Validation of Remotely-Sensed Hurricane Force Winds in Extratropical Cyclones

Paul S. Chang[1], Zorana Jelenak,[1] James Carswell[2],
Stephen Frasier[3], Tao Chu[3]

[1]NOAA/NESDIS/STAR
5200 Auth Road, Camp Springs, MD 20746, USA
<paul.s.chang@noaa.gov>

[2]Remote Sensing Solutions, Inc.
Barnstable, MA 02630, USA

[3]Microwave Remote Sensing Laboratory
University of Massachusetts
Amherst, MA 01003, USA

Over the past 20 years global ocean wind field data has been obtained from a variety of space-based scatterometers, such as NASA's NSCAT scatterometer, the European Space Agency's Active Microwave Instrument (AMI), the SeaWinds instrument on board the QuikScat satellite, and the EUMETSAT ASCAT instrument on board the METOP satellite. A scatterometer is an active microwave sensor specifically designed to measure the energy scattered back to it, and has specifically been used to infer the near surface ocean wind vector from the energy backscattered from the ocean surface. In general, the scatterometer design is such that the backscattered portion of the transmitted signal is modified by the ocean surface roughness which is closely correlated to the local wind field at the surface. The performance of wind vector retrievals from scatterometry measurements in moderate wind regimes (3-25m/s) generally satisfies many operational and scientific users.

However, there are situations where utilization of existing space-based scatterometer wind vector retrievals can prove challenging. One particular situation is the retrieval of hurricane force winds found in the strongest extratropical storms. Detection of these wind conditions from QuikSCAT directly supports wind warnings issued by NOAA's National Weather Service for the North Pacific and North Atlantic. The accuracy and performance of these retrievals in winds greater than 25 m/s are difficult to characterize and validate using more traditional methods. In hurricane force wind conditions, the ocean surface becomes severely distorted from the shear strength of wind, characterized with vigorous wave breaking. This special environment cannot be modeled by simple extrapolation of a global wind model.

To better understand performance of scatterometer wind retrievals in these limiting conditions, we have worked over the past several years with the NOAA Aircraft Operations Center and the University of Massachusetts' (UMASS) Microwave Remote

Sensing Laboratory to conduct airborne field experiments flying the UMASS Integrated Wind and Rain Profiling System (IWRAP) and the Stepped Frequency Microwave Radiometer (SFMR). IWRAP is a high-resolution, dual-band (C- and Ku-band), dual-polarized, pencil-beam radar that profiles the Doppler velocity and the volume backscatter from rain at 15 to 120 m range resolution and measures the ocean backscatter response. The system operates simultaneously at four separate incidence angles (covering an effective continuous swath of 25 to 50 degree incidence) while conically scanning at 60 RPM. The SFMR is a C-band nadir viewing radiometer that measures the emission from the ocean surface and atmosphere simultaneously at six separate frequencies (approximately ranging from 4 to 7 GHz). It is used operationally to provide continuous estimates of the surface wind speed and the column average rain rate.

During January and February of 2007, IWRAP and SFMR were deployed aboard the NOAA WP-3D aircraft N42RF ("Kermit") as part of the NESDIS Ocean Winds winter experiment program. Flights were conducted into extratropical cyclones over the North Atlantic waters from our base of operations in St. Johns, NewFoundland, Canada. Numerous storms were sampled in a variety of environmental conditions. On February 8 and 9, 2007 hurricane force winds were sampled in-situ in two different extratropical cyclones. IWRAP data was acquired with coincident SFMR measurements and GPS dropsonde measurements. QuikSCAT and ASCAT passes were coordinated with whenever possible. These data and the result of the validation analyses will be presented and discussed.