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Atsushi G. Fujimura
University of Guam

Susanne Lehner
German Aerospace Center, susanne@dlr.de

Alexander Soloviev
Nova Southeastern University, soloviev@nova.edu

Xiaofeng Li
NCWCP-E/RA3, 5830 University Research Court College Park, MD 20740
Find out more information about [Nova Southeastern University](#) and the [Halmos College of Natural Sciences and Oceanography](#).

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Editorial

Sea Surface Roughness Observed by High Resolution Radar

Atsushi Fujimura ^{1,*} , Susanne Lehner ², Alexander Soloviev ³ and Xiaofeng Li ⁴

¹ Marine Laboratory, University of Guam, Mangilao, Guam 96923, USA

² German Aerospace Center, Muenchner Strasse 20, 82234 Wessling, Germany

³ Nova Southeastern University, 8000 N. Ocean Dr., Dania Beach, FL 33029, USA

⁴ NCWCP-E/RA3, 5830 University Research Court, College Park, MD 20740, USA

* Correspondence: fujimuraa@triton.uog.edu

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Changes in the sea surface roughness are usually associated with a change in the sea surface wind field. This interaction has been exploited to measure the sea surface wind speed by scatterometry. A number of features on the sea surface associated with changes in roughness can be observed by synthetic aperture radar (SAR) because of the change in Bragg backscatter of the radar signal by damping of the resonant ocean capillary waves. With various radar frequencies, resolutions, and modes of polarization, sea surface features have been analyzed in numerous campaigns, bringing various datasets together, thus allowing for new insights in small-scale processes at a larger areal coverage. This Special Issue aims at investigating sea surface features detected by high spatial resolution radars, such as SAR.

Overview of Contributions

Rikka et al. [1] demonstrate an empirical method for estimating meteo-marine parameters over the Baltic Sea. The empirical function CWAVE_S1-IW combines spectral analysis of Sentinel-1A/B Interferometric Wide swath subscenes with wind data derived with common C-Band Geophysical Model Functions. The estimated wave heights and wind speed agree with the wave model (WAM) and in-situ data, respectively. Their methods are implemented in near-real-time service in the German Aerospace Center's ground station, Neustrelitz.

SAR is applied to tropical storm conditions in several contributed papers. Zhang and Perrie [2] retrieve the wind field of Hurricane Bertha (2008) from the RADARSAR-2 cross-polarized SAR images using the C-3PO (C-band Cross-Polarization Coupled-Parameters Ocean) hurricane wind retrieval model and extract an axisymmetric double-eye structure from an idealized vortex model called Symmetric Hurricane Estimates for Wind. Adding data from airborne measurements using a stepped-frequency microwave radiometer reveal the hurricane's internal dynamic process related to the double-eye structure, which is consistent with past studies.

Zhang et al. [3] examine fetch- and duration-limited parametric models (H-models) using the SAR-retrieved wind speed, Sentinel-1 SAR wave mode, and buoy data to estimate wind wave parameters (wave height and period) generated by hurricanes or typhoons. The models provide an effective method to obtain the wave parameters inside storms.

A paper by Shen et al. [4] introduces a hurricane wind quality index to evaluate SAR wind retrievals from cross-polarization and co-polarization observations for storm conditions. The index shows rain-contaminated wind cells, and it is used for wind correction under heavy rain-contaminated areas. The proposed method improves the SAR-derived wind field under hurricane conditions.

Another wind retrieval model is proposed for the European Space Agency (ESA) Sentinel-1A (S-1A) Extra-Wide swath mode VH-polarized images [5]. The new model is validated by comparing the wind speeds retrieved from S-1A images with the wind speeds measured by Soil Moisture Active

Passive (SMAP) radiometer under tropical cyclone conditions. The results suggest that the proposed model can be used to retrieve wind speeds up to 35 m/s for sub-bands 1 to 4 and 25 m/s for sub-band 5.

Sun et al. [6] develop ocean wind retrieval models for right circular-vertical and right circular-horizontal polarizations from the compact-polarimetry mode of the RADARSAT Constellation Mission (RCM), a set of three satellites just launched in 2019. The wind retrieval models are validated and contribute to temporal oceanography or atmosphere dynamic research based on RCM SAR data.

A hybrid wind retrieval model is proposed by using two models: C-2PO (C-band cross-polarized ocean backscatter) and CMOD4 (C-band model) [7]. Sets of SAR images over the Northwest Pacific off the coast of China are used to establish a wind speed threshold (9.4 m/s). Ocean surface wind speeds are retrieved by the C-2PO model as VH-polarized images when the wind speeds are higher than the threshold, while the CMOD4 geophysical model function for VV-polarized images is used when the wind speeds are less than or equal to the threshold.

Kammerer and Hackett [8] show that phase-resolved ocean wave fields are reconstructed from X-band Doppler radar measurements of the ocean surface by proper orthogonal decomposition (POD) more accurately than the conventional FFT-based dispersion curve filtering. The results indicate that the group line (a linear feature at frequencies lower than the first order dispersion relationship in wavenumber-frequency spectra of the ocean surface) influences the phase-resolved wave field.

Buono et al. [9] discover that under low-to-moderate wind conditions ($\approx 3\text{--}12$ m/s), SAR imaging parameters have a stronger effect on the standard deviation of the co-polarized phase difference than meteo-marine parameters; they use a theoretical model based on the tilted-Bragg scattering. The results can support the improvement of the SAR algorithms for a variety of ocean applications including object detection.

Tings et al. [10] propose an extension of their ship-wake detectability model by using a non-linear basis that allows consideration of all the influencing parameters simultaneously. The parameters affecting wake detectability include environmental conditions (wind speed, wind direction, sea state height, sea state direction, and sea state wave length), ship properties (size, heading, and velocity), and image acquisition settings (incidence angle, beam looking direction). The detectability model can be applied to control an automatic wake-detection system.

An overview of the GeoFen-3 (GF-3), a Chinese C-band SAR satellite launched in August 2016, is provided by Li et al. [11]. They demonstrate the capabilities of the GF-3 SAR in ocean and coastal observations by presenting selected features (i.e., intertidal flats, offshore tidal turbulent wakes, oceanic internal waves, sea surface winds, and waves). For more details and other applications of GF-3, see MDPI journal Sensors Special Issue "First Experiences with Chinese Gaofen-3 SAR Sensor" (https://www.mdpi.com/journal/sensors/special_issues/gaofen_3_SAR_sensor).

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