Sea Ice and Snow Products Derived from Satellite Scatterometer Data

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Abstract

This paper presents sea ice and snow products derived from satellite scatterometer data. The data have been acquired by the SeaWinds scatterometer on QuikSCAT satellite since July 1999. For sea ice, an initial algorithm is developed to detect and map sea ice extent daily. The algorithm takes into account differences in polarization signature, azimuth anisotropy, and stability of sea ice and ocean surface backscatter. The algorithm requires a strict collocation of scatterometer data with different polarizations and azimuth directions in space and in time. Results show that QuikSCAT/SeaWinds scatterometer can map sea ice extent even in the difficult case of summer sea ice with surface melt on ice and strong winds on ocean. Polynyas with surrounding sea ice can be identified by the scatterometer. QuikSCAT ice mapping results compare well with sea ice extent defined by 15% concentration derived from SSM/I data with the NASA Team algorithm. However, scatterometer results have less effect of land contaminations, and can identify smaller sea ice areas and ice floes. These QuikSCAT results are verified with OLS and MODIS optical data under clear or partially clear sky conditions. Moreover, backscatter patterns within sea ice extent are different from those observed by passive microwave data indicating that scatterometer data contain independent and thus complementary information. From scatterometer data over sea ice, melt and frozen zones can be determined. Over a melt zone, areas with positive and negative integrated energy absorption can be identified. Over a frozen zone, areas with seasonal and perennial sea ice types can be classified. Composite sea ice products including ice extent, melt zone, surface energy balance, and sea ice type can be used to study cloud-ice radiation feedback, sea ice production and export, and seasonal and interannual sea ice mass variability. Furthermore, composite sea ice products can be combined with ocean surface wind products obtained by the same scatterometer at the same time to investigate ocean-ice-atmosphere interactions. QuikSCAT sea ice images with ocean bottom bathymetry overlay uncover the mystery of the Svalbard sea-ice barrier, which forms rapidly and traps fishing ship in the ocean region east of Svalbard. For snow, initial algorithms are developed to obtain several snow products from local to hemispheric scales. The timing and duration of snowmelt process can be determined accurately. Rapid snowmelt causing spring floods in cold land regions can be monitored leading to possible early detection or prediction of flooding conditions. Product of snowmelt duration indicates flood severity as shown over the Lena River flood plain. Melt zone products from scatterometer data over the Greenland ice sheet and Antarctica have shown recent anomalous melt events.