中綱觀測網下的海洋物理觀測成果分享

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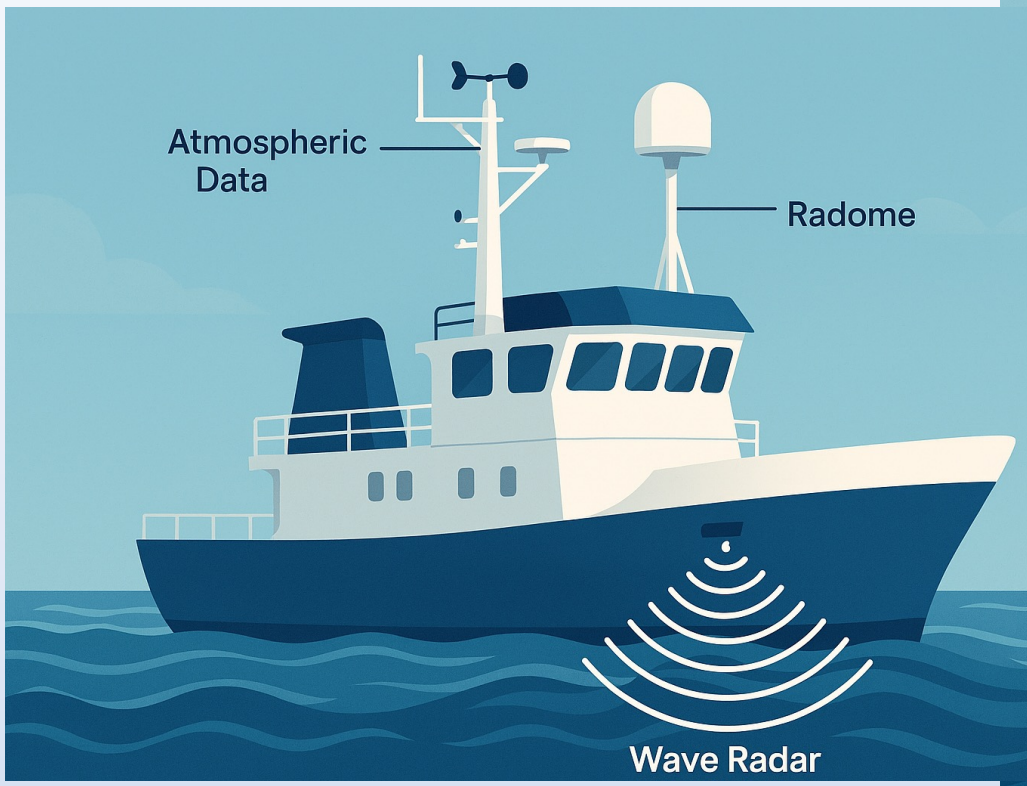
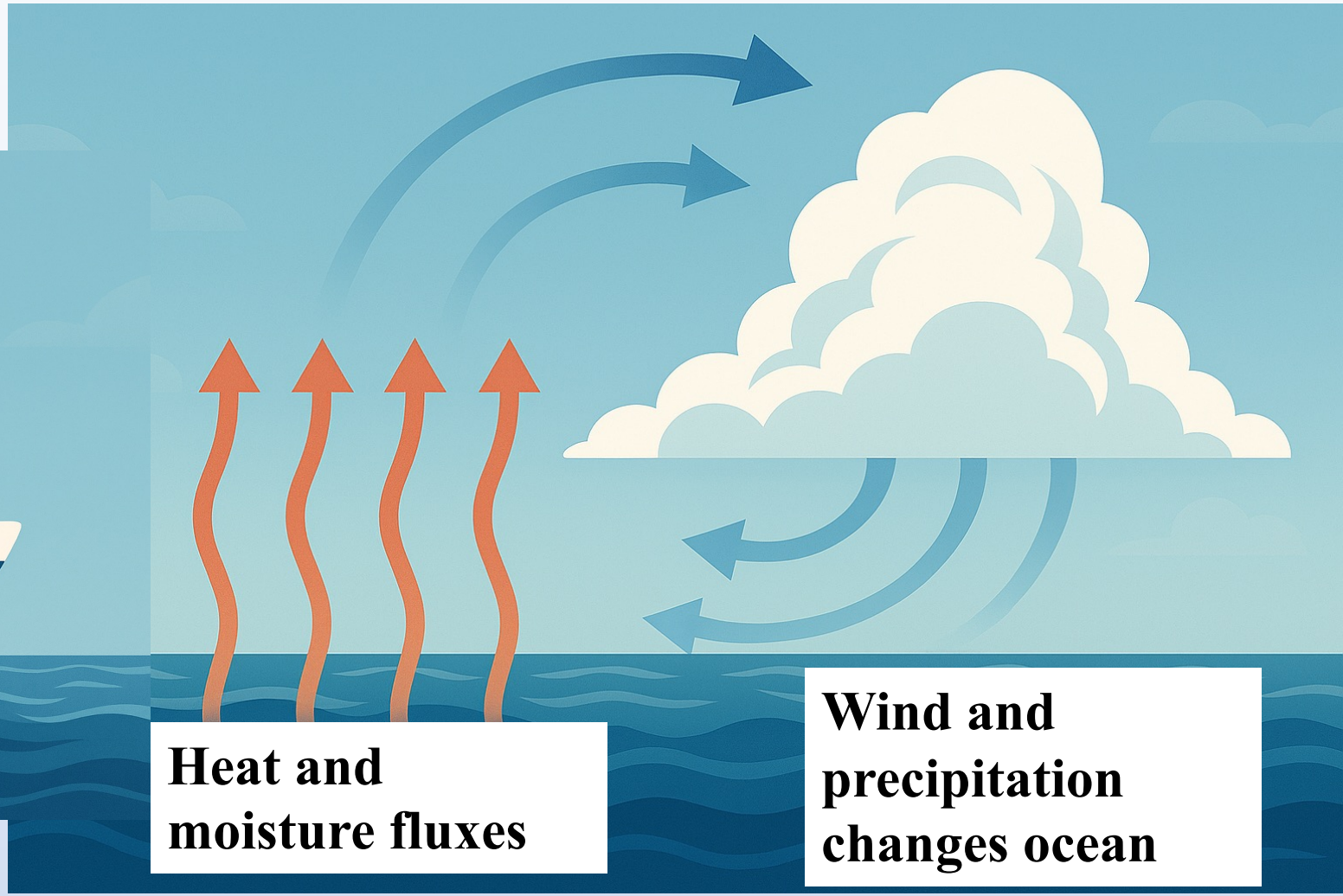
Why Ocean Data Matters

Sensors measure temperature, wind, pressure and humidity



Wave radar measures surface wave spectra

Deep convection development

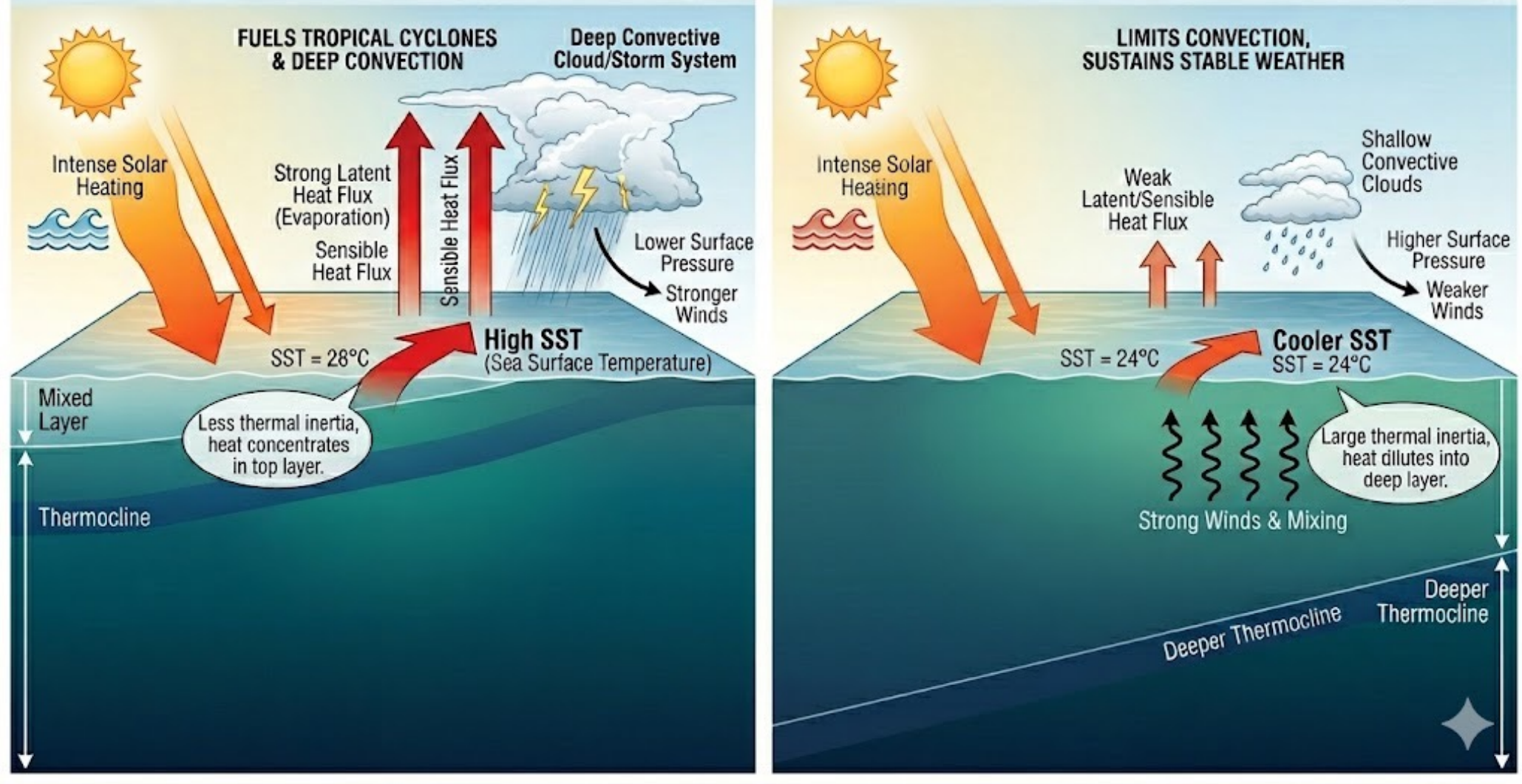


Heat and moisture fluxes

Wind and precipitation changes ocean

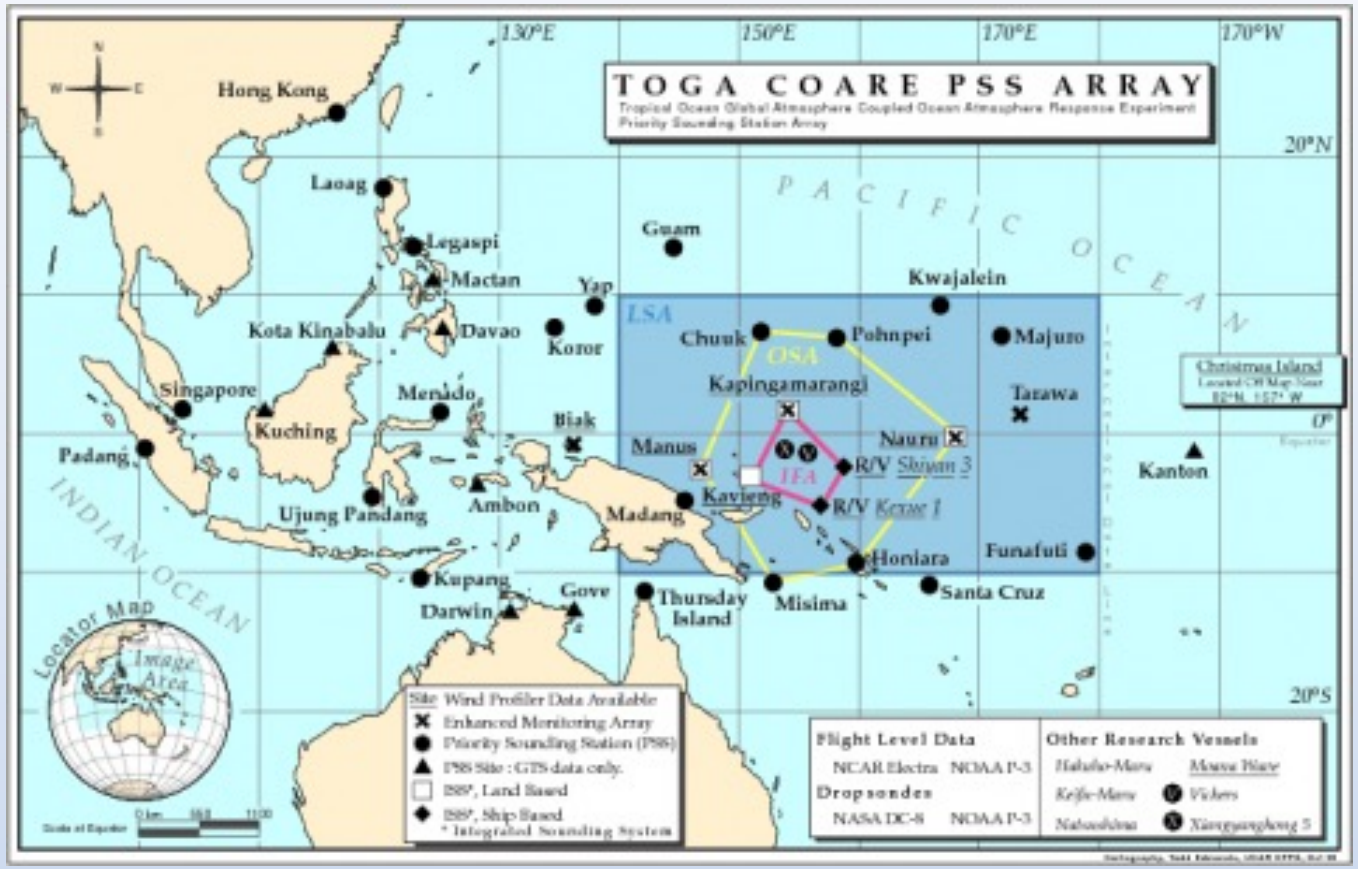
Challenges in SST Prediction

Solar radiation is the major source, but we cannot guarantee the heat stayed near the sea surface



Flux Measurements in TOGA COARE

Tropical Ocean-Global Atmosphere (TOGA) Coupled Ocean Atmosphere Response Experiment (COARE) is an international experiment in 1990s.



Bulk formula:

$$SH = \rho_{air} c_{pa} C_s |\mathbf{U_{10}}| (SST - T_a)$$

$$LH = \rho_{air} L C_L |\mathbf{U_{10}}| (q_s - q_a)$$

where C_s and C_L are the transfer coefficient for SH and LH, respectively, $|\mathbf{U_{10}}|$ the wind speed, T_a the air temperature, q_s the saturated air, q_a the mixing ratio

Version of COARE algorithm

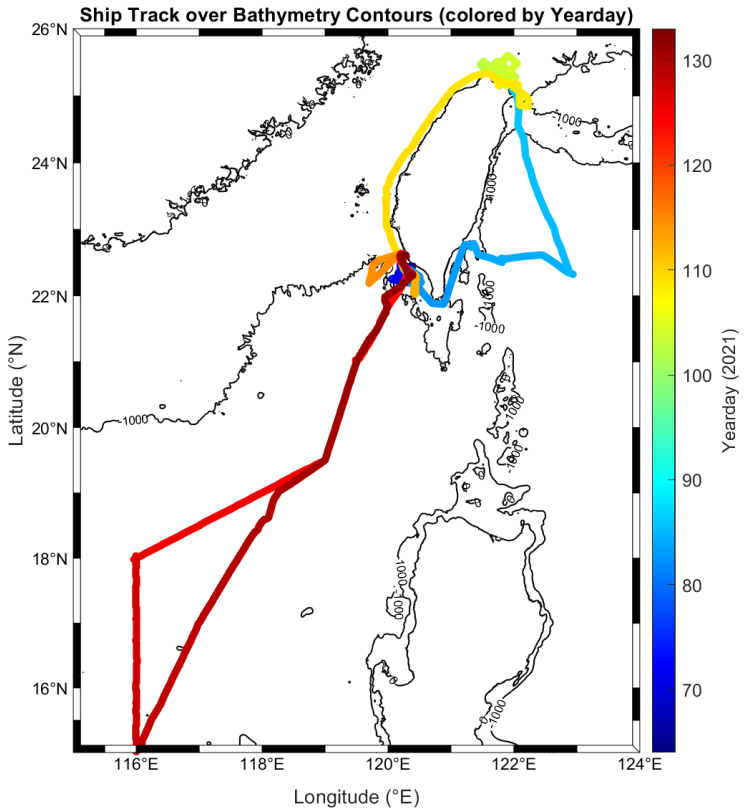
COARE 2.5 (Fairall et al., 1996)

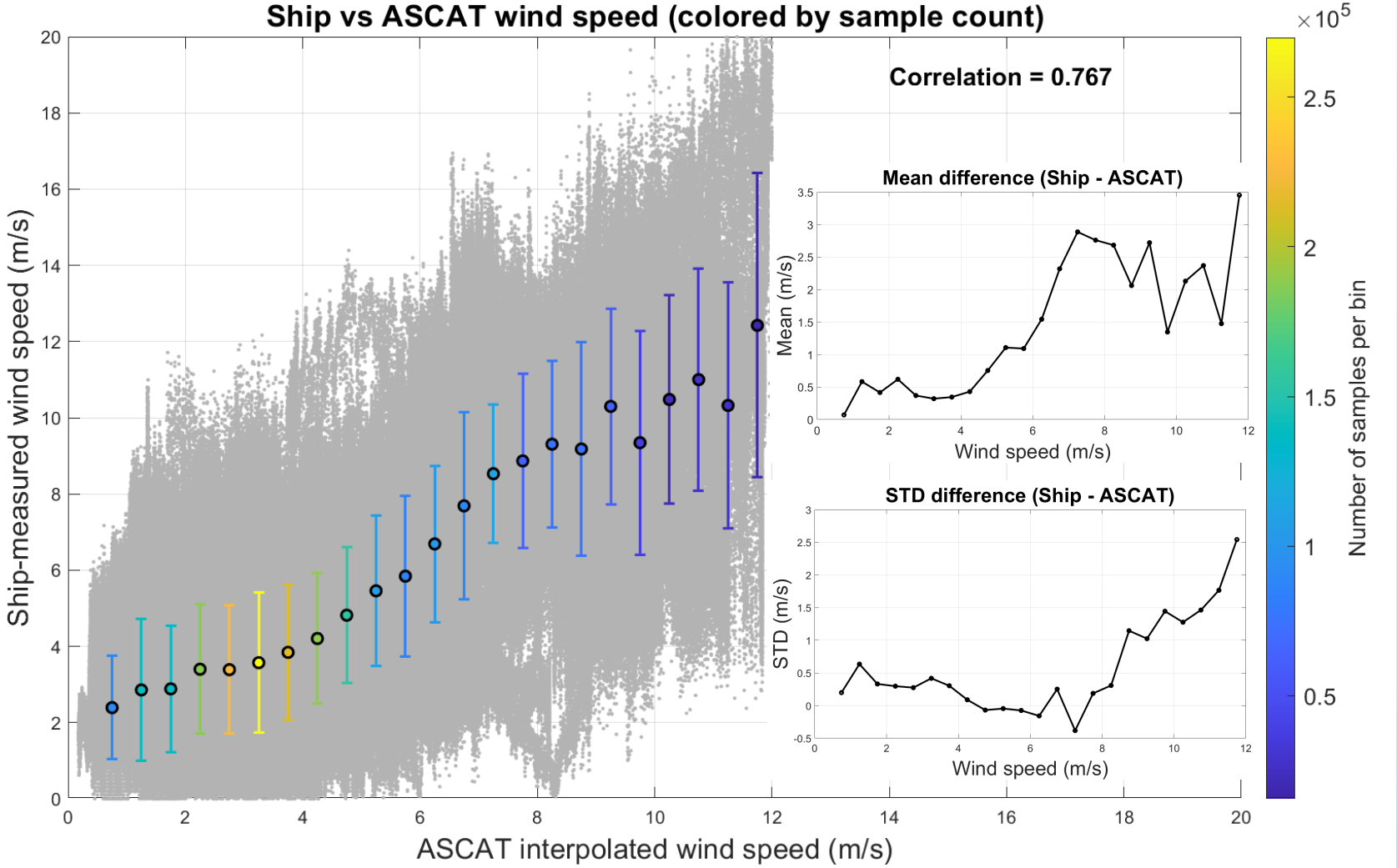
COARE 3.0 (Fairall et al., 2003)

COARE 3.5 (Edson et al., 2013)

ASCAT vs. R/V NOR1

- At higher wind speeds, the difference and uncertainty increase
- Implementing shipboard observations on the wind product, which can later be used as initial conditions in the weather forecast





Direct Method for Measuring Fluxes

Ultrasonic anemometer (wind)

Reynolds flux

$$SH = \rho_{air} c_{pa} \langle w'\theta' \rangle$$

$$LH = \rho_{air} L \langle w'q' \rangle$$

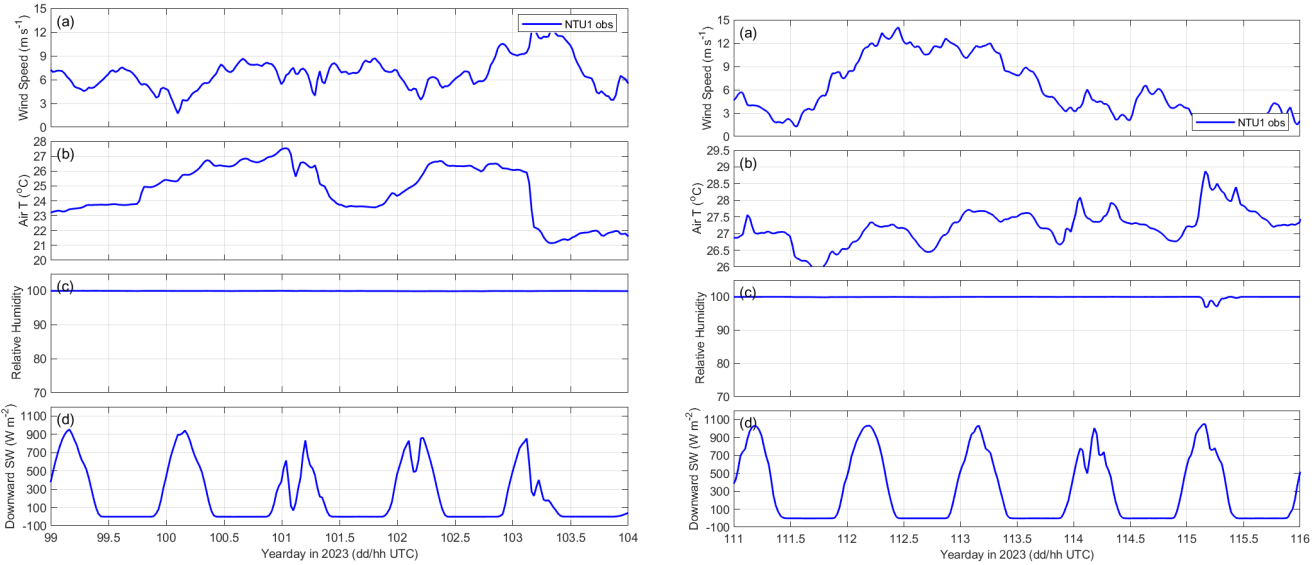
$$\boldsymbol{\tau} = \rho_{air} \langle \mathbf{u}'w' \rangle$$

LI-Cor (humidity)

Radiometers

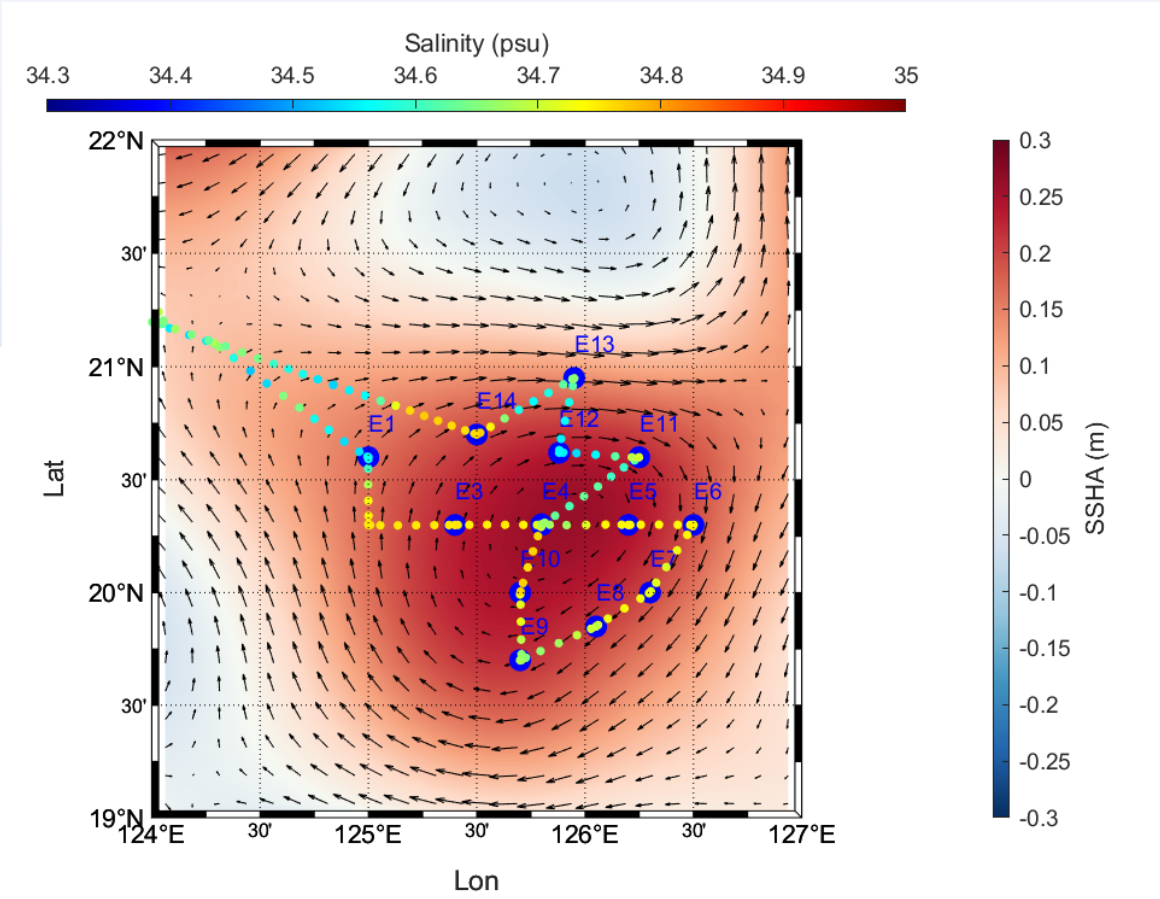
Review of NOR1-0075

Shipboard atmospheric measurements in leg 1 and leg 2



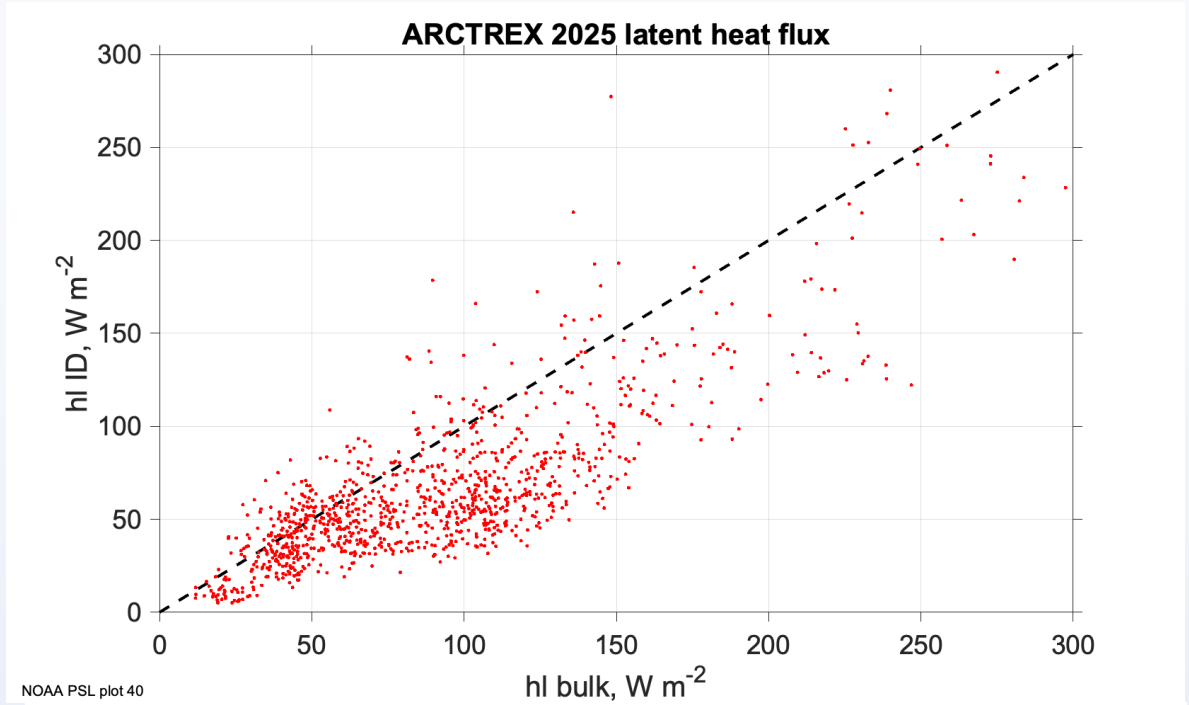
Ocean observations in leg2

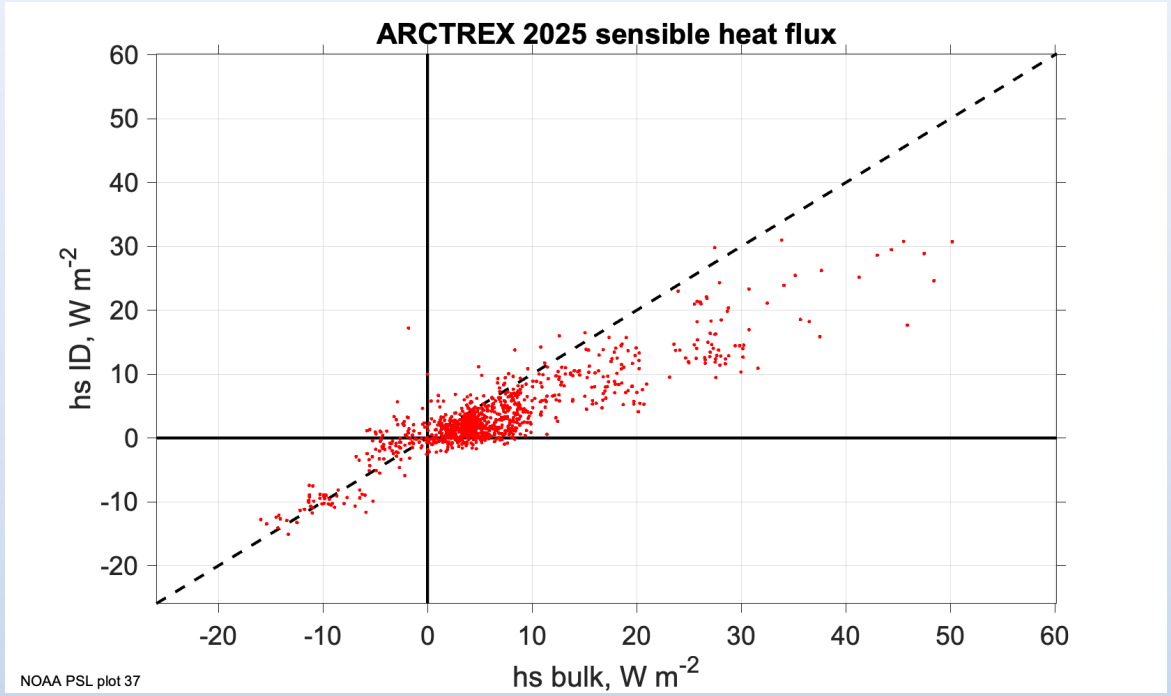
- Two CTD transects across the eddy
- Underway shipboard salinity and temperature measurements
- 14 CTD stations

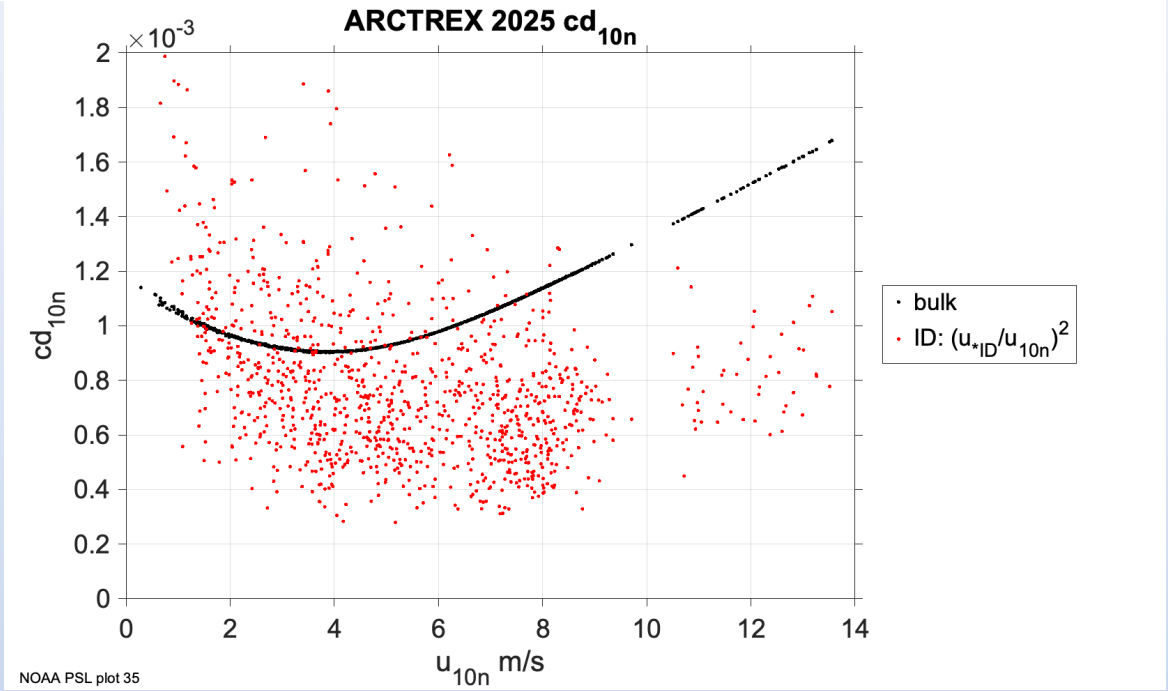


Comparison to COARE

- The observed heat and momentum fluxes are all lower than the results from the empirical COARE algorithm
- The overestimated momentum transfer efficiency (Cd) could lead to unrealistic forcing to ocean currents







Past Air-sea Joint Experiments

2024: R/V NOR1-0069A and B between Taiwan and Palau

2025: R/V NOR1-0075A and B in western Pacific

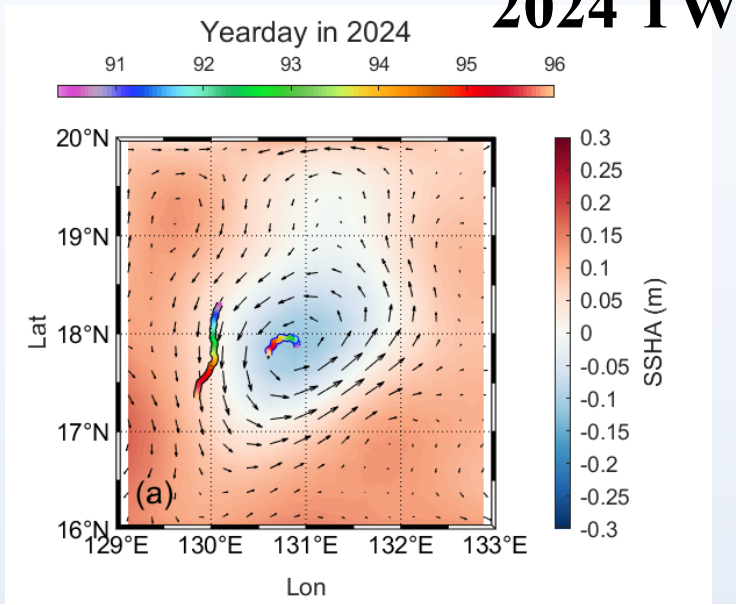
2026: R/V Legend at the northeast shelf of Taiwan for cold surge research

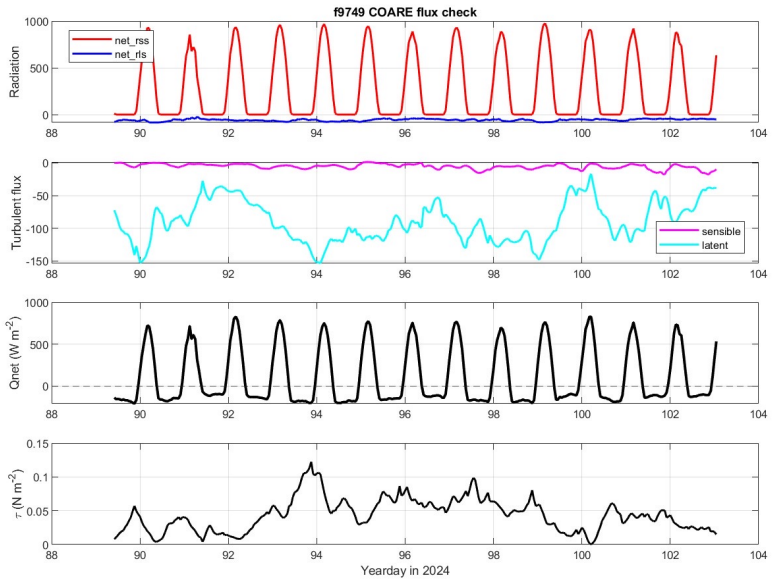
Photos in March 2026

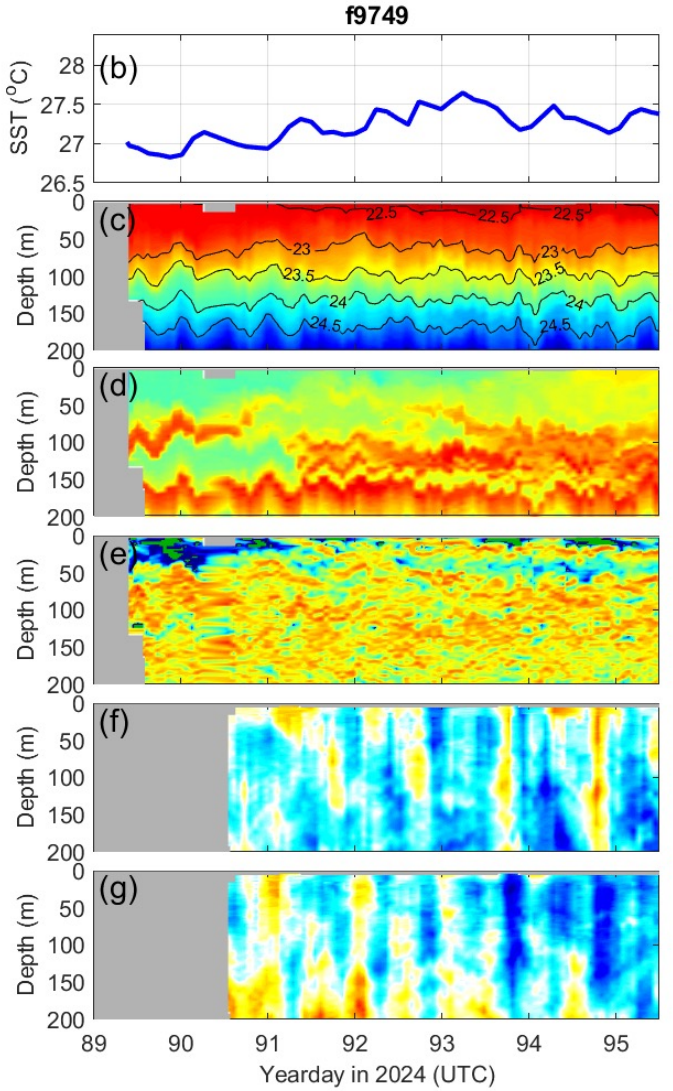
Diurnal Warming Modulated by Cold Eddy

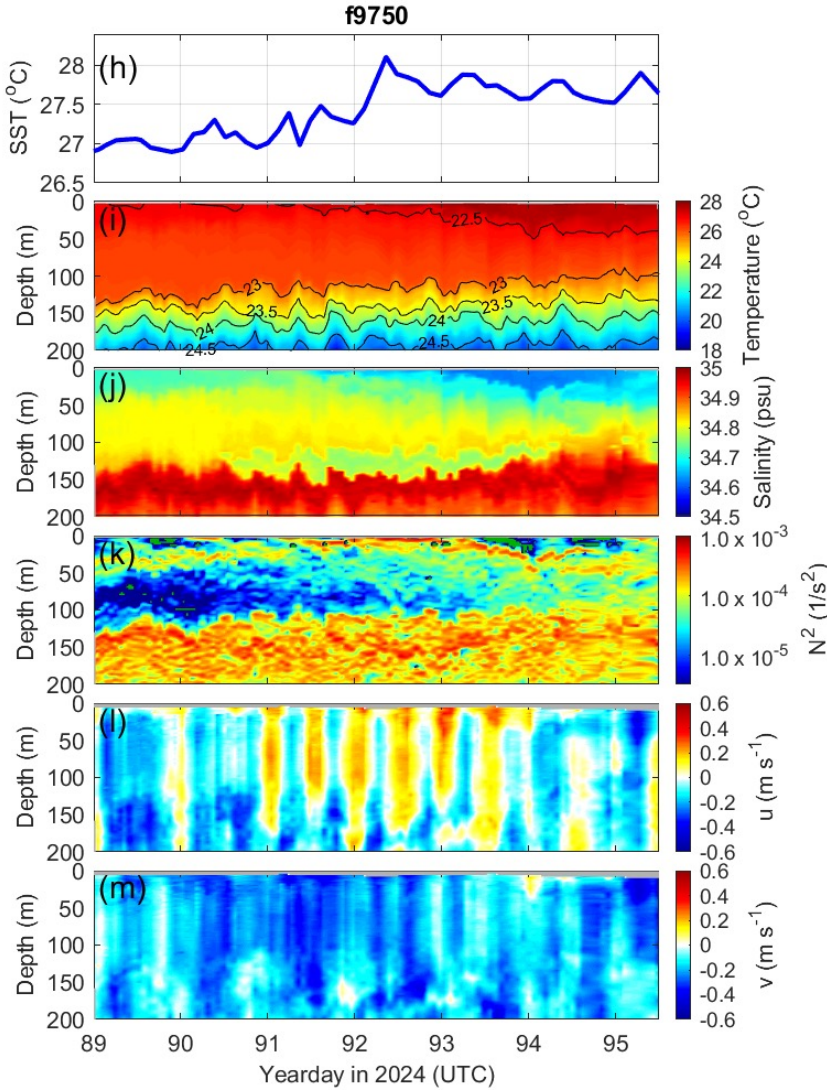
2024 TW-Palau

Scientific question:
Will the presence of a cold eddy affect the diurnal warming?







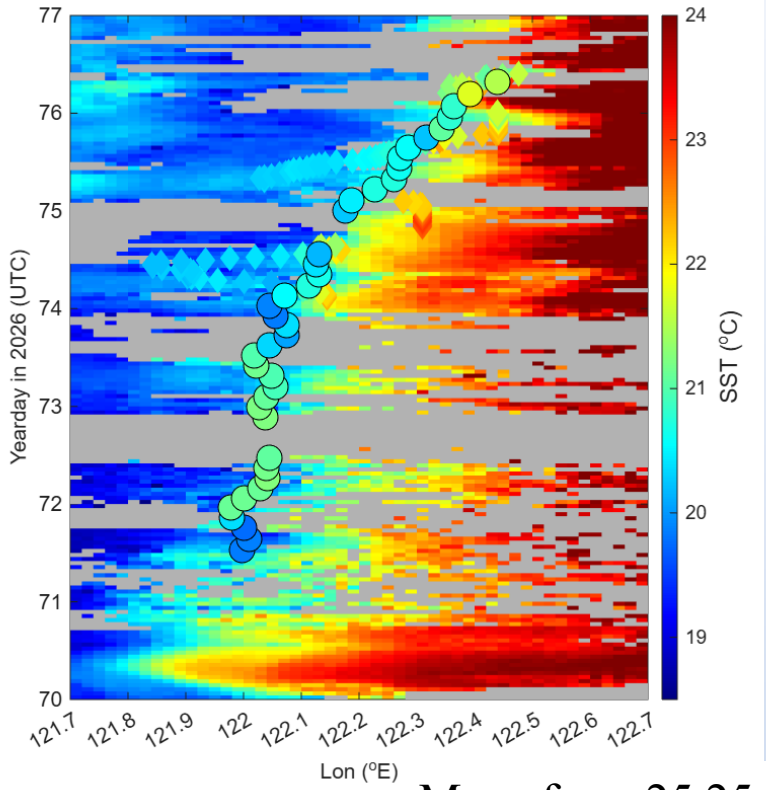


Evolution of Kuroshio's Warm SST Edge

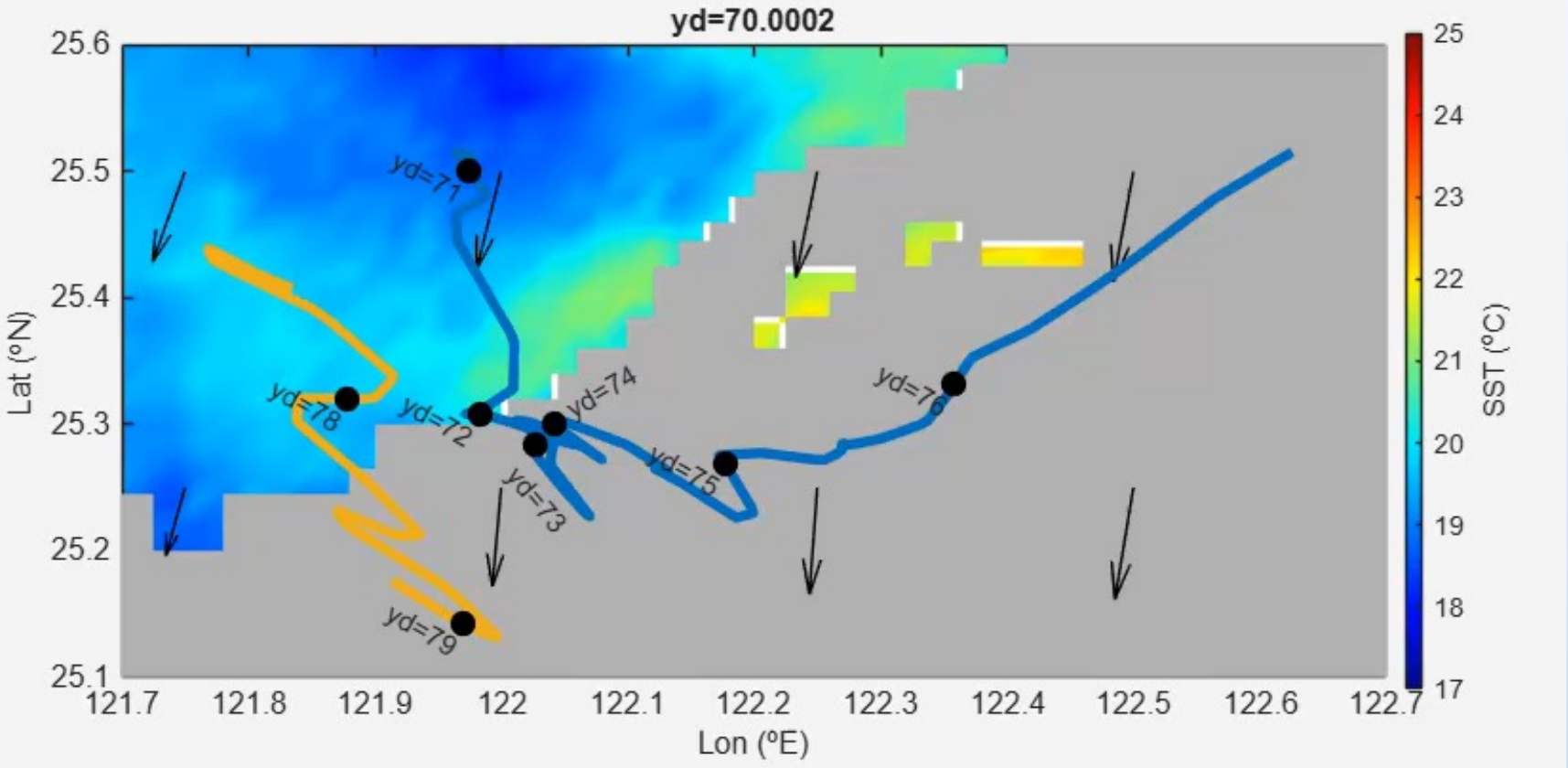
2026 TW NE shelf

- R/V Legend arrived the northeast shelf of Taiwan on yearday 71.
- Kuroshio's warm SST edge retreated to the east for more than 40 km in five days
- In situ SST measurements agreed with satellite observations

Himawari-9 SST



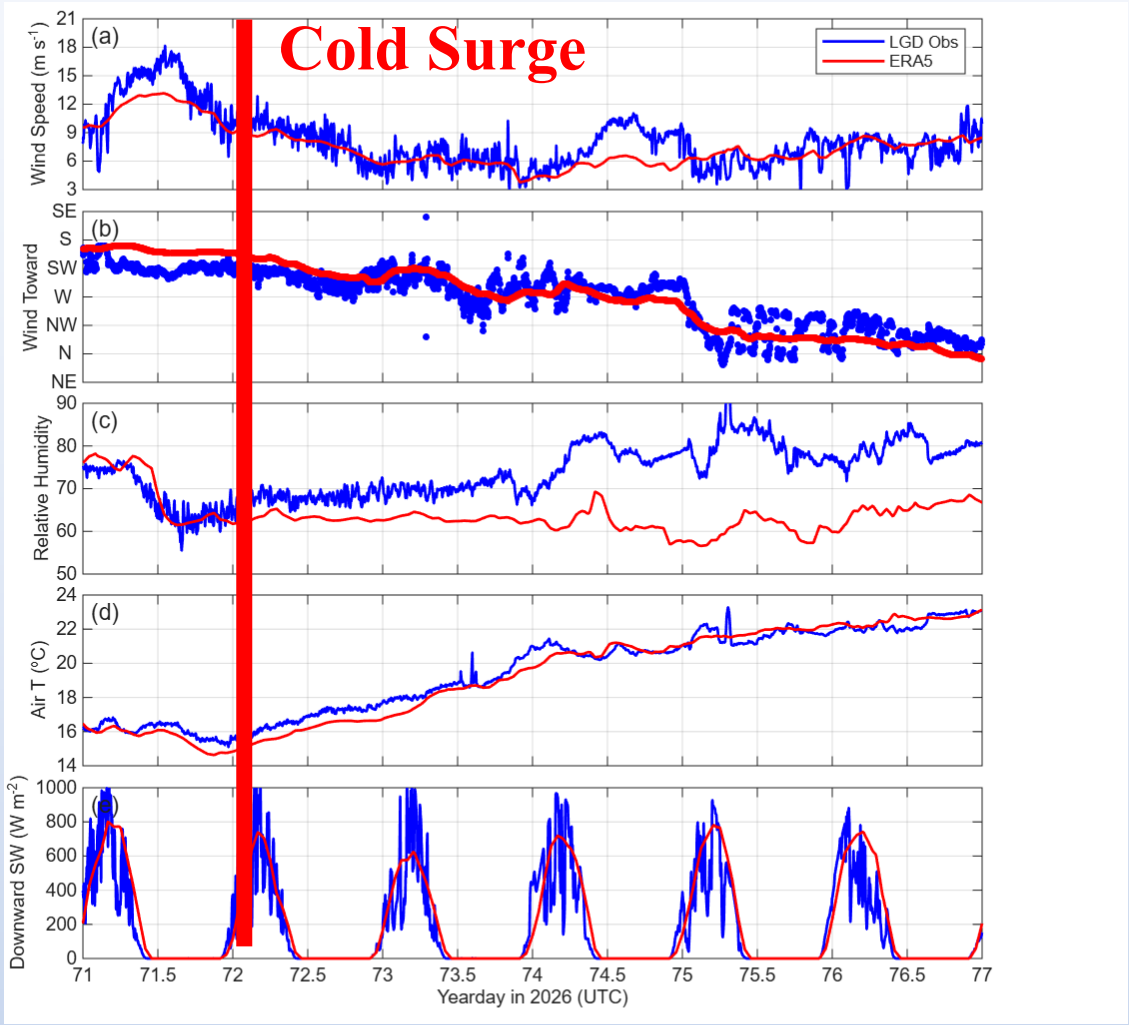
Mean from 25.25 to 25.4 °N



Shipboard Observed Flux Changes

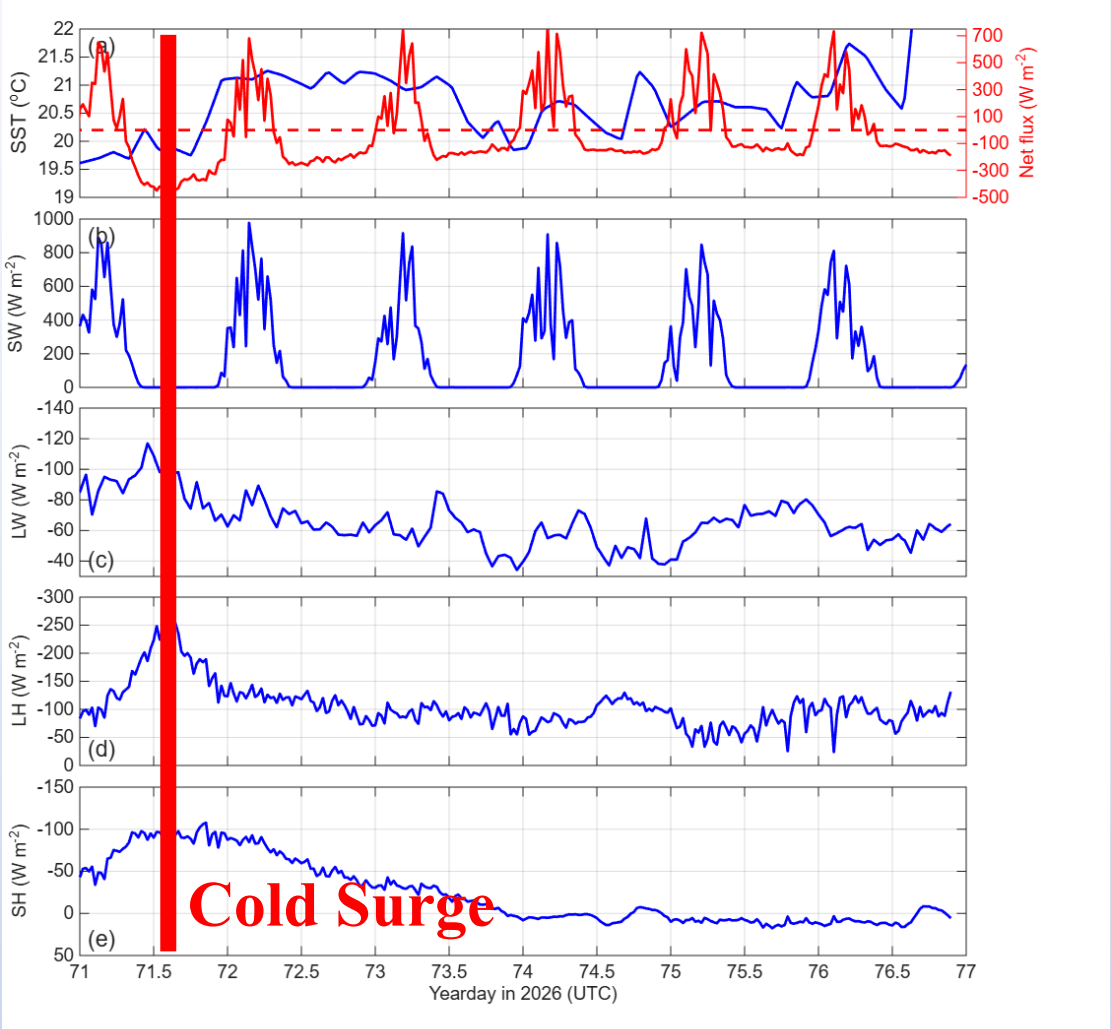
During cold surges:

- Air temperature drop enhanced SH
- Strong wind speed enhances LH



After cold surges:

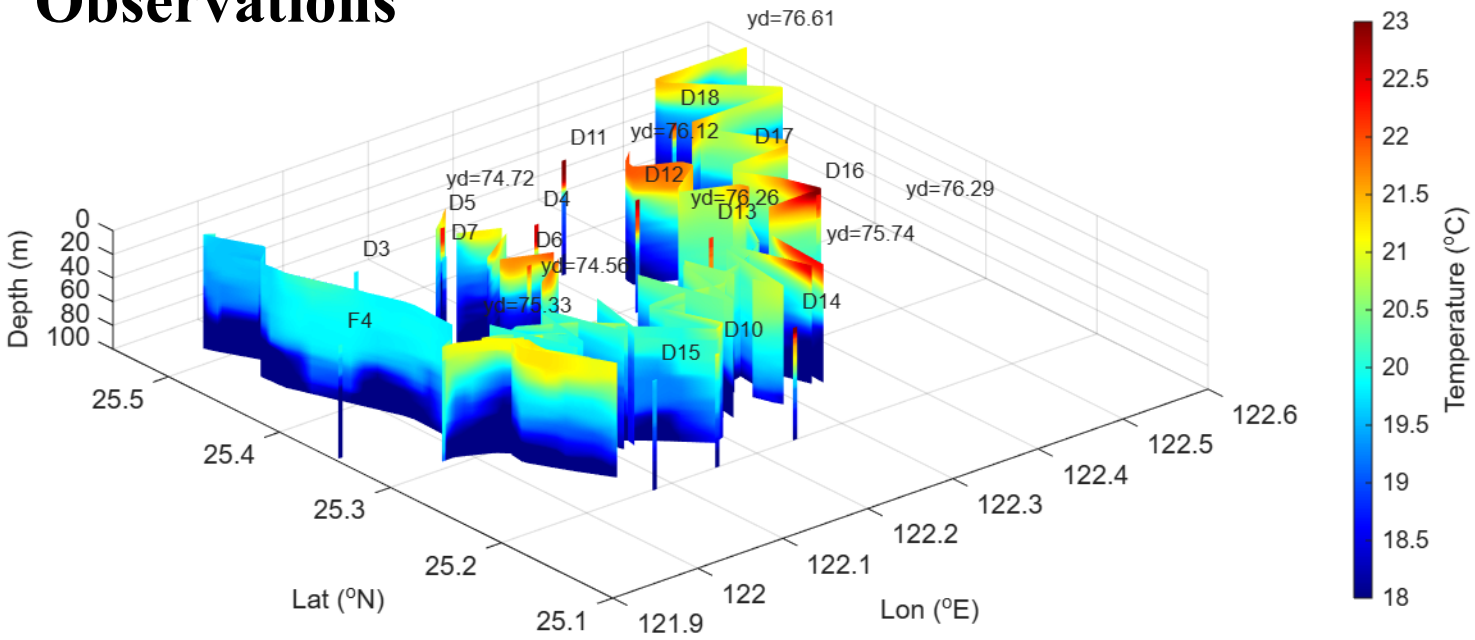
- Rising Air temperature suppressed SH
- Weaker wind speed caused weaker LH

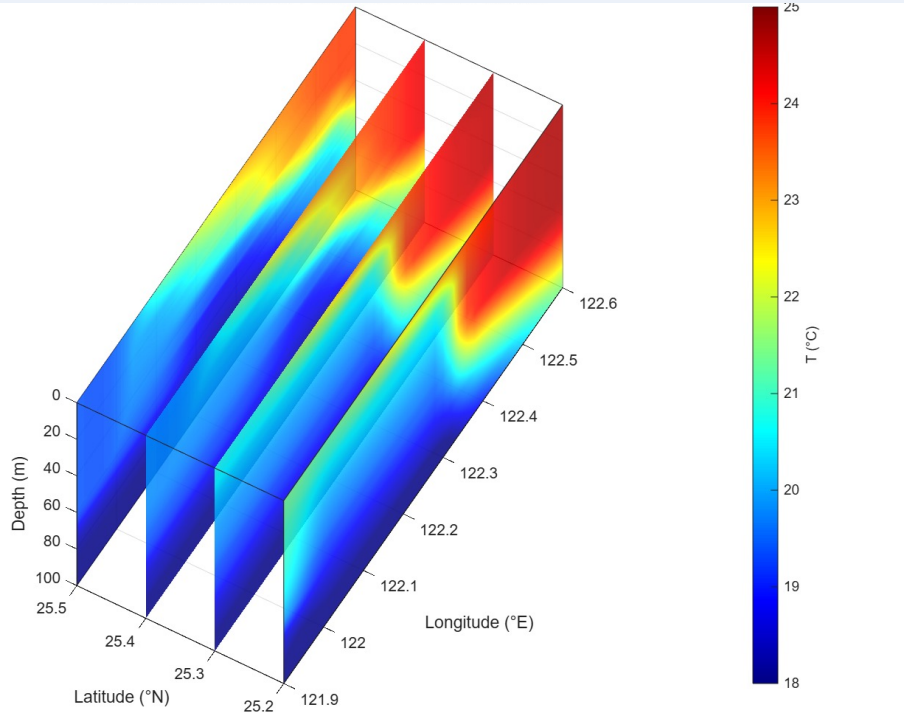


Ocean Initial Conditions from Field Observations

1. Collect scattered observations, including CTD casts, EM-APEX float, SCT, and Himawari-9 SST
2. Build platform super-observations onto the target grid pressure levels
3. Objective mapping temporal variations of SST using satellites, and subsurface temperature using in situ data.
4. Blend temperature toward GLORYS (NEMO platform driven at surface by ECMWF ERA5) at locations far from in-situ data

Observations



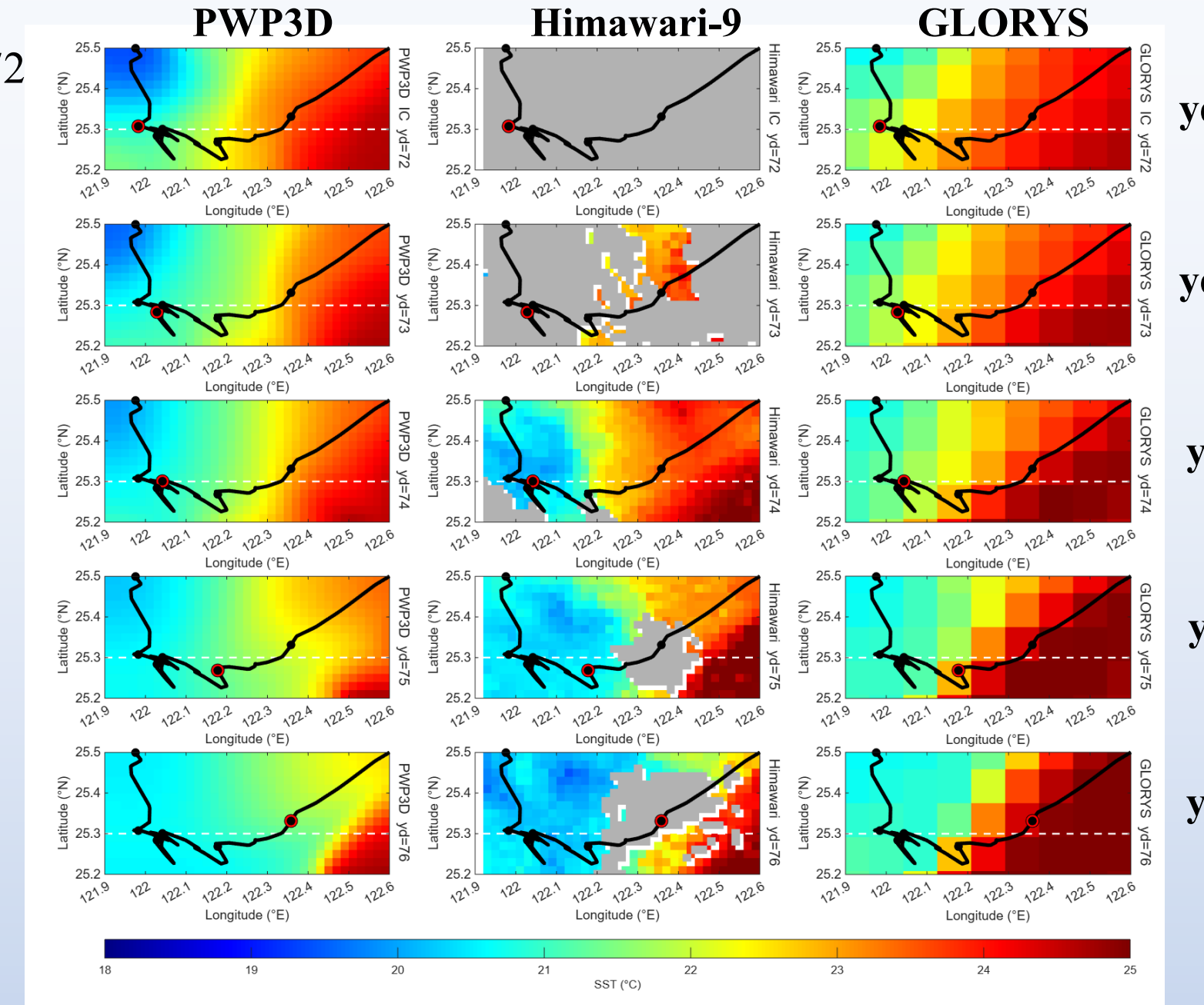


Simulated SST vs. Satellites and GLORYS

- Simulation starts from yearday 72 after the passage of cold surges
- Vertical resolution: 2 m; horizontal resolution: 2 km
- Homogeneous atmospheric forcings (shipboard measurements)
- PWP mixing scheme
- Nudging at the east and south boundary to allow Kuroshio's advection

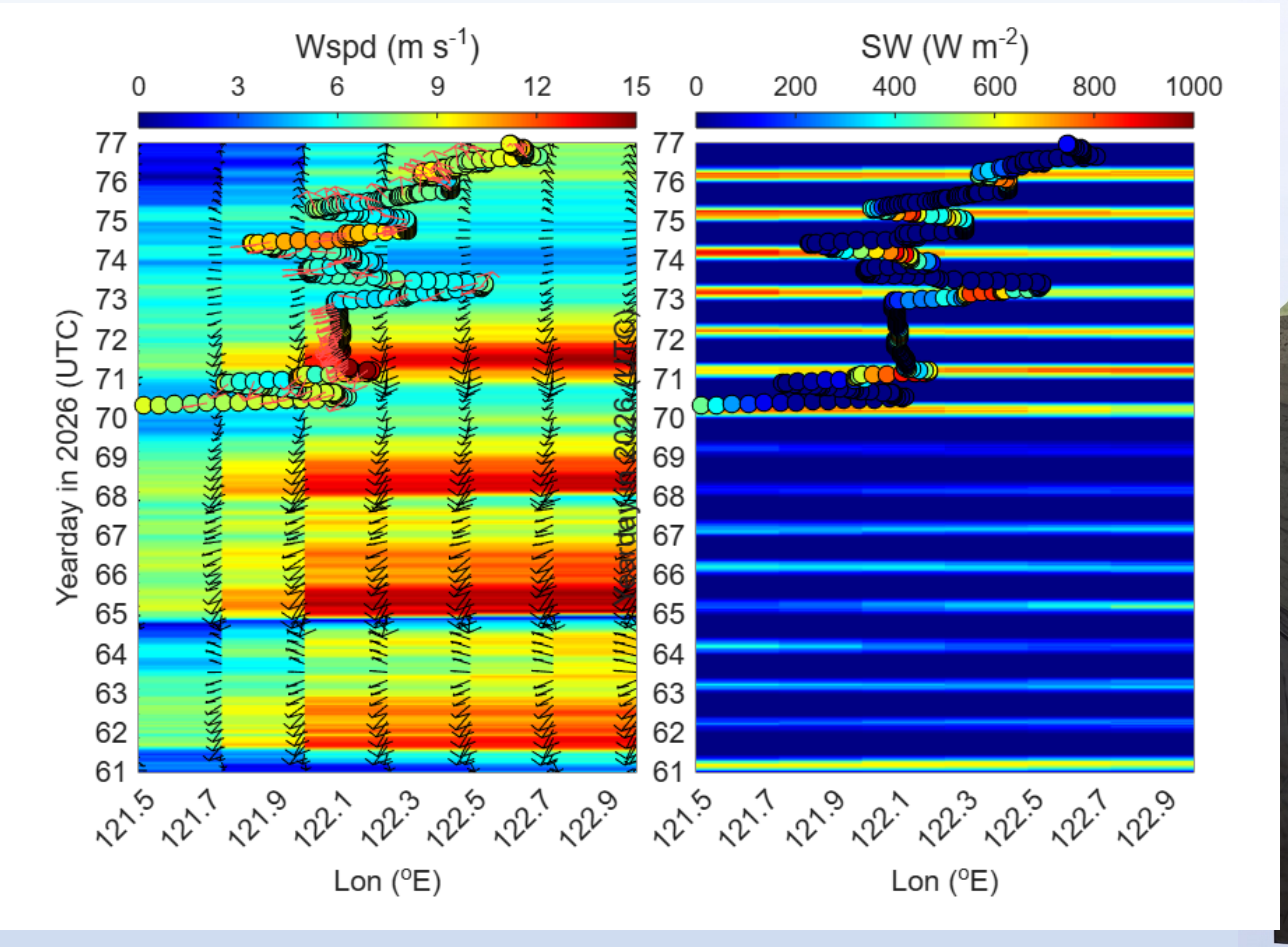
Key Results:

Reliable subsurface ocean structure captured by in situ measurements is crucial for simulating the retreat of Kuroshio's SST edge

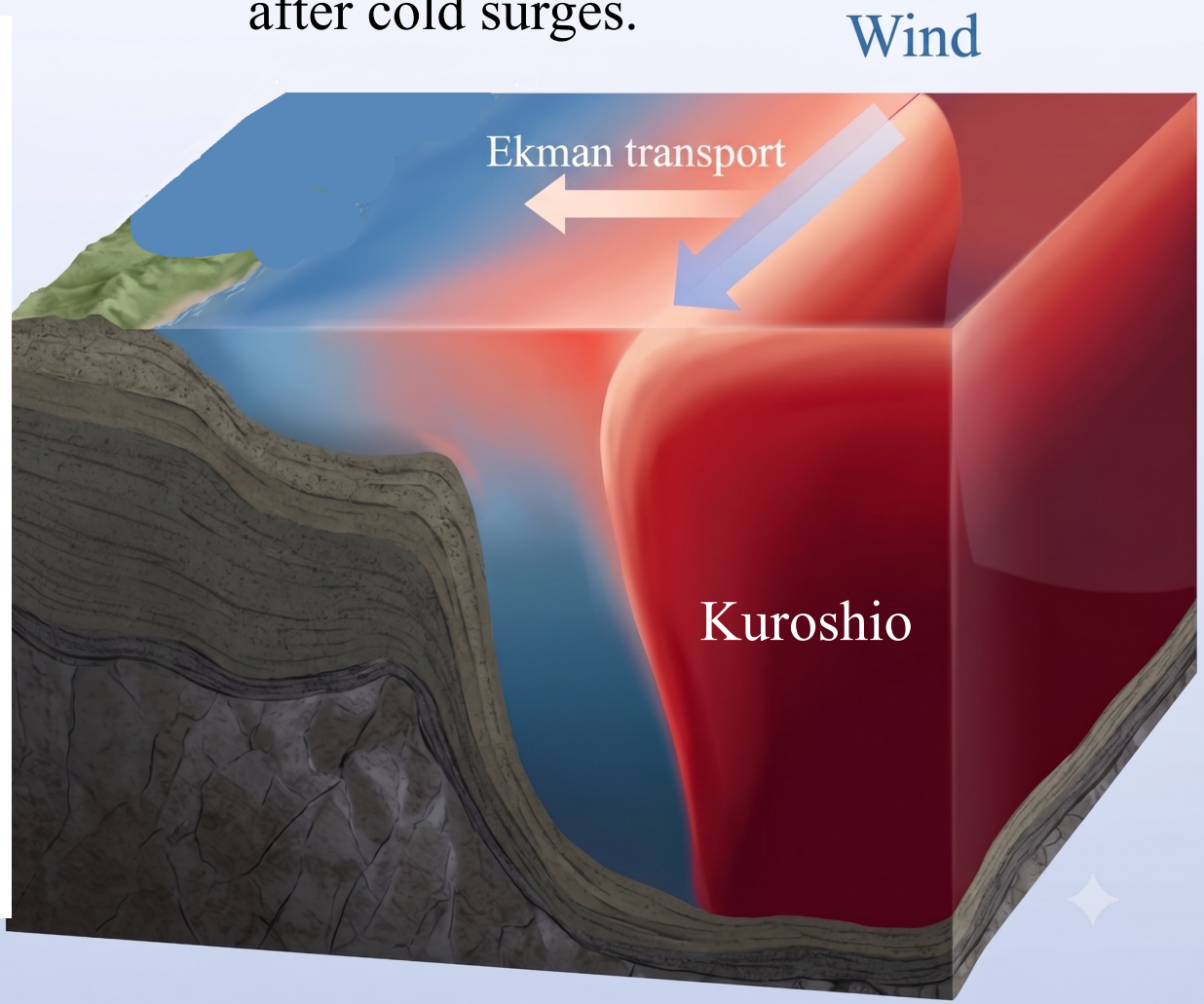


Extension of Warm SST Edge during Cold Surges

Strong northeasterly wind for more than 10 days prior to our field experiment



Northeasterly wind causes the near-surface warm water extending to the west. Our observations show the Kuroshio's warm SST edge retreats after cold surges.



Future PO Observation Roles

Synthesized budget analysis in OSBL to MABL

- The air-sea heat fluxes modulated by atmospheric forcings change upper ocean structure and SST, and thereby the heat and moisture after the passage of weather system

Investigation of subsurface ocean dynamics

- Measuring and quantifying the impacts of ocean interior dynamics like mixing or upwelling

Data assimilation using both satellite and underwater data in near-real time

- Reliable subsurface ocean measurements are crucial to the prediction of ocean surface signature

Ocean observational network built by autonomous vehicles

- Optimizing the spatial and temporal coverage of platforms is always challenging under limited budget.

Thanks for your listening!
Looking forward to future collaborations!