Snowmelt Processes on Antarctic Sea Ice Observed by Radar Scatterometers

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ABSTRACT

Snowmelt processes on sea ice are the key drivers determining the seasonal sea-ice energy and mass budgets. Around Antarctica, snowmelt on perennial ice is weak and very different than in the Arctic, with most snow surviving the summer. Here, we compile time series of snowmelt onset dates on perennial Antarctic sea ice from 1992 to 2014 using active microwave observations from European Remote Sensing Satellite (ERS-1/2), Quick Scatterometer (QSCAT) and Advanced Scatterometer (ASCAT) radar scatterometers. Describing snow melt processes, we define two transition stages: a weak backscatter rise indicating the initial warming and metamorphosis of the snowpack (pre-melt), followed by a rapid rise indicating the onset of thaw-freeze cycles (snowmelt). Results show large interannual variability with average pre-melt and snowmelt onset dates of 29 November and 10 December, respectively, without any significant trends over the study period. Related to different signal frequencies, we show that QSCAT Ku-band (13.4 GHz signal frequency) derived pre-melt and snowmelt onset dates are earlier by 25 and 11 days, respectively, than ERS and ASCAT C-band (5.6 GHz) derived dates. This offset has been considered when constructing the time series. Combining the observed successive timing of melt events retrieved from radar scatterometers with melt onset dates retrieved from 37 GHz passive microwave radiometers, allows us to develop a conceptual model which illustrates how the evolution of seasonal snow temperature profiles affects different microwave bands with different penetration depths. These suggest that future multi-frequency microwave satellite missions could be used to resolve melt processes throughout the vertical snow column.

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