Wideband Microwave Radiometry for the Retrieval of Arctic Sea Ice Physical Properties in the MOSAiC Campaign

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Microwave radiometry has been used by the SMAP and SMOS missions for remotely sensing the thickness of sea ice. However, the maximum thickness sensitivity of these L-band systems is limited to 1 m or less due to limits on the penetration through sea ice of the 1.4 GHz signals used. The Ultra-Wideband Microwave Radiometer (UWBRAD) was developed to extend this thickness limit by monitoring ice microwave emissions over a wider spectrum of 0.5 - 2 GHz. The UWBRAD utilizes advanced RFI detection and mitigation to enable its operation outside the protected 1400-1427 MHz frequency band.

A four channel UWBRAD (540, 900, 1380, 1740 MHz) was deployed on an Arctic sea ice floe in December 2019 as a part of the MOSAiC expedition (www.mosaic-expedition.org). The radiometer was designed to observe ice emissions continuously from a stationary mast at an oblique angle. The instrument periodically performed observations of the sky to assist with radiometric calibration.

Sea ice thickness retrievals are performed by matchups with a forward model that predicts sea ice brightness temperatures as a function of thickness, salinity, temperature, and snow cover properties. The forward model describes sea ice as a multilayer structure of snow, ice and ocean. The radiative transfer equations are applied to predict emissions for the oblique angles at which the instrument was operated during the campaign. The forward model also incorporates the effects of the antenna beam pattern. As a first step toward ice property retrievals, ice properties from in-situ measurements were used in the model to compare forward model predictions with observed brightness temperatures.

The meaningful correlation between model predictions and measurements obtained demonstrates that the simultaneous retrieval of multiple ice parameters such as ice thickness, ice salinity, and even the average ice temperature should be feasible. These results confirm the utility of wideband 0.5-2 GHz brightness temperature measurements for the remote sensing of sea ice properties.

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