

JAMSTEC Monsoon Research Platforms: Now and the Future

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with contributions from Shin-Ya OGINO, Mikiko FUJITA, Ayako SEIKI, Satoru YOKOI, Iwao UEKI, and Eisuke AKANE



< Outline >

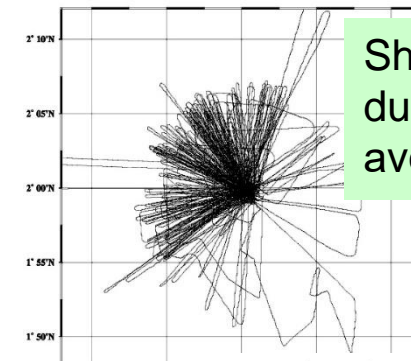
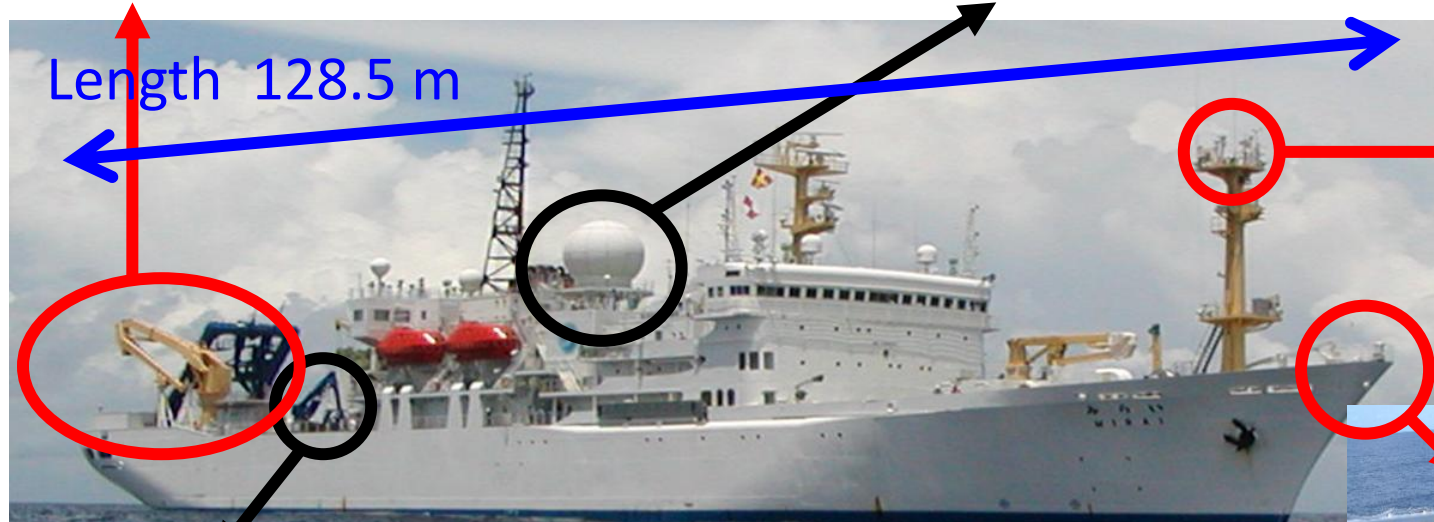
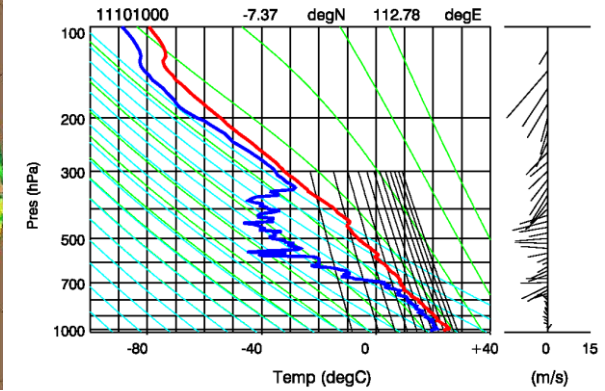
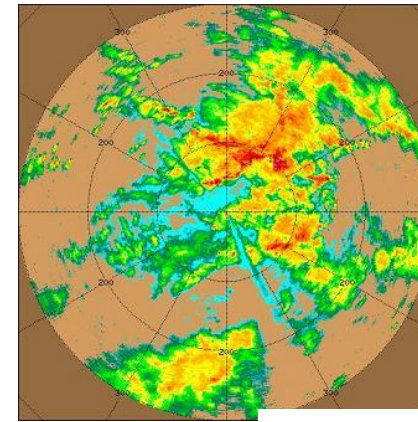
1) Ship-based Observations

Autonomous Surface Vehicles

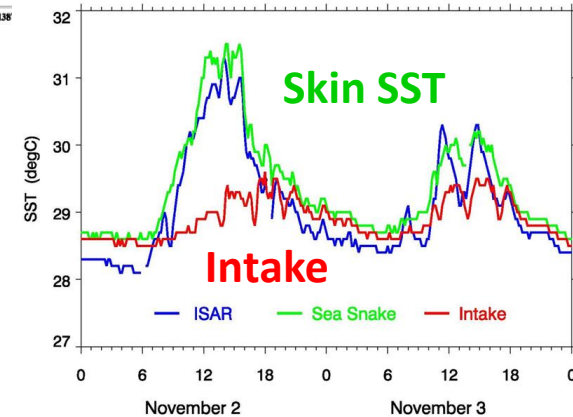
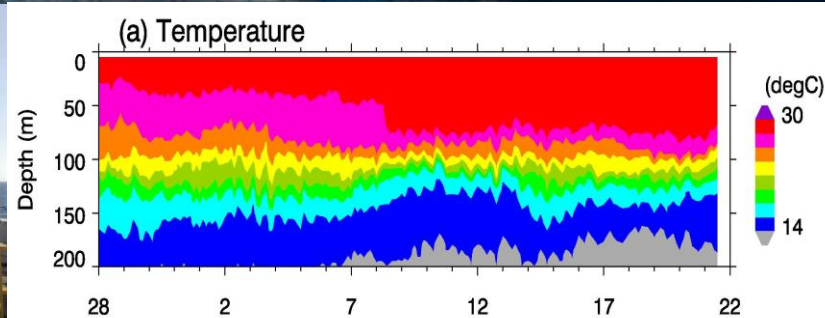
Moorings

2) New ship

R/V Mirai ... A Base of Observations



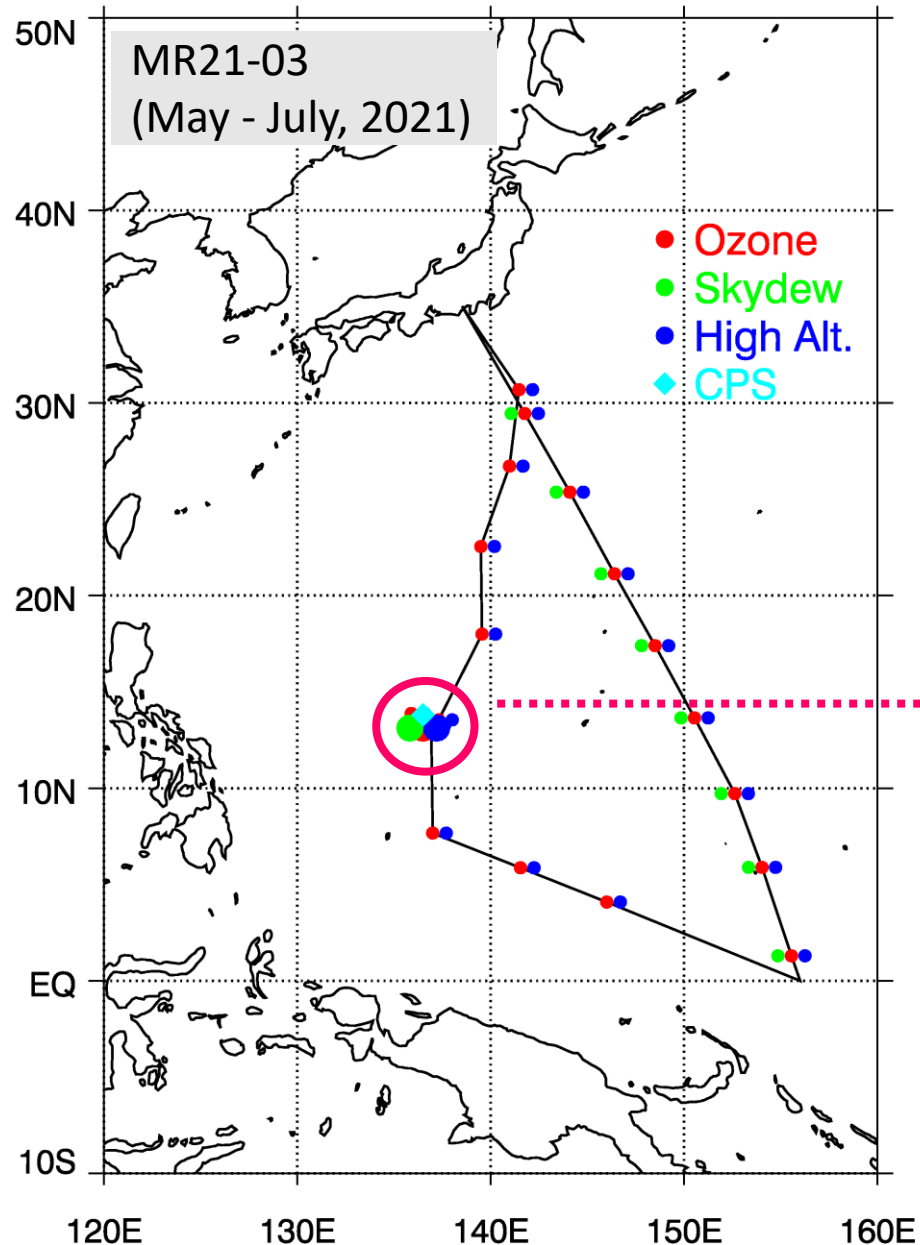
Ship cruises upwind during on-station to avoid ship's influence.



Skin SST Measurement using sea-snake thermistor

Sometimes, large difference appears btwn Skin & intake SST

Special sondes (Ozone, High accurate water vapor, and High-altitude)



Objective:

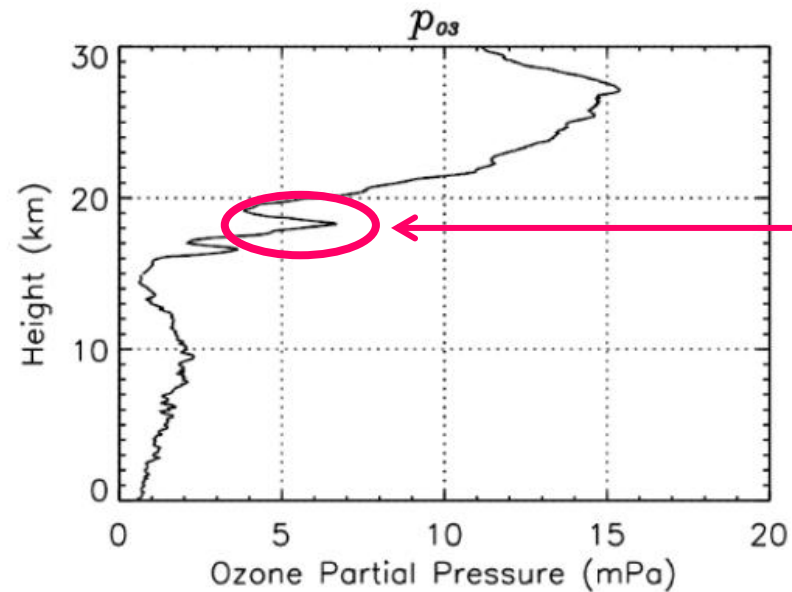
To capture the nature of material transport driven by the active convections associated with the Asian Summer Monsoon.

Special measurement sensors:

ECC ozone-sonde

Meisei Skydew chilled-mirror dew/frost point hygrometer

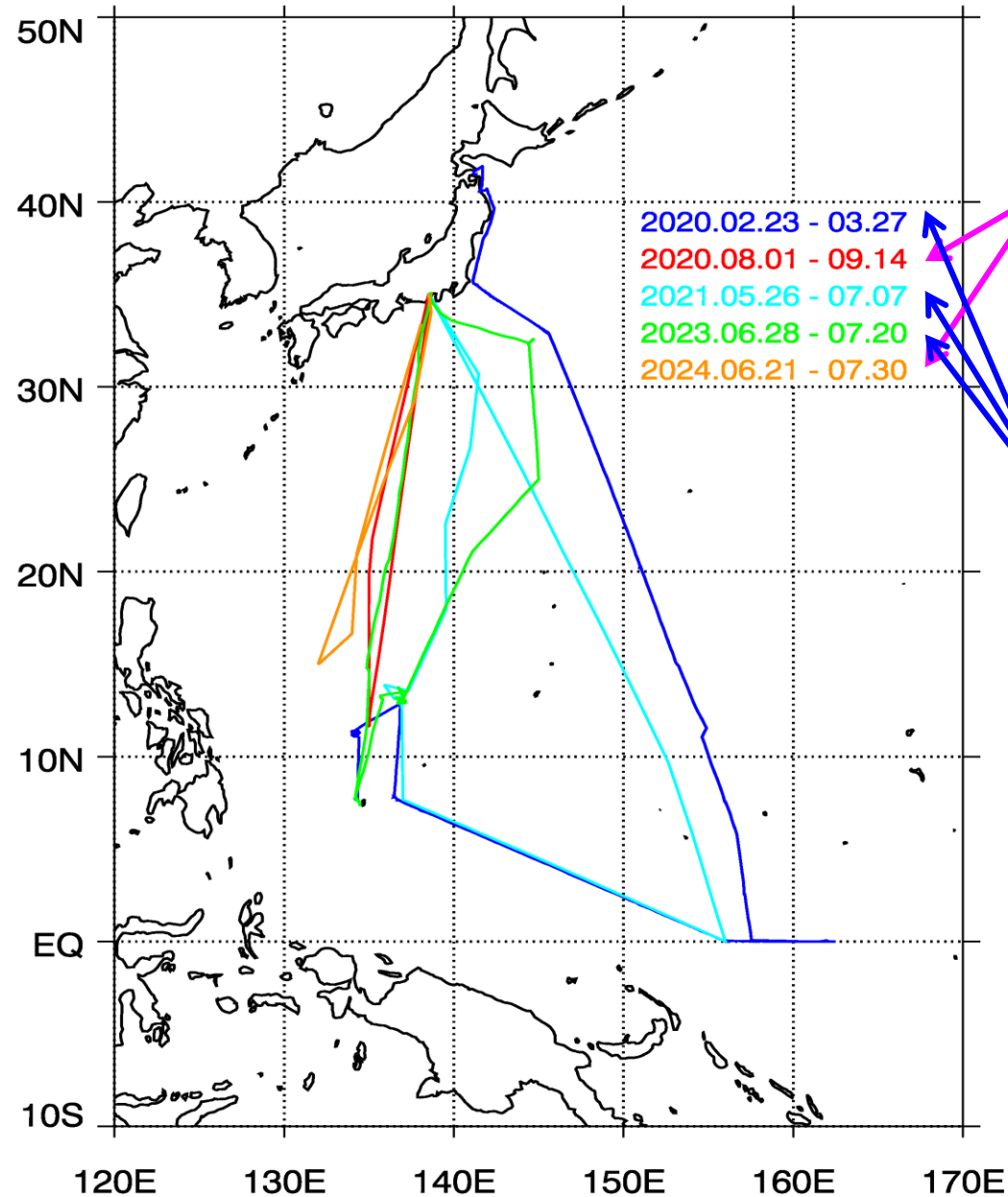
Meisei CPS cloud particle counter



High O₃ at 18km may imply the transport of stratospheric air mass from mid-latitudes.

Ref. R/V Mirai Cruise Report (MR21-03) <https://doi.org/10.17596/0002529>
Data: YMC Project JAMSTEC Office (2023) <https://doi.org/10.17596/0003404>

Recent R/V Mirai cruises for air-sea interaction studies



Main Targets:

Boreal Summer Intraseasonal Oscillation (BSISO)

Main Activities:

Stationary observation (3-4 weeks)

Main Targets:

Northern (Eastern) Edge of Warm Pool

ENSO, Multi-timescale SST variability Impact

Main Activities:

Recovery/Deployment of Mooring

Purpose

To improve our understanding and prediction skill of local multi-scale variability of the MC weather-climate systems and their global impact.

Participants

Over 70 institutes/universities from Australia, China, France, FSM, Germany, Indonesia, Japan, Malaysia, Palau, Philippines, Singapore, Taiwan, UK, US, Vietnam, and more.

Period

Phase-1 July 2017 - Feb 2020 (IOPs)
Phase-2 Mar 2020 - (IOPs + Feedback)

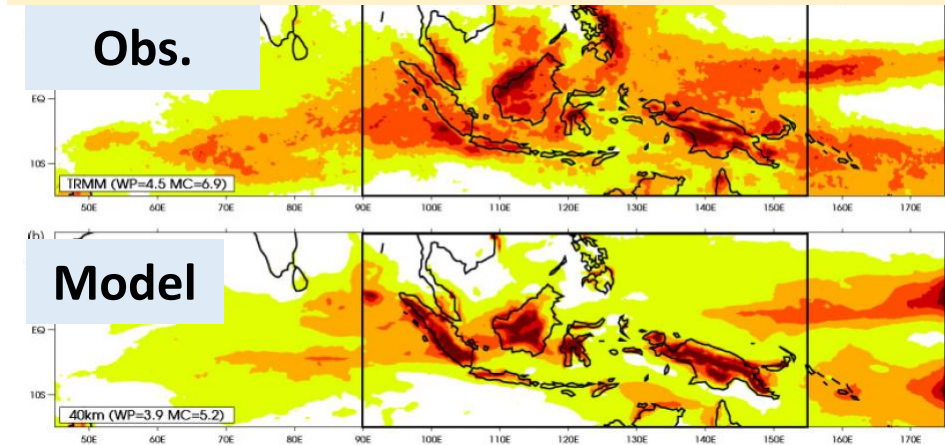
Main Activities

- 1) Data sharing
- 2) Field campaign
- 3) Modeling
- 4) Prediction and applications
- 5) Outreaching and capacity building

Remarks

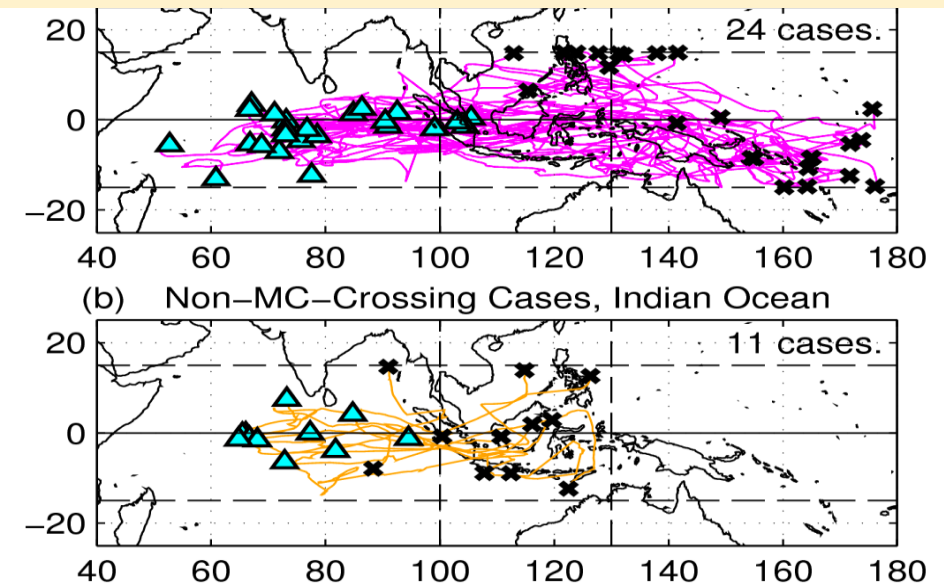
YMC has been endorsed or supported by ; WWRP/WGTMR, S2S, WGNE/MJO TF, CLIVAR, etc.

State-of-the-art numerical models suffer from systematic errors of rainfall estimation



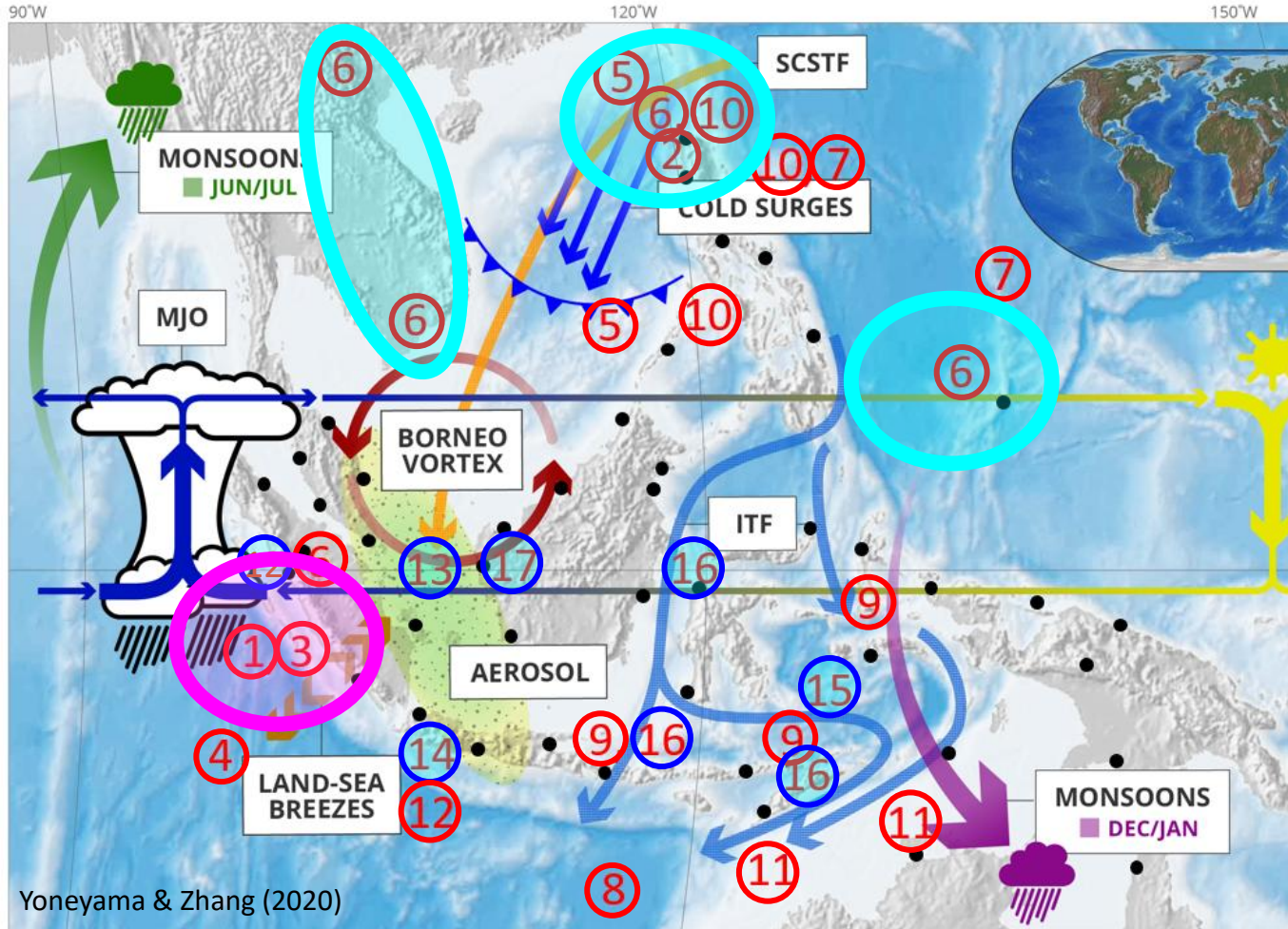
Comparison of rainfall averaged Oct 2008 - Mar 2009. Love et al. (2011, QJRMMS)

About 30% of MJO convection envelop failed to pass by the MC region



Kerns and Chen (2016, JGR)

YMC field campaign consists of intensive observations and long-term measurements.



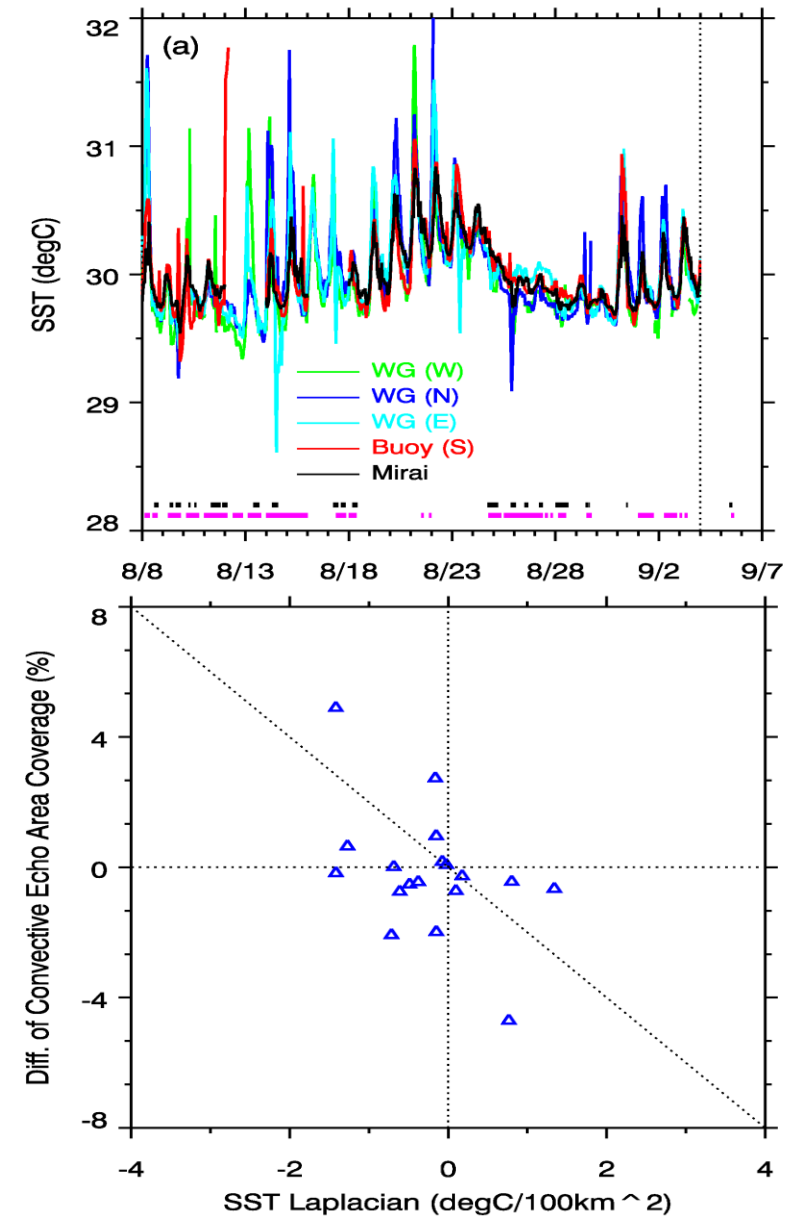
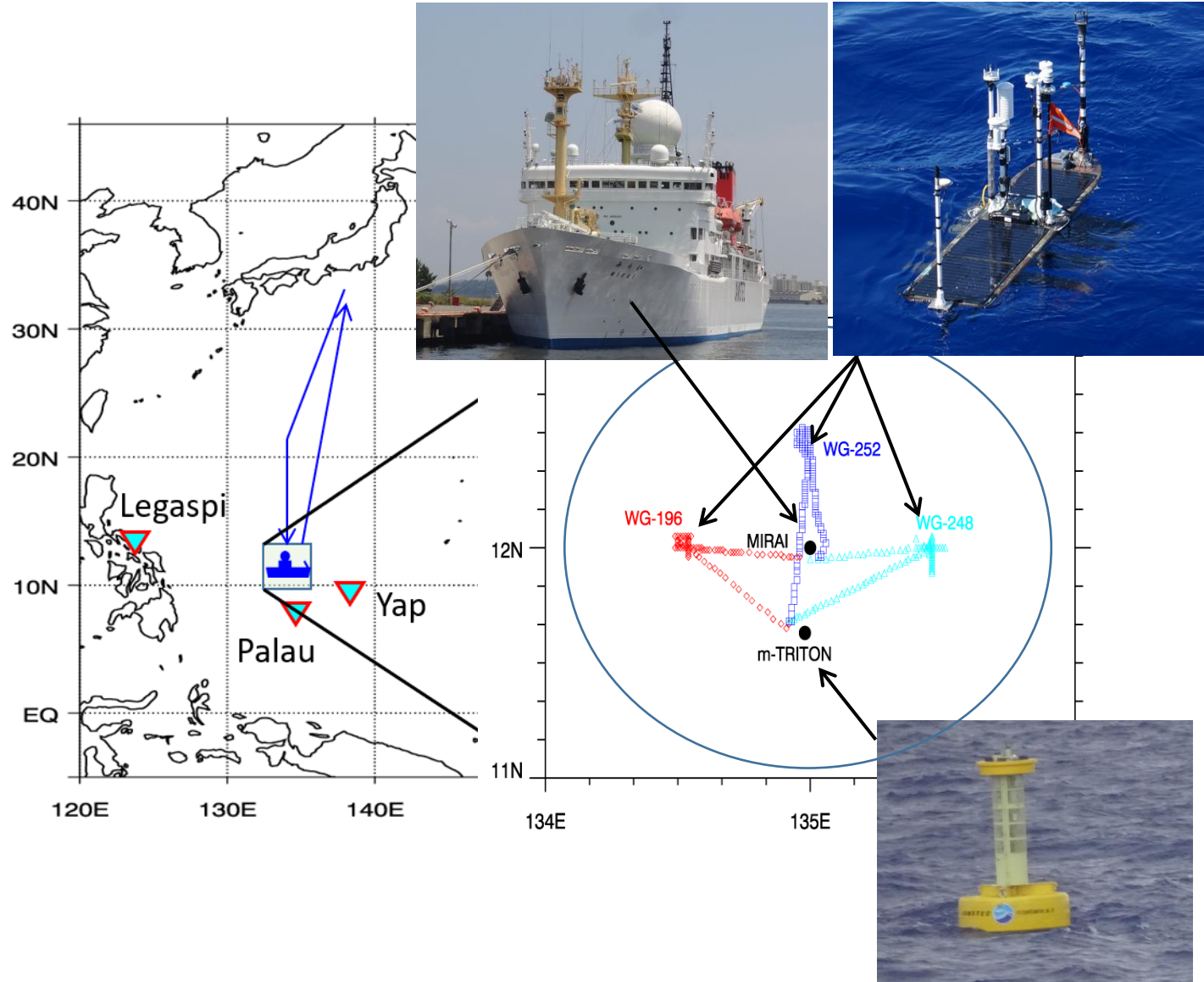
Number Conducted or Planned Intensive Observations
 ● Radiosonde sounding stations

2015.10-12	1	Pre-YMC in Sumatra
2017.08	2	RSVP (air-sea)
2017.11-01	3	Sumatra (MJO, Diurnal Cycle)
2017.11-02	4	EIOURI (Upwelling)
2017.12	5	SCSTIMX (monsoon)
2018.03-04	5	SCSTIMX (monsoon)
2018.05-06	5	SCSTIMX (monsoon)
2018.06-08	6	Boreal Summer Monsoon (ISV)
2018.08-10	7	PISTON (DC, ISV)
2018.11	8	MAMOS/CWPDIP (MJO, monsoon)
2019.01-04	12	ELO (ocean)
2019.02-03	9	Ocean Mixing/CAT (ITF, tide)
2019.08-10	10	CAMP ² Ex (Aerosol)
2019.09	7	PISTON (DC, ISV)
2019.10-12	11	Investigator(MJO, DC, Ocean)
2020.08-09	6	Boreal Summer Monsoon (ISV)
2021.12-02	12	ELO (CCKW)
2021.12-02	13	ELO-O (Cold surge)
2021.12-02	14	TerraMaris (DC, MJO)
2022.01-02	15	Banda Sea (air-sea)
2022.01	16	MINTIE (ITF)
(2018.09-)	17	DIMOP (DC, MJO)

**Cancelled
due to
COVID-19
or
Logistical
Difficulty**

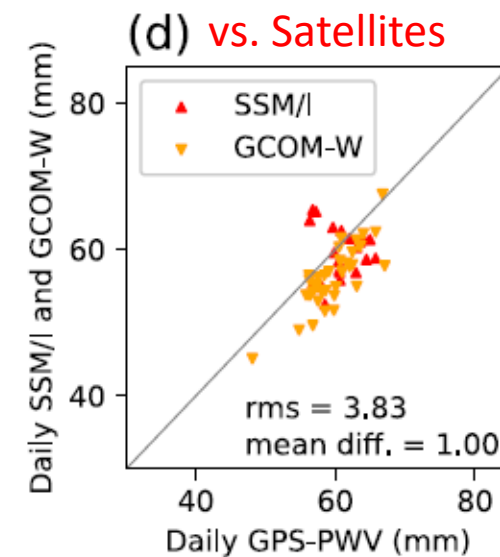
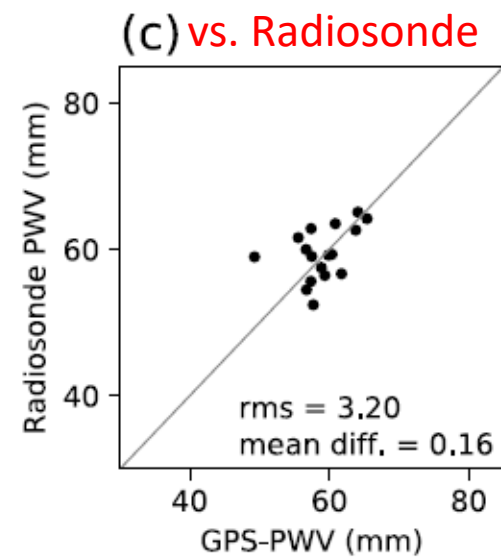
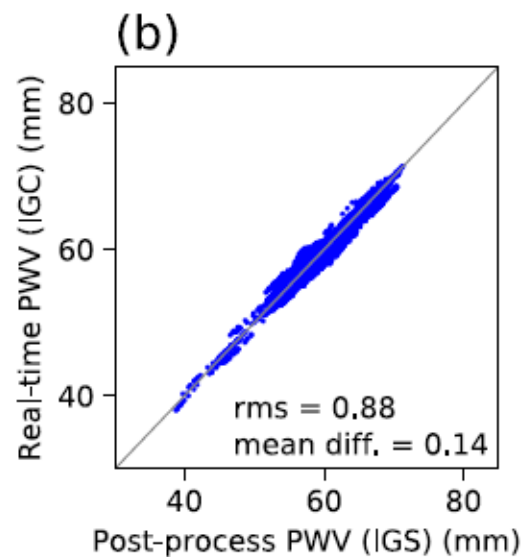
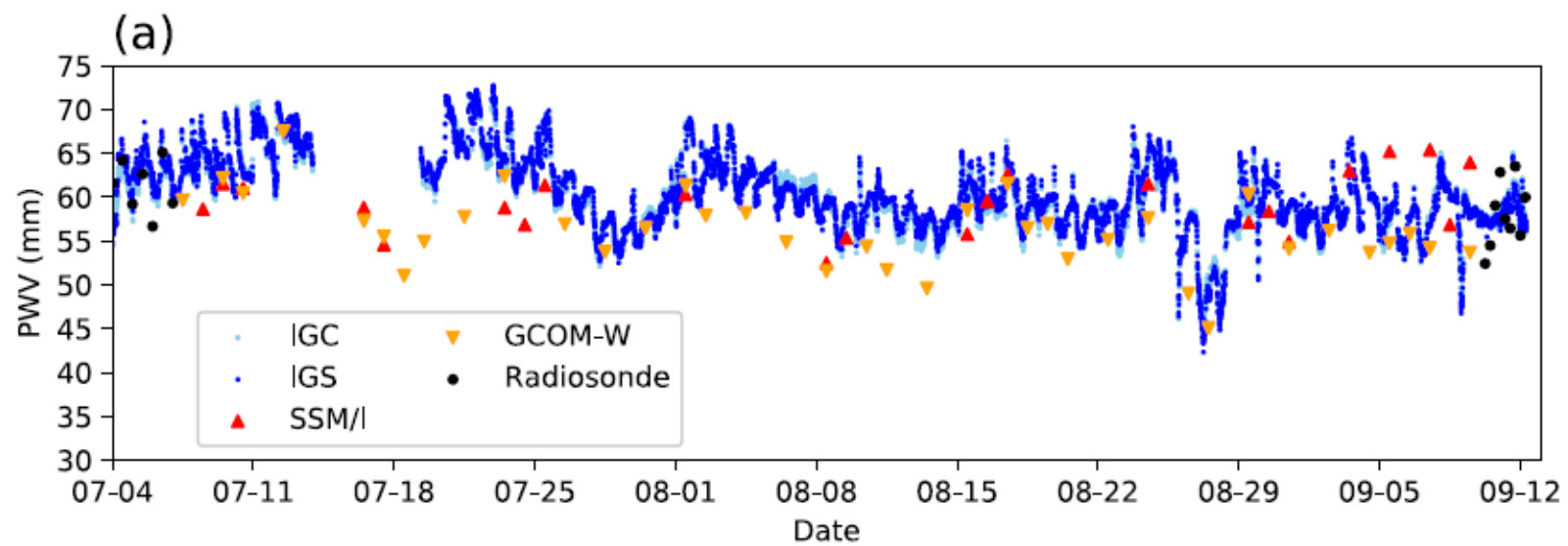
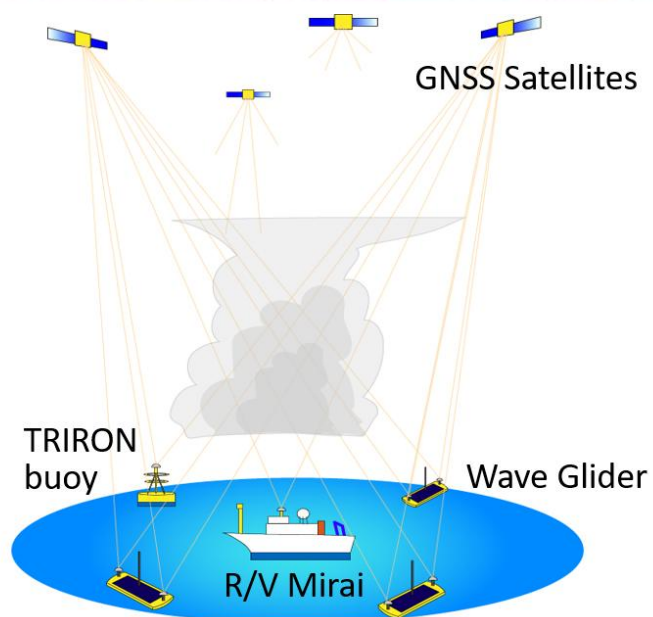
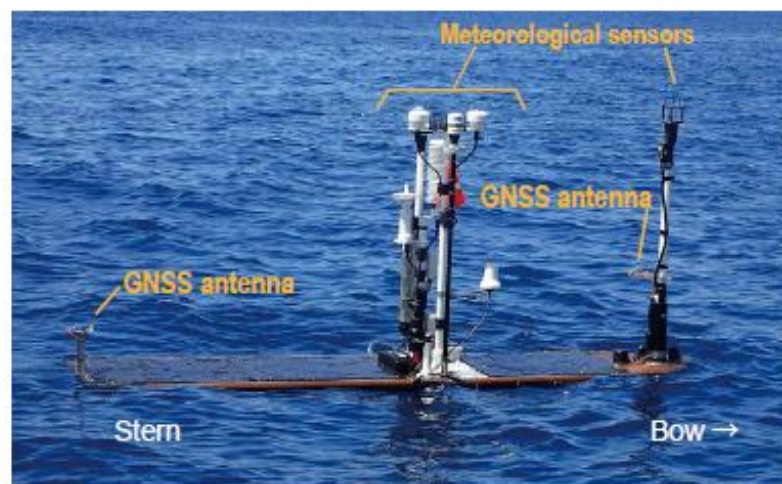
Autonomous Surface Vehicles

YMC-BSM (Boreal Summer Monsoon study in) 2020
IOP: Aug. 8 - Sept. 4, 2020



Yoneyama et al. (2023, Mausam)

GNSS-derived Water Vapor Measurement on ASV



Philippine Sea Mooring (PHSMO)

Period: Dec. 2016 - current

Position: 13N, 137E

Parameters:

<atmos> T-air, RH, Pressure, Wind,
Rain, SW/LW radiation

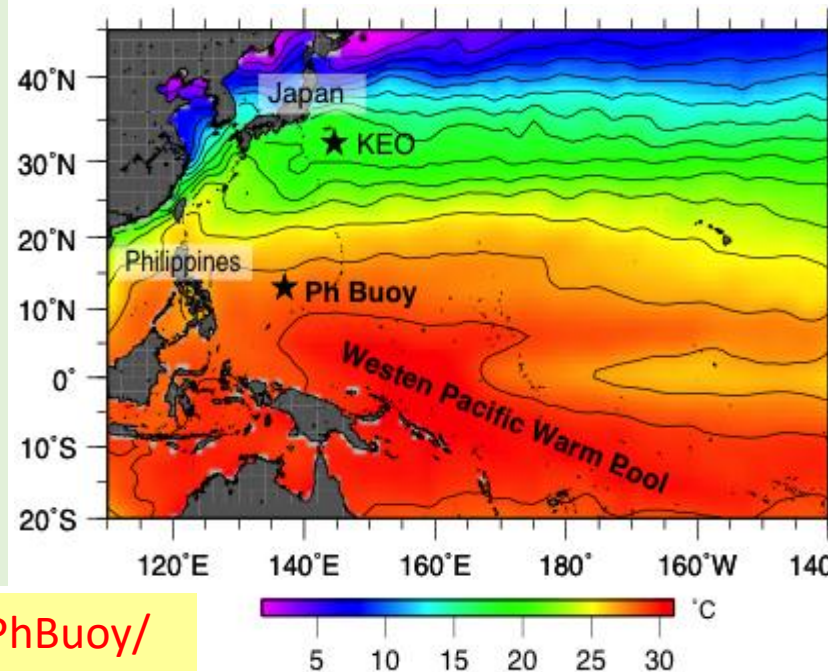
<ocean> CTD (~300m), ADCP, DO

Remarks:

1) When we call at PHSMO site, we deploy wave-gliders and several drifters/floats for data quality-control by comparison as well as for enhancement of air-sea interaction study.

2) Raw data have been sent out through GTS, while QC-ed data are available from the following website.

<https://www.jamstec.go.jp/ipobs/PhBuoy/>



Meteorological Sensors

Wind vector (H: 3.1 m), Air temperature (H: 2.3 m), Relative humidity (H: 2.3 m),
Precipitation (H: 3.0 m), Shortwave radiation (H: 2.9 m), Longwave radiation (H: 2.9 m)
Air pressure (H: 2.2 m)

Surface Buoy

(Height: 3.1 m, Diameter: 1.8 m, Weight in air: 800 kg, Displacement: 300 kg)

Underwater Sensors

CT/CO₂/Ph Sensors: 1m

CT/CTD Sensors: 10, 20, 40, 60, 80, 100, 110, 120, 150, 180, 200, 300 m

DO Sensors: 80, 100, 150 m

ADCP: 1 m (Frequency: 300 kHz, Beam direction: downward)

Wire Rope ø14 mm, 520 m

Ballast weight 200 kg

Nylon Rope ø17 mm, 4500 m
(1.14 g/cm³)

Polypropylene Rope ø19 mm, 2200 m
(0.91 g/cm³)

Nylon Rope ø17 mm, 70 m
(1.14 g/cm³)

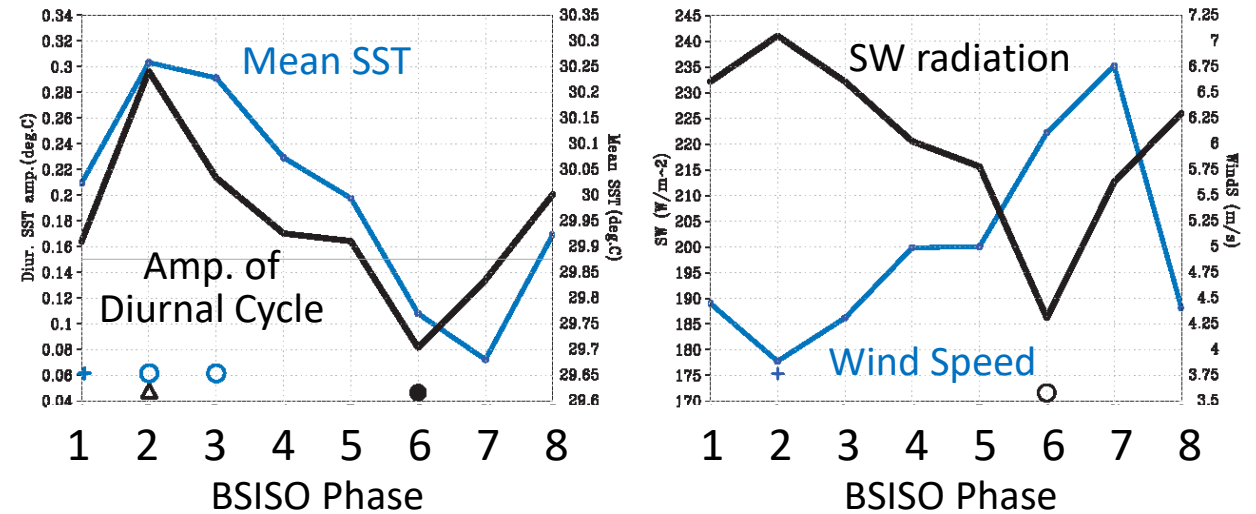
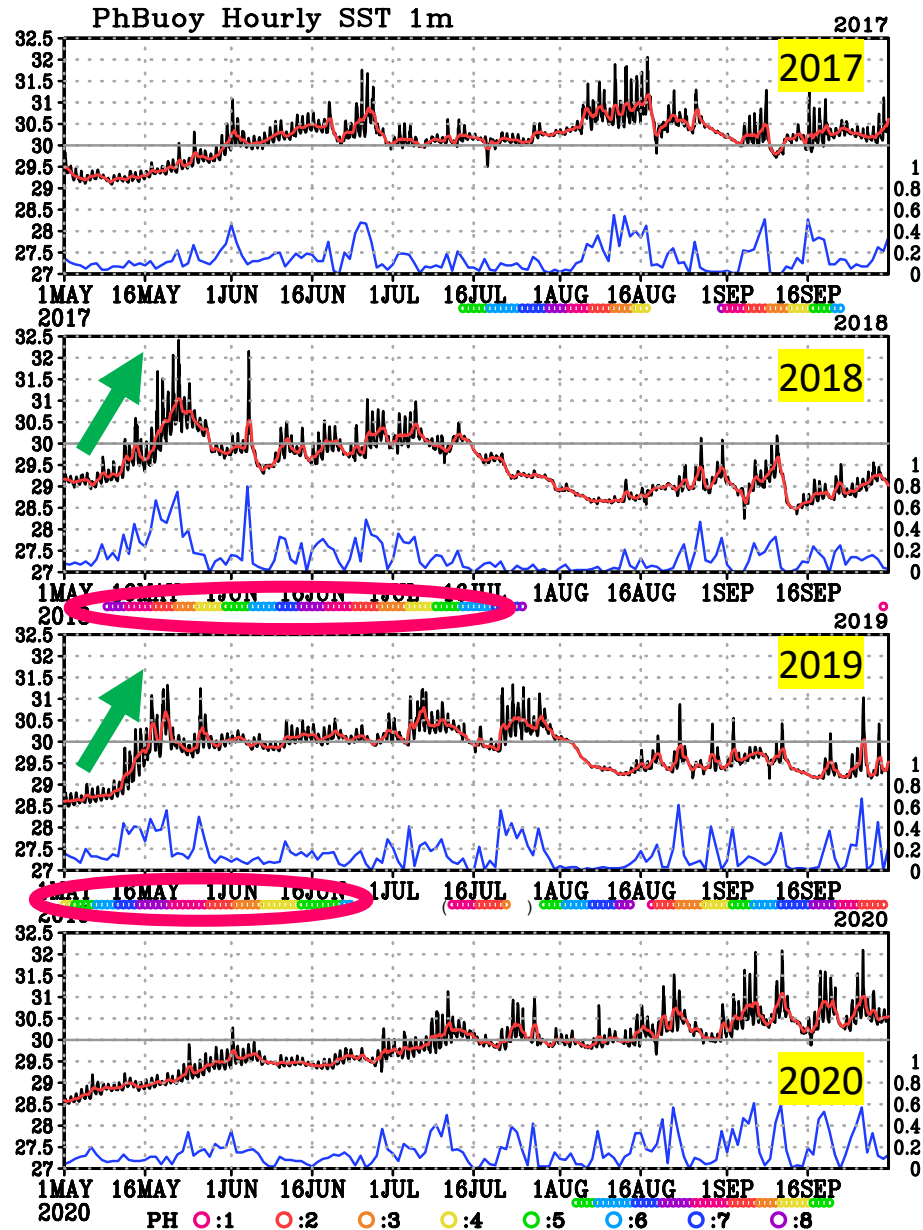
Standard scope ratio (line length/water depth) 1.3

Glass float

Benthos Acoustic releaser
(double)

Anchor
(3.5 ton)

BSISO Study using PHSMO data ... BSISO vs. Diurnal Cycle of SST

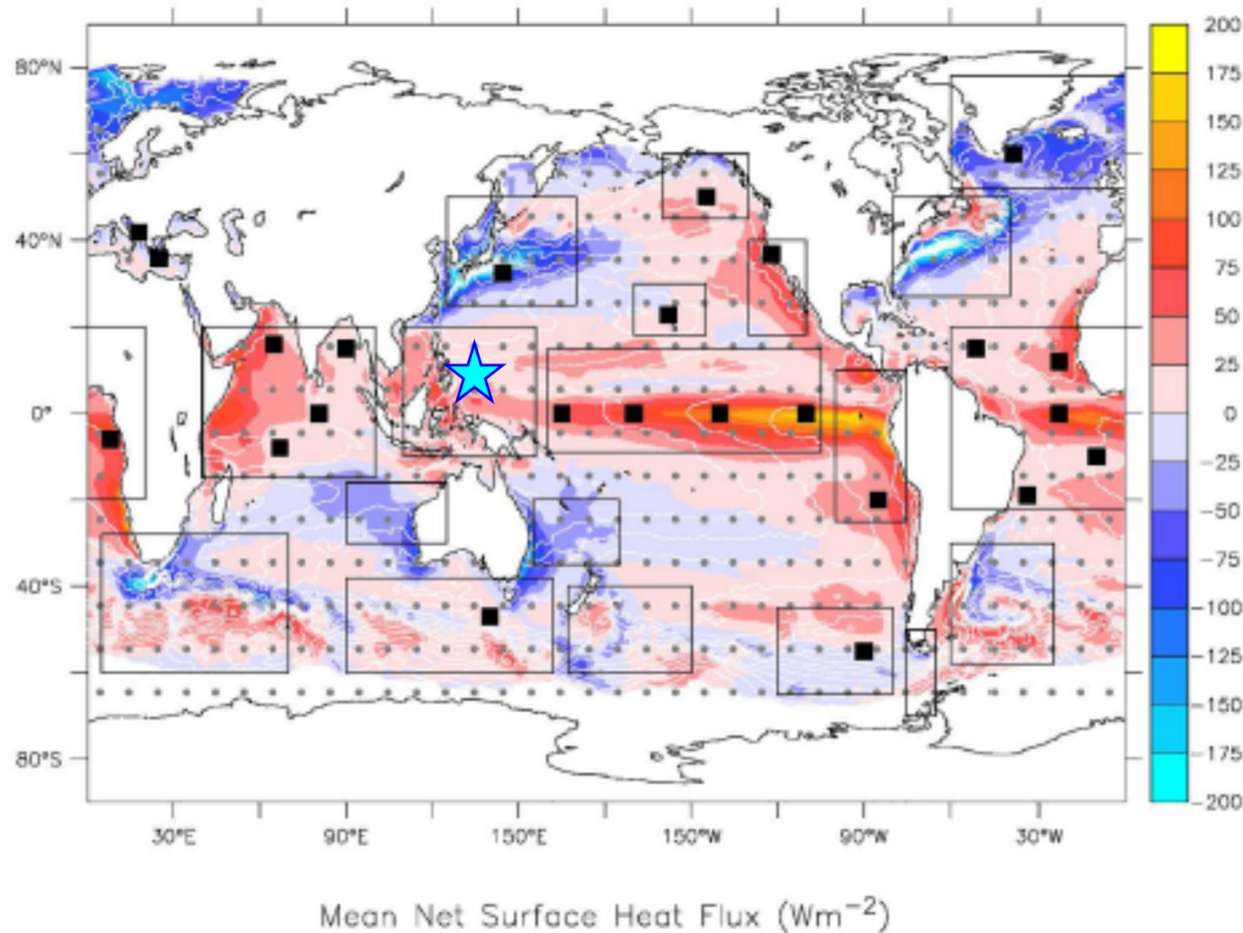


Abrupt SST increase with strong diurnal cycle is found in May of 2018 and 2019, when the BSISO active phase appeared, while other two years (2017, 2020) showed gradual increase with small diurnal SST amplitude.

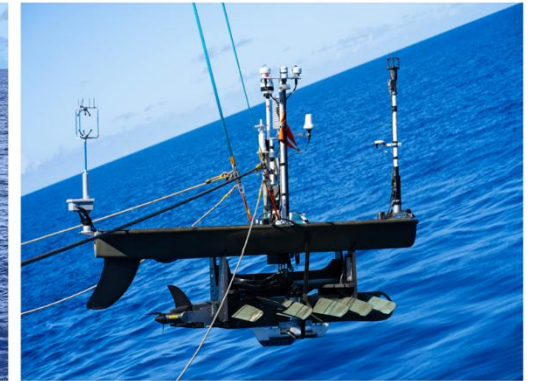
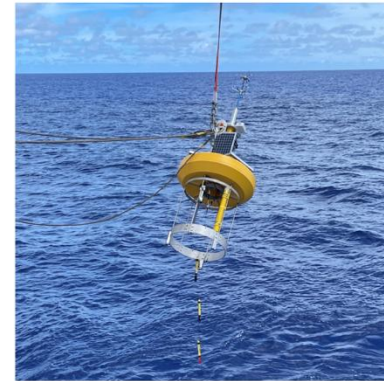
Note. BSISO phase was determined from OLR data according to Kikuchi et al. (2012, CD)

Time-series of SST & BSISO Phase in May-Sept.

PHSMO acts as a reference site for OceanSITES and others



■ indicates existing OceanSITES network of surface heat flux. Solid box indicates priority region and background depicts mean net surface heat flux. Adapted from Cronin et al. (2019, FMARS).

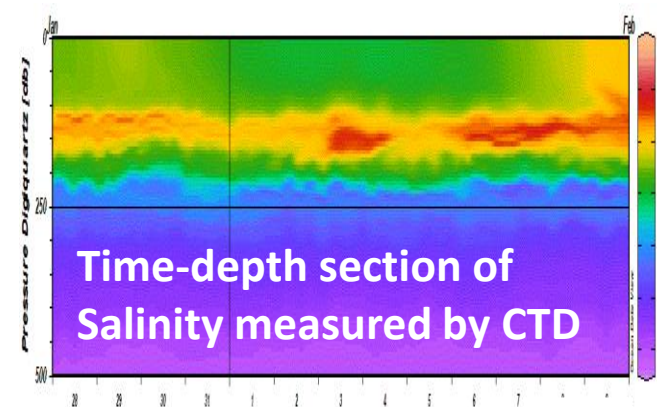
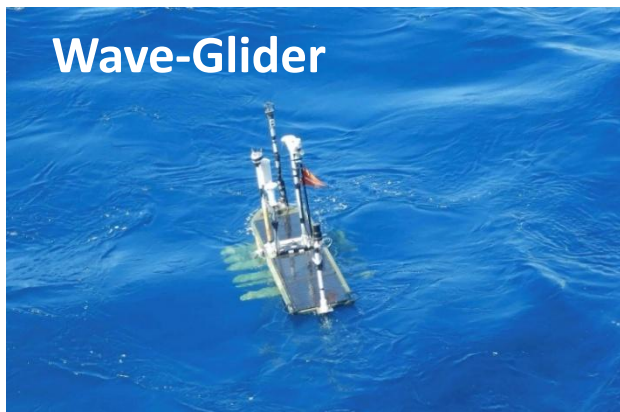
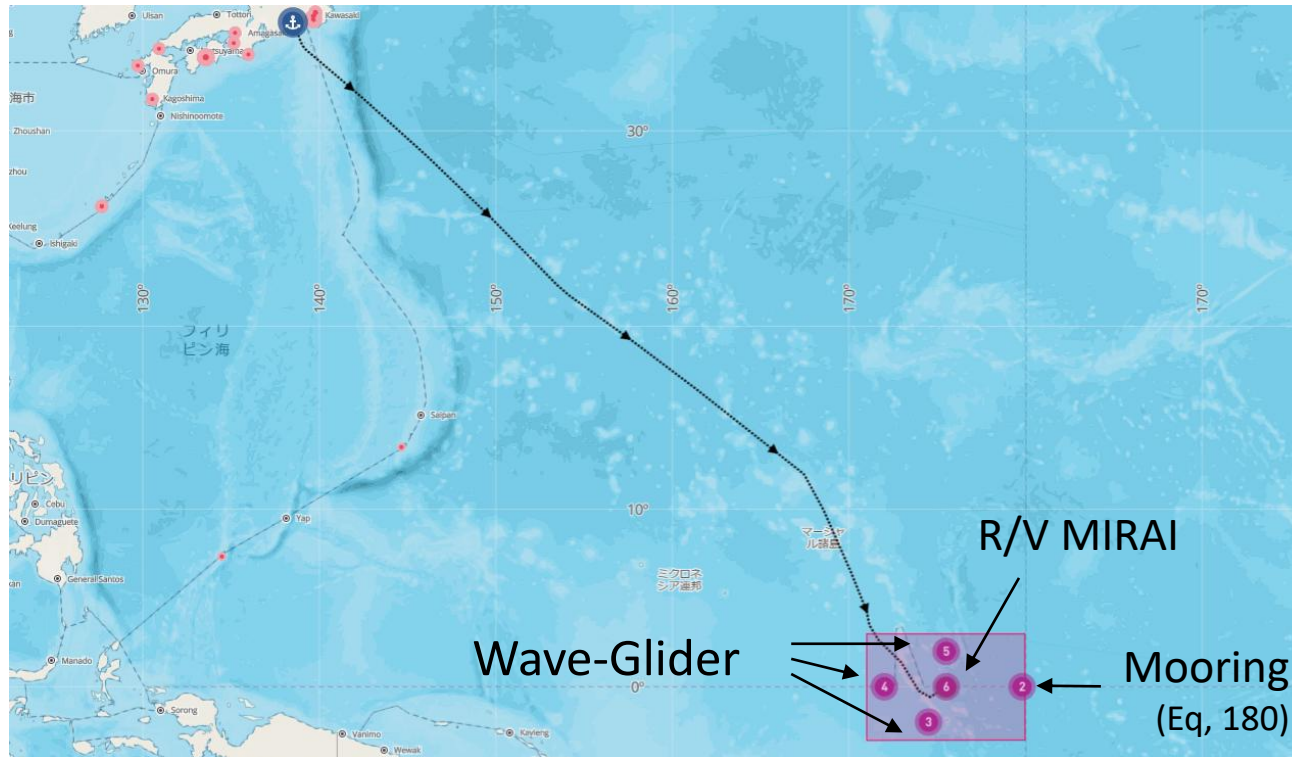


When we recover/re-deploy moorings, we also conduct air-sea flux measurement using ASVs and drifters for intercomparison.

Another very recent cruise conducted in Jan-Feb 2025

Period: Jan. 9 - Feb. 25, 2025 (Jan. 31 - Feb. 9, on station at EQ, 175.5E)

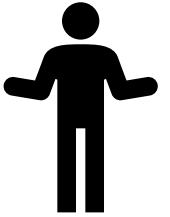
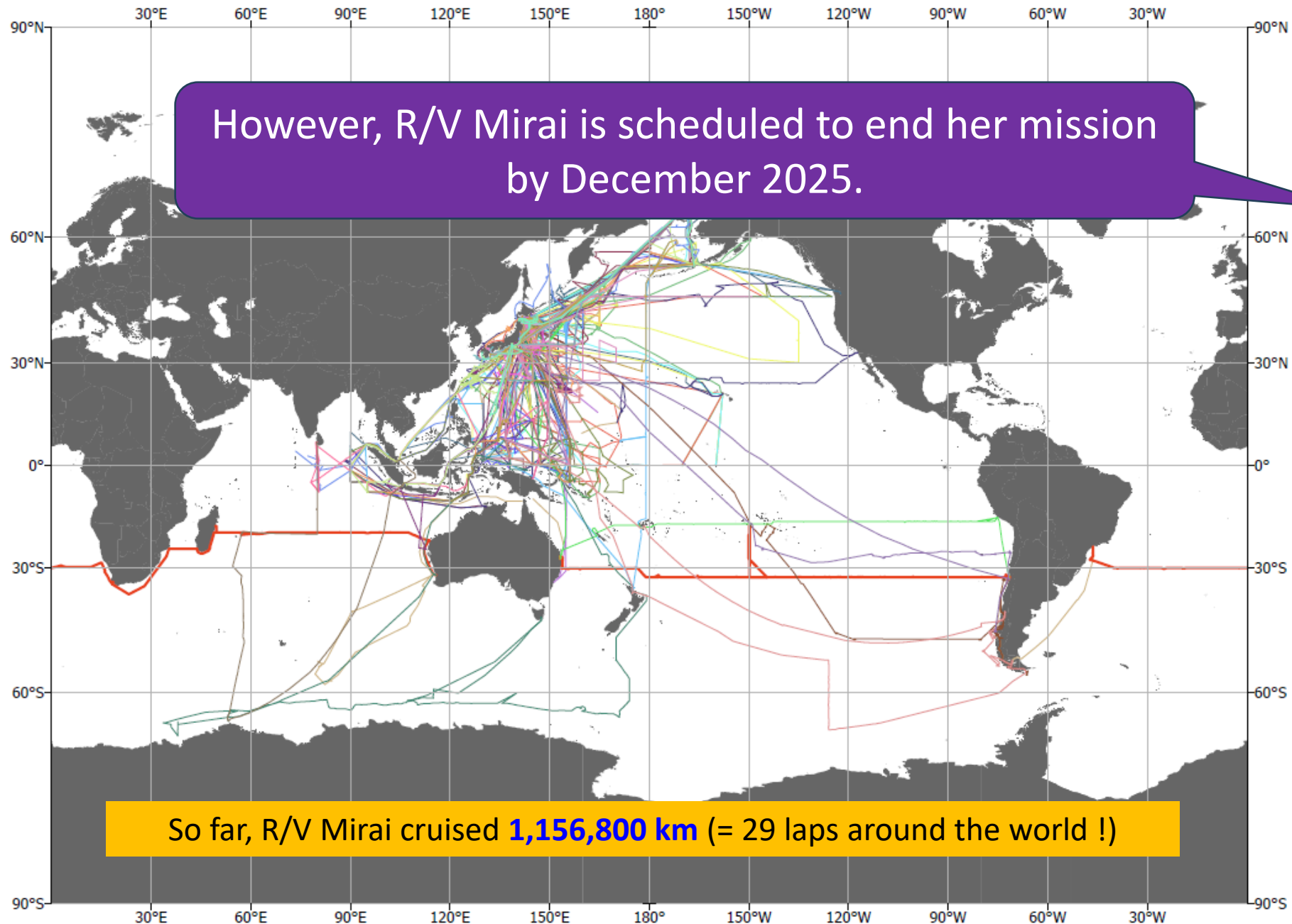
Target: Air-Sea Interaction at the Eastern Edge of Warm Pool



Point:

During this cruise, we deployed one surface mooring at (EQ, 180) and left it there. This is because this mooring is planned to measure until its recovery in 2026 during the NOAA TEPEX (TPOS Equatorial Pacific Experiment) cruise, which is expected to contribute to GPEX.

R/V Mirai Cruise Tracks during Jan. 1998 - Aug. 2024



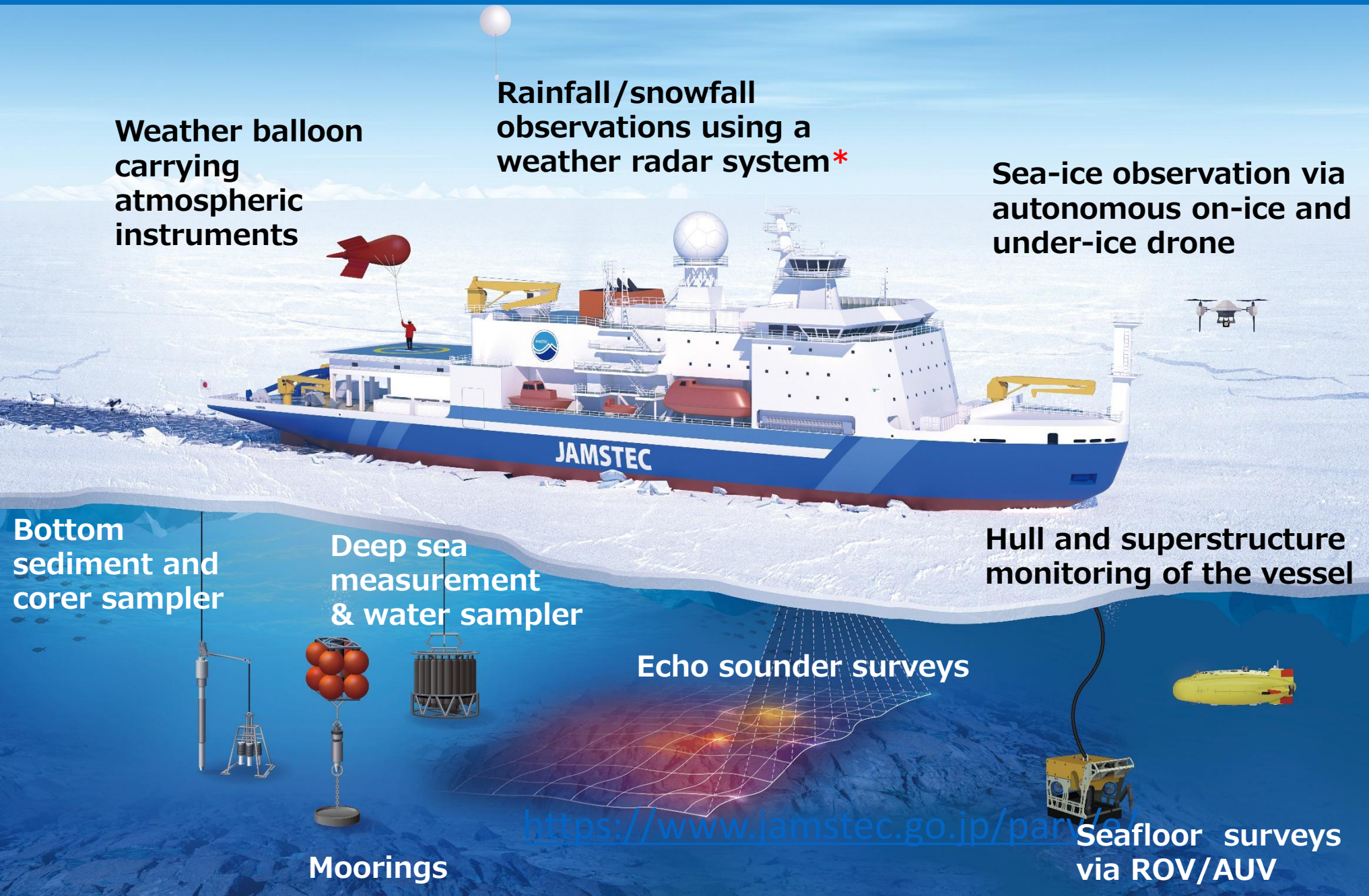
Arctic Research Vessel “MIRAI II”



Major Specifications - Mirai II		<i>cf.</i> Mirai
L x B x D (draft)	128 m x 23 m x 12.4 m (8 m)	128.5 m x 19 m x 10.5 m (6.9 m)
Gross Tonnage	13,000 tons	8,706 tons
Accommodation	97 (34 crews, 63 researchers)	80 (34 crews, 46 researchers)
Generator power	5,600 kW x 3; DFD 2,600 kW x 1	1,838 kW x 4; Electric 700 kW x 2
Ice-Breaking Capacity	1.2 m of flat, 1-year ice at 3.0 knots	N/A

<https://www.jamstec.go.jp/parv/e/>

Major Functions and Facilities



* ... As a weather radar system, MIRAI's C-band Polarimetric Doppler radar will be **re-used**.

< Basic >
Surface Met
Radiosonde
Doppler weather radar
CTD
ADCP
Thermosalinograph, etc.

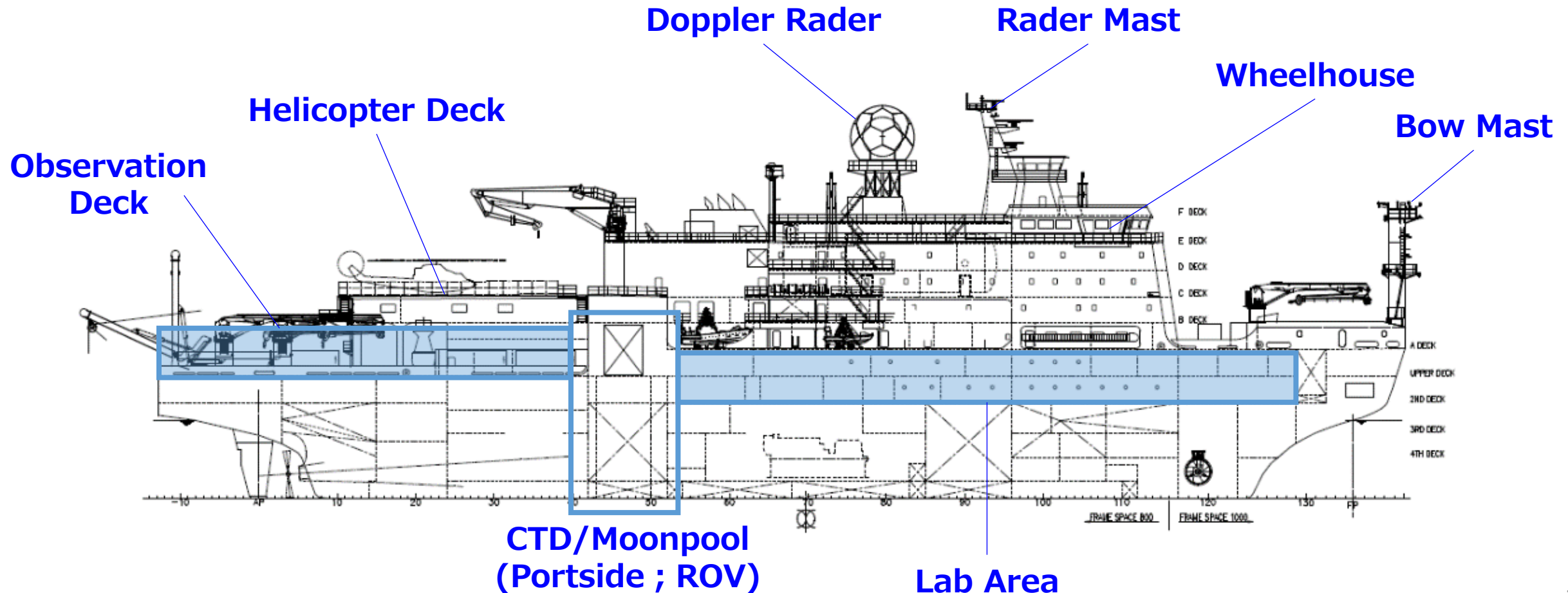
< Optional >
Lidar
Air sampler
Aerial drone
Under-ice drone, etc.

<https://www.jamstec.go.jp/parv/>

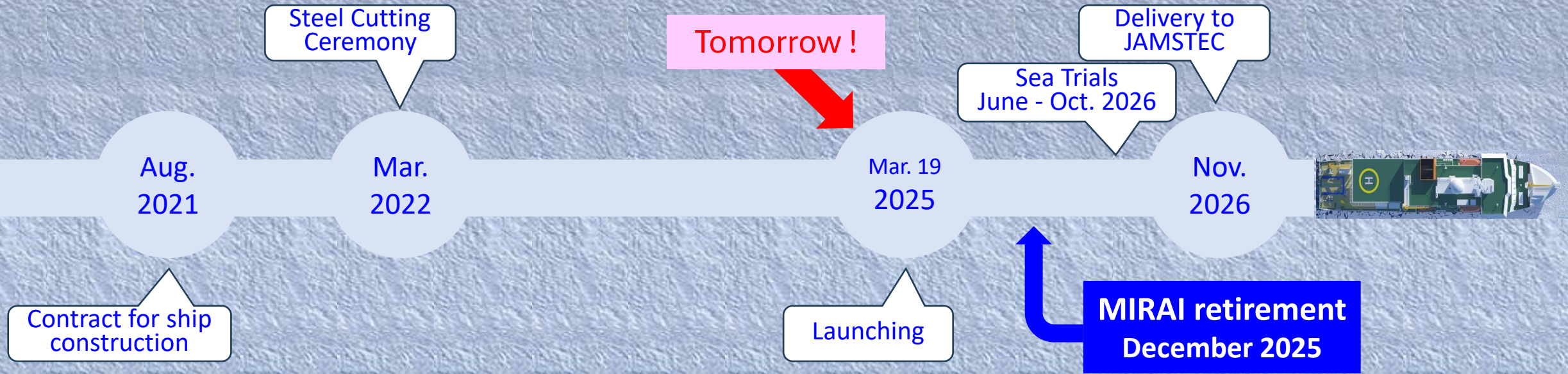
Seafloor surveys
via ROV/AUV

General Arrangement

Bow crane (with Man Riding Basket capability): 1
Midship crane: 1
Starboard stern crane (with Man Riding Basket capability): 1
Port stern crane: 1
A-frame crane: 1



Schedule (some are provisional)



After delivery to JAMSTEC

2026	Dec.	Start of training cruises
2027	Aug. or around	First cruise to the Arctic Ocean
2028		Start for others

Remarks:

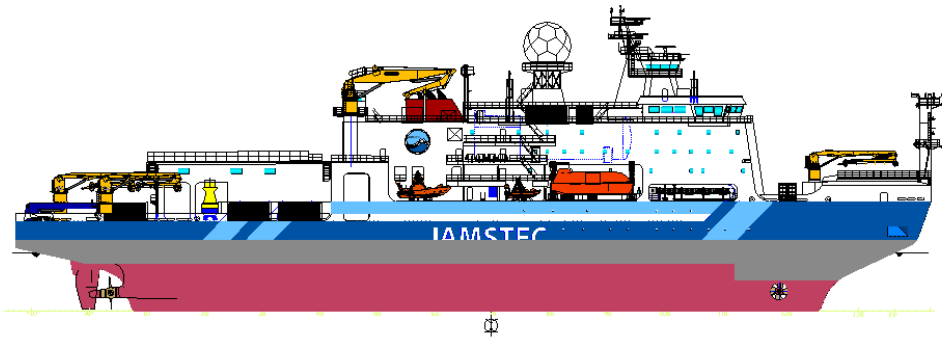
“MIRAI II” is expected to be operated as an international research platform for Arctic Research, and special coordination will be made. To enhance this activity, international workshops had been/will be held. However, **the details about total management have not been fixed yet**. In particular, while arctic research will have priority for her use (e.g., International Polar Year 2032-33), **it is possible to use for other research topics in other regions**. Even for other topics, we expect international cooperation would be mandatory.

Concluding Remarks

JAMSTEC has conducted various research cruises using the R/V MIRAI targeting air-sea interactions mainly under the international framework. However, MIRAI is scheduled to step down from her mission by December 2025.

Here, platforms for monsoon study after MIRAI retirement can be summarized;

- ✓ PHSMO, a moored buoy at 13N, 137E, will continue to provide data.
- ✓ Combination with several ASVs make it possible to form an observation array.
- ✓ A new icebreaker named Mirai II will be launched soon. While her main mission will be Arctic research, it is possible to use for scientific targets in other regions after 2027 or 2028. To use for monsoon research, international cooperation and framework will be minimum requirements.



For more and latest information about the Mirai II can be found at

<https://www.jamstec.go.jp/parv/e/>

