INFERRING SEA ICE CHARACTERISTICS FROM MULTI-SENSOR SATELLITE DATA

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Past, current, and future satellite sensors include microwave scatterometers, microwave radiometers, synthetic aperture radars (SAR), and multi-spectral sensors operated at different frequencies, resolutions, and coverages in time and in space. For applications to sea ice and polar environments, each sensor has its advantages and limitations. Together with sea-ice field-experiment data and model results, we present various approaches using different sensors and their combinations to derive parameters representing sea ice characteristics, which are necessary inputs to address important issues such as the role of polar regions in climate feedback processes.

Geophysical processes in polar regions involve a wide range of temporal and spatial scales. For a process with a short time scale over a large spatial scale such as sea-ice melt onset or fall freeze-up, a very-wide-swath sensor with a coarse resolution such as a microwave scatterometer or radiometer is appropriate because it covers large regions in a short period of time. We use QuikSCAT/SeaWinds scatterometer (QSCAT) data to obtain melt-related parameters such as melt onset date, freeze-up date, and melt zones. Due to differences in backscatter (scattering measured by scatterometer) and brightness temperature (emission measured by radiometer), we observe a delay period between melting times detected by a radiometer and by a scatterometer. The delay period represents the time duration between an early melting stage (detected by a scatterometer) and the later melting stage (detected by a radiometer). It indicates the melting rate: strong melt for a short time delay (or no delay) and weak melt for a long time delay. We compare ice extent obtained from QSCAT and from the Special Sensor Microwave Imager (SSM/I, NASA Team algorithm) to show how both data sets can be used together to improve the results. We show that each of these sensor types can provide certain parameters that the other sensor cannot, and thus their combination is needed.

A high-resolution sensor such as a SAR can observe small details in space enabling the detection of features such as leads, ridges, and polynyas in sea ice, which are important to operational ice navigation. Furthermore, it allows analyses that can separate effects of ice dynamics and deformations from ice thermodynamics (thermal and radiation processes). We use products derived from RADARSAT SAR data with the RADARSAT Geophysical Processor System together with field measurements from the Surface Heat Budget of the Arctic Ocean (SHEBA) campaign to extend the local scale (km) of SHEBA observations to the aggregation scale (10's km). From this result, we use the large coverage of scatterometer data to obtain the timing of sea ice albedo transitions over the Arctic-basin scale and verify the accuracy with Collaborative Interdisciplinary Cryospheric Experiments results. We present the Nested Dynamic Approach (NDA) to track high-resolution features in SAR data with a daily coverage from wider-swath data such as the proposed HYDROS radar data. A multi-spectral sensor such as the Advanced Very High Resolution Radiometer (AVHRR) or the Moderate Resolution Imaging Spectroradiometer (MODIS) contains crucial information on cloud cover over polar regions. We show concurrent observations from AVHRR and QuikSCAT/SeaWinds data revealing the impact of clouds on sea ice surface melt.

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