Analysis of Propagation of Typhoon Waves Based on CFOSAT Observation

XU Ying, LIU Jianqing, XIE Lingling*, SUN Congrongv, LI Junyi, LIU Jinpu, XIAN Di
National Satellite Ocean Application Service
Key Laboratory of Space Ocean Remote Sensing and Application, Ministry of Natural Resources
Guangdong Ocean University
National Satellite Meteorological Center

CFOSAT Mission

- A China/France joint oceanography satellite to measure sea surface wind and waves
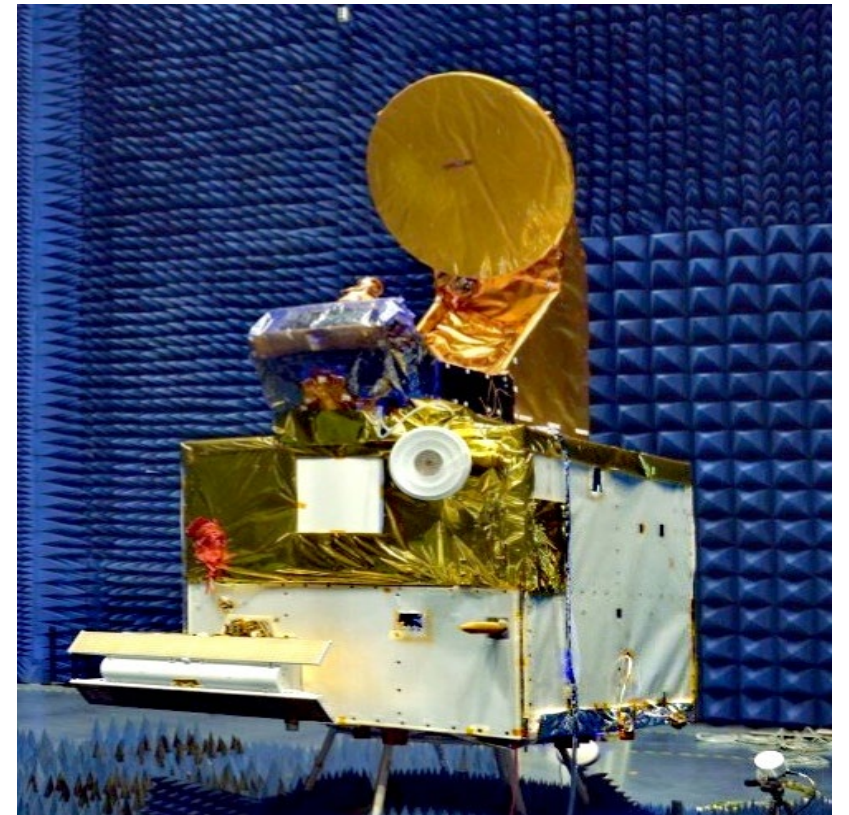
Chinese wind scatterometer (SCAT)

Ocean surface wind vector

French wave spectrometer(SWIM)

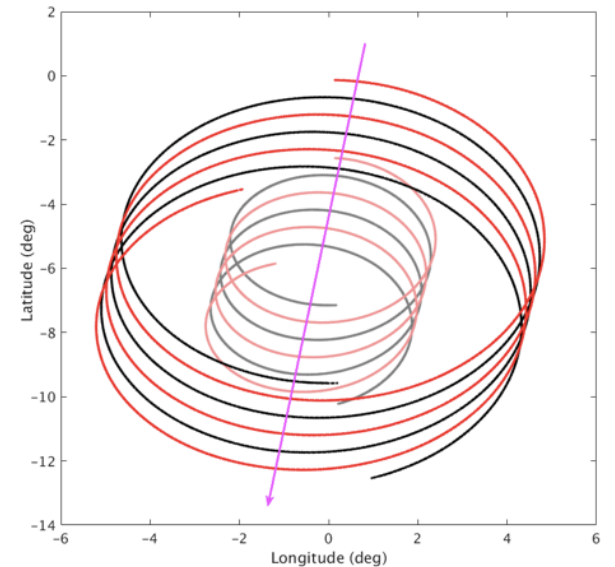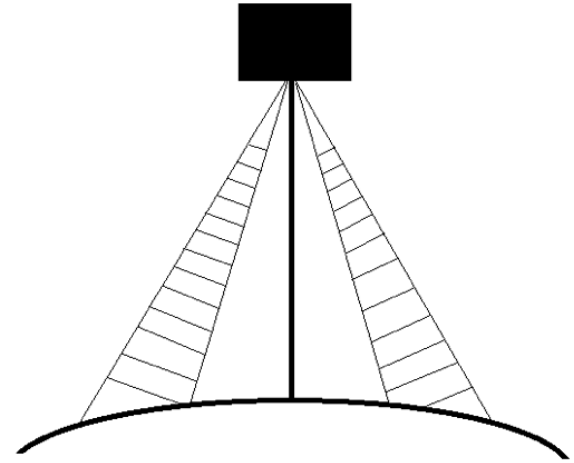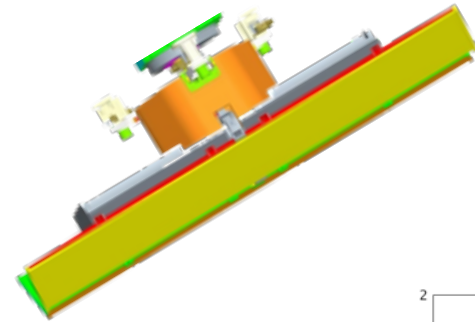**Directional spectrum of ocean surface waves**
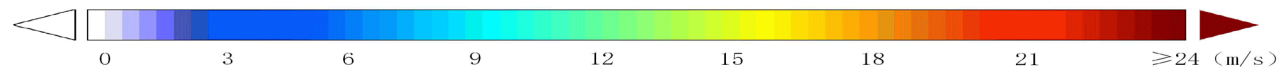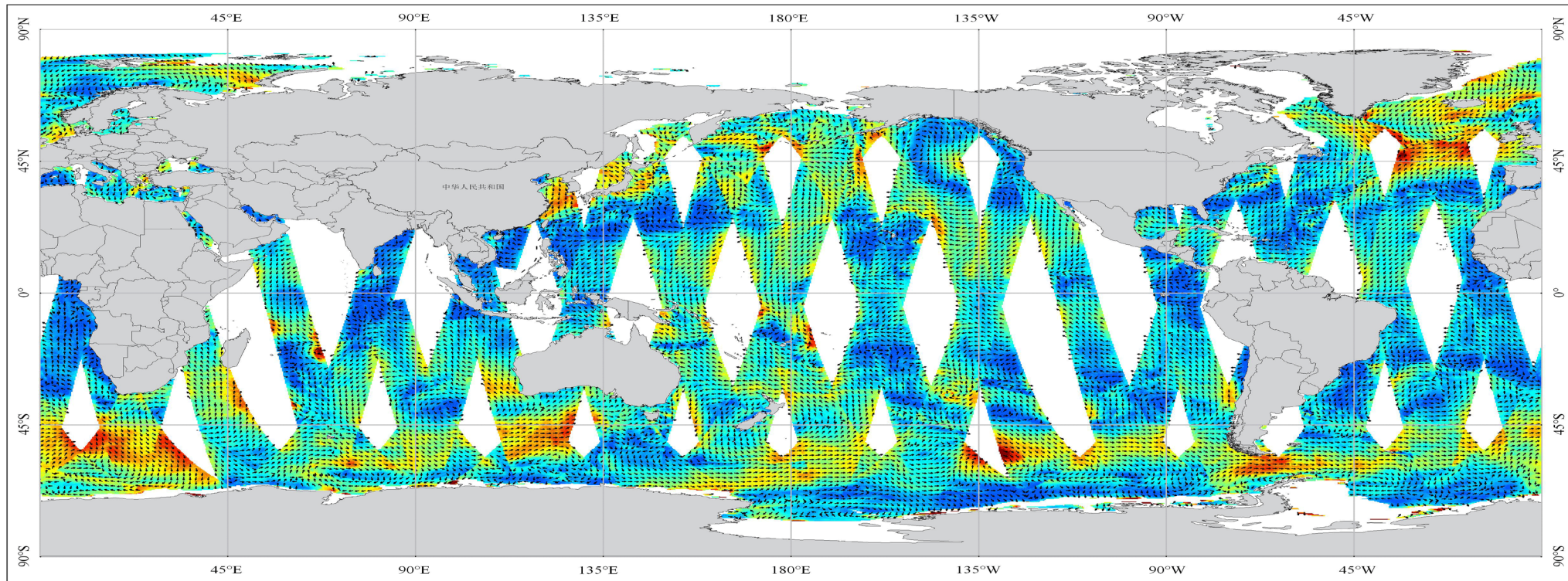**Nadir wind and Hs**

Chinese wind scatterometer (SCAT)

➢ Ku band rotating fan beam concept

➢ Incidences between 26° to 50°

➢ Provides

- σ0

- Ocean wind vector at the scale :

  12.5 km x 12.5 km/25 km x 25 km

- Swath ~ 1000 km

➢ Expected accuracy:

- Wind speed   2 m/s,

- Wind direction   15°

CFOSAT

海面风场全球分布专题图
（20190207T00：09：07 UTC -- 20190207T23：52：44 UTC）

制图单位：国家卫星海洋应用中心　　　　　　　　坐标系：CGCS2000　　　　　　　　卫星名称：CFOSAT

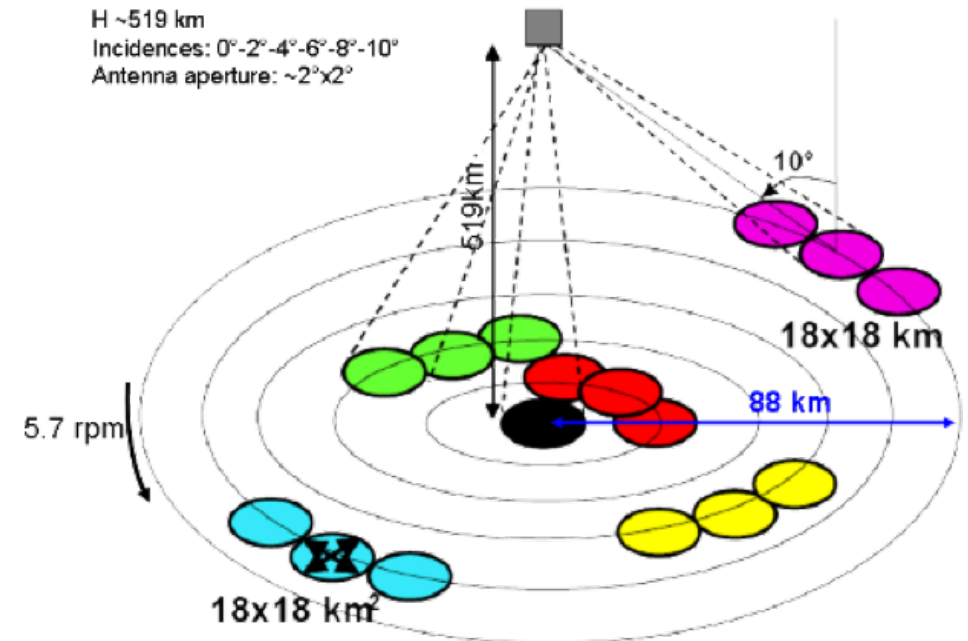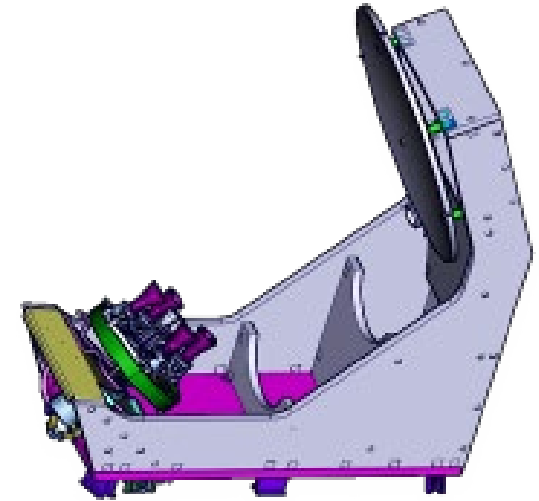制图时间：2019年02月08日　　　　　　　　　　比例尺：1:100,000,000　　　　　　　　传　感　器：微波散射计

French wave spectrometer(SWIM)

- Ku band real aperture radar

- 6 incidence angles：0°, 2°, 4°, 6°, 8°, 10°

- Provides :

  - Directional wave spectra

  - Significant wave height and wind speed

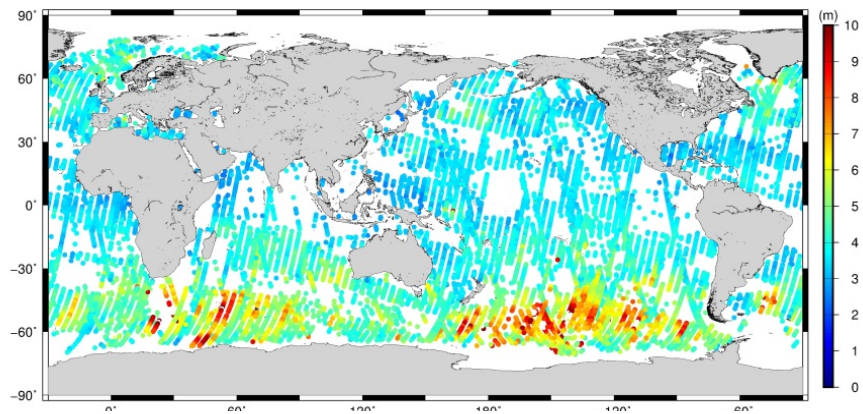 - σ_0 mean profiles, 0 to 10°

- Expected accuracy:

  - Energy error   ≤15%,

  - Wavelength error ≤ 10-20% (70 - 500m)

  - Azimuth error   ≤ 15°

  - Nadir SWH   max(10%, 50 cm) , Nadir Wind Speed   max(10%, 2 m/s)

H ~519 km
Incidences: 0°-2°-4°-6°-8°-10°
Antenna aperture: ~2°x2°

519km

10°

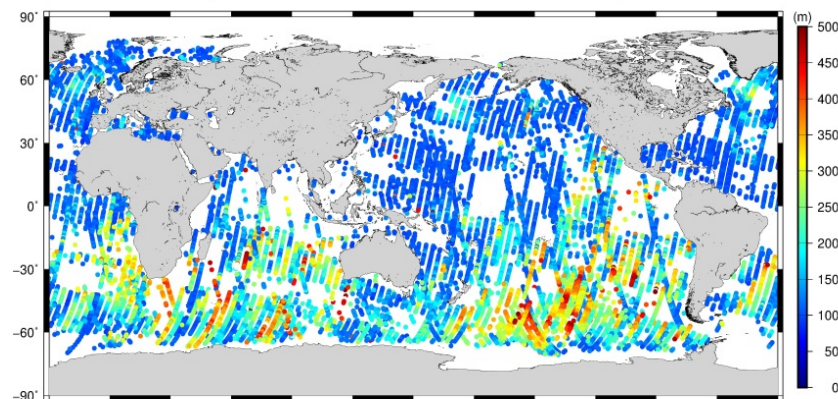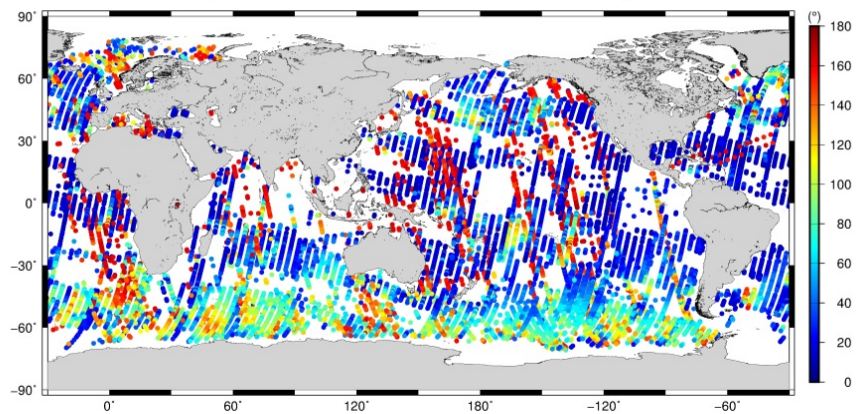18x18 km

5.7 rpm

88 km

18x18 km

5

CFOSAT Significant Wave Height
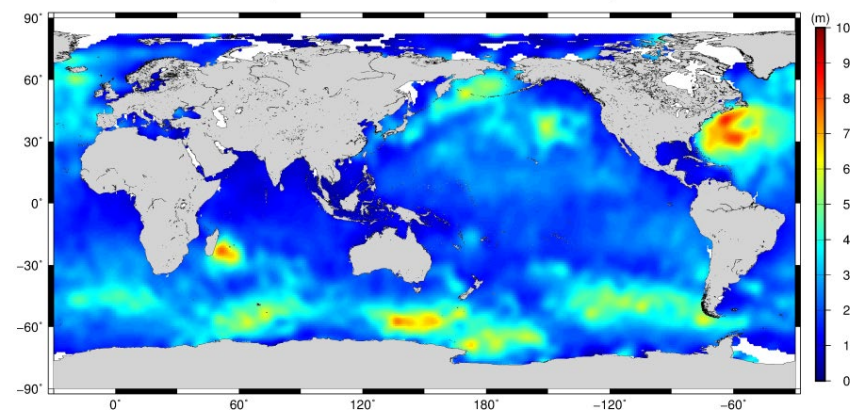(20190501T000001 – 20190507T235959)

CFOSAT Peak Wavelength
(20190501T000001 – 20190507T235959)

CFOSAT Peak Wave Direction
(20190501T000001 – 20190507T235959)

CFOSAT SWI_L4A Significant Wave Height
(20190501T000001 – 20190501T235959)
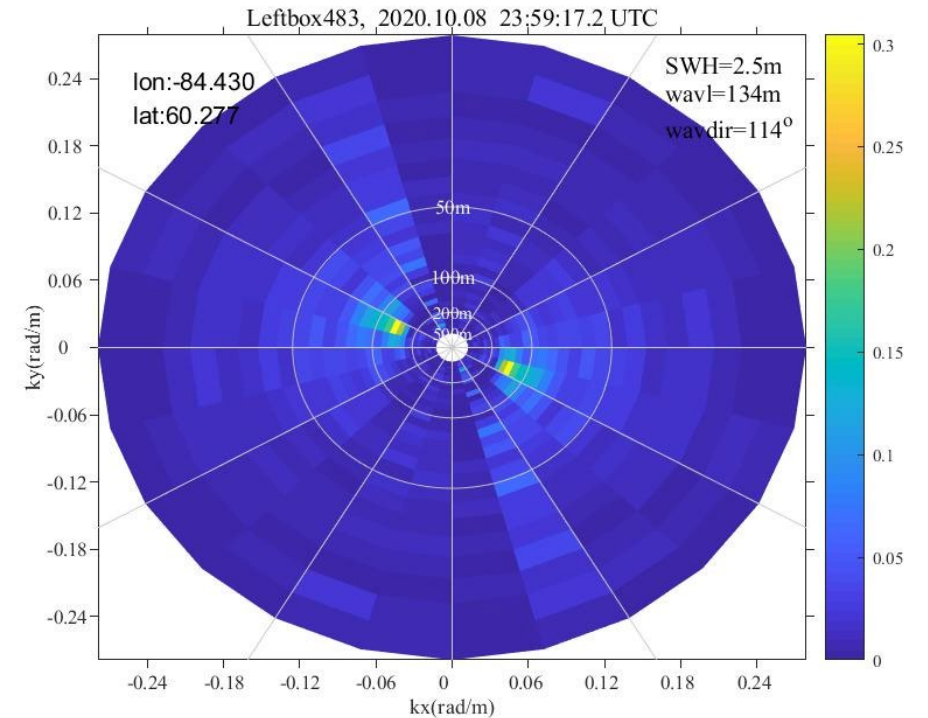
Mean wave parameters

➤ SWH

$$SWH = 4\sqrt{\iint \frac{E_{part}(k,\phi)dkd\phi}{k}}$$

➤ Dominant Wave Length

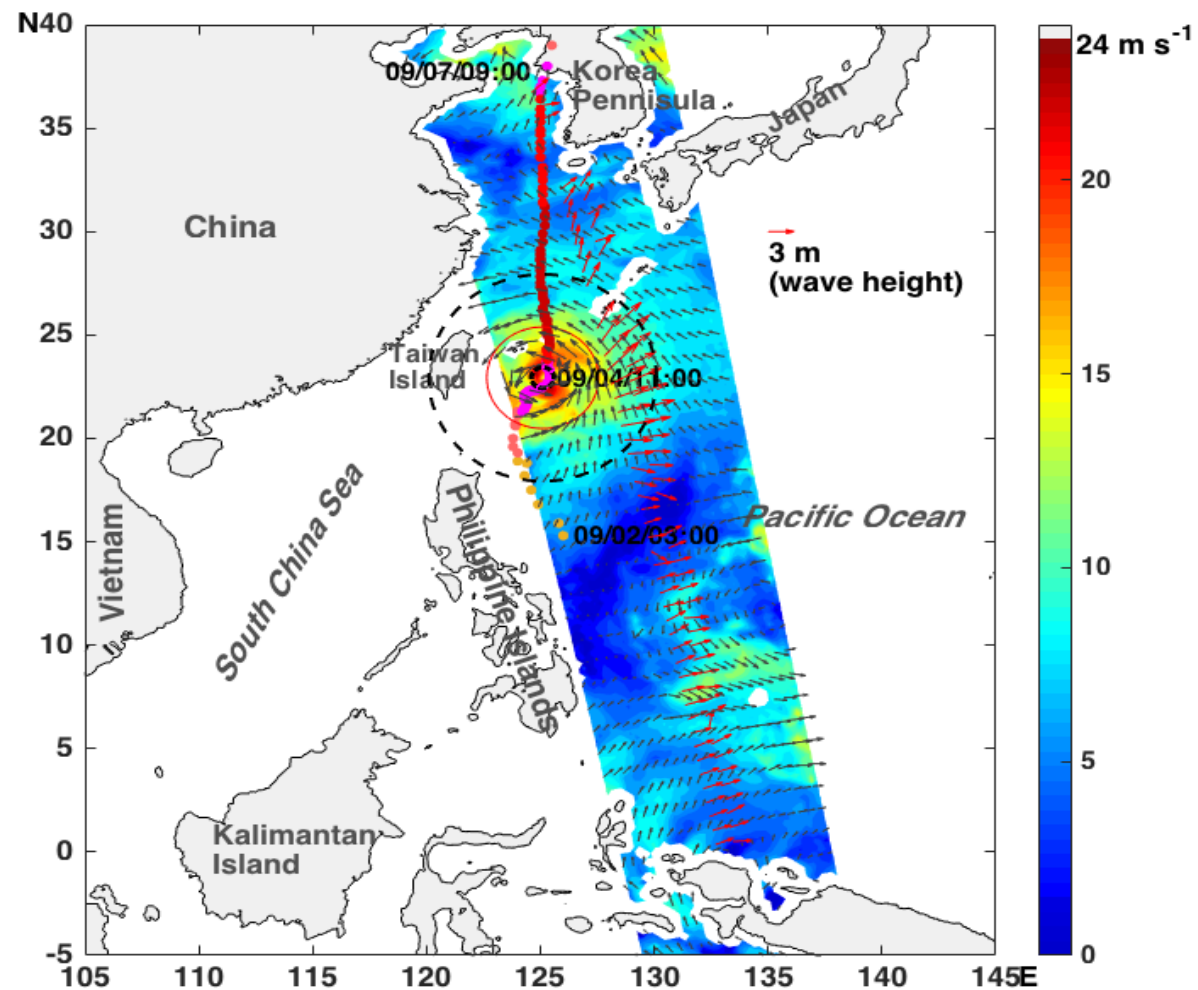$$\lambda_p = {2\pi} \Big/ {\iint kE_{part}(k,\phi)dkd\phi \Big/ \iint E_{part}(k,\phi)dkd\phi}$$

➤ Dominant Direction

$$\Phi_p = \frac{\iint \phi E_{part}(k,\phi)dkd\phi}{\iint E_{part}(k,\phi)dkd\phi} MOD 180°$$
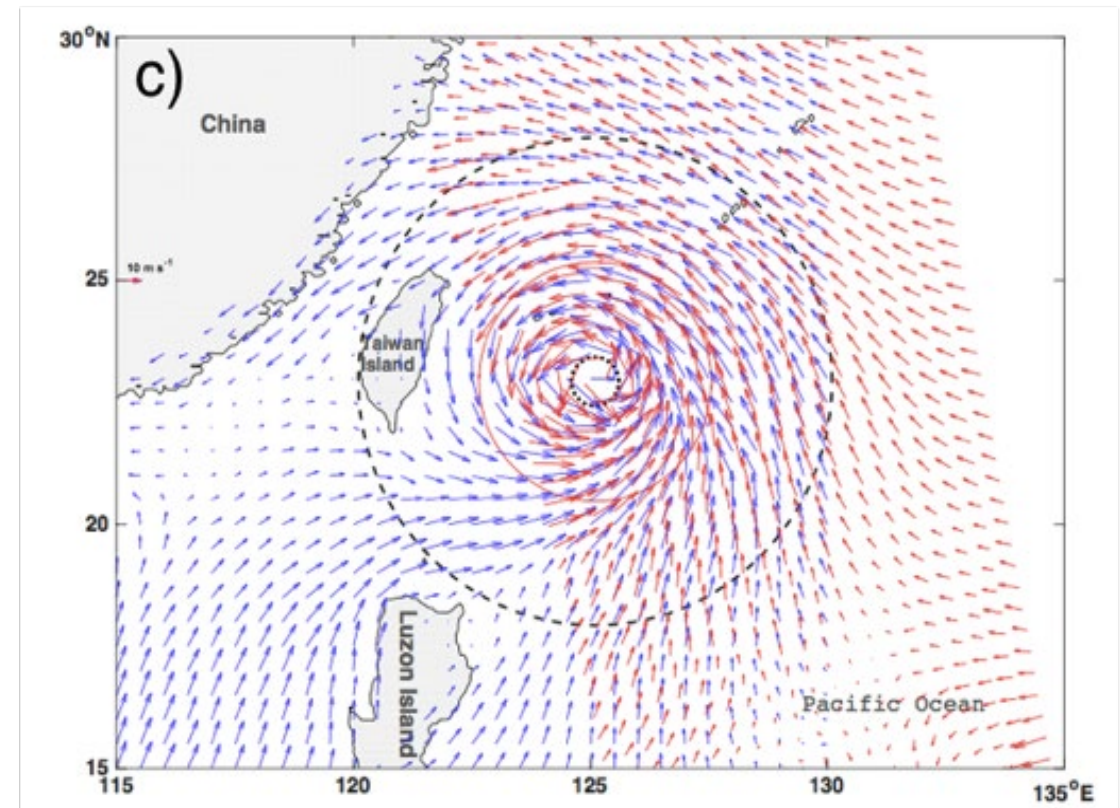

Leftbox483, 2020.10.08 23:59:17.2 UTC

- CFOSAT met typhoon Lingling (2019) and measured wind and wave fields at about 10:22 UTC on September 4.
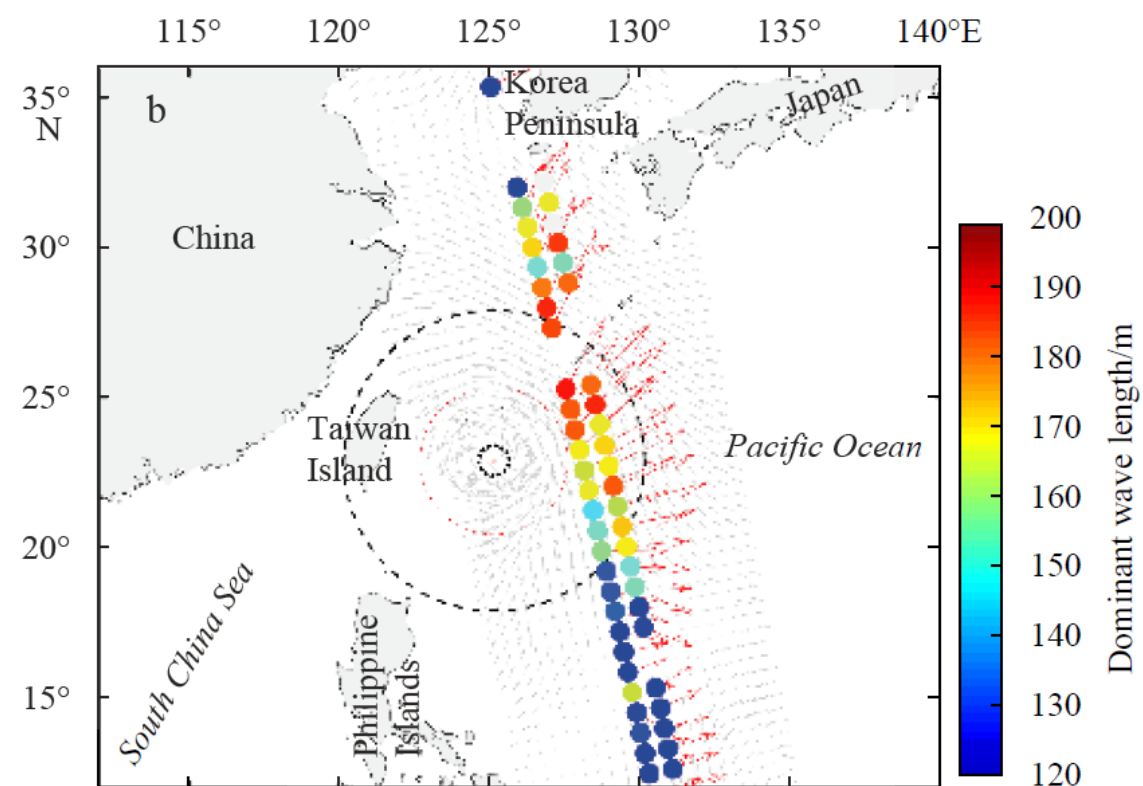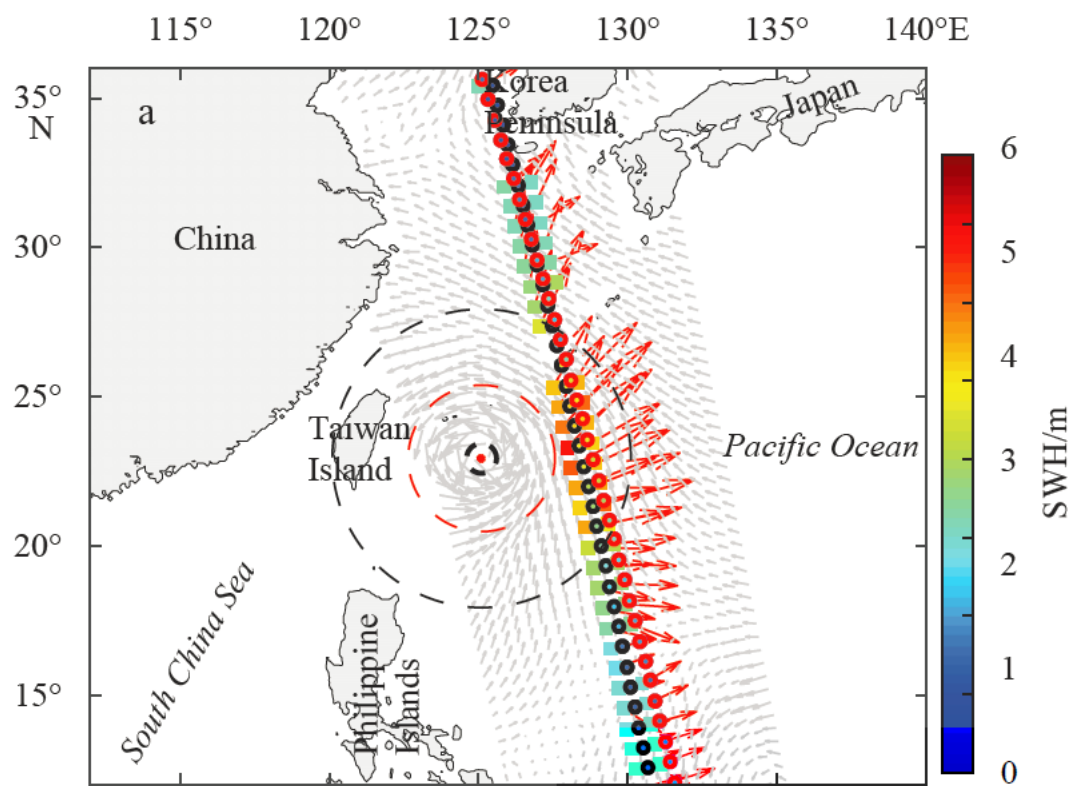
- Comparison of the CFOSAT wind vectors to the remote sensed surface winds from CMEMs two hours later at 12:00 UTC on September 4, 2019

- The mean difference of wind speed is 1.1 m/s

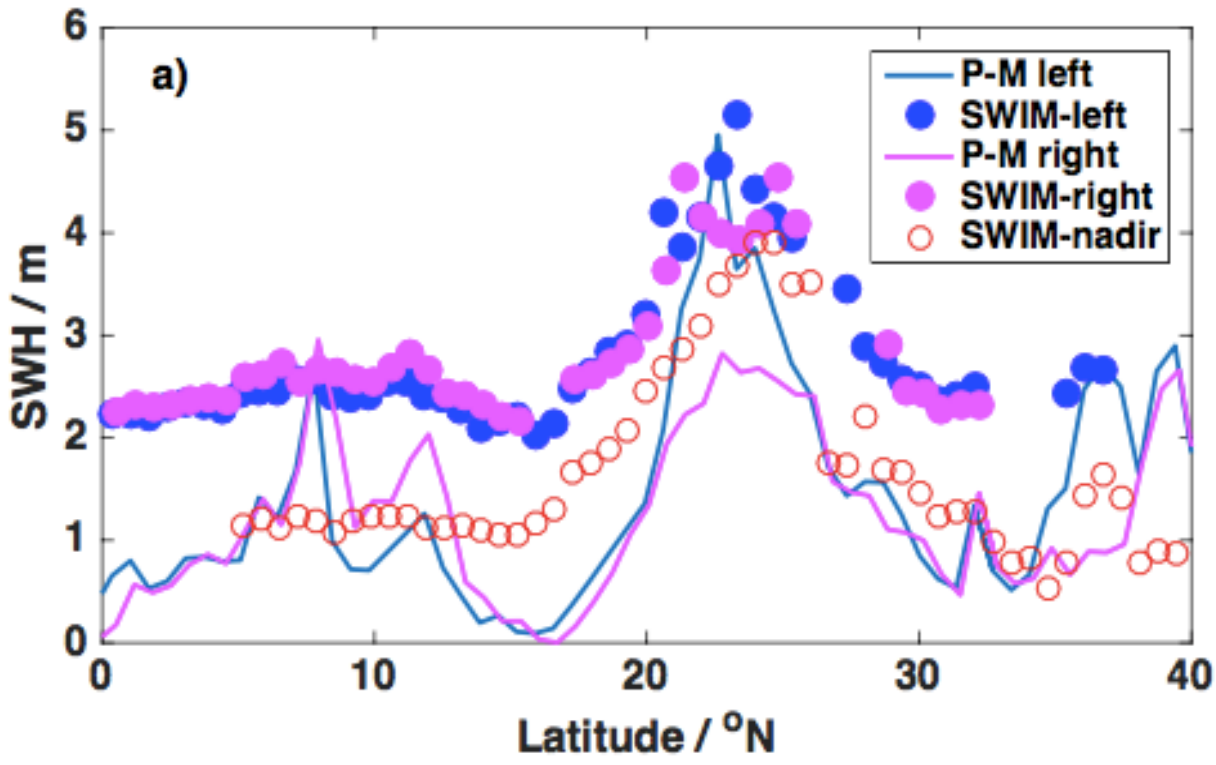The SWH and Dominant Wave length of SWIM observation during typhoon Lingling

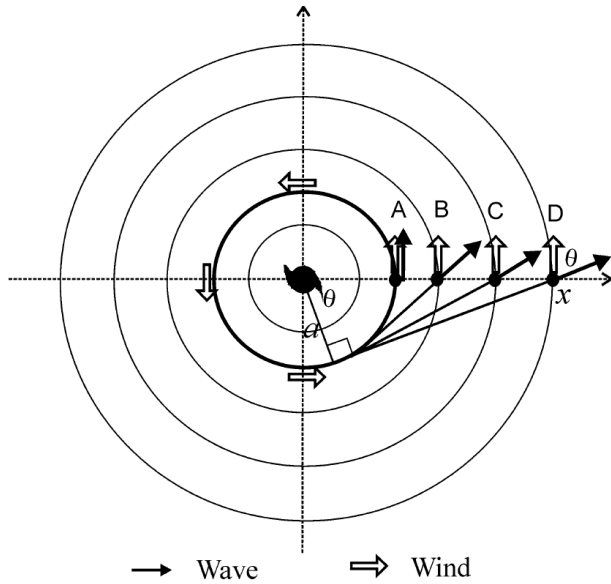- Comparison of CFOSAT observed SWHs and estimated SWHs based on the P-M spectrum.

$$h_{PM} \approx 0.22 \frac{(U_{10})^2}{g}$$

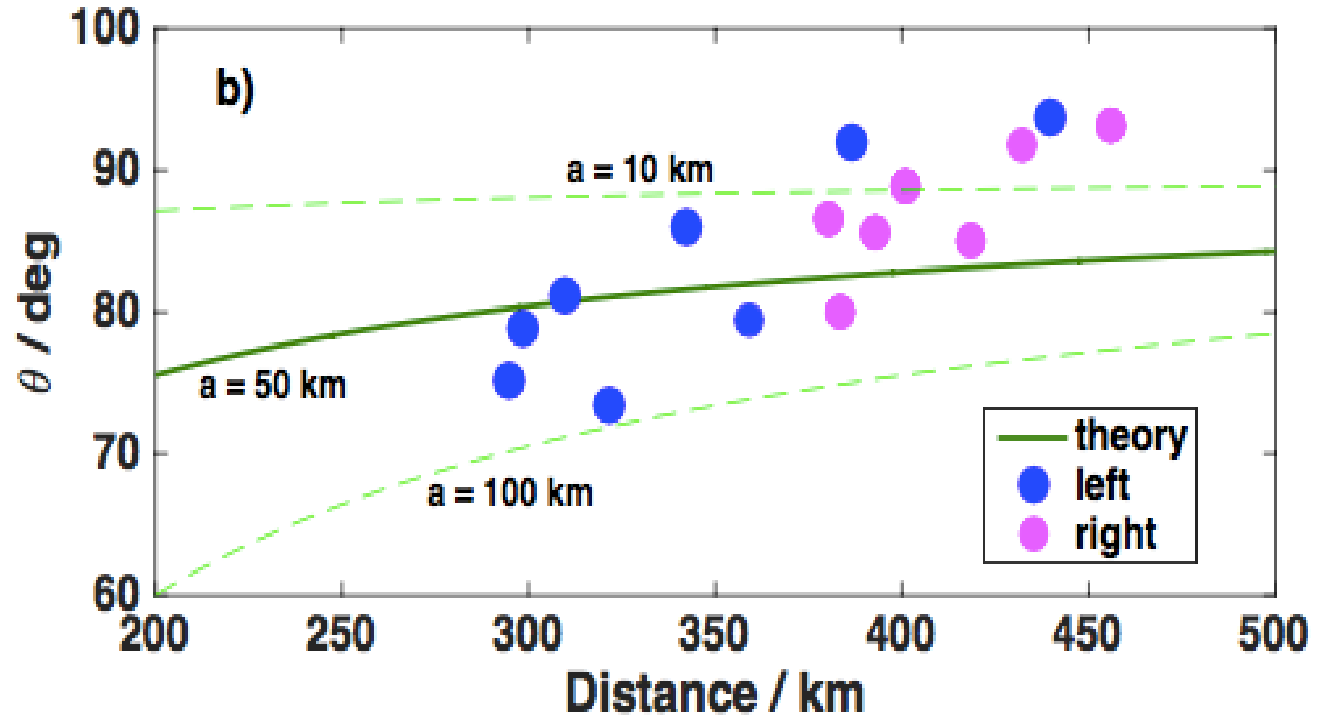Stewart (2008)

NOTE: SWIM product version 4.3.2

- Comparison of observed deviation angles and theoretical deviation angles.

$$\theta = \cos^{-1}(a/x) \quad (x>=a)$$

Moon et al. (2003)
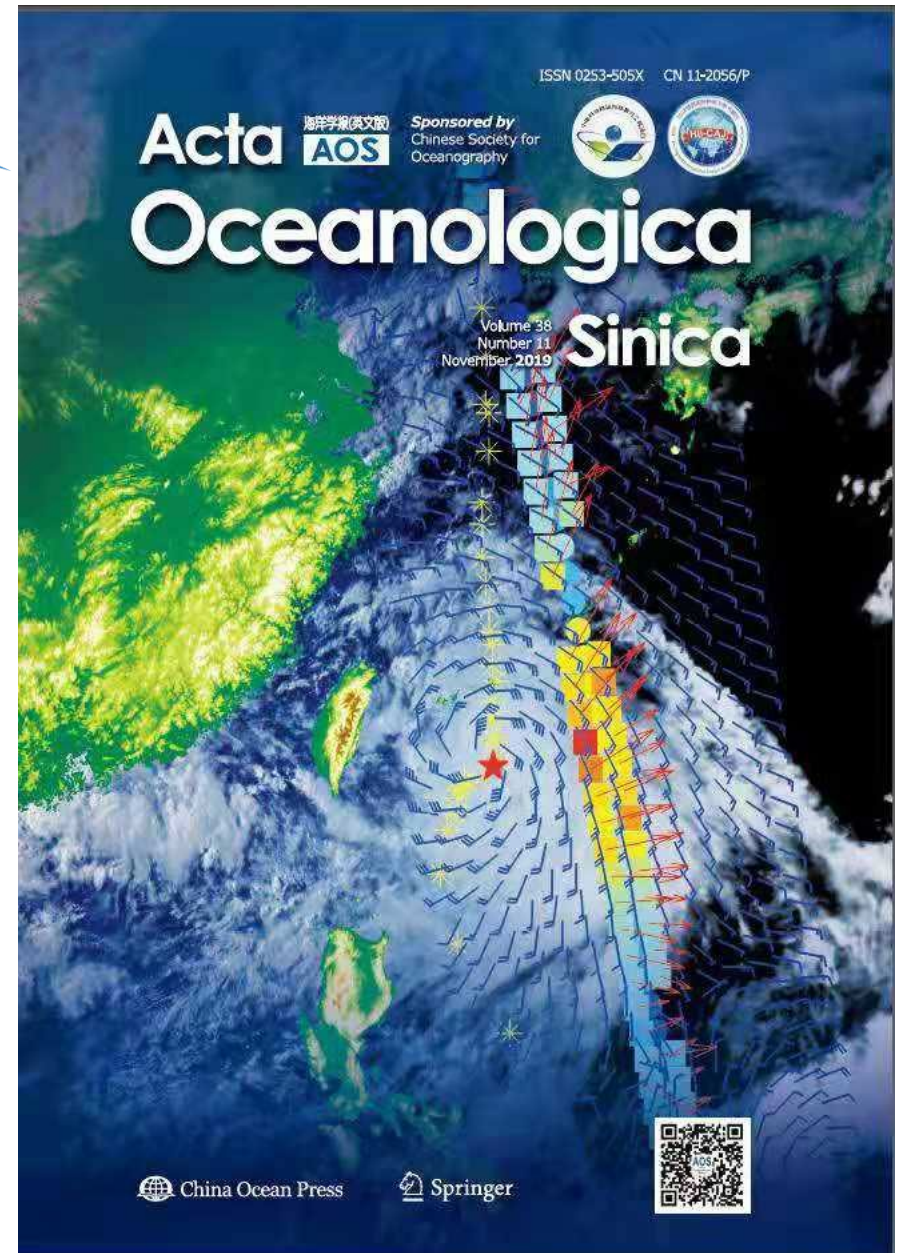
- Simultaneous CFOSAT observation of wind fields and wave fields under typhoon Lingling.

CFOSAT simultaneous observation of super typhoon 'Lingling' in 2019
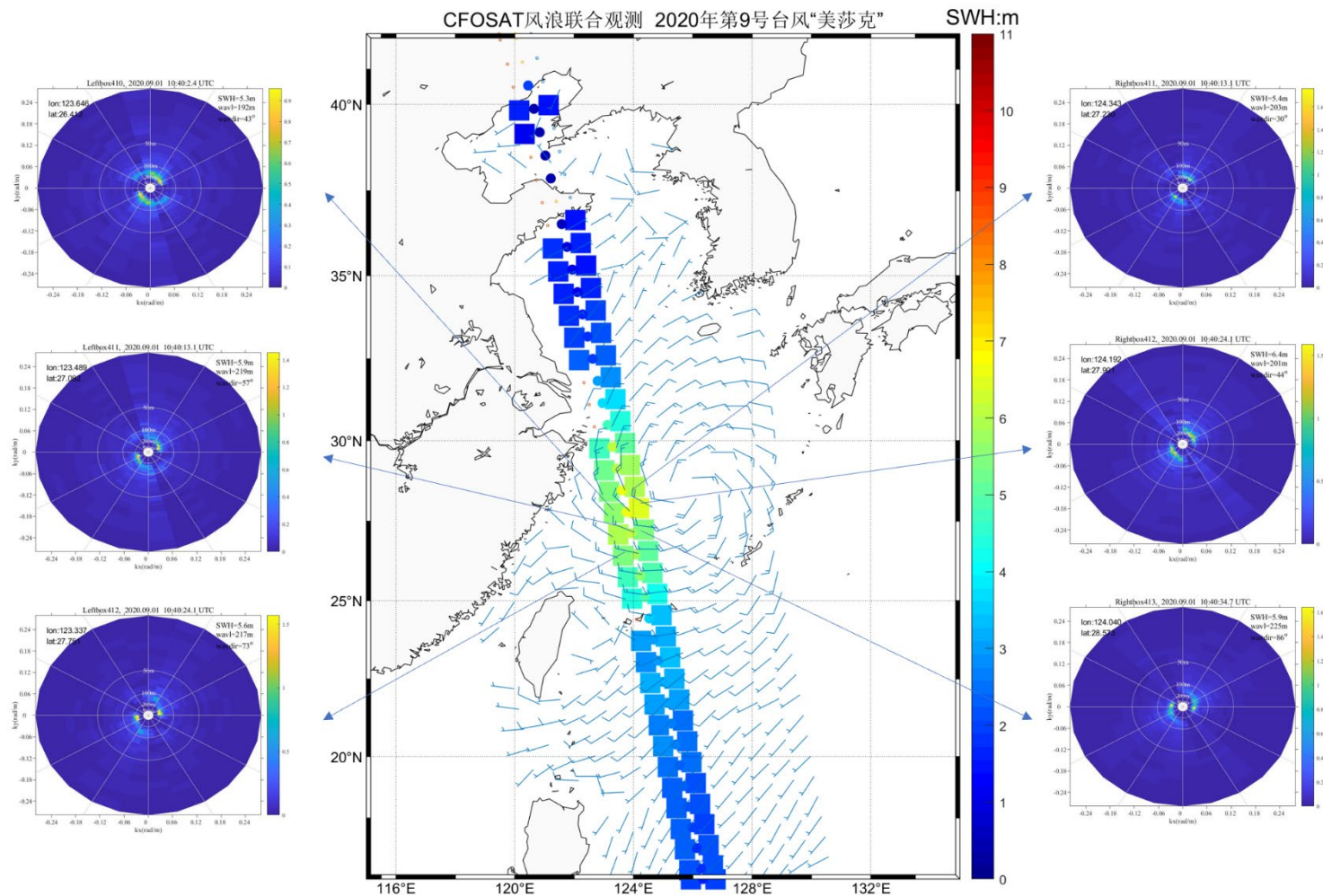**Cover story of *Acta Oceanologica Sinica* 2019 38(11)**
By: Ying Xu, Jianqiang Liu, Lingling Xie*, Congrong Sun, Jinpu Liu, et al.

- Simultaneous CFOSAT observation of wind fields and wave fields under typhoon Maysak, 2020.

- 500 km away from the center of the typhoon, the wave speed is 12~14.6 m/s (43-52 km/h), with wavelength 92-136 m and wave heights about 2-3 m, and local wind speed about 7 m/s.

λ (m)	V (m/s)
136.66	14.61
100.85	12.55
113.21	13.29
103.38	12.71
122.56	13.83
106.71	12.91
131.03	14.30
104.09	12.75
115.22	13.41
92.11	11.99
126.58	14.06
116.21	13.47
117.36	13.54
124.22	13.93
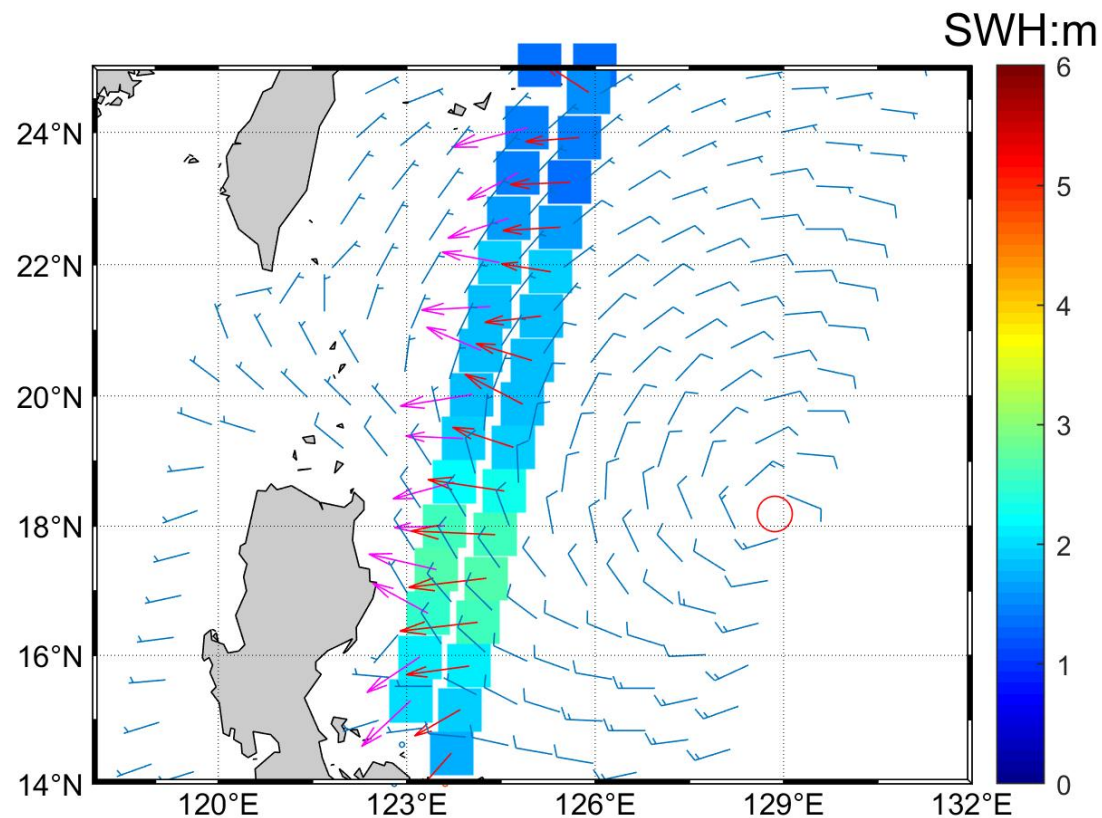
- Both of SCAT products and SWIM products show promising results.

- The observed SWHs generally agree with the theoretical estimates in high sea state.

- The misalignment of the wind and wave directions during typhoon was observed, and the deviation angle increases with the distance from the typhoon center as theoretically predicted.

- With the improvement of inversion algorithms and data processing, further research is implementing.

谢谢！

Merci!