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Interactive comment on "A Simple Method for Retrieving Significant Wave Height from Dopplerized X-Band Radar" *by* Ruben Carrasco et al.

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The authors appreciate the thorough and constructive review by Dr. Plant. When we started analyzing the dataset we were also very surprised about the outcome of the statistical results. We are aware of the dependencies which we neglected and therefore we welcome a scientific discussion on the issues that are pointed out by Dr. Plant.

Dr. Plant depicts in his comments the physical relationship between the line-of-sight velocities and the height of ocean surface waves:

"The true relationship between the wave-height-variance spectrum, F_a , and the variance spectrum of V_{los} , F_V , is

$$\int F_V(\omega,\varphi)d\omega d\varphi = \int \omega^2 F_a(\omega,\varphi-\varphi_a)d\omega d\varphi \tag{1}$$

where ω is angular frequency, φ wave propagation direction relative to the wind and φ_a is the antenna look direction relative to the wind. If one assumes that F_a and F_V are very sharply peaked at a given frequency and azimuth angle, then this may be written

$$F_V = \omega_p^2 F_a, \tag{2}$$

assuming that the antenna looks into the wave propagation direction. Therefore, in the authors' notation,

$$H_s = 4\sigma_D/\omega_p. \tag{3}$$

There is no doubt that ω_p belongs in the equation."

The authors are aware of this relationship and agree that from the physical point of view, according to linear wave theory, the radial frequency has to be taken into account to transform from speeds to heave. However, we realized that a simple, empirically derived relationship between the periodic features in the Doppler signal and the Significant Wave Height (Hs) of the sea state is statistically performing better than previous attempts of estimating Hs using physically more substantiated approaches. This new finding was the main motivation for the submission of this article.

It is mentioned that *"in the real world it is not easy to determine ω_p because sometimes the frequency chosen as the peak of the spectrum is that of the wind waves and sometimes that of the swell. In reality, as we see above, H_s is determined by the whole spectrum. Therefore, any simple method of determining it is bound to be approximate.*

The authors' method may work better than one containing ω_p because of the difficulty of determining its value. However, their method is bound to be location-specific and the relationship will not always be $\omega_p = 1$ as the authors propose. Just think of carrying out their procedure in a wind wave tank at short fetch. (Yes, this can be done with a CW system and the antenna at a higher grazing angle.) The constant of proportionality will not be one.

The authors need to acknowledge this and show a histogram of ω_p for their entire time series. Care will have to be taken to be sure that ω_p corresponds to the type of waves carrying the most energy."

Indeed it is a hard task to assess a representative estimate of ω_p for a specific wave spectrum. For most of the cases of this study, the highest energy peak is clearly defined. This might be due to the fact that the German Bight of the North Sea is not influenced by high energy swell events and we think that for the future it would be great to check the applicability of the method to swell-dominated areas. Nevertheless, the analyzed dataset contains a high variation of the peak frequency. Fig. 1 (of this document) shows a histogram of ω_p for the whole dataset used in this study. It can be seen that, the peak radial frequencies range from approximately 0.25 up to 2.5 with most events slightly smaller than 1. The reason why we decided not to include this figure in the article is that we think that the color-coding in the scatter plot depicted in Figure 7 delivers enough information on the variability of the Peak Period for the analysed dataset. In addition, Figure 3 provides information on the large variety of

different wave conditions, from developing seas to storm events as well as decaying seas.

"The authors also need to inform the reader how the antenna was aligned to look into the waves and what was done when swell and wind waves were not aligned. Perhaps this was easy to do at the authors' site but it will not be so at all sites."

The radar was scheduled as described here (Page 3, Lines 13-21). We added a line to the revised manuscript (highlighted in blue) to inform the reader about what was done in swell cases:

"The radar can be operated with two different modes. In the rotational mode the antenna rotates at 30 rounds per minute capturing 360° of the surrounding of the platform (Figure 2). Within the static mode the antenna is oriented into a preselected direction where it then collects data over time. ... The radar was scheduled with an hourly cycle starting with 10 minutes of rotational data, which were utilized to retrieve the wave spectra and in particular the peak wave direction (Nieto-Borge et al., 1999). Within the following 32 minutes, 10 predefined directional scans were acquired in the static mode, which were not used within this study. After these 10 acquisitions the antenna was oriented into the radar-retrieved peak wave direction (looking up-wave) to acquire 15 minutes of data in the static mode. For multi-modal sea states the radar antenna was solely pointing in the direction of the highest energy peak of the radar image spectra derived automatically from the polar radar image sequences."

Of course this might be a limitation of the proposed method for cases with a significant portion of energy located in a second wave system traveling perpendicular to the main one. As mentioned above the German North Sea is weakly influenced by strong swell events. Therefore, if a second system is apparent in the analysed dataset, its energy is mostly small (amplitudes < 0.5 m). We thank Dr. Plant for pointing out the need for a more profund discussion on that topic and modified our consideration of this limitation in the Results and Discussion section of the paper:

Page 6, Lines 30-33: "Additionally, multi-modal seas are expected to influence the accuracy of the method, because the energy of the second wave system is not caught by the radar if the secondary peak wave direction differs strongly from the first. The energy of a second wave system travelling perpendicular to the antenna view direction would be underestimated due to a reduction of the radial velocity variations by projection effects. As the German Bight of the North Sea is not influenced by high energy swell events this might be a major issue in the open ocean where the presence of pronounced swell systems is more frequent. For older sea states (or long waves) an underestimation is expected because linear wave theory has not been applied to transform the horizontal orbital speeds to surface elevation."

"Also, it would be nice to know which radar method was used to determine Hs in Figure 8."

It's the simple method introduced in this paper. We have added the information in the figure caption.

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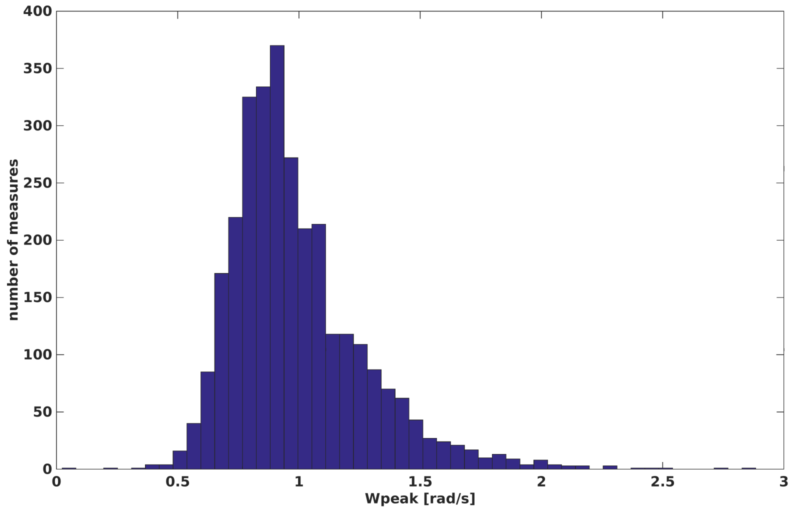

Fig. 1. Histogram of peak radial frequencies of the analysed datased