# A. Cruise narrative

## Highlights

Cruise designation: RF18-05, RF18-06 (WHP-P13 revisit)

1. EXPOCODE: RF18-05 49UP20180614

RF18-06 49UP20180806

1. Chief scientist: Keizo SAKURAI

Marine Division

Global Environment and Marine Department

Japan Meteorological Agency (JMA)

1. Ship name: R/V Ryofu Maru
2. Ports of call: RF18-05: Leg 1: Tokyo (Japan) – Hakodate (Japan)

Leg 2: Hakodate (Japan) – Tokyo (Japan)

RF18-06: Leg 1: Tokyo (Japan) – Pohnpei (FSM)

Leg 2: Pohnpei (FSM) – Tokyo (Japan)

\*FSM: Federated States of Micronesia

1. Cruise dates (JST): RF18-05: Leg 1: 14 June 2018 – 4 July 2018

 Leg 2: 8 July 2018 – 22 July 2018

 RF18-06: Leg 1: 6 August 2018 – 30 August 2018

 Leg 2: 3 September 2018 – 27 September 2018

1. Principal Investigator (Contact person):

Toshiya NAKANO

Marine Division

Global Environment and Marine Department

Japan Meteorological Agency (JMA)

1-3-4, Otemachi, Chiyoda-ku, Tokyo 100-8122, JAPAN

Phone: +81-3-3212-8341 Ext. 5131

E-mail: seadata@met.kishou.go.jp

## Cruise Summary

RF18-05 and RF18-06 cruises were carried out during the period from June 14 to September 27, 2018. The cruise started from the south of Hokkaido, Japan, and sailed southeastern line along the Kuril Islands, thereafter from 50°N to 8°S along approximately 165°E meridian. This line (WHP-P13) was observed by JMA in 2011 as CLIVER (Climate Variability and Predictability Project) / GO-SHIP (Global Ocean Ship-based Hydrographic Investigations Program).

A total of 103 stations were occupied using a Sea-Bird Electronics (SBE) 36 position carousel equipped with 10-liter Niskin water sample bottles, a CTD system (SBE911plus) equipped with SBE35 deep ocean standards thermometer, JFE Advantech oxygen sensor (RINKO III), Teledyne Benthos altimeter (PSA-916D), and Teledyne RD Instruments L-ADCP (300kHz). To examine consistency of data, we carried out the observation repeatedly twice at stations of 47°N, 165°E (Stn.21 and 22), 37°N, 165°E (Stn.33 and 34) and 8°N, 165°E (Stn.73 and 74). Cruise track and station location are shown in Figure A.1.

At each station, full-depth CTDO2 (temperature, conductivity (salinity) and dissolved oxygen) profile were taken, and up to 36 water samples were taken and analyzed. Water samples were obtained from 10 dbar to approximately 10 m above the bottom. In addition, surface water was sampled by a stainless steel bucket at each station. Sampling layer is designed as so-called staggered mesh as shown in Table A.1 (*Swift*, 2010). The bottle depth diagram is shown in Figure A.2.

Water samples were analyzed for salinity, dissolved oxygen, nutrients, dissolved inorganic carbon (DIC), total alkalinity (TA), pH, CFCs (CFC-11, CFC-12, and CFC-113) and phytopigments (chlorophyll-*a* and phaeopigment). Underway measurements of partial pressure of carbon dioxide (*p*CO2), temperature, salinity, chlorophyll-*a*, subsurface current, bathymetry and meteorological parameters were conducted along the cruise track.



Figure A.1. Location of hydrographic stations of RF18-05 and RF18-06.



Figure A.2. The bottle depth diagram for WHP-P13 revisit.

Table A.1. The scheme of sampling layer in meters.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Bottle count*** | ***Scheme 1*** | ***Scheme 2*** | ***Scheme 3*** | ***Scheme 4*** | ***Scheme 5*** | ***Scheme 6*** |
| ***1*** | 10 | 10 | 10 | 10 | 10 | 10 |
| ***2*** | *25**50**75**100**125**150**200**250**300**400**500**600**700**800**900**1000**1200**1400**160050* | *25* | *25* | *25* | *25* | *25* |
| ***3*** | 50 | 50 | 50 | 50 | 50 | 50 |
| ***4*** | *75* | *75* | *75* | *75* | *75* | *75* |
| ***5*** | 100 | 100 | 100 | 100 | 100 | 100 |
| ***6*** | *125* | *125* | *125* | *125* | *125* | *125* |
| ***7*** | 150 | 150 | 150 | 150 | 150 | 150 |
| ***8*** | 200 | 200 | 200 | 200 | 200 | 200 |
| ***9*** | 250 | 250 | 250 | 250 | 250 | 250 |
| ***10*** | 300 | 330 | 280 | 300 | 330 | 280 |
| ***11*** | 400 | 430 | 370 | 350 | 380 | 320 |
| ***12*** | 500 | 530 | 470 | 400 | 430 | 370 |
| ***13*** | 600 | 630 | 570 | 450 | 480 | 420 |
| ***14*** | 700 | 730 | 670 | 500 | 530 | 470 |
| ***15*** | 800 | 830 | 770 | 600 | 630 | 570 |
| ***16*** | 900 | 930 | 870 | 700 | 730 | 670 |
| ***17*** | 1000 | 1070 | 970 | 800 | 830 | 770 |
| ***18*** | 1200 | 1270 | 1130 | 900 | 930 | 870 |
| ***19*** | 1400 | 1470 | 1330 | 1000 | 1070 | 970 |
| ***20*** | 1600 | 1670 | 1530 | 1200 | 1270 | 1130 |
| ***21*** | 1800 | 1870 | 1730 | 1400 | 1470 | 1330 |
| ***22*** | 2000 | 2070 | 1930 | 1600 | 1670 | 1530 |
| ***23*** | 2200 | 2270 | 2130 | 1800 | 1870 | 1730 |
| ***24*** | 2400 | 2470 | 2330 | 2000 | 2070 | 1930 |
| ***25*** | 2600 | 2670 | 2530 | 2200 | 2270 | 2130 |
| ***26*** | 2800 | 2870 | 2730 | 2400 | 2470 | 2330 |
| ***27*** | 3000 | 3080 | 2930 | 2600 | 2670 | 2530 |
| ***28*** | *3250* | *3330* | *3170* | *2800* | *2870* | *2730* |
| ***29*** | 3500 | 3580 | 3420 | 3000 | 3080 | 2930 |
| ***30*** | *3750* | *3830* | *3670* | *3250* | *3330* | *3170* |
| ***31*** | 4000 | 4080 | 3920 | 3500 | 3580 | 3420 |
| ***32*** | *4250* | *4330* | *4170* | *3750* | *3830* | *3670* |
| ***33*** | 4500 | 4580 | 4420 | 4000 | 4080 | 3920 |
| ***34*** | *4750* | *4830* | *4670* | *4250* | *4330* | *4170* |
| ***35*** | 5000 | 5080 | 4920 | 4500 | 4580 | 4420 |
| ***36*** | 5250 | 5330 | 5170 | 4750 | 4830 | 4670 |
| ***37*** | 5500 | 5580 | 5420 | 5000 | 5080 | 4920 |
| ***38*** | 5750 | 5830 | 5670 | 5250 | 5330 | 5170 |
| ***39*** | 6000 | 6000 | 6000 | 5500 | 5580 | 5420 |
| ***40*** |  |  |  | 5750 | 5830 | 5670 |
| ***41*** |  |  |  | 6000 | 6000 | 6000 |

Scheme 1 to Scheme 3 are applied to the area north of 20°N, while Scheme 4 to Scheme 6 are applied to the area south of 20°N. At some deep stations over 36 layers, some layers shown in italic may be skipped.

Table A.2(a). Station lists of RF18-05 cruise. The ‘RF’ column indicates the JMA station identification number.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Leg*** | ***Station*** | ***Location*** |  | ***Leg*** | ***Station*** | ***Location*** |
|  | *Stn.* | *RF* | *Latitude* | *Longitude* |  |  | *Stn.* | *RF* | *Latitude* | *Longitude* |
| 1 | 1 | 6245 | 42-50.18 N | 145-36.48 E |  | 1 | 18 | 6262 | 49-59.35 N | 165-00.16 E |
| 1 | 2 | 6246 | 42-30.93 N | 145-48.32 E |  | 1 | 19 | 6263 | 48-59.63 N | 165-01.21 E |
| 1 | 3 | 6247 | 41-59.72 N | 146-09.29 E |  | 1 | 20 | 6264 | 48-00.63 N | 165-01.01 E |
| 1 | 4 | 6248 | 41-20.12 N | 146-40.60 E |  | 1 | 21 | 6265 | 47-00.05 N | 164-59.97 E |
| 1 | 5 | 6249 | 40-39.71 N | 147-09.18 E |  | 2 | 22 | 6266 | 47-00.27 N | 165-00.42 E |
| 1 | 6 | 6250 | 39-39.35 N | 147-52.95 E |  | 2 | 23 | 6267 | 46-00.05 N | 164-59.38 E |
| 1 | 7 | 6251 | 40-55.78 N | 149-52.16 E |  | 2 | 24 | 6268 | 44-59.99 N | 164-58.23 E |
| 1 | 8 | 6252 | 41-35.03 N | 150-52.31 E |  | 2 | 25 | 6269 | 44-01.34 N | 165-01.00 E |
| 1 | 9 | 6253 | 42-20.57 N | 152-04.61 E |  | 2 | 26 | 6270 | 43-00.88 N | 164-58.46 E |
| 1 | 10 | 6254 | 43-05.28 N | 153-19.20 E |  | 2 | 27 | 6271 | 42-00.07 N | 164-59.10 E |
| 1 | 11 | 6255 | 44-05.06 N | 154-57.09 E |  | 2 | 28 | 6272 | 41-00.30 N | 164-59.99 E |
| 1 | 12 | 6256 | 45-04.97 N | 156-38.26 E |  | 2 | 29 | 6273 | 40-00.45 N | 164-59.62 E |
| 1 | 13 | 6257 | 46-03.67 N | 158-20.28 E |  | 2 | 30 | 6274 | 39-00.60 N | 164-58.51 E |
| 1 | 14 | 6258 | 46-33.33 N | 159-12.29 E |  | 2 | 31 | 6275 | 38-01.41 N | 164-59.87 E |
| 1 | 15 | 6259 | 47-04.83 N | 160-04.44 E |  | 2 | 32 | 6276 | 37-30.89 N | 164-59.08 E |
| 1 | 16 | 6260 | 47-59.29 N | 161-39.94 E |  | 2 | 33 | 6277 | 37-01.36 N | 164-59.17 E |
| 1 | 17 | 6261 | 48-59.67 N | 163-20.29 E |  |  |  |  |  |  |

Table A.2(b). Station lists of RF18-06 cruise.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ***Leg*** | ***Station*** | ***Location*** |  | ***Leg*** | ***Station*** | ***Location*** |
|  | *Stn.* | *RF* | *Latitude* | *Longitude* |  |  | *Stn.* | *RF* | *Latitude* | *Longitude* |
| 1 | 34 | 6279 | 37-01.10 N | 164-59.37 E |  | 1 | 69 | 6314 |  9-59.43 N | 163-59.60 E |
| 1 | 35 | 6280 | 36-31.46 N | 165-02.19 E |  | 1 | 70 | 6315 |  9-29.76 N | 164-00.44 E |
| 1 | 36 | 6281 | 36-00.82 N | 165-02.64 E |  | 1 | 71 | 6316 |  9-00.61N | 163-59.05 E |
| 1 | 37 | 6282 | 35-29.80 N | 164-59.61 E |  | 1 | 72 | 6317 |  8-29.99 N | 163-58.81 E |
| 1 | 38 | 6283 | 34-57.76 N | 164-59.29 E |  | 1 | 73 | 6318 |  8-01.13 N | 164-00.75 E |
| 1 | 39 | 6284 | 34-28.57 N | 164-59.41 E |  | 2 | 74 | 6319 |  7-59.79 N | 164-00.79 E |
| 1 | 40 | 6285 | 33-58.88 N | 165-00.20 E |  | 2 | 75 | 6320 |  7-30.04 N | 164-15.50 E |
| 1 | 41 | 6286 | 32-59.67 N | 165-01.43 E |  | 2 | 76 | 6321 |  7-00.04 N | 164-30.19 E |
| 1 | 42 | 6287 | 32-00.36 N | 165-00.79 E |  | 2 | 77 | 6322 |  6-30.33 N | 164-45.50 E |
| 1 | 43 | 6288 | 31-00.64 N | 164-59.94 E |  | 2 | 78 | 6323 |  6-00.75 N | 165-00.92 E |
| 1 | 44 | 6289 | 29-59.62 N | 164-58.36 E |  | 2 | 79 | 6324 |  5-29.47 N | 165-01.23 E |
| 1 | 45 | 6290 | 28-59.54 N | 164-59.41 E |  | 2 | 80 | 6325 |  5-00.37 N | 165-00.81 E |
| 1 | 46 | 6291 | 27-59.85 N | 165-00.41 E |  | 2 | 81 | 6326 |  4-31.00 N | 165-01.17 E |
| 1 | 47 | 6292 | 26-59.58 N | 164-59.01 E |  | 2 | 82 | 6327 |  4-00.80 N | 165-00.88 E |
| 1 | 48 | 6293 | 25-59.32 N | 164-59.49 E |  | 2 | 83 | 6328 |  3-30.31 N | 165-00.81 E |
| 1 | 49 | 6294 | 24-59.17 N | 164-59.86 E |  | 2 | 84 | 6329 |  3-00.18 N | 165-00.54 E |
| 1 | 50 | 6295 | 24-00.22 N | 164-59.80 E |  | 2 | 85 | 6330 |  2-29.86 N | 165-00.30 E |
| 1 | 51 | 6296 | 22-59.72 N | 164-59.23 E |  | 2 | 86 | 6331 |  1-59.65 N | 165-00.06 E |
| 1 | 52 | 6297 | 21-59.24 N | 164-59.56 E |  | 2 | 87 | 6332 |  1-29.73 N | 164-59.08 E |
| 1 | 53 | 6298 | 20-59.43 N | 164-59.39 E |  | 2 | 88 | 6333 |  0-59.75 N | 164-59.58 E |
| 1 | 54 | 6299 | 20-29.87 N | 164-59.51 E |  | 2 | 89 | 6334 |  0-29.57 N | 164-59.58 E |
| 1 | 55 | 6300 | 20-00.28 N | 164-58.05 E |  | 2 | 90 | 6335 |  0-04.44 S | 164-59.83 E |
| 1 | 56 | 6301 | 19-30.08 N | 164-59.05 E |  | 2 | 91 | 6336 |  0-30.66 S | 165-00.40 E |
| 1 | 57 | 6302 | 19-00.14 N | 165-00.08 E |  | 2 | 92 | 6337 |  1-00.02 S | 165-00.42 E |
| 1 | 58 | 6303 | 18-30.12 N | 164-59.52 E |  | 2 | 93 | 6338 |  1-30.10 S | 164-59.89 E |
| 1 | 59 | 6304 | 17-59.46 N | 165-00.31 E |  | 2 | 94 | 6339 |  1-55.60 S | 165-00.83 E |
| 1 | 60 | 6305 | 16-59.60 N | 164-59.83 E |  | 2 | 95 | 6340 |  2-29.73 S | 165-00.00 E |
| 1 | 61 | 6306 | 15-59.92 N | 164-59.51 E |  | 2 | 96 | 6341 |  2-59.05 S | 164-59.92 E |
| 1 | 62 | 6307 | 14-59.39 N | 164-58.80 E |  | 2 | 97 | 6342 |  3-59.50 S | 164-58.84 E |
| 1 | 63 | 6308 | 13-59.54 N | 164-59.68 E |  | 2 | 98 | 6343 |  4-59.62 S | 164-59.62 E |
| 1 | 64 | 6309 | 12-59.46 N | 164-59.51 E |  | 2 | 99 | 6344 |  5-44.17 S | 163-58.36 E |
| 1 | 65 | 6310 | 11-59.28 N | 164-29.83 E |  | 2 | 100 | 6345 |  6-30.64 S | 163-00.11 E |
| 1 | 66 | 6311 | 11-29.56 N | 164-14.31 E |  | 2 | 101 | 6348 |  7-15.47 S | 162-00.13 E |
| 1 | 67 | 6312 | 10-59.71 N | 163-59.29 E |  | 2 | 102 | 6347 |  7-37.42 S | 161-30.45 E |
| 1 | 68 | 6313 | 10-29.44 N | 163-58.69 E |  | 2 | 103 | 6346 |  8-00.17 S | 160-59.70 E |

## List of Principal Investigators for Measurements

The principal investigators for each parameter are listed in Table A.3.

|  |
| --- |
| Table A.3. List of principal investigators for each parameter. |
| Hydrography | CTDO2 | Keizo SHUTTA |
|  | Salinity | Keizo SHUTTA |
|  | Dissolve oxygen | Kazuhiro SAITO |
|  | Nutrients | Kazuhiro SAITO |
|  | Phytopigments | Kazuhiro SAITO |
|  | DIC | Kazutaka ENYO |
|  | TA | Kazutaka ENYO |
|  | pH | Kazutaka ENYO |
|  | CFCs | Kazutaka ENYO |
|  | LADCP | Keizo SHUTTA |
| Underway | Meteorology | Keizo SAKURAI |
|  | Thermo-Salinograph | Kazutaka ENYO |
|  | *p*CO2 | Kazutaka ENYO |
|  | Chlorophyll *a* | Kazuhiro SAITO |
|  | ADCP | Keizo SHUTTA |
|  | Bathymetry | Keizo SHUTTA |

***Reference***

Swift, J. H. (2010): Reference-quality water sample data: Notes on acquisition, record keeping, and evaluation. *IOCCP Report No.****14****, ICPO Pub. 134, 2010 ver.1*