Algorithm optimization for real-time reporting of hurricane wave field data products measured with the NOAA Wide Swath Radar Altimeter

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The Wide Swath Radar Altimeter (WSRA) of the NOAA/ESRL/Physical Sciences Division is an airborne instrument that produces a real-time topographic map of the sea surface. Installed on a NOAA WP-3D aircraft, over the past decade the WSRA has routinely operated during reconnaissance flights into hurricanes. From the sea surface topographic maps and backscattered power, the WSRA processing software estimates directional wave spectra, rain rate, and the mean square slope of the sea surface. These data products are calculated and transmitted in real-time to the National Hurricane Center and also made available on a public website during and after the flights.

The WSRA is a digital beamforming radar with an antenna comprised of 64 narrow microstrip subarrays oriented in the along-track direction, and spaced at half wavelength intervals in the cross-track direction. The radar returns from sequential transmissions on each of 62 of the array elements are collected and coherently combined to produce 80 narrow beams spread over ±30º from the antenna boresight, covering a swath of about 3,46 km at the typical 3 km (10,000 feet) aircraft altitude.

The WSRA directional ocean wave spectra, important information about the air-sea interface, are produced at a rate of 4 minutes and 16 seconds. That makes the WSRA a unique instrument that routinely documents the rapid spatial variation of sea surface inside the evolving hurricane.

Over the past year, work on the WSRA real-time processing algorithm focused on two issues:

1. Developing a set of covariance matrix applied to the directional ocean wave spectra to improve significant wave height estimate by correct for radar backscattering biases at off-nadir angles and spatial filtering by the antenna beam footprints near nadir.
2. Improving the algorithm for removal of the 180-degree ambiguity inherent in producing directional ocean wave spectra from wave topography measurements. Several refinements have been made to improve prediction of the general direction of the ocean wave field at each observation point using only information available in real-time: hurricane maximum wind speed, radius of maximum wind, and its track and forward speed.