Microwave Emission of Reproducible Breaking Waves:
The POlarimetric Emissivity of Whitecaps EXperiment (POEWEX '02)

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WindSat, the first polarimetric microwave radiometer in orbit, was launched on January 6, 2003, in order to demonstrate the viability of passive sensing of the ocean wind vector from space and to perform risk reduction for the NPOESS Conical Microwave Imager/Sounder. The Naval Research Laboratory and the WindSat Science Team are studying the retrieval of the ocean wind vector using a physically-based approach, which depends upon an accurate forward model of surface emission, as well as of atmospheric emission and its reflection from the surface. Aircraft measurements and model results have shown that the signature in azimuth with respect to the wind direction is much smaller in magnitude (roughly 1-3 K peak-to-peak) than that of wind speed. Therefore, it is necessary to determine the dependence of the surface microwave emission on the wind vector as accurately as possible. The microwave emission of the sea surface depends upon wind roughness, whitecaps, surfactants, temperature and salinity. For moderate wind speeds and greater, the increased ocean surface emission caused by whitecaps and foam due to wave breaking is very significant, relative to the wind direction signal. This increase is the product of foam emissivity and the foam fractional coverage in area. The importance of radiometer measurements with bore sighted video cameras near the sea surface is that they determine the *emissivity* of foam independent of the foam fraction as a function of wind speed that occurs on the open ocean.

The authors have conducted several experiments to measure the microwave emissivity of foam. The first study measured beam-filling foam on a calm water surface, along with microphysical measurements to characterize the artificially-produced foam. Second, open ocean measurements during the FAIRS experiment observed that the foam emissivity changes due to the temporal wave development and the viewing angle of the radiometer. Third, in order to measure the time, polarization, frequency and angular dependence of foam emission on the sea surface, reproducible breaking waves were generated in a saltwater wave tank. Passive polarimetric measurements of the breaking waves were performed at X-band (10.8 GHz), K-band (18.7 GHz), and Ka-band (36.5 GHz). The radiometric emission of the breaking waves was observed as a function of time, polarization, frequency, incidence and azimuth angles. In order to correlate features of individual breaking waves as well as to perform ensemble averages, wave and foam properties were measured concurrently. These include the void fraction and bubble size spectrum of the foam, wave height, Ku-band radar backscatter to infer roughness and turbulence parameters using acoustic Doppler velocimetry. Results of the POEWEX '02 experiment will be reported and discussed.