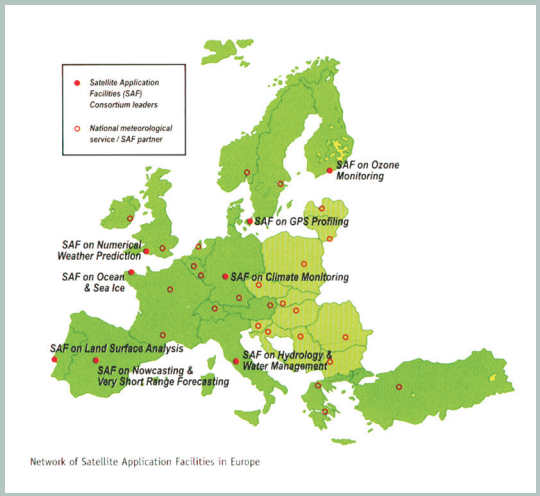
Pre-Processing of the IASI Data

Although IASI has thousands of channels, only 366 channels are extracted for the observation database. Selection of the active channels (channels contributing to the analysis) is the most important task when assimilating the IASI data. Two-steps monitoring technique was used to select the active channels. The first step was based on the analysis of bias and standard deviation of the analysis departures after bias correction (observation-minus-background values), while the second section took into account biases before and after the bias correction. The second selection guarantees that selected channels "obey" the bias correction scheme used in the system.

Assimilation Trial

Different sets of active channels were tested. Common conclusion from the analysis of the impact of the IASI data on analysis is well shown on the respective values of DFS (Degrees of Freedom for Signal) computed using information from analysis with and without IASI data. We see that the relative values of most of the observations were higher when assimilated with IASI data than without them. This means that most of the assimilated observations were better used in the analysis system with IASI data probably due to better background fields (in our case 6-hour forecasts). Preliminary impact studies showed slightly positive and negative impact of IASI data on forecasts of wind, geopotential ans temperature for a summer and winter period, respectively. Thus, further tuning of IASI assimilation scheme should be done to ensure positive impact of the AISI data during both winter and summer periods.

The Satellite Application Facilities (SAFs)



Satellite Application Facilities (SAFs) are specialised development and processing centres within the EUMETSAT Applications Ground Segment. Utilising specialised expertise in Member States, they complement the production of standard meteorological products derived from satellite data at EUMETSATs Central Facilities in Darmstadt and distribute user software packages.

The overall objective of a SAF is the provision of operational services, ensuring a cost-effective and synergetic balance between the central and distributed services. The SAF services are an integral part of the overall EUMETSAT operational services.

In this context, the objective of a SAF is to undertake, on a distributed basis, the necessary research and development to deliver services and products aimed at enhancing the value and use of data for applications, which are a common need of EUMETSAT Member States and Cooperating States.

There are a number of specific benefits arising from the SAFs, including:

- Improvements to short-range forecasting of severe weather hazards;
- Benefits to the aviation, agriculture, construction, gas, water and electricity industries;
- Better understanding of causes and effects of pollution of the upper atmosphere and the depletion of ozone;
- Early warning of hazards;
- Better data for climate monitoring;
- Improved information for land use, ecology, disaster monitoring and agricultural forecasting;
- Benefits for sea transport, fishing and offshore industries;
- Improved data for input to Numerical Weather Prediction and the availability of user software packages for operational applications.

SAFs providing with end of 2008 following operational products:

Support to Nowcasting and Very Short Range Forecasting
Ocean and Sea Ice
Climate Monitoring
Numerical Weather Prediction
Land Surface Analysis
Land Surface Analysis
GRAS Meteorology

SAFs under Development

Support to Operational Hydrology and Water Management

The OSI SAF

- Global Sea Ice Monitoring for Operational Weather and Ocean Forecasting

Numerical weather prediction (NWP) which is the backbone of modern weather forecasting needs daily accurate updates of earth surface parameters. One of these parameters is sea ice. The variations in sea ice impact the ocean-atmosphere fluxes of heat, momentum and water, and thereby the development of both local as well as large scale weather systems.

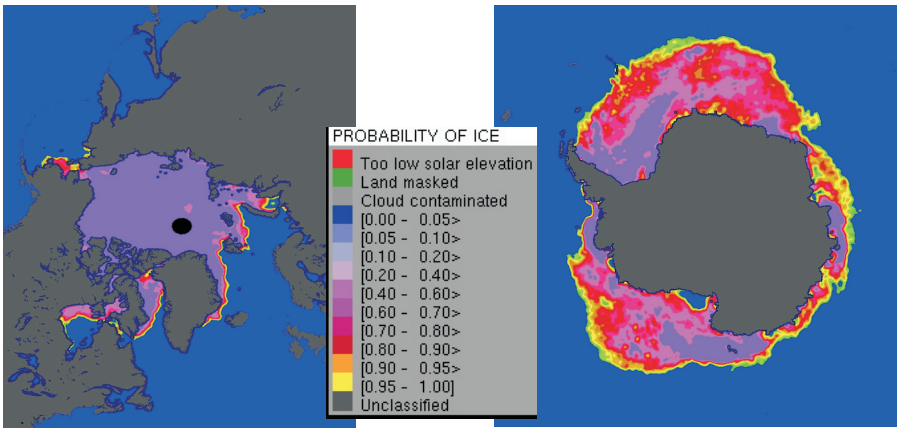


Figure 1: OSI SAF estimated Sea ice concentration 4. December 2008.

Authors:
Steinar Eastwood, Thomas Lavergne and Lars Anders Breivik

Norwegian Meteorological Institut
P.O. Box 43 Blindern,
N-0313 Oslo Norway.
Phone +47 22963000.

TAs an answer to these needs EUMETSAT (http://www.eumetsat.int/Home/index.htm) has established the Ocean & Sea Ice Satellite Application Facility (OSI SAF) as a consortium led by Météo-France. The OSI SAF Sea Ice center is hosted by the Norwegian Meteorological Institute, met.no in cooperation with the Danish Meteorological Institute, DMI. The main task of the OSI SAF Sea Ice center is to provide global sea ice data products derived from operational satellites. The development of the service started in 1997 and it has been operational since 2002. In addition to operational meteorology, the daily OSI SAF products also serve as input to operational oceanography as well as research activities.

Operational status

The sea ice products are currently sea ice concentration, - edge and - type and are delivered daily at 10km resolution in a polar stereographic projection in three data formats: GRIB, HDF5 and NetCDF. The global products are split in two areas, covering the Northern Hemisphere and the Southern Hemisphere. Currently the products are based on SSM/I (Special Sensor Microwave/Imager, see http://www.ncdc.noaa.gov/oa/satellite/ssmi/ssmiproducts.html for more information). The data products are freely available through http://saf.met.no and ftp://saf.met.no.

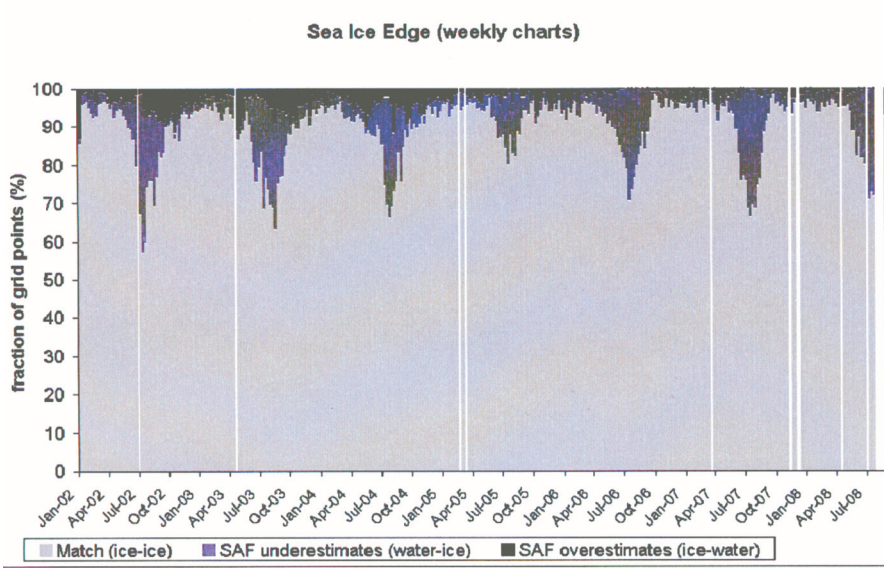


Figure 2: Validation statistics for ice edge product in the Greenland Sea. Independent satellite observations, SAR data and optical data (AVHRR) are used to produce the validation dataset. The figure illustrates the seasonal variations in the quality of ice estimates based on satellite passive microwave measurements. During summer large meltponds on the ice is miss-interpreted as open water. The same problem is seen in ice concentration products. The validation area is focused on areas close to the actual ice edge.

The sea ice products are regularly validated against the ice charts provided 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 found at http://saf.met.no/validation.

On-Going Developments

Use of the AMSR-E instrument flown on the EOS Aqua satellite for sea ice concentration estimation is running as experimental product. Compared to SSM/I the improved spatial resolution of this instrument yields a much better retrieval especially close to the ice edge. Operationally, this instrument is attractive due to similar capabilities on the Japanese GCOM-W AMSR-F/O to be launched in a few years. The large improvement to resolution gives 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 included 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/download.html

As the methods for calculating sea ice from passive micro wave data have improved, the OSI SAF have decided to reprocess the historical data series of SMMR 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 cooperation between the OSI SAF, the MetOffice (UK) and NSIDC (National Snow and Ice Data Center). 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 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 will be ready in January 2009 and will be available through the OSI SAF web site.

The European meteorology satellite METOP is equipped with a scatterometer ASCAT designed to measure ocean surface wind. The instrument is performing excellent and ASCAT wind observations are very important for weather analysis and forecasting over large ocean areas. Over sea ice, the measured backscatter is systematically different compared to

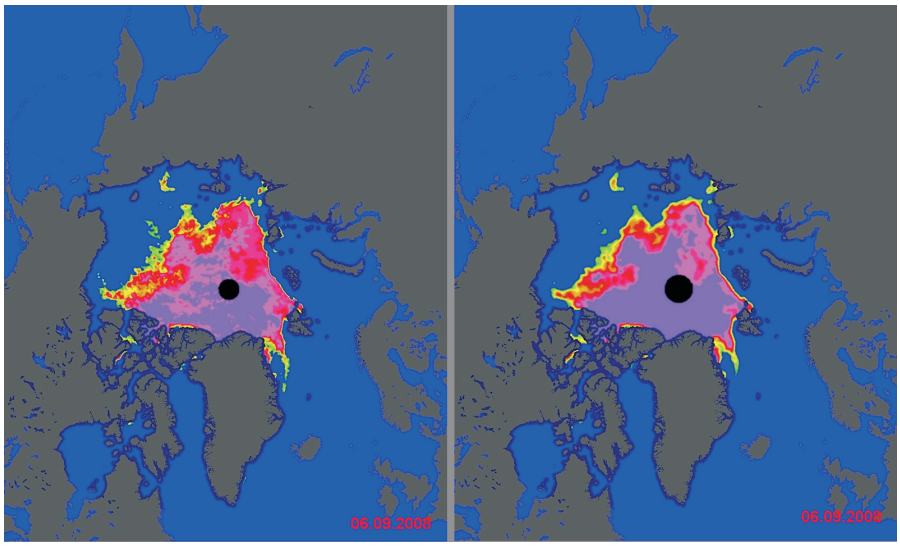


Figure 3: Comparison of AMSR-E based ice concentration analysis (left) to the operational OSISAF product based on SSMI (right). Both are from derived using the 19 and 37 GHz channels.

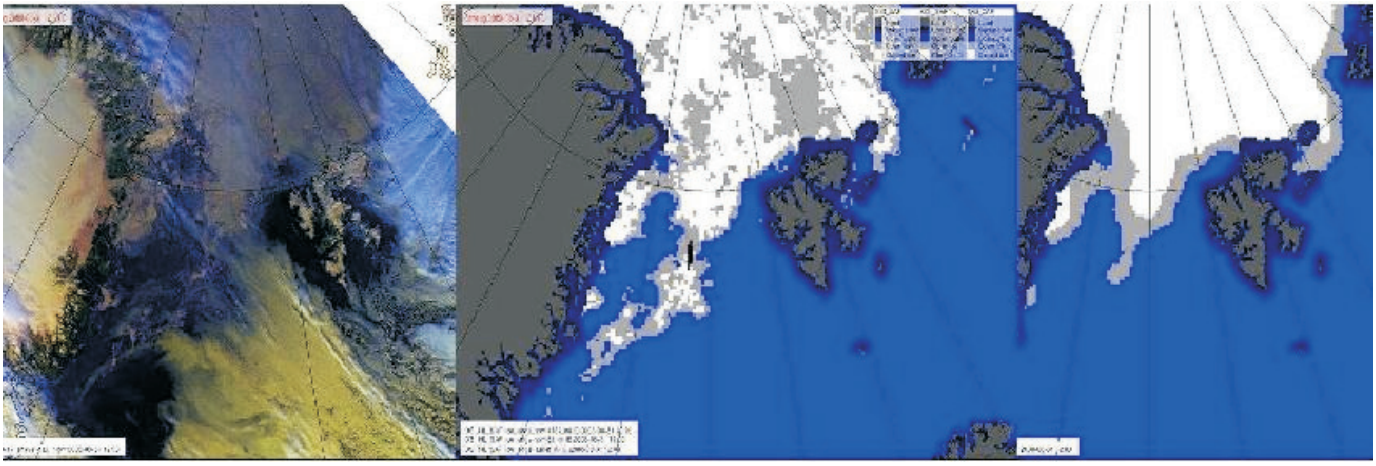


Figure 4: Left NOAA17image, middle ASCAT ice probabilities, right: SSM/I (19/37) ice probabilities. 31 August 2008. White represents high probability of closed drift ice, grey; of open drift ice. The ASCAT observations are given in 12 km resolution and give more details in the ice edge compared to SSM/I. However certain wind directions over the ocean can give a similar backscatter pattern as sea ice and therefore lead to miss classifications. A method combining scatterometer and passive microwave is under development and is aimed to give an optimal combination of the sensors.

over the ocean. Thereby ASCAT can also be used for sea ice detection. The OSI SAF is currently preparing for adding ASCAT data to the OSI SAF multi sensor sea ice estimation. 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.

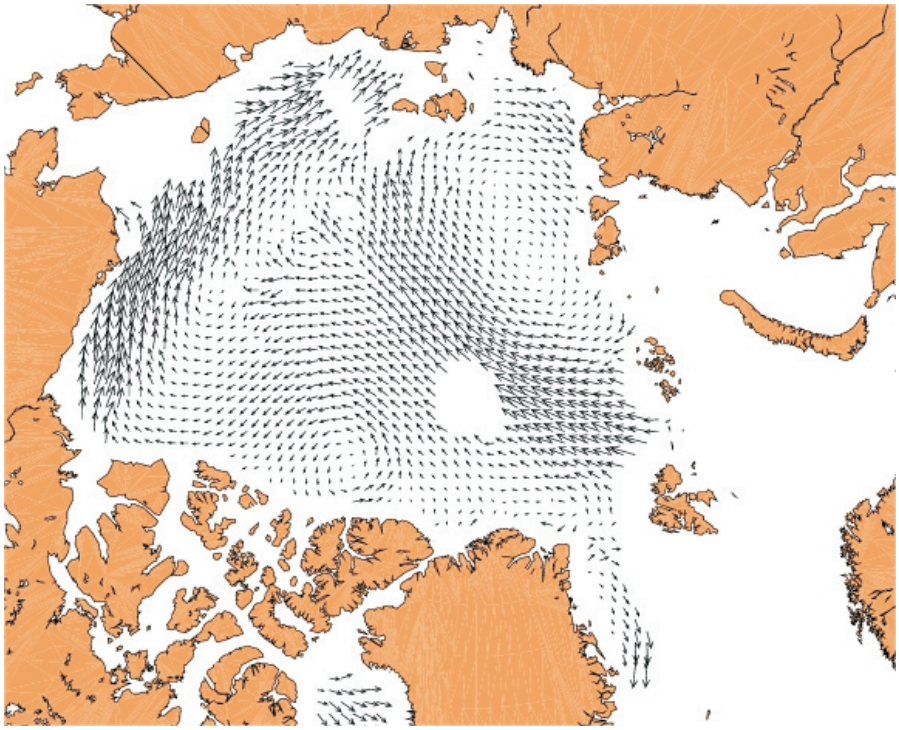


Figure 5: An ice motion field where each arrow stands for the displacement of sea ice between November, 22nd and 24th 2008. It has been retrieved from a pair of images acquired from the Advanced Microwave Scanning Radiometer (AMSR-E), a satellite sensor operated by NASA. Most of the research effort has been devoted to designing an alternative tracking algorithm to permit the retrieval of relatively short (2 days) and spatially consistent ice drift vectors. After some final tests, this processing chain will soon be integrated into the OSI SAF and the products will thus be freely available for all interested users.

Pushed by winds and ocean currents, sea ice in the Arctic is constantly moving. This motion has a great influence on the mechanical forces inside the ice sheet and thus on its deformation rate. The opening of leads (ice free areas where a ship can sail) or the formations of ridging structures (regions of compacted ice) is a direct effect of those stresses. For an enhanced monitoring and forecasting of the ice motion and internal stresses, an operational sea ice drift observing system based on sequence of satellite images have recently been developed. Figure 5 displays an example motion field.

Conclusion

The OSI SAF sea ice system represents a unique source of global and near real time ice information to operational meteorology and oceanography by integrating the complete chain from state of the art algorithms, unparalleled removal or correction of anomalous data, online quality indicators, regular quality control and validation into one system. Moreover, the system is open to evolution and is making progress in terms of spatial resolution and accuracy. A continuous focus is on product validation and monitoring.