GLOBSNOW

# Newsletter

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FINNISH METEOROLOGICAL INSTITUTE

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

*Development of Global Snow Monitoring Services*

## WorkShop 1 in Innsbruck

The first User WorkShop of the ESA DUE GlobSnow project was held at the Hofburg, Innsbruck, Austria, during 12-13 January 2010. The purpose of the meeting was to present the work carried out during the first phase of the project, including: the algorithm evaluation results for Snow Extent (SE) and Snow Water Equivalent (SWE) products, the selected GlobSnow algorithms and the prototype datasets. A key objective was to openly discuss the results obtained and determine the direction of the project in the future with the user community. In addition to the presentations given by the GlobSnow consortium, the User community gave presentations on several different topics concerning the GlobSnow and satellite-based snow and cryosphere monitoring efforts in general.

The workshop minutes and all the presentations, both by the consortium and the users present, are available through the GlobSnow webpages. The direct link to the materials is: http://globsnow.fmi.fi/index.php?page=Innsbruck_2010

The general response from the user community regarding the GlobSnow efforts of Phase One and the prototype datasets was positive overall. The most participated discussion of the workshop concerned the aggregation scheme for the GlobSnow products. In addition to the daily products for both the SE and SWE, aggregated products will be produced. After the discussions with the User community it was clear that there were different needs for the aggregated products for different users. The conclusion drawn based on the discussion was that in addition to a monthly product a 7-days or a 10-days product should be provided. Finally, the consortium decided to go with the weekly (7-days) aggregated product for the next batch of prototype products. So both the SE and SWE prototype products (the next versions) will include a daily, a weekly and a monthly product. Any feedback is still very much welcome concerning the aggregation (send your comments to Dr. Luojus / FMI and Dr. Bojkov / ESA).

The second GlobSnow User Workshop is currently scheduled for January 2011.

# The updated prototype products

The prototype datasets, released between November 2009 and February 2010, include SE data for the Pan-European region for the years 2003 to 2006 and SWE data for the Northern Hemisphere for the years 1994 to 1997 and 2003 to 2008. The datasets have been made available for the GlobSnow user consortium. Access to the data, by any interested party, can be achieved by contacting the project manager: Dr. Kari Luojus (firstname.lastname@fmi.fi).

## Snow Extent (SE) v.0.9.2

A new version of the GlobSnow Snow Extent (SE) prototype product was released 5th February 2010. The products are available from the same FTP site as the previous version (ftp://litdb.fmi.fi). The main changes are improved cloud masking and a new approach for establishing information on forest transparency ('ground visibility from space'). Additionally, 10-day aggregated products have been produced for Labrador, Canada. These are based on Version 0.9.1 products. (What is available for Labrador is currently only based on Version 0.9.1 data.)

## Ground visibility in forest

The retrieval of fractional snow cover in forest is based on SYKE's SCAmod algorithm. The algorithm depends on information of the degree of visibility of the ground surface from above. This visibility information is represented in a transmissivity map applied by the algorithm. The transmissivity was previously established from several acquisitions by MODIS under full snow cover conditions (assuming that tree branches were free of snow). This is a viable approach for

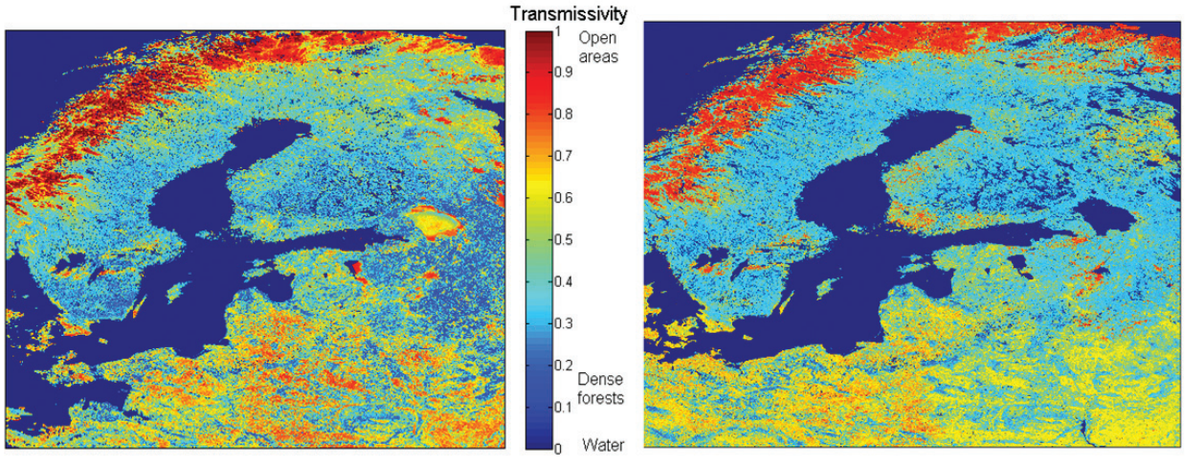


Figure 1. Original MODIS-derived transmissivity (left) and GlobCover-derived transmissivity (right).

smaller regions, but would require significant resources to do globally, as it requires manual retrieval of cloud-free snow covered images for the desired region and on global scale it would be an enormous effort. So, an alternative approach was needed in the GlobSnow project, and a suitable solution was found using vegetation data from the ESA GlobCover project (http://ionia1.esrin.esa.int/).

A study has been carried out by SYKE on the correspondence between the previous transmissivity map (based on MODIS data) and GlobCover data. We found that transmissivity for SE product grid cell can be expressed as a linear combination of class-wise statistics of GlobCover classes covered by an SE cell. In order to relate the GlobCover classes and transmissivity, the mean and standard deviation of transmissivity for each class was determined using the already existing transmissivity data over Europe. It was found that GlobCover classes are relatively well discriminated in terms of transmissivity (i.e. mean and standard deviation of transmissivity is different for each class). The mean and standard deviation for each class was determined by extracting all GlobCover pixels of a certain class and collecting their corresponding transmissivity.

Following this approach, a GlobCover-based transmissivity map was generated using GlobCover data covering the Baltic region (from Western Europe Regional). The resulting transmissivity map was highly correlated with the original (see Figure 1). The root mean squared (RMS) sum of differences between these two is 0.13, accompanied with a small systematic error of -0.008 (transmissivity range is 0-1). The comparison shows that GlobCover transmissivity tends to lose the low values, i.e., part of the areas with originally low transmissivity are overestimated. On the other hand, also parts of the high transmissivities are underestimated.

Since the analysis presented above indicated that GlobCover-derived transmissivity is quite useful in SE mapping, we generated a preliminary GlobCover transmissivity map for the pan-European area (see Figure 2). This map was applied when Version 0.9.2 snow products were produced.

In conclusion, the study encourages us to use GlobCover data in order to derive global transmissivites for GlobSnow snow extent mapping purposes in a cost effective way. This approach requires that a thorough statistical analysis between GlobCover classes and the MODIS-derived transmissivity maps is made. In practice, this means that a set of 'training areas' covering both datasets must be prepared. In order to provide a solid dataset for statistical analysis, those areas together have to provide a cross-section of different types of vegetation. GlobCover data includes 63 classes, 32 of which were used in our study. We are going to choose two other areas, one from North America and one from East Eurasia, when establishing transmissivity masks for the whole Northern Hemisphere.

## Cloud masking

The cloud algorithm chosen in the previous project phase was a simple approach developed by SYKE, nicknamed Simple Cloud Detection Algorithm (SCDA). The algorithm has now been evaluated a second time and slightly improved by SYKE based on a data set for the period from March to beginning of June 2004 for Finland and the Baltic drainage basin. A subset of cloud masks were extracted by NR from the pan-European product set.

Cloud masks were first evaluated visually by comparing with colour composite images of AATSR image bands. Secondly, based on the visual inspection, the SCDA algorithm was improved and a quantitative comparison was done using cloud masks computed with the improved version of the SCDA algorithm.

In general, good performance of the algorithms (old and new versions) was observed by visual inspection based on the colour composites. In some cases thin cirrus cloud layers and cumulus clouds were not fully detected by the previous version. Besides, cloud shadows of cumulus clouds were problematic (detection of cloud shadows is not covered by the cloud-detection algorithm, although partly accounted for by mask growing). As shown in Figure 3.

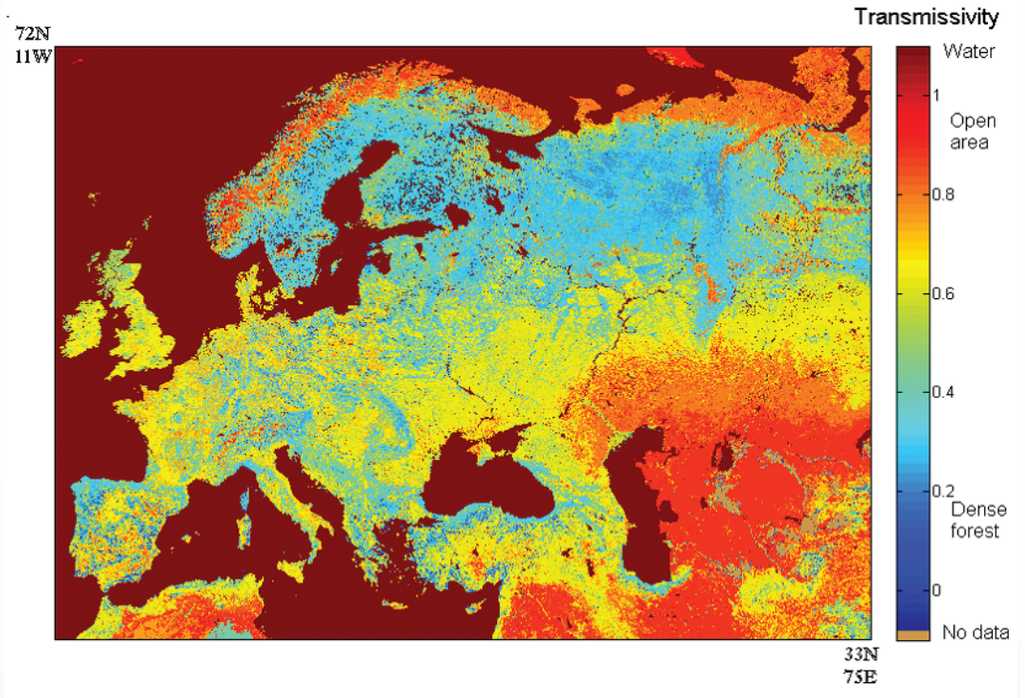


Figure 2. GlobCover-derived transmissivity map for the pan-European region.

For the majority of inspected days cloud masks from different versions of SCDA showed good correspondence (> 70% in 12 out of 20 cases). The previous version gives in all cases less pixels classified as cloud than the improved version. In none of the cases the previous version detected additional clouds compared to the improved version.

Typically, thin cloud cover over snow was not fully detected by the previous version, but recognized with the improved version. However, in some cases the new version may overestimate the actual cloud cover.

The new version of the SCDA has been applied for SE Version 0.9.2 except for the cloud mask growing feature, which has not yet been implemented in the laboratory production system. The growing feature expands the cloud mask slightly in order to get rid of 'mixed pixels' at the cloud borders as well as, to some degree, cloud shadows (depending of solar illumination geometry and cloud altitude).

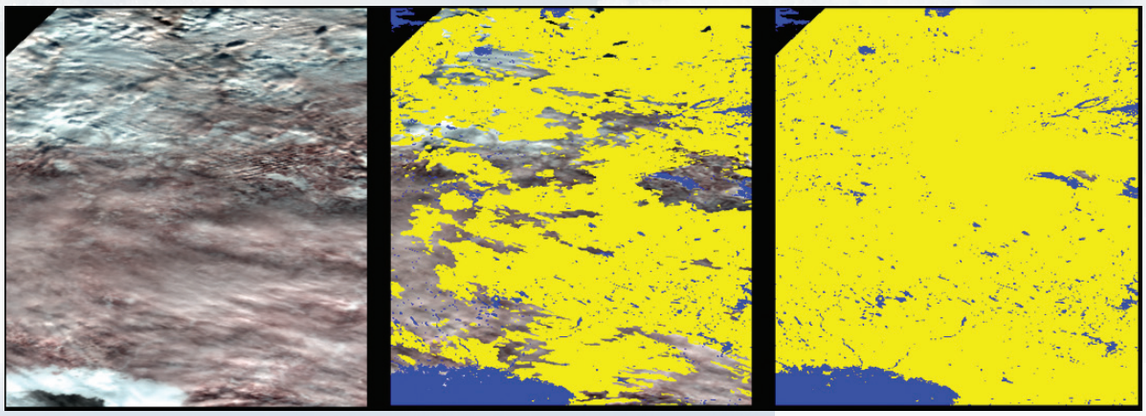

Figure 3. AATSR subset of 23 March 2004 from Finland. R-G-B colour composite image is shown on the left (bands 870, 670, 580 nm). Cloud mask derived with the previous version of SCDA in the middle and with the improved algorithm on the right. Cloud cover is shown in yellow and water in blue.

## Snow Water Equivalent (SWE) v.0.9.2

SWE prototype data v.0.9 was released on November 2009, v.0.9.1 was released on December 2009 and the v.0.9.2 will be released during March 2010 on the GlobSnow FTP site.

The biggest difference between the v.0.9.1 and the v.0.9.2 will be the addition of quicklook images and aggregated products to the set. Additionally the areas containing wet or melting snow will be identified and will not be masked out as in v.0.9.1. Identification of wet snow/melting snow areas will allow intercomparison between the SWE and SE products.

The SWE prototype dataset v0.9.1 (and v.0.9.2) contains snow information derived for the Northern Hemisphere for the years 1994-1997 using SSM/I data and 2003-2008 from AMSR-E data. The prototype data are provided in HDF4-format: a single file contains the data for a single day; a single file contains the data for a single day with two fields 1) the SWE estimate and 2) an error estimate. The snow water equivalent describes the amount of liquid water in the snow pack that would be formed if the snow pack was completely melted. The goal of the ESA GlobSnow project is to eventually produce daily SWE estimates for the Northern Hemisphere for the years 1978-2010. The final SWE dataset spanning 30+ years is expected to be produced by October 2010 and will be made available to all interested parties.

The GlobSnow SWE methodology is based on the algorithm developed by Prof. Pulliainen *[J. Pulliainen, "Mapping of snow water equivalent and snow depth in boreal and sub-arctic zones by assimilating space-borne microwave radiometer data and ground-based observations." Remote Sensing of Environment, Vol. 101, pp 257-269, 2006]*. The SWE product is projected to Equal-Area Scalable Earth Grid (EASE-Grid) and provides the daily SWE estimates for whole Northern Hemisphere (lambert's equal-area azimuthal - projection) in a single file. Although the EASE-Grid projection can represent data almost to the equator the product is limited between latitudes 35° and 85° for physical reasons (extent of seasonal snow cover). The input data for the SWE products are from AMSR-E sensor acquired from National Snow and Ice Data Center, Boulder Colorado, U.S.A. (NSIDC).

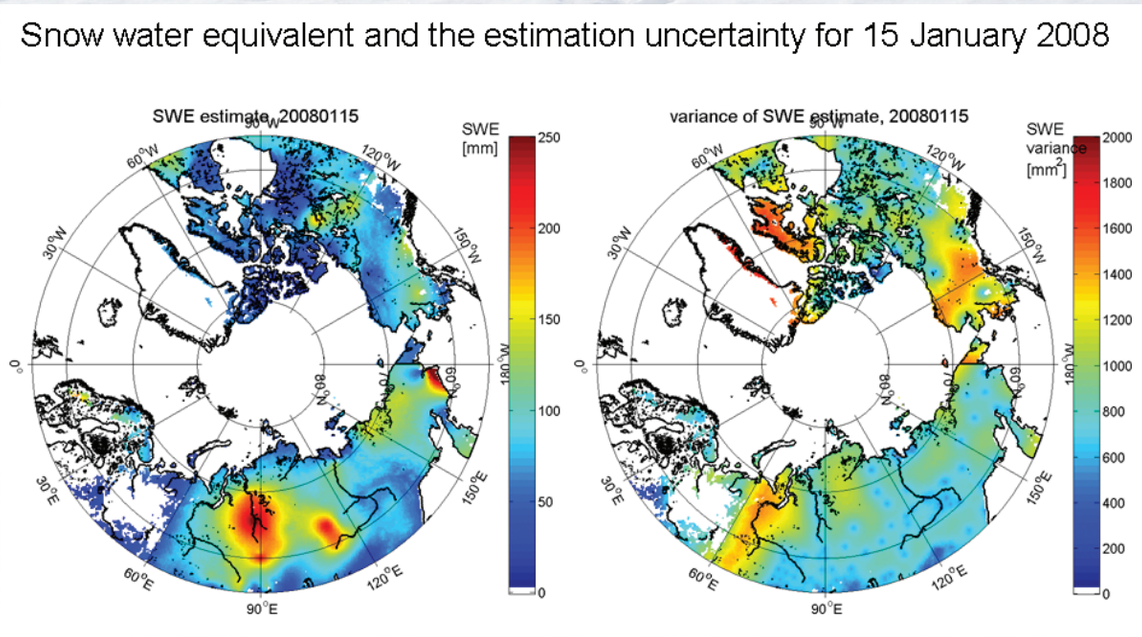


Figure 4. Snow Water Equivalent and the estimated uncertainty for 15 January 2008 for Northern Hemisphere. Data version 0.9.1, with wet snow areas masked out.

## Project overview

*The European Space Agency (ESA) funded GlobSnow project aims at creating a global database of snow parameters for climate research purposes. 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 constructed. Information on two essential snow parameters: snow water equivalent (SWE) and areal snow extent (SE) will be provided. The archive 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.*

## GlobSnow consortium

**Finnish Meteorological Institute (FMI)**
www.fmi.fi

**ENVEO IT GmbH**
www.enveo.at

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

**Finnish Environment Institute (SYKE)**
www.ymparisto.fi

**GAMMA Remote Sensing AG**
www.gamma-rs.ch

**Norwegian Computing Center (NR)**
www.nr.no

## Co-operative partners

**Northern Research Institute (Norut)**
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