OSI SAF SEA ICE

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Abstract

The paper gives an overview of the sea ice product portfolio and their status in the OSI SAF. The ice edge, concentration and type products are shortly described. Emphasize are put on the distribution of the products and evaluation of their quality.

Test products that also are daily available, ice type from QuikScat and ice concentration from AMSR, are briefly presented. Further the paper present three ongoing development activities on sea ice in the OSI SAF: use of ASCAT for ice edge and ice type, new ice drift products and reprocessing of sea ice products.

INTRODUCTION

The EUMETSAT Ocean & Sea Ice Satellite Application Facility (OSI SAF) is a consortium led by Météo-France, with a High Latitude center hosted by the Norwegian Meteorological Institute, met.no in cooperation with the Danish Meteorological Institute, DMI. The development of the OSI SAF service started in 1997 and the service has been operational since 2002. The OSI SAF is evolving continuously and the product portfolio are improved and expanded on basis of new operational satellite programs.

A main objective for the OSI SAF High Latitude center is to provide global sea ice products derived from operational satellites. Currently these products are sea ice concentration, sea ice edge and sea ice type. The products are used for weather and ocean models, for environmental studies, ocean monitoring etc. The OSI SAF provides a fully operational service with focus on high quality and well validated products freely available for all users. To further develop the service the on going development work is focused on higher resolution and better coverage and quality of the products.

This paper presents the status of the OSI SAF sea ice products and activities, as well as the ongoing development and upcoming products.

OPERATIONAL PRODUCTS

At present the OSI SAF delivers three global sea ice products in operational mode:

- sea ice concentration
- sea ice edge
- sea ice type

These products are provided daily at 10km resolution in a polar stereographic projection. The global products are split in two areas, one covering the Northern Hemisphere and one covering the Southern Hemisphere. Currently the products are based on SSM/I data. The timeliness of the products is 4½ hours.
The products are delivered in three formats:

- GRIB
- HDF5
- NetCDF

The products are available through:

- the OSI SAF Sea Ice web/ftp server, [http://saf.met.no](http://saf.met.no) and [ftp://saf.met.no](ftp://saf.met.no).
- the EUMETCast distribution system, [http://www.eumetsat.int](http://www.eumetsat.int).

*Figure 1:* Operational OSI SAF Sea Ice products 16. September 2007. From left to right: Ice concentration, edge and type.

*Figure 2:* Operational OSI SAF Sea Ice products, Southern Hemisphere 16. September 2007. From left to right: Ice concentration and edge.

The OSI SAF sea ice products and algorithms are described in Breivik et al. 2001 and some aspects in more detail in Andersen (1998 and 2000). Updated information of the products, algorithms and technical description are found in the *Sea Ice Product Manual* (2007).
VALIDATION AND MONITORING

The sea ice products are validated against the ice charts produced by the operational sea ice services at DMI and met.no. These charts are produced at daily to weekly intervals by trained ice analysts and are based on manual interpretation of SAR, MODIS, AVHRR and in situ observations. Validation reports are available on http://saf.met.no/validation. Figure 3 and 4 below shows the evaluation of the OSI SAF ice concentration and edge products against DMI ice charts around Greenland from 2002 to present.

Figure 3: validation of OSI SAF sea ice concentration against DMI Sea Ice Service weekly charts.

Figure 4: validation of OSI SAF sea ice edge against DMI Sea Ice Service weekly charts.
AMSR-E: IMPROVED ICE CONCENTRATION

Use of the AMSR-E instrument flown on the EOS Aqua satellite for sea ice concentration is running as experimental product in the OSI SAF. Compared to SSM/I the improved spatial resolution of this instrument yields a much better retrieval especially close to the ice edge. There are known calibration issues which have been assessed. However the large improvement to resolution warrants a significant step-up in OSISAF product performance. Particularly, it is expected that the spill-over of the ice edge will be significantly reduced. The AMSR data will also be used in the sea ice edge products. The daily AMSR-E based ice concentration test product is available in HDF5 format, at http://saf.met.no/p.

Figure 5: Sea ice concentration 6. September 2007, left panel: AMSR, right panel: SSM/I.

QUIKSCAT FOR ICE TYPE

The operational OSI SAF Sea Ice Type product is based use of SSM/I data. The gradient ratio of the 19 and 37 GHz vertically polarized channels are used for estimation of the probability of multi year and first year sea ice. However the products are known to have weaknesses. During Arctic summer season (May-September) the ice type product is dubious because melting of the ice surface obscures the ice type signals. Further, in the Arctic winter season, in areas where there is a mixture of first year and multi year ice the probability for multi year ice is underestimated. This has become evident in areas continuously monitored by the operational sea ice services in particular the east Greenland coastal current. These areas are characterized by a mixture of multi year ice transported from the polar areas southward along the Greenland coast. In the SSM/I based product the probability for multi year ice is underestimated in these areas as seen at the left panel in the example below from January 4, 2006. The situation improves by use of scatterometer data. The change in QuikScat measured backscatter with ice roughness has proven to be a good indicator for ice type distinction. Therefore the Ice Type product has been upgraded to combine SSM/I data with QuikScat data in a multi sensor sea ice analysis An example of multi sensor ice type analysis is given in the right panel below in figure 6. Here it is seen that the domination of MY ice along the east Greenland coast is more realistically classified.
METOP ASCAT: IMPROVING ICE EDGE AND TYPE

The METOP ASCAT instrument provides global scatterometer data and the OSI SAF is currently preparing for adding this information to the OSI SAF multi sensor method. This is done by training a Bayesian algorithm to estimate probabilities of different sea surface classes: open water, open ice, closed ice, first year ice and multi year ice. This statistical method will use monthly depending parameters, so that a full year of training data is needed before the ASCAT instrument can be used operationally. Probability distribution functions for the different ice classes are needed and examples of these are given in the figures below. For ASCAT there is a strong dependency on the incidence angle (cell number) which needs to be accounted for. This will be done by using separate PDFs for each cell number. ASCAT data is expected to be used operationally from spring 2008.

**Figure 6:** Sea ice type, 4. January 2006, left panel: SSM/I, right panel: SSM/I and QuikScat. White indicate multi year, grey: first year and pink: uncertain

**Figure 7:** Plots for deducing the PDFs of different ASCAT parameters given known ice surface classes. Left plot is mean values for each individual cell number. Right plot is averaged histograms for all incidence angles.
REPROCESSING OF SSMR AND SSM/I DATA

As the methods for calculating sea ice from passive microwave data have improved, the OSI SAF have decided to reprocess the historical data series of SSMR and SSM/I data back to 1978. This will provide a global updated climate consistent data set of ice concentration, edge and type. The work is ongoing and is cooperation between the OSI SAF, MetOffice (UK), NSIDC (National Snow and Ice Data Center, US) and DTU (Technical University of Denmark). The reprocessing is based on swath data using brightness temperatures both corrected and uncorrected for atmospheric effects. This low-level data is used to create daily and monthly accumulated products. Detailed measures of uncertainties will be provided together with several types of quality flags, so that users can choose how to filter the data set. The data set should be ready in spring 2008.

Figure 8: ASCAT ice edge. Left panel: 2. April 2007, right panel: 31. August 2007. White indicate closed ice while grey indicate pen ice.

Figure 9: Sea ice extent at end of melting season (16. September) from the last three years. From right to left: 2005, 2006, 2007.
UPCOMING PRODUCT: SEA ICE DRIFT

Routinely available sea ice drift will be a new product in the OSISAF chain in 2008. Novel retrieval methods and software are being implemented at met.no (SSM/I, ASCAT) and DMI (AVHRR) to automatically detect movements in the ice pack. Part of the challenge is the optimal merging of information coming from different sensors and thus at various spatial resolutions, into one consistent dataset. Strong efforts are being put on characterising the uncertainties associated with each vector. This operational product should thus be more efficiently ingested into coupled circulation models through assimilation. Further development of the ice drift product will be done in cooperation with IFREMER.

![Figure 10: Two days of sea ice drift based on SSM/I 85 GHz, 8. February 2007.](image)

CONCLUSION

The OSI SAF sea ice system represents a unique source of operational, global and near real time ice information for weather prediction and oceanography. It integrates the complete chain from state of the art algorithms, unparalleled removal or correction of anomalous data, online status indicators, regular quality control and validation into one system. A continuous focus on product validation and monitoring ensures that products are always distributed with best quality and on time to users.

Parallel to the maintenance of this operational sea ice monitoring service, the development work focuses on improved spatial resolution and quality of the products. Introduction of new satellites and sensors such as ASCAT, AMSR, SSMIS and SeaWinds both improves the current operational products and will allow new parameters (e.g. ice drift, surface emissivity, regional ice edge) to be integrated into the OSI SAF chain.
REFERENCES


