On Synthetic Aperture Radar Backscattered Cross-sections Under Hurricanes

Hui Shen[1,3], William Perrie[2], Yijun He[1,3], Zhongfeng Qiu[1,3]
shenhui@ms.qdio.ac.cn; PerrieW@dfo-mpo.gc.ca; heyj@ms.qdio.ac.cn; Qiuzhongfeng@ms.qdio.ac.cn
1. Institute of Oceanology, Chinese Academy of Sciences
2. Bedford Institute of Oceanography, Fisheries and Oceans, Canada
3. Key Laboratory of Ocean Circulation and Waves, Chinese Academy of Sciences

***Abstract*:**
The objective of this work is to investigate characteristics of synthetic aperture radar backscattered cross-sections under hurricane conditions. Recent studies show that the radar backscattered signal is saturated under super high wind conditions; it does not continue to increase with the increasing wind speed, which is the case under low to moderate wind speeds. However, this result does not have extensive *in situ* field verification data, due to the difficulties in making *in-situ* measurements under severe wind speeds. Buoys often malfunction in extremely high winds and high seastate conditions. Among all available datasets of hurricane wind speeds, surface analysis winds by the Hurricane Research Division (HRD) are considered the state-of-the-art. For this presentation, the HRD product of concern is the so-called H*winds, which constitute a re-analysis of all the available datasets including measurements from *in-situ* buoys, ships, aircrafts, and satellites.

Compared to the difficulties of collecting *in-situ* measurements on the ocean surface under hurricane conditions, satellite remote sensing is relatively easier, capable of providing monitoring of hurricanes from space. Among all qualified spatial instruments, Synthetic Aperture Radar (SAR) is unique for hurricane monitoring because of its ability to accurately measure ocean surface dynamics, with ability to penetrate through the clouds and light rains present within the hurricane processes. Heavy rains remain a challenge for SAR. The Canadian Hurricane Watch program is

an established program for tracking and capturing images of the eyes of hurricanes by Radarsat SAR imagery. Supported by the Hurricane Watch program, we have access to the entire SAR dataset of hurricane eye images from Radarsat.

Based on HRD H*winds surface wind analysis dataset and Canadian Hurricane Watch dataset of SAR images, we are able to investigate the relationship between wind speed and synthetic radar backscattered signals under hurricane conditions.

Our methodology includes traditional statistical analysis and Neural Network analysis to analyze the relationship between synthetic radar backscattered signals from SAR and high wind speeds in the Hurricane Watch archive of SAR images of hurricane eyes. A new geophysical model function (GMF) is derived and presented which establishes relations between the radar backscattered signals (under hurricane conditions) and wind speeds, wind directions, and radar incident angles. The new GMF is compared with CMOD5, and HWGMF, which are presently used for wind speed analysis from SAR imagery in high winds and hurricane conditions.

***Key words*: Hurricane, GMF, Saturation**