



# Newsletter

no. 1 & 2 / 2009

[globsnow.fmi.fi](http://globsnow.fmi.fi)



FINNISH METEOROLOGICAL INSTITUTE

# European Space Agency DUE - GlobSnow (2008–2011)

*Development of Global Snow Monitoring Services*



## Overview

The European Space Agency (ESA) funded the Data User Element (DUE) GlobSnow project aims at creating a global database of snow parameters for climate research purposes (DUE: <http://www.esa.int/duel>; GlobSnow: <http://globsnow.fmi.fi>). In addition to a historical data set comprising of 15 to 30 years of snow data an operational near-real time snow information service will be demonstrated. Information on two essential snow parameters: snow water equivalent (SWE) and areal snow extent (SE) will be provided. The database and the demonstrated snow service will be based on data acquired from

active and passive, optical and microwave-based spaceborne sensors combined with ground-based weather station observations.

## Background

Global monitoring of climate and climate change depends critically upon satellite based Earth Observation as recognized in the Global Climate Observation System (GCOS) implementation plan. The GCOS calls for global observations of a number of Essential Climate Variables (ECV) needed to fulfil requirements formulated within the United Nations Framework Convention on Climate Change (UNFCCC). The

GCOS implementation plan has recognized the global areal extent of snow as one of its terrestrial ECV. The European Space Agency (ESA) funded GlobSnow project will provide new and enhanced global snow monitoring services for GCOS and climate research purposes. The monitoring of seasonal snow cover is essential for hydrological, meteorological, and climate research purposes. Snow cover directly affects the planetary albedo, has impacts on the hydrological cycle and acts as indicator for climate trends and variability. Information on snow-melt conditions can be utilized for hydrological monitoring, optimization of hydropower production and for

the validation of climate models. Additionally, operational snow monitoring is relevant for a variety of Global Earth Observation System of Systems (GEOSS) societal benefit areas: Climate, weather, water and energy resources, ecosystems as well as disaster monitoring.

A key requirement in snow monitoring for climate research purposes is that observations should cover the largest achievable temporal and spatial span. The GlobSnow project will develop a operational near-real time (NRT) service for global snow monitoring and a historical data set comprising of 15 to 30 years of snow data. Additionally, a fundamental climate data record (FCDR) for snow, spanning 15 to 30 years, will be constructed within the GlobSnow project.



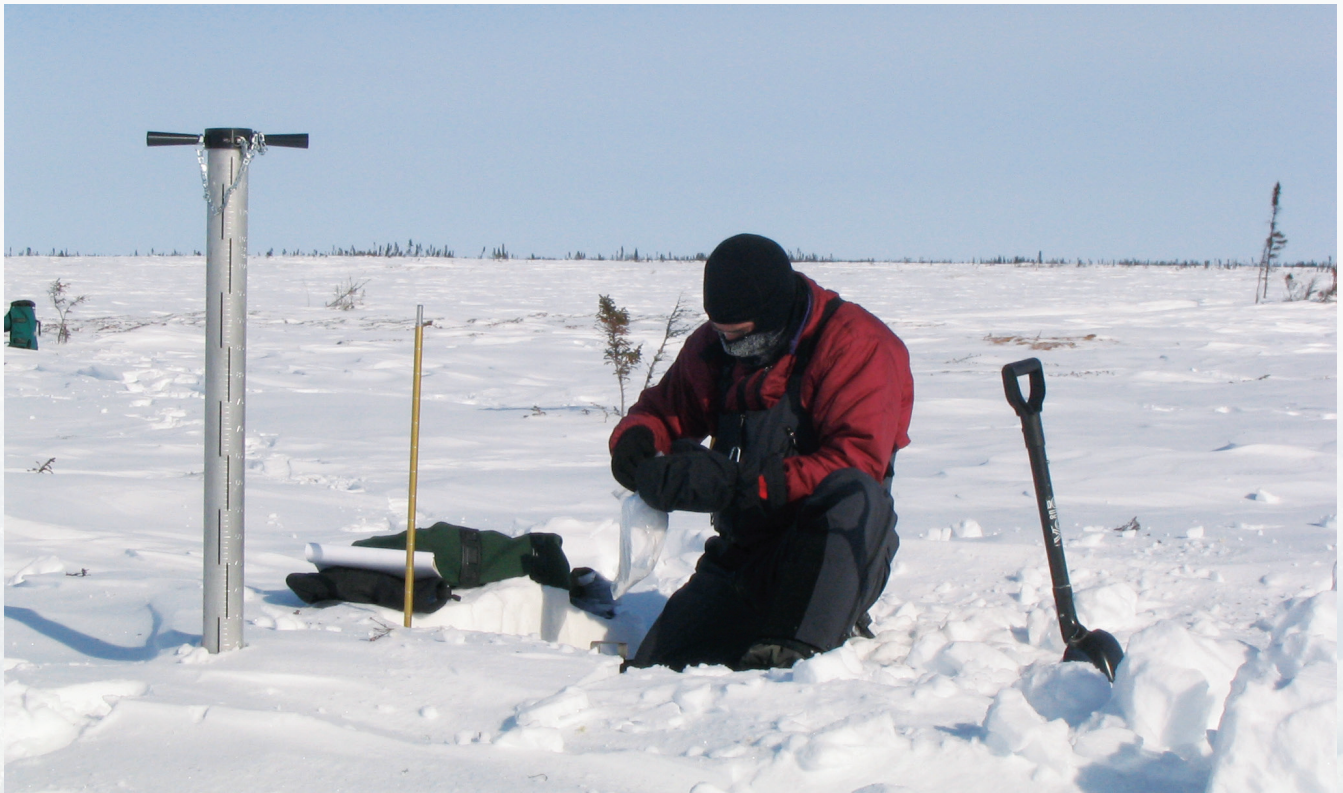
## Impacts & expected results

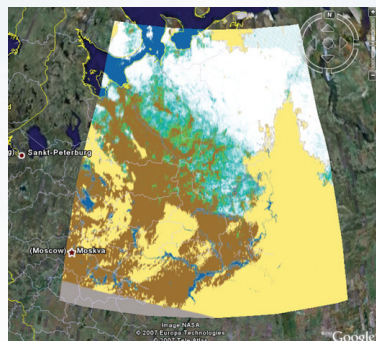
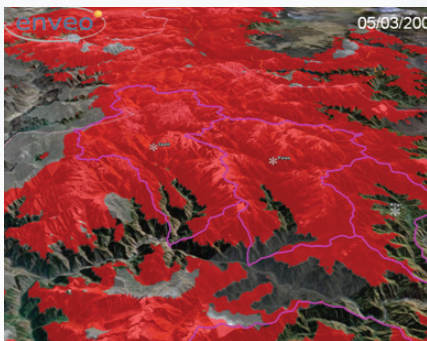
The project aims at creating temporally and spatially extensive snow products with well known accuracy characteristics. The snow products will be based on the state-of-the-art algorithms that are thoroughly validated using an ex-

tensive ground truth database gathered from Canada, Scandinavia, Russia and the Alps. The consistency of the historical datasets will be investigated and characterized for different geographical regions. The snow products will be archived and distributed through ESA network and the data will be available for the User community from (<http://globsnow.fmi.fi/>).

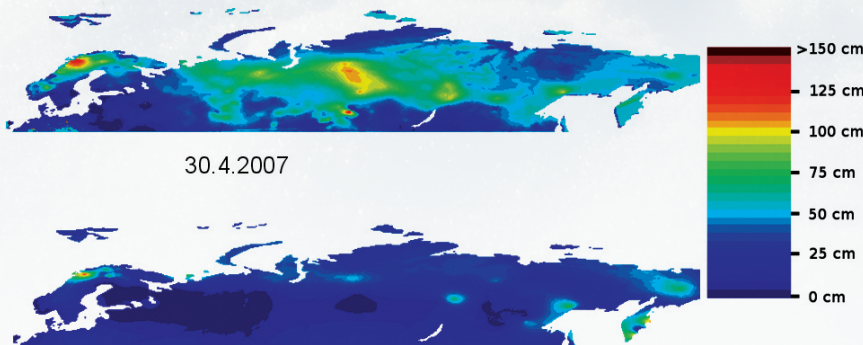
## Snow products & services

The specifications for the GlobSnow snow products were decided with the user community during the Requirements Engineering Review held at Geneva in the beginning of February 2009.





8.3.2007



Satellite-based Snow Depth estimates for the northern Eurasia.

Satellite-based Snow Extent maps for the Scandinavia, western Russia and the Alps.

### Snow Water Equivalent (SWE)

The SWE product will be generated on a daily, weekly and monthly basis for using SSM/I and AMSR-E data along with ground-based weather station data.

- The SWE end-product and FCDR will span the years 1987 through 2010.
- It will be evaluated for non-mountainous areas of Northern Hemisphere, excluding the mountainous areas, Greenland, the glaciers and snow on ice (lakes/seas/oceans).
- The spatial resolution of the product will be 25 km on EASE-grid projection.
- Several snow water equivalent estimation algorithms will be investigated for different geographical regions, including:
  1. Direct inversion algorithm based on channel difference by Chang et al 1987 and Foster et al. 1997
  2. SWE algorithms suite by Environment Canada
  3. SWE data assimilation suite by Finnish Meteorological Institute.
- The validation and algorithm evaluation will be carried out using Russia, Canada and Finland as the test regions.
- The evaluation will be conducted for the years 1995-1997 and 2003-2008 using mainly ground based measurements of snow cover for the different test sites.

### Global areal Snow Extent (SE)

The SE product will include a weekly and a monthly snow cover composite based on ESA ERS-2 ATSR-2, Envisat AATSR and Envisat ASAR data.

- The SE end-product and FCDR will span years through 1995 to 2010.
- It will be evaluated for areas with seasonal snow cover on both Northern and Southern Hemispheres, excluding glaciers, Greenland, Antarctica and snow on ice (lakes/seas/oceans).
- The SE product will be generated using WGS 84 latitude/longitude grid and a 0.01° resolution.
- Several snow cover detection algorithms will be investigated for different geographical regions.
- The validation and algorithm evaluation will be carried out using the Alps, the Scandinavian Alps and Finland as the test regions.
- The evaluation will be conducted for the years: 2000 and 2003-2006 using high resolution optical and ground-based measurements on snow cover for the different test sites.

## Test sites

The GlobSnow algorithm evaluation and validation will be carried out using data from several distinct test sites from around the world. The main test areas are Canada, Russia, the Alps, Scandinavia and the land areas of Finland. The coverage and locations of the test sites are shown on the following figures.



Figure 1: Overview map of location of GlobSnow test sites.



Figure 2: Coverage of test site Alps.



Figure 3: Coverage of test sites Scandinavia (1) and Finland (2).



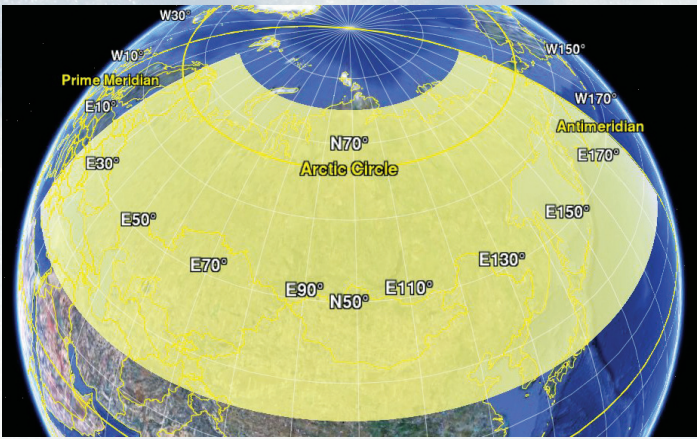


Figure 4: Coverage of test site Russia.



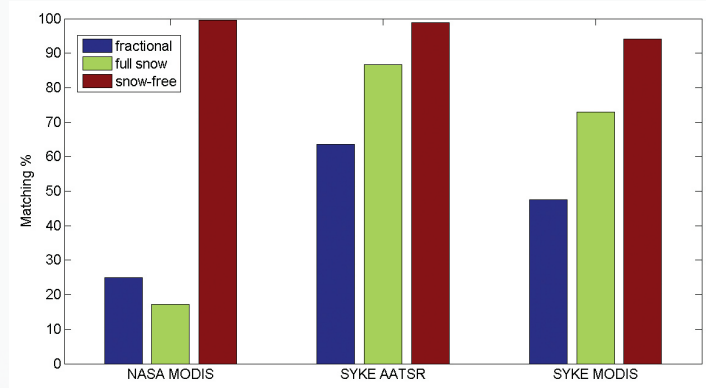
Figure 5: Coverage of test sites in Canada. 1 – Northwest Territories, 2 – Northern Manitoba, 3 – Boreal Ecosystem Monitoring and Modelling Site, and 4 – Prairie.

## First validation results for Snow Extent

In GlobSnow, Finnish Environment Institute (SYKE) applies its own SCAMod method to calculate fractional snow coverage (FSC) using both Terra/MODIS data and Envisat/AATSR data. (For the validation purposes, the FSC serves better than quantified SE-data, though the later eventually serves as an actual GlobSnow product). The third data set used for validation are the NASA MODIS fractional snow coverage product (mod10\_l2\_v005). 18 dates from years 2003-2005 were selected to provide a validation data set of more than 24000 cases (snow classified pixels). These were compared with daily snow coverage information acquired from the

Finnish weather station network. The analyses clearly indicate that FSC estimates produced by the SYKE SCAMod algorithm using AATSR shows the strongest agreement with the snow reference data. For example, with AATSR, 64% of partial snow coverage cases (ie. patchy melting snow) was correctly recognized as partial, while with MODIS, only 47% was successfully classified. NASA snow product showed the least successful classification performance with only 25% being correctly recognized as partial snow coverage, the

rest of the cases being misclassified as snow-free or snow-covered ground. These first validation results show the direction for the GlobSnow validation efforts that will eventually be carried out using several distinct test sites with different characteristics and several different snow classification algorithms.



The performance of the three snow extent products: matching with snow cover data from Finnish weather stations.

## The Project Consortium

The project is being funded by the European Space Agency ESA ([www.esa.int](http://www.esa.int)).

### COORDINATOR



FINNISH METEOROLOGICAL INSTITUTE

Finnish Meteorological Institute (FMI) ([www.fmi.fi](http://www.fmi.fi))

Finnish Meteorological Institute is a research institute under the Ministry of Transport and Communications of Finland. It provides operational and research information related to weather and climate for the needs of the public and decision-makers, including the production of numerical weather predictions.

## PARTNERS



ENVEO IT GmbH ([www.enveo.at](http://www.enveo.at))

ENVEO IT GmbH, founded in 2001, is an engineering company based in Innsbruck, Austria. It is specialised in remote sensing techniques and applications for hydrology and meteorology, including basic research, transfer from research to applications, and services in hydrology and water management.



Environment  
Canada

Environnement  
Canada

Environment Canada (EC) ([www.ec.gc.ca](http://www.ec.gc.ca))

The Climate Processes Section of Environment Canada conducts research that contributes to a better understanding of climate system behaviour in Canada, with a focus on cold climate processes and their representation in climate models. A long-standing research program is the development of satellite-based capabilities to characterize the spatial and temporal aspects of the cryosphere in northern Canada, with a focus on snow cover (snow water equivalent), sea ice and lake ice.



Finnish Environment Institute (SYKE) ([www.ymparisto.fi](http://www.ymparisto.fi))

The Finnish Environment Institute (SYKE) with a staff of about 600 is a national research and development centre under the Ministry of the Environment, Finland. The institute provides environmental information, publishes assessments on the state of the environment, conducts research on the environment and environmental effects of activities and analyses approaches and methods for the prevention and mitigation of harmful effects.



GAMMA Remote Sensing AG ([www.gamma-rs.ch](http://www.gamma-rs.ch))

GAMMA Remote Sensing AG is a Swiss corporation located in Gümüliigen near Bern, Switzerland founded in 1995. The overall objective of GAMMA is to conduct research studies and to provide consulting and processing services in the field of microwave remote sensing. The topics include signal processing, microwave signature interpretation, retrieval algorithm development, and modeling activities.



Norwegian Computing Center (NR) ([www.nr.no](http://www.nr.no))

Norwegian Computing Center (NR) is a private, independent, non-profit foundation established in 1952. NR carries out contract research and development projects in the areas of information and communication technology, applied statistical modelling and earth observation. NR has been a leading research and development institute in satellite remote sensing since Norway started to focus on this discipline in the beginning of the 1980s.



## Contact information:

**Prof. Jouni Pulliainen**

Project Principal Investigator  
Finnish Meteorological Institute  
tel: +358 50 589 5821  
email: jouni.pulliainen@fmi.fi

**Dr. Kari Luojus**

Project Manager  
Finnish Meteorological Institute  
tel: +358 40 505 8417  
email: kari.luojus@fmi.fi

**Dr. Bojan Bojkov**

Project Technical Officer  
European Space Agency  
email: bojan.bojkov@esa.int



FINNISH METEOROLOGICAL INSTITUTE

WWW-pages: <http://globsnow.fmi.fi/>