

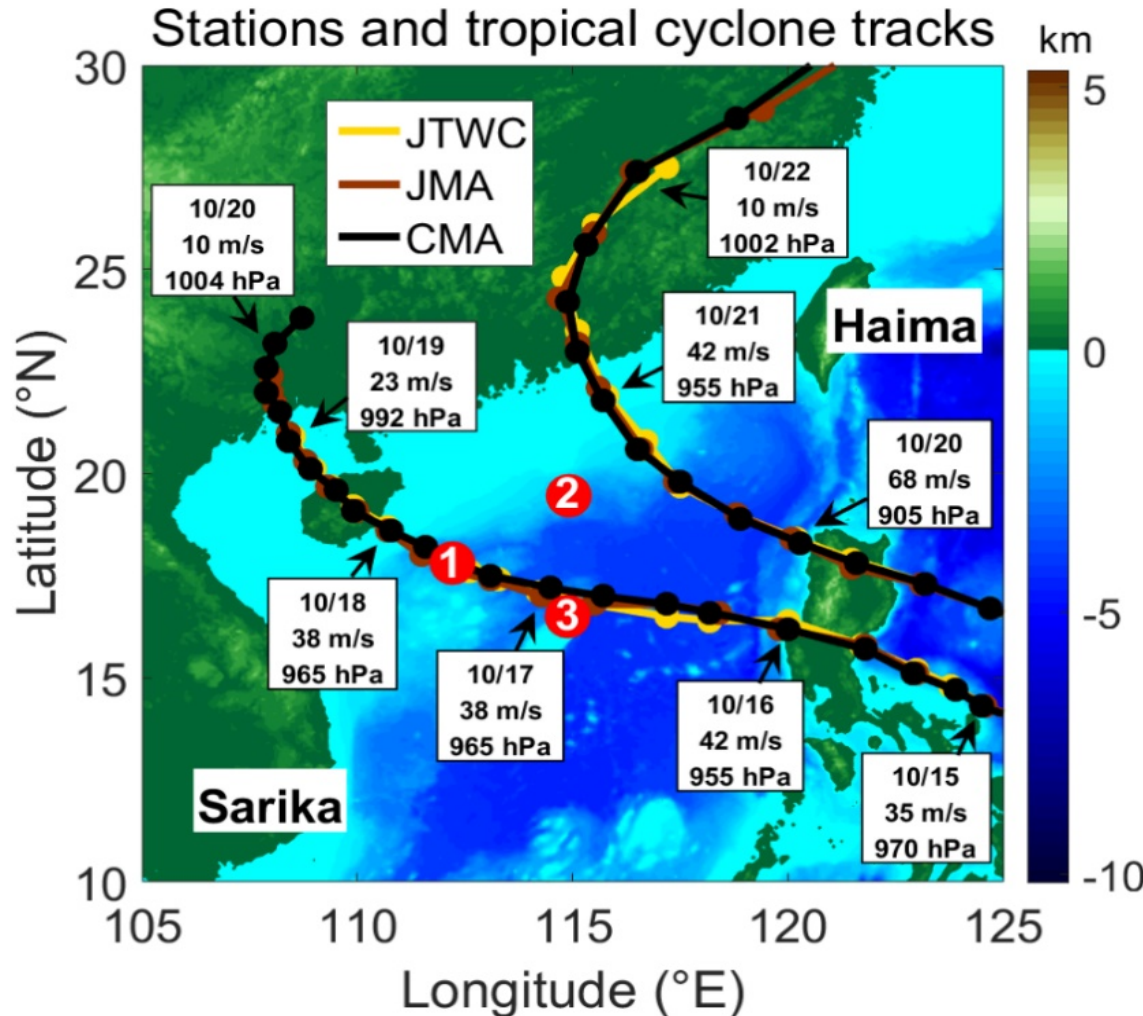
Ocean Response to Successive Typhoons Sarika and Haima (2016) in the Northern South China Sea

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Paper: Zhang et al., Ocean Response to Successive Typhoons Sarika and Haima (2016) based on Data Acquired via Multiple Satellites and Moored Array, ***Romte Sensing***, 2019, 11(20), 2360. <https://doi.org/10.3390/rs11202360>

Sarika and Haima (2016)



Sarika:

Wind Speed: ~ 38 m/s

Translation Speed: ~ 6.53 m/s

Haima:

Wind Speed: ~ 42 m/s

Translation Speed: ~ 7.18 m/s

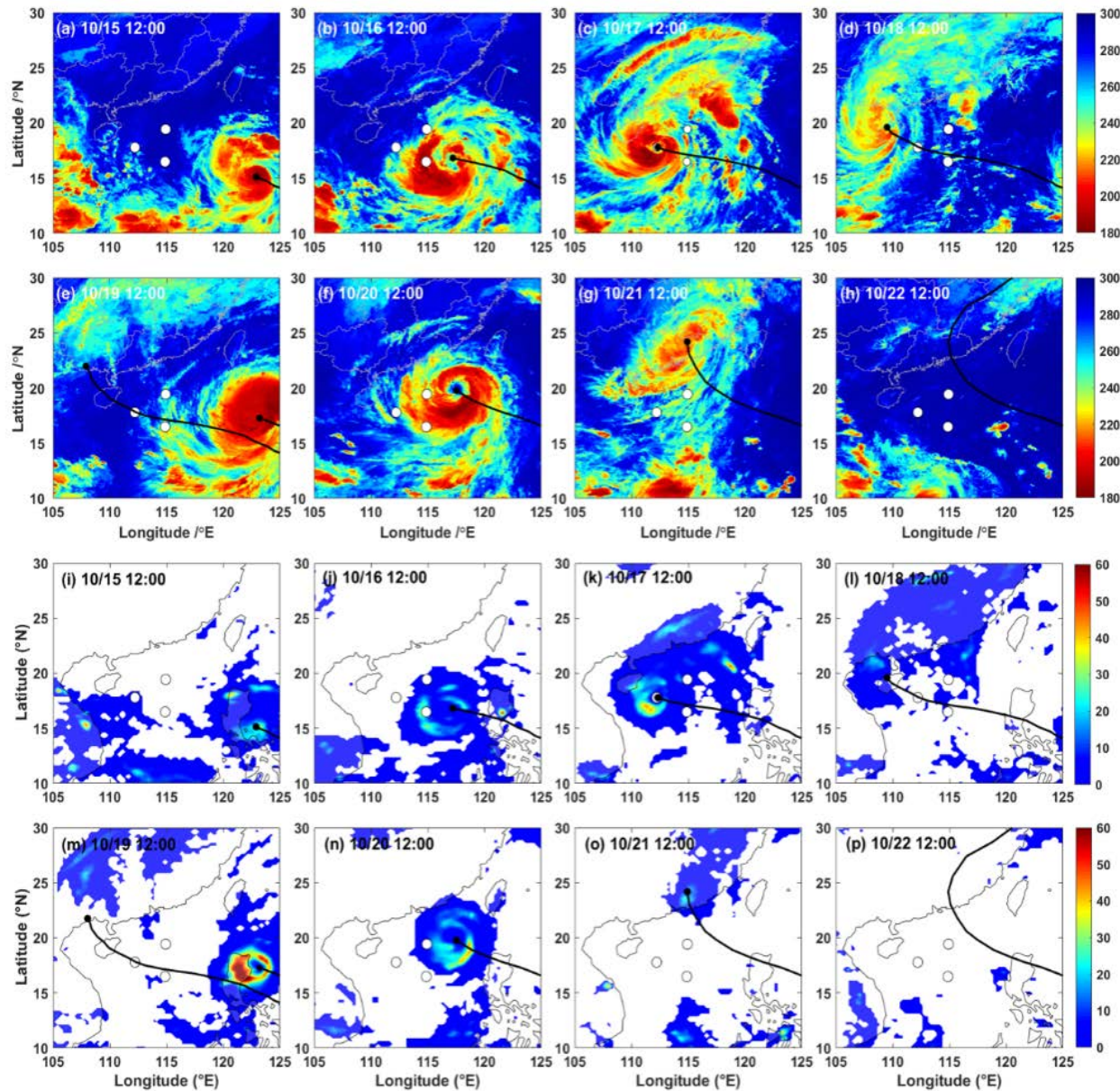
**Buoy 1 and 3 was damaged
during observation**

Observation

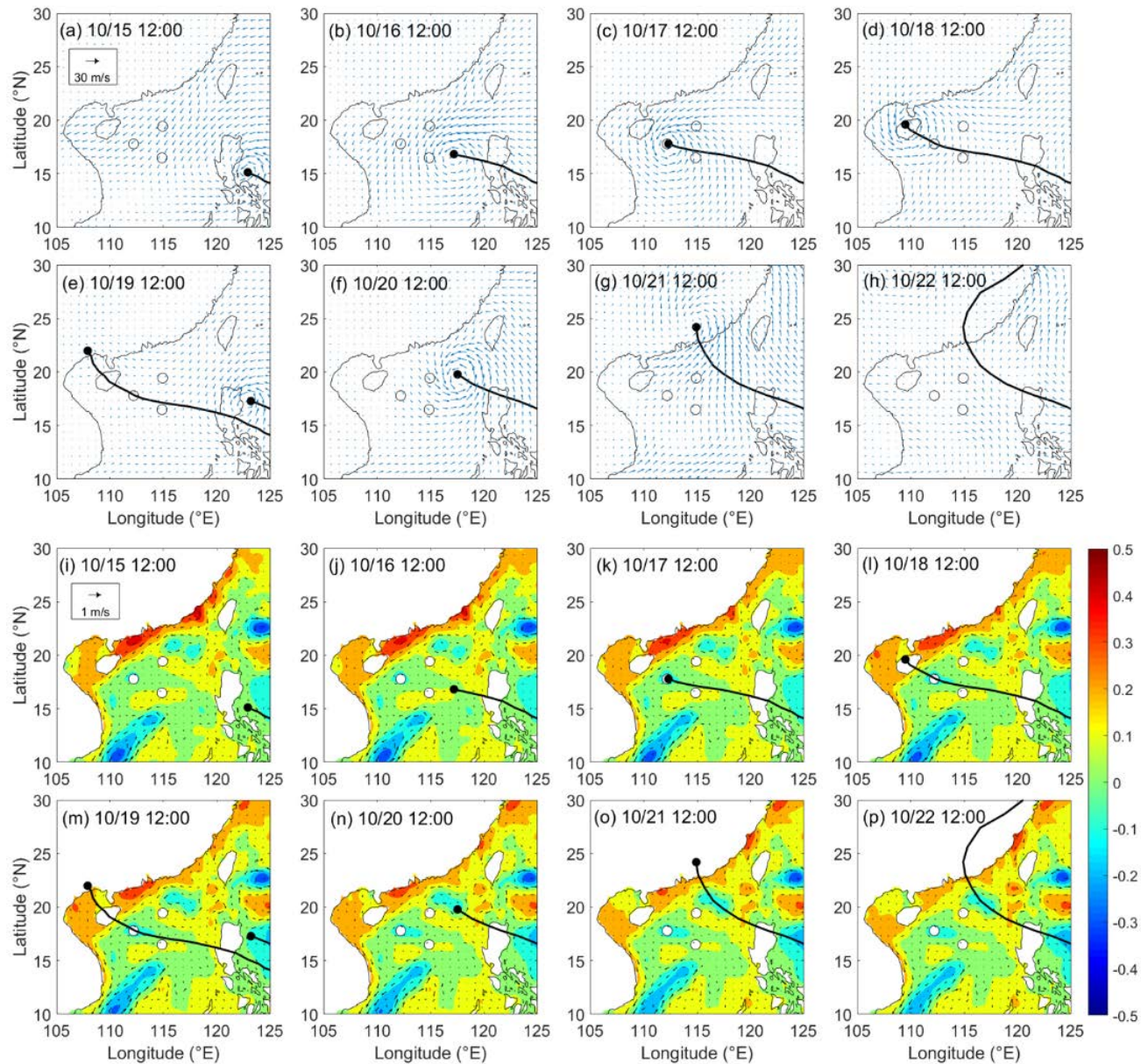
Instruments	Measured elements	Designed depth (m)	Resolution (s)
Gill-MetPak	Meteorology	4 m above from sea surface	1 (3600)
JFE-A7CT	T, S	12\22\52\68.5\90.5\111\131\142\162\182\202\242\282\322\362\402\442\482	300
ONT7000	T	17\27.5\44\49.5\63\74\85\96\106\147\157\302\342\382\422\462\502	1
SBE-56	T	33\38.5\57.5\79.5\101\116\121\126\121\126\137\152\172\192\222\262	1
RDI 75K-ADCP	U, V	location: 133 m, uplooking; first bin: 24.74 m; last bin: 136.74 m; bin size: 16 m	300
RDI 300K-ADCP	U, V	location: 1385 m, uplooking; first bin: 15.69 m; last bin: 255.69; bin size: 8 m	600

Parameters of Typhoons Sarika and Haima

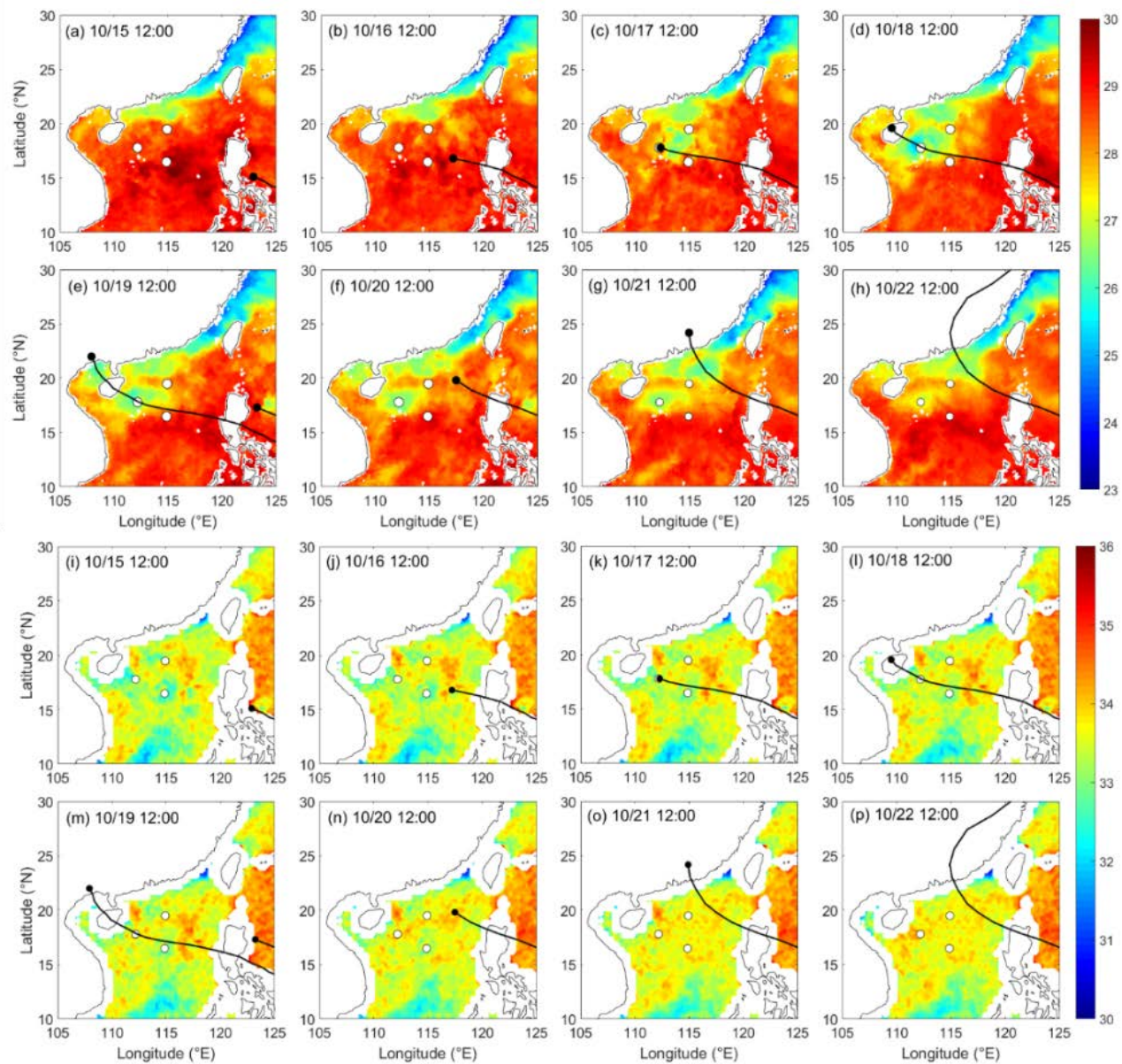
	Sarika	Haima
Maximum wind speed (V_{max} , m/s)	38.00	42.00
Translational speed (U , m/s)	6.53	7.18
Radius of fastest wind (r_m , km)	120.0 (37.04)	150.0 (46.3)
Mixed layer depth (h_{mix} , m)	45	50
Nondimensional translational speed, ($S = \frac{U}{r_{mf}}$)	1.161 (3.760)	1.021 (3.308)
Rossby number of mixed layer current, ($Q = \frac{\tau_{max}}{\rho h_{mix} U f}$)	0.253	0.257



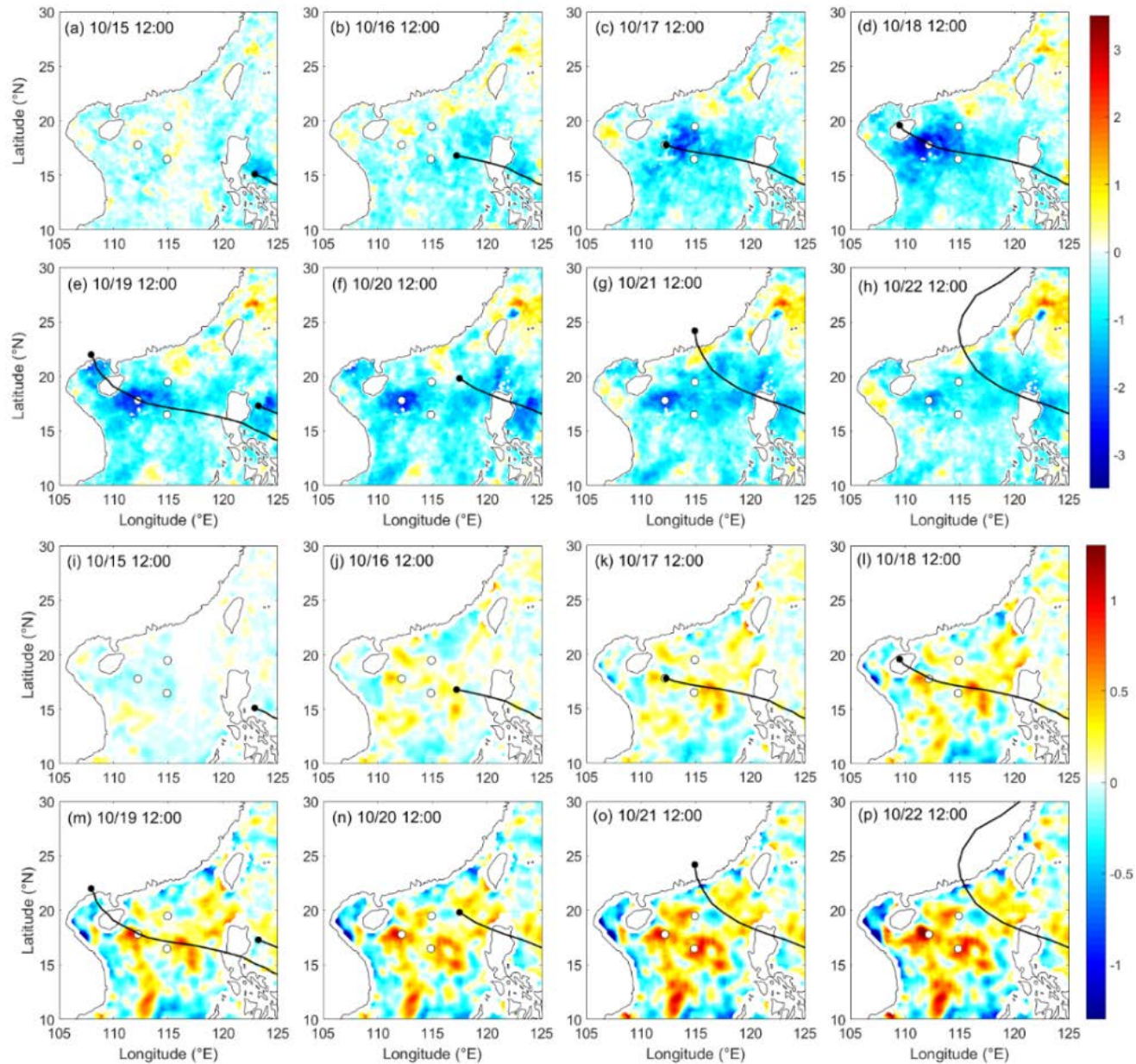
Cloud-top brightness temperature (a-h) and rainfall (i-p)



Wind field (a-h) and sea surface height anomaly (i-p)

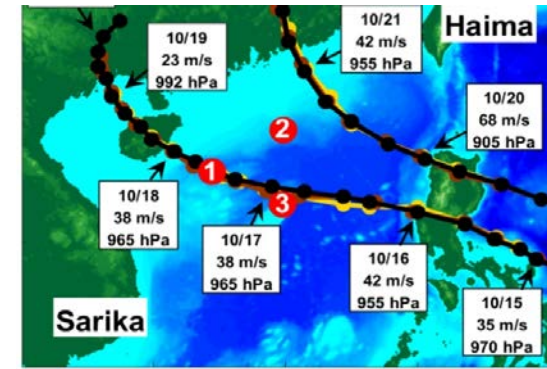


Sea surface temperature (a-h) and salinity (i-p)

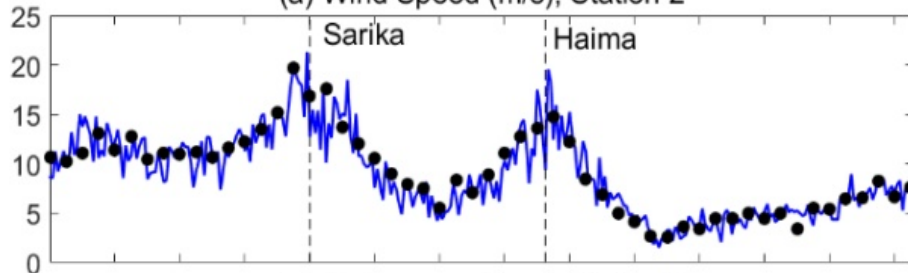


Anomalies of sea surface temperature (a-h) and salinity (i-p)

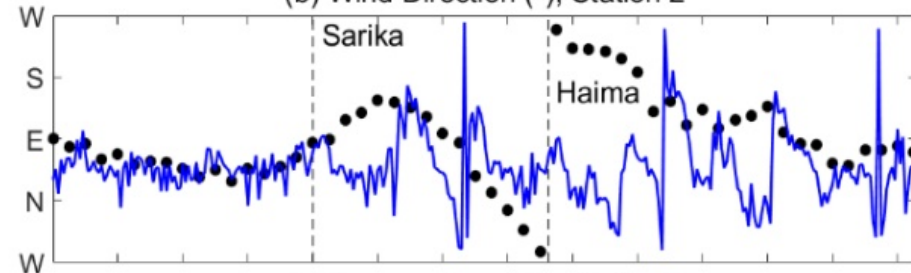
Atmosphere Data



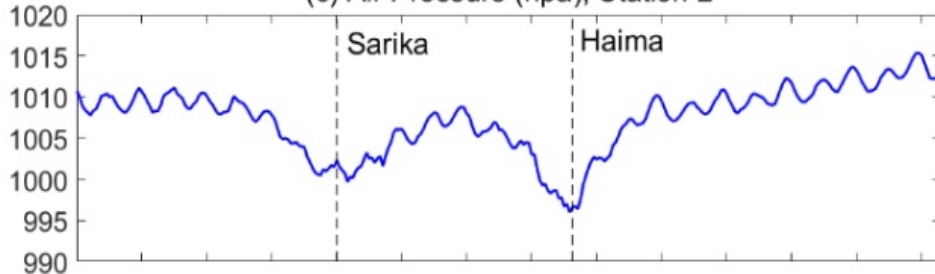
(a) Wind Speed (m/s), Station 2



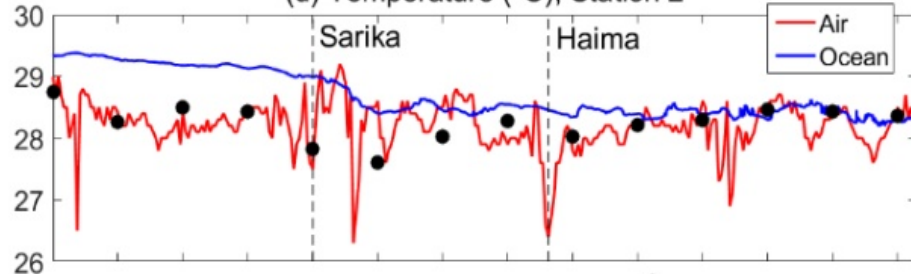
(b) Wind Direction ($^{\circ}$), Station 2



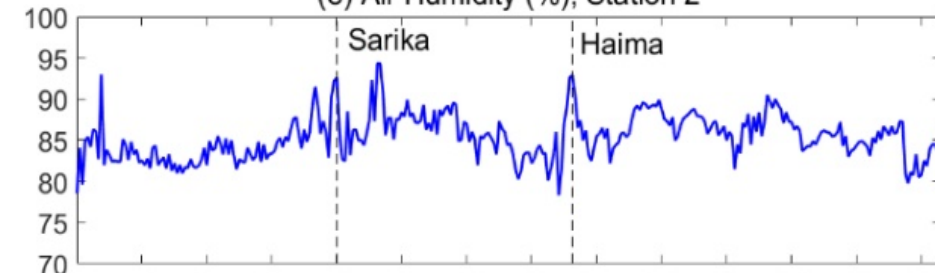
(c) Air Pressure (hpa), Station 2



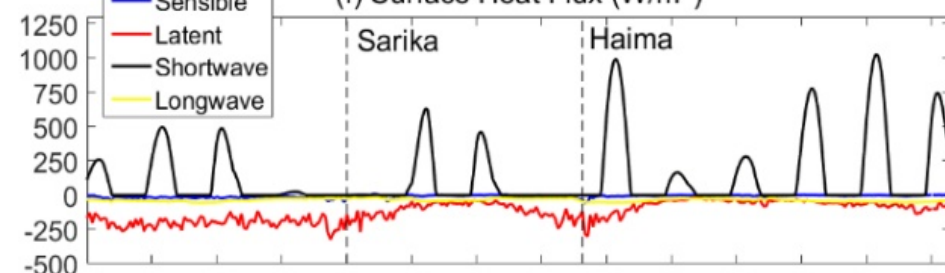
(d) Temperature ($^{\circ}\text{C}$), Station 2



(e) Air Humidity (%), Station 2



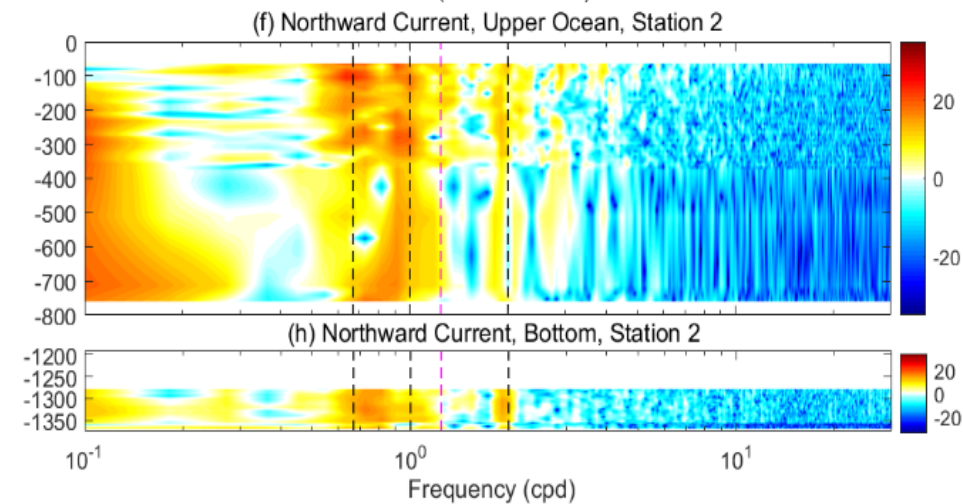
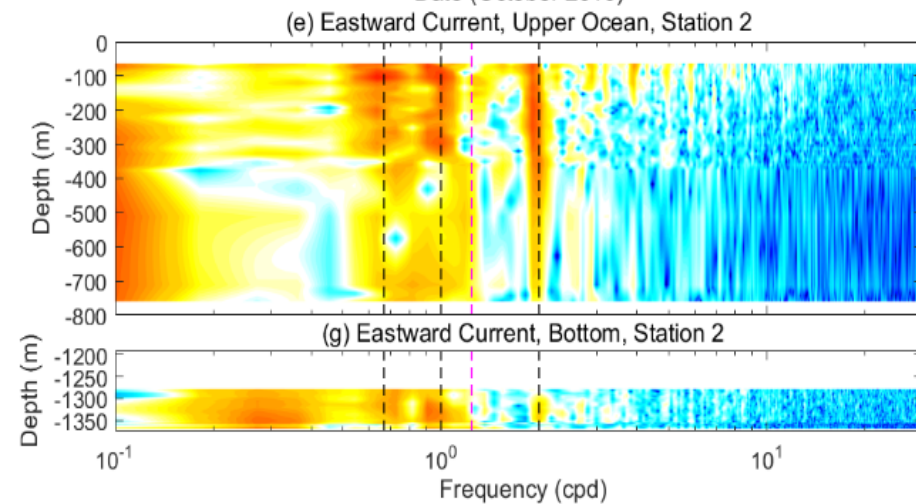
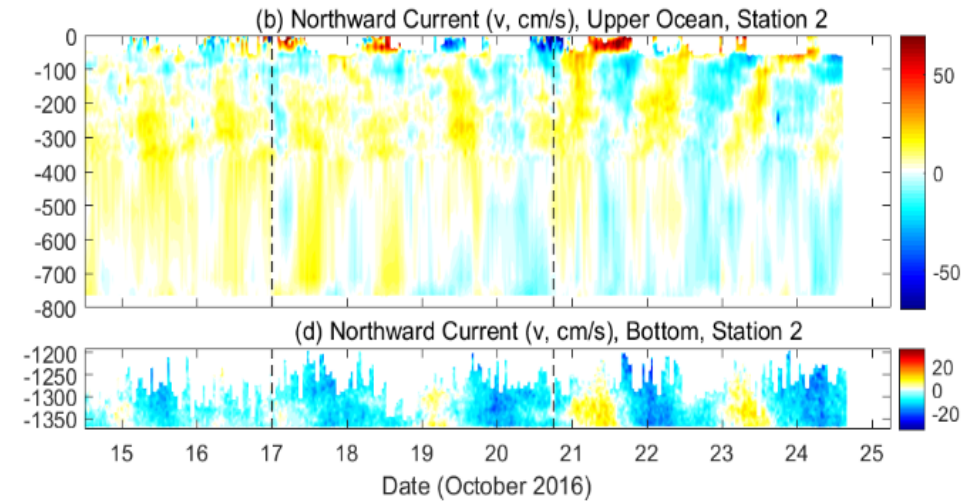
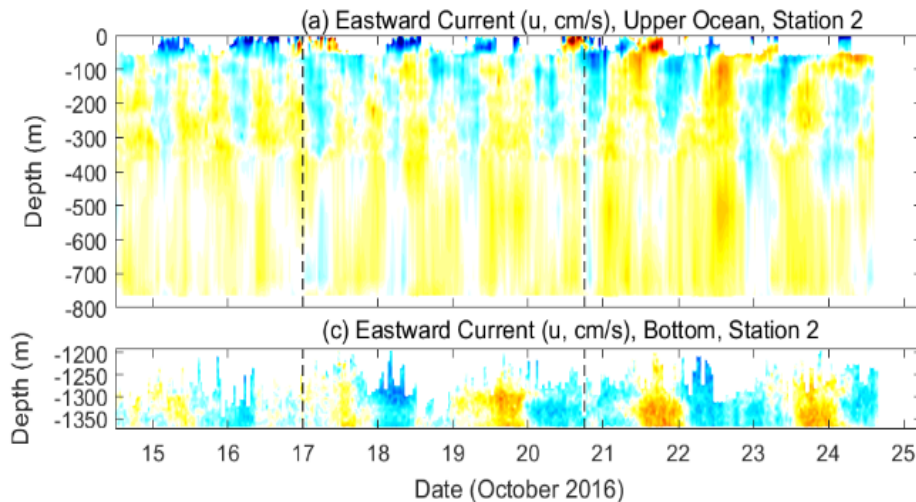
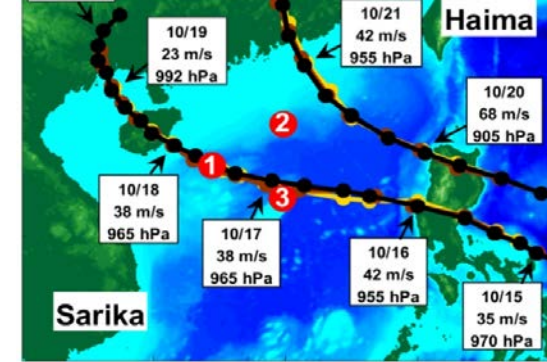
(f) Surface Heat Flux (W/m^2)



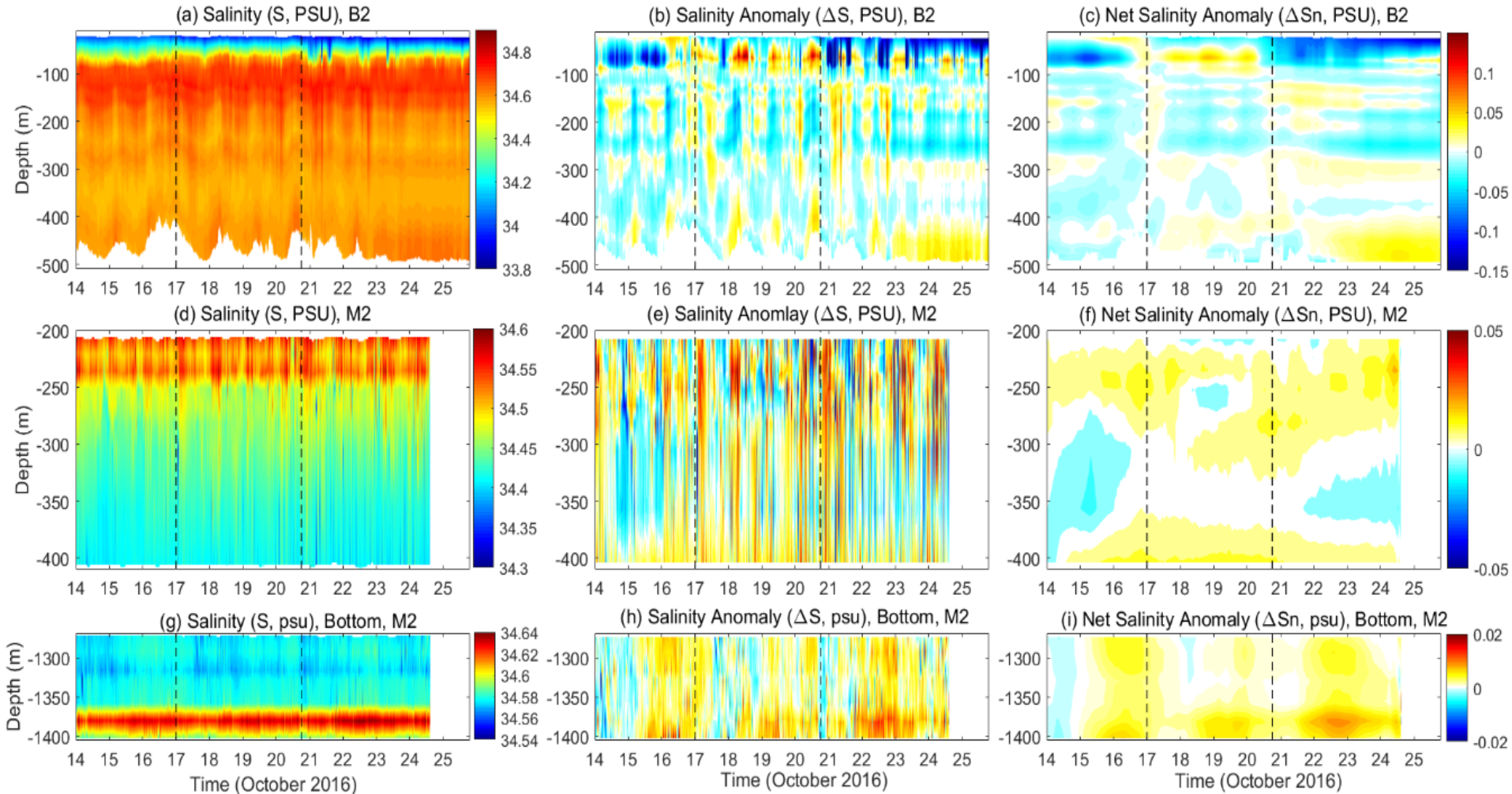
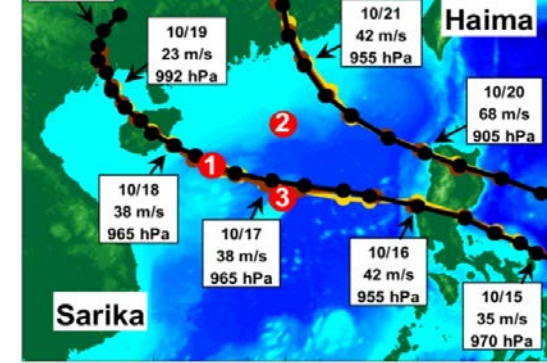
Date (October 2016)

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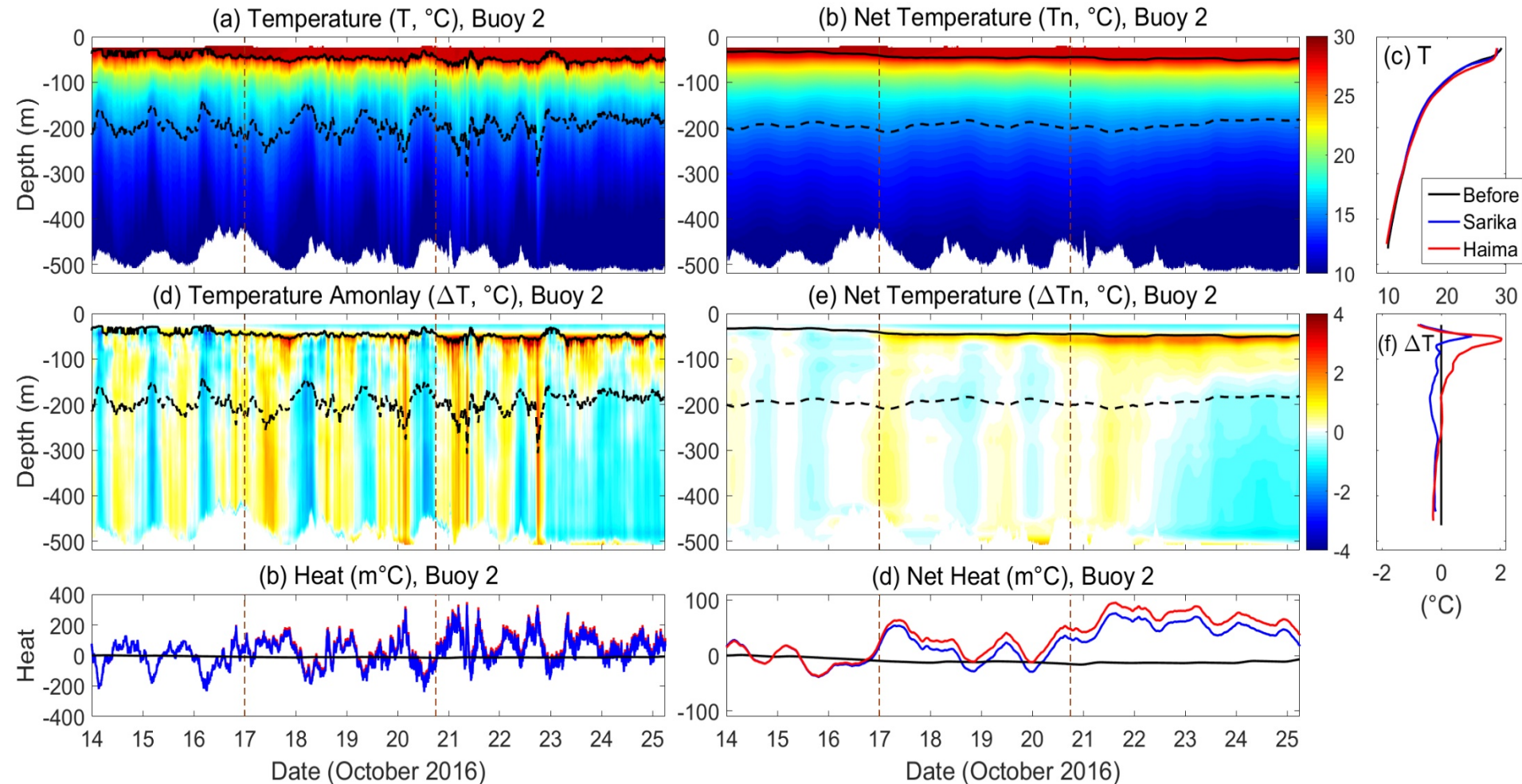
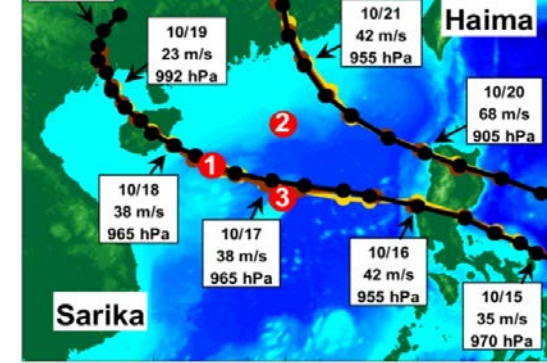
Current and Spectrum



Salinity



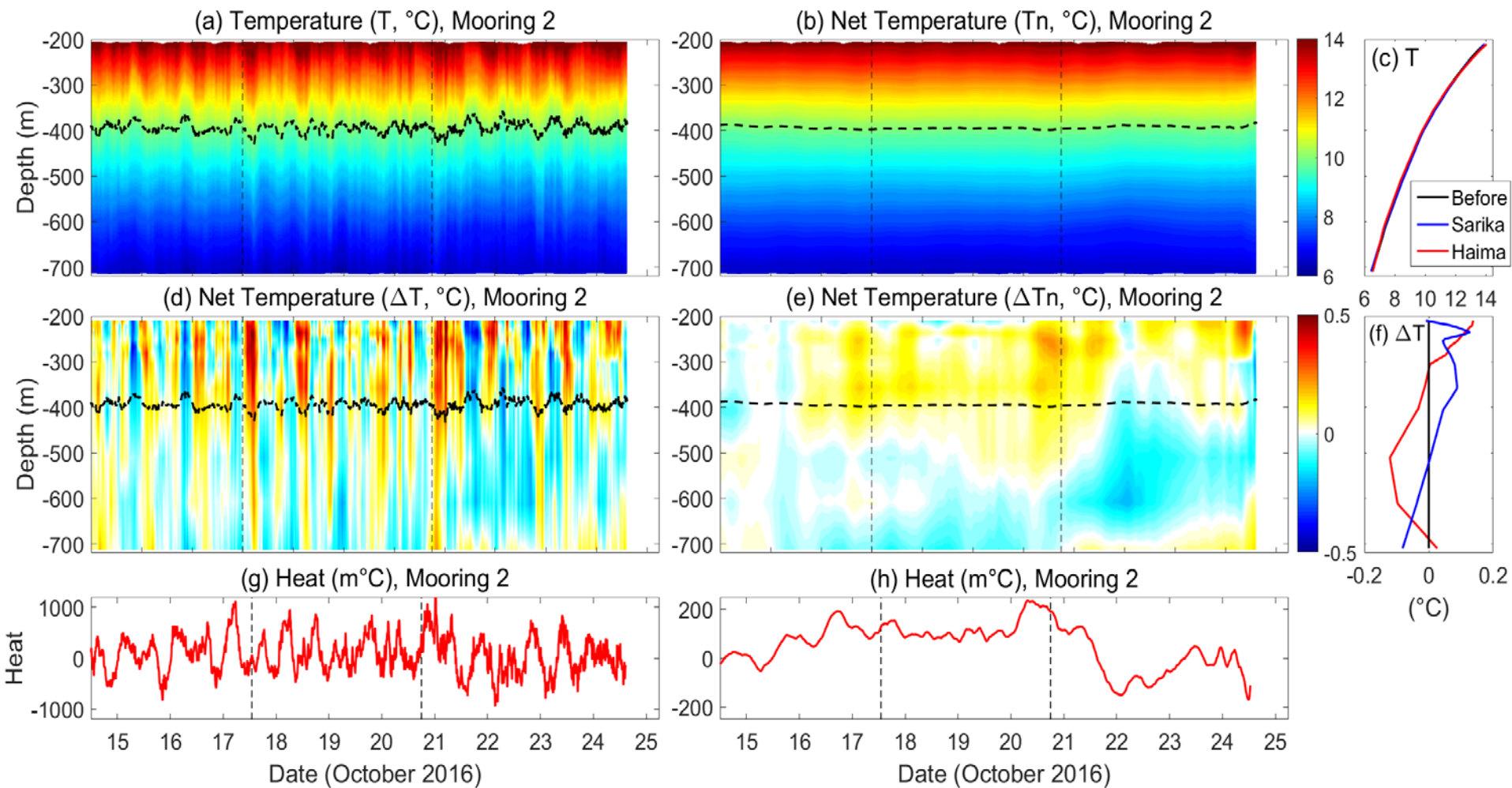
Temperature



The map displays the tropical Indian Ocean region, with latitude from 10°N to 10°S and longitude from 60°E to 120°E. Three tropical cyclone tracks are shown:

- Sarika (Red line with circles):**
 - 10/19: 23 m/s, 992 hPa
 - 10/18: 38 m/s, 965 hPa
 - 10/17: 38 m/s, 965 hPa
- Haima (Black line with circles):**
 - 10/21: 42 m/s, 955 hPa
 - 10/20: 68 m/s, 905 hPa
 - 10/16: 42 m/s, 955 hPa
 - 10/15: 35 m/s, 970 hPa
- Hailu (Yellow line with circles):**
 - 10/17: 38 m/s, 965 hPa
 - 10/16: 42 m/s, 955 hPa

Red circles with numbers 1, 2, and 3 are placed along the tracks. The background shows a satellite image of the ocean with cloud clusters.



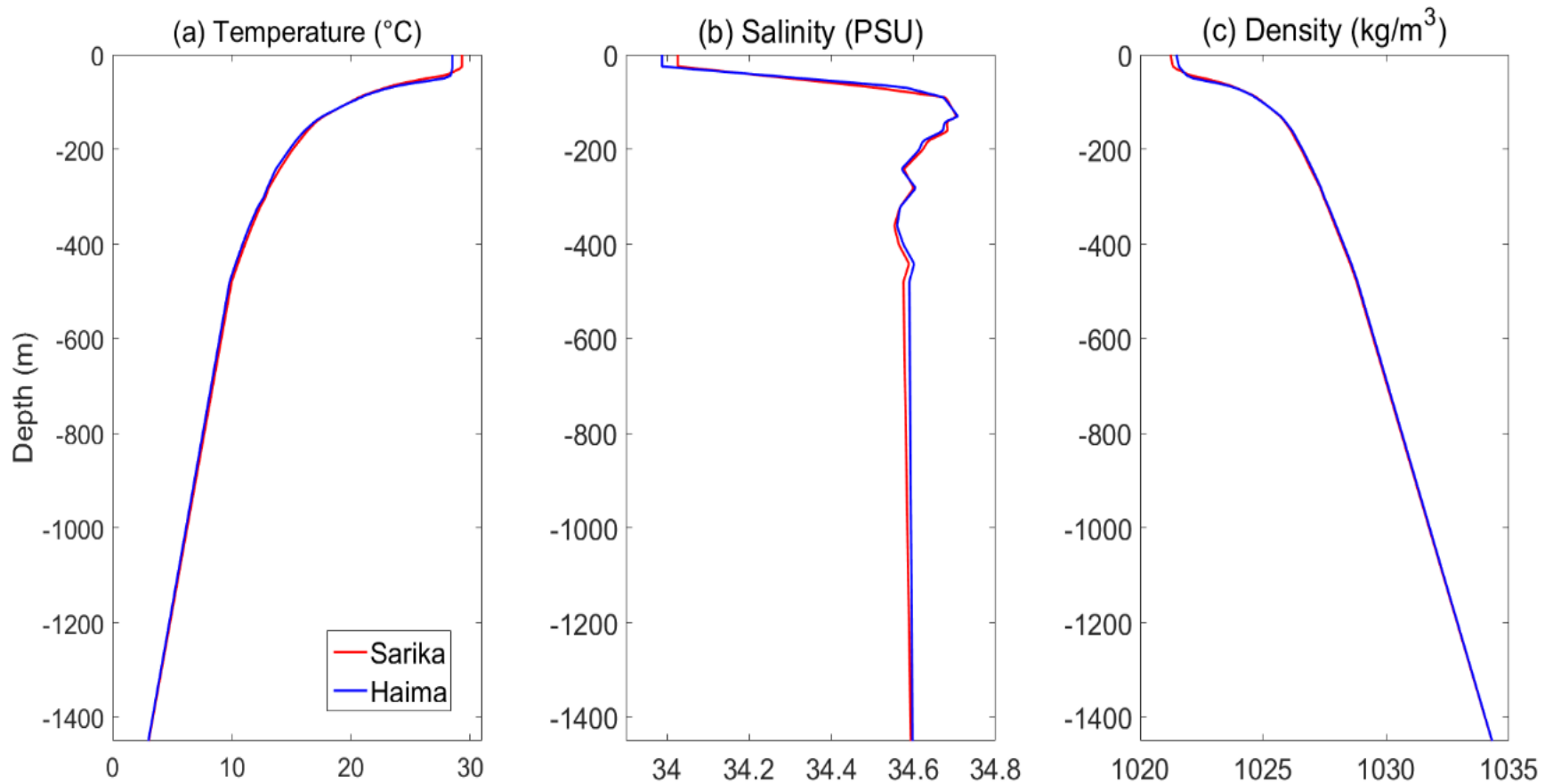


Three-dimensional Model

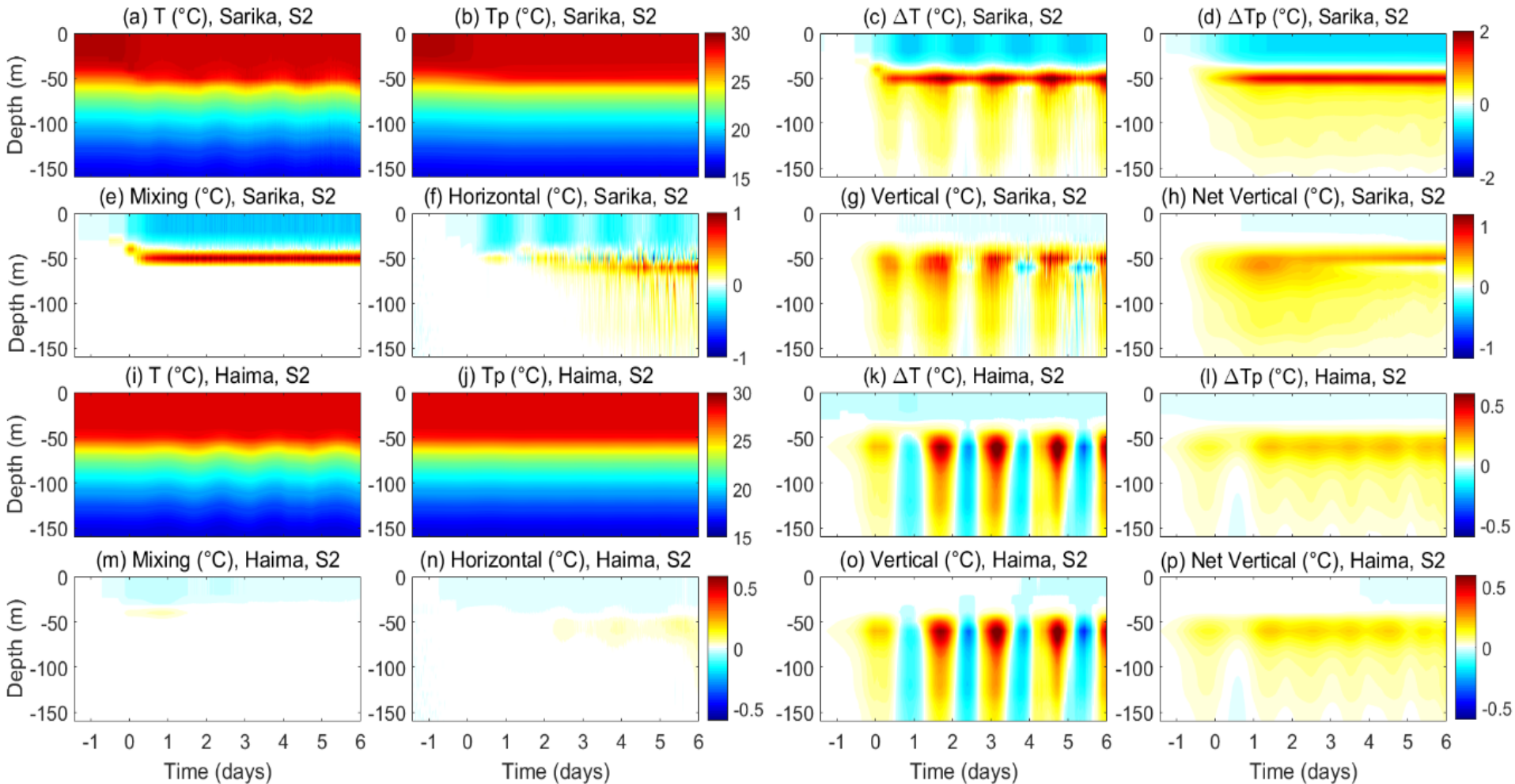
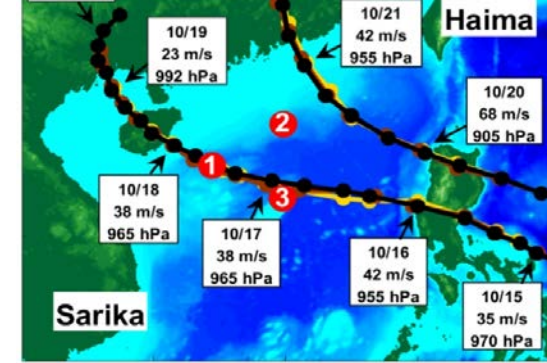
Name	Setup
Model	3DPWP (Price, 1994, <i>JPO</i>)
Horizontal Resolution	8 km
Vertical Resolution	10 m
Time Resolution	120 s
Depth	1450 m
Coriolis Parameter	$4.851 \cdot 10^{-5}$ rad/s (19.7°N)
Boundary Condition	Radiation Condition
Surface Flux	No air sea heat flux and fresh water flux

See the papers for another case (Kalmaegi 2014) of the model simulation: Zhang *et al.* 2016, *JGR*; Zhang *et al.* 2018, *JGR*

Initional Condition



Mechanisms



Sketch



Mixing



After Sarika



After Haima

Conclusions

- Winds (clouds and rainfall) biased to the right (left) sides of the typhoon tracks.
- Strong near-inertial currents with weak signal at twice the inertial frequency ($2f$).
- Sarika deepened the mixed layer, cooled the sea surface, Haima subsequently pushed the subsurface warming anomaly into deeper ocean.
- Rainfall refreshed sea surface, changing the positive subsurface salinity anomaly to negative.

Thank You