Frequency and Timing of Snow Melt and Refreeze in the Northern U.S. from Satellite Brightness Temperature and Air Temperature

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ABSTRACT

Knowledge of snow melt and refreeze events from satellite observations can be used to constrain snowpack metamorphism and stratigraphy, and runoff timing. Compared to an otherwise identical frozen snowpack, a snowpack that contains liquid water will emit more microwave radiation. Diurnal snow phase changes will thus lead to large changes in the brightness temperature (Tb) observed by a passive microwave radiometer, with higher brightness temperatures corresponding to wet snowpacks. We build on the diurnal amplitude variation (DAV) method of Ramage and Isacks (2002, Ann. Glaciol.) in order to identify individual snow melt and refreeze events. Here, we compare the difference between nighttime and daytime microwave Tb observations to coincident changes in air temperature (Ta). This allows the effect of diurnal snow phase changes on brightness temperature change to be isolated, by removing the effect of physical temperature change on brightness temperature change. Individual melt and freeze events are detected as large excursions from the modal linear regression line fit to the relationship between Tb change (ΔTb) and Ta change (ΔTa), using clustering techniques. This ΔTb-ΔTa method, previously validated at Senator Beck Study Basin, Colorado, is used examine the distribution of melt and refreeze events over the northern contiguous United States during the operational lifetime of the AMSR-E satellite instrument. We also examine some of the limitations of this method, including the difficulty of detecting snow melt and refreeze beneath vegetation canopy.

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