Sea-ice and snow facies classifications from Altika data over the Polar Regions

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OVERVIEW

Two sets of classification algorithms have been computed for Altika mission following developments performed previously for the Envisat altimetry mission. They take advantage of having both passive and active microwave sensors on the same platform with co-registered measurements.

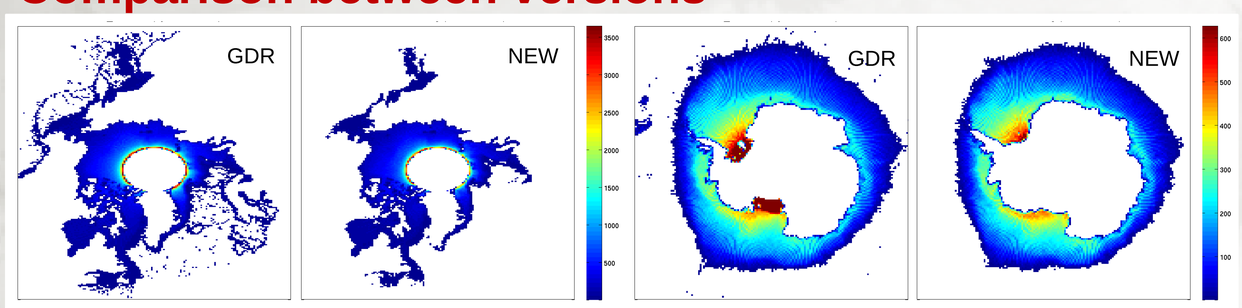
The first set of algorithms concerns sea-ice. They detect sea-ice corrupted sea surface height data for oceanography applications, but also provide sea-ice type (i.e. first-year ice, multi-year ice, ambiguous ice observed during summer and mixture of types) for cryosphere studies. Their performances have been evaluated based on collocations between the along-track Altika data with daily grids of sea ice type from the Ocean and Sea Ice Satellite Application Facility (OSI SAF). Results show better performances for the present approach for recognition of sea-ice corrupted data vs. ice-free ocean data when one compares with those observed with the operational algorithm. Concerning the sea-ice extent monitoring, we obtain a good continuity with the Envisat time-series and a good agreement with other mission estimations.

The second algorithm aims to separate different snow regions within the polar ice sheets based on measured microwave signatures. Our approach broadens the description of the snow pack by taking into account characteristics such as surface roughness, grain size, stratification, and snow melt effects, whereas this latter has often been solely considered in most previous works. This difference in snow morphology is due to variable conditions in local climate which is governed by local topography. Such partition of the ice sheet might help to better understand relationships between microwave signatures and snow morphology and might represent a useful and simple tool for tracking the effects of climate change. Comparison with past Envisat results has been performed.
All these results come from the CNES PEACHI project.

Sea-ice classification

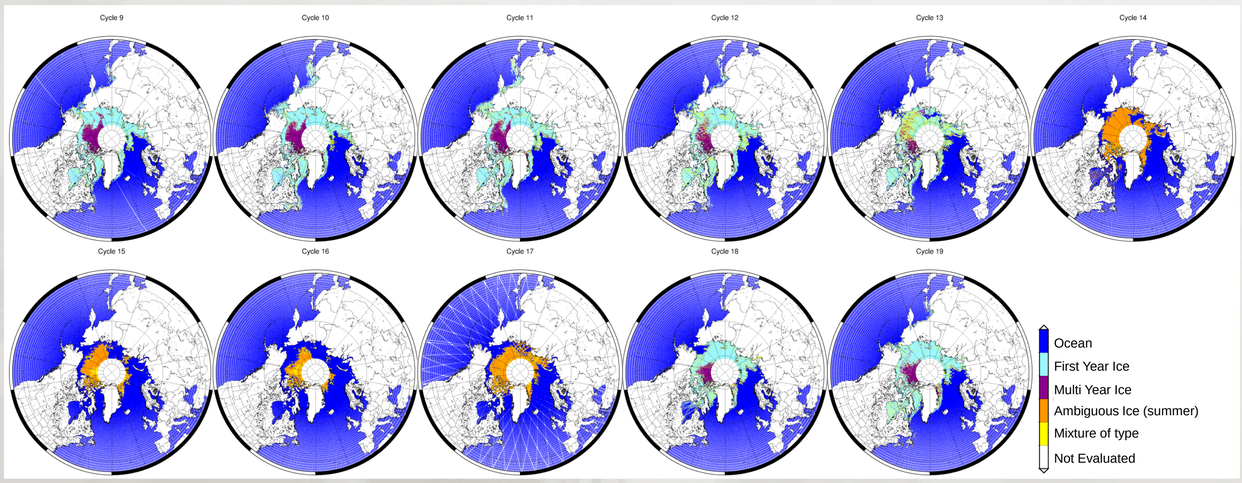
- Improvement of the sea-ice detection in current Altika product (a two-state flag: ocean / sea-ice)
- Development of a multi-state sea-ice flag at 1-Hz as for Envisat mission (ocean, FYI, MYI, ambiguous) to help both oceanic and cryosphere studies in data selection
- Differences: Envisat (ocean, FYI, MYI, WI, ambiguous = mixture) vs Altika (ocean, FYI, MYI, ambiguous = FYI or MYI during summer, mixture)
- Two algorithms: one for each polar region
- Extension of the monitoring of the SI extent started with ENVISAT altimetric data

Comparison between versions



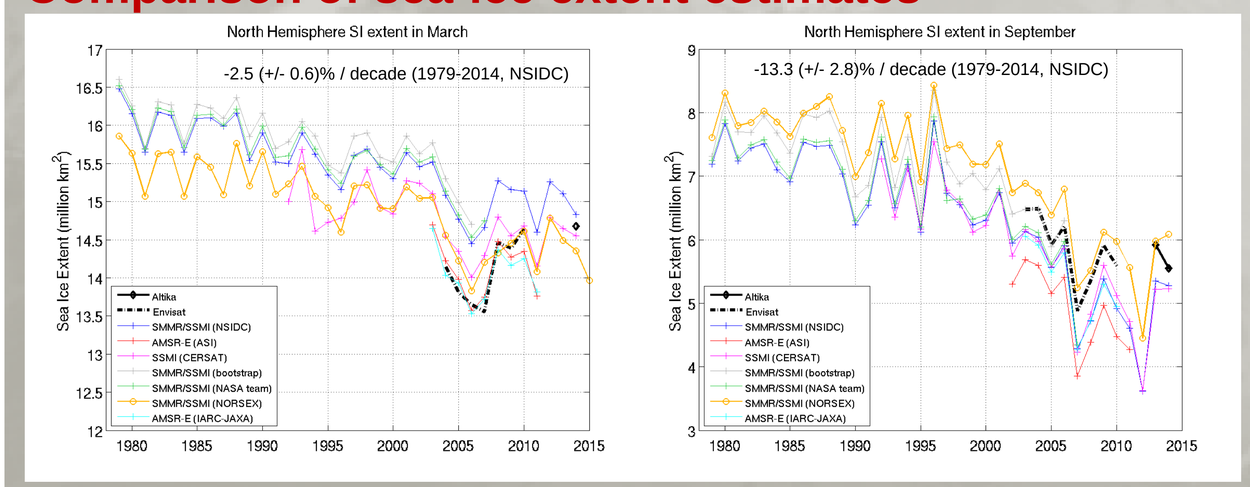
Cumulated density maps of sea-ice detection over a year period display some false detection by the algorithm used to generate the GDR products along coasts and over open ocean zones where one knows that there is no ice. Moreover Antarctic ice-shelves are identified as sea-ice. This is corrected with the new version of the algorithm

Arctic region



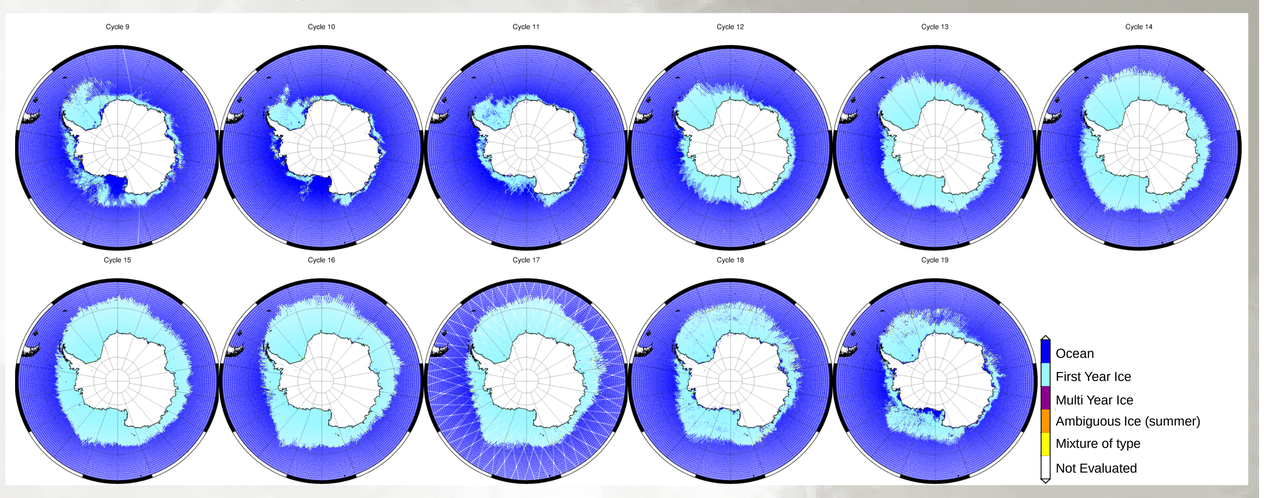
The arctic algorithm is applied on a time series of Altika images covering a year-period. In addition to help oceanographic users to edit sea ice contaminated sea surface height data, the complementary ability to distinguish unambiguously between FYI and MYI in the arctic region during winter season is important from the standpoint of long-term studies of ice production, destruction, and distribution. Indeed, they represent the two major sea ice types that dominate in the region. During summer, the presence of liquid water on the sea-ice makes that it is impossible to distinguish between the FYI and MYI, therefore the sea-ice is called ambiguous ice.

Comparison of sea-ice extent estimates



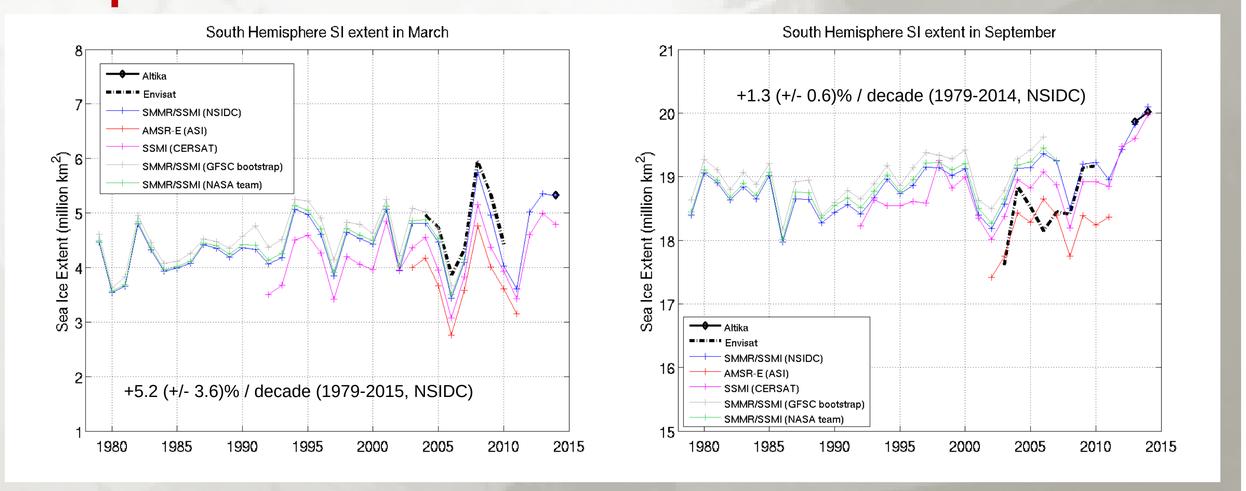
Several algorithms used to estimate the Arctic ice extent are compared from 1979 to 2014. There is up to ~1 million square km difference between the algorithms, which use different satellite input data (SMMR, SSMI, AMSR-E, Envisat and Altika). The estimations of ice extent decrease over the last three decades with slightly different trends. The altimetric estimates are in good agreement with those derived from other instrument data. Altika estimates show good continuity with Envisat ones.

Antarctic region



The Antarctic algorithm is applied on a time series of Altika images covering a year-period. We developed a specific algorithm to classify Antarctic sea ice because there are some environmental context differences between the two Polar Regions. Unlike the Northern Hemisphere sea ice cover, its counterpart in the Southern Hemisphere surrounds the continent with no outer land boundaries to block ice to drift away and melt when it reaches lower latitude and warmer ocean. Therefore no MYI are observed and there is no ambiguous ice during summer period.

Comparison of sea-ice extent estimates



Several algorithms used to estimate the Antarctic ice extent are compared from 1979 to 2014. The estimations of ice extent increase over the last three decades with slightly different trends. The altimetric estimates are in good agreement with those derived from other instrument data. Altika estimates show good continuity with Envisat ones. Note that the Envisat anomalous behaviors in 2006 and 2007 are due to problems of missing data which directly cause some large underestimation of the extent by Envisat.

Snow facies classification

- There are uncertainties in estimating the correct height over ice sheet because of the radar wave penetration within the cold and dry snow medium. They display dependencies on snowpack characteristics which vary seasonally and spatially.
- Partition of ice sheet into different homogeneous regions can help for the interpretation of altimetry data.
- There is one algorithm by ice-sheet as done for Envisat
- The monitoring of the extent changes of these regions could help to highlight some climate change effects on Greenland and Antarctica.
- Presently, question about observed differences over Greenland is still an open issue. Are they mainly related to changes from 2012 summer (melting observed over all of the ice-sheet) or differences due to frequency difference Ku / Ka ?
- Coming soon Sentinel-3 data will be helpful to answer this question

Data soon available at http://odes.altimetry.cnes.fr

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