GLOBSNOW 2

Newsletter

no. 1 / 2012

www.globsnow.info

Topics of the Newsletter:

GlobSnow-2 overview
General information on SWE upgrades within GS-2
New SE processing chains (VIIRS SE & AVHRR SE)
General information on SE upgrades within GS-2
Introduction of project partners

esa

FINNISH METEOROLOGICAL INSTITUTE

Short overview of GlobSnow-2

The European Space Agency (ESA) Data User Element (DUE) funded GlobSnow-2 project is a direct continuation of the GlobSnow-1 project that was active from 2008 to 2012. GlobSnow-1 resulted in two long-term datasets at the hemispherical scale. Information on two essential snow parameters: snow water equivalent (SWE) and areal snow extent (SE), were provided for a period of 30 years and 17 years respectively.

The aim of the ESA DUE GlobSnow-1 project was the production of global long term records of snow parameters intended for climate research purposes. The GlobSnow snow datasets contain satellite-retrieved information on snow extent (SE featuring Fractional Snow Cover, FSC) and snow water equivalent (SWE) extending as far to the past as feasible using the selected sensor-families. The current SE dataset is based on optical data from Envisat AATSR and ERS-2 ATSR-2 sensors covering the Northern Hemisphere between 1995 to 2012. The SWE record is based on the time series of measurements by two different space-borne passive microwave sensors (SMMR and SSM/I) spanning 1979 to 2012. The SWE product combines satellite-based passive microwave measurements with ground-based weather station data in a data assimilation scheme. Both products are provided on a daily, weekly and monthly basis in NetCDF CF format accompanied with quicklook images for each product. In addition to the long term series of SE and SWE, an operational near-real time (NRT) snow information service is maintained. The NRT service initiated operations on October 2010. Both the historical datasets and the NRT products have been made available for the GlobSnow user community through the GlobSnow web-portal (www.globsnow.info). The ESA GlobSnow project was initiated in November 2008, and is being coordinated by the Finnish Meteorological Institute (FMI).

The objective of the GlobSnow-2 project is further enhancement of the retrieval methodologies for SE and SWE products and a re-processing of the long term datasets utilizing the improved retrieval algorithms. In addition to the further development of methodologies for the legacy sensor families of GlobSnow-1, the consortium will investigate the utilization of AVHRR and NPP Suomi VIIRS data as gap fillers before the launch of the Sentinel-3 SLSTR-sensor. Also the development of a new product combining the high resolution SE data with the lower resolution SWE product will be an area of focus for GlobSnow-2.

General information on SWE upgrades within GS-2

The GlobSnow-1 project produced the first satellite-based daily SWE dataset for the northern hemisphere that extends over 30 years. The GlobSnow SWE retrieval scheme utilizes a novel data-assimilation approach for SWE estimation based on a combination of satellite passive microwave measurements, weather station observations of snow depth, and forward simulations with a semi-empirical snow emission model to produce coarse resolution (25 km) maps of terrestrial SWE.

The efforts planned for the GlobSnow-2 project include improvement of the SWE retrieval methodology and an ultimate reprocessing of the full product dataset, covering the years 1979 to 2012. The main efforts for the SWE algorithm development include 1) the implementation of an improved multi-layer HUT snow emission model, 2) implementation of climatologically based spatially and temporally varying snow density values and 3) homogenization of the weather station input data.

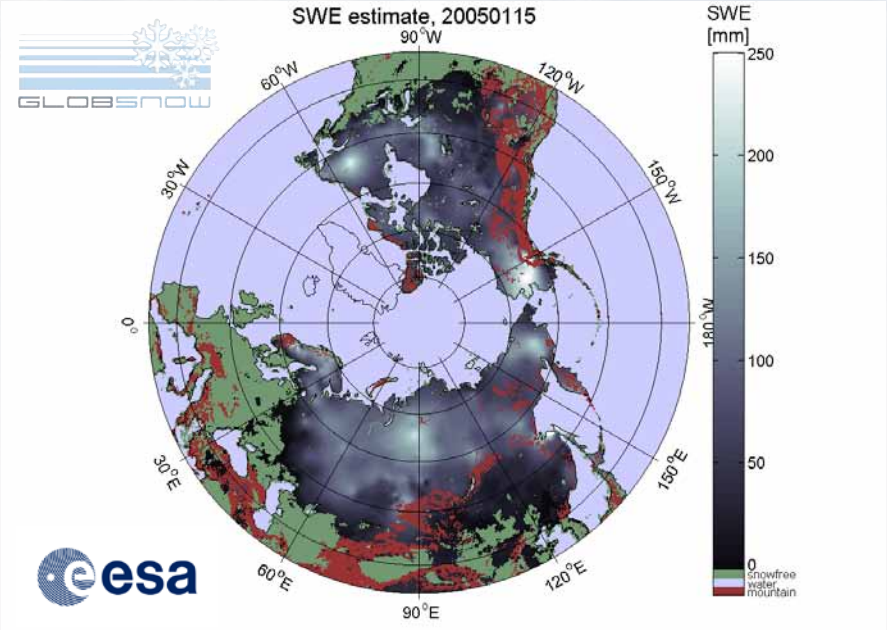


Figure 1. Daily Snow Water Equivalent (SWE) product for 15 January 2005.

1) Improved multi-layer HUT snow emission model

In order to improve the SWE retrieval over heterogeneous landscapes and in regions with significant lake coverage, an improved version of the HUT multi-layer snow emission model will be incorporated into the existing SWE retrieval methodology. Improvements will result from the forward snow emission modeling component of the SWE retrieval scheme through snow grain size estimates that are physically more reasonable than the current estimates of the effective snow grain size.

2) Climatological based spatially varying snow density

The SWE retrieval methodolgy from GlobSnow-1 utilizes a fixed snow density value to convert snow depth to SWE within the retrieva schemel. A significant improvement to the retrieval accuracy may be obtained by treating the snow density values within the algorithm with spatially and temporally varying values based on climatology (temporal and spatial variability according to land cover and climate zone).

3) Homogenization of the weather station input data

An important issue affecting the overall quality of the long term SWE data record is the snow depth observation input data from the global synoptic weather station network. These data are used for two purposes: (a) to derive a background field of snow depth by applying kriging interpolation and (b) to derive the value of snow grain size at the locations of the weather stations through forward snow emission model simulations. Any issues with the weather station data therefore directly affect the SWE time series. Efforts for detecting and removing of erroneous input data and spatio-temporal filtering of the weather station data will be investigated within the GlobSnow-2 project.

Efforts for improving the SWE retrieval will be assessed by producing and evaluating a prototype SWE data set that extends 10 years for non-alpine areas of the northern hemisphere. After the evaluation of the enhancements the full long-term SWE time series will be reprocessed using the new improved methodology.

Reference for GlobSnow SWE method:
Takala, M., Luojus, K., Pulliainen, J., Derksen, C., Lemmetyinen, J., Kärnä, J.-P., Koskinen, J. and Bojkov, B. (2011): Estimating northern hemisphere snow water equivalent for climate research through assimilation of space-borne radiometer data and ground-based measurements. Remote Sensing of Environment, Vol. 115 no. 12, December 2011, pp. 3517-3529, doi: 10.1016/j.rse.2011.08.014.

New SE processing chains

VIIRS SE & AVHRR SE

After the end of the Envisat mission (in April 2012) and the end of AATSR data delivery the GlobSnow consortium decided to start producing the GlobSnow NRT snow extent product by utilizing the data from the NPP SUOMI VIIRS sensor, with Metop-AVHRR as a backup data source. The modification of the legacy AATSR-based production chains for the SUOMI VIIRS data took place during the summer of 2012, and the operational production of NRT SE maps was initiated in October 2012, currently covering the pan-European domain. There are two different production chains, one utilizing the Suomi VIIRS data and another relying on Metop-AVHRR data. The production chains are independent and provide daily fractional snow cover extent for the pan-European domain. The Suomi VIIRS production chain will be expanded to cover the Northern Hemisphere during the winter of 2012-2013 and global coverage is planned for the winter of 2013-2014 using VIIRS data. The current VIIRS operational production chain utilizes VIIRS Direct Broadcast data received at the FMI Sodankylä satellite receiving station.

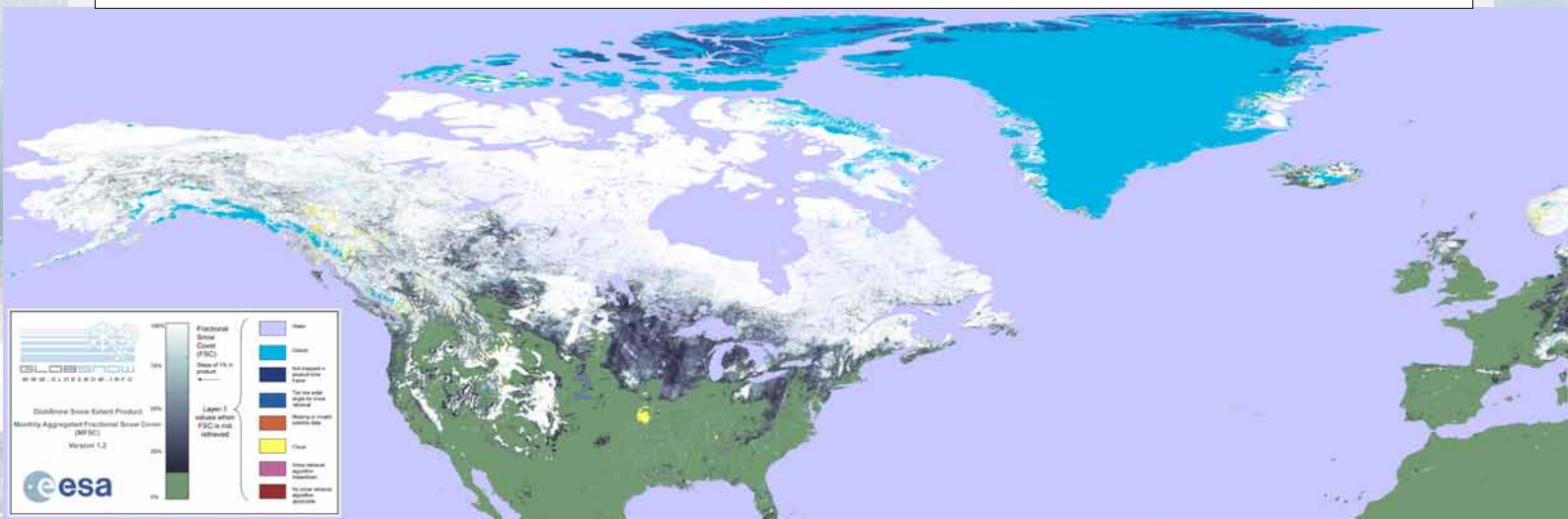
As a NRT backup system for Europe, the Metop-AVHRR real time facilities at the University of Bern are being used. The Remote Sensing Research Group receives and archives MetOp AVHRR data at the local receiving station in Bern. The AVHRR instrument provides data in 5 different spectral channels (optical and thermal infrared). After reception, the data is automatically pre-processed, which includes radiometric calibration, geolocation and orthorectification, and cloud masking. This pre-processed data is used as input to the automatic snow detection algorithm: As the Metop AVHRR sensor is equipped with the necessary spectral information (channel 1, centered at 0.6 μm and channel 3A, centered at 1.6 μm) the snow detection is based on the Normalized Difference Snow Index (NDSI). This band ratio method capitalizes on the snow's distinct decrease of reflectance from the visible range towards the near-infrared part of the electromagnetic spectrum. It represents a widely used, simple and robust technique, which is insensitive to a wide range of illumination conditions and partially normalizes for atmospheric effects. Furthermore, it does not depend on reflectance of a single band.

Figure 2. Example of a daily fractional snowmap derived from Metop AVHRR data over Europe for October 29, 2012. The product is available through http://www.globsnow.info/se/nrt/2012/Europe_AVHRR/ approximately 20 minutes after the satellites overpass.

Snow information can either be binary (when NDSI > 0.4) or snow fraction can be inferred from NDSI by a linear regression method. As with most other snow detection schemes, densely forested regions (especially during snow melt) pose certain problems as vegetation tends to mask underlying snow cover. By applying a method whereby a lower NDSI threshold is used together with NDVI, this uncertainty can be partly compensated for. Likewise, snow anisotropy may result in some errors when mapping at larger view angles.

Reference for GlobSnow legacy SE method:
Metsämäki, S., Mattila, O.-P., Pulliainen, J., Niemi, K., Luojus, K., Böttcher, K. (2012): An optical reflectance model-based method for fractional snow cover mapping applicable to continental scale. Remote Sensing of Environment, Vol. 123, pp. 508-521, doi: 10.1016/j.rse.2012.04.010.

Reference for Metop-AVHRR SE method:
Hüsler, F. and Jonas, T. and Wunderle, S. and Albrecht, S. (2012): Validation of a modified snow cover retrievalalgorithm from historical 1-km AVHRR data over the European Alps. Remote Sensing of Environment, 121, 1, pp. 497—515



General information on SE upgrades within GS-2

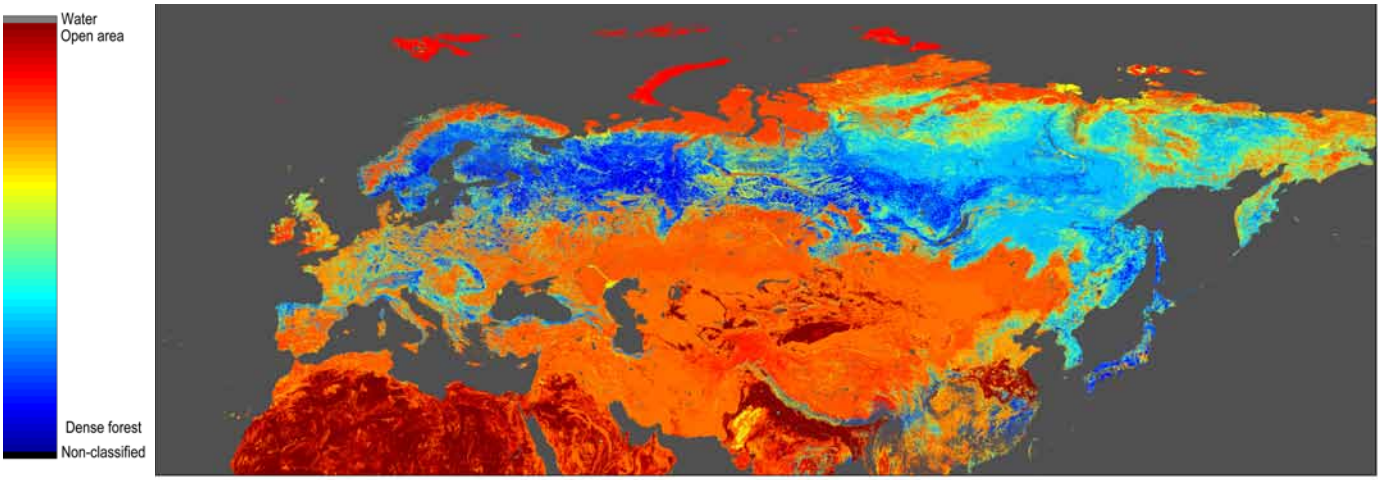
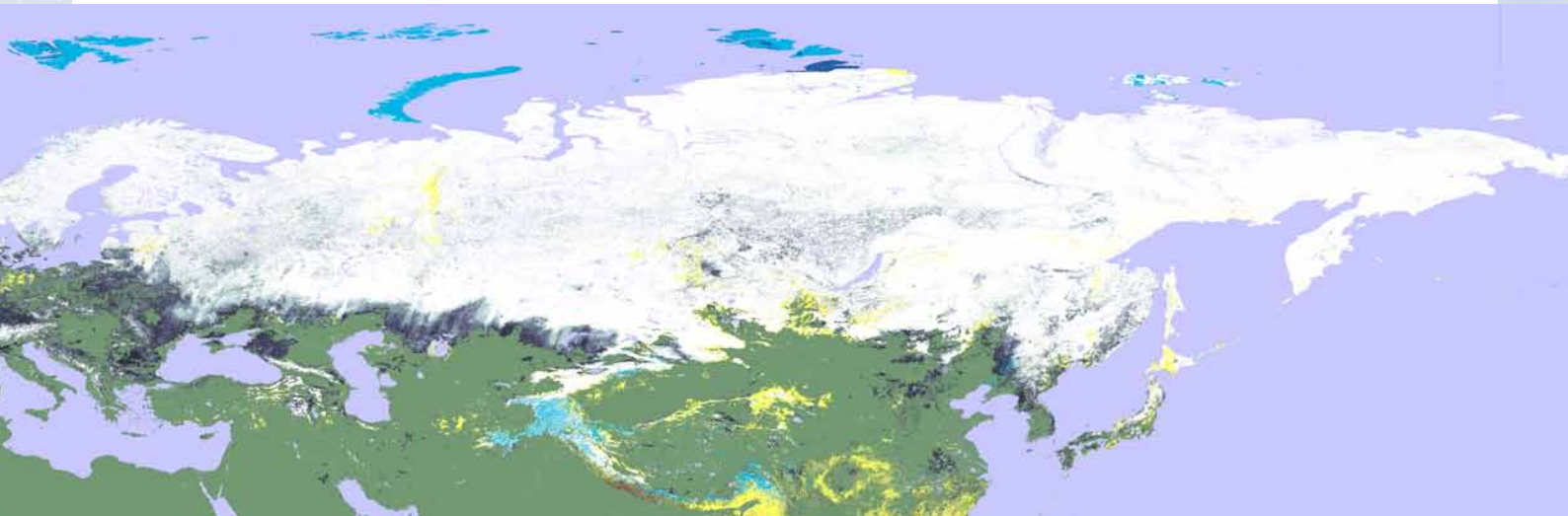


Figure 3. A new transmissivity map (presented for Eurasia here), based on combined use of MODIS reflectance data, GlobCover-data and GlobAlbedo-data.

SCAmod-method was developed for accurate mapping of FSC particularly in boreal forests and tundra. SCAmod uses the pre-determined forest transmissivity map to compensate for the effect of tree-canopy on the observed reflectance. Accordingly, under-canopy snow can be mapped with high accuracy (Metsämäki et al., 2012). In principle, transmissivity is generated using wavelength-specific reflectance data from EO-acquisitions during full snow cover. For hemispheric snow mapping in GlobSnow-1, SYKE developed a method for transmissivity generation based on the combined use of MODIS-reflectances and GlobCover classification. It was found however, that very dense forests were assigned with somewhat too high transmissivity, due to the fact that GlobCover-data does not distinguish between different forest densities with an accuracy appropriate for the needs of SCAmod approach. For the densiest forests, this led to underestimations of fractional snow cover. To better identify the densest forests in terms of low transmissivity, a new approach using ESA GlobAlbedo data as supplementary information was developed and implemented. in GlobSnow-2 . In the resulting transmissivity map, dense forests are clearly better identified that in the previous version from GlobSnow-1 (Fig 3). Consequently, FSC in dense forests can be mapped with higher accuracy. This is shown e.g. in SE-product for March 2010 with full snow cover prevailing in Russia. Only slight FSC underestimations can be found in very dense forest areas (Fig 4).

The determination of Fractional Snow cover from optical reflectance data is based on the high contrast between snow and the ground beneath the snow pack. SCAmod utilizes this by using snow-free ground reflectance as a model parameter. Up to now, a fixed value has been used for all seasonal snow covered areas. This value was determined from EO-observations and also by field spectroscopy for boreal forest areas. Considering that there might be considerable variations in snow-free ground reflectance particularly in non-forested areas like praeries, grasslands etc., a snow-free ground reflectance. map for those areas will be generated in GlobSnow-2.

Figure 4. New Snow Extent (monthly average of FSC) for March 2010, GlobSnow-2



GlobSnow-2 consortium

FMI - Finnish Meteorological Institute

FINNISH METEOROLOGICAL INSTITUTE

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.
FMI is the coordinator of the GlobSnow-2 project. In addition to the general coordination, FMI is also responsible for coordinating the efforts of the snow water equivalent (SWE) product development and production.

SYKE - Finland's environmental administration

SYKE

www.environment.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. The efforts by SYKE aim at a still better Fractional Snow Cover retrievals when applying SCAmod-method.

ENVEO

enveo

www.enveo.at

ENVEO was founded in 2001, with main business activities in the field of research and development for remote sensing applications in hydrology, cryosphere and meteorology. In the GlobSnow project ENVEO leads the work package on validation of the GlobSnow snow extent product and is responsible for investigating the multi-spectral snow extent algorithms in mountain regions and multi-sensor MERIS and AATSR data sets in preparation for Sentinel.

ZAMG

ZAMG
Zentralanstalt für Meteorologie und Geodynamik

www.zamg.ac.at

Zentralanstalt für Meteorologie und Geodynamik is a research institution under the Federal Ministry of Science and Research of Austria. It is structured into four major fields of activity, weather forecast, climatology, environmental meteorology and geodynamics. In GlobSnow-2 ZAMG contributes to the validation of satellite products using ground truth observations of snow depth as well as modelled gridded data of snow water equivalent and snow depth for the Alpine region. Besides validation, ZAMG will also test the capability of a snow data assimilation routine.

GAMMA

GAMMA REMOTE SENSING

www.gamma-rs.ch

GAMMA Remote Sensing AG is a Swiss corporation located in Gümligen 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.

University of Bern

The Remote Sensing Research Group at the Department of Geography, University of Bern has a long tradition in the retrieval and analysis of various land surface (e.g. lake surface water temperature, NDVI, albedo, snow extent) and atmospheric parameters (aerosol optical depth, cloud) from satellite data. Within the Globsnow-2 project, the Remote Sensing Research Group leads the workpackage 2.2, which aims at investigating the compilation of a long time series of snow extent based on GlobSnow SE, AVHRR SE and CryoClim SE.

http://www.geography.unibe.ch

MeteoSwiss

MeteoSwiss is the national weather and climate service in Switzerland. The Swiss GCOS Office, in the International Affairs Division, coordinates the National Climate Observing System (GCOS Switzerland). Within GlobSnow-2, MeteoSwiss will focus on compiling user requirements in a white paper based on user consultation meetings, to optimize the value of GlobSnow-2 products for the user community. Within GCOS Switzerland a "National Basic Climatological Network for Snow (NBCN-S)" was defined and will be used for the in-situ validation of GlobSnow-2 products.

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

www.meteoswiss.ch

NR

Norsk Regnesentral (Norwegian Computing Center, NR) is a private, independent, non-profit foundation established in 1952. 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 1980's. NR's roles in the project are mainly related to SE algorithm refinements and uncertainty estimates for mountain regions. NR will calculate local reflectance statistics in mountains that will be used to parameterise the retrieval algorithm.

www.nr.no

Norut

Norut is a Norwegian applied research institute located in Tromsø, Norway. Norut has long time experience in the field of remote sensing of the cryosphere, and is particularly specializing on the use of SAR for retrieval of snow parameters including snow extent and snow water equivalent. In Globsnow-2 Norut contributes to validation and intercomparison of the snow extent product and improvements of the snow extent product using SAR.

www.norut.no

Environment Canada

Scientists with the Climate Research Division of Environment Canada are collaborating with colleagues at the Finnish Meteorological Institute to develop and evaluate enhanced versions of the GlobSnow SWE retrieval algorithm. Primary areas of focus include the development of a technique to dynamically (spatially and temporally) treat snow density, and the consideration of lake ice fraction within the retrieval. Environment Canada involvement in GlobSnow-2 is supported by the Canadian Space Agency.

Environment Canada Environnement Canada

www.ec.gc.ca

FINNISH METEOROLOGICAL INSTITUTE

Project overview

The European Space Agency (ESA) Data User Element (DUE) funded GlobSnow-2 project is a direct continuation to the GlobSnow-1 project that was active from 2008 to 2012. The objective of the GlobSnow-2 project is further enhancement of the retrieval methodologies for SE and SWE products and a re-processing of the long term datasets utilizing the improved retrieval algorithms before the end of the project.

Finnish Meteorological Institute (FMI)
www.fmi.fi

Finnish Environment Institute (SYKE)
www.environment.fi

ENVEO IT GmbH
www.enveo.at

ZAMG
www.zamg.ac.at

GAMMA Remote Sensing
www.gamma-rs.ch

University of Bern
http://www.geography.unibe.ch

MeteoSwiss
www.meteoswiss.ch

Norwegian Computing Center (NR)
www.nr.no

Northern Research Institute (Norut)
www.norut.no

Environment Canada (EC)
www.ec.gc.ca

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. Simon Pinnock
Project Technical Officer
European Space Agency
email: simon.pinnock@esa.int

Photos and layout by Sini Merikallio
Front cover: Myrskylä, Finland, 4.2.2011