A practical method to detect the freezing/thawing onsets of seasonal frozen ground in Alaska

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Microwave remote sensing can provide useful information about freeze/thaw state of soil at the Earth surface. An edge detection method is applied in this study to estimate the onsets of soil freeze/thaw state transition using L band space-borne radiometer data. The Soil Moisture Active Passive (SMAP) mission has a L band radiometer and can provide daily brightness temperature (TB) with horizontal/vertical polarizations. We use the normalized polarization ratios (NPR) calculated based on the Level-1C TB product of SMAP (spatial resolution: 36 km) as the indicator for soil freeze/thaw state, to estimate the freezing and thawing onsets in Alaska in the year of 2015 and 2016. NPR is calculated based on the difference between TB at vertical and horizontal polarizations. Therefore, it is strongly sensitive to liquid water content change in the soil and independent with the soil temperature. Onset estimation is based on the detection of abrupt changes of NPR in transition seasons using edge detection method, and the validation is to compare estimated onsets with the onsets derived from in situ measurement. According to the comparison, the estimated onsets were generally 15 days earlier than the measured onsets in 2015. However, in 2016 there were 4 days in average for the estimation earlier than the measured, which may be due to the less snow cover. Moreover, we extended our estimation to the entire state of Alaska. The estimated freeze/thaw onsets showed a reasonable latitude-dependent distribution although there are still some outliers caused by the noisy variation of NPR. At last, we also try to remove these outliers and improve the performance of the method by smoothing the NPR time series.