

Response to reviewer comments

We thank all reviewers for their helpful comments. Please find below our responses in blue.

Response to reviewer #2

The manuscript describes a climatology of snow melt days across the Arctic or land regions poleward of 50N using passive microwave observations. They also validate their results against reanalysis datasets and from station data/snowpit surveys. They find that snowmelt days are relatively rare (a week or less) over the winter period. They do find that snowmelt days are positively correlated with length of the winter season (defined as the period of a stable snowpack) and that there are only weak trends in snowmelt days.

This is a strong team of topic experts, a well-written manuscript and the analysis was expertly executed. The topic is of interest and the manuscript a worthy contribution to the cryosphere community and has relevance to climate change as well. I have very few comments to add to improve the manuscript. My few minor comments are listed below.

I did see that another reviewer found inconsistencies in the definition of melt events. I was not bothered by potential inconsistencies though it is probably best for the authors to clarify their definitions.

We thank the reviewer for the positive comments. We have added some additional explanation in Lines 190-192 to clarify the melt event/day issue.

I recommended that the manuscript be accepted pending minor revisions.

Minor comments: 1. Line 110 – the authors state that they filled data gaps through linear interpolation from adjacent days. However the authors mentioned above the technique for detecting water is robust because there are large variations in TB depending on the presence of water. Therefore simply linear interpolating would be problematic near dates of snowmelt?

Good point. Filling data gaps through linear interpolation from adjacent days will certainly bring some uncertainties to the detection results. However, this should have been somewhat mitigated by using both T_{BD} and T_{B37V} for melt detection (see section 2.2 Lines 156-158). In addition, the large differences of T_{BD} and T_{B37V} for days with melt and freeze conditions (Fig. 2) would limit false detection for days filled by linear interpolation.

The Kim et al. [2011] study was for freeze/thaw detection from the SSM/I data globally (thus they had more data gaps than this study). They also used linear interpolation from adjacent days for gap filling as in this study.

2. Figure 5 – in panels 5a and 5b why not show MSOD and NMOD as day of year rather than as month?

We show MSOD and MMOD as month in Fig. 5 so that it is easier to understand the spatial distribution patterns of monthly mean number of melt days described in Section 3.2 and shown in Fig. 7. In addition we describe the spatial distribution of MSOD and MMOD by months in Section 3.2.

3. Is it possible that the reanalysis products (especially ERA-Interim) in general have more snowmelt days because they are sampled four times daily and the PMW only once a day? This should be checked.

The reanalysis-based method that we employed, used the daily mean temperature to estimate melt events so the potential impact of the more frequent sub-daily sampling is dampened. We also now use both morning and afternoon overpass to detect winter melt from the satellite data, making the satellite results more comparable to those of the daily reanalysis data. Using both the morning and afternoon satellite passes results in some increase in melt days from the satellite mainly in temperate climate regions, such as southern Alaska and northern Europe (Fig. 6), however, the increases are too small to fully resolve the different melt days from the satellite and reanalysis (especially ERA-I).

4. Figure 8 – why use a temperature climatology of 1961-1990 which is colder than the period of the passive microwave data set of 1988-2013? Preferably an overlapping period should be used for the temperature climatology or even 1981-2010.

This figure was removed from the paper as it was not considered essential and the climatology can be readily generated from existing gridded observational or reanalysis datasets.

5. Figure 12 – the results presented in the figure where temperatures are warming in the fall and spring but not winter across the Northern Hemisphere landmasses is not a new result but is very similar to seasonal temperature trends shown in Cohen et al. 2012.

Reference: Cohen, J., J. Furtado, M. Barlow, V. Alexeev and J. Cherry 2012: Asymmetric seasonal temperature trends. *Geophys. Res. Lett.*, 39, L04705, doi:10.1029/2011GL050582.

Thank you for noting. We have cited the reference in the paper.