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新青丸研究航海報告書

＊ 航海番号　　KS-22-10次研究航海

＊ 航海名称　　航空機との同時観測による北西太平洋の海洋起源エアロゾルとその雲微物理影響の解明
Simultaneous observations with an aircraft on marine aerosols and their effects on cloud microphysics in the Northwestern Pacific

＊ 観測海域　　北海道南東方沖
Southeast off Hokkaido

＊ 航海期間　　令和　4年 7月 15日（金）～令和　4年 8月 2日（火）

＊ 出港日時・場所　　7月 15日　14時　横須賀港

＊ 入港日時・場所　　8月　2日　14時　八戸港

＊ 寄港期間・場所　　7月　24～26日　釧路港

＊ 研究課題
１．夏季の北西太平洋亜寒帯域におけるエアロゾルの物理・化学特性の観測とそれらが雲に与える影響の評価

２．北海道南東方沖における海洋熱波発生時の海洋構造の観測

＊ 主席研究員（氏名・所属・職名）
川合義美・海洋研究開発機構・主任研究員

＊ 研究内容，主調査者，観測項目
１．親潮域・黒潮続流域における大気構造の観測、川合義美、
GPS ラジオゾンデによる高層気象観測（気温、湿度、風向、風速、気圧）、マイクロ波放射計及び GNSS 受信機による積算水蒸気量観測、雲カメラによる雲観測、シーロメーターによる雲底高度・後方散乱強度観測、乱流フラックス測定装置による海面フラックス観測

２．親潮域・黒潮続流域における海洋観測、川合義美、
CTD・XCTD による水温・塩分・溶存酸素・クロロフィル観測、ドップラー波高計による波高・波向・周期観測、タイムラプスカメラによる海面形状観測

３．親潮域・黒潮続流域におけるエアロゾル・海水中粒子の観測、吉田淳・大畑祥、
ハイボリュームエアサンプラー・ローボリュームエアサンプラー・氷晶核粒子用エアロゾルサンプラー・電子顕微鏡エアロゾルサンプラーによるエアロゾル採取、複素散乱振幅計測器

（CAS）による海水中及び大気中固体粒子観測、走査型移動度粒径測定装置（SMPS）による粒径分布観測、光学式粒子計測器による粒子数観測、スチームサイクロンによる非水溶性エアロゾルの物理特性観測、ディスドロメーターによる降水粒子観測

＊ 乗船研究者氏名・所属・職名

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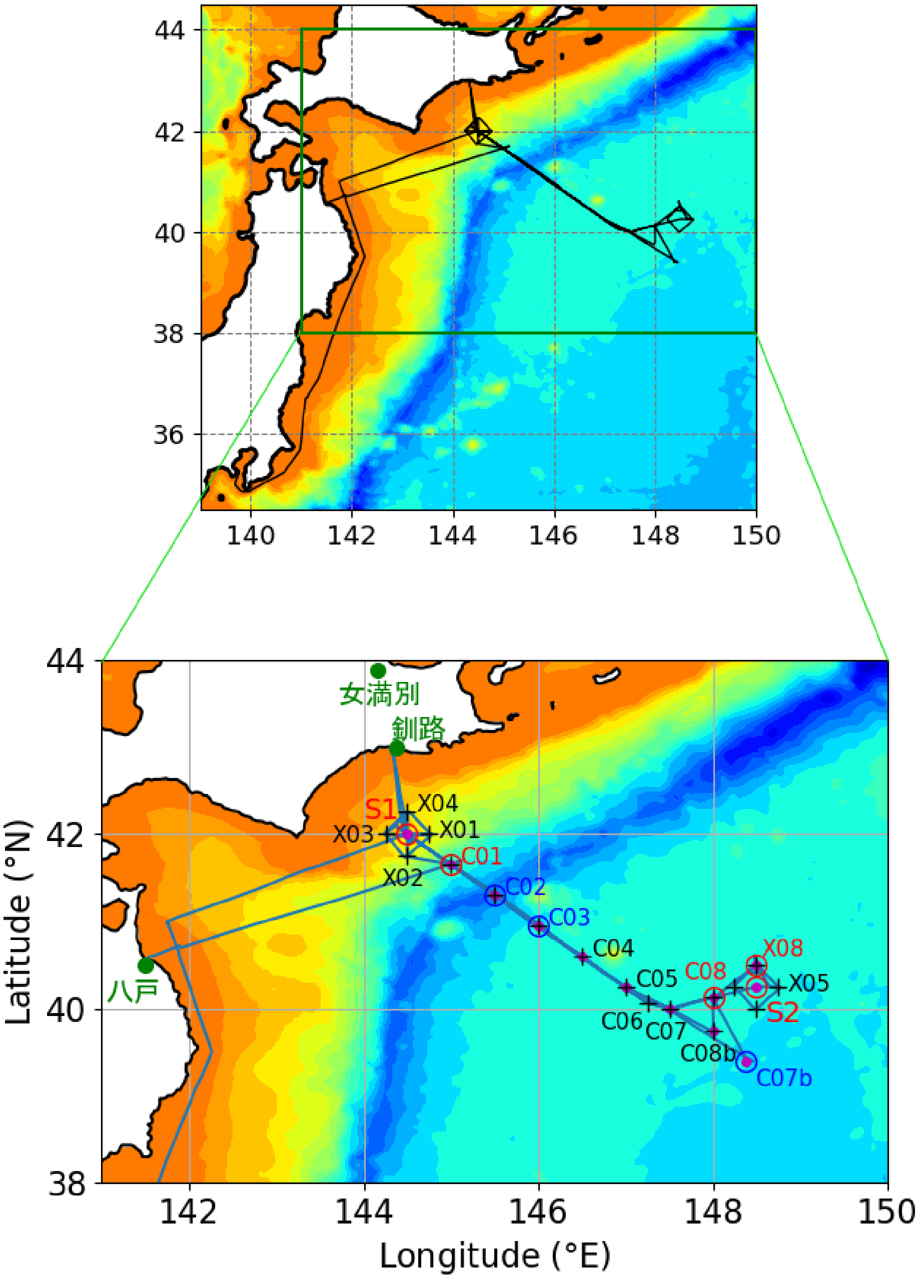
＊ 航跡・測点図



上図：航路、下図：観測域拡大図

青丸及び赤丸：CTD、赤丸：航空機との同時観測点、＋：XCTD、赤点：ラジオゾンデ

＊ 研究活動・観測の詳細や成果等について

（※別紙の英語版クルーズレポートをご利用ください）

Shinsei-maru Cruise Report

KS-22-10

Southeast off Hokkaido, Northwestern Pacific Ocean

15 July 2022 – 2 August 2022

Version 1.0

Contents

1. Cruise Information

1.1. Cruise ID: KS-22-10

1.2. Name of vessel: Shinsei-maru

1.3. Title of the cruise: Simultaneous observations with an aircraft on marine aerosols and their effects on cloud microphysics in the Northwestern Pacific

1.4. Chief scientist: Yoshimi Kawai

Global Oceanic Environment Research Group
Global Ocean Observation Research Center
Research Institute for Global Change (RIGC)
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

1.5. Representative of the Science Party: Yoshimi Kawai (JAMSTEC)

1.6. Science party

Scientists onboard

Yoshimi Kawai	JAMSTEC
Shigeki Hosoda	JAMSTEC
Eitarou Oka	University of Tokyo, AORI
Hatsumi Nishikawa	University of Tokyo, AORI
Toshiyuki Murayama	Tokyo University of Marine Science and Technology
Sho Ohata	Nagoya University, ISEE
Atsushi Yoshida	National Institute of Polar Research
Givo Alsepan	Hokkaido University
Yuta Ando	Niigata University
Rentaro Suzuki	Tokyo University of Marine Science and Technology
Gaku Nishihira	Tohoku University
Yui Kobayashi	Tohoku University
Aya Takagi	Tohoku University
Hayato Kanazawa	Tohoku University
Ratu Almira Kismawardhani	Tohoku University
Toru Sakamoto	Niigata University
Daichi Hata	Niigata University

Observation technician

Hiroyasu Sato	Marine Works Japan Ltd.

Scientists not onboard

Makoto Koike	University of Tokyo
Nobuhiro Moteki	University of Tokyo
Tatsuhiro Mori	Keio University
Yuzo Miyazaki	Hokkaido University
Michihiro Mochida	Nagoya University, ISEE
Hideaki Aiki	Nagoya University, ISEE
Kouji Adachi	Meteorological Research Institute
Yutaka Tobo	National Institute of Polar Research
Kosei Komatsu	University of Tokyo, GSFS/AORI
Fumiyoshi Kondo	Japan Coast Guard Academy
Akira Kuwano-Yoshida	Kyoto University, DPRI
Mikiko Fujita	JAMSTEC
Takuma Miyakawa	JAMSTEC
Yugo Kanaya	JAMSTEC
Kosei Sasaoka	JAMSTEC

1.7. Cruise period: 15 July – 2 August 2022

1.8. Ports of departure / call / arrival: Yokosuka / Kushiro / Hachinohe

1.9. Research area: Southeast off Hokkaido, Northwestern Pacific

1.10. Research map:

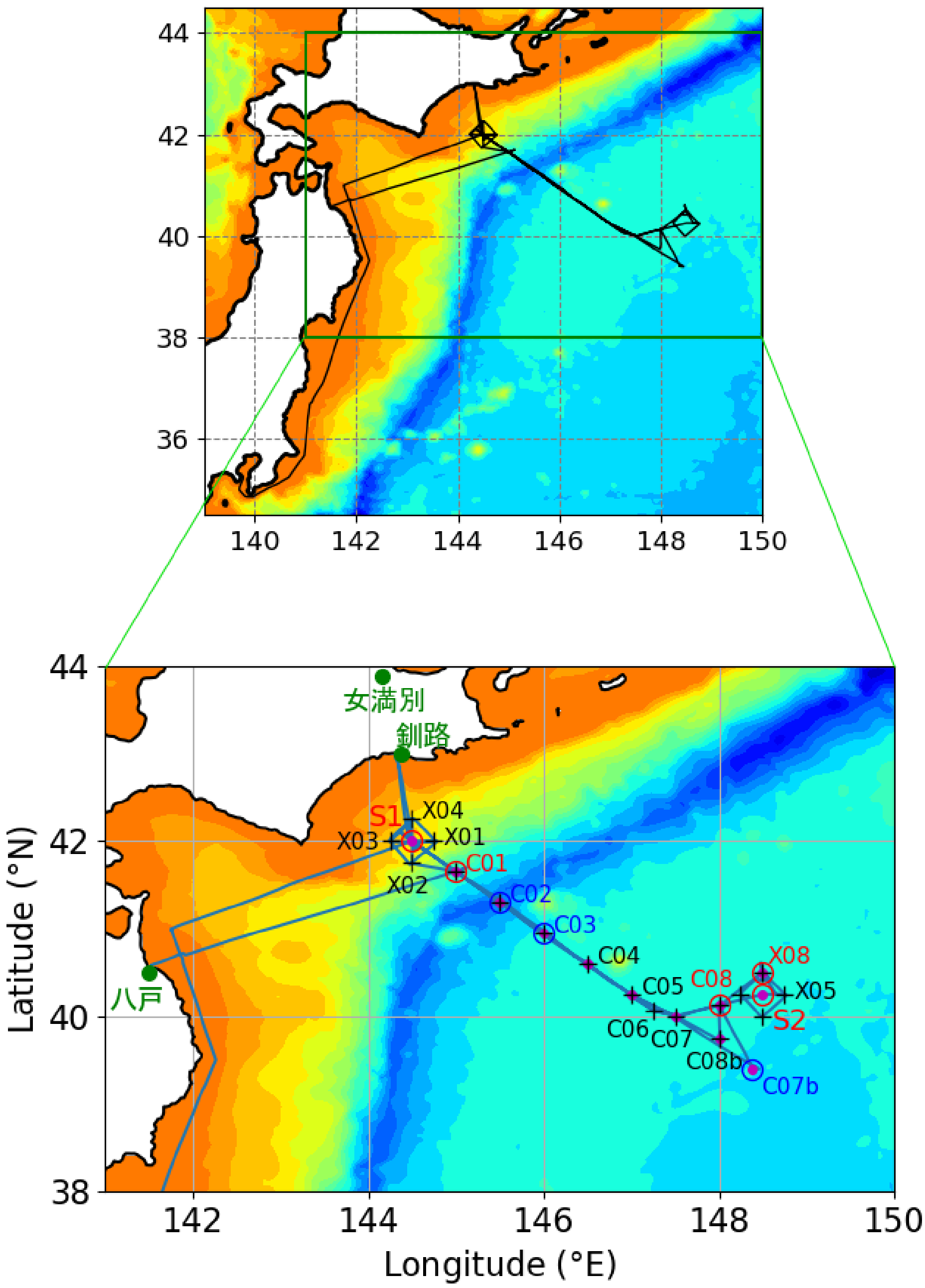


Figure 1. Cruise track (solid line) and observation sites. Circles, pluses and red dots represent CTD, XCTD and GPS radiosondes, respectively. Red circles denote the locations of simultaneous observations with an aircraft.

2. Overview of Research Activities

2.1. Purpose and outline

This cruise conducted observations together with an aircraft, aiming to evaluate physical and chemical properties of aerosols and their impacts on clouds in summer in the subarctic Northwestern Pacific Ocean, which is one of the regions where low-level cloud amount and its radiative forcing are highest in the globe and plays an important role in the earth's radiation budget. One of the purposes of the cruise was to reveal physical and chemical properties of marine aerosols comprehensively using various state-of-the-art instruments. Another purpose was to quantitatively evaluate flux of aerosols from the ocean. Such a comprehensive observation campaign, which had not been conducted before in this region, reveals the basic features of aerosols in the region of high biological activities. Furthermore, this cruise investigated air-sea interaction related with a marine heat wave. Besides air temperature, humidity, wind speed, and air pressure, the aircraft observed cloud microphysics properties, chemical composition of aerosols, the number of particles, particle radius distribution, and their vertical profiles, which cannot be measured on a vessel or land. These aircraft observations are combined with the near-surface observations on the vessel such as SST, chlorophyll-a concentration, surface fluxes, cloud base height, and aerosol particles, which are difficult to be measured by an aircraft.

2.2. Activities

2.2.1. Atmospheric sounding using GPS radiosonde, and aircraft observations

Vertical profiles of air temperature, relative humidity, and wind velocity were observed 50 times in total at 12 sites with GPS radiosondes (red dots in Fig.1). Simultaneous observations with an aircraft were performed 7 times in total (red circles in Fig.1). Balloons of 150g were used except for two cases, in which 100-g balloons were launched. The aircraft came from/to Memanbetsu airport in Hokkaido.

2.2.2. Oceanographic survey using CTD/XCTD

Vertical profiles of water temperature and salinity up to 1100-m depth were observed 30 times in total at 17 sites (black pluses in Fig.1). CTD observations and water sampling were carried out 12 times in total at 8 sites (red and blue circles in Fig.1)

2.2.3. Continuous atmospheric measurements

Air temperature, relative humidity, wind speed, wind direction, atmospheric pressure, rain rate, and downward radiation were continuously measured with instruments permanently installed on the vessel. Cloud base height, cloud cover, turbulent surface fluxes, and precipitable water were also observed with special instruments brought by the scientists during the cruise.

2.2.4. Continuous oceanic measurements

Surface temperature, salinity, chlorophyll concentration, dissolved oxygen, turbidity, and current speed were continuously measured with instruments permanently installed on the vessel. Wave height and visible images of the sea surface were also observed with special instruments brought by the scientists during the cruise.

2.2.5. Sampling and measurement of aerosol and seawater particles

Aerosol and seawater particles were measured with special instruments brought by the scientists during the cruise.

2.3. Details of observations

2.3.1. Aerological observations

1-1) Instrument: GPS radiosonde (Vaisala, RS41-SG), ASAP sounding station (balloon launcher) (Vaisala, ALS211), ground check device (Vaisala, RI41-B), software (Vaisala, DigiCORA MW41), subsystem (Vaisala, SPS311G), GPS antenna (Vaisala, GA31AL), UHF antenna (Vaisala, RM32AL), balloon (TOTEX Corporation, TA-150, TA-100)

1-2) Person in charge: Yoshimi Kawai (JAMSTEC)

1-3) Objective: To capture the thermodynamic structure of the atmosphere, especially the marine boundary layer

1-4) Parameter: Vertical profiles of temperature, relative humidity, altitude, pressure and wind speed/direction

1-5) Method: Atmospheric soundings were carried out using the Vaisala sounding system and launcher. Prior to launch, each radiosonde was calibrated. In case the relative wind to the ship was not appropriate for the launch, the hand launch was selected. Note that this type of radiosonde had no pressure sensor, and pressure was derived from the hypsometric equation and altitude.

2.3.2. Oceanographic survey using CTD/XCTD

1-1) Instrument: XCTD (Tsurumi-Seiki Co., Ltd., XCTD-1N)

1-2) Person in charge: Yoshimi Kawai (JAMSTEC)

1-3) Objective: To capture vertical and horizontal structure of temperature and salinity along the observation line and around the stations (S1 and S2), where the Kuroshio and Oyashio waters adjoin each other.

1-4) Parameter: Temperature, salinity, and depth

1-5) Method: XCTDs were released from an auto launcher, which was installed on the right side of the stern. XCTDs were loaded into the launcher in advance.

2-1) Instrument: CTD system (Sea-Bird Electronics, Inc., SBE911plus), carousel water sampler (Sea-Bird Electronics, Inc., SBE32), dissolved oxygen sensor (Sea-Bird Electronics, Inc., SBE43), transmissometer (WET Labs, Inc., C-Star), turbidity sensor (Seapoint Sensors, Inc., Seapoint Turbidity Meter), fluorescence sensor (Seapoint Sensors, Inc., Seapoint Chlorophyll Fluorometer), photosynthetically active radiation (PAR) sensor (Li-cor, Inc., Biospherical/Licor)

2-2) Person in charge: Eitarou Oka (University of Tokyo, AORI)
Hatsumi Nishikawa (University of Tokyo, AORI)
Yoshimi Kawai (JAMSTEC)
Hiroyasu Sato (MWJ)

2-3) Objective: Investigation of oceanic structure and water sampling

2-4) Parameter: Temperature, salinity, pressure, dissolved oxygen concentration, beam transmission, fluorescence, turbidity, and PAR

2-5) Method: Carousel system used in this cruise consisted of a 24-positions carousel water sampler and 12-liter sampling bottles. CTD was deployed from starboard side of the working deck. Seawater was sampled during the upcast by sending fire command from the operation PC. CTD was lowered down to 1000 m or 2000 m depth except for the first cast at S1 site, in which CTD was put down to 10 m above the bottom.

2-6) Date of calibration: Temperature sensor: 19-Jan-2021, Pressure sensor: 29-Jan-2021, Transmissometer: 28-Jan-2021, PAR sensor: 19-Jul-2021, others: none

3-1) Correction of dissolved oxygen concentration

3-2) Person in charge: Eitarou Oka (University of Tokyo, AORI)
Hatsumi Nishikawa (University of Tokyo, AORI)

3-3) Method: Seawater for oxygen correction was transferred from a Niskin bottle to

a volume-calibrated flask. Seawater was overflowed for more than 30 seconds. Two reagent solutions (Reagent I and II) of 0.5 ml each were added immediately into the sample flask and a 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 settled, at least 30 minutes later, 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 At least one hour after the re-shaking, the pickled samples were measured on board. Sulfuric acid solution of 1.0 ml and a magnetic stirrer bar were added into the sample flask and stirring began. Samples were titrated by sodium thiosulfate solution.
Reagent I: Manganese chloride solution
Reagent II: Sodium hydroxide / Sodium iodide solution

First of all, raw voltage value of the dissolved oxygen sensor was corrected using a hysteresis correction algorism shown in "Application Note No. 64-3" and coefficients shown in sensor's calibration sheet. The coefficients in the following polynomial were then determined by non-linear least square fitting so that downcast CTD oxygen values agreed well with the sampled water values:

$$Ox = \left[A\left(Ov + B\frac{dOv}{dt} + F\right) + Cexp(-0.03T)\right] Ox_{sat}(T,S)exp(DT + EP),$$

where T, S, and P are temperature (°C), salinity (PSS78), and pressure (dbar), respectively. Ox is dissolved oxygen concentration (ml/l), Ov is voltage value, and $Ox_{sat}(T, S)$ is saturated oxygen concentration at T and S.

	C009	C010	C011, C012
A	0.484	0.457	0.482
B	0.0	0.0	0.0
C	0.159	0.369	0.069
D	5.73e−5	1.12e−2	2.97e−3
E	−1.35e−4	−2.29e−4	−1.29e−4
F	−0.769	−1.18	−0.638

[Problem encountered]
Raw downcast CTD oxygen values were obviously abnormal and seemed wrong in C001-C008, and the oxygen sensor was replaced with a spare after C008. While the above-mentioned correction was applied to downcast CTD values for

C009-C012, upcast CTD values were corrected by linear least square fitting to the sampled water values for C001-C008. The downcast CTD oxygen values in C001-C008 must not be used.

4-1) Correction of salinity

4-2) Person in charge: Eitaro Oka (University of Tokyo, AORI)

Hatsumi Nishikawa (University of Tokyo, AORI)

4-3) Method: Brown glass bottles of 250 ml with screw caps were used for collecting sample water. After the cruise, the bottles were sent to AORI (Kashiwa campus), where salinity measurement was carried out using a salinometer. Cell factor (CF), which is the ratio of upcast CTD conductivity to sampled water conductivity, was determined by 5th-order polynomial approximation in terms of pressure p:

$$CF = a + bp + cp^2 + dp^3 + ep^4 + fp^5.$$

The correction of salinity was carried out by multiplying downcast CTD conductivity by CF. The coefficients are as follows:

	C001-C004	C005-C006	C007	C008-C009	C010-C012
a	0.9994074	1.000461	0.9996403	1.000206	0.9994551
b	0.7857396e−5	0.1193010e−5	0.3064712e−5	0.2153393e−5	0.6464422e−5
c	−0.2176444e−7	−0.6390550e−8	−0.2675530e−8	−0.6902364e−8	−0.1691753e−7
d	0.2579722e−10	0.8676513e−11	0.0	0.7982462e−11	0.1853511e−10
e	−0.1380568e−13	−0.3742740e−14	0.0	−0.3930499e−14	−0.8984467e−14
f	0.2741360e−17	0.0	0.0	0.6976074e−18	0.1592106e−17

5-1) Measurement of chlorophyll-a concentration

5-2) Person in charge: Yoshimi Kawai (JAMSTEC)

Shigeki Hosoda (JAMSTEC)

Kosei Sasaoka (JAMSTEC)

5-3) Method: Seawater samples for chlorophyll *a* (chl-*a*) were collected into 250ml brown polyethylene bottles from a bucket at the surface, and from Niskin bottles at 9 depths between 10 and 200 dbar including a chl-*a* maximum layer, which was determined by a fluorometer (Seapoint Sensors, Inc.) installed in the CTD system. All seawater samples were gently filtrated by low vacuum pressure (<0.02 MPa) through Whatman GF/F filter (diameter 25 mm) in the dark room on board. The filters were stored in the freezer of the vessel, and sent to JAMSTEC Yokosuka HQ just after the cruise. Phytoplankton pigments retained on the filters were extracted in a polypropylene tube with 7 ml of N,Ndimethylformamide in the laboratory of JAMSTEC. The tubes were stored at –20°C under the dark condition to extract chl-*a* at least for 96 hours. Fluorescence of each sample were measured by Turner Designs fluorometer (10-AU-005), which was calibrated against a pure chl-*a* (Sigma chemical Co.). To estimate the chl-*a* concentrations, we applied to the fluorometric "Non-acidification method" (Welschmeyer, 1994).

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

2.3.3. Continuous atmospheric and oceanic measurements

1-1) Instrument: continuous sea surface salinity and temperature monitoring system (Nippon Kaiyo Co. Ltd., NDAS V7.0)

1-2) Person in charge: (permanently installed on the vessel)

1-2) Parameter: Chlorophyll concentration, conductivity, turbidity, dissolved oxygen concentration, temperature, salinity, and flow rate

1-3) Method: The parameters were obtained every one minute. The monitoring system was located in No.2 laboratory, and seawater was continuously pumped up to the laboratory from an intake placed at approximately 3.0 m below the sea surface and flowed into the system.

2-1) Instrument: Microwave radiometer (Furuno ELECTRIC Co., Ltd., KASMI-100)

2-2) Person in charge: Akira Kuwano-Yoshida (Kyoto University)

2-3) Objective: To measure column-integrated water vapor and its variations

2-4) Parameter: Column-integrated water vapor, vertical profile of water vapor

2-5) Method: Receiving microwave from atmosphere (around 23GHz, 39 channels) above with every tens of seconds.

3-1) Instrument: All-sky camera (Furuno ELECTRIC Co., Ltd., MLACMO-100)

3-2) Person in charge: Akira Kuwano-Yoshida (Kyoto University)

3-3) Objective: To measure cloud fraction and rain presence

3-4) Parameter: Visible images of skies, cloud cover, cloud type

3-5) Method: Taking pictures atmosphere above with every 2 minutes.

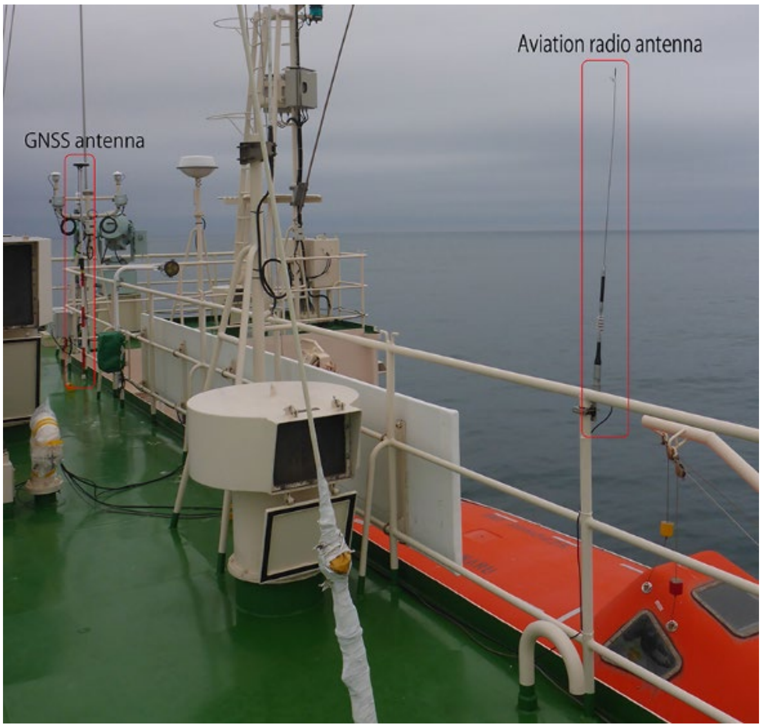
4-1) Instrument: GNSS receiver (LiGHTHOUSE Technology and Consulting Co.,Ltd., SKR-L9P) and antenna (Hemishphere, A45)

4-2) Person in charge: Mikiko Fujita (JAMSTEC)

4-3) Objective: To measure column-integrated water vapor and its variations

4-4) Parameter: Column-integrated water vapor

4-5) Method: GNSS satellite data were archived to the receiver at 5-sec intervals, and the GNSS antenna was set on the starboard of the compass deck. The observations were carried out all through the cruise. We will calculate the total column-integrated water vapor from the obtained GNSS satellite data after the cruise.



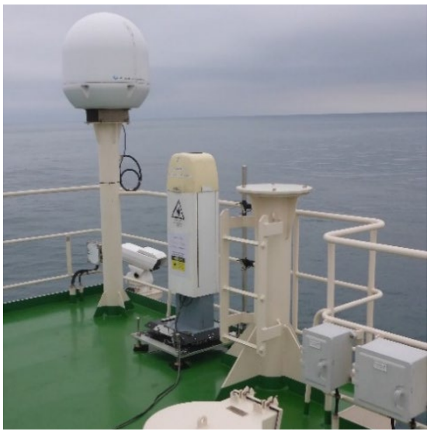
5-1) Instrument: Ceilometer (CL31, Vaisala)

5-2) Person in charge: Toshiyuki Murayama (Tokyo University of Marine Science and Technology)

5-3) Objective: To measure cloud base height, mixing layer height, and backscattering, which are important to understand the process on formation of clouds

5-4) Parameter: Cloud base height, mixing layer height, and backscattering

5-5) Method: The principle of the operation is Lidar (light detection and ranging). Backscatter profiles were recorded from the ground to 7500 m with 10-m height resolution every 16 seconds and processed to estimate the cloud base heights and the boundary layer heights.


Ceilometer

6-1) Instrument: Turbulent flux measurement system (Climatec, Inc., custom order)

6-2) Person in charge: Fumiyoshi Kondo (Japan Coast Guard Academy)

6-3) Objective: To measure air-sea momentum, heats, CO_2 gas, and particle fluxes

6-4) Parameter: Horizontal and vertical wind velocities, sonic temperature, water vapor and CO_2 gas densities, particle fluctuations

6-5) Method: Turbulent parameters by sonic anemometer-thermometer, H_2O/CO_2 gas analyzer, and optical particle counter were measured at 10 Hz to evaluate turbulent fluxes by eddy covariance technique.

7-1) Instrument: Time lapse camera (Brinno, model TLC200pro)

7-2) Person in charge: Takuma Miyakawa (JAMSTEC)
Yugo Kanaya (JAMSTEC)

7-3) Objective: Characterization of wave breaking state and atmospheric condition affecting the cloud condensation nuclei (CCN) in the marine boundary layer

7-4) Parameter: Visible images of the sea surface and atmosphere

7-5) Method: Visible images of the sea surface and atmosphere were taken by a camera every 1 minute and processed to estimate the whitecap fraction of the sea surface.


Time lapse camera

8-1) Instrument: Wave gauge using the marine radar system (Japan Radio Co., Ltd., X-band radar)

8-2) Person in charge: Kosei Komatsu (University of Tokyo, GSFS/AORI)

8-3) Objective: To measure 2D wave energy spectrum continuously

8-4) Parameter: Wave height, wave direction, wave length, and wave group velocity

8-5) Method: Cross-spectral analysis of STC-processed video signals of marine radar reflection from the sea surface yields wave parameters composed of wave height, wave direction, wave length and wave group velocity, which provide 2D wave energy spectrum at 20 minutes intervals throughout the cruise.

2.3.4. Sampling and measurement of aerosol and seawater particles

1-1) Instrument: Optical particle counter (OPC) (Particle Plus, model 8306) × 2

1-2) Person in charge: Miyakawa Takuma (JAMSTEC)
Yugo Kanaya (JAMSTEC)

1-3) Objectives: Characterization of atmospheric aerosols in the marine boundary layer

1-4) Parameters: Size-resolved particle number concentrations at dry and 300°C conditions (online measurements)

1-5) Method: Based on a light scattering technique, particles are counted and sized. One OPC minutely measured the particle size distributions at dry condition, another did those in air heated at 300°C.

OPCs

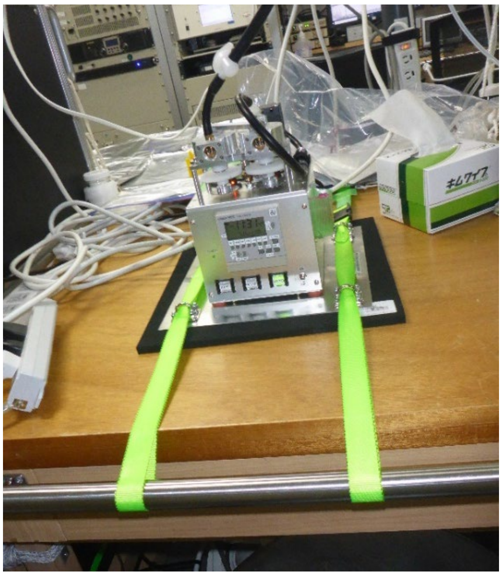
2-1) Instrument: Aerosol sampler (Arios, AS-24W)

2-2) Person in charge: Kouji Adachi (Meteorological Research Institute)

2-3) Objective: To measure compositions and mixing states of aerosol particles using transmission electron microscopy

2-4) Parameter: Shapes, compositions, and sizes of aerosol particles

2-5) Method: Samplings were conducted every two hours with 30 min sampling and 1.5h interval during the entire cruise. Individual particle compositions and shapes are analyzed using a transmission electron microscope (JEM-1400, JEOL, Japan) with an energy dispersive-Xray spectrometer (EDS; X-Max 80 mm, Oxford instrument, Japan) after the cruise.



Aerosol sampler

3-1) Instrument: Laser disdrometer (Adolf Thies GmbH & Co. KG, 5.4110, provided by Senecom. Inc. in Japan as a disdrometer model SE-LP5411)

3-2) Person in charge: Makoto Koike (University of Tokyo)

Tatsuhiro Mori (Keio University)

3-3) Objective: To monitor precipitation rates and size distributions of precipitating particles

3-4) Parameter: Precipitation rates and size distributions of precipitating particles (online measurements)

3-5) Method: Sizes of individual precipitating particles, which fall through a laser beam, are measured and one minute averages are recorded.


Laser disdrometer

4-1) Instrument: High volume air sampler (KIMOTO ELECTRIC Co., Ltd., Model 120SL)

4-2) Person in charge: Yuzo Miyazaki (Hokkaido University)

4-3) Objective: To measure chemical compositions of size-segregated aerosols

4-4) Parameter: Bulk and molecular compositions and stable carbon isotopic compositions of organic aerosols

4-5) Method: Twelve-hour sampling of size-segregated aerosols on quartz-fiber filters. They are analyzed after the cruise.

5-1) Instrument: Complex Amplitude Sensing version 1 (CAS) (handmade; Moteki 2021 Optics Express)

5-2) Person in charge: Atsushi Yoshida (National Institute of Polar Research)
Tobo Yutaka (National Institute of Polar Research)

5-3) Objective: To characterize and quantify suspended particulate matter in seawater

5-4) Parameter: Complex scattering amplitude and size-resolved number concentration of particles in seawater

5-5) Method: Seawater samples collected at various depths were introduced to the CAS using a peristaltic pump. Complex scattering amplitudes of individual particles suspended in seawater were measured by the CAS (Moteki 2021 Optics Express). Based on the complex scattering amplitude and frequency of signal occurrence measured by the CAS, particle composition and size-resolved number concentrations will be estimated. Samplings were conducted approximately once a day.

6-1) Instrument: Low volume aerosol sampler (Tokyo Dylec Corp.)

6-2) Person in charge: Atsushi Yoshida (National Institute of Polar Research)
Tobo Yutaka (National Institute of Polar Research)

6-3) Objective: To measure ice nucleating particles (INPs) over ocean.

6-4) Parameter: Number concentration of INPs

6-5) Method: Aerosol particles were collected on filters by the aerosol sampler. Number concentration of INPs for filter samples will be measured using the Cryogenic Refrigerator Applied to Freezing Test (CRAFT; Tobo 2016 Scientific Reports). Samplings were conducted approximately once a day.

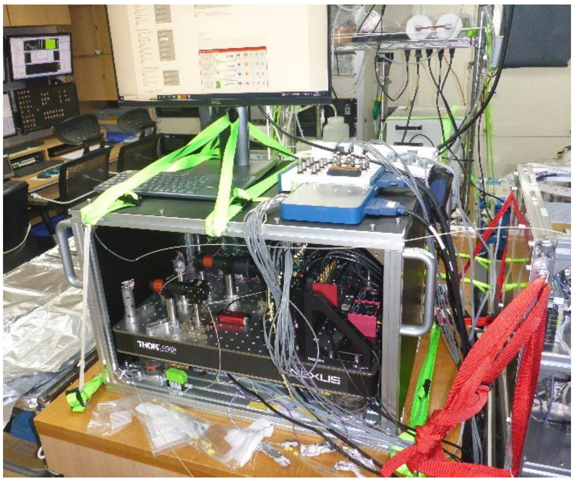
7-1) Instrument: Steam Cyclone - CAS (handmade)

7-2) Person in charge: Nobuhiro Moteki (University of Tokyo)
Sho Ohata (Nagoya University, ISEE)
Atsushi Yoshida (National Institute of Polar Research)

7-3) Objective: To measure physical properties (such as complex refractive index and volume) of water-insoluble aerosol particles

7-4) Parameter: Complex forward-scattering amplitude of water-insoluble aerosol particles (online single-particle measurements)

7-5) Method: Atmospheric aerosol particles are continuously collected into water by the Steam Cyclone and then physical properties of individual water-insoluble particles are measured by the self-reference interferometric technique (CAS).



8-1) Instrument: Scanning Mobility Particle Sizer (SMPS) (TSI Inc., DMA Model 3080 + CPC Model 3775)

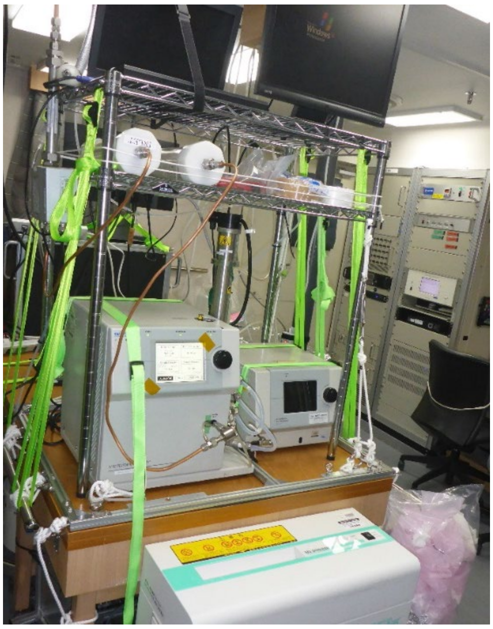
8-2) Person in charge: Sho Ohata (Nagoya University, ISEE)

Michihiro Mochida (Nagoya University, ISEE)

8-3) Objective: To measure size distributions of submicron aerosol particles

8-4) Parameter: Size distributions of aerosol particles (online measurements)

8-5) Method: Electrical mobility sizing combined with single-particle counting. Data is acquired every 5 minutes.



9-1) Instrument: High-volume air sampler, KIMOTO ELECTORIC Co., Ltd., Model 120SL

9-2) Person in charge: Sho Ohata (Nagoya University, ISEE)
Michihiro Mochida (Nagoya University, ISEE)

9-3) Objective: To measure chemical composition and properties of aerosols

9-4) Parameter: Chemical composition and properties of aerosols

9-5) Method: Submicron and supermicron aerosol samples were collected on quartz fiber filters and substrates, respectively, on a daily basis. Chemical composition and properties of the samples are measured by various analytical methods after the cruise.

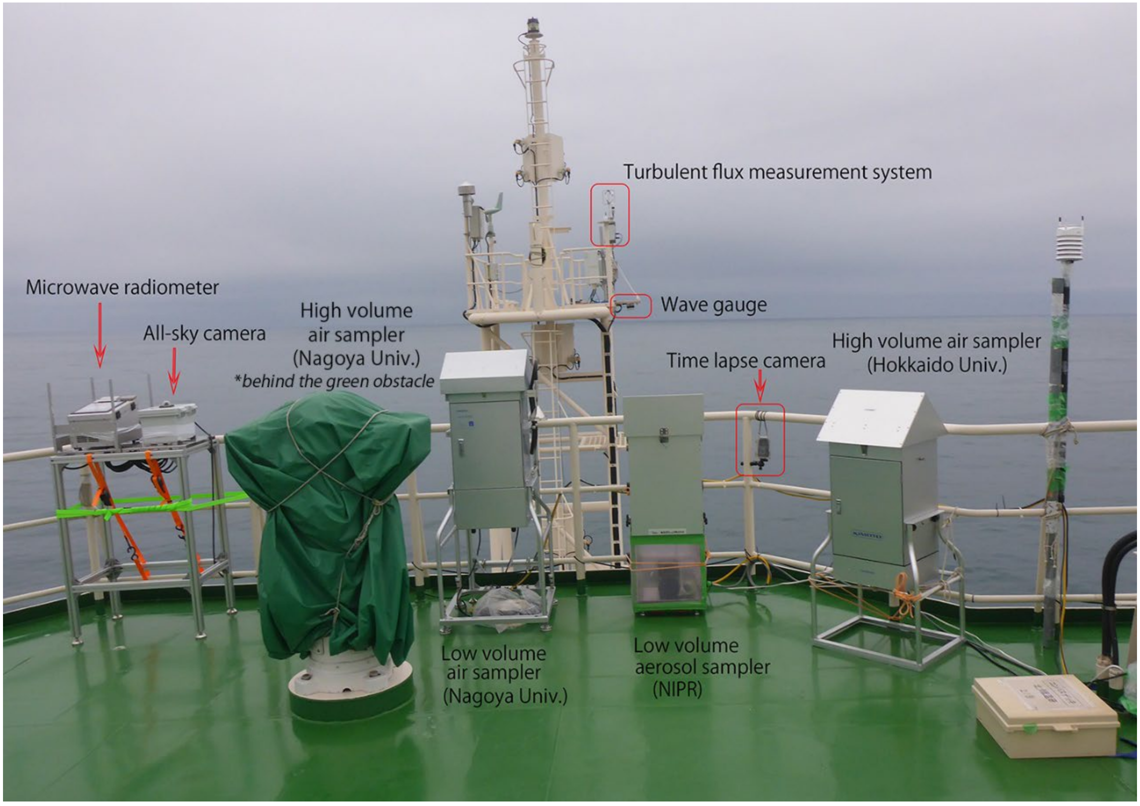
10-1) Instrument: Low-volume air sampler (handmade)

10-2) Person in charge: Sho Ohata (Nagoya University, ISEE)
Michihiro Mochida (Nagoya University, ISEE)

10-3) Objective: To measure chemical structure of organic aerosols

10-4) Parameter: Chemical structure of organic aerosols

10-5) Method: PM2.5 samples were collected on PTFE filters on a daily basis. Samples are analyzed by a FT-IR spectrometer after the cruise.



3. Logs

3.1 Cruise log

Date	Time		Event
	JST	UTC	
15 July	14:00	05:00	Depart from Yokosuka
17 July			(Evacuation off Shimokita Peninsula)
18 July	08:45	23:45 (-1d)	CTD at S1 (C001)
	11:51-03:11	02:51-18:11	Search cruise around S1 with XCTD
19 July	08:45	23:45 (-1d)	CTD at C01 (C002)
	12:45	03:45	Aviation radio test with aircraft
	13:00	04:00	CTD at C02 (C003)
	17:20	08:20	CTD at C03 (C004)
	19:57-22:40	10:57-13:40	Cruise for turbulent flux measurement (F001, F002)
			(Back to S1 to avoid severe weather)
20 July			(Evacuation at S1)
	20:33	11:33	First radiosonde at S1 (S001)
21 July	08:45	23:45 (-1d)	CTD at S1 (C005)
	10:54-11:42	01:54-02:42	Aircraft observation #1
	11:45	02:45	Depart from S1 to C08
	14:42	05:42	Radiosonde and XCTD from C01 to C08
22 July	06:00	21:00 (-1d)	Arrive at C08
	08:30	23:30 (-1d)	Radiosonde at C08 (S010)
	08:45	23:45 (-1d)	CTD at C08 (C006)
	11:50-12:09	02:50-03:09	Aircraft observation #2
	12:17	03:17	Depart from C08 to C08b
	14:27	05:27	Radiosonde and XCTD from C08b to S1
23 July	08:45	23:45 (-1d)	Depart from S1 to Kushiro port to avoid severe weather
	13:45	04:45	(Wait off Kushiro port)
24 July	10:00	01:00	Arrive at Kushiro port
25 July	14:00	05:00	Cancel the departure
26 July	14:00	05:00	Depart from Kushiro port
	20:30	11:30	Radiosonde at S1 (S019)
	20:34-23:20	11:34-14:20	Cruise for turbulent flux measurement (F003, F004)

27 July	08:45	23:45 (-1d)	CTD at S1 (C007)
	10:58-11:19	01:58-02:19	Aircraft observation #3
	11:51	02:51	Depart from S1 to S2
	14:32	05:32	Radiosonde and XCTD from C01 to S2
28 July	08:45	23:45 (-1d)	CTD at S2 (C008)
	11:44-12:09	02:44-03:09	Aircraft observation #4
	12:13-22:16	03:13-13:16	Search cruise around S2 with XCTD
29 July	08:45	23:45 (-1d)	CTD at X08 (C009)
	11:38-12:42	02:38-03:42	Aircraft observation #5
			Cruise for turbulent flux measurement (F005)
	14:34-16:42	05:34-07:42	Search cruise around X08
30 July	08:45	23:45 (-1d)	CTD at X08 (C010)
	11:30-11:46	02:30-02:46	Aircraft observation #6
	14:35	05:35	Depart from X08 to C07b
31 July	08:45	23:45 (-1d)	CTD at C07b (C011, for Argo float calibration)
	17:35	08:35	Radiosonde and XCTD from C07 to C01
1 August	08:45	23:45 (-1d)	CTD at C01 (C012)
	10:55-11:28	01:55-02:28	Aircraft observation #7
	11:34-12:34	02:34-03:34	Cruise for turbulent flux measurement (F006)
	12:35	03:35	Depart from C01 to Hachinohe
2 August	10:00	01:00	Arrive at Hachinohe port

3.2 Research log

Station	Obs no.	Date and time (UTC)	Latitude	Longitude	Memo
S1	C001	2022/07/18 00:04	42-00.00N	144-29.99E	Bottom cast start SST=20.6, DO, S, Chl-a
S1	C001	2022/07/18 01:52	42-00.00N	144-30.00E	End
X01	X001	2022/07/18 04:00	42-00.00N	144-45.26E	S/N 21075558, SST=20.9, SSS=33.74
X02	X002	2022/07/18 06:00	41-44.58N	144-29.53E	S/N 21075561, SST=20.9, SSS=33.43
X03	X003	2022/07/18 07:54	42-00.09N	144-14.99E	S/N 21075556, SST=20.6, SSS=33.32
X04	X004	2022/07/18 09:36	42-15.00N	144-30.13E	S/N 21075557, SST=20.9, SSS=33.64
C01	C002	2022/07/18 23:59	41-38.90N	145-00.00E	1000m cast start SST=20.1, Chl-a
C01	C002	2022/07/19 00:59	41-38.90N	145-00.00E	End
C02	C003	2022/07/19 04:15	41-17.65N	145-29.76E	1000m cast start SST=21.3, Chl-a
C02	C003	2022/07/19 05:11	41-17.94N	145-30.12E	End
C03	C004	2022/07/19 08:28	40-56.70N	145-59.98E	1000m cast start SST=21.9, DO, Chl-a
C03	C004	2022/07/19 10:31	40-56.66N	145-59.84E	End
C03	F001	2022/07/19 10:57	40-56.60N	146-00.04E	Flux cruise
C03	F001	2022/07/19 11:57	40-53.59N	146-06.60E	End
C03	F002	2022/07/19 12:39	40-56.78N	145-59.77E	Flux cruise
C03	F002	2022/07/19 13:40	40-53.79N	146-05.75E	End
S1	S001	2022/07/20	42-02.56N	144-26.21E	S/N 0660078, SST=20.8

		11:33			
S1	S002	2022/07/20 17:31	41-59.97N	144-29.97E	S/N 0710306, SST=19.5
S1	S003	2022/07/20 23:30	41-59.99N	144-30.00E	S/N 0710348, SST=19.4
S1	C005	2022/07/21 00:04	42-00.00N	144-30.00E	1000m cast start SST=19.4, DO, Chl-a
S1	C005	2022/07/21 01:23	41-59.98N	144-29.98E	End
C01	S004	2022/07/21 05:42	41-38.88N	144-00.03E	S/N 0710345, SST=19.8
C01	X005	2022/07/21 05:44	41-38.60N	145-00.42E	S/N 21075550, SST=19.9, SSS=33.04
C02	S005	2022/07/21 08:30	41-17.72N	145-30.11E	S/N U0660084, SST=21.5
C02	X006	2022/07/21 08:32	41-17.47N	145-30.48E	S/N 21075555, SST=21.6, SSS=34.03
C03	S006	2022/07/21 11:18	40.56.95N	146-00.05E	S/N U0710347, SST=20.2
C03	X007	2022/07/21 11:18	40-56.66N	145-59.86E	S/N 21075551, SST=20.1, SSS=33.39
C04	S007	2022/07/21 14:08	40-4747N	146-11.62E	S/N U0660073, SST=19.4
C04	X008	2022/07/21 14:10	40-35.22N	146-30.51E	S/N 21075552, SST=18.6, SSS=32.89
C05	S008	2022/07/21 16:52	40-14.43N	147-00.07E	S/N U0660076, SST=22.3
C05	X009	2022/07/21 16:59	40-13.58N	147-01.78E	S/N 21075553, SST=22.3, SSS=33.71
C07	S009	2022/07/21 19:09	40-00.00N	147-29.98E	S/N U0660077, SST=20.3
C07	X010	2022/07/21 19:02	39-59.94N	147-30.30E	S/N 21075554, SST=21.2, SSS=33.52
C08	S010	2022/07/21 23:30	40-07.50N	148-00.00E	S/N U0660083, SST=19.1

C08	C006	2022/07/22 00:03	40-07.50N	148-00.00E	1000m cast start SST=19.2, DO, S, Chl-a
C08	C006	2022/07/22 01:14	40-07.50N	148-00.00E	End
C08b	S011	2022/07/22 05:27	39-44.96N	148-00.00E	S/N U0710346, SST=24.0
C08b	X011	2022/07/22 05:28	39-44.85N	147-59.99E	S/N 21117907, SST=23.7, SSS=33.56
C07	S012	2022/07/22 08:13	40-00.26N	147-29.50E	S/N U0710301, SST=21.0
C05	S013	2022/07/22 10:47	40-14.50N	146-59.96E	S/N U0710339, SST=22.8
C04	S014	2022/07/22 13:29	40-35.75N	146-29.72E	S/N U0710343, SST=20.7
C03	S015	2022/07/22 16:02	40-56.71N	145-59.95E	S/N U0710302, SST=19.5
C02	S016	2022/07/22 18:55	41-17.94N	145-29.80E	S/N U0710305, SST=21.8
C01	S017	2022/07/22 21:07	41-38.97N	144-59.78E	S/N U0710340, SST=19.6
S1	S018	2022/07/22 23:43	42-00.01N	144-29.98E	S/N U0710303, SST=19,9
S1	S019	2022/07/26 11:30	42-00.00N	144-30.00E	S/N U0710338, SST=17.8
S1	F003	2022/07/26 11:34	41-59.86N	144-30.09E	Flux cruise
S1	F003	2022/07/26 12:34	41-53.73N	144-31.31E	End
S1	F004	2022/07/26 13:20	42-00.04N	144-29.92E	Flux cruise
S1	F004	2022/07/26 14:20	41-54.72N	144-33.40E	End
S1	S020	2022/07/26 17:31	41-59.99N	144-29.98E	S/N T4750709, SST=18.6
S1	S021	2022/07/26 23:30	42-00.00N	144-29.99E	S/N T4750725, SST=20.0

S1	C007	2022/07/27 00:02	42-00.00N	144-30.00E	1000m cast start SST=20.2, DO, S, Chl-a
S1	C007	2022/07/27 01:16	41-59.72N	144-30.05E	End
C01	S022	2022/07/27 05:32	41-38.88N	145-00.06E	S/N T4750713, SST=21.9
C01	X012	2022/07/27 05:32	41-38.84N	145-00.11E	S/N 21117912, SST=21.7, SSS=33.13
C02	S023	2022/07/27 08:25	41-59.99N	144-30.00E	S/N T4750722, SST=23.2
C02	X013	2022/07/27 08:25	41-17.80N	145-30.14E	S/N 21096793, SST=23.2, SSS=33.67
C03	S024	2022/07/27 11:11	40-56.69N	146-00.00E	S/N T4750732, SST=21.7
C03	X014	2022/07/27 11:12	40-56.69N	146-00.15E	S/N 21117913, SST=21.4, SSS=32.83
C04	S025	2022/07/27 14:08	40-35.54N	146-30.09E	S/N T4750730, SST=24.2
C04	X015	2022/07/27 14:08	40-35.52N	146-30.13E	S/N 21096792, SST=24.2, SSS=33.58
C05	S026	2022/07/27 16:54	40-14.46N	147-00.03E	S/N T4750728, SST=21.9
C05	X016	2022/07/27 16:54	40-14.40N	147-00.12E	S/N 21117908, SST=21.9, SSS=33.57
C06	X017	2022/07/27 18:16	40-03.84N	147-15.25E	S/N 21117911, SST=21.7, SSS=33.46
C07	S027	2022/07/27 19:20	39-59.94N	147-30.09E	S/N T4750726, SST=21.4
C07	X018	2022/07/27 19:21	40-00.05N	147-30.14E	S/N 21117910, SST=21.4, SSS=32.96
C08	S028	2022/07/27 21:31	40-07.50N	148-00.01E	S/N T4750731, SST=21.1
C08	X019	2022/07/27 21:31	40-07.54N	148-00.17E	S/N 21117909, SST=21.1, SSS=33.39
S2	S029	2022/07/27 23:45	40-15.00N	148-29.99E	S/N T4750255, SST=19.7

S2	C008	2022/07/28 00:00	40-15.00N	148-30.04E	2000m cast start SST=19.7, DO, S, Chl-a
S2	C008	2022/07/28 02:19	40-15.00N	148-30.01E	End
X05	X020	2022/07/28 04:17	40-15.00N	148-45.15E	S/N 21096794, SST=22.3, SSS=33.31
X06	X021	2022/07/28 06:05	39-59.95N	148-29.87E	S/N 21096791, SST=22.9, SSS=33.60
X07	X022	2022/07/28 07:52	40-15.04N	148-15.00E	S/N 21096795, SST=18.7, SSS=32.80
X08	X023	2022/07/28 09:36	40-30.02N	148-30.15E	S/N 21096796, SST=19.8, SSS=32.47
X08	S030	2022/07/28 13:25	40-30.00N	148-30.06E	S/N T4750255, SST=19.7
X08	S031	2022/07/28 17:30	40-29.95N	148-30.00E	S/N T4750710, SST=17.6
X08	S032	2022/07/28 23:30	40-29.94N	148-29.94E	S/N T4750729, SST=19.3
X08	C009	2022/07/28 23:59	40-30.00N	148-30.00E	1000m cast start SST=19.6, DO, Chl-a
X08	C009	2022/07/29 01:24	40-30.00N	148-30.00E	End
X08	F005	2022/07/29			Flux cruise
X08	F005	2022/07/29			End
X08	S033	2022/07/29 05:30	40-29.99N	148-29.94N	S/N T4750705, SST=19.0
X08	S034	2022/07/29 09:00	40-29.96N	148-30.05E	S/N T4750719, SST=20.2
X08	S035	2022/07/29 11:30	40-29.95N	148-29.94E	S/N T4750727, SST=20.0
X08	S036	2022/07/29 14:30	40-30.04N	148-30.02E	S/N T4750711, SST=19.3
X08	S037	2022/07/29 17:30	40-29.94N	148-29.92E	S/N T4750723, SST=18.9

X08	S038	2022/07/29 20:30	40-30.00N	148-29.96E	S/N T4750721, SST=19.7
X08	S039	2022/07/29 23:30	40-30.00N	148-30.01E	S/N T4750712, SST=19.9
X08	C010	2022/07/30 00:00	40-30.00N	148-30.00E	1000m cast start SST=19.6, DO, Chl-a
X08	C010	2022/07/30 01:03	40-30.00N	148-30.00E	End
X08	S040	2022/07/30 05:30	40-29.97N	148-29.99E	S/N T4640491, SST=21.1
C08	S041	2022/07/30 08:35	40-07.52N	148-00.02E	S/N T4640490, SST=20.3
C07b	S042	2022/07/30 12:31	39-24.22N	148-22.92E	S/N T4640417, SST=25.2
C07b	S043	2022/07/30 23:30	39-24.28N	148-22.95E	S/N T4640416, SST=25.0
C07b	C011	2022/07/31 00:02	39-24.25N	148-22.54E	2000m cast start SST=, DO, S, Chl-a
C07b	C011	2022/07/31 01:47	39-23.66N	148-25.05E	End
C07b	S044	2022/07/31 02:17	39-23.59N	148-26.13E	S/N T4640520, SST=25.2
C07	S045	2022/07/31 08:35	40-00.07N	147-30.06E	S/N T4640391, SST=21.6
C07	X024	2022/07/31 08:36	40-00.16N	148-30.13E	S/N 21096799, SST=21.6, SSS=33.13
C06	X025	2022/07/31 09:24	40-04.00N	147-14.88E	S/N 21097104, SST=21.2, SSS=34.40
C05	S046	2022/07/31 11:20	40-14.58N	147-00.08E	S/N T4640468, SST=21.4
C05	X026	2022/07/31 11:20	40-14.50N	147-00.03E	S/N 21097103, SST=21.4, SSS=33.43
C04	S047	2022/07/31 14:14	40-35.63N	146-30.01E	S/N T4640516, SST=21.6
C04	X027	2022/07/31 14:14	40-35.64N	146-30.01E	S/N 21096797, SST=21.6, SSS=33.30

C03	S048	2022/07/31 16:59	40-56.67N	145-59.93E	S/N T4640489, SST=22.6
C03	X028	2022/07/31 16:59	40-56.64N	145-59.82E	S/N 21097107, SST=22.1, SSS=32.93
C02	S049	2022/07/31 19:50	41-17.79N	145-29.97E	S/N T4710056, SST=23.1
C02	X029	2022/07/31 19:50	41-17.73N	145-29.84E	S/N 21096798, SST=23.1, SSS=33.86
C01	X030	2022/07/31 22:39	41-38.94N	144-59.92E	S/N 21097105, SST=20.8, SSS=33.03
C01	S050	2022/07/31 23:30	41-38.44N	145-00.04E	S/N T4710863, SST=20.6
C01	C012	2022/07/31 23:55	41-38.91N	145-00.00E	1000m cast start SST=20.6, Chl-a
C01	C012	2022/08/01 00:50	41-38.90N	145-00.00E	End
C01	F006	2022/08/01 02:34	41-39.00N	145-00.02E	Flux cruise
C01	F006	2022/08/01 03:34	41-41.67N	145-06.98E	End

4. Notice on using

This cruise report is a preliminary documentation as of the end of cruise.

This report is not necessarily corrected even if there is any inaccurate description (i.e. taxonomic classifications). This report is subject to be revised without notice. Some data on this report may be raw or unprocessed. If you are going to use or refer the data on this report, it is recommended to ask the Chief Scientist for latest status.

Users of information on this report are requested to submit Publication Report to Cooperative Research Cruise office.

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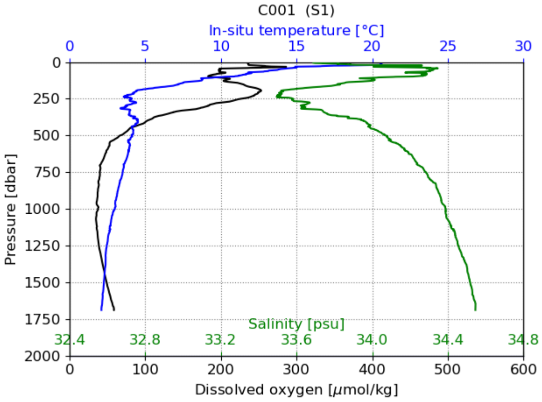
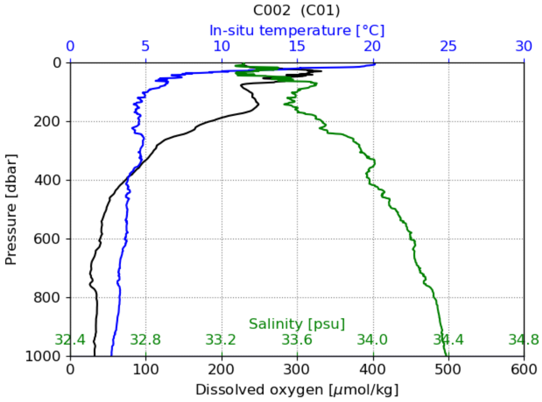
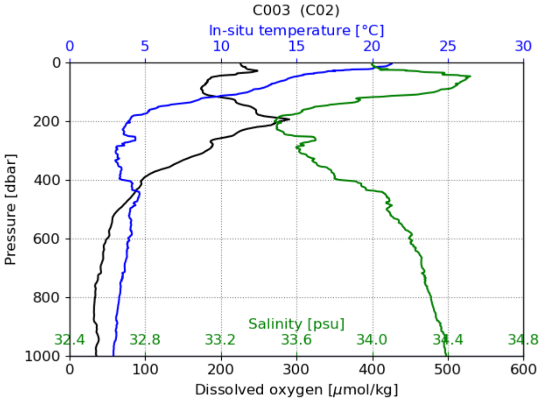
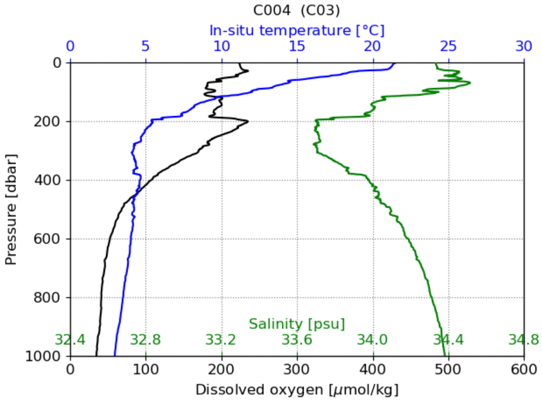
5. Preliminary results

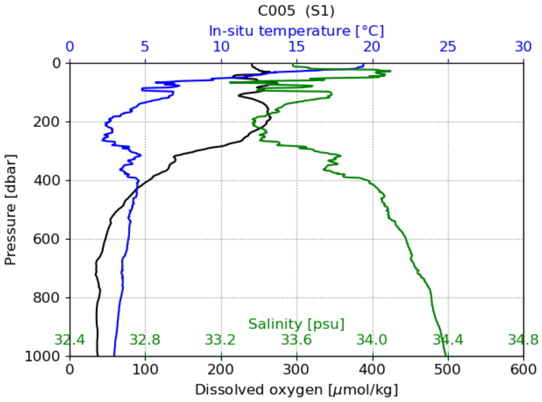
CTD

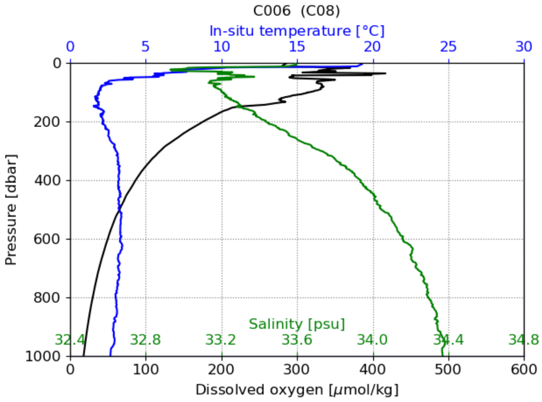


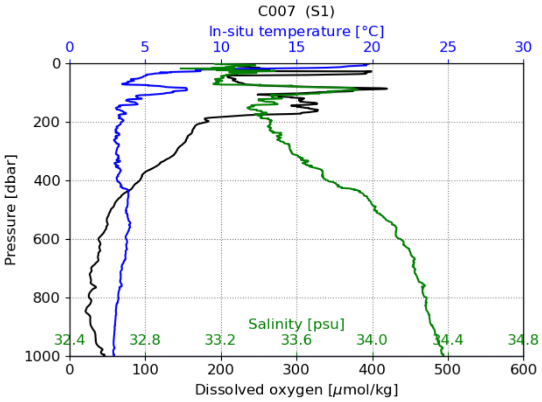


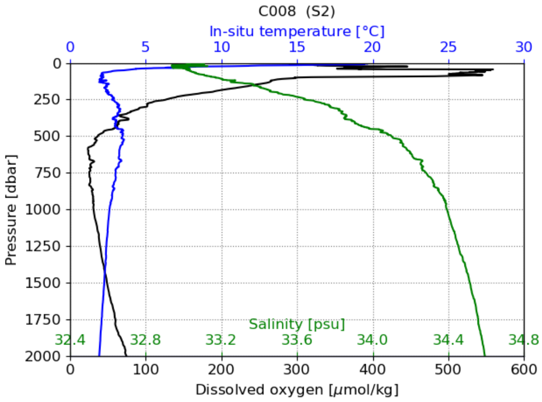


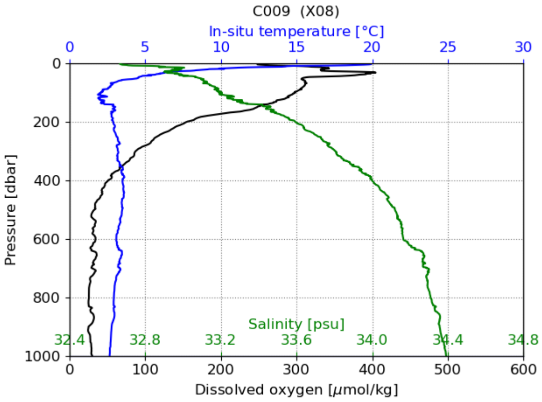


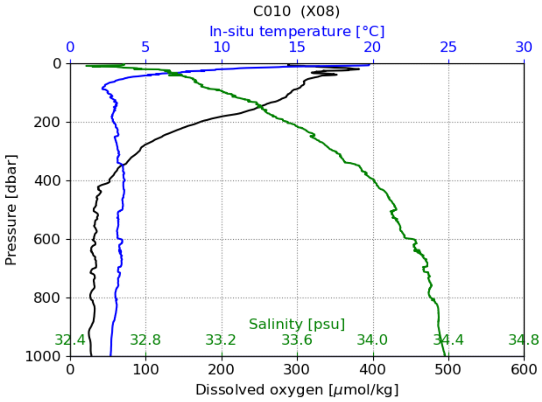


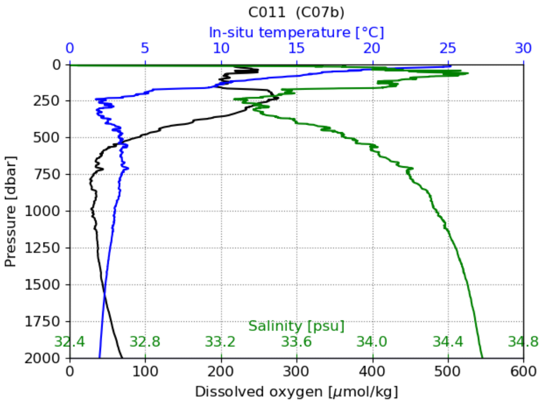


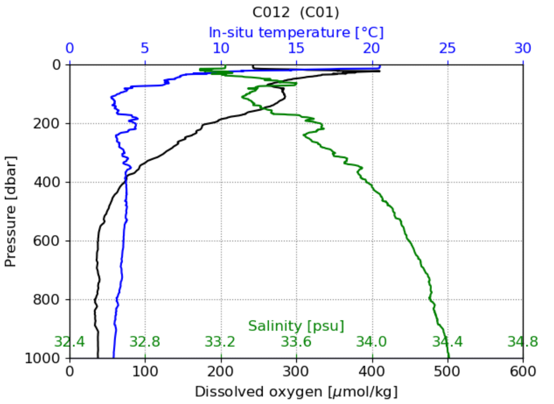

C007 (S1)
In-situ temperature [°C]
Pressure [dbar]
Salinity [psu]
Dissolved oxygen [μmol/kg]


C008 (S2)
In-situ temperature [°C]
Pressure [dbar]
Salinity [psu]
Dissolved oxygen [μmol/kg]

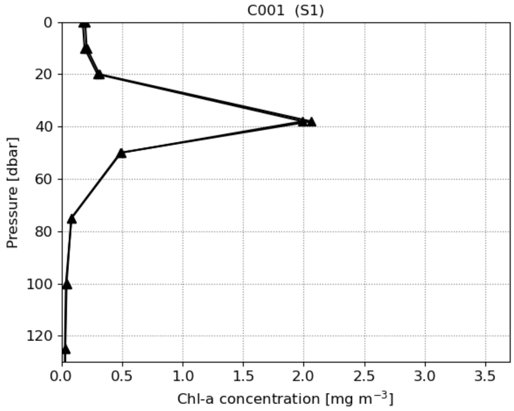

C009 (X08)
In-situ temperature [°C]
Pressure [dbar]
Salinity [psu]
Dissolved oxygen [μmol/kg]

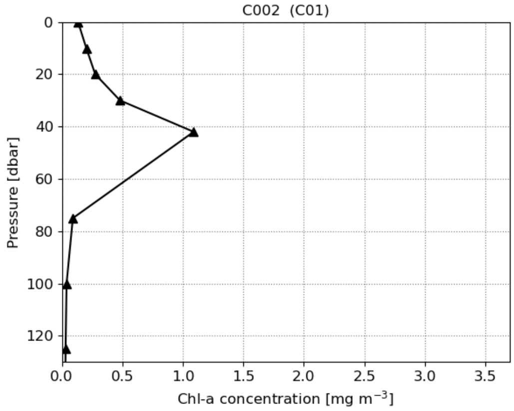

C010 (X08)
In-situ temperature [°C]
Pressure [dbar]
Salinity [psu]
Dissolved oxygen [μmol/kg]

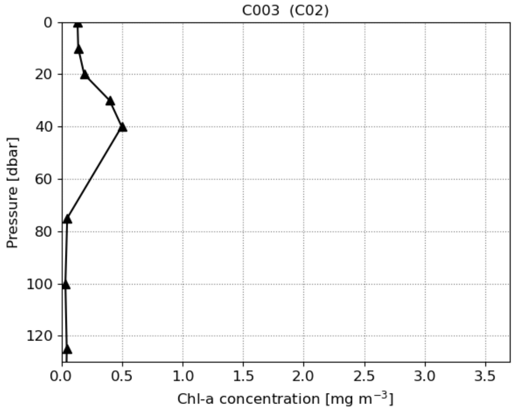

C011 (C07b)
In-situ temperature [°C]
Pressure [dbar]
Salinity [psu]
Dissolved oxygen [μmol/kg]

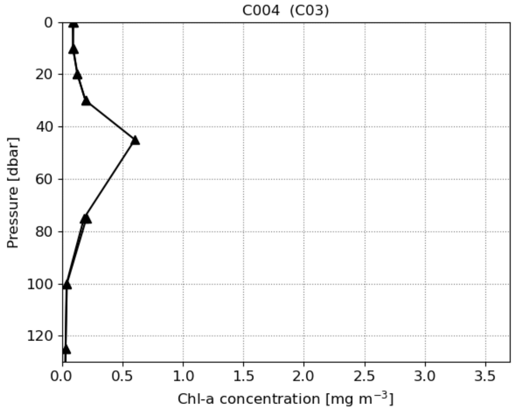

C012 (C01)
In-situ temperature [°C]
Pressure [dbar]
Salinity [psu]
Dissolved oxygen [μmol/kg]

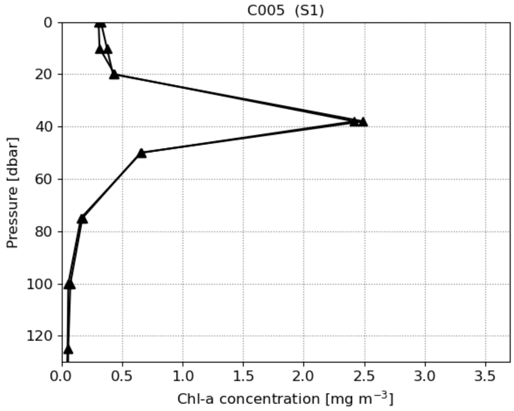
Chlorophyll-a concentration

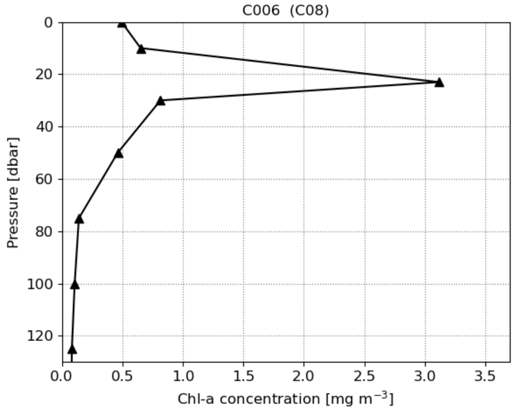


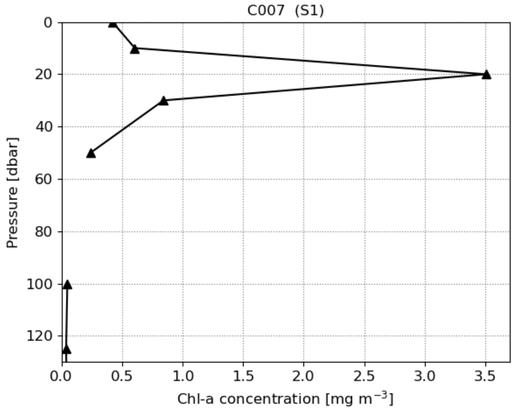


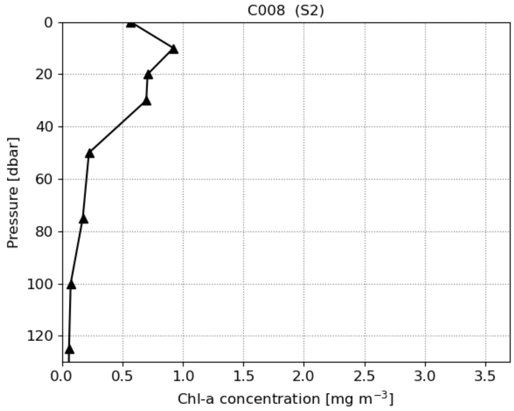


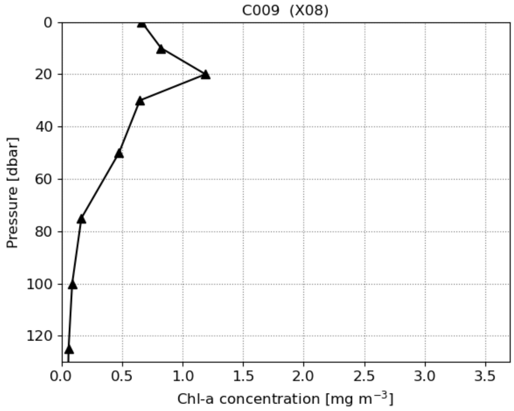


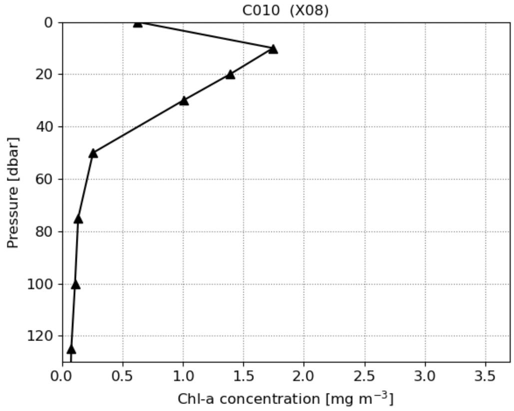


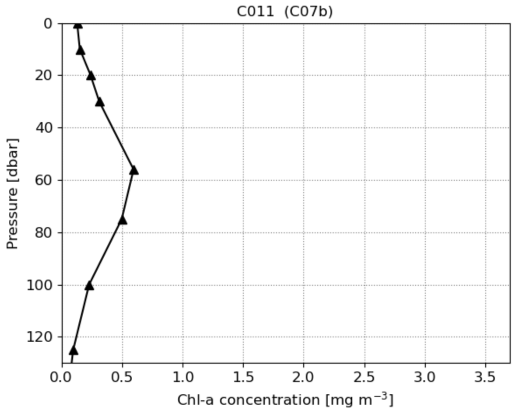


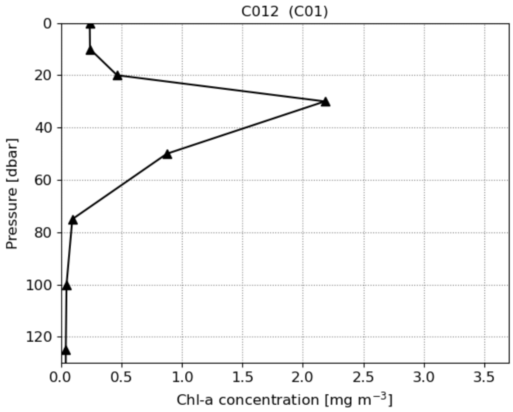

C007 (S1)
Pressure [dbar]
Chl-a concentration [mg m^{-3}]


C008 (S2)
Pressure [dbar]
Chl-a concentration [mg m^{-3}]

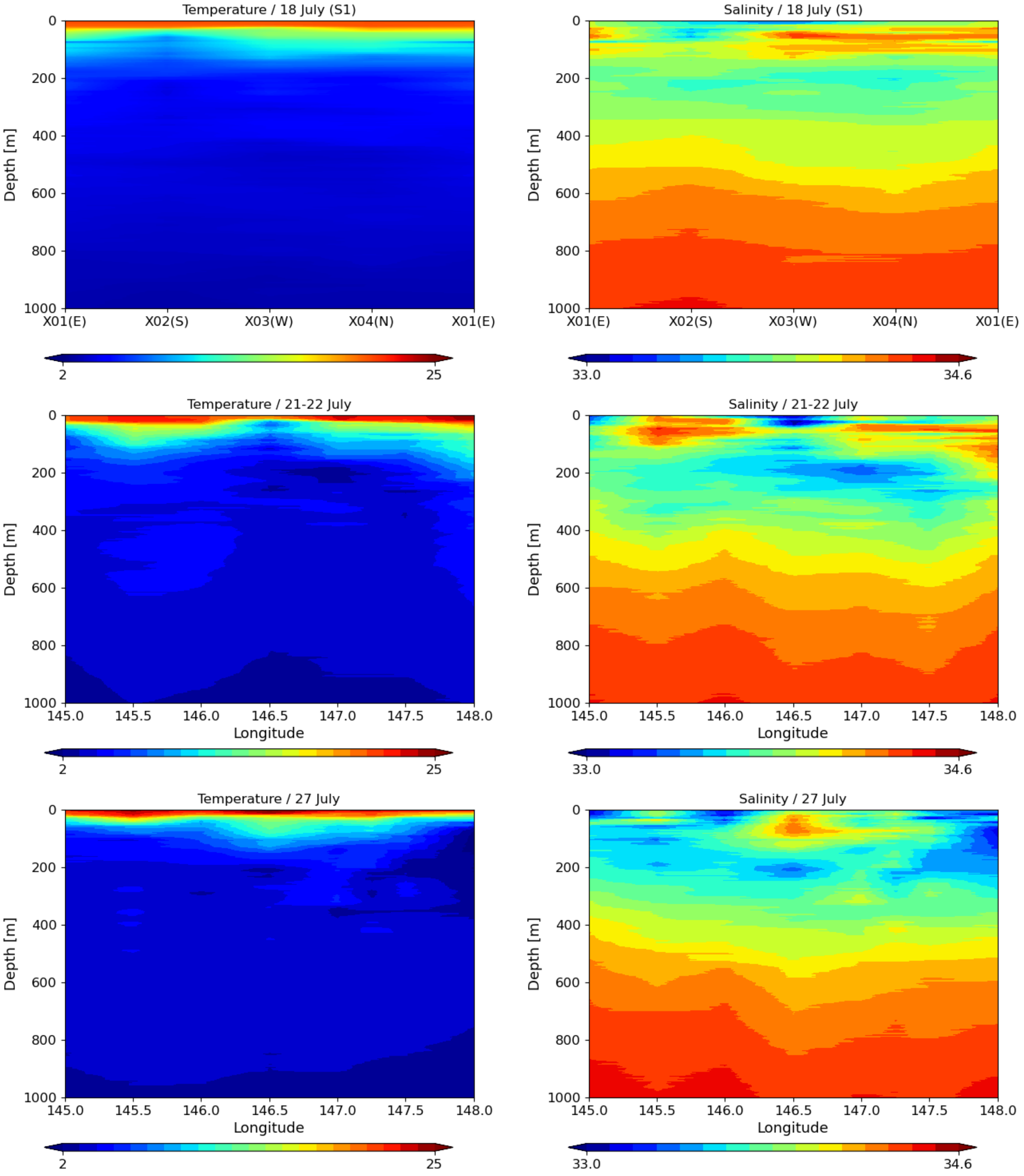

C009 (X08)
Pressure [dbar]
Chl-a concentration [mg m^{-3}]


C010 (X08)
Pressure [dbar]
Chl-a concentration [mg m^{-3}]

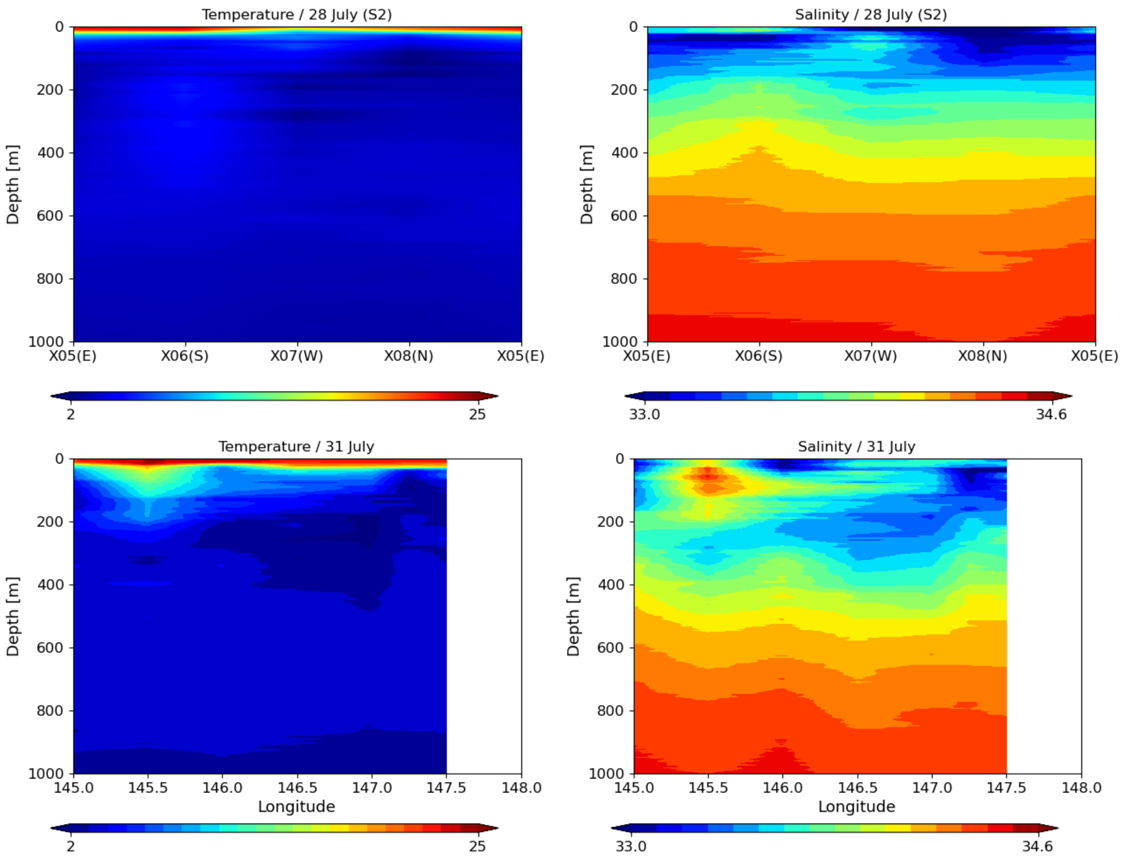

C011 (C07b)
Pressure [dbar]
Chl-a concentration [mg m^{-3}]


C012 (C01)
Pressure [dbar]
Chl-a concentration [mg m^{-3}]

XCTD

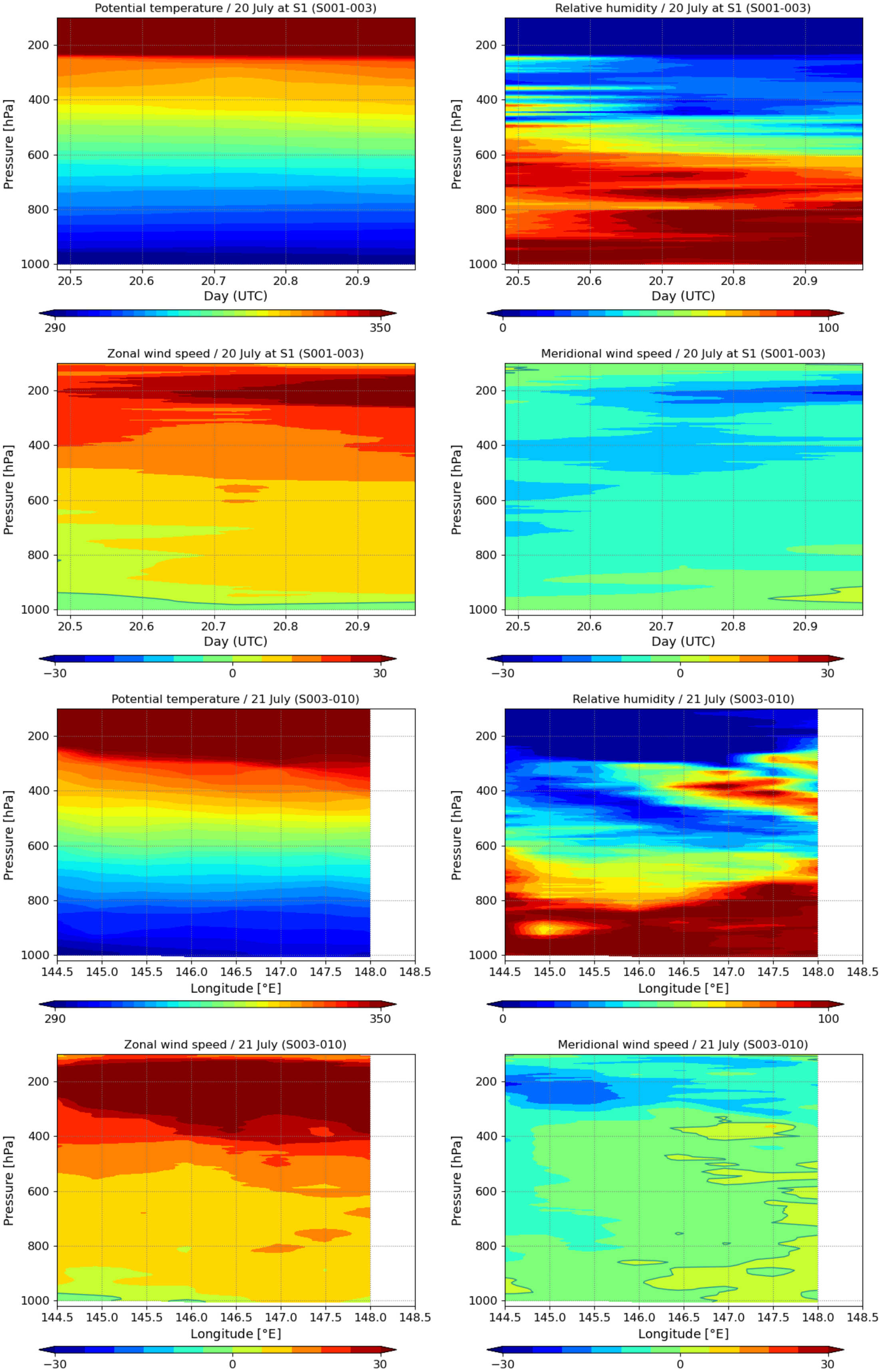


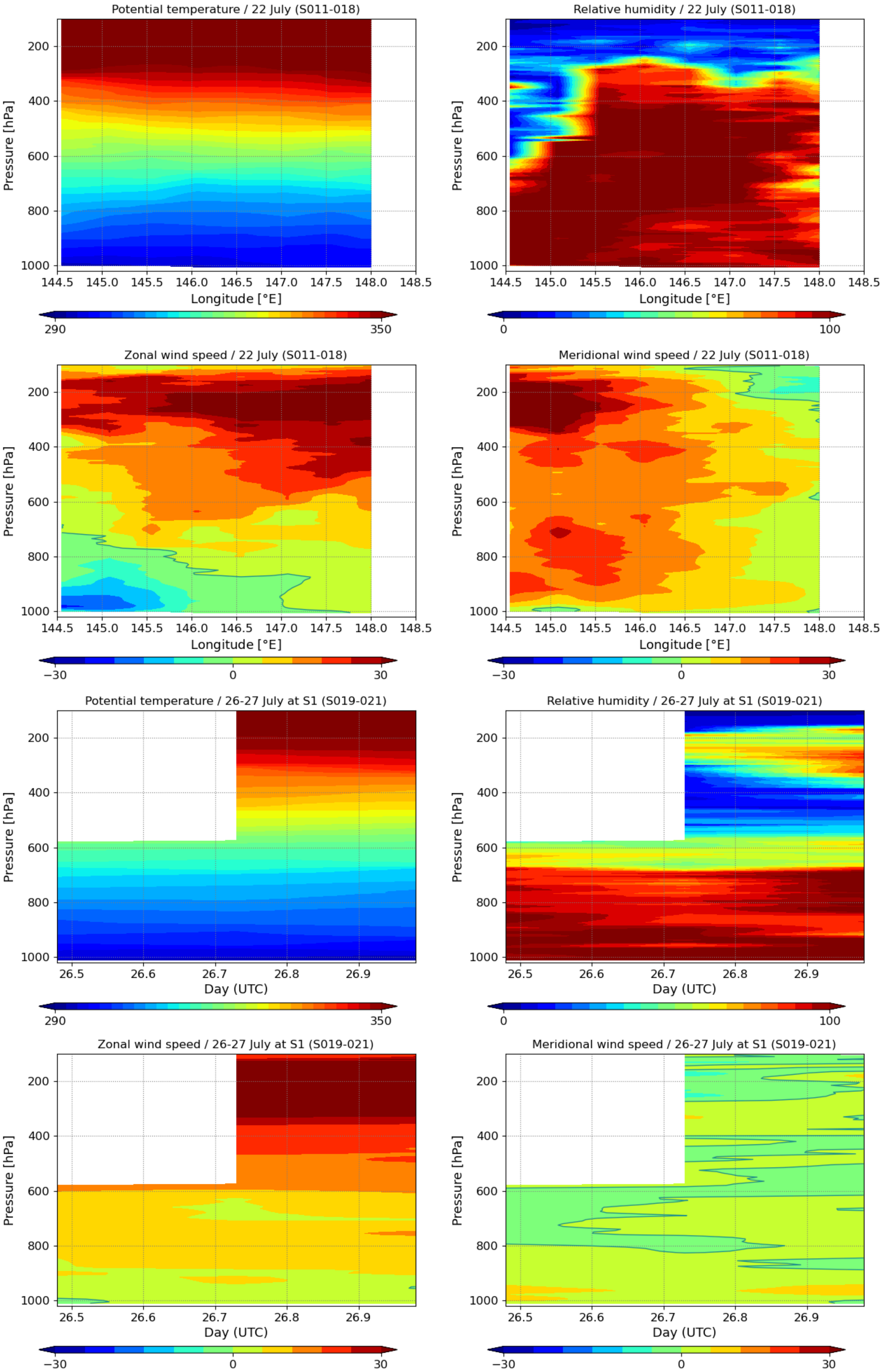
Temperature / 18 July (S1)
Salinity / 18 July (S1)
Depth [m]
0
200
400
600
800
1000
X01(E)
X02(S)
X03(W)
X04(N)
X01(E)
2
25
33.0
34.6
Temperature / 21-22 July
Salinity / 21-22 July
145.0
145.5
146.0
146.5
147.0
147.5
148.0
Longitude
Temperature / 27 July
Salinity / 27 July

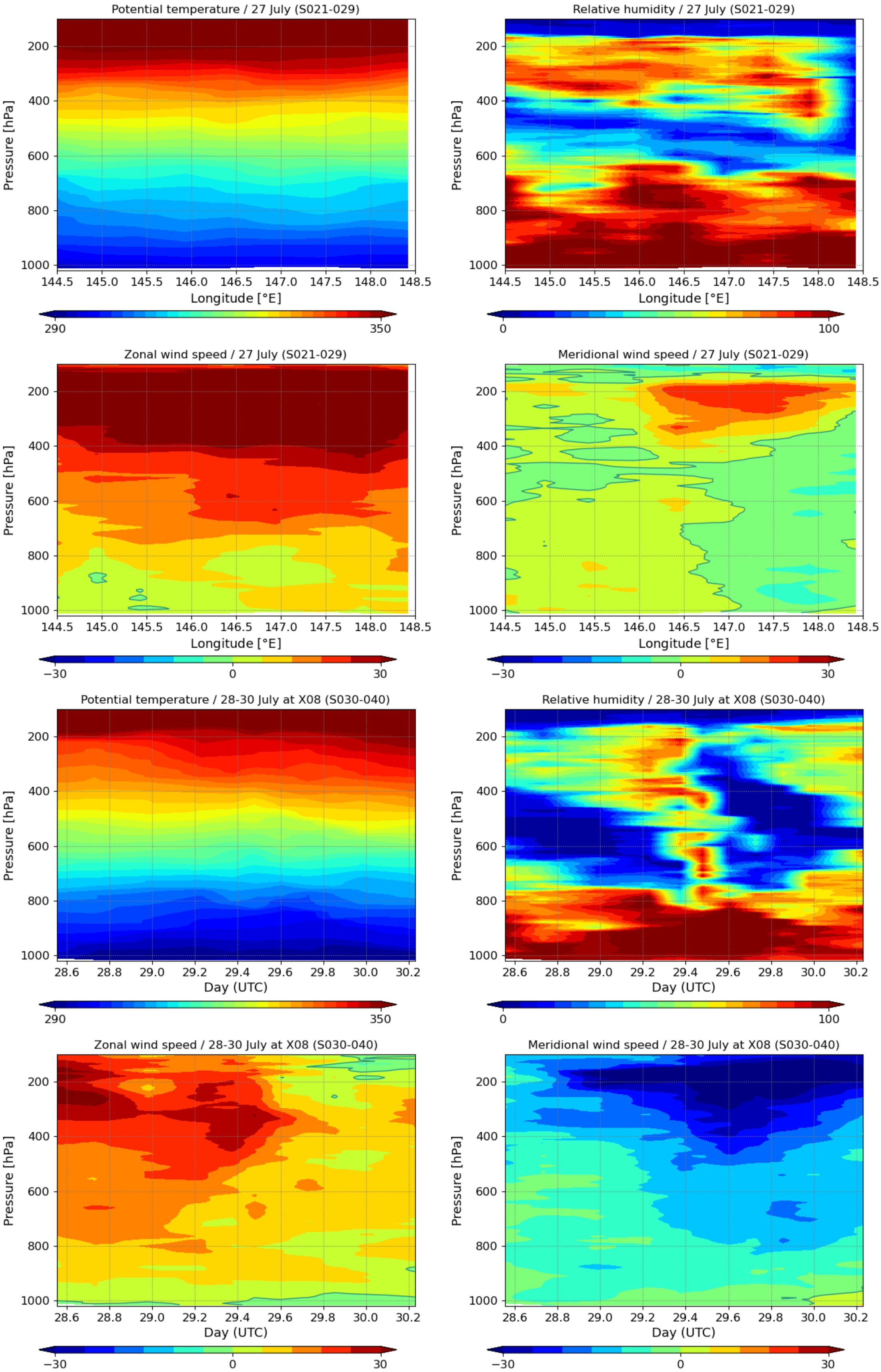


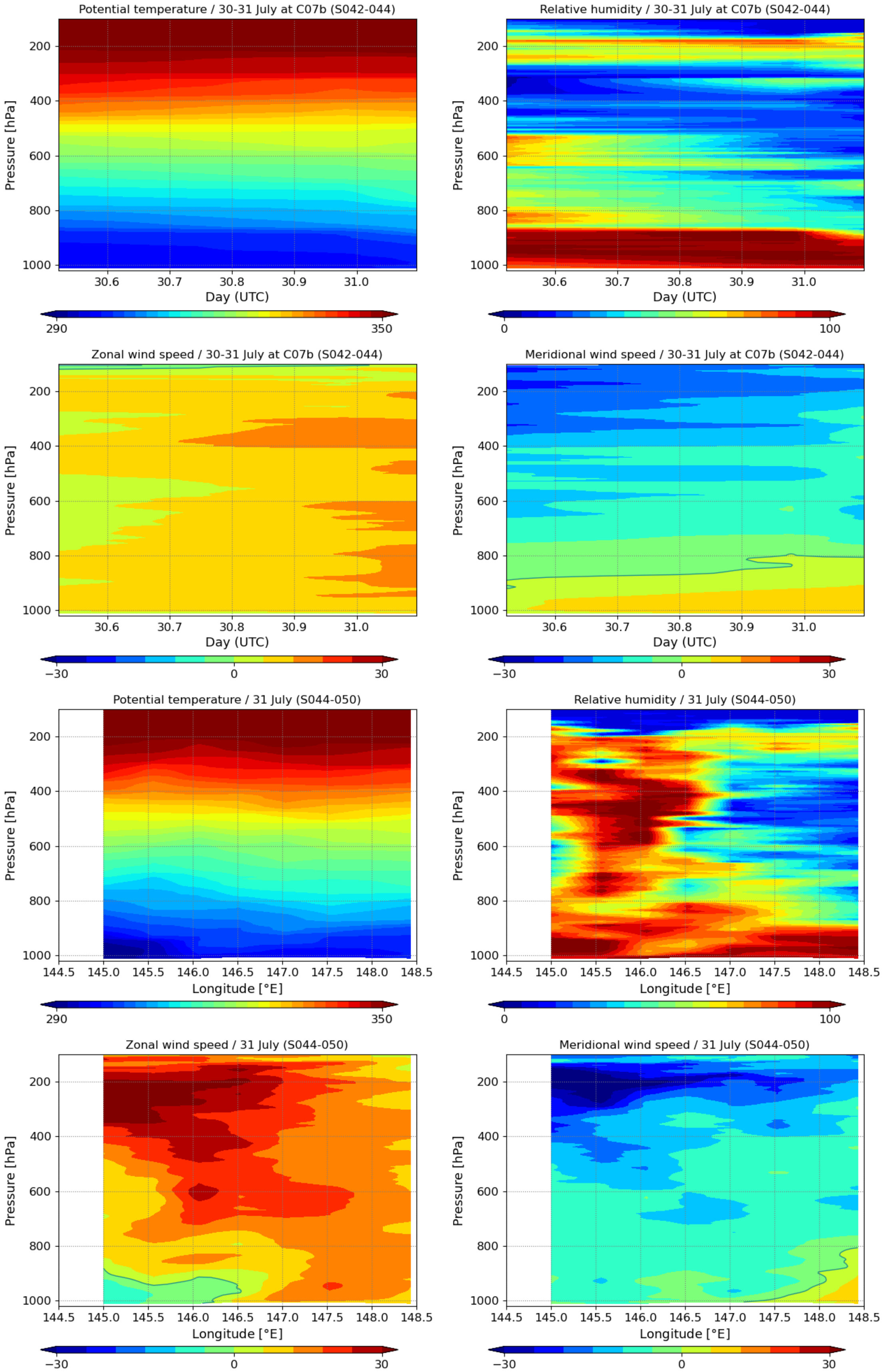
Temperature / 28 July (S2)
Salinity / 28 July (S2)
Depth [m]
0
200
400
600
800
1000
X05(E)
X06(S)
X07(W)
X08(N)
X05(E)
2
25
33.0
34.6
Temperature / 31 July
Salinity / 31 July
145.0
145.5
146.0
146.5
147.0
147.5
148.0
Longitude

GPS radiosonde

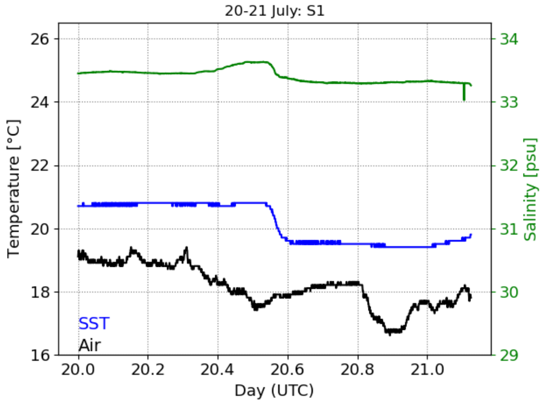


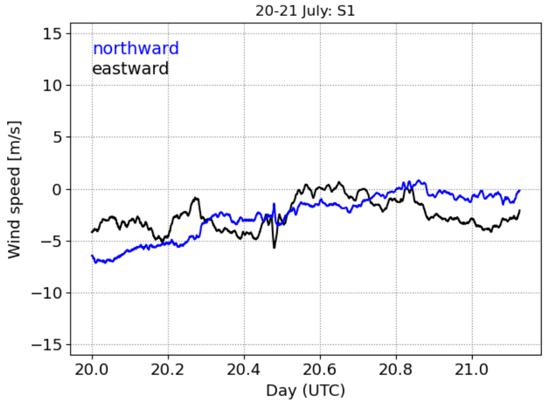

Potential temperature / 22 July (S011-018)
Relative humidity / 22 July (S011-018)
Zonal wind speed / 22 July (S011-018)
Meridional wind speed / 22 July (S011-018)
Potential temperature / 26-27 July at S1 (S019-021)
Relative humidity / 26-27 July at S1 (S019-021)
Zonal wind speed / 26-27 July at S1 (S019-021)
Meridional wind speed / 26-27 July at S1 (S019-021)
Pressure [hPa]
Longitude [°E]
Day (UTC)
200
400
600
800
1000
144.5
145.0
145.5
146.0
146.5
147.0
147.5
148.0
148.5
26.5
26.6
26.7
26.8
26.9
290
350
0
100
−30
30

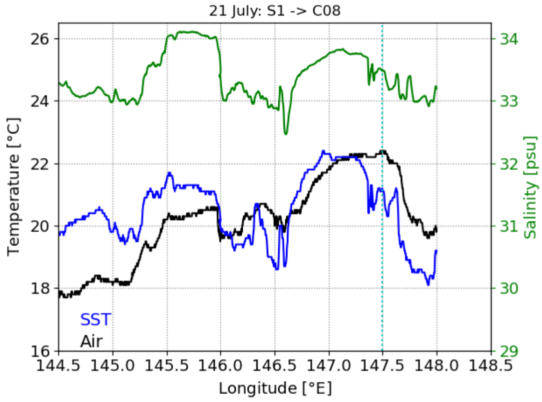

Potential temperature / 27 July (S021-029)
Relative humidity / 27 July (S021-029)
Zonal wind speed / 27 July (S021-029)
Meridional wind speed / 27 July (S021-029)
Potential temperature / 28-30 July at X08 (S030-040)
Relative humidity / 28-30 July at X08 (S030-040)
Zonal wind speed / 28-30 July at X08 (S030-040)
Meridional wind speed / 28-30 July at X08 (S030-040)
Pressure [hPa]
Longitude [°E]
Day (UTC)

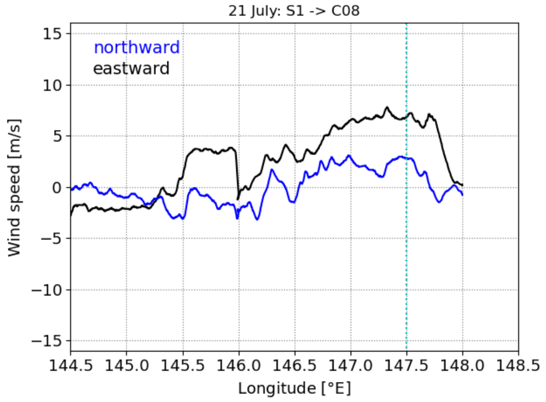

Potential temperature / 30-31 July at C07b (S042-044)
Relative humidity / 30-31 July at C07b (S042-044)
Zonal wind speed / 30-31 July at C07b (S042-044)
Meridional wind speed / 30-31 July at C07b (S042-044)
Potential temperature / 31 July (S044-050)
Relative humidity / 31 July (S044-050)
Zonal wind speed / 31 July (S044-050)
Meridional wind speed / 31 July (S044-050)
Pressure [hPa]
Day (UTC)
Longitude [°E]
200
400
600
800
1000
30.6
30.7
30.8
30.9
31.0
144.5
145.0
145.5
146.0
146.5
147.0
147.5
148.0
148.5
290
350
0
100
−30
0
30

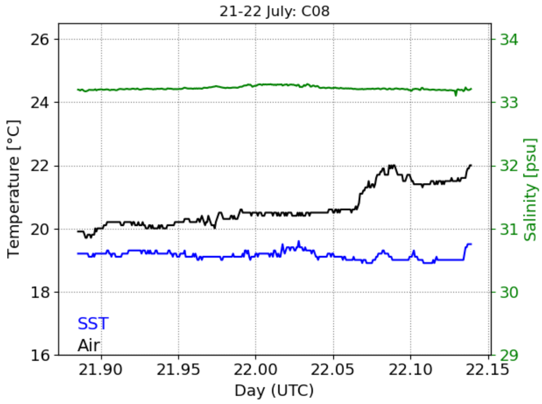
Surface temperature and wind speed

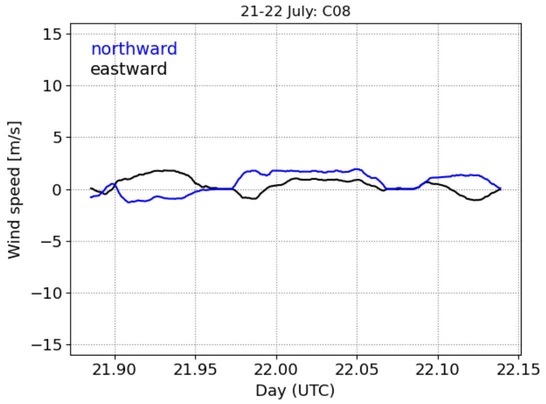


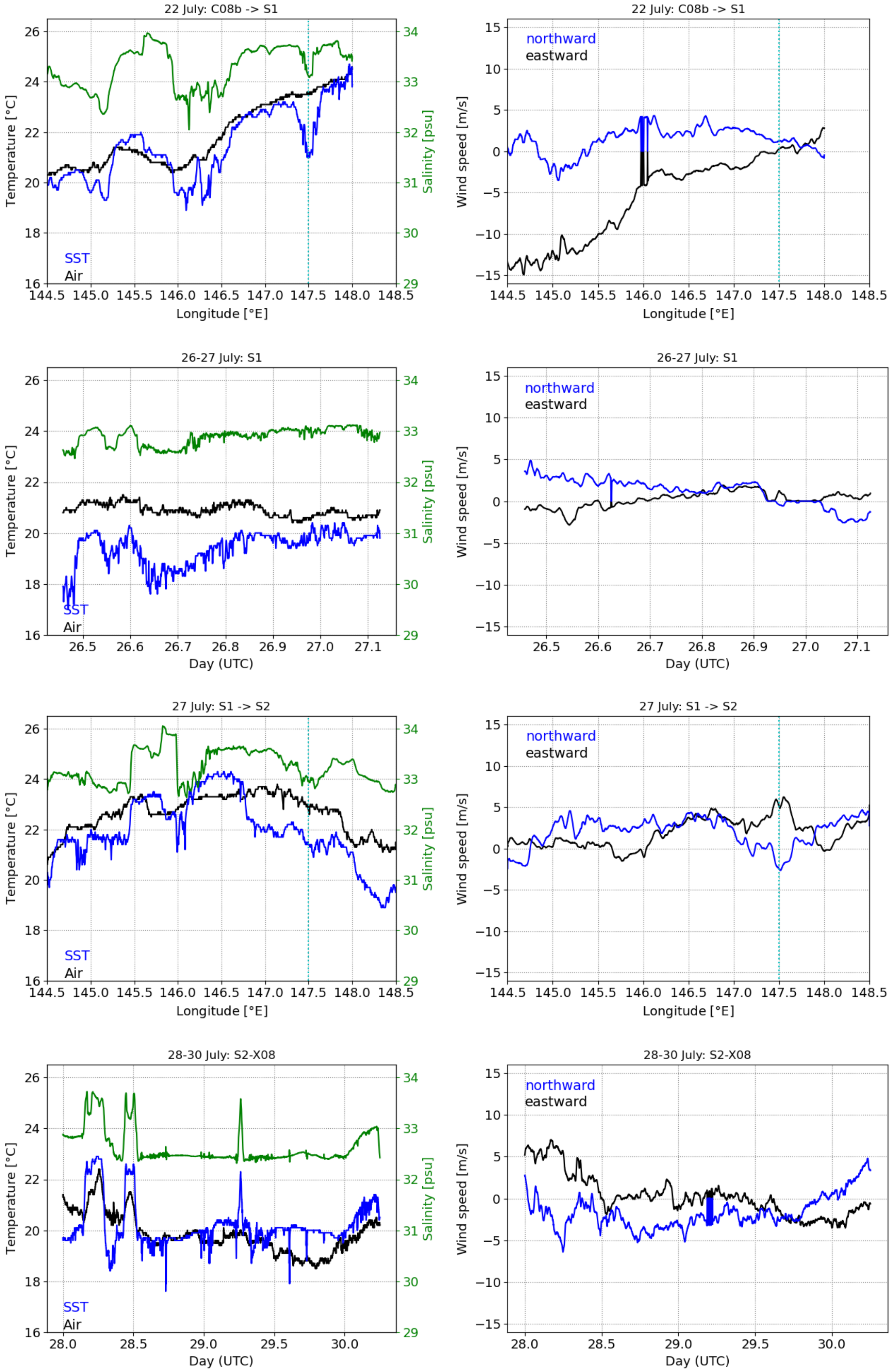


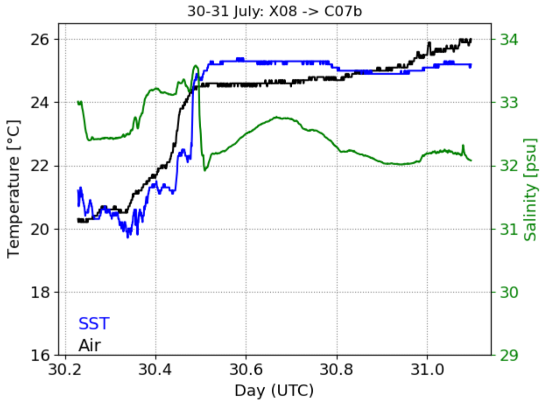


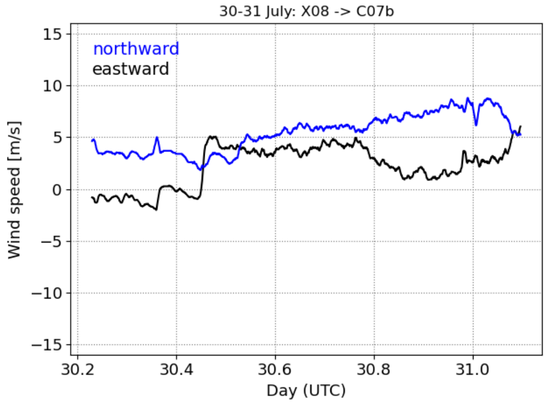


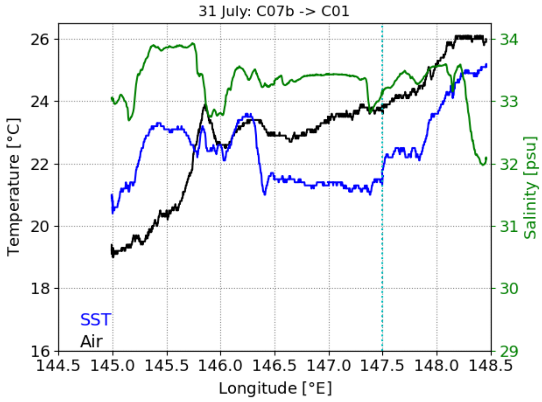


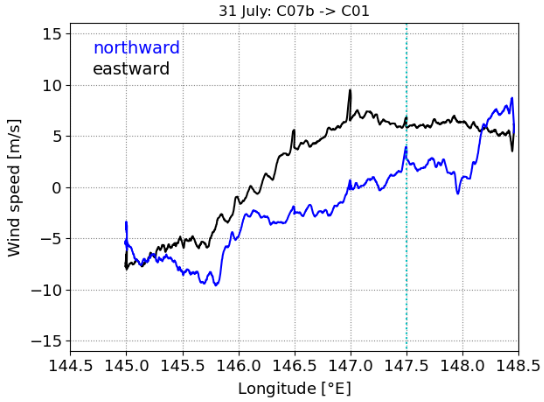



22 July: C08b -> S1
SST
Air
Temperature [°C]
Salinity [psu]
Longitude [°E]
northward
eastward
Wind speed [m/s]
26-27 July: S1
Day (UTC)
27 July: S1 -> S2
28-30 July: S2-X08


30-31 July: X08 -> C07b
Temperature [°C]
Salinity [psu]
Day (UTC)
SST
Air


30-31 July: X08 -> C07b
Wind speed [m/s]
Day (UTC)
northward
eastward


31 July: C07b -> C01
Temperature [°C]
Salinity [psu]
Longitude [°E]
SST
Air


31 July: C07b -> C01
Wind speed [m/s]
Longitude [°E]
northward
eastward