Comment on the manuscript „Scatterometer hurricane wind speed retrievals using cross polarization“ by van Zadelhoff et al.

Referee: Xiao-Ming Li, Remote Sensing Technology Institute, German Aerospace Center (DLR), Oberpfaffenhofen, 82234, Wessling, Germany.

Email: Xiao.Li@dlr.de

A detailed study on using RADARSAT-2 cross polarized data (VH) to retrieve high wind speed under hurricanes is presented in the manuscript. It is an interesting study and it merits to be published after some revisions.

Some minor comments are given below.

Q.1. It is understood the primary purpose of the study is to demonstrate the necessarily to establish a VH channel in the next generation scatterometer instruments. However, the presented study is fully based on RADARSAT-2 data. Please consider whether the title matches well with the contents.

Q.2. Pp. 7947, line 13, “In the case of SAR instruments, additional wind direction (or speed) information…”.

The referee would like to know why “additional wind speed information” is needed for SAR to retrieve the absolute wind speed using co-polarization data.

Q.3. Pp. 7947, line 21-22, “provided the prevailing wind direction is uniform…”.

This argument is not always. Wind direction can be derived from SAR using kinds of methods, e.g., FFT, local gradient, and Doppler centroid shift, even the prevailing wind is not uniform, which, on the other hand, is the advantage of using SAR to retrieve sea surface wind field in high spatial resolution. Among many typical examples, tropical cyclone is a nice one showing wind direction with significant spatial resolution can be derived from SAR.

Q.4. Pp. 7947, line 24. The referee doubts the argument “SAR systems typically achieve< 2dB”. It might be true for the SAR sensors which had operated for a long extended-life (after 10 years or so), e.g., ERS-2/SAR. However, for the new generation SAR systems, e.g., RADARSAT-2 and TerraSAR-X, the radiometric stability is very good. For instance, after its launch of three years, radiometric stability of TerraSAR-X is only 0.15 dB. Therefore, please be sure on this value.

Q.5. Pp. 7951, line 26.

If the NESZ is of around -30dB, why Fig.3 (top panel) shows so many data pairs with sigma naught of VH between -30dB and -35 dB? Are they noise?

Q.6. Pp. 7953, line 17. How the "wind speed ambiguity" is resolved to retrieve high wind speed cases using CMOD5 from VV polarization data? This question is related with the orange curve shown in the top panel in Fig. 3.

Following are two major considerations. Minor comments related with them are not pointed out individually. Please check them thoroughly based on the two points.

Q.7. The wide ScanSAR has a nominal pixel size of 50 x 50 m in both azimuth and range directions. According to the description, e.g., pp.7956, line 9, the EMCWF wind field results in 25 km scale are up-scaled to the Radarsat-2 resolution (100m) for matching up. This assumes that the averaged σ_0 in two SAR pixels is considered to be related with real wind at the locations of the two pixels. However, one has to realize that the study deals with wind speed retrieval but not a single SAR pixel.

An individual SAR pixel is not naturally corresponded to wind in the pixel location. To retrieve wind field from SAR, a regular grid with a size generally larger than 500 m should be considered (e.g., Horstmann et al., 2000), in order to: 1) reduce the speckle effect in SAR image; and 2) average the tilt modulation induced by long surface waves. Although the spatial resolution of retrieved wind speed can be further increased to be less than 500 m in some special cases (e.g., 250 m used in the study by Li and Lehner (2013)), a spatial resolution of 100 m (only averaging two pixels!) used in the present study tends to bring many problems.

Q.8. The RADARSAT-2 wide Scansar dual-polarization data is quite different from the Quad-polarization data. The previous studied by Vachon and Wolfe (2011) and Zhang and Perrie (2011) were based on the Quad-polarization data. The referee once heard a presentation by Shen and Perrie (2012) in the SeaSAR workshop. They showed a slide presenting the large difference of VH backscatter intensity between dual-pol. and quad-pol. data.

It is interesting to plot the equ. (3) given in the manuscript and overlay the scatter diagram given by Shen and Perrie (2012). Please refer to the following figure. The blue asterisks represent the VH σ_0 in dual-pol. against buoy measurements of wind speed, while the red ones represent the Quad-pol. data. The dash-dot line represents the linear equation given by Vachon and Wolfe (2011) and Zhang and Perrie (2011) (they are almost identical). It is strange that the Quad-pol. data collected by Shen and Perrie don't fit the two given linear functions, but this is beyond the discussion here. However, their dual-pol. data seem to fit well with equ.(3). If equ. (3) is extended to the regime of wind speed between 0 -20 m/s, they show very good agreement. The sharp edge between Vachon and Wolfe (2011) and equ. (3) disappears.

Therefore, the referee considers that the large difference between the RADARSAT-2 dual-pol. and quad-pol. data is an important issue that should be discussed in detail in the present manuscript.

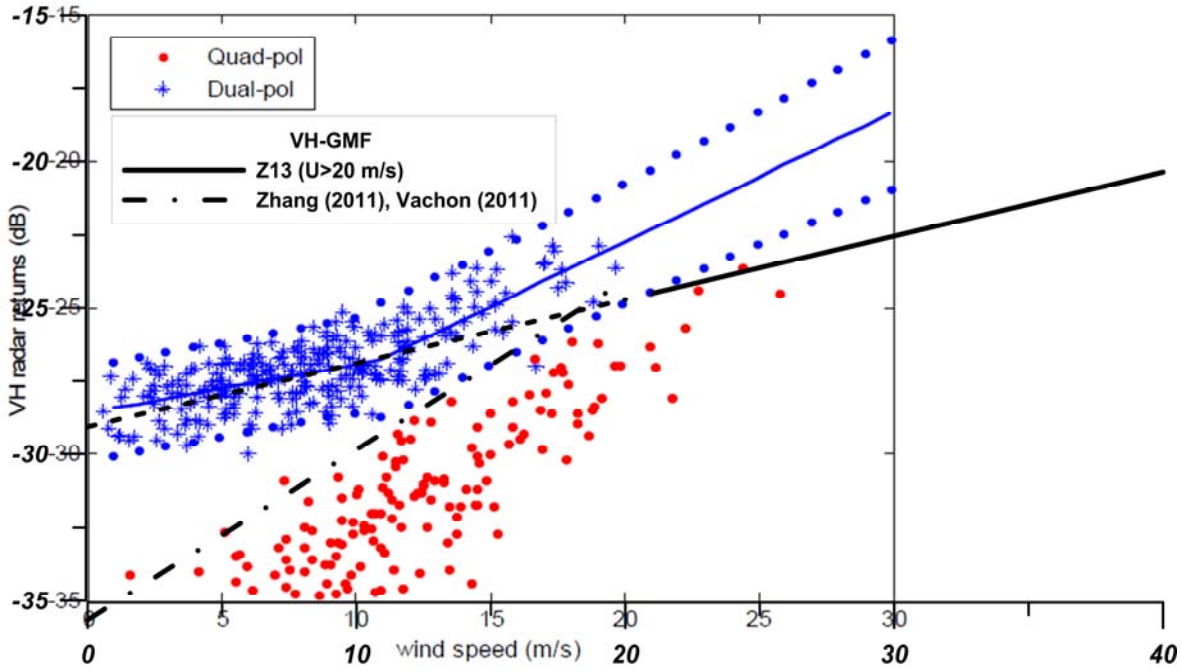

Fig. R1. Comparison of different VH-GMF for sea surface wind speed retrieval using RADARSAT-2 dual-polarization and quad-polarization data. The scatter diagram in the background is adopted from Shen and Perrie (2012).

Although the study is related with high wind speed retrieval, Fig. 3 also shows that there many available collocations for the sea surface wind speed lower than 20 m/s. In particular, wind speed retrieval using CMOD5.N shows a strikingly match with SFMR measurements, which indicates that a new and a continuous function could be derived for sea surface wind speed retrieval using the RADARSAT-2 cross-polarized data (of dual-pol.) to differentiate from the previous ones based on the Quad-pol. data.

Reference:

[1] J. Horstmann, W. Koch, S. Lehner, and R. Tonboe, “Computation of wind vectors over the ocean using spaceborne synthetic aperture radar,”*Appl. Phys. Lab. Tech. Dig.*, vol. 21, no. 1, pp. 100–107, Nov.2000.

[2] H. Shen and W. Perrie (2012), “On ocean surface wind retrieval from VH dual-pol Radarsat-2 SAR imagery”, presented in SeaSAR 2012 workshop. Online available at: https://earth.esa.int/documents/10174/233984/4-On-Ocean-Surface-Wind-Retrieval-VH-dual-pol.pdf/0b41bbaf-b50a-4152-bf5e-2d91919aa72f?version=1.0

[3] Li, X.-M., & Lehner, S. (2013). Observation of TerraSAR-X for studies on offshore wind turbine wake in near and far fields. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 6 (3), 1757-1768, doi: 10.1109/JSTARS.2013.2263577