Title: Ocean Surface Emissivity at L-band (1.4 GHz): The Dependence on Salinity and Roughness

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Abstract:

A characterization of the emissivity of sea water at L-band is important for the remote sensing of sea surface salinity. Measurements of salinity are currently being made in the radio astronomy band at 1.413 GHz by ESA's Soil Moisture and Ocean Salinity (SMOS) mission and NASA's Aquarius instrument aboard the Aquarius/SAC-D observatory. The goal of both missions is accuracy on the order of 0.1 psu. This requires accurate knowledge of the dielectric constant of sea water as a function of salinity and temperature and also the effect of waves (roughness). The former determines the emissivity of an ideal (i.e. flat) surface and the later is the major source of error from predictions based on a flat surface. These two aspects of the problem of characterizing the emissivity are being addressed in the context of the Aquarius mission.

First, laboratory measurements are being made of the dielectric constant of sea water. This is being done at the George Washington University using a resonant cavity. In this technique, sea water of known salinity and temperature is fed into the cavity along its axis through a narrow tube. The sea water changes the resonant frequency and Q of the cavity which, if the sample is small enough, can be related to the dielectric constant of the sample. An extensive set of measurements have been conducted at 1.413 GHz to develop a model for the real and imaginary part of the dielectric constant as a function of salinity and temperature. The results are compared to the predictions of models based on parameterization of the Debye resonance of the water molecule. The models and measurements are close; however, the differences are significant for remote sensing of salinity. This is especially true at low temperatures where the sensitivity to salinity is lowest.

Second, observations from Aquarius are being used to develop a model for the effect of wind-driven roughness (waves) on the emissivity in the open ocean. This is done by comparing the measured radiometric brightness temperature with the value expected for a surface with the same salinity and physical temperature. A parametric model for the excess brightness temperature as function of wind speed and wind direction is developed in the form:

$$\Delta TB = A0(w) + A1(w)\cos(\varphi) + A2(w)\cos(2\varphi)$$

Where w = wind speed; φ = wind direction (relative to the look direction of the radiometer) and $\Delta TB = \Delta E\ Ts$ where Ts is the physical temperature and ΔE is the change in emissivity caused by the waves. A0(w) is roughly linear with wind speed with values on the order of 3 K at 15 m/s. The directional dependence is much smaller but the data definitely indicate a directional component for wind speeds greater than 10-15 m/s. The coefficients depend on the incidence angle of the radiometer.