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## An In-situ Reference for High and Extreme Winds

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A particularly pressing requirement in the Ocean Surface Vector Wind (OSVW) community is to obtain reliable extreme winds in hurricanes (> 30 m/s) from wind scatterometers, since extreme weather classification, surge and wave forecasts for societal warning are a high priority in nowcasting and in numerical weather prediction (NWP). A main goal of the EUMETSAT C-band High and Extreme-Force Speeds (CHEFS) study is therefore to consolidate an in-situ wind reference for assessing scatterometer high and extreme-force wind capabilities.

Scatterometers have proven to have very good performances when retrieving low to moderate winds. However, measuring high and extreme winds is still challenging as vicarious calibration is needed and calibrated in situ reference winds are scarce.

Moored buoy data are usually used as absolute reference to calibrate the scatterometer Geophysical Model Functions (GMF), however, for very high and extreme winds above 25 m/s, moored buoys may not be reliable. Moreover, controversy exists in the OSVW satellite community on the quality of moored buoys above 15 m/s rather than 25 m/s. Hence, the quality of buoy winds between 15 m/s and 25 m/s is thoroughly evaluated. The buoy wind performance, estimated with triple collocation analyses of buoy, ASCAT and ERA5 winds, shows that the quality of buoy wind vectors up to 25 m/s is within 2 m/s, indicating that buoy winds can indeed be used for wind scatterometer GMF calibration in the mentioned wind range.

The NOAA hurricane hunters fly into hurricanes to drop sondes, and thus obtain wind profiles in the lowest few kilometers of hurricanes, and operate dedicated microwave instrumentation on aircraft to obtain detailed wind patterns in hurricanes, such as the Stepped-Frequency Microwave Radiometer (SFMR). Ideally, local dropsonde winds may be statistically used to calibrate SFMR as they have similar spatial representation ("footprint"). SFMR, in turn, after spatial aggregation to scatterometer footprints, may be used to calibrate satellite scatterometers and radiometers in overflights.

The so-called WL150 algorithm is operationally used to estimate 10-m surface winds from dropsonde wind profiles. The measured radiosonde 10-m winds are a more direct calibration

resource for the 10-m surface wind than WL150 estimates. However, an improved assessment of the position processing of the sonde near the surface, where its deceleration is maximum, is needed.

The air mass density needs to be considered to calibrate scatterometer winds in hurricanes, as these mainly occur at low pressures and hence low air mass density, i.e., so-called stress-equivalent winds should be used for comparison.

Finally, ASCAT winds show sensitivity to high winds, but lack good GMF calibration due to the lack of a consolidated in-situ wind reference. The saturation of the GMF at extreme winds is somehow compensated by the high calibration stability of the ASCAT instrument. As a result, further backscatter calibration refinements will support the retrieval of good-quality ASCAT winds in extreme conditions. In addition, GMF development and wind retrieval studies will be useful to improve high and extreme winds, in particular after a consolidated in-situ wind reference has been established.