Melt onset dates for Arctic regions derived from satellite passive microwave data for 1979-2011; a comparison between the operational CDR and research level ESDR data sets

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Introduction

The rapid nature and extent of the sea ice loss during recent summers has shown the importance of monitoring melt during the spring and summer transition. Using remotely sensed brightness temperatures, snow melt overlying sea ice can be identified. The purpose of this presentation is to illustrate the usefulness of the new NOAA CDR and NASA MEaSUREs ESDR melt onset data. The NOAA CDR melt onset algorithm is designed as an operational algorithm and uses the daily brightness temperature differences between the 37H and 19H GHz channels from the special sensor microwave imager (SSMI) on board the Defense Meteorology Satellite Program (DMSP) platform for the years 1987-2007 to determine the melt onset date. The melt onset dates are archived as part of the NOAA CDR for sea ice. The NASA MEaSUREs ESDR melt onset algorithm uses the same brightness temperature differences between the 37H and 19H GHz channels, however, a ten day window and different thresholds are used to determine melt onset dates (see Anderson and Drobot 2001). An improvement was also made to remove the two pixel buffer around coastal waters that was found in the older ABBA version of the melt onset dates. The ESDR melt onset dates are also calculated for the scanning multi-channel microwave sensor (SMMR) on board the NASA Nimbus-7 platform and special sensor microwave imager and sounder (SSMIS) on board the DMSP platform. Therefore the ESDR melt-onset dates are calculated from 1979-2011, producing a longer time series.

Results

Comparisons have been made between the NOAA CDR melt onset data and the NASA MEaSUREs ESDR melt onset data during overlapping time periods. For the most part, the two data sets are comparable, indicating melt occurring at roughly the same time and location during spring. However, there are situations when the two algorithms produce different melt onset dates and are discussed further. The years 1999 (Figure 1 and 2) and 2005 (Figure 2) are presented here, despite the results are similar between all the years. 1999 was chosen to represent a year occurring in the earlier part of the time series. 2005 was chosen because it was the first year that the Arctic saw a greatly reduced sea ice cover by the fall.

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In each year there are instances when the two algorithms differ, producing different melt onset dates (Figures 3 and 4). One of the main temporal differences occurs during the earlier part of spring when questions brightness temperatures are observed. These represent in the differences plus as individual pixels that have an earlier melt onset date in the NOAA CDR than in the NASA MEaSUREs ESDR. According to this, the difference is a result of the different melt onset algorithms. For example, there may be low level clouds containing liquid water passing over the area, affecting the brightness temperature data for a single day, however, there is no change in the snow crystals which the algorithm should identify as melt. To account for these effects, the NASA MEaSUREs ESDR algorithm implements a ten day window. Since the brightness temperature differences do not persist over the ten day period, no melt is indicated. Therefore both algorithms do not interpret the resulting brightness temperature differences the same, and thus, calculate a different melt date. Another situation when large differences exist between the data sets occurs with the land and coastal pixel indentifications used with each data set. There are points where one algorithm does not calculate melt compared to the other because of differing land or coastal pixels applied to the data sets. These pixels are highlighted in Figure 4 where one algorithm does have a melt area compared to the other algorithm.

Spatial differences can also be observed between the NASA MEaSUREs ESDR and NOAA CDR melt onset date data sets (Figure 5). The majority of the differences throughout the Arctic Basin are within 10 days. The largest differences in melt onset dates are seen in the first-year ice regions especially along the Eurasian and North American coastlines, although almost all first-year ice regions have differences. In almost all cases, the NOAA CDR melt onset dates are earlier than the NASA MEaSUREs ESDR melt onset dates. It should also be noted that the actual differences are greater in the earlier years of the overlap period, mainly the late 1980s and early 1990s time frame.

Conclusions

The melt onset dates have also been used to generate average melt onset dates for the Arctic in general and specific regions within the Arctic. When the average melt date is calculated for the entire Arctic region (Figure 5) the differences between the two algorithms again show small differences. Generally speaking, the average melt onset dates for the NOAA CDR are later in the melt season than the NASA MEaSUREs ESDR melt onset dates. This difference is less than 2 days between the two algorithms. For the Chukchi Sea region (Figure 6), the reverse is observed. The NASA MEaSUREs ESDR melt onset dates are later in the melt season than the NOAA CDR melt onset dates. Again differences are rather small. While in the Kara Sea region (Figure 7) the differences between the algorithms are much greater. Regionally, in the Kara and Chukchi Seas, the average melt dates occur earlier in the NOAA CDR data than the NASA MEaSUREs ESDR melt onset dates.

Notes

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