AZIMUTHAL DEPENDENCE OF THE MICROWAVE EMISSION FROM FOAM GENERATED BY BREAKING WAVES

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WindSat, the first polarimetric microwave radiometer on orbit, and the NPOESS Conical Microwave Imager/Sounder, scheduled for launch in 2010, are both designed to retrieve the ocean surface wind vector from radiometric brightness temperatures. Measurements and model results show that the wind direction signal is only 1-3 K peak-to-peak at 19 and 37 GHz, much smaller than the wind speed signal. Therefore, quantitative knowledge of the dependence of the ocean surface emissivity on properties such as surface roughness and wave breaking is critical for wind vector retrieval. However, the azimuthal dependence of the microwave emission from breaking waves and foam has not been adequately addressed. Recently, a number of experiments have focused on the increase in microwave emission due to foam.

The Polarimetric Observations of the Emissivity of Whitecaps Experiment (POEWEX ´04) was conducted during Nov. 2004 at the OHMSETT wave tank and focused on characterization of the azimuthal dependence of the microwave emissivity of foam. A wave tank was used to observe highly repeatable breaking waves as a function of both incidence and azimuth angles. Microwave radiometers at 6.8, 10.7, 18.7 and 37 GHz were suspended below the basket of a boom-lift crane and positioned to view the water surface at azimuth angles of 0°, 45°, 90°, 135° and 180° and incidence angles of 45°, 53° and 65°. The radiometers also measured emission from the roughened surface with no breaking in the field of view. The fractional area foam coverage in the field of view of the radiometers was found by analyzing bore-sighted video measurements. In-situ measurements included void fraction, bubble size spectrum, and large-scale wave field measurements from an array of pressure transducers. These measurements demonstrated several first-order similarities between the wave dynamics of the wave tank and those on the open ocean.

The increases in emissivity at all frequencies vary as a function of azimuth angle, and this variation is more significant for horizontal polarization than for vertical polarization. For the increases in emissivity measured at 6.8, 10.7, 18.7 and 37 GHz, the azimuthal variations as a percentage of the mean vary from 13% to 25% for vertical polarization and from 11% to 45% for horizontal polarization. The azimuthal averages of the increases in emissivities from POEWEX ´04 measurements were also used to estimate the effects of whitecap coverage on brightness temperatures measured by a satellite radiometer. These effects were expressed as a function of wind speed using a number of empirically-based parameterizations of whitecap coverage with wind speed. These results can be used to quantify and correct spaceborne passive microwave measurements for the effect of increased surface emission due to foam.

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