

TRACKING STORMS AND HURRICANES USING SAR IMAGES

Since the launch of the constellation, Sentinel-1 keeps monitoring meteocean extremes over European and worldwide seas.

The challenge

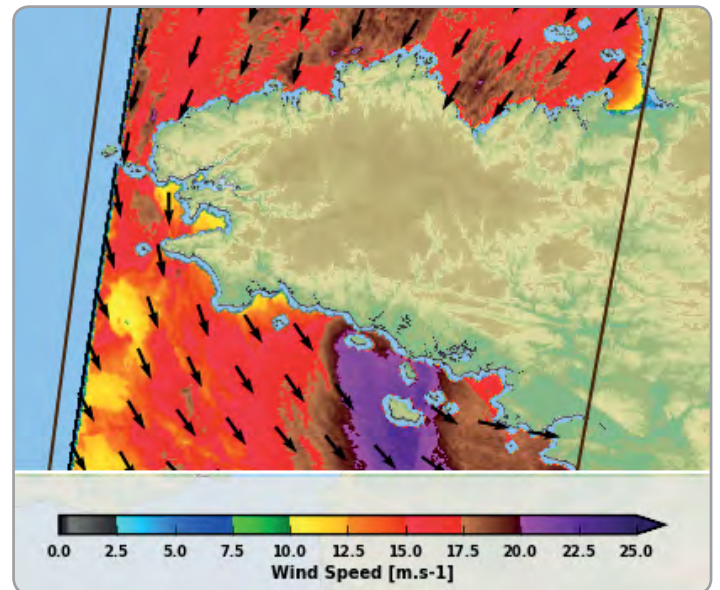
Earth Observation techniques on board the Sentinel satellites contribute to the monitoring of the marine environment. With its unique ability to observe sea surface and derive wind, wave and currents measurements in all weather and in day or night time over a wide swath image at high resolution, spaceborne Synthetic Aperture Radar (SAR) instruments are normally perfectly suited for meteocean applications. The wealth of acquisitions recently allowed by Sentinel-1 constellation opens the path to imagine and build added-value services, in order to make the most of Sentinel-1 potential and provide new meteocean applications.

The space based solution

The ocean products derived from Sentinel-1 mission are routinely produced and delivered by European Space Agency (ESA) core ground segments. Yet, they do not provide state-of-the-art wind measurements, especially limited for strongest events. To make the most of Sentinel-1 potential for the measurement of extreme winds, a dedicated campaign named SHOC (for Satellite Hurricane Observation Campaign) was performed in summer 2016. An unprecedented acquisition scenario was set up to trigger acquisitions based on forecast hurricane trajectories provided by supporting meteorological centers. More than 25 observations over hurricane eyes were acquired and Tropical Cyclones (TC) were captured at different development stages (up to category 5). Based on this unique dataset, the great relevance of Sentinel-1 dual-pol observations to measure extreme winds was demonstrated and a new methodology developed for dual SAR operating in C-band, enabling better wind measurements for wind larger than 20m/s. This is illustrated over Hurricane Irma. Based on these results, hurricane experts from the WMO (World Meteorological

Organization) Hurricane Committee for USA/Caribbean region, listed in their recommendations that "Special acquisitions plans during Irma, Jose and Maria have demonstrated the high value of kilometric-scale information provided by Sentinel-1 SAR data". They thus recommend that "these data are made available to help monitor critical aspects of the TC structure (wind radii, maximum wind, eye diameter...)."

Wind maps will be produced by CLS Brest with Sentinel-1 and Radarsat-2 SAR instruments and distributed in near-real time, after reception of the satellite data (see <http://eoda.cls.fr> for demonstrations) over European seas for extra-tropical storms and the Indian Ocean for hurricanes applications.



Sentinel-1 derived surface wind speed over Irma on 07/09/2017 during a category-5 hurricane, showing winds greater than 80m/s
Credit: Contains modified Copernicus Sentinel data [2017]

Thematic Area



CLIMATE, WATER AND ENERGY

Region of Application



BRITTANY (BRETAGNE)

Sentinel mission used



S1

Copernicus Service used



-

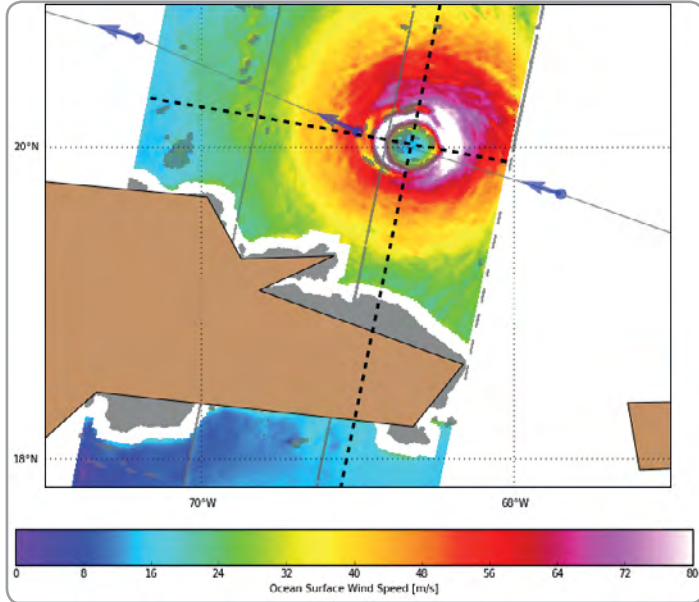
Usage Maturity Level



3

Benefits to Citizens

Extreme wind monitoring is essential for safety and emergency services. At present, SAR-derived wind measurements could already help meteorological forecasters to better estimate hurricane intensities in complex situations and improve the accuracy of weather forecast warnings. Forecasters from the RSMC, the Tropical Cyclone Center of Meteo-France at La Reunion are potential users.



Sentinel-1 derived surface wind speed over Irma on 07/09/2017 during a category-5 hurricane, showing winds greater than 80m/s
Credit: Contains modified Copernicus Sentinel data [2017]

Outlook to the future

This is mainly explained by the only recent increase of freely accessible satellite data provided by Sentinel-1 constellation at resolutions now approaching that of meteorological models. Pilot studies have shown the benefit of using these satellite measurements to correct wrongly estimated winds in wave models, thus improving the confidence in weather forecast

“Tropical cyclones represent 20% of the damage and casualties caused by natural hazards, when all phenomena are taken into consideration”

*Philippe Caroff,
Head of the cyclone forecast centre at Météo-France*

warnings. The development of new assimilation methodologies adapted to such high-resolution measurements in atmospheric models is also a potential perspective. To be operationally used, a dedicated acquisition strategy over hurricane basins would be needed that enables the activation of emergency services with late-programming of Sentinel-1 acquisitions. This has already been demonstrated in pilot studies but it is not operationally implemented. Additionally, the downlink and production of the SAR extreme wind observations in Near-Real Time (NRT) would be needed, which might require using emergency framework and/or collaborative stations.

Acknowledgements

The SHOC campaign was performed in collaboration between CLS, IFREMER and ESA. This campaign also benefited from complementary acquisitions from Radarsat-2, thanks to the support of the GIS BreTel.

Romain Husson¹, Alexis Mouche², Nicolas Bellec³ and Philippe Monbet⁴

1. CLS Brest, France
2. IFREMER, France
3. GIS BreTel, France
4. Pôle Mer Bretagne Atlantique-Booster MoreSpace, France

Email: rhusson@cls.fr

ABOUT COPERNICUS4REGIONS

This Copernicus User Story is extracted from the publication “**The Ever Growing use of Copernicus across Europe’s Regions: a selection of 99 user stories by local and regional authorities**”, 2018, Edited by NEREUS, the European Space Agency and the European Commission.

The model cases focus on local and regional authorities who successfully applied Copernicus data in 8 major public policy domains. The views expressed in the Copernicus User Stories are those of the Authors and can in no way be taken to reflect the official opinion of the European Space Agency or of the European Commission.

Funded by the European Union, in collaboration with NEREUS. Paging, printing and distribution funded by the European Space Agency. IPR Provisions apply. Copernicus4Regions material may be used exclusively for non commercial purposes and provided that suitable acknowledgment is given.