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Wave and Wind Direction Effects on SFMR Brightness Temperatures

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Surface winds in a tropical cyclone are essential for determining its strength. Currently the Stepped-Frequency Microwave Radiometer (SFMR) and Global Positioning System (GPS) dropwindsondes are the main instruments used for obtaining in situ surface wind measurements. The platforms for these instruments are the National Oceanographic and Atmospheric Administration (NOAA) P-3 and Air Force C-130J hurricane hunter aircraft. The SFMR measures sea surface microwave brightness temperatures at six frequencies ranging from 4.7 to 7.2 GHz. Surface wind speed estimates are obtained from these brightness temperatures by using a retrieval algorithm that employs a geophysical model function relating surface emissivity and wind speed. The SFMR is designed to obtain a single nadir track of surface wind speeds directly beneath the aircraft during level flight and not when turning because of the complexity of the wave field and foam distribution when the SFMR views the surface off-nadir or during aircraft rolls. However, the effects of the wave field on the measurements can be investigated using measurements obtained during the 2008 and 2014 Atlantic hurricane seasons. An SFMR module was flown in precipitation-free regions of the tropical cyclones to collect data at specified roll angles of 15°, 30°, 45°, and 60° in some cases. Excess brightness temperatures are then calculated with respect to zero wind speed values and independent of wind direction. An asymmetry is found in the resulting excess brightness temperatures. It is hypothesized that this asymmetry is caused by the direction of wave propagation and the angle at which the wave field is viewed by the SFMR. Wind direction may also play a role in the asymmetry. To analyze the asymmetry further measurement from WindSat will be used. Once the relationship is determined between surface wind speed, brightness temperature, and incidence angle a technique will be developed to obtain a surface wind speed when the aircraft is turning. This will begin to improve the spatial coverage of measurements of the tropical cyclone wind field to try to increase the probability that the maximum sustained wind speed within the tropical cyclone will be measured during the flight.