Effects of ocean eddies on surface wave features

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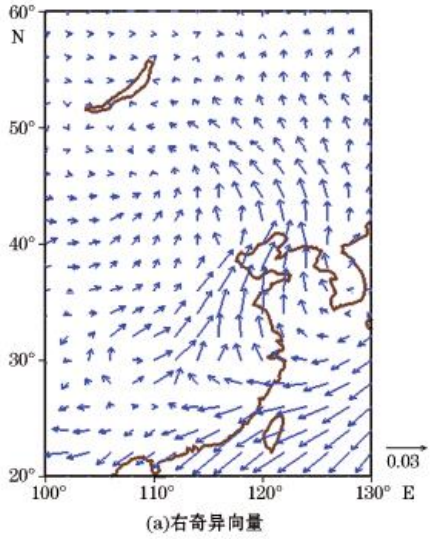
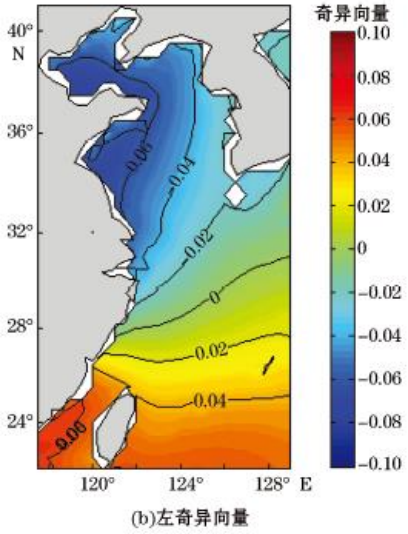
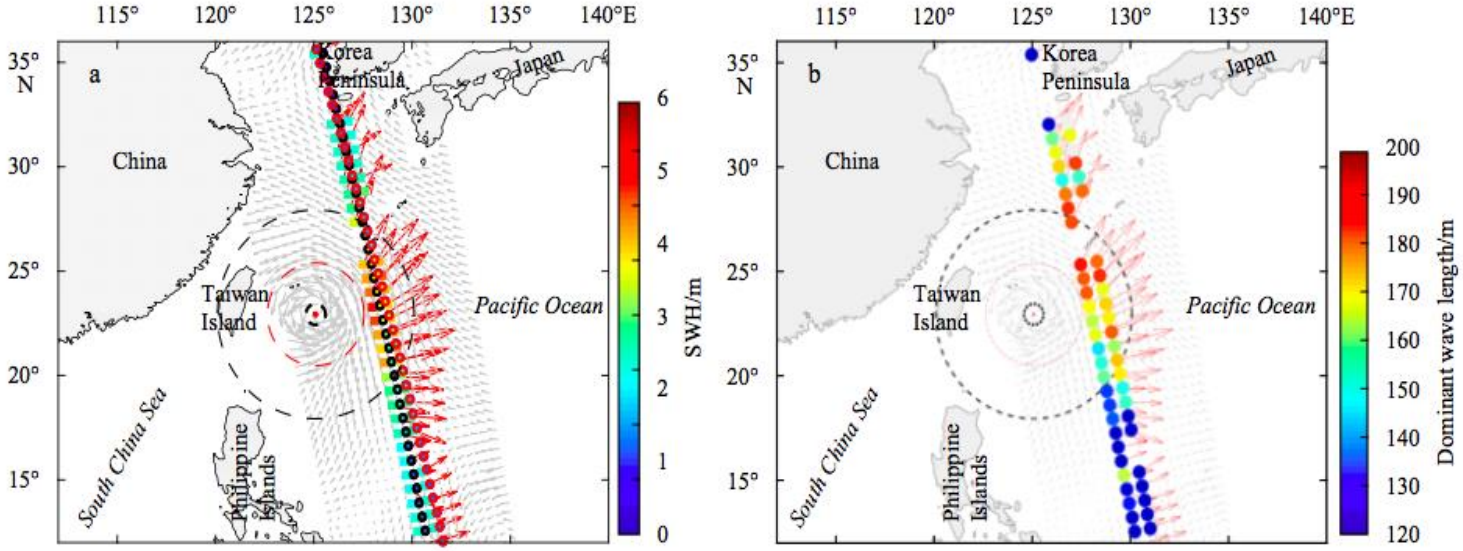
1. Introduction



(a)右奇异向量



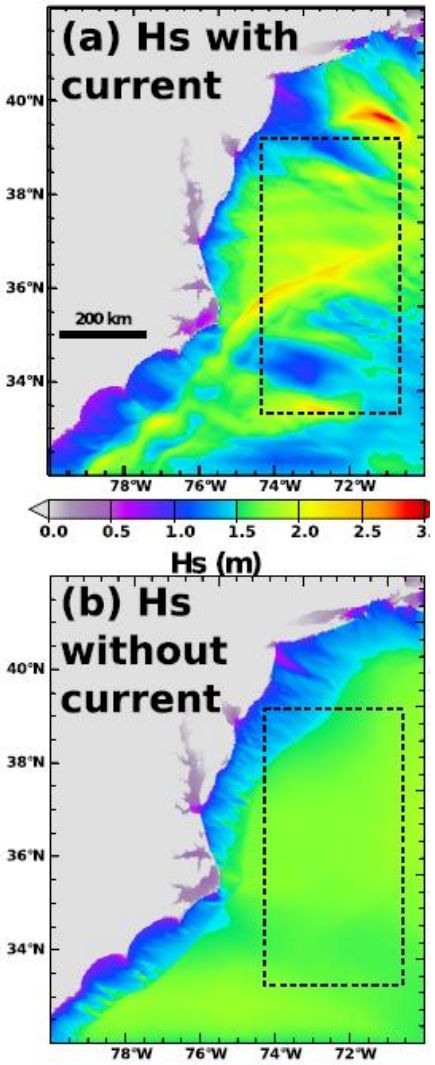
(b)左奇异向量



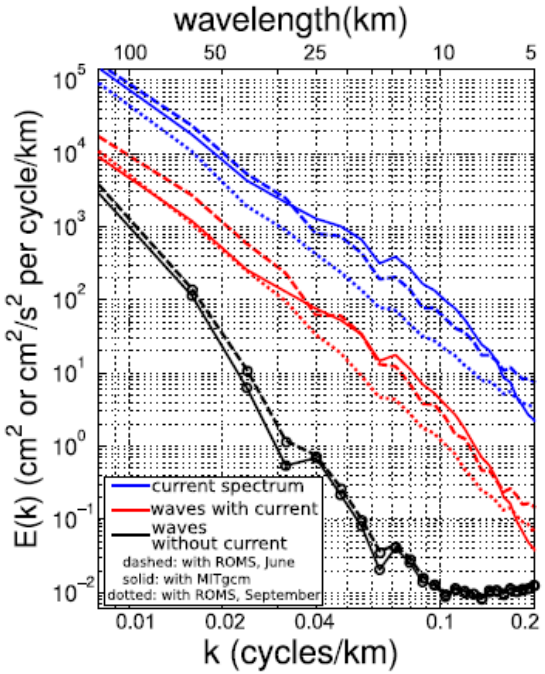
Using the daily wave field simulated by WAVEWATCHIII and daily wind field of CCMP in the East China Sea from 1993 to 2011, analysis shows that the correlation with one day lead by wind is more meaningful.（Zhou et al., 2020）

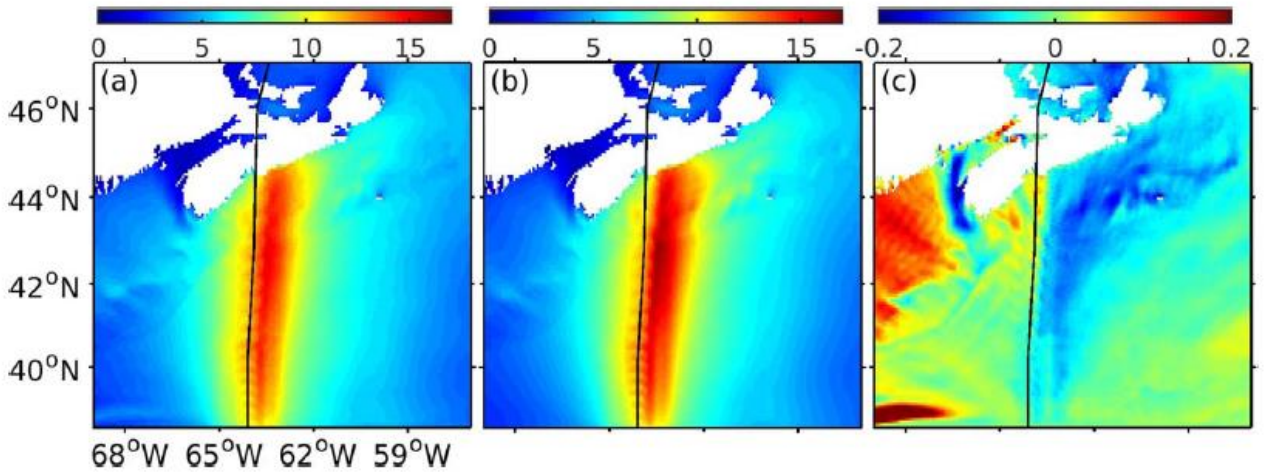
The CFOSAT simultaneously observed the wind fields, nadir SWHs and wave spectrum parameters (SWHs, wave direction and wave length) during typhoon Lingling (2019) at 10:22 UTC on September 4

The observed SWHs were over 5 m on the right side of the typhoon track for wind speeds over 14 m s^{-1}. The dominant waves had wavelengths of 150 – 180 m, and propagated eastward.(Xu et al., 2019)



the spatial variability at 100 km scales is 4 times higher than in the model without currents (in black): in other words, currents account for more than 75% of the spatial variability of wave heights at scales of 100 km in the model.
(Fabrice et al., 2017)

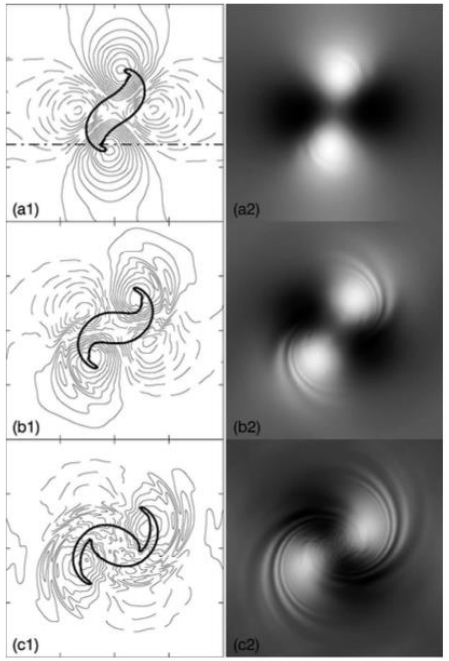




① A significant reduction of Hs (11-15%) due to effects of currents on waves occurs on the RHS of the hurricane track.
② The dominate mechanisms of the WCI on waves include the current-induced modification of wind energy input to the wave generation, and current-induced wave advection and refraction.
(Wang et al., 2016)

Previous theoretical/numerical studies have shown that balanced eddies have effects on generation, reflection and dissipation of gravity waves in geostrophic flow (Lighthill, 1952; Ford, 1994)
Gravity waves may also have effects on eddy or vortex structure (Wang and Tan, 2007)

When the IGWs propagate into the vortex, the vortex could be deepening and the wind structure of the vortex could become asymmetric
As the IGWs leaving the vortex , the initially symmetric IGWs take on asymmetric structure
the wave-vortex interaction is related to the initial structure, strength and propagating direction of the IGWs and the characteristics of vortex.



Pallas-sanz and Viudez (2008)

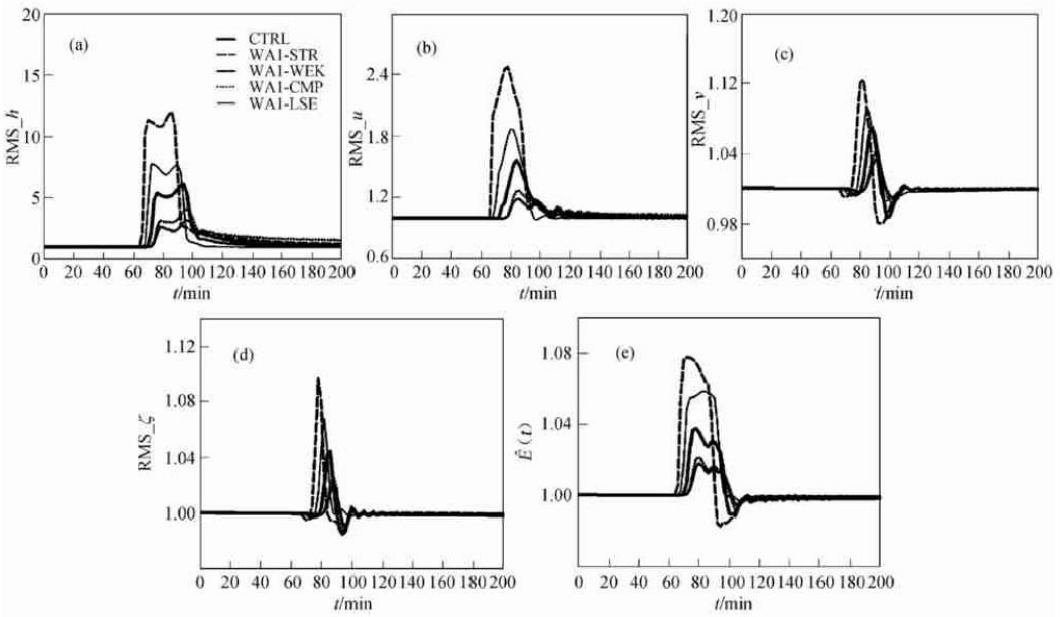
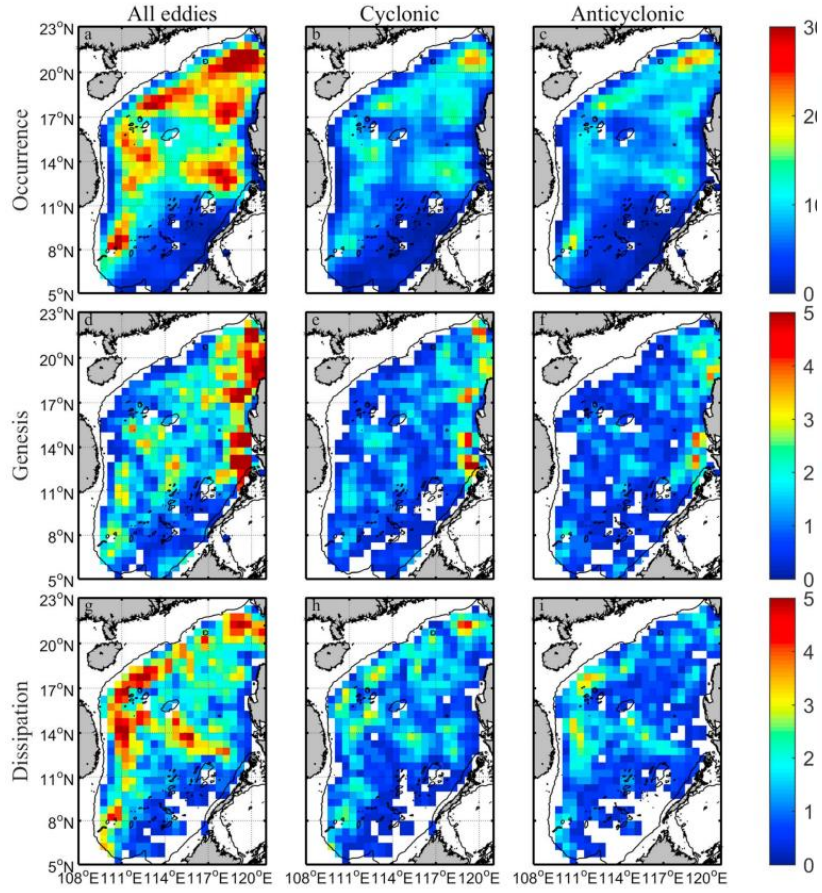


图 5　不同初始强度、结构的惯性重力波与同一涡旋相互作用过程中，各个物理量的均方根 RMS(t)及能量 $E(t)$ 随时间的变化
(a) h; (b) u; (c) v; (d)涡度 ζ 以及(e)能量 $E(t)$. 计算范围为涡旋中心周围 400 km×400 km. 粗实线代表 CTRL.

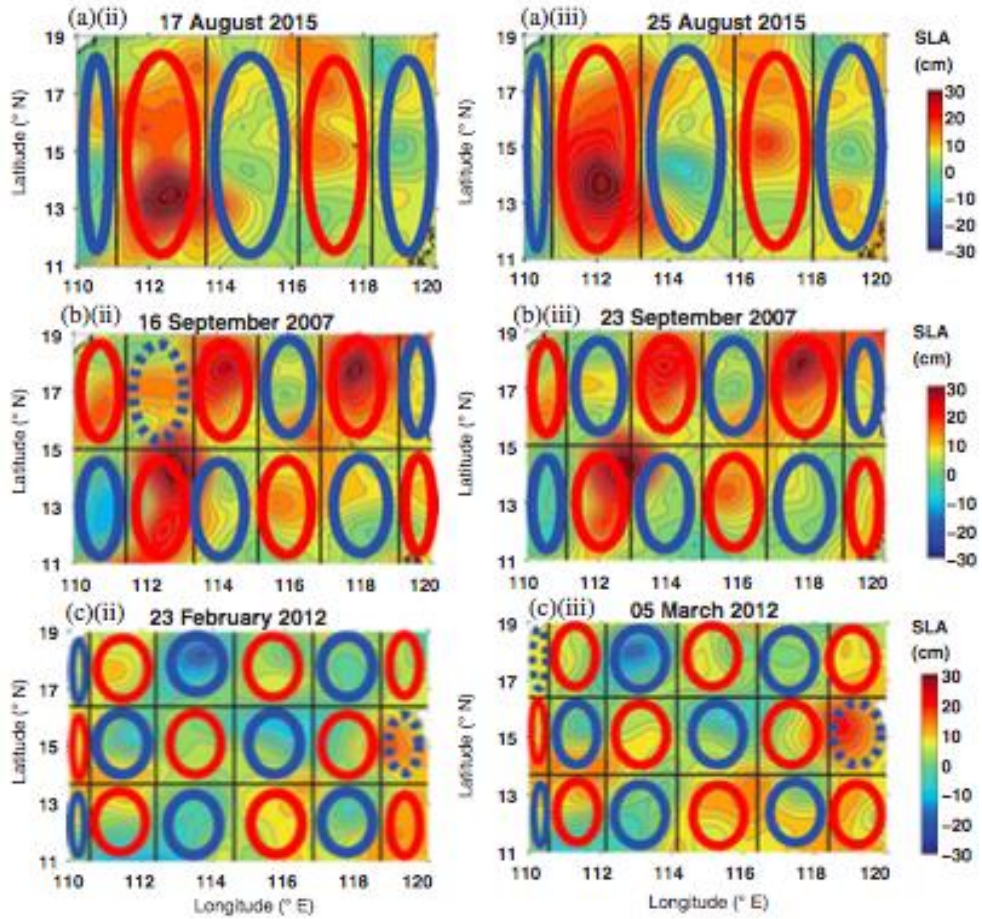
Wang and Tan(2007)

The South China Sea (SCS) is characterized by frequent occurrence of energetic mesoscale eddies.



eographic distributions of (top) eddy occurrence, (middle) genesis, and (bottom) dissipation at each 0.5° × 0.5° pixel in the SCS betwee
)15. The eddy occurrence denotes all the detected eddy snapshots, eddy genesis is the first time an eddy is identified, and eddy dissip
eddy is detected. The left, middle, and right columns are for all eddies, cyclonic eddies, and anticyclonic eddies, respectively. The black
) m isobath.

He et al. (2018)



new insight into the SCS eddy dynamics

Xie and Zheng (2017) 、Xie et al. (2018) 、Zheng et al. (2017)

Research history of eddies in SCS

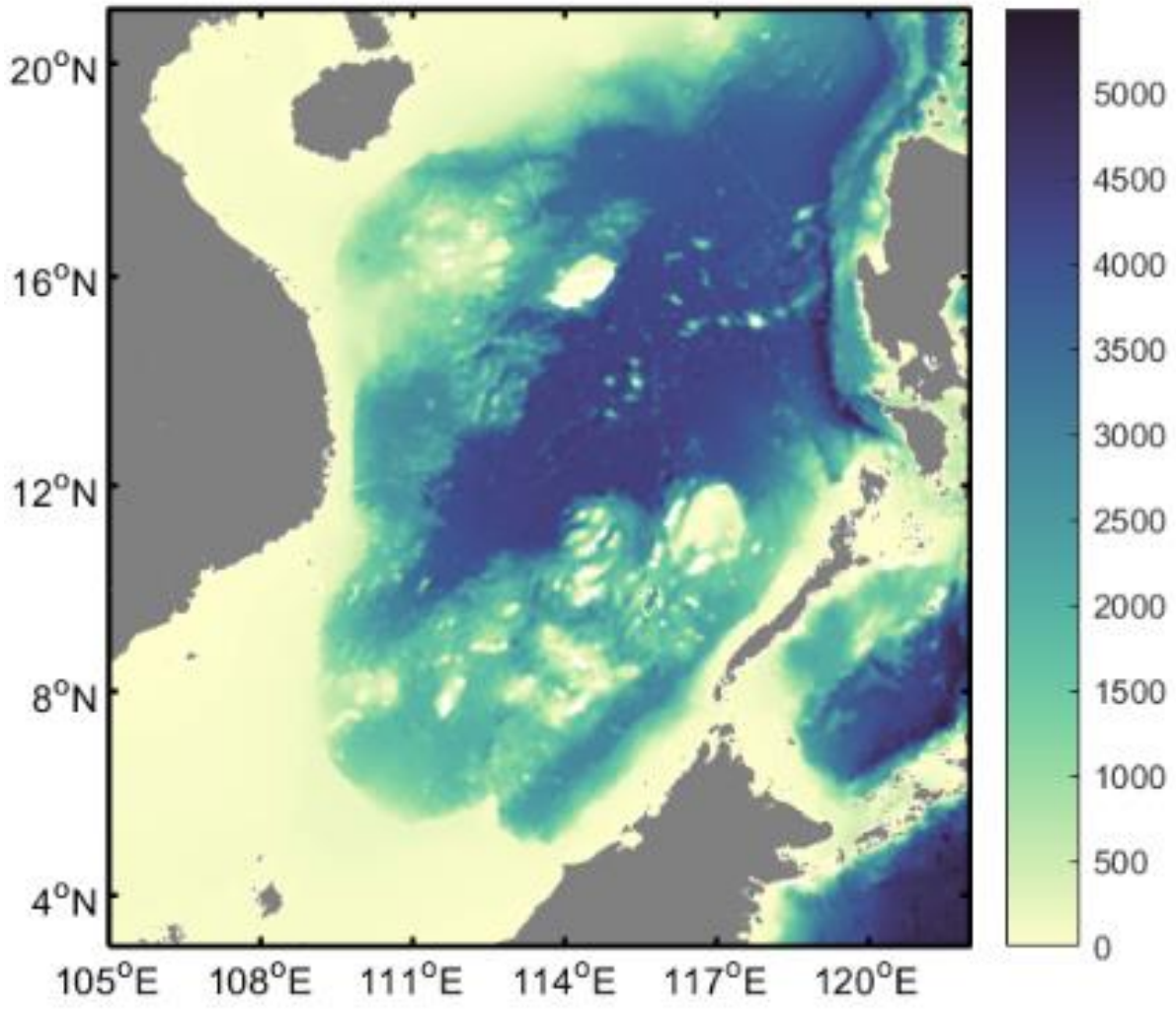
1956 - 2011
Individual process

2011 - 2014
Grouped process

2014 -
Internal-linked process (waves)

- Discovery
- Statistics
- Mechanisms
- Long-live eddy train
- Standing wave modes
- Rossby normal modes

2. Data & Method

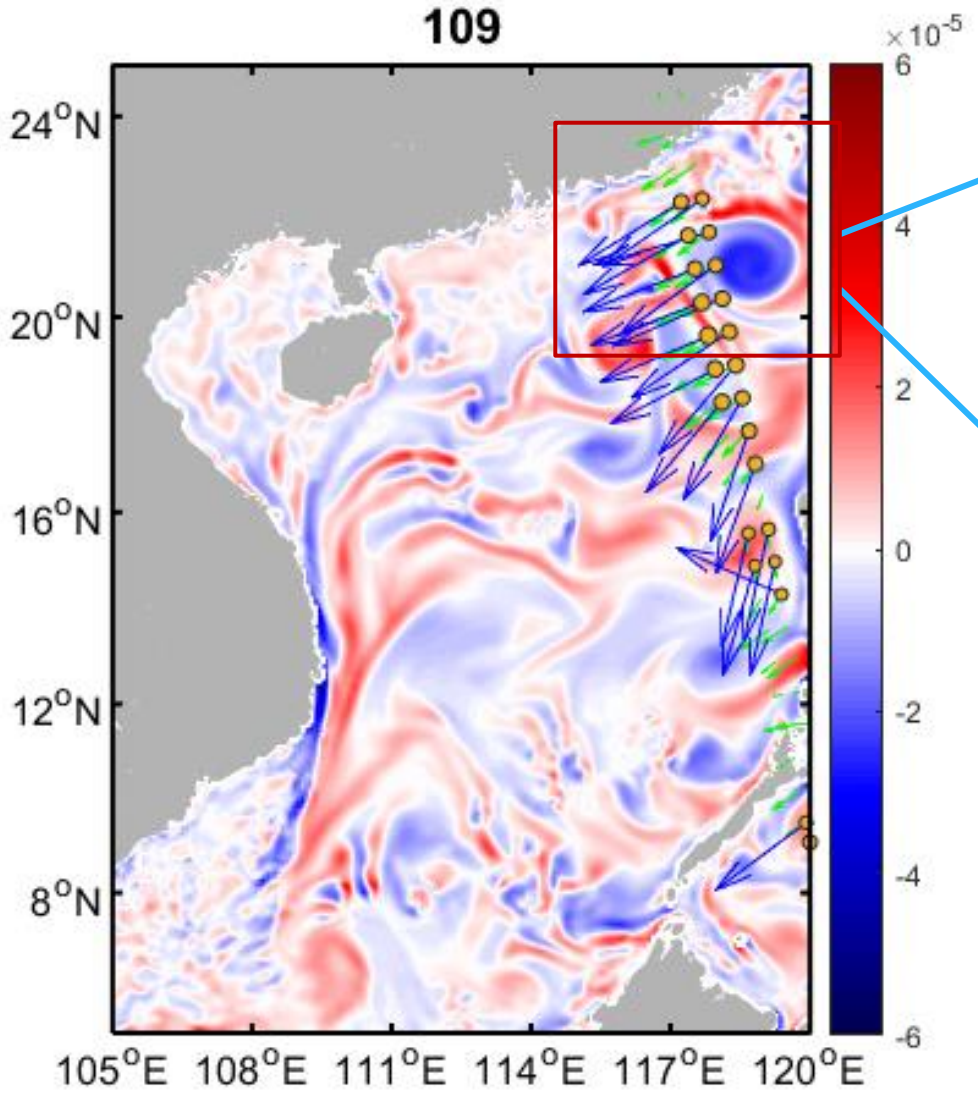


Study area: the South China Sea

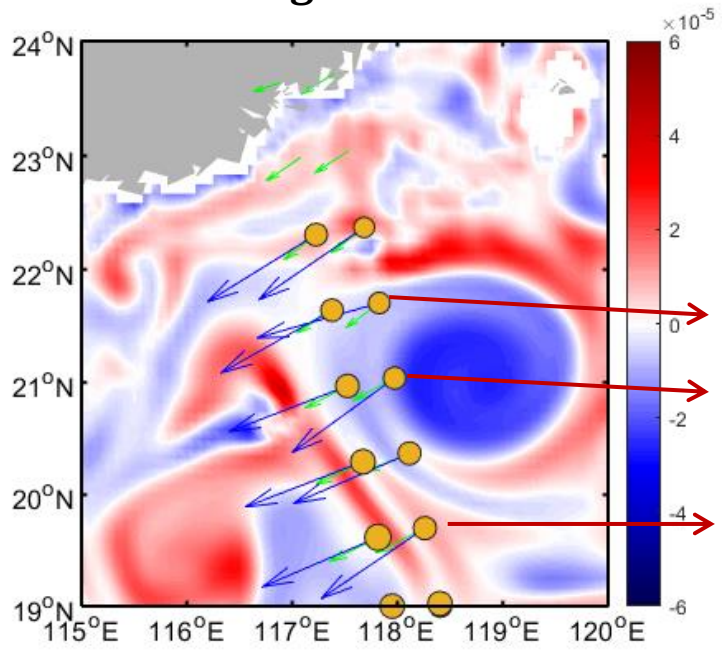
Method: statistical analysis
Corresponding

Purpose: wave characteristics in eddies from simultaneous CFOSAT observation and altimetry data

3. Effects of eddy on waves



Strong eddies



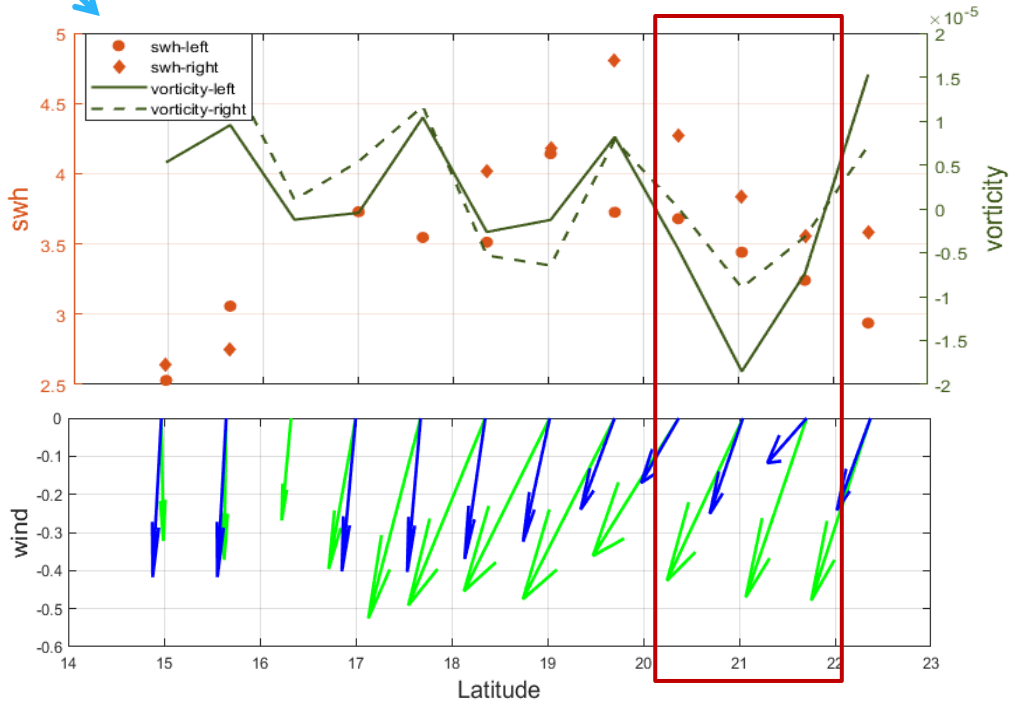
wave

wind

edge

inside

outside



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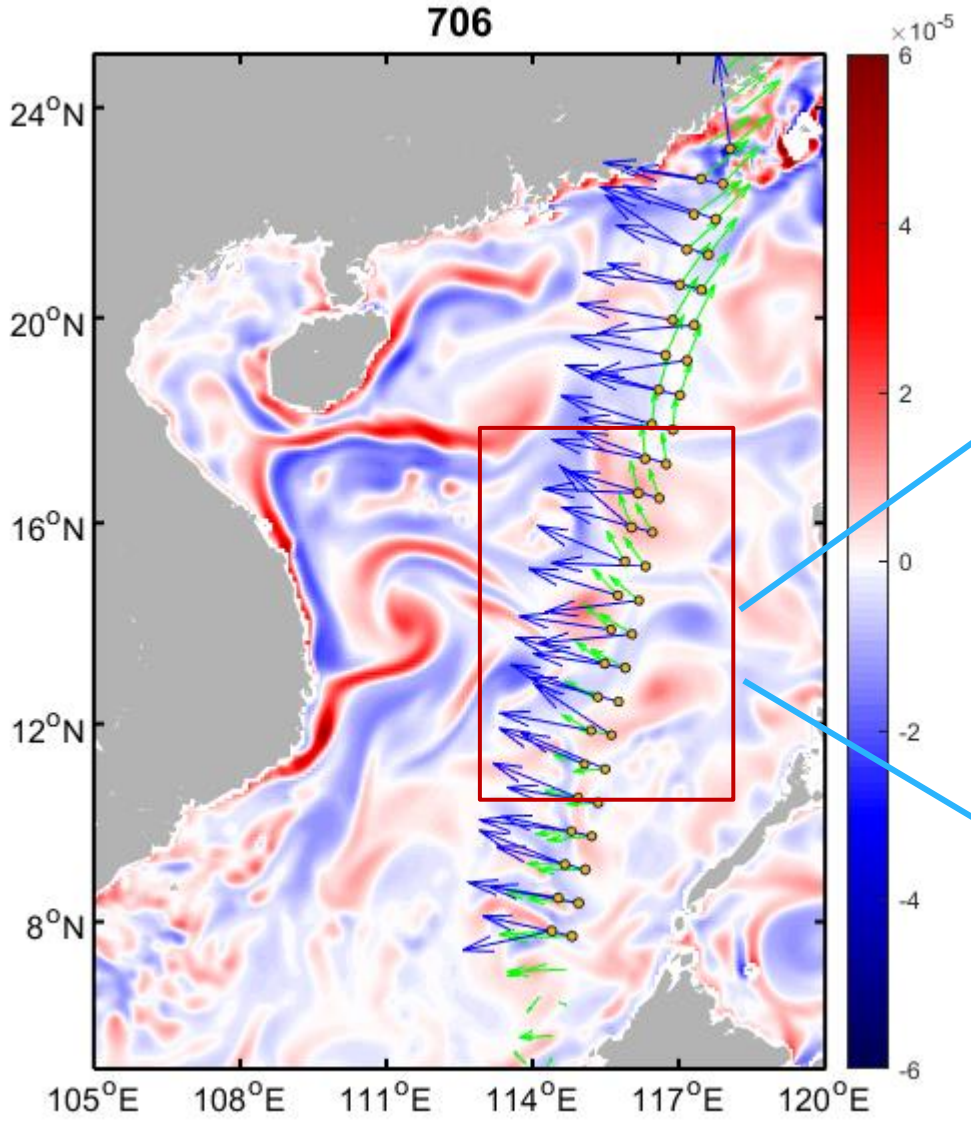
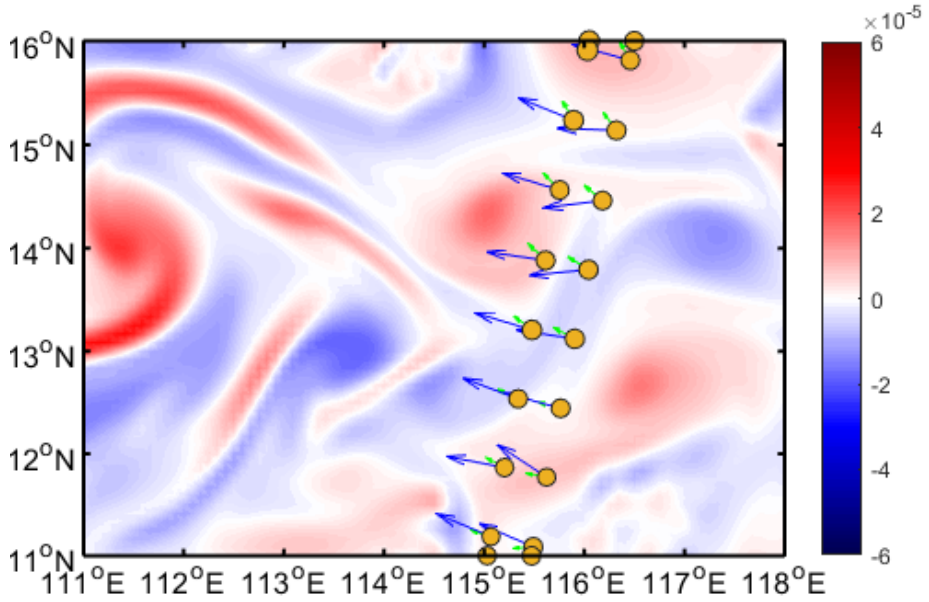
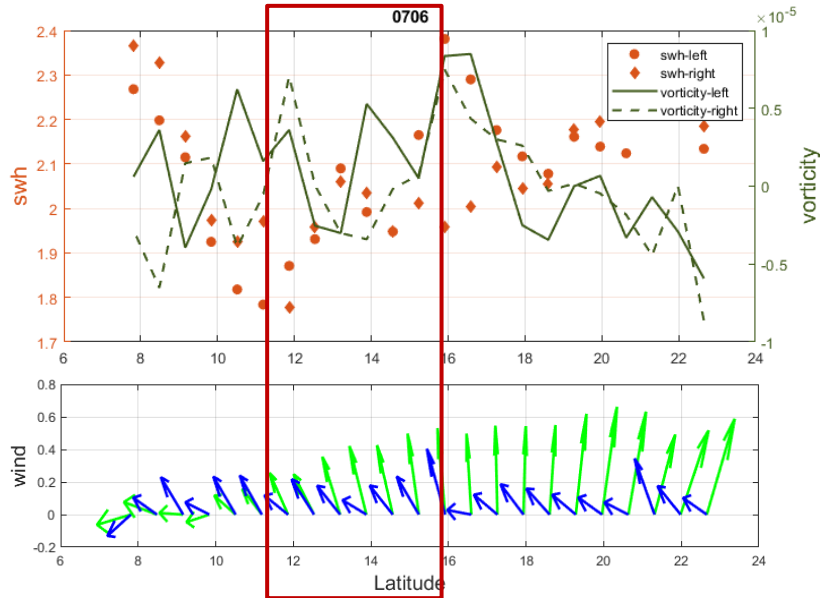
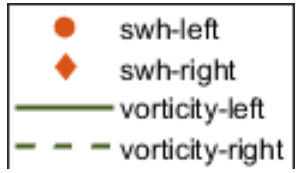


Weak eddies

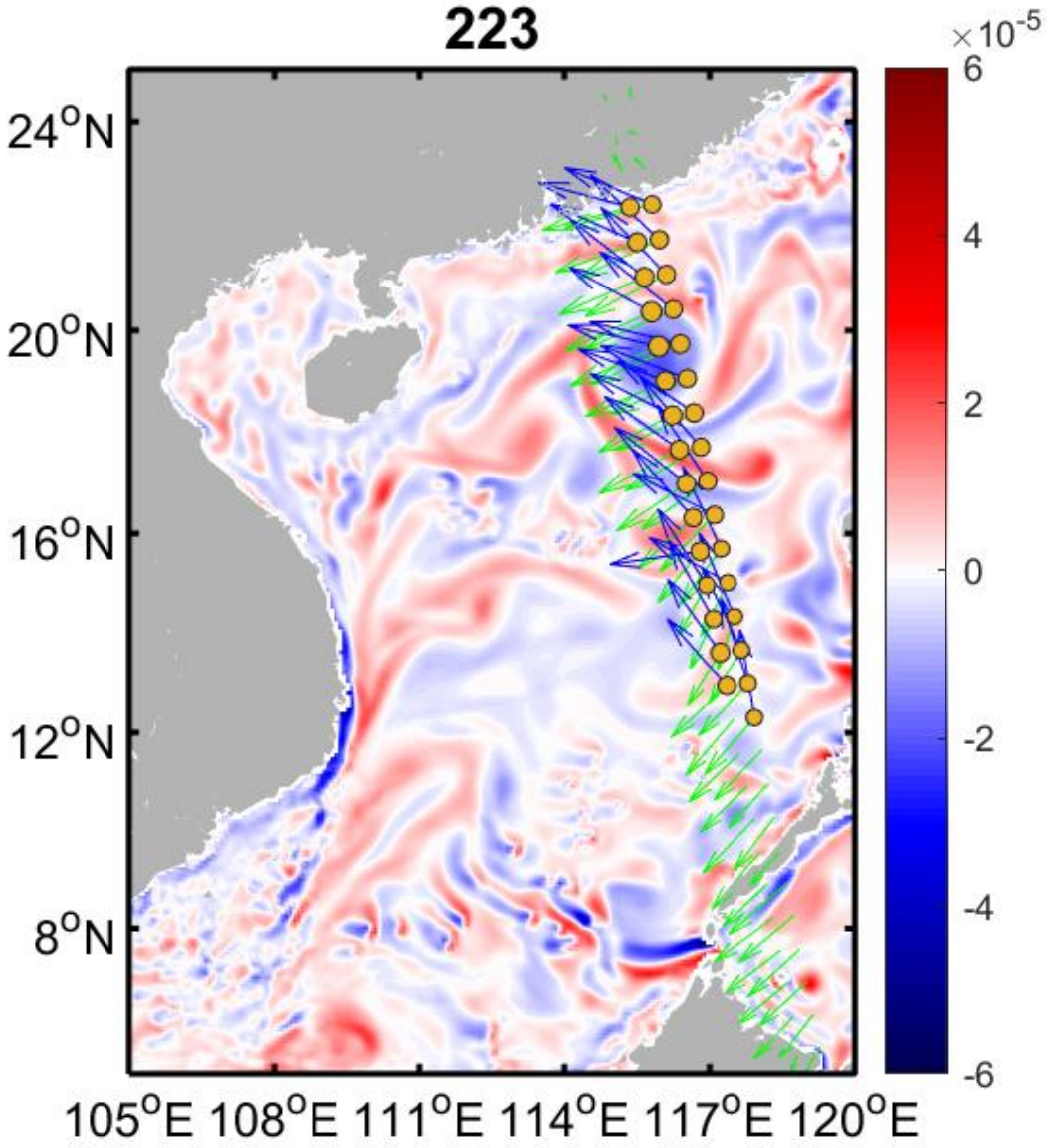






wave

wind



temporal coverage:

2019.7.28-2021.02.28

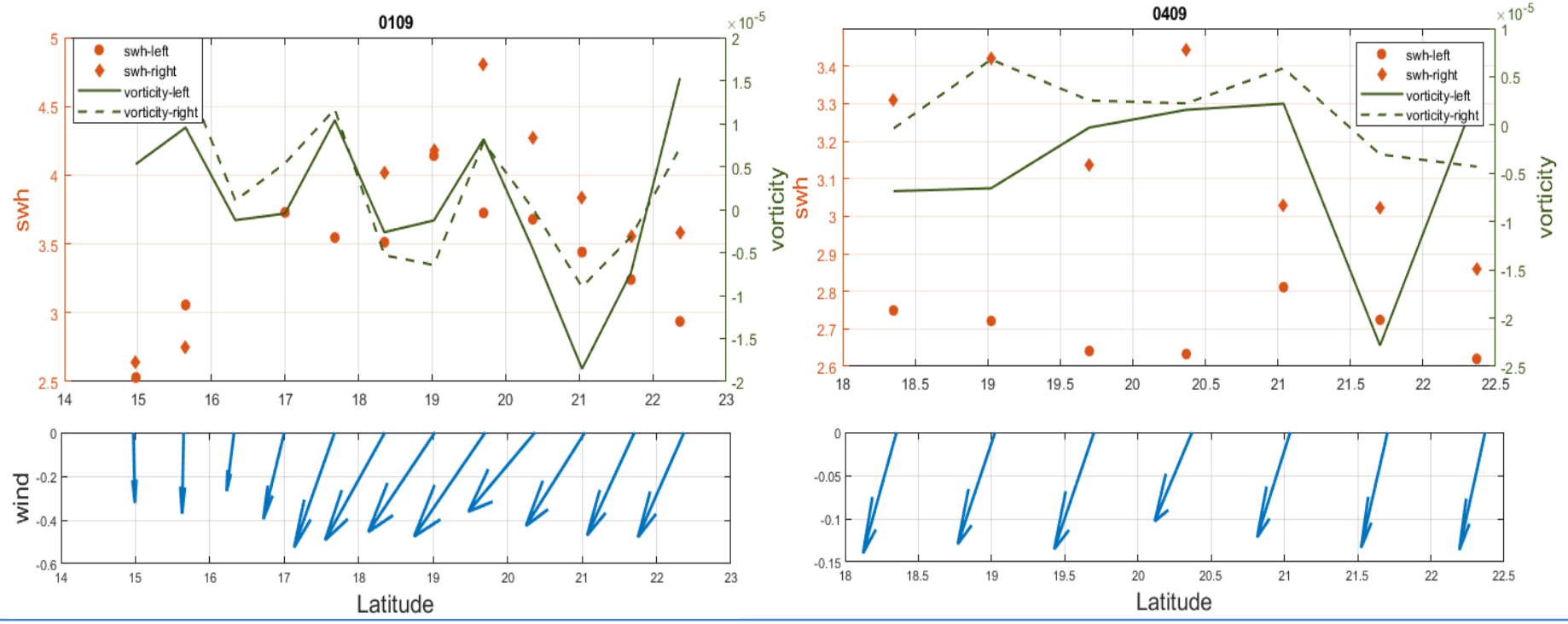
Total samples: 96

Strong eddy: 24 **Week eddy: 72**

The strong eddies are almost warm eddies.

		inside-outside	inside-edge	edge-outside
Strong eddies	Rms of wave direction(°)	9.3	8.4	31.9
	Difference of swh (m)	1.06	0.41	1.0
	Error percentage of swh	14%	5%	16%
Weak eddies	Rms of wave direction(°)	12.3	11.5	17.6
	Difference of swh (m)	0.15	0.1	0.1
	Error percentage of swh	7%	7%	8%
Total	Rms of wave direction(°)	10.9	11.3	23.89
	Difference of swh (m)	0.30	0.15	0.36
	Error percentage of swh	8%	5%	11%

- **Correlation coefficient**



	swh	Wave length	Wave direction
wind	0.42	0.25	0.37
Vorticity(total)	0.10	-	-
Vorticity(low)	0.06	-	-
Vorticity(high)	0.10	-	-

Conclusion

1、The statistical results show that the significant wave heights (SWH) at the inside the eddy are generally higher than that outside the eddy. The error percentage of the SWH variation is around 8%.

2、The wave propagation directions change significantly at the eddy edge where submesocale frontal processes occur, and the error percentage of the SWH variation is around 11%.

3、According to the result of Correlation coefficient, the effect of winds on surface wave is more significantly. Eddies, leading to convergence or divergence of sea water affect the upper wind field, as an indirect role.