# The Norwegian Sea Ice service participation in a GMES Service Element project - ICEMON

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**The Norwegian sea ice service at the Norwegian Meteorological Institute participated in the European Space Agency GSE consolidation phase through the ICEMON project. The sea ice services brought the production of high resolution ice charts up to an operational level and improved the quality of the daily low resolution ice charts with input from two new products generated in ICEMON.**

**Keywords:** GSE, GMES, ICEMON, Sea ice

## 1. INTRODUCTION

In 2002/2003 the Norwegian Meteorological Institute (met.no) participated in a proposal for a GMES Service Element project sponsored by the European Space Agency (ESA) called ICEMON. Met.no was represented by the Forecasting Division for Northern Norway, where the sea ice service is located. Met.no did the project management task for a consortium with over sixteen partners. For two years, during stage one of GSE, the sea ice service delivered high resolution ice charts for local areas in the European Arctic. This paper will briefly present the Norwegian sea ice service and describe what has been accomplished during the ICEMON project.

## 2. THE NORWEGIAN SEA ICE SERVICE

### 2.1 Background

The first organized observations of sea sea ice started in 1930, partly due to an initiative from Fridtjof Nansen. In 1966 met.no and the Norwegian Polar institute started using satellite images to chart sea ice. The sea ice service moved from met.no in Oslo to Tromsø in 1997, and increased the production from one chart a week to five charts a week made digitally.

### 2.2 Sea Ice chart service before ICEMON

The main satellite earth observation data sources have traditionally been the SSM/I based concentration products and NOAA AVHRR images. Sea ice edge, concentration and type products based on the SSM/I data are now generated by the Eumetsat Ocean and Sea Ice Satellite Application Facility (OSI-SAF) on a 10 km grid. Met.no is responsible for the Northern Latitude OSI-SAF, and will continue to develop the platform together with the Danish Meteorological Institute. The OSI-SAF has recently extended to global coverage and there are proposals to include data from other satellite sensors. The OSI-SAF is an operational system and intended to be the platform for sea ice products from the Eumetsat Metop satellites that is to be launched.

The sea ice service produces ice concentration charts that cover the sea between Greenland and Novaya Zemlya, shown in Figure 1. Due to cloudy conditions AVHRR 1-2km images are seldom available. The background resolution of this chart is therefore usually 10km. The charts are available on http://met.no. The sea ice service also provides sea ice edge products, sea surface temperature charts and snow charts.

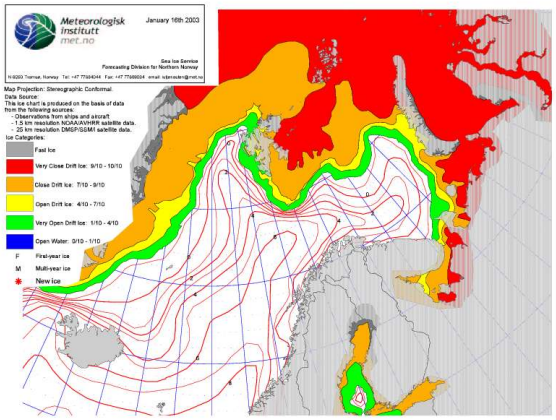


Figure 1. Ice concentration chart with sea surface temperature from January 2003 produced at the Norwegian Sea Ice Service.

## 3. GSE AND ICEMON OBJECTIVES

### 3.1 Background

In September 2002 ESA issued an ITT to define and consolidate operational GMES services within Europe (EOEP-GSE-EOAD-SW-02-0001, 2002). In November the same year a consortium led by Nansen Environmental and Remote Sensing Center (NERSC) submitted a proposal to answer the ITT specifically covering the area of sea ice monitoring. The kick off was held in Bergen in March 2003. The cardinal requirements from the statement of work were:

- What information is needed?
- What services can be provided?
- What are the benefits for the Europe's citizens?
- Do the benefits justify the costs?

From these requirements a number of tasks originated. First of all was the need to compile end user product requirements, generate a service portfolio, deliver products and collect end user feedback on the products. Second was to provide documents that describe the current and future status on algorithms, data sources, infrastructure, policies and cost benefit analysis of services in the service portfolio.

### 3.2 ICEMON Accomplishments

The first year of ICEMON, a major part of the effort was spent on trying to understand and fulfill the detailed requirements for the content in the documents. The project and documents gradually matured and ICEMON achieved some important milestones in the development of sea ice services

- ICEMON was successful in consolidating a set of existing services and refining requirements that provide a route map to the future provision of enhanced services.
- ICEMON was instrumental in bringing together service providers, researchers, system developers and end users providing the basis for future services.
- ICEMON provided guidance to ESA on the development of future mission requirements.
- ICEMON documented that the consolidated service portfolio is a sound investment for the society as a whole, even when the intangible benefits is not included.

## 4. RESULTS OF ICEMON FOR MET.NO

### 4.1 High resolution ice charts

Met.no contributed the high resolution ice chart service to ICEMON. This service provide a sea ice concentration chart based on SAR images covering an area of approximately 400x400km with a pixel spacing of 150 to 300meters as shown Figure 1.

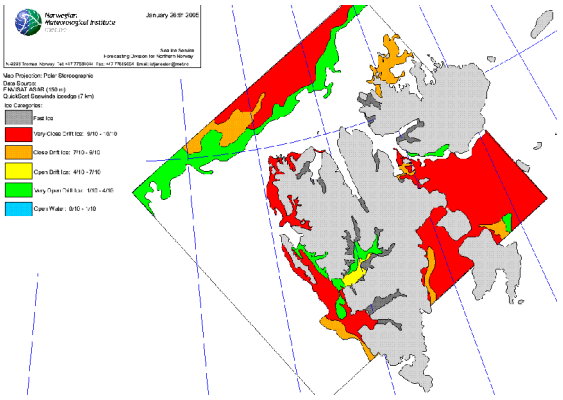

Figure 2. High resolution ice chart of the Svalbard area by met.no

The ICEMON project made it possible to run this service by

- Funding near real time data acquisition and processing of 36 SAR scenes at Kongsberg Satellite Services
- Providing additional training of SAR analysis staff
- Contributing man hours to analyze SAR images

To create a sustainable service it is important to provide the products at a stable and operational level. This will demonstrate the real value of the service to the end user and show the real cost for the service provider. Only when the real value can be documented to be higher than the substantial cost of SAR data for this service sustainability can be secured.

The high resolution ice charts were downloaded from the met.no website by at least 260 different end users. Twelve users from a wide range of business areas provided an overall positive feedback, which show that the product is important for a large community. Met.no has proposed to continue to provide this service in stage two of GSE.

### 4.2 Improved accuracy on low resolution ice charts

The daily production of low resolution ice chart which was not a part of the ICEMON portfolio benefited from two products which were introduced to the portfolio during the project.

Early in 2004 ESA made data from the ASAR Global Mode background mission available in a rolling archive only few hours after acquisition. These data are made available free-of-charge for GSE projects. Vexcel UK developed a mosaic of all Global Mode data acquired over 24 hours covering the Arctic as shown in Figure 3. The Global mode data from ESA have a resolution of 1km, while the mosaics have a resolution of 2km to reduce noise and image size. A range normalization is applied to the swaths in the mosaic to ease interpretation and this is based on the average range fall-off of ice from north of Greenland (i.e. mainly multi-year ice).

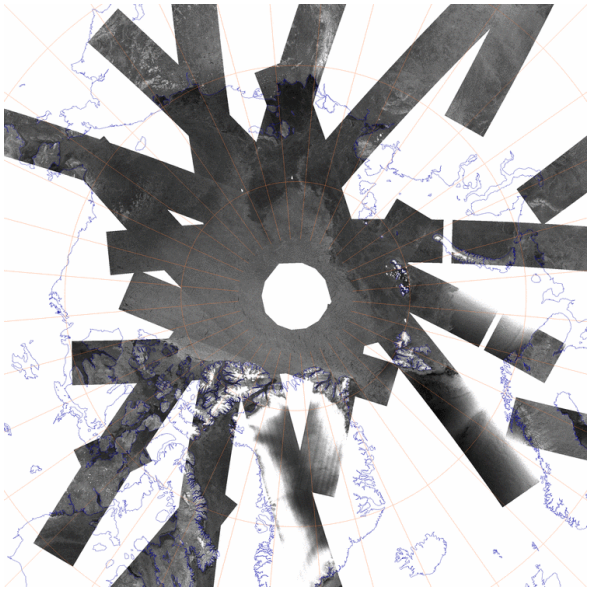

Figure 3. Envisat ASAR Global Mode 24 hours mosaic of the Arctic. ESA©2005 and Vexcel UK.

Met.no saw the immediate use of this product and asked Vexcel UK to provide the mosaics as geotiff images and to "push them" to a ftp server at met.no. The products from the previous day are available just in time to be ready when the working day starts. The products cover on average at least 50% of the area of interest for the Norwegian sea ice service every day. This means that the accuracy of the ice edge and visibility into small fjords and straits have

improved, although it is more difficult to analyze ice concentration and wind features on global mode data than 300m resolution wide swath products.

University of Bremen, Institute of Environmental physics became partners in ICEMON during the second year. They contributed with an automatically generated medium resolution ice chart based on AQUA AMSR-E data fetched from National Snow and Ice data center in USA. The ARTIST Sea Ice (ASI) algorithm is used to find the ice concentration (Kaleschke,2001). This chart has a resolution from 3.125 to 6.25km depending on the size of area selected. An example of the 6.25km Arctic medium resolution chart that show the level of detail around the Svalbard islands is shown in Figure 4.

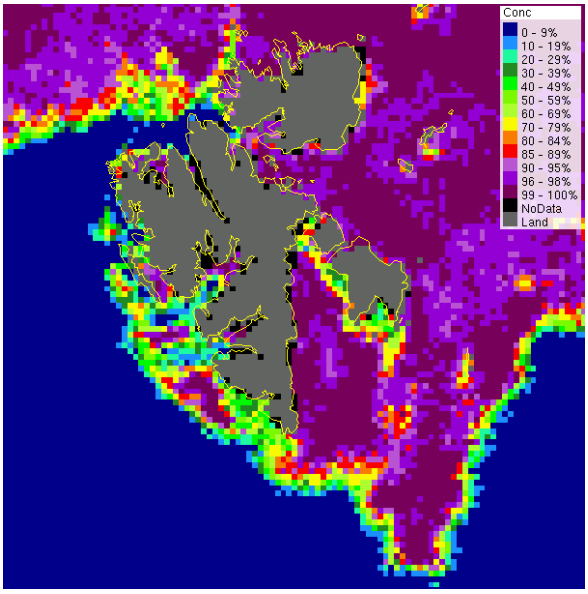


Figure 4. Arctic medium resolution ice concentration chart from University of Bremen in met.no DIANA analysis tool. Image show the Svalbard islands. Courtesy IUP University of Bremen and met.no.

The University of Bremen kindly started to make geotiff images of their Arctic and Antarctic product after a request from the Norwegian ice service.

Met.no now fetches updated Arctic AMSR-E ASI products every morning and uses this in the daily ice chart production. This is an excellent supplement to the ice concentration charting. It is more reliable close to land- and has a considerable better resolution than DMSP SSM/I based products.

## 5. CONCLUSION

ESA's ICEMON project resulted in an invaluable consolidation of products and services in support of met.no's mandate for sea ice monitoring. The SAR data were used at both ends of the sampling spectrum to generate high resolution ice charts in areas of importance to met.no and through the ENVISAT GM data met.no were able to provide Arctic-wide coverage on a near daily basis. The advent of AMSR-E products complements the GM mosaics by providing information on ice concentration at higher resolution than has previously been available.

The second stage ITT (EOEP-GSE-EOAD-SW-04-0001,2005) for the continuation of GSE contains requirements to harmonize data and product exchange between all GSE projects and with the INSPIRE initiative (ref: http://inspire.jrc.it). The hope is that the achievements of the ICEMON project will be built on through a continuation GSE project called Polarview, which will introduce further service enhancements and additional international coordination..

## 6. ACKNOWLEDGEMENTS

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