

SMOS Sea Ice Concentration maps

Since more than a year ago, the Barcelona Expert Center (BEC) team researches on the capabilities of SMOS for the characterizations of the Cryosphere.

First maps of the Arctic Sea Ice concentration from SMOS data have been produced for the year 2014, with the algorithm explained bellow.



Two indices have been chosen to compute ice concentration: Angular Difference ($AD = TBV(\theta_2) - TBV(\theta_1)$) and Polarization Difference ($PD = TBV - TBH$). The sensitivity of those indices to ice salinity and temperature is much less (about 60%) than that of raw TB's, but they are still quite sensitive to the physical state (sea or ice). This property is very convenient for the empirical characterization of the physical state, because the distribution of the geophysical parameters is not very well known (specially for the ice salinity).

A necessary parameter to retrieve ice concentration is the set of tie-points. Tie-points are typical radiometric measurements of sea ice (100% sea ice concentration) and open water (0% sea ice concentration) used to assign each pixel with a given observed radiometric parameter to ice or open water.

The values of AD and PD, for a convenient incidence angle, can be used as tie-points for ice and sea water, because the characteristic distributions of sea and ice according both indices are clearly disjoint (see figure below), what allows a good classification. However, the distributions of values of AD and PD on First Year Ice (FY) and Multi Year ice (MY) overlap, with different shapes, making the correct classification of both types more challenging. The temporal

and spatial stability of the tie points has been verified.

Tie points for Ice and Sea for the Arctic.

The values of ice concentration have been obtained applying an inversion algorithm which uses the Maximum Likelihood Estimation (MLE) algorithm, which takes into account the mean values of AD and PD but also their standard deviation.

The following figures show SMOS Sea Ice Concentration maps of the Arctic compared with the values from OSI-SAF algorithm for March, July and November.

SMOS 2nd-5th March 	OSISAF 3rd March 	OSISAF – SMOS 
SMOS 2nd-5th July 	OSISAF 3rd July 	OSISAF – SMOS 
SMOS 2nd-5th November 	OSISAF 3rd November 	OSISAF – SMOS 

Maximum differences are observed during Autumn, at the time of maximum extent of thin ice (less than 60 cm) in the Arctic. If thin ice is present, SMOS measurements of completely ice covered pixels will be reported as mixed (i.e. not 100% ice), since the brightness temperature is not as high as for thick ice (used for the tie point definition). This is because SMOS measures electromagnetic radiation at a lower frequency than AMRS and SMMI, and therefore presents larger penetration into ice than higher frequency bands, as the ones used in the OSISAF algorithm. The differences observed during melting period (July maps) are not yet well understood.

Stay tuned to see more applications of SMOS data on Sea Ice now being explored by BEC.

**What can SMOS tell us about
the Arctic oceans?**