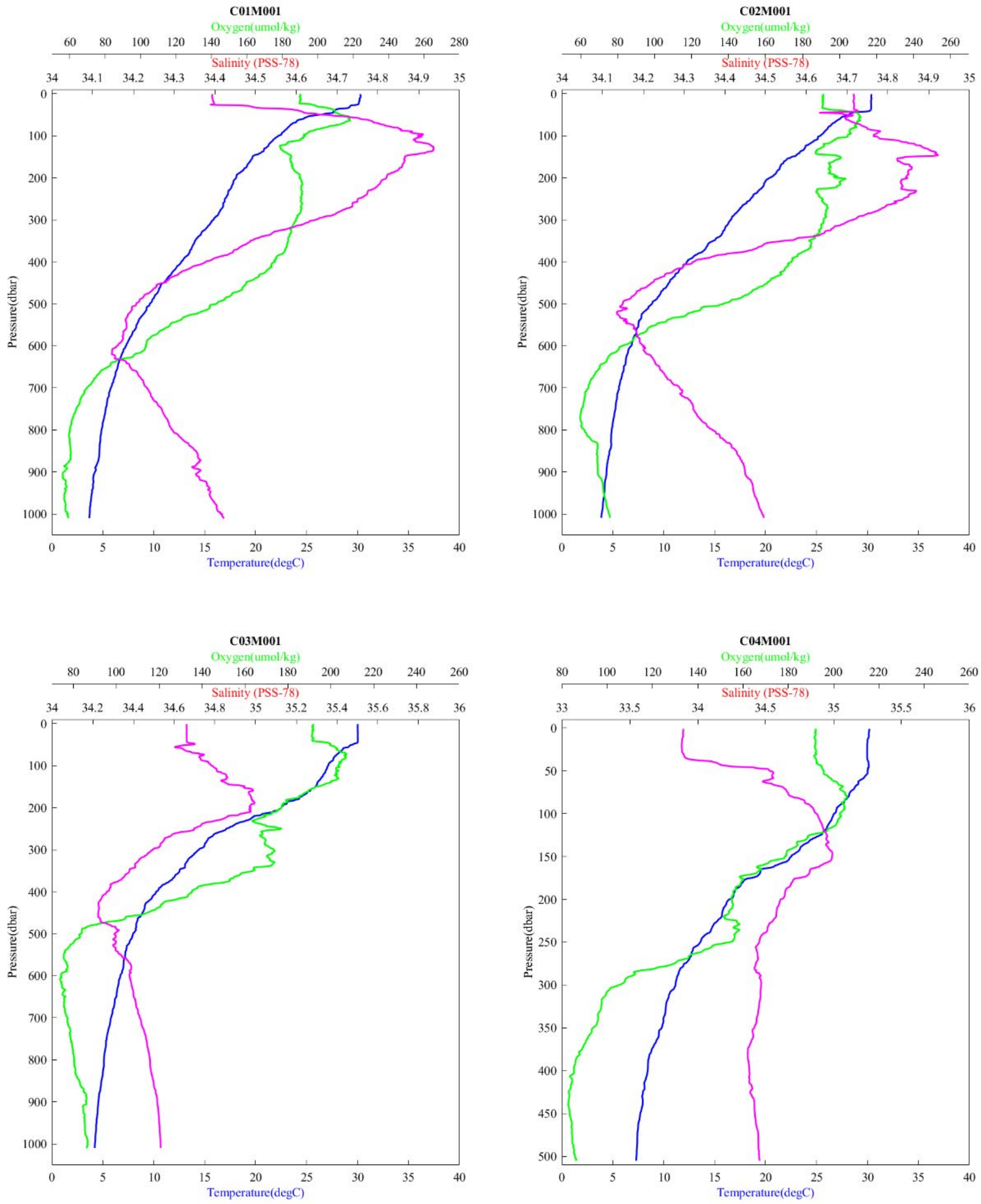
20/09/10 02:30 [136.2668E 20.0019N]



20/09/10 05:30 [136.3620E 20.5468N]

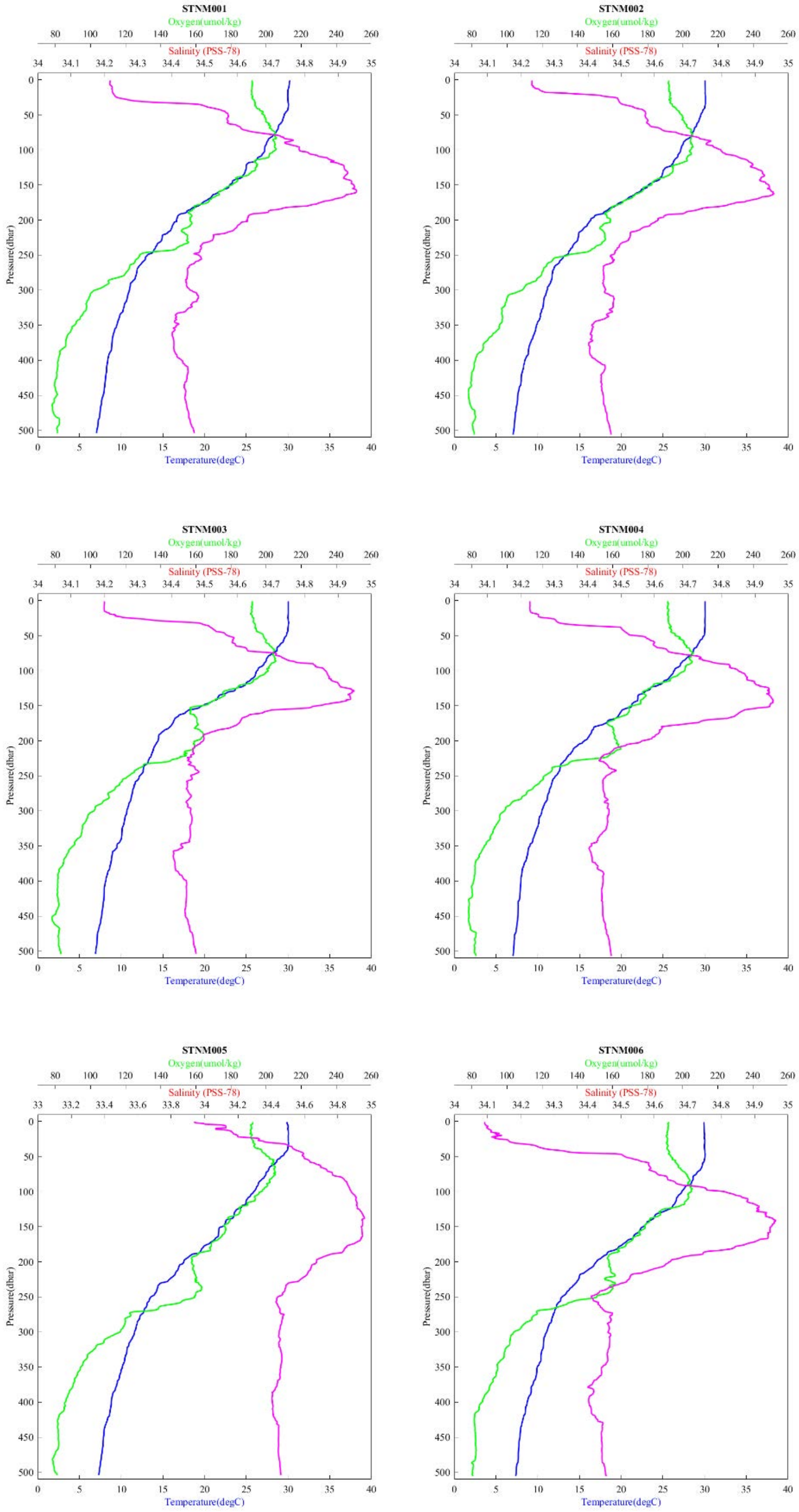


Appendix B: Oceanic profiles by the CTD observations

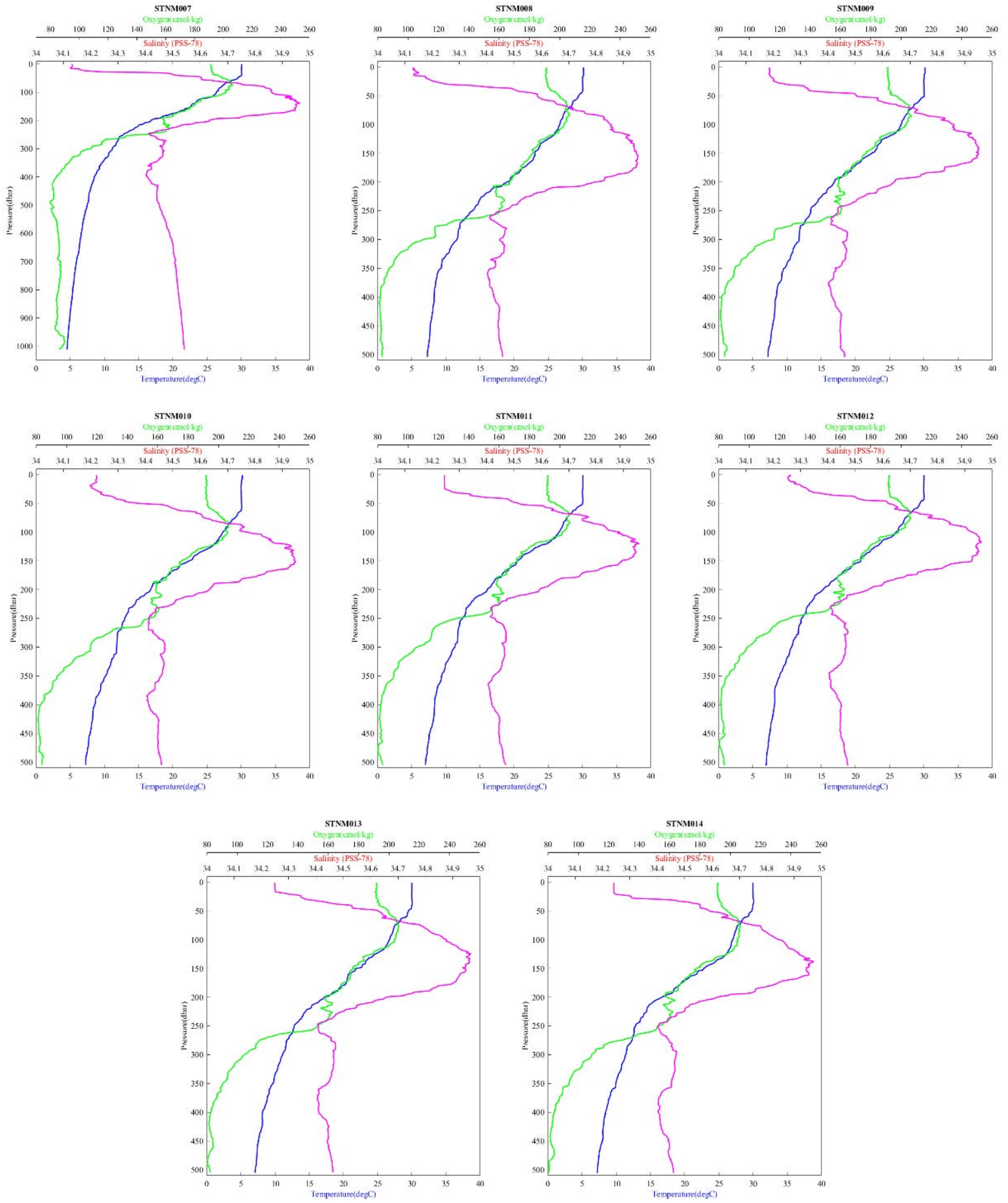


CTD profile (ARGO Deployment 4th Aug. 2020 – 5th Aug. 2020 C01M001, C02M001, C03M001)

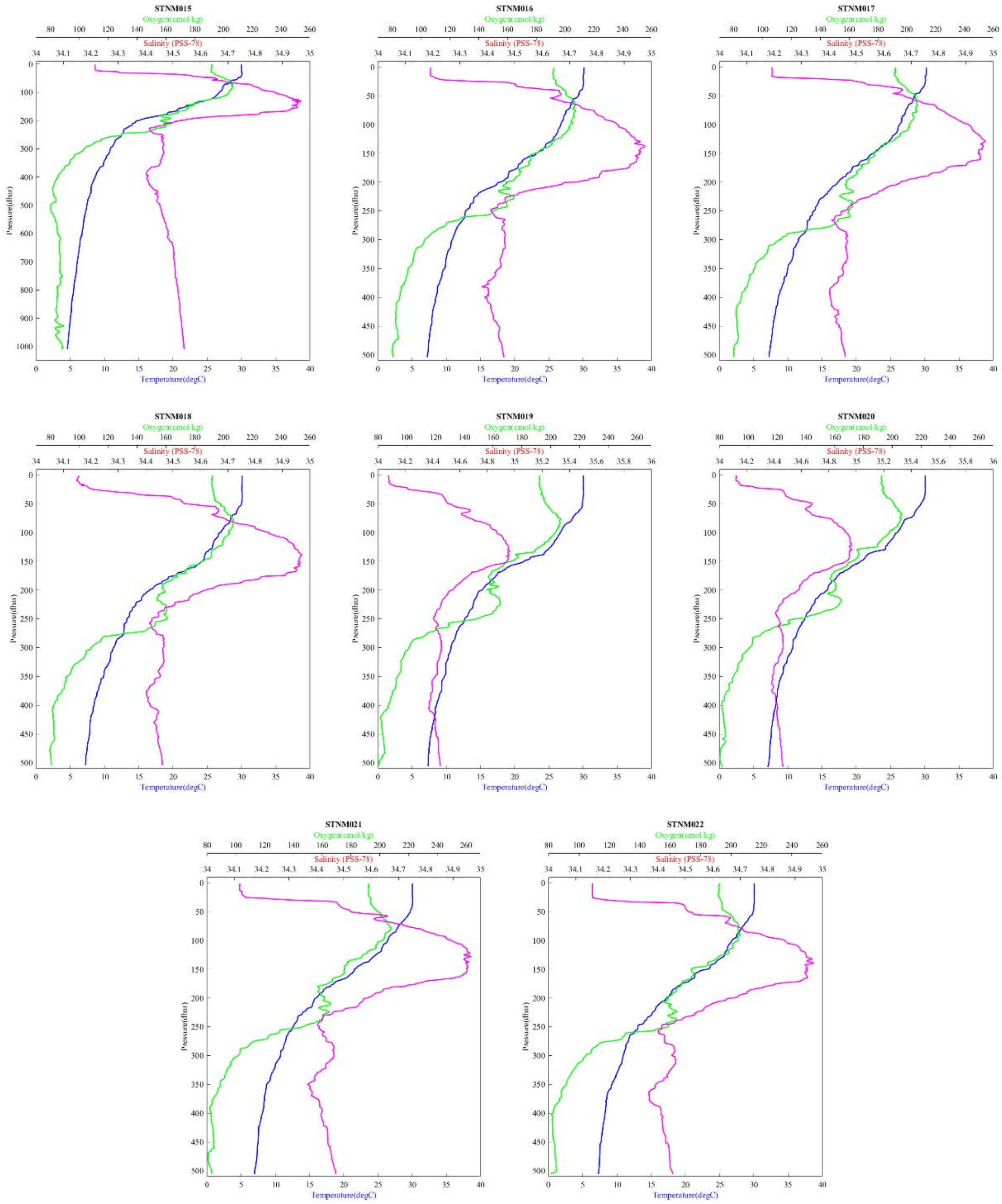
(m-TRITON Buoy Deployment 7th Aug. 2020-C04M001)



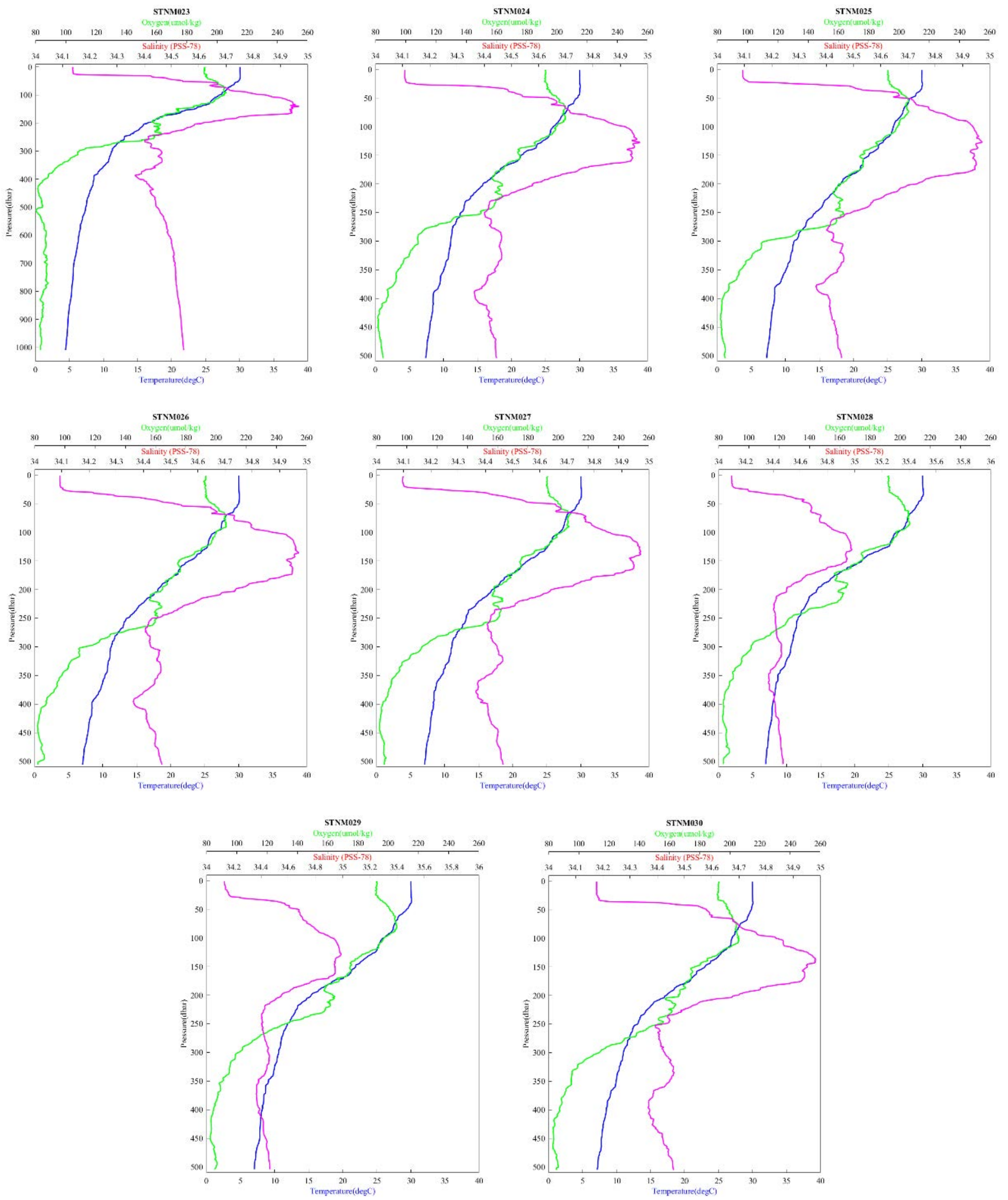
CTD profile (Fixed Station Observation 09 Aug. 2020 STNM001, STNM002, STNM003, STNM004, STNM005, STNM006)



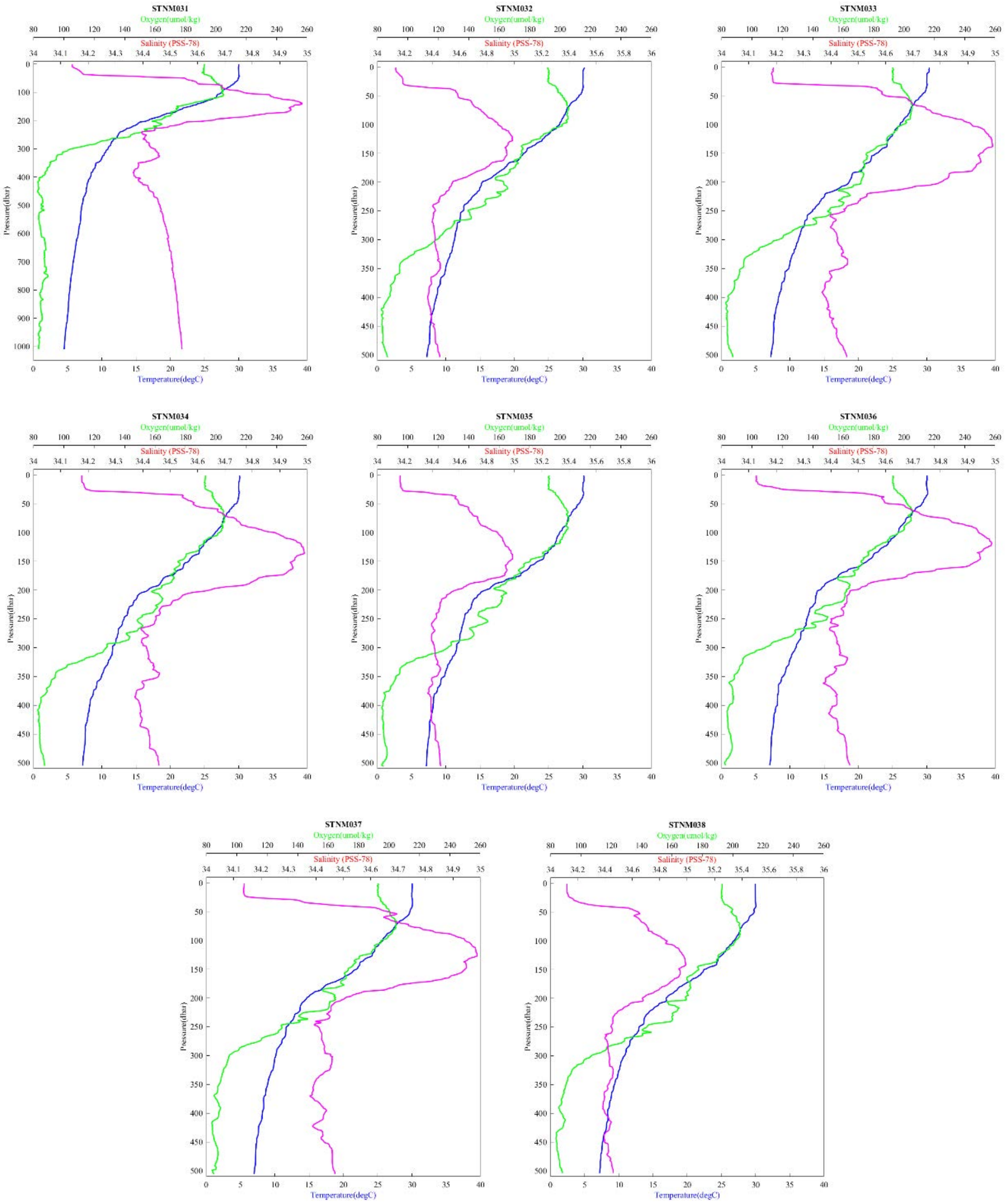
CTD profile (Fixed Station Observation 10th Aug. 2020 STNM007, STNM008, STNM009, STNM010, STNM011, STNM012, STNM013, STNM014)



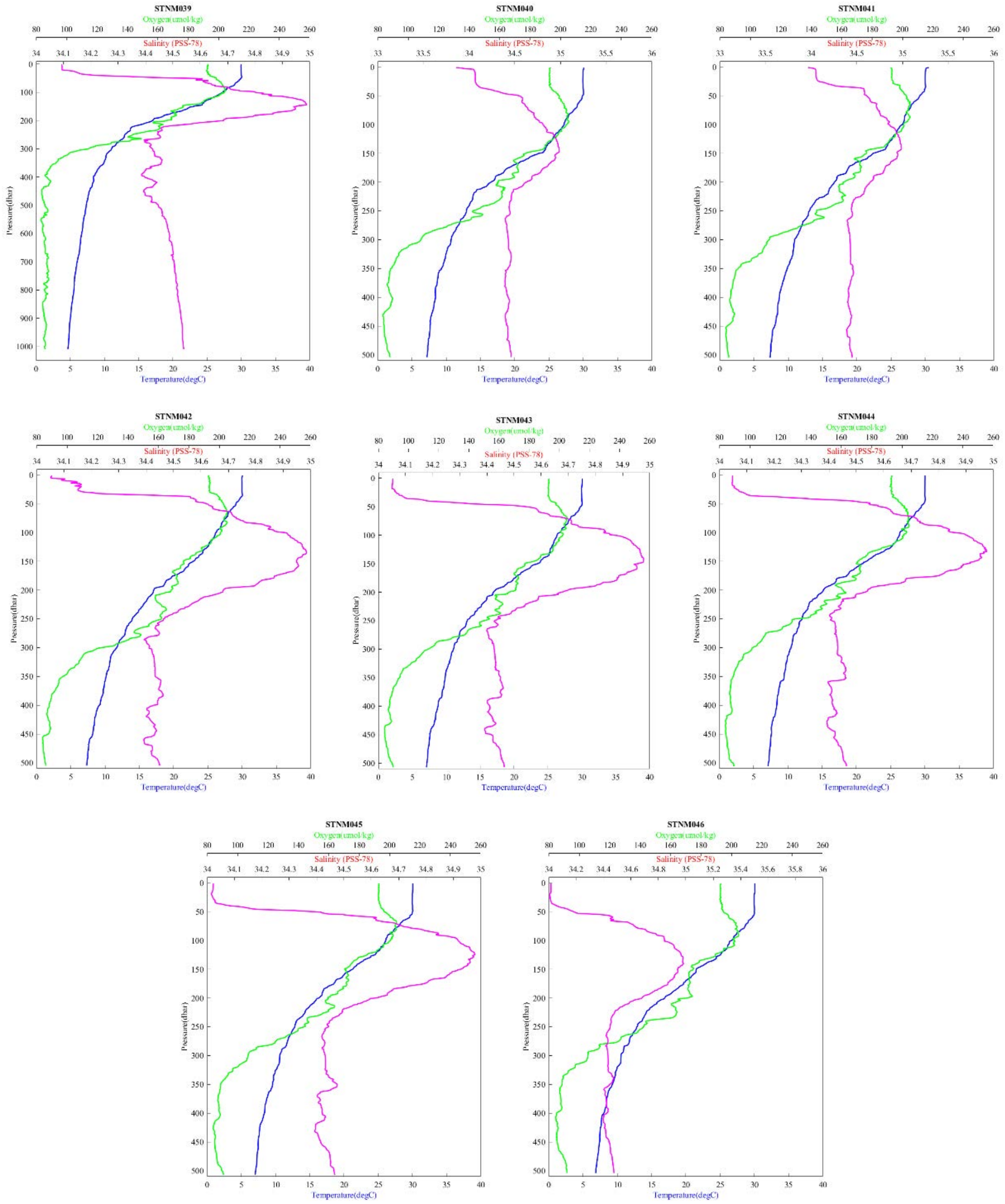
CTD profile (Fixed Station Observation 11st Aug. 2020 STNM015, STNM016, STNM017, STNM018, STNM019, STNM020, STNM021, STNM022)



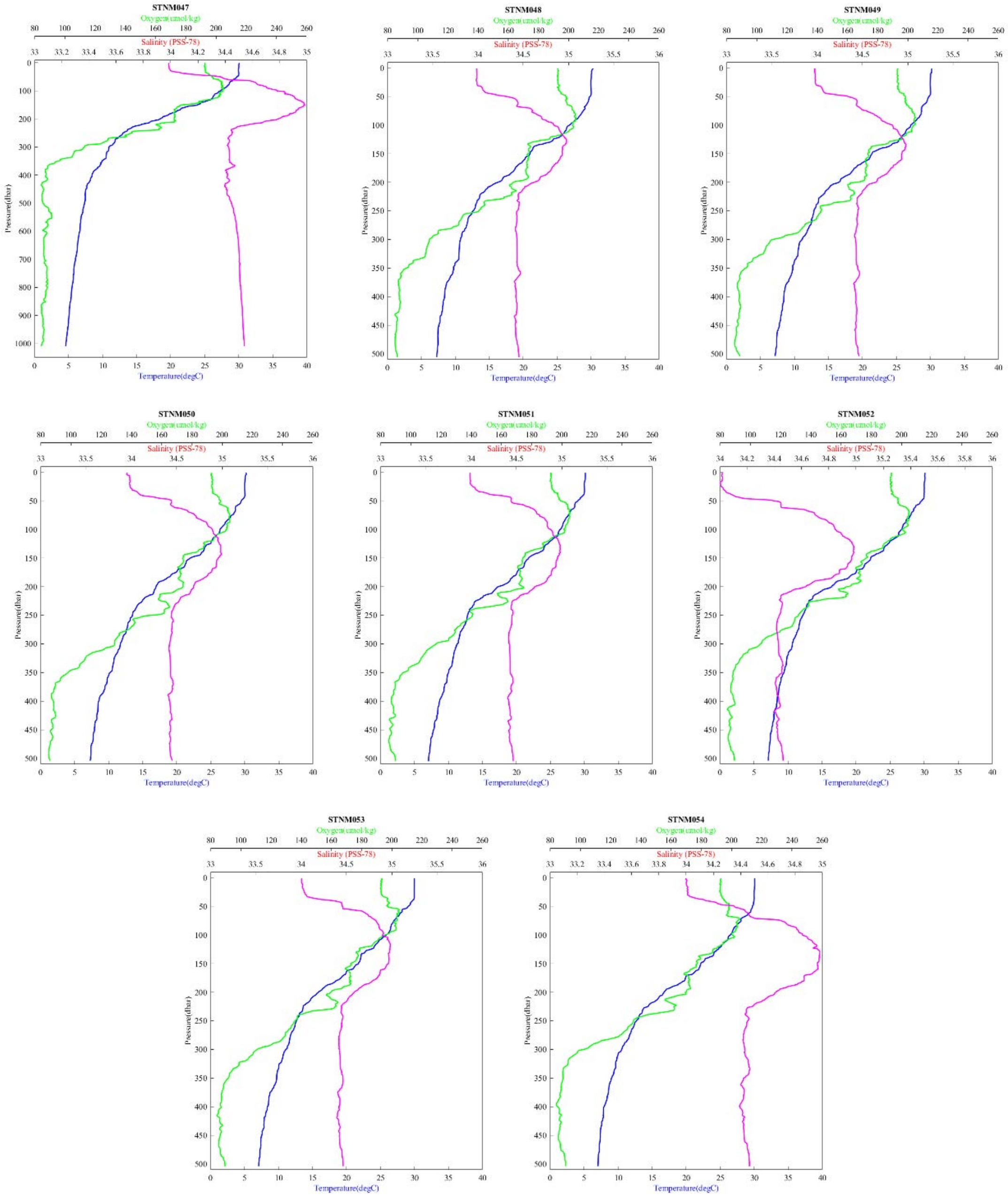
CTD profile (Fixed Station Observation 12nd Aug. 2020 STNM023, STNM024, STNM025, STNM026, STNM027, STNM028, STNM029, STNM030)



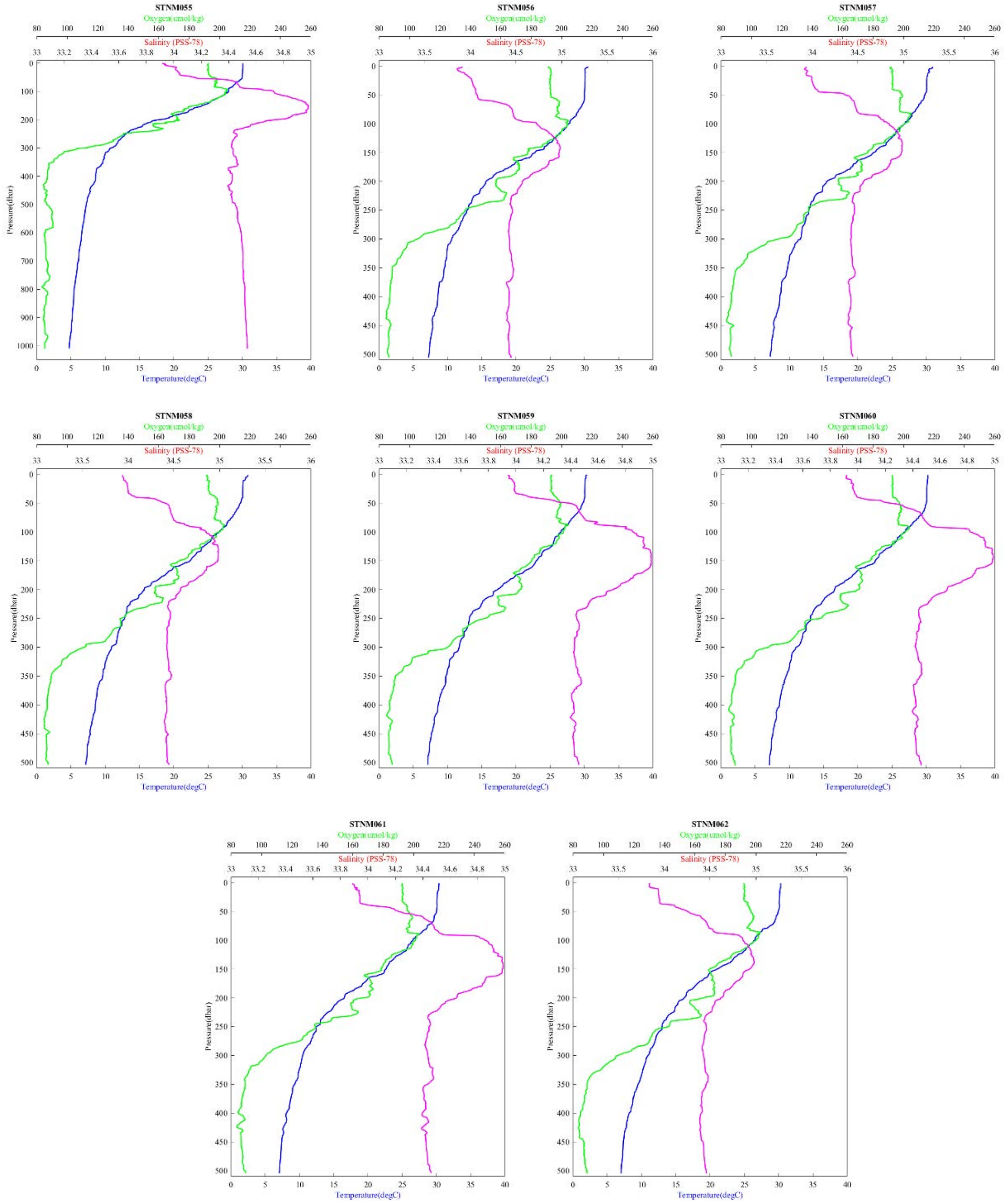
CTD profile (Fixed Station Observation 13rd Aug. 2020 STNM031, STNM032, STNM033, STNM034, STNM035, STNM036, STNM037, STNM038)



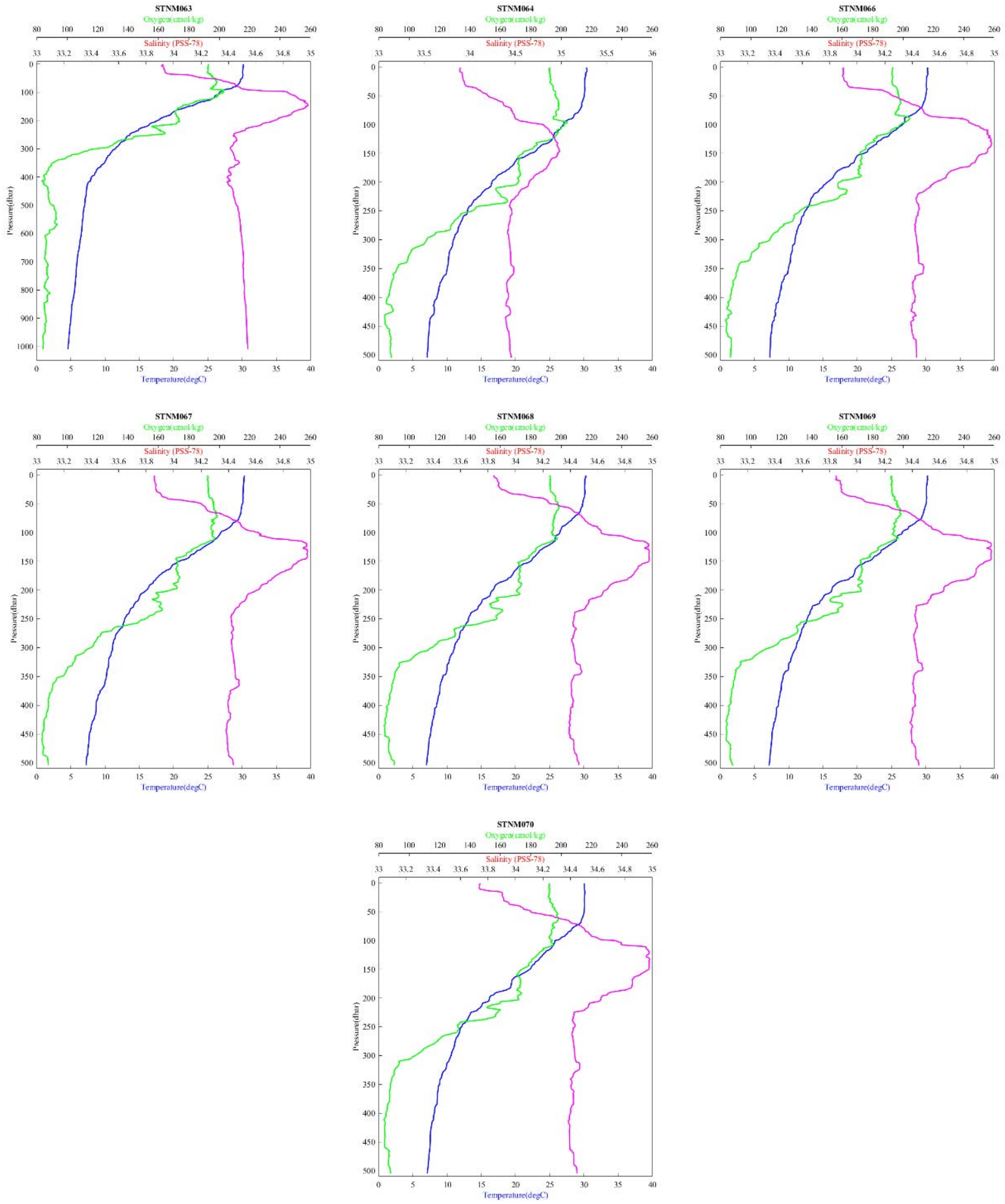
CTD profile (Fixed Station Observation 14th Aug. 2020 STNM039, STNM040, STNM041, STNM042, STNM043, STNM044, STNM045, STNM046)



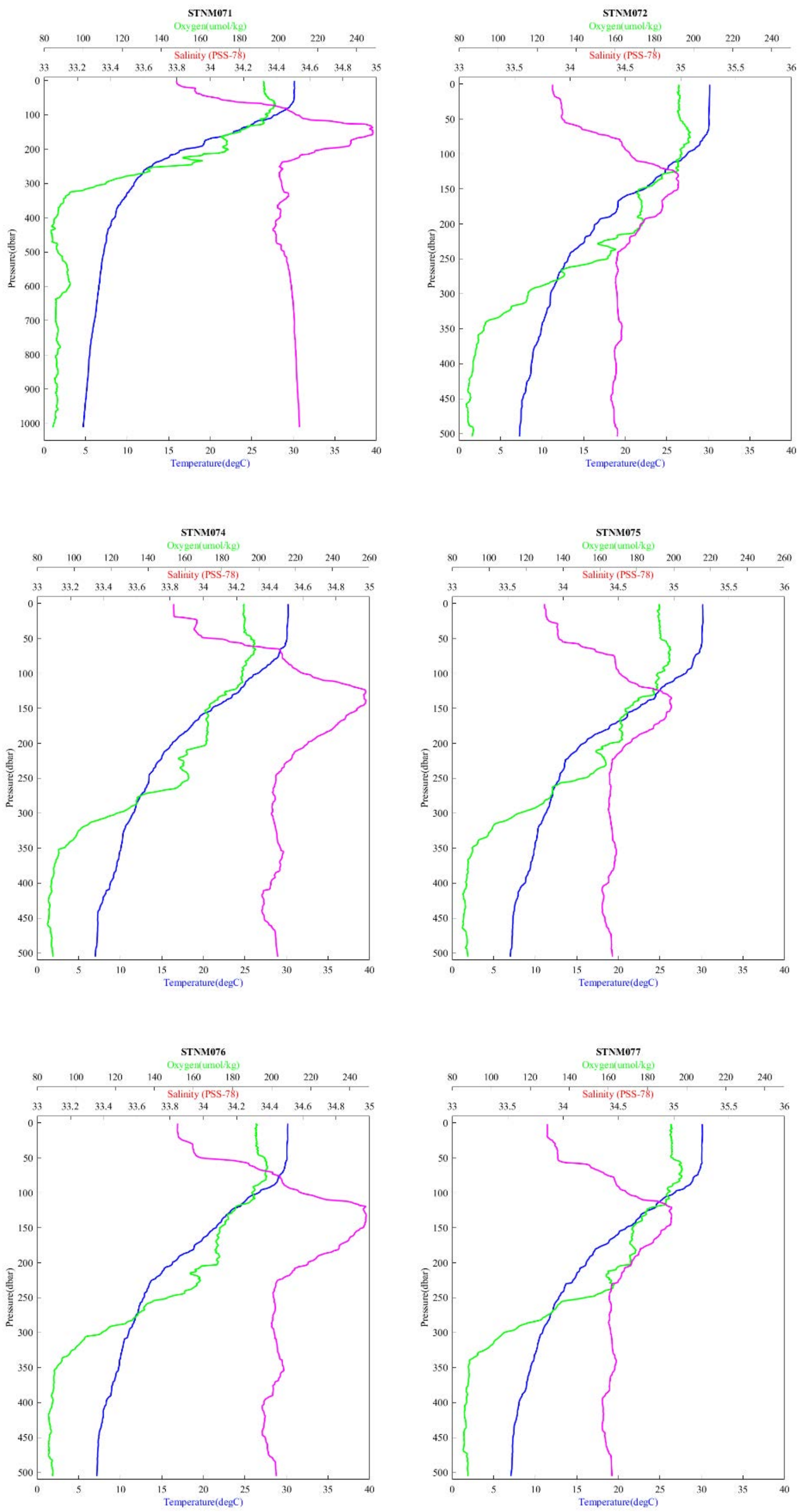
CTD profile (Fixed Station Observation 15th Aug. 2020 STNM047, STNM048, STNM049, STNM050, STNM051, STNM052, STNM053, STNM054)



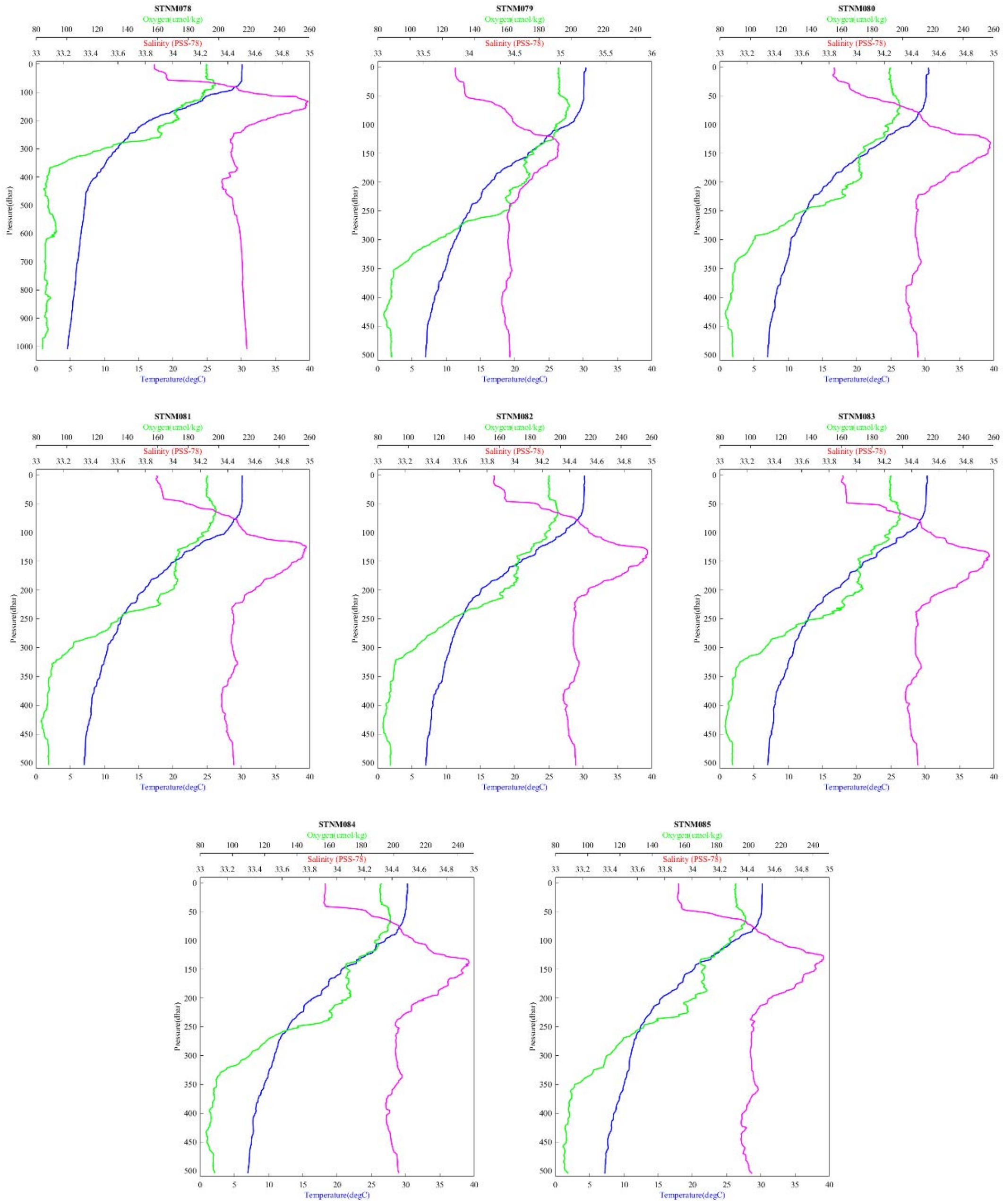
CTD profile (Fixed Station Observation 16th Aug. 2020 STNM055, STNM056, STNM057, STNM058, STNM059, STNM060, STNM061, STNM062)



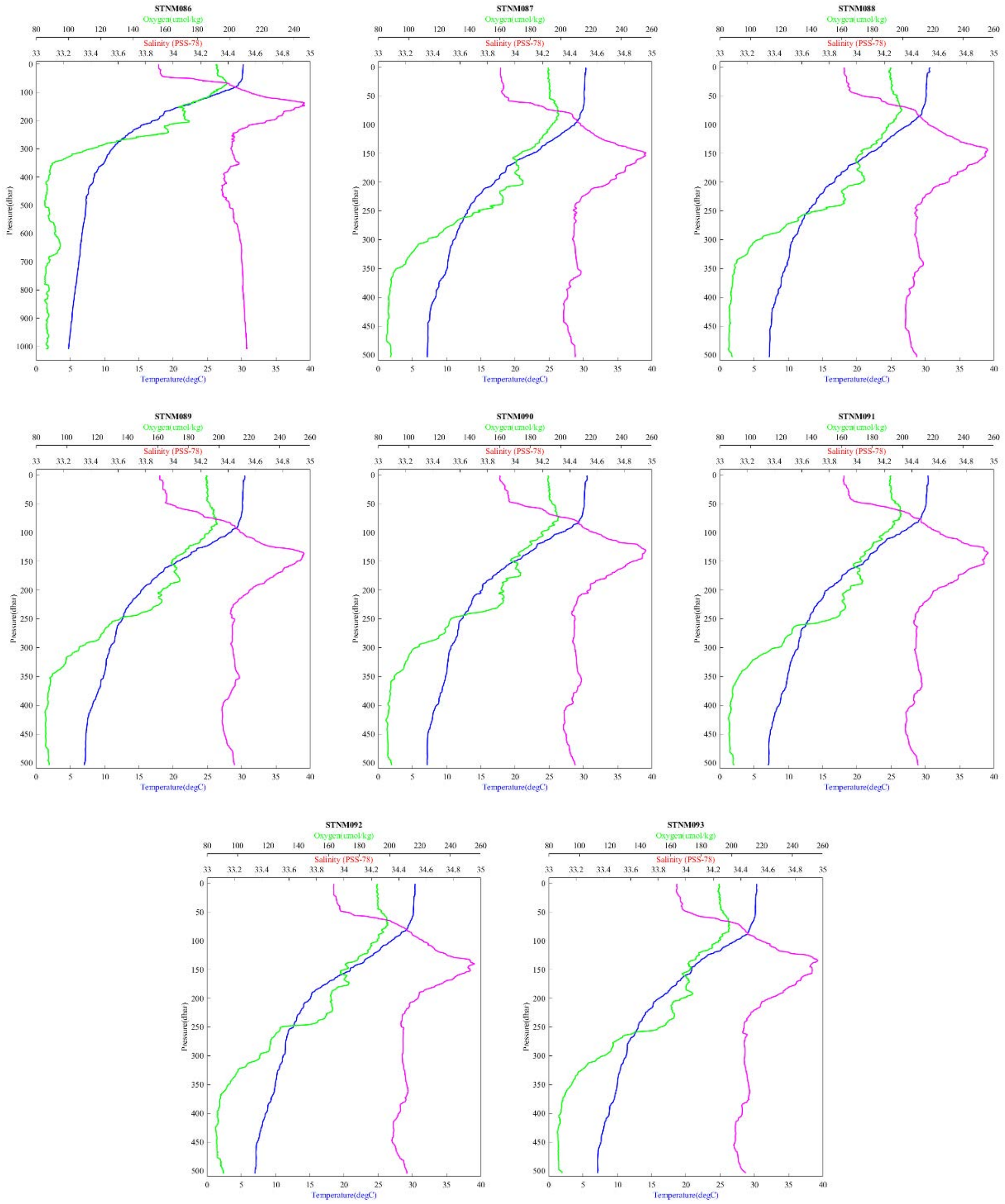
CTD profile (Fixed Station Observation 17th Aug. 2020 STNM063, STNM064, STNM066, STNM067, STNM068, STNM069, STNM070)



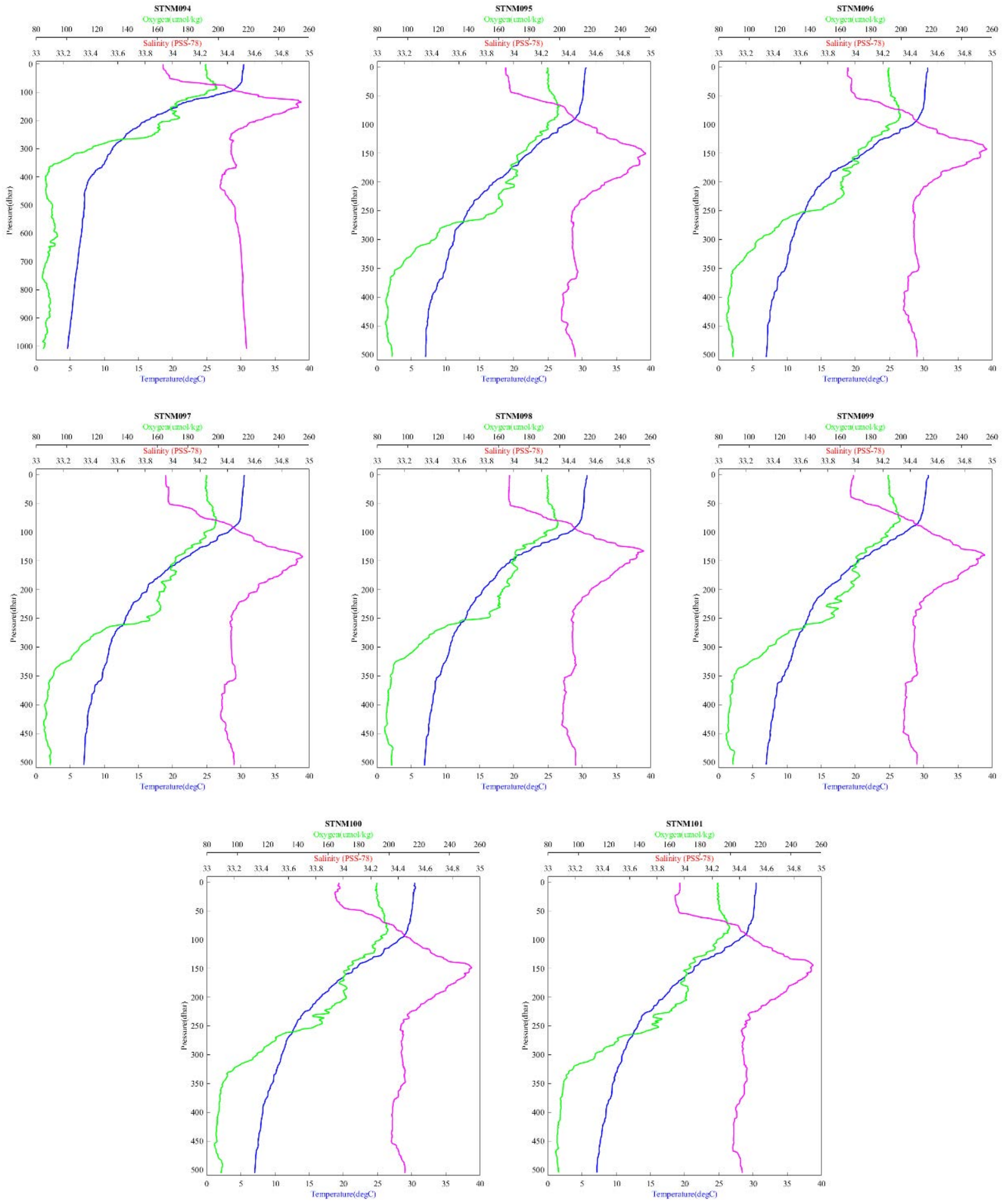
CTD profile (Fixed Station Observation 18th Aug. 2020 STNM071, STNM072, STNM074, STNM075, STNM076, STNM077)



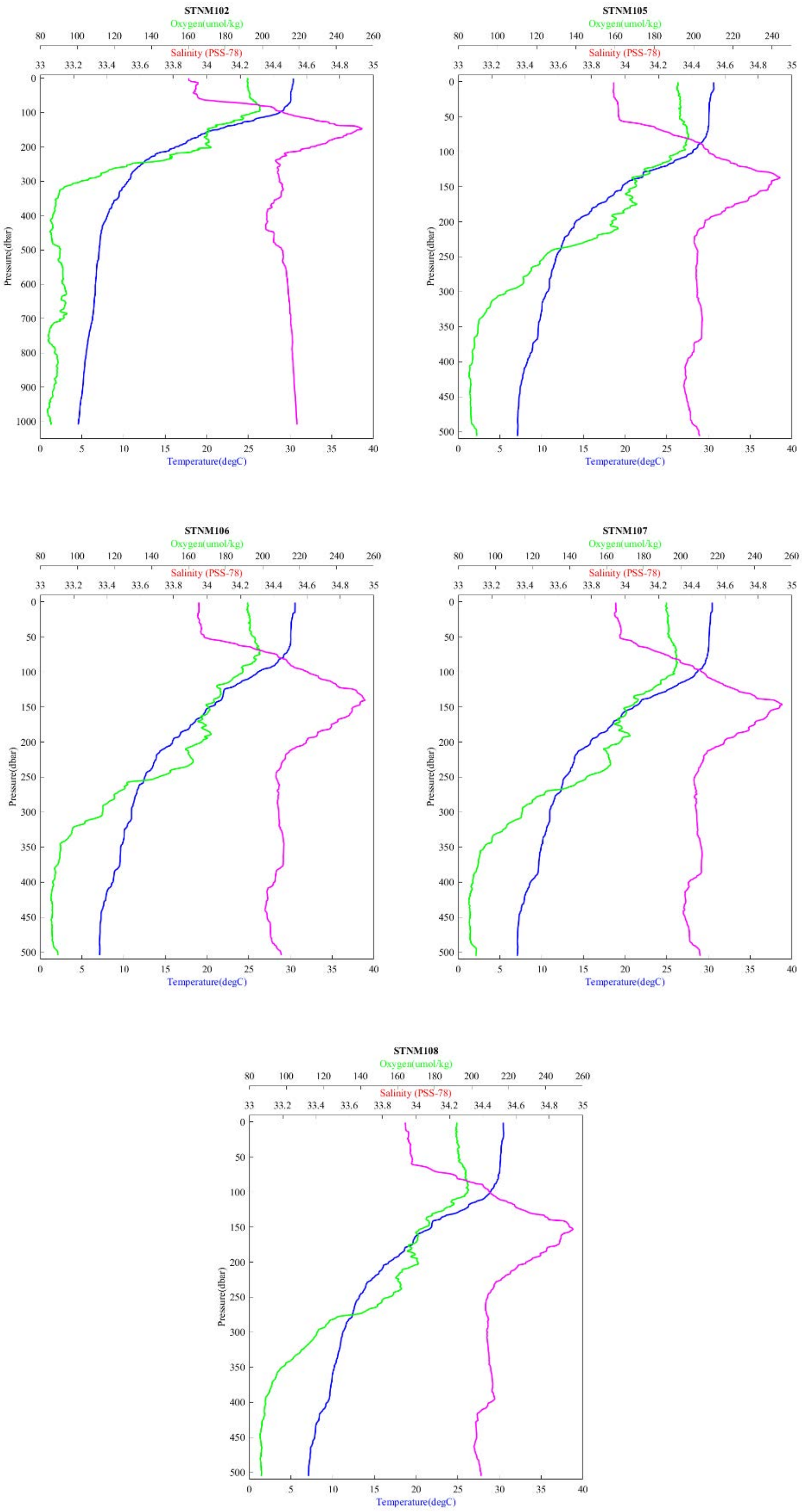
CTD profile (Fixed Station Observation 19th Aug. 2020 STNM078, STNM079, STNM080, STNM081, STNM082, STNM083, STNM084, STNM085)



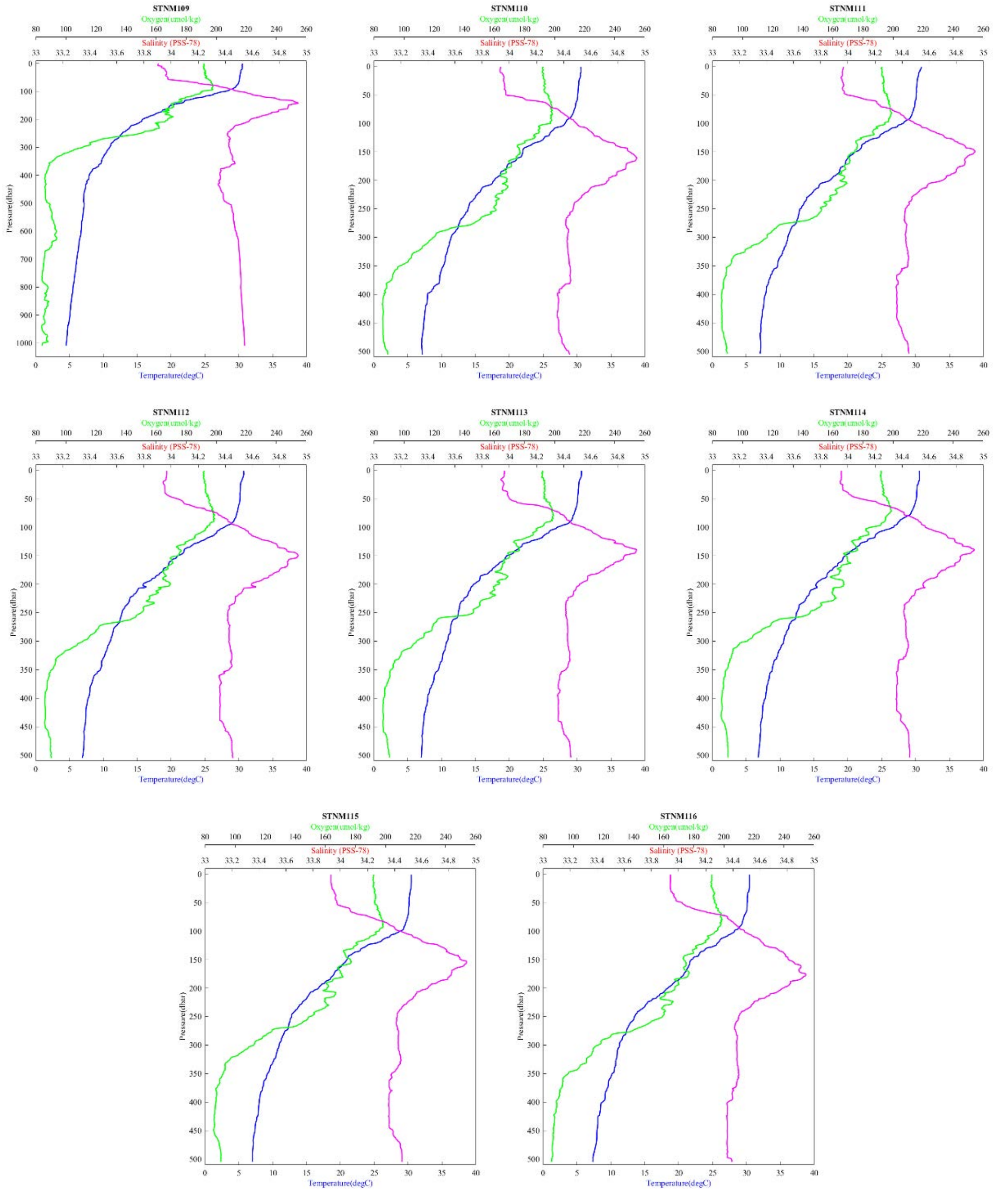
CTD profile (Fixed Station Observation 20th Aug. 2020 STNM086, STNM087, STNM088, STNM089, STNM090, STNM091, STNM092, STNM093)



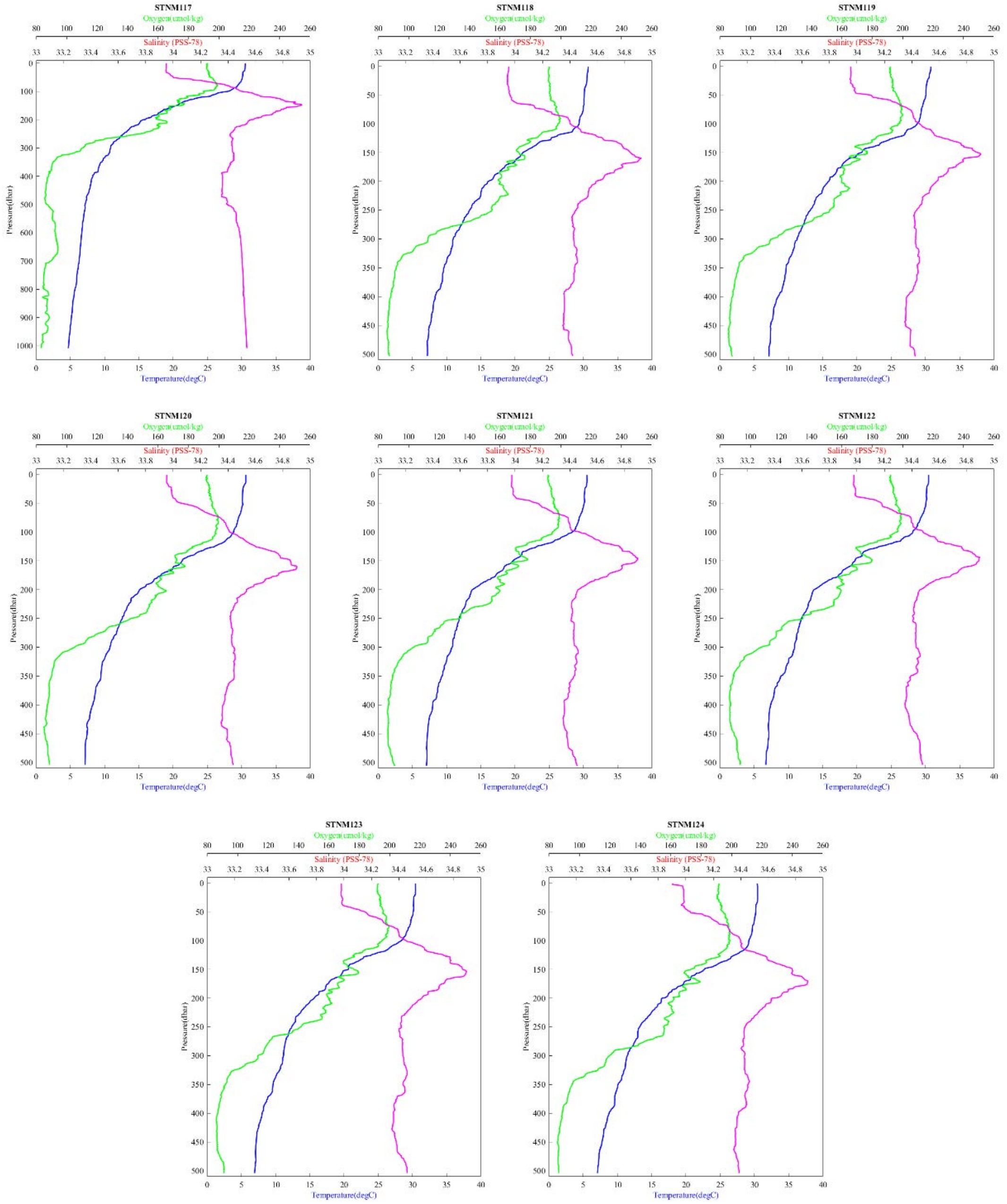
CTD profile (Fixed Station Observation 21st Aug. 2020 STNM094, STNM095, STNM096, STNM097, STNM098, STNM099, STNM100, STNM101)



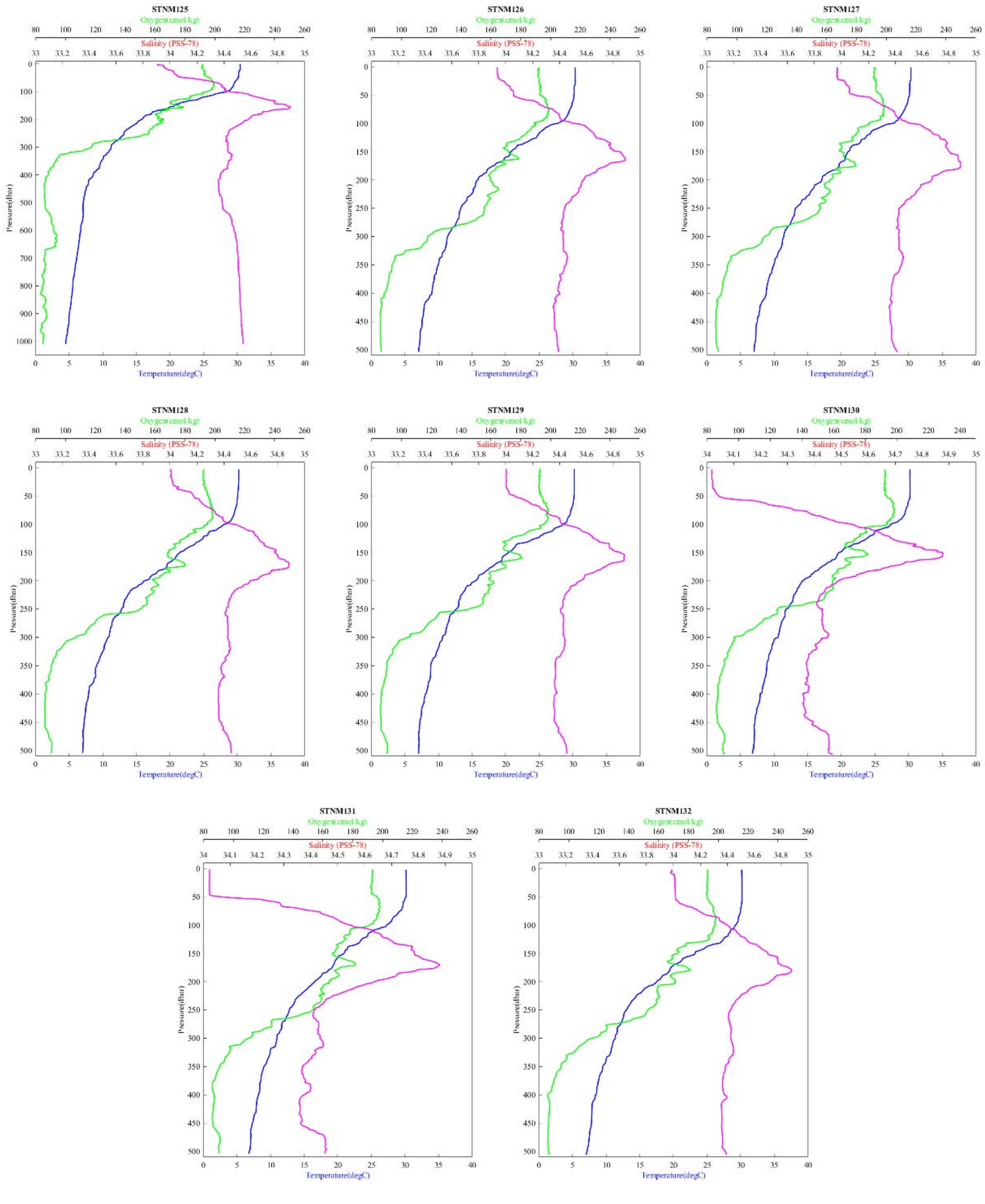
CTD profile (Fixed Station Observation 22nd Aug. 2020 STNM102, STNM105, STNM106, STNM107, STNM108)



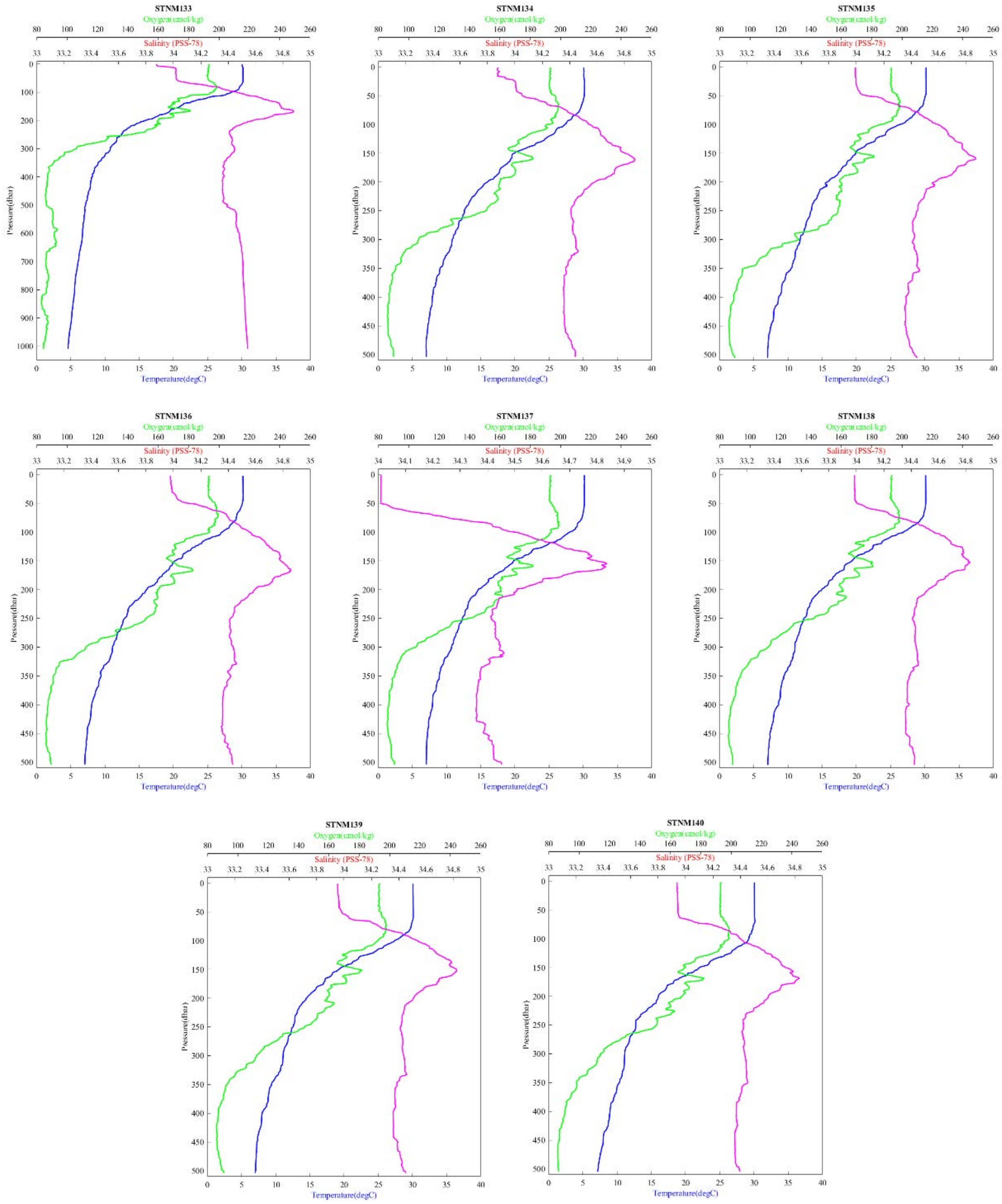
CTD profile (Fixed Station Observation 23rd Aug. 2020 STNM109, STNM110, STNM111, STNM112, STNM113, STNM114, STNM115, STNM116)



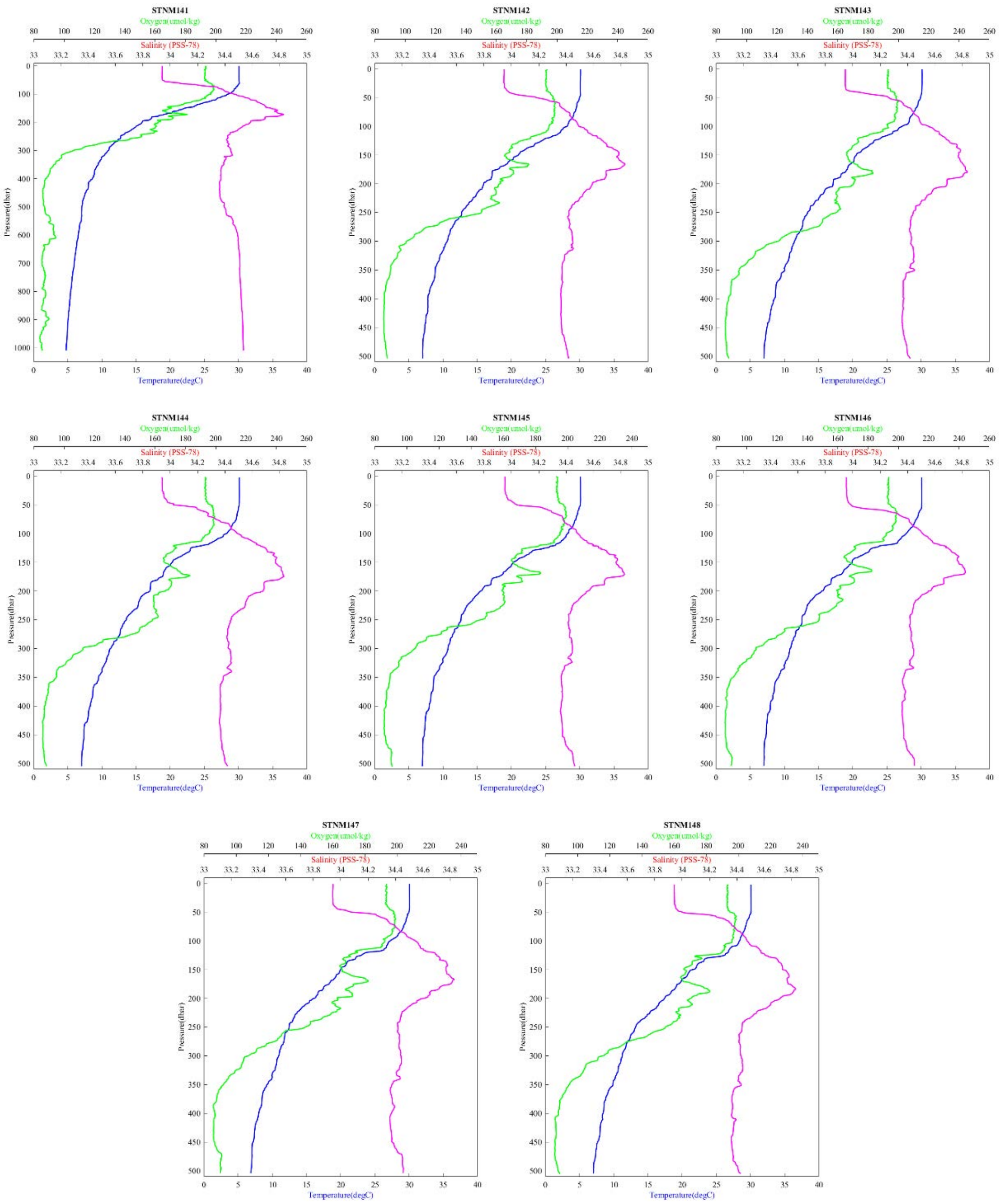
CTD profile (Fixed Station Observation 24th Aug. 2020 STNM117, STNM118, STNM119, STNM120, STNM121, STNM122, STNM123, STNM124)



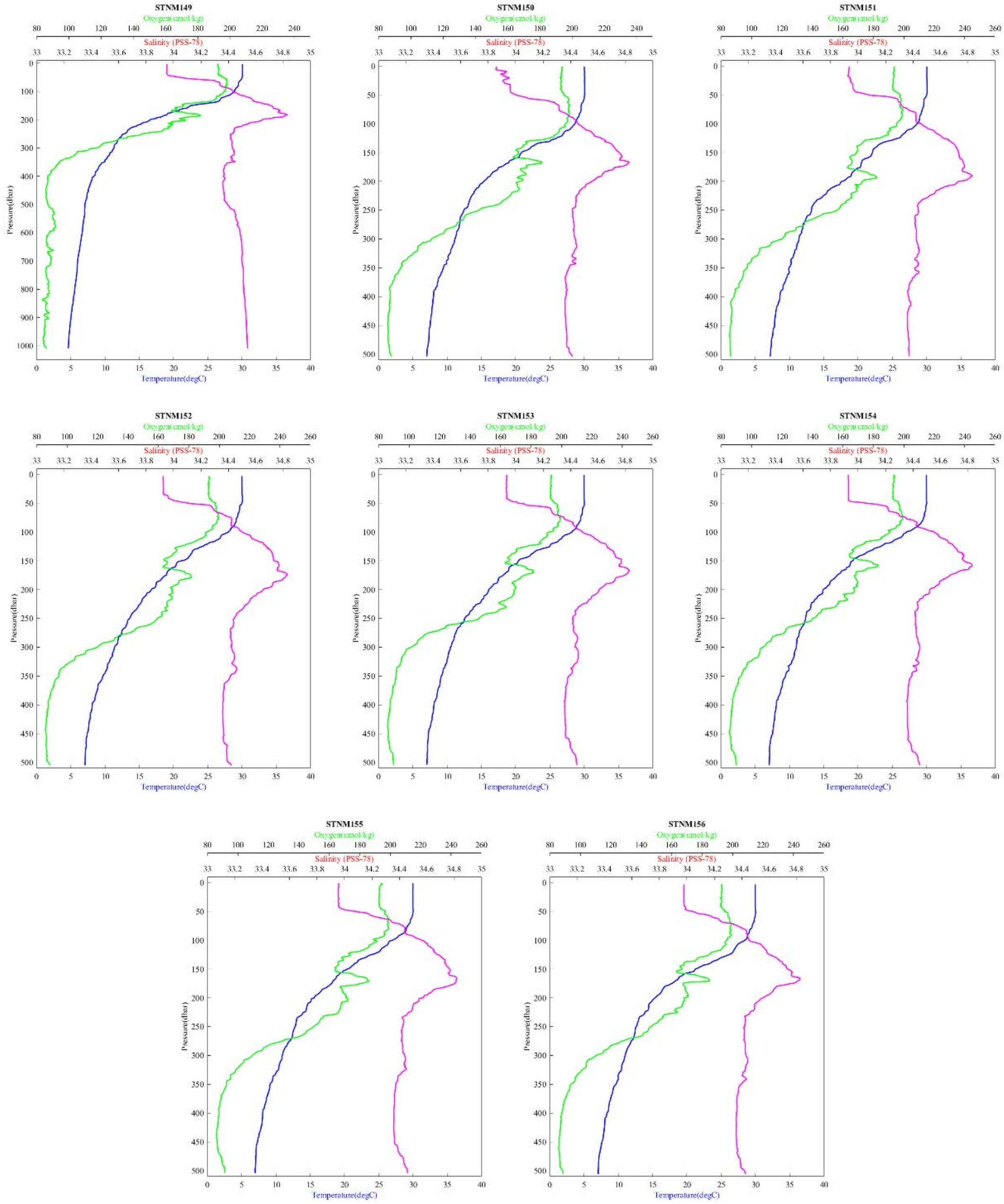
CTD profile (Fixed Station Observation 25th Aug. 2020 STNM125, STNM126, STNM127, STNM128, STNM129, STNM130, STNM131, STNM132)



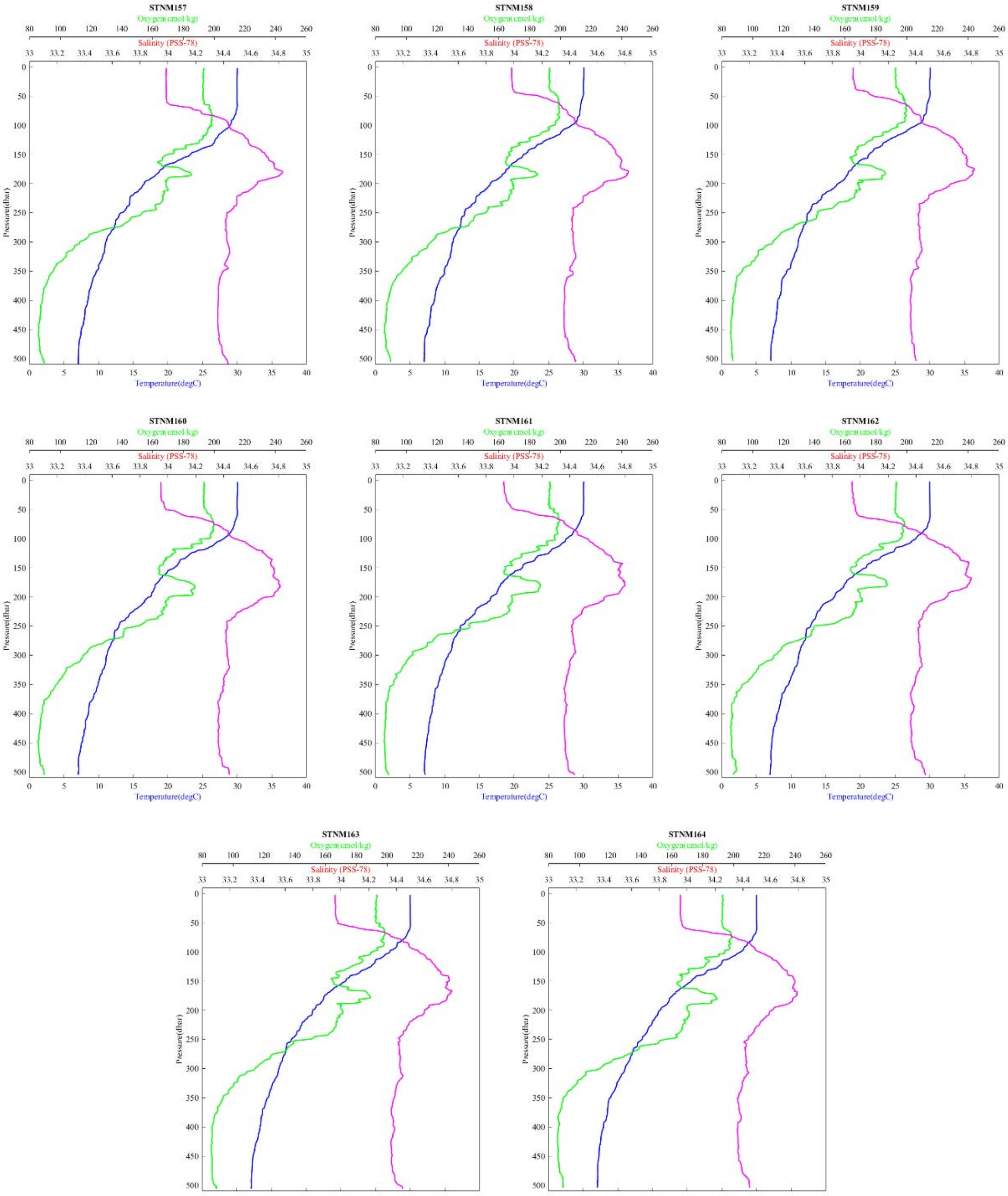
CTD profile (Fixed Station Observation 26th Aug. 2020 STNM133, STNM134, STNM135, STNM136, STNM137, STNM138, STNM139, STNM140)



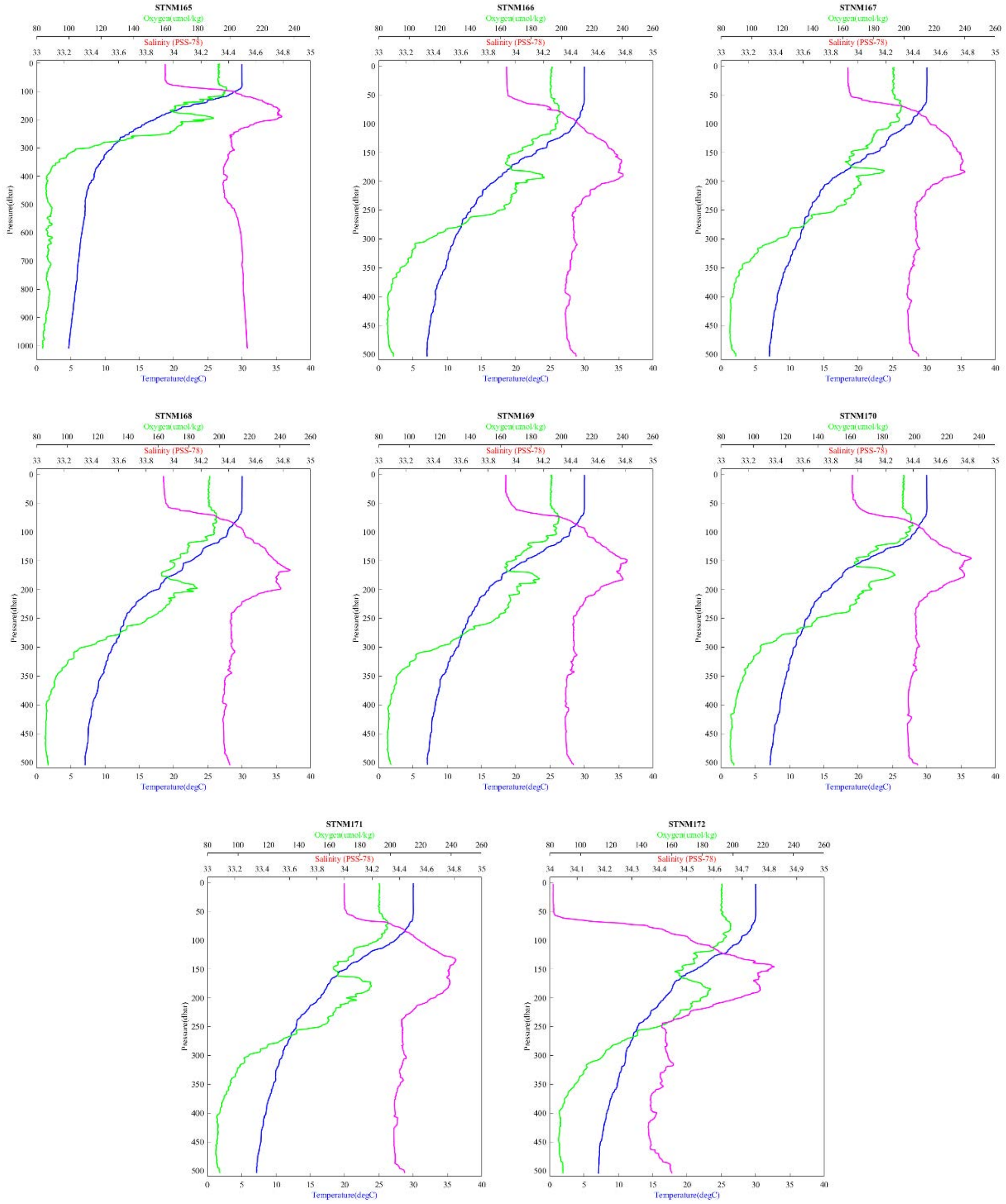
CTD profile (Fixed Station Observation 27th Aug. 2020 STNM141, STNM142, STNM143, STNM144, STNM145, STNM146, STNM147, STNM148)



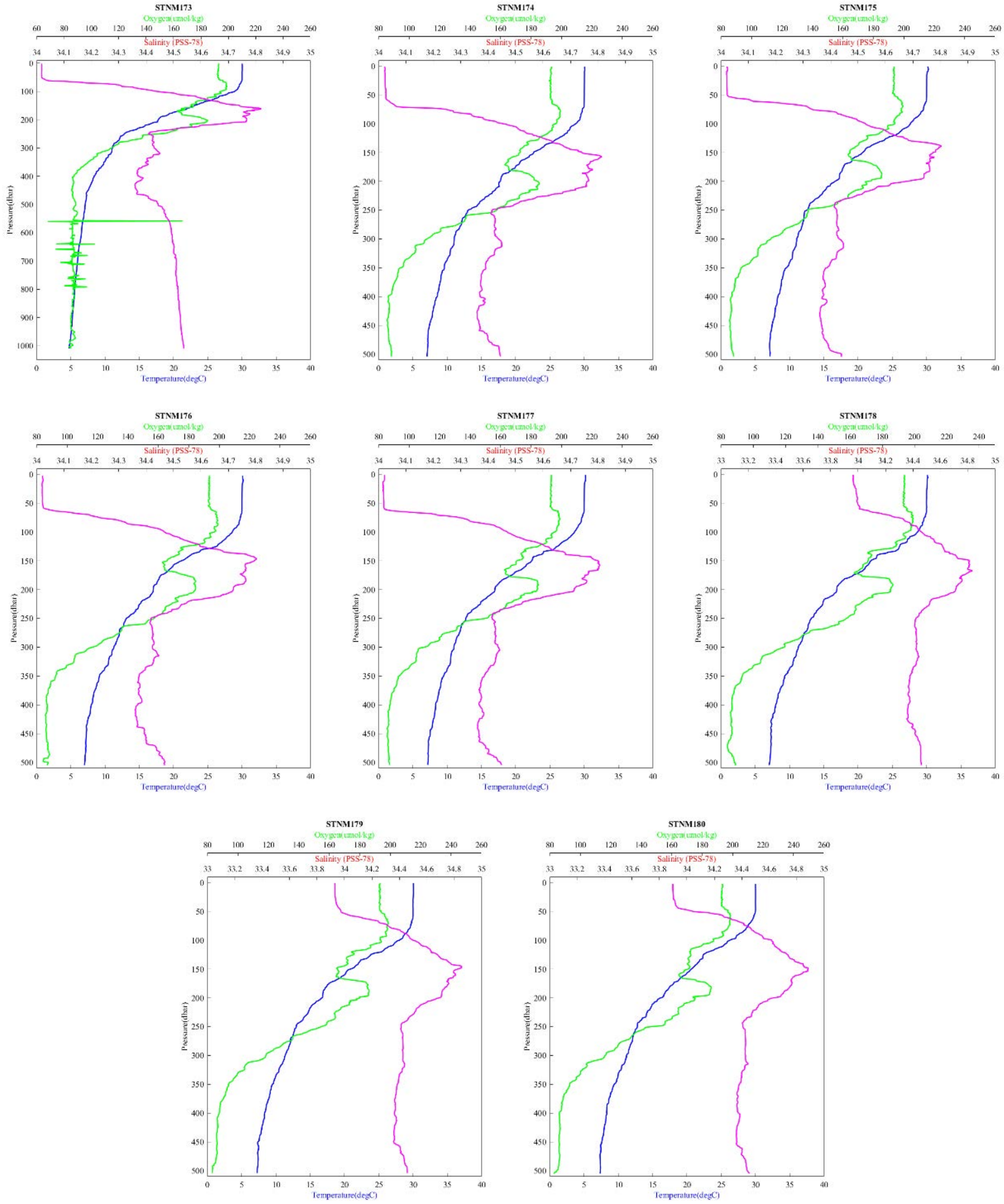
CTD profile (Fixed Station Observation 28th Aug. 2020 STNM149, STNM150, STNM151, STNM152, STNM153, STNM154, STNM155, STNM156)



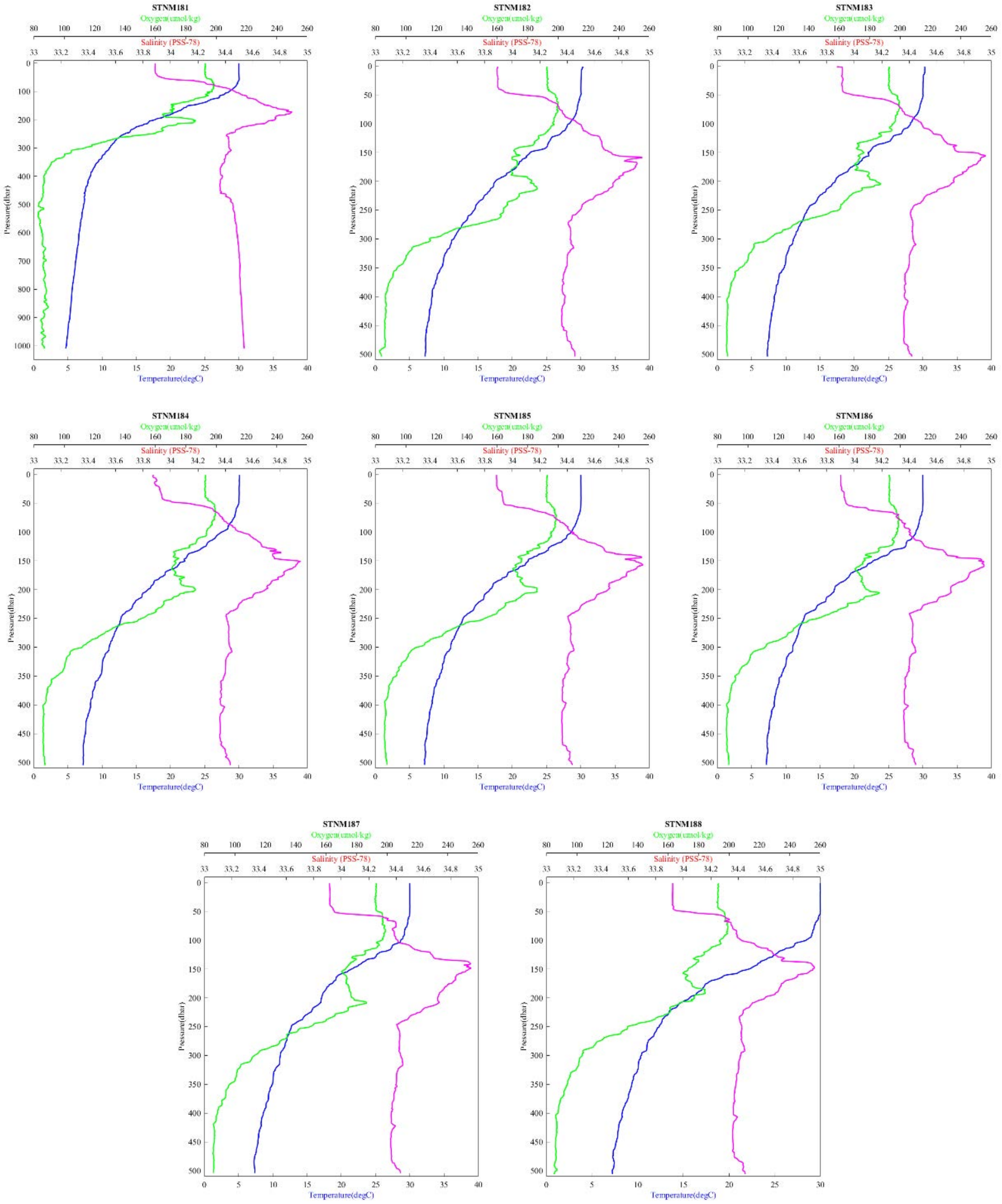
CTD profile (Fixed Station Observation 29th Aug. 2020 STNM157, STNM158, STNM159, STNM160, STNM161, STNM162, STNM163, STNM164)



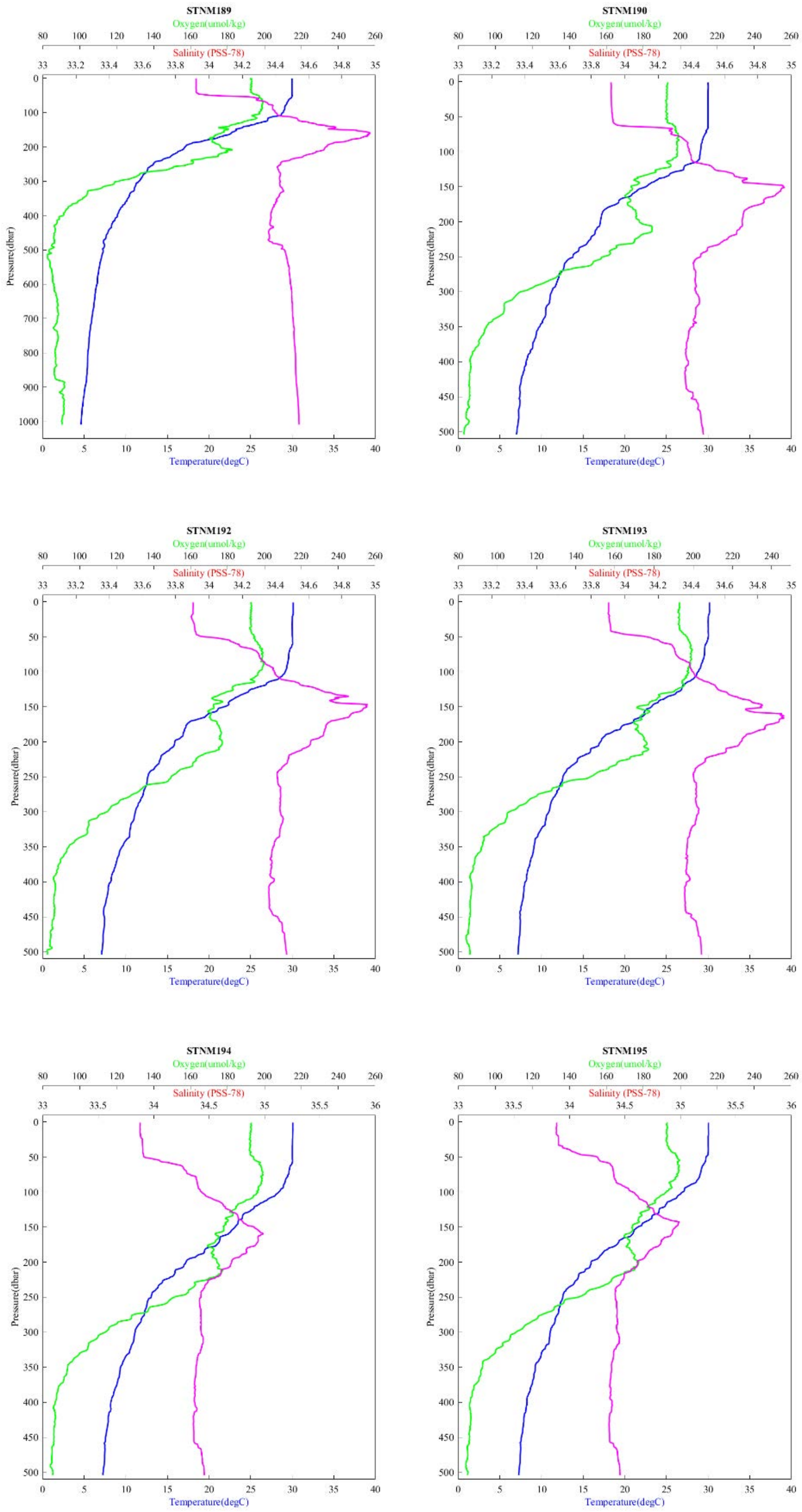
CTD profile (Fixed Station Observation 30th Aug. 2020 STNM165, STNM166, STNM167, STNM168, STNM169, STNM170, STNM171, STNM172)



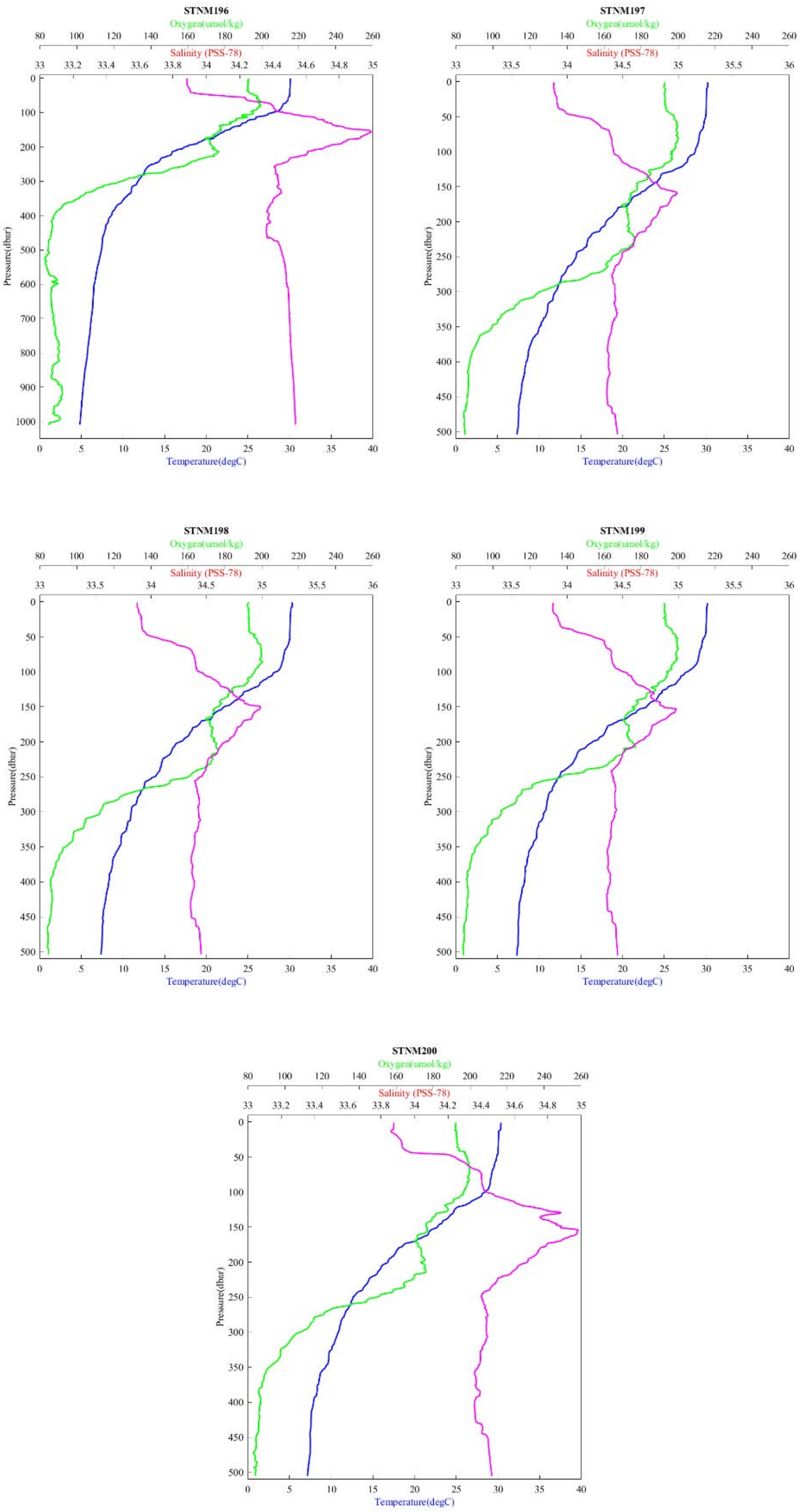
CTD profile (Fixed Station Observation 31th Aug. 2020 STNM173, STNM174, STNM175, STNM176, STNM177, STNM178, STNM179, STNM180)



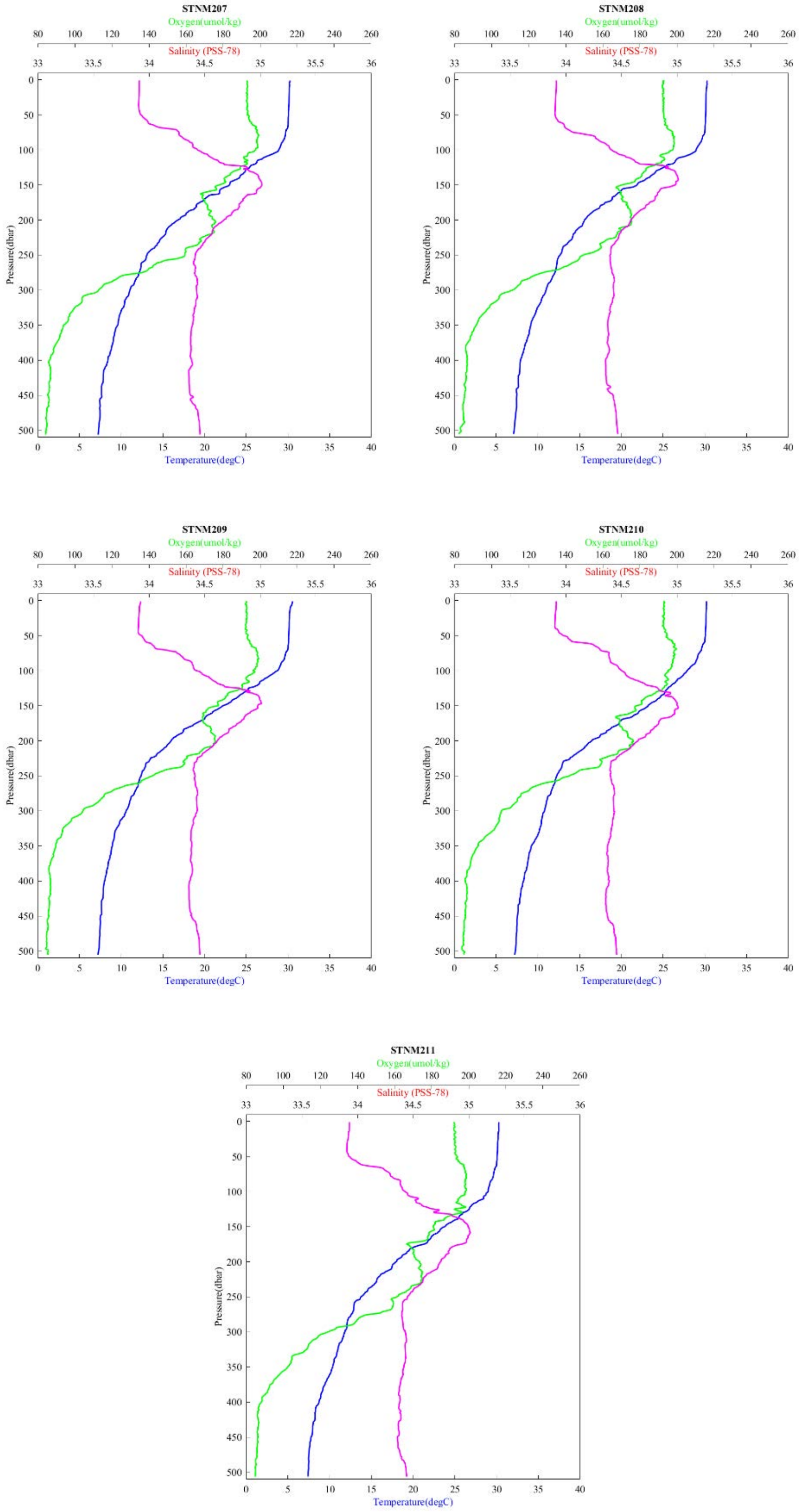
CTD profile (Fixed Station Observation 1st Sep. 2020 STNM181, STNM182, STNM183, STNM184, STNM185, STNM186, STNM187, STNM188)



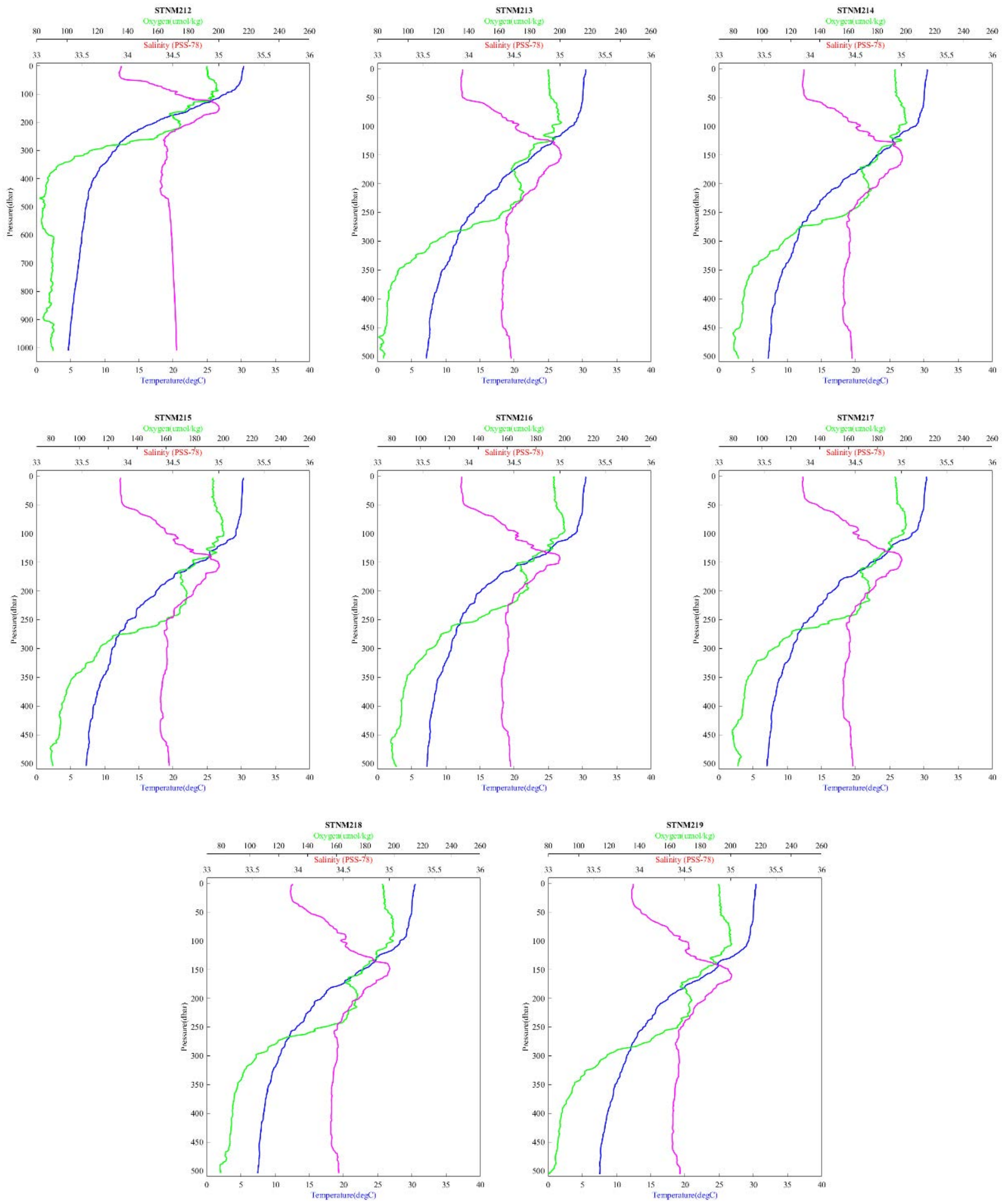
CTD profile (Fixed Station Observation 2nd Sep. 2020 STNM189, STNM190, STNM191, STNM192, STNM193, STNM194, STNM195)



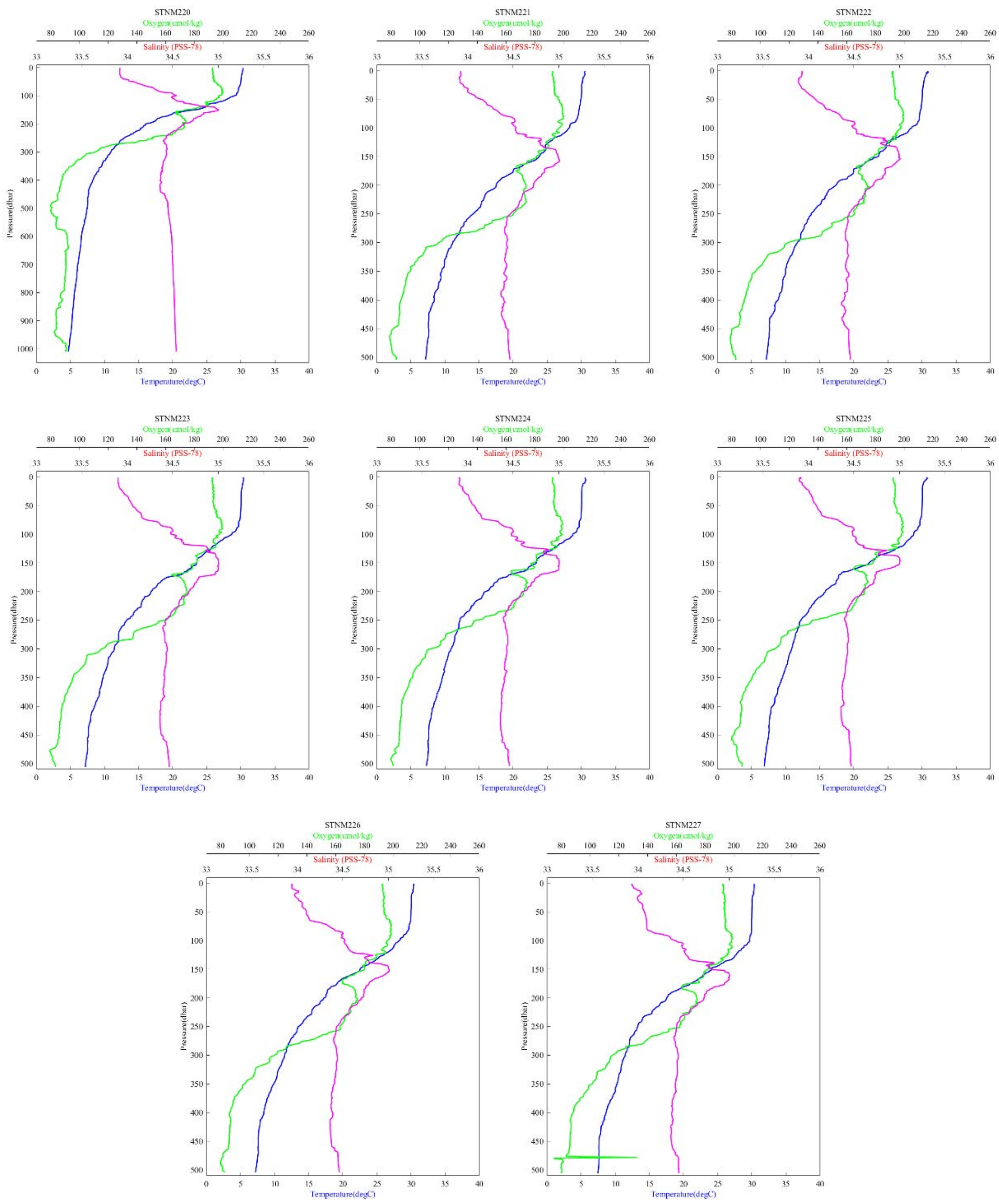
CTD profile (Fixed Station Observation 3rd Sep. 2020 STNM196, STNM190, STNM197, STNM198, STNM199, STNM200)



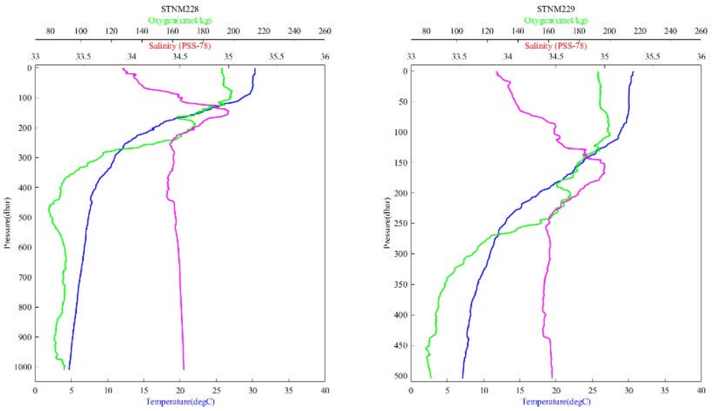
CTD profile（Fixed Station Observation 4th Sep. 2020 STNM207, STNM208, STNM209, STNM210, STNM211）



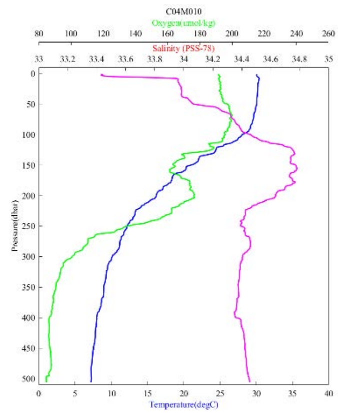
CTD profile (Fixed Station Observation 5th Sep. 2020 STNM212, STNM213, STNM214, STNM215, STNM216, STNM217, STNM218, STNM219)



CTD profile（Fixed Station Observation 6th Sep. 2020 STNM220, STNM221, STNM222, STNM223, STNM224, STNM225, STNM226, STNM227）



CTD profile (Fixed Station Observation 7th Sep. 2020 STNM228, STNM229)



CTD profile (m-TRITON Buoy Recovery 7th Sept 2020-C04M010)