Title

Mesoscale sea surface wind and SST coupling characteristics in the northern South China Sea

Members

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Aim

Combining recent research progress from two recently finished projects founded by National Natural Science Foundation of China (NSFC, 2017-2020) and JSPS KAKENHI (2017-2020), deepening understanding on the fine structure of the coastal fronts and the accompanied mesoscale SST-wind couplings in the northern South China Sea, especially focusing on the different coupling characteristics obtained by using QuiKSCAT data and ERA5 reanalysis data.

Procedure

1. Use high resolution sea surface wind and SST data to investigate the relationships between the spatially high-pass filtered downwind (crosswind) SST gradient and wind stress divergence (curl) in the northern South China Sea.
2. Compare the statistics parameters and fitting performances presented by satellite and reanalysis data.
3. Use different spatial filters to find the possible physical explanations for the different SST-wind coupling coefficients obtained by satellite and reanalysis data.

Results

In this year, the influences of coastal fronts on the sea surface wind are further studied by using satellite and reanalysis data. Our study finds that both satellite and reanalysis data present an apparent meso-scale SST-wind couplings associated with the thermal fronts in the northern South China Sea. However, there is also a significant difference between the results from satellite and reanalysis data, which could provide more details about the SST-wind coupling in this area but has not been documented well.

The temporally averaged maps in DJF of 2008 are used as an example. It is shown that there is no general linear relation between the gradient of the wind stress magnitude and the SST gradient in the study area. Then, a spatial high-pass filter was applied to isolate the mesoscale perturbations of sea surface wind and SST. The spatially high-passed fields show an apparent linear relationship between the perturbation wind stress divergence, $\nabla \cdot \vec{\boldsymbol{\tau}}'$ and the perturbation downwind SST gradient $(\nabla T \cdot \vec{\boldsymbol{\tau}})'$ (Figure 1). Furthermore, it is also noticed that the standard deviations of the scatter of points within each bin using satellite data is larger than the standard deviations using reanalysis data. Menawhile, the coupling coefficients (slopes of the regression line) obatined by satellite data is a little smaller than that of reanalysis data. The same results are presented in the linear relationships between the perturbation wind stress curl, $\nabla \times \vec{\boldsymbol{\tau}}'$ and the perturbation crosswind SST gradient $(\nabla T \times \vec{\boldsymbol{\tau}})'$.

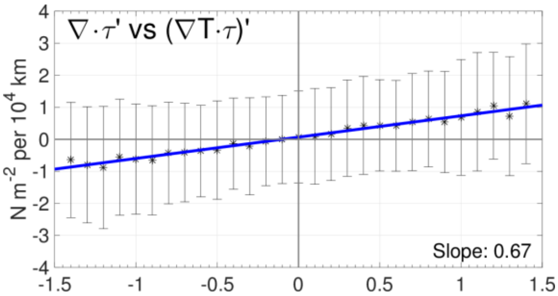

Figure 1. Binned scatterplots of the relationships shown by the perturbation wind stress divergence, $\nabla \cdot \vec{\boldsymbol{\tau}}'$, plotted as a function of the perturbation downwind SST gradient $(\nabla T \cdot \vec{\boldsymbol{\tau}})'$ using (a) the QuikSCAT wind stress and OSTIA SST in DJF of 2008; (b) the ERA5 sea surface wind stress and SST. The solid circles and vertical bars in (b) and (c) represent the mean and ± 1 standard deviation of the scatter of points within each bin.

Then, the physical mechanisms for the different standard deviations given by satellite and reanalysis data (Figure 1) are further discussed. Although satellite and reanalysis data have a spatial resolution of 27 km (0.25 degree) for QuikSCAT data and of 31 km for ERA5 data, the QuikSCAT data could provide more information on the spatially high wave number perturbtions in surface wind stress field and SST than ERA5 data does, because the input SST is spatially pre-smoothed one to drive the ERA5 model. This feature is further examined by Figure 2. Figure 2 shows that the standard deviations for the scatterplots are significantly reduced, when the original QuikSCAT data are spatially smoothed by a window of 0.75° × 0.75°. Therefore, it is proved that QuikSCAT observed the perubations of wind stress that has a smaller spatial size less than 0.75°. It also indicates that there could be a possibility that no apparent linearship between the pertubation of SST and wind stress exists over this scale and therefore the discoupling enlarges the standard devations in the linear relationship of mesoscale SST-wind coupling. This finding expands our understanding for the influences of coastal fronts on the atmospheres.

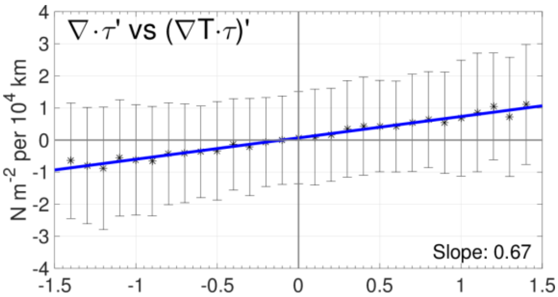

Figure 2. The same as Figure 1 but for the (a) the perbutaions using unsmoothed wind stress and SST; (b) the pertubations obtained after pre-smoothed wind stress and SST data.

Publication

1. Rui Shi, Xinyu Guo. Comparison between the difference SST-wind coupling revealed by satellite and reanalysis data in the northern South China Sea (In preparation).

Perspectives in future

In the last year, I kept contacting with my LaMer supervisor Prof. Guo through online meeting, so we can continue our research as planned. During our study, we found that the SST-wind coupling characteristics, e.g. the regression slopes shown in Figure 1, varies year by year either using satellite data or using reanalysis data. The physical mechanisms for such variation is not clear. Therefore, we want to further study the annual or decadal variations of the SST-wind coupling and find out the related mechanisms.