In-Flight Data Processing for the Wide Swath Radar Altimeter (WSRA) for Real Time Reporting of Directional Ocean Wave Spectra from the NOAA WP-3D Hurricane Reconnaissance Aircraft

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Joint Hurricane Test-bed (JHT) Opportunities for Transfer of Research and Technology into Tropical Cyclone Analysis and Forecast Operations

Submitted by

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A. Abstract

This JHT project focuses on developing the processing algorithms and real-time software needed to perform in-flight data processing for the newly developed Wide Swath Radar Altimeter (WSRA). The WSRA is a novel digital beamforming radar altimeter developed with funding from the NOAA SBIR program, with additional support from the University of Massachusetts and DARPA. This instrument was first deployed aboard the NOAA P-3 hurricane reconnaissance aircraft during the 2008 hurricane season. Raw data gathered during several hurricane reconnaissance flights was processed into directional ocean wave spectra, demonstrating the functionality of the WSRA. Under this contract ProSensing will develop and deploy an in-flight processor to implement the required radar signal processing algorithms in real-time. This effort will include optimization of the WSRA digital beamforming and range centroid tracking algorithms, conversion of the processing algorithms into a multi-threaded C application, and deployment of a multi-core PC processor to execute in-flight processing.

Successful completion of this project will provide continuous real-time reporting of directional ocean wave spectra, significant wave height and the radius of 12’ seas from the NOAA P-3 aircraft to the National Hurricane Center through a satellite data link.

B. Work Performed

During the period of performance covered by this progress report we have performed the following tasks:

TASK 1. Analysis of WSRA data gathered during the 2008 hurricane season

During the 2008 season, ProSensing operated and collected data with WSRA on six missions in hurricanes Fay, Gustav and Ike. For these missions, WSRA was configured to collect raw data for offline analysis. Under the JHT-funded contract, we have continued to analyze the 2008 flight data, discovering processing artifacts induced by cross-track velocity. We are now adjusting the processing algorithm to compensate for this effect.

Analysis of the 2008 hurricane data has shown that the WSRA has expanded the operational capability over the retired NASA prototype SRA system. WSRA has obtained a usable signal from significantly higher altitudes (12,500-ft vs. 5,000-ft) and is less susceptible to attenuation in rainfall.

At the upcoming IHC conference at the beginning of March 2010, we will present the results of our analysis and changes to the processing algorithm. One of the most important findings was the realization that cross-track aircraft motion impacts WSRA’s effective sub-array spacing. This effect changes the 80 cross track antenna beam angles thus distorting the reconstructed profile of

the ocean surface waves. This processing artifact can be eliminated by taking into account the instantaneous cross-track velocity to continuously re-calculate the cross-track beam angles.

TASK 2. Hardware functionality testing and repair of the WSRA

At start of the contract we first worked on diagnosing and repairing hardware problems that were observed during test flight during the 2008 hurricane season. One issue was that the Ku-Band PLO oscillator was operating in an "out-of-lock" condition. Problem was solved by increasing input drive power into the Ku-Band PLO from the 10 MHz locking oscillator.

In-depth analysis of the raw data collected also revealed that 2 microwave antenna switches in the network of 64 switched were not functioning. Those switches were sent to the manufacturer and quickly repaired.

After resolving all the hardware problems, the WSRA was fully tested at ProSensing. Proper operation of the WSRA was confirmed, and at the beginning of December of 2009 system was shipped to NOAA AOC in Tampa FL for installation on one of the reconnaissance aircraft.

TASK 3. WSRA Installation on WP-3D #N42 aircraft

For the previous test flights, WSRA was installed on the N43 aircraft. Because of scheduling conflicts during the next season, NOAA AOC decided to install the WSRA on the #N42 aircraft. Therefore, this was a new installation for this instrument and NOAA AOC had to remake most of the harness and cooling lines running through the aircraft's fuselage. ProSensing also had to modify the WSRA antenna installation on the N42 fearing which was significantly different from the fearing on the N43 aircraft. Modifications were done in such a manner that in the future the WSRA will be able to be installed on either aircrafts.

The WSRA is currently installed on NOAA's WP-3D N42 aircraft. A test flight with the WSRA is scheduled for February, 2010, and collected data will be used to verify the implemented improvements in the WSRA processing algorithm.

Labor breakdown for the work performed during the Period 8/15/2007 – 2/15/2008

Employee	Title	Hours
Baldi, Chad A	Electrical Engineer I	15.50
Lee, Geoffrey D	Mechanical Engineer	4.00
Piecuch, Brian J	Electrical Technician	1.50
Popstefanija, Ivan	Principal Investigator	12.00
Seeger, Bethany A	Software Engineer	25.75
Volain, Barry L	Electrical Engineer II	5.00
TOTAL		**63.75**