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TC observations from Synthetic Aperture Radar: short term perspectives

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More than 200 Sentinel-1 acquisitions over Tropical Cyclones (TC) eyes have been accumulated since 2016 thanks to the SHOC scheme (Satellite Hurricane Observation Campaign) operated in collaboration with ESA ground segment. These high-resolution observations have shown the great potential offered by S1 constellation in dual-polarization to monitor TC along their lifetime and to provide numerous observable parameters such as maximum sustained wind speed (up to 80 m/s) and TC structure (e.g. wind radii, eye geometry and position). Co-locations with the Stepped Frequency Microwave Radiometer (SFMR) confirm that, even for extreme cases, S1-derived ocean wind speeds are found in agreement and able to provide consistent measurements in the eyewall. Similarly, co-locations between SMOS and S1-wind degraded at a similar medium resolution are in good agreement. Also, Hurricane experts listed in their recommendations at the 40th WMO Hurricane Committee for USA/Caribbean region that “Special acquisitions plans during Irma, Jose and Maria having demonstrated the high value of kilometric-scale information provided by Sentinel-1 SAR data, HC40 recommends that these data are made available to help monitor critical aspects of the TC structure”.

Based on this demonstration, a new ESA-funded project called CYMS (CYclone Monitoring service with S-1) starts in February 2020, with the objective of scaling up the SHOC initiative for its potential integration as part of a Copernicus Service. One objective is the operational delivery of tailored S1-derived TC observations to tropical cyclone forecasters of all tropical cyclone Regional Specialized Meteorological Centres (RSMCs) and Tropical Cyclone Warning Centres (TCWCs). Besides, S1 TC observations will contribute to a new database for science applications.

In order to continuously keep improving the S1-derived TC observations, current limitations in the wind field retrieval are recalled and perspectives to overcome them are proposed. First, the presence of rain signatures over SAR images requires a fine pre-processing filtering of these non-wind related features in order not to interpret them as wind speed. Second, the current inversion using the co- and cross-polarized NRCS channels via a noise-dependent mixing can show some limitations for wind speed around 30m/s. Alternative schemes are proposed to mitigate this issue. Third, S1 wind directions are mostly influenced by the co-located atmospheric model which can show some significant shifts with respect to the actual situation. Pre-processing methods based on

the exploitation of wind rolls signatures, ubiquitous under intense TC, are presented to improve the wind direction retrieval. Finally, improvements of the current cross-polarized Geophysical Model Function (GMF), MS1A, are proposed taking advantage of a more complete dataset of S1 TC observations since its first estimation in 2017.

Overall, the current and future developments for S1 wind field retrieval aim at integrating all valuable observations as inputs. Additional candidate parameters of interest are the Doppler Centroïd anomaly, which is related to the radial wind, and the Co-Cross Polarization Coherence (CCPC), which is related to both the wind speed and direction.

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