Estimation of tropical cyclone location and intensity using HY-2B scatterometer data

Wenming Lin[1], Siqi Liu[1], Marcos Portabella[2], and Carla Chevillard[2,3]

[1] School of Marine Sciences, Nanjing University of Information Science and Technology, Nanjing, China; Email: wenminglin@nuist.edu.cn

[2] Institut de Ciències del Mar (ICM-CSIC), Barcelona, Spain;

[3] IMT Atlantique Bretagne, Brest, France

1. Introduction

Having a precise estimation of Tropical Cyclone (TC) center and intensity is of common concern to both physical oceanographers and weather. In this paper, an alternative approach to directly taking the maximum scatterometer-derived wind speed is proposed to assess the TC intensity. First, the TC center location is identified based on the unique characteristics of wind stress divergence/curl near the TC core. Then the radial extent of 17-m/s winds (i.e., R17) is calculated using the wind field data from the Haiyang-2B (HY-2B) scatterometer (HSCAT). The feasibility of HSCAT wind radii in determining TC intensity is evaluated using the maximum sustained wind speed in the best-track database.

2. Data and Method

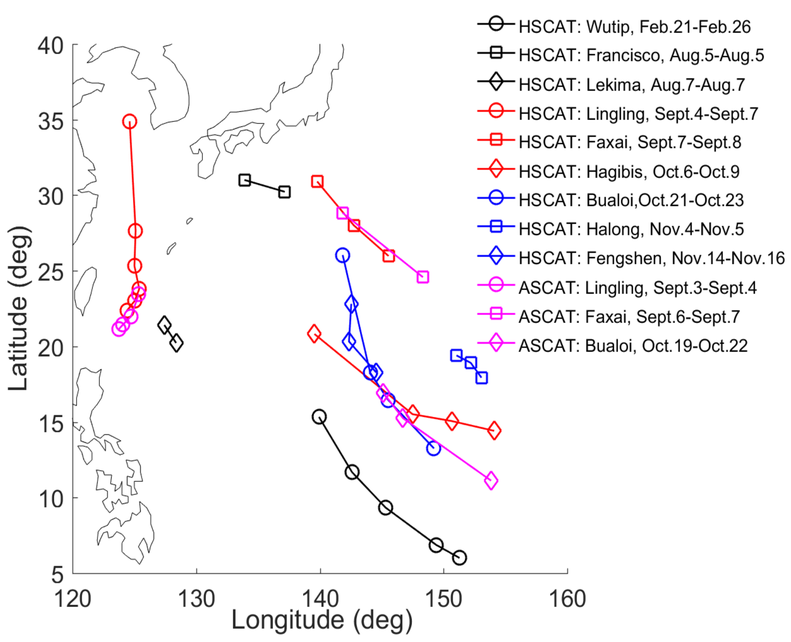

Fig. 1 The observation data used in this study. The legend indicates the observing sensors, the TC names, and the TC durations in year 2019. The markers indicate the TC center location identified with the method in Fig.2.

- The divergence and/or the curl of scatterometer wind stress near the TC core show distinct signatures which are useful for identifying TC center location. That is, two (positive) local maxima and two (negative) local minima appear symmetrically near the TC core, as shown in Figure 2. Consequently, one can take the intersection of the two lines constructed separately by the local maxima and the local minima as the TC center.

- Taking the identified TC center as the origin of Polar coordinates, the wind speed profiles along a set of equally spaced azimuth angles (e.g., 24 intervals in total) are calculated using spatial bilinear interpolation. At the i^{th} azimuth angle, the radial extent of 17-m/s wind is recorded as d_i, as such the azimuthally averaged radius (R17) is given by, $R17 = \frac{1}{24}\sum_{i=1}^{24} d_i$

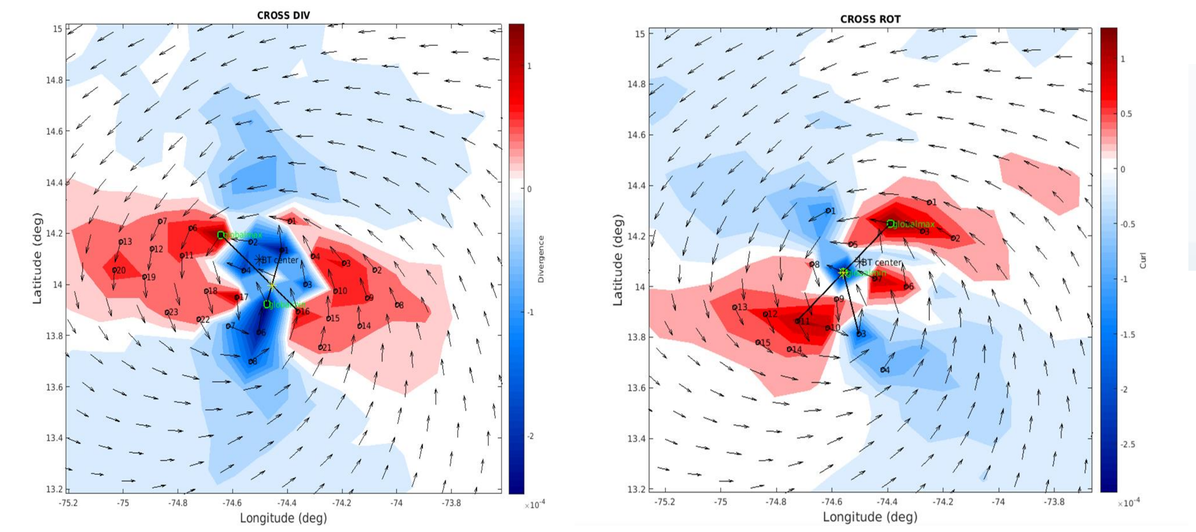

Fig. 2 ASCAT-derived wind stress divergence (left plot) and curl (right plot) fields for the case of storm MATTHEW, superimposed to the associated ASCAT-derived wind field. The local maxima and minima are indicated by numbers and black circles, while the global maximum and minimum are identified with the green circles. The estimated TC centre is indicated by the yellow cross.

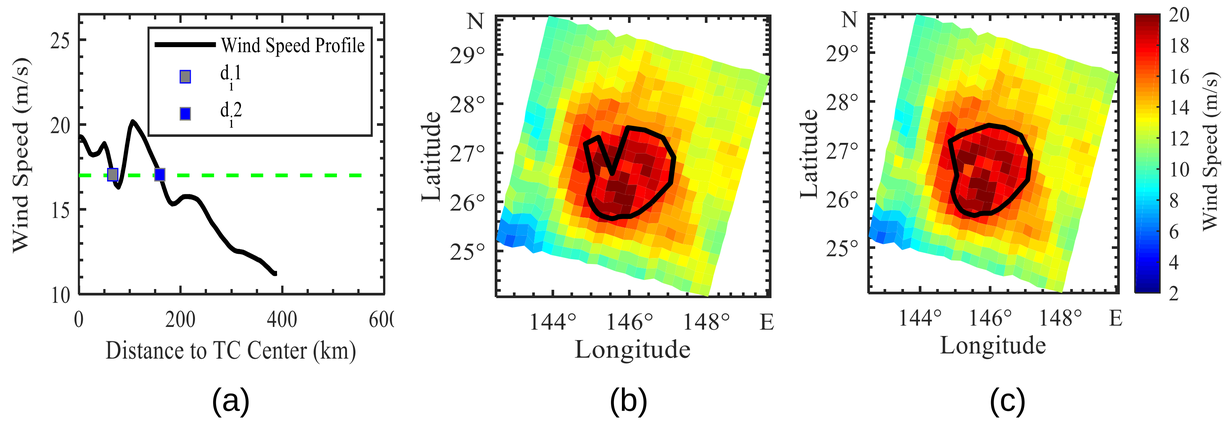

Fig.3. Illustration of exception handing in the estimation of R17: (a) more than one 17-m/s intersections in a wind profile; (b) isogram of 17-m/s wind speed constructed from the radial extent of 17 m/s winds closest to TC center; (c) corrected isogram of 17-m/s wind speed.

3. Results

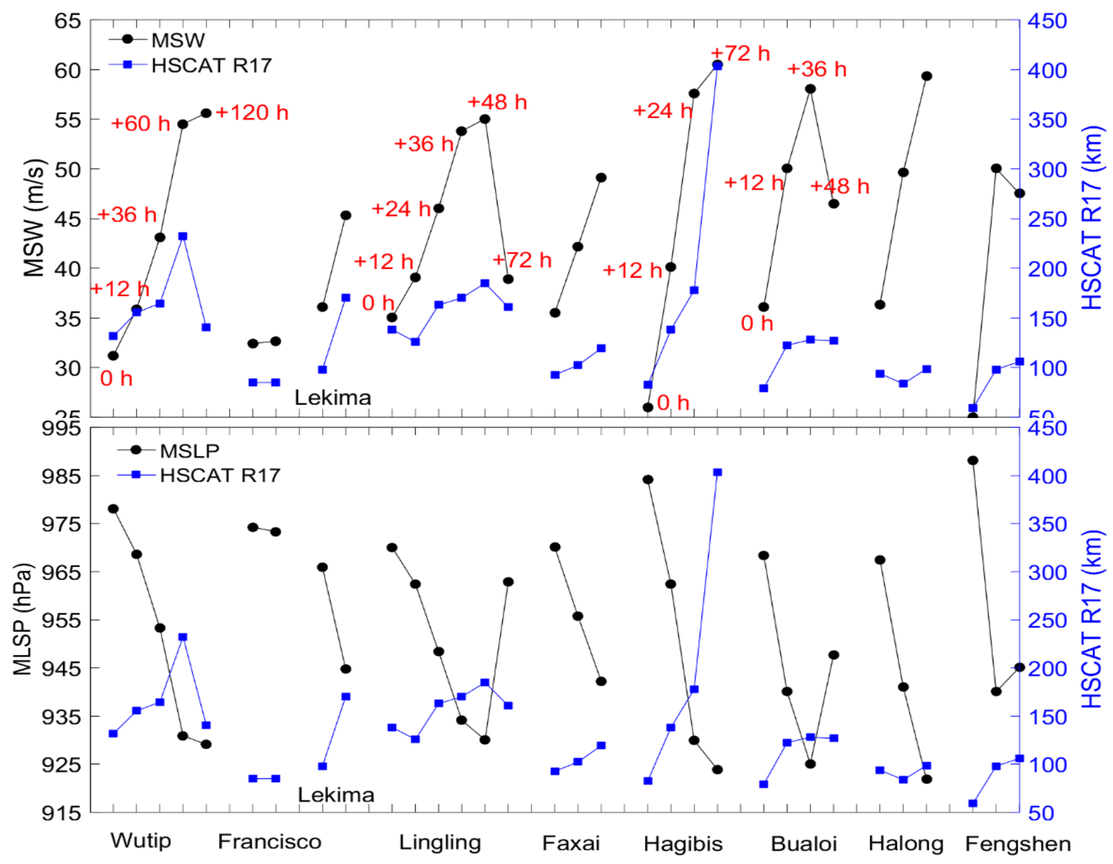

Fig. 4 The correspondence between HSCAT R17 and best-track Maximum Sustained Wind (MSW) (**upper**) and Mean Sea Level Pressure (MSLP) (**lower**), respectively. The red text in (**upper**) shows the temporal evolution of the TC events with more than three HSCAT acquisitions.

Table 1. Correlation between different variables and best-track MSW/MSLP

TC name	Correlation coefficient					
	R17 vs MSW	HSCAT W_{max} vs MSW	ECMWF W_{max} vs MSW	R17 vs MSLP	HSCAT W_{max} vs MSLP	ECMWF W_{max} vs MSLP
Wutip	0.53	-0.36	0.33	-0.54	0.36	-0.34
Wutip (<72h)	0.97	0.04	0.89	-0.97	-0.02	-0.88
Lingling	0.83	0.63	0.56	-0.84	-0.61	-0.54
Hagibis	0.79	0.76	0.91	-0.81	-0.78	-0.92
Bualoi	0.86	0.16	-0.08	-0.87	-0.17	0.09

4. Conclusions

In tropical cyclones (TC), the maximum wind speed derived from operational satellite radars (scatterometers) operating at Ku-band is generally much lower than the real TC intensity (maximum sustained wind), hampering the use of scatterometer winds in monitoring TC-induced disasters. Here we develop a novel method to retrieve wind radii information (i.e., the spatial extent of a TC above a certain wind speed value) from the HY-2B scatterometer (HSCAT) observations, and then assess the feasibility of HSCAT wind radii in determining the TC intensity. Comparing to the best-track data reanalyzed by the China Meteorological Administration (CMA), the HSCAT wind radii are better proxy for TC intensity than the HSCAT-derived maximum wind speed. For a single TC event, the correlation coefficient between the wind radii of 17-m/s HSCAT winds and the best-track maximum sustained wind speed is up to 0.86.

References

[1] S. Liu, W. Lin, M. Portabella, Z. Wang. Characterization of Tropical Cyclone Intensity using the HY-2B Scatterometer Wind Data. Remote Sensing, 14(4), 1035, 2022.