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- First User Workshop Information -

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DUE - GlobSnow (2008–2011)
Development of Global Snow Monitoring Services

First User Workshop Information

The first GlobSnow User workshop will be held at Innsbruck, Austria, 12 - 13 January 2010. The workshop will present the work carried out during the first year of operations on GlobSnow. The main focus will be given to the algorithm evaluation results and the prototype datasets concerning both the Snow Extent (SE) and the Snow Water Equivalent (SWE) products. The prototype datasets, released during November 2009, include SE data for the Pan-European region for the years 2003 to 2006 and SWE data for the Northern Hemisphere for the years 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).

The workshop will include discussions and decisions between the GlobSnow consortium and the user community on how to proceed with the project and whether the prototype products are suitable for the end-users. The workshop will also include a number of presentations regarding the prototype datasets, algorithm evaluation results and presentations from the user community describing the utilization of the GlobSnow products on different end-user applications.

The Level 3 aggregated snow products are also a key issue to be discussed at the workshop. So far the consortium has developed a few exemplary level 3 product samples and the consortium wishes to point out that the decisions for the final products are based on the user requirements and the user feedback. The decision on how to devise the aggregated Level 3 products will be made based on the outcome of the Workshop. If an interested party is unavailable to participate to the Workshop, they can express their points of view regarding the issue to the project manager (contact details given above and on the last page).

The workshop will contain several presentations given by the GlobSnow user community. The confirmed speakers include, Dr. Vladimir Ryabinin, giving a key note presenta-

tion on the importance on snow remote sensing related to global climate monitoring. Dr. Ryabinin is a Senior Scientific Officer for the World Climate Research Programme (WCRP) at the World Meteorological Organization (WMO). Another key note presenter is Dr. Michael Kern of European Space Agency, giving a talk on the ESA future snow remote sensing missions. User presentations currently include:

- Dr. Amir Ali Khan of Department of Environment and Conservation, Government of Newfoundland and Labrador, giving a presentation titled: "Snow Monitoring in Newfoundland and Labrador, Canada."
- Dr. William Lahoz of Norwegian Institute for Air Research (NILU), a presentation titled "Toward assimilation of snow data."
- Dr. Annette Bartsch of Vienna University of Technology Institute of Photogrammetry and Remote Sensing, a presentation titled "GlobSnow product use within the ESA DUE Permafrost project."
- Dr. Florian Appel of Vista Remote Sensing in Geosciences GmbH, a presentation titled "Polar View Snow Services and Application in Hydrology"
- Dr. Peter Bissolli of Deutscher Wetterdienst (DWD), a presentation titled "SnowClim - the European snow climate monitoring programme of Deutscher Wetterdienst (DWD)"
- Dr. Lothar Schüller of EUMETSAT, a presentation titled "Snow products and activities in the EUMETSAT Network of Satellite Application Facilities"

The workshop will take place at the 1st floor of Hofburg, Rennweg 1, Innsbruck, BFW - Bundesforschungs- und Ausbildungszentrum für Wald, Naturgefahren und Landschaft (Department of Natural Hazards and Alpine).

The workshop will begin at 13:30 on Tuesday 12th January 2010 and is planned to conclude at 16:00 on Wednesday 13th January 2010.

We anticipate an interesting and a fully scheduled workshop participated by a number of key snow remote sensing people from Europe. The workshop includes an evening reception giving a nice opportunity for informal networking between the European and international snow research community on the evening of 12th January. On behalf of the organizing committee, we heartily welcome all the interested parties to Innsbruck for the workshop on January 2010. No participation fees will be charged for the workshop.

The interested parties that have yet to register for the GlobSnow workshop 1 are advised to contact Dr. Kari Luojus directly via email (firstname.lastname@fmi.fi), registration will be open until Christmas (23rd December), after this date the participation for the workshop can not be guaranteed.

Additional information on the workshop is available through **http://globsnow.fmi.fi**, (or directly at: **http://globsnow.fmi.fi/index.php?page=Innsbruck_2010**).

GlobSnow Prototype Datasets

The GlobSnow prototype Snow Water Equivalent (SWE) and Snow Extent (SE) data were released during November 2009. The prototype data include snow water equivalent data for Northern Hemisphere and snow extent data for the pan-European region. Both data are publicly accessible through a FMI hosted FTP-server; access information to the server can be acquired through Dr. Kari Luojus.

The GlobSnow datasets consist of:
- The SE dataset covers the time period 2003 to 2006 and the SWE dataset covers the time period 2003 to 2008.
- The SWE product covers the Northern-Hemisphere north of 35 deg on a 25 x 25 km equal area grid (EASE-Grid).

- The provisional SE product covers the pan-European area and Newfoundland and Labrador on a 0.01 x 0.01 degree grid
- Readme files are provided for each product describing the data, resolution, known shortcomings, etc. are available on the ftp site

Snow Water Equivalent (SWE)

The GlobSnow snow water equivalent (SWE) prototype dataset v0.9.1 contains snow information derived for the Northern Hemisphere for the years 2003-2008 from AMSR-E data and ECMWF collected weather station observations. The prototype SWE data are provided in HDF4-format: a single file contains the data for a single day; a single file contains 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 result if the snow pack was completely melted. The goal of the 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 August 2010 and will be made available to all interested parties. The GlobSnow SWE processing system applies passive microwave observations and weather station observations collected by ECMWF in an assimilation scheme to produce maps of SWE estimates (in EASE-Grid format) over the northern hemisphere, covering all land surface areas with the exception of mountainous regions and Greenland. A semi-empirical snow emission model is used for interpreting the passive microwave (radiometer) observations through model inversion to
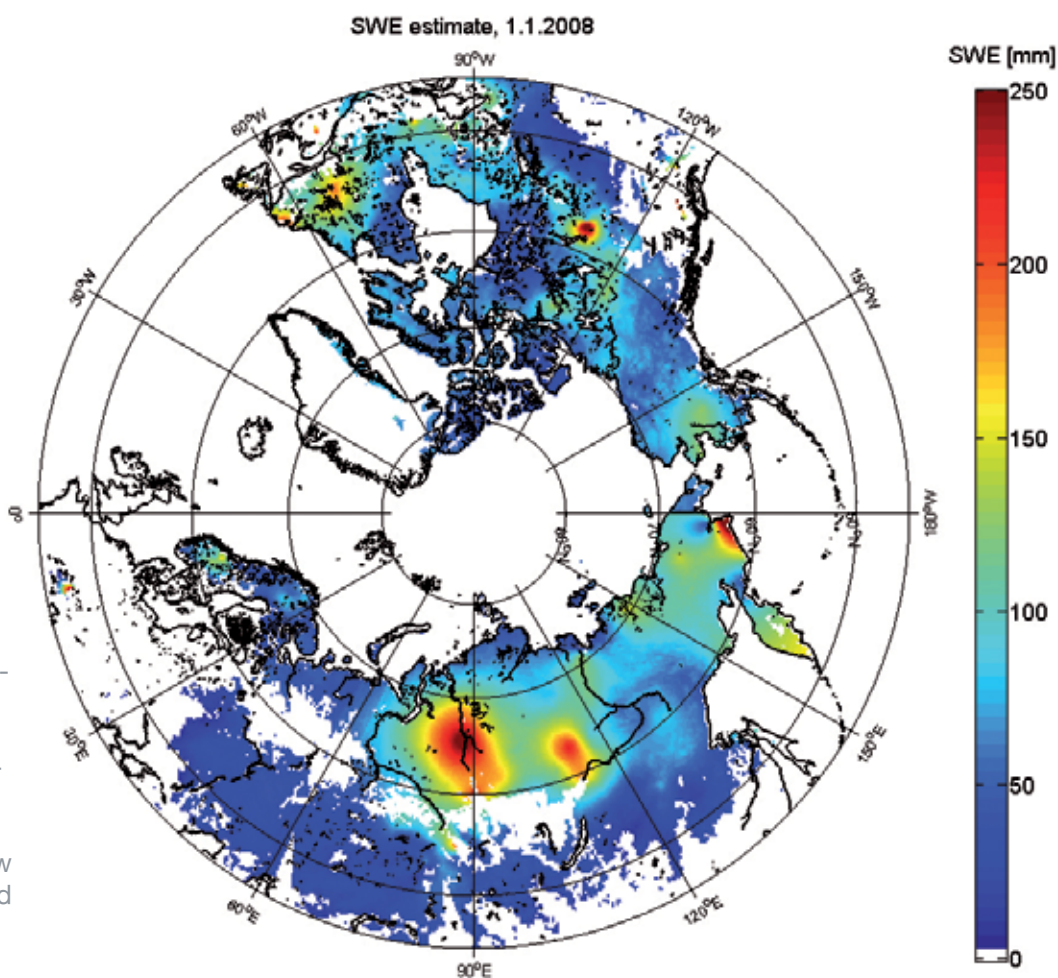
Snow Water Equivalent conditions derived for 1 January 2008 using the GlobSnow SWE algorithm. Snow-free and melting snow areas are masked out from the illustration.

the corresponding SWE estimates. The FMI methodology is based upon an algorithm developed by Prof. Pulliainen and published in Remote Sensing of Environment in 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 (v0.9.1) are from the AMSR-E sensor acquired from National Snow and Ice Data Center, Boulder Colorado, U.S.A. (NSIDC).

Prototype Snow Extent products available

The GlobSnow Snow Extent (SE) prototype product set (version 0.9.1) for the pan-European region and Labrador, Canada, is now available for review by the user community. The products contain information on snow coverage retrieved from Envisat AATSR for the years 2003-2006 (3.5 years). There are three types of products available:

- Daily Fractional Snow Cover (FSC), snow fraction (%) per grid cell for all satellite over-passes of a given day
- Daily classified snow cover (4CL), snow cover classified into four categories per grid cell for all satellite overpasses of a given day. The four categories are 0-10%; 10-50%; 50-90% and 90-100% of snow cover
- Aggregated Fractional Snow Cover, FSC for all satellite passes within a given time period. (This is an experimental product currently covering ten days.)

A two-algorithm approach

The GlobSnow SE processing system applies optical measurements in the visual-to-thermal part of the electromagnetic spectrum acquired by the ERS-2 sensor ATSR-2 and the Envisat sensor AATSR. The snow cover information is retrieved by two algorithms, one for high-mountain areas of steep topography above the tree line (NLR) and another developed for forested and open areas (SCAmod). The retrieval results from the two algorithms are merged into one product. Clouds are detected by a cloud-cover retrieval algorithm and masked out. Large water bodies (oceans and lakes) are also masked out. Thematic masks are used in the GlobSnow SE processing system to support the selection of algorithms for specific land cover types (forested, not forested) and to label areas where SE processing is not applied, such as oceans and open water areas.

The SE product coordinate system is geographical (latitude/long) based on, the reference ellipsoid WGS 84

and a grid resolution of 0.01 × 0.01 degrees. The pan-European area covered by the prototype products is defined by the domain 33N - 72N and 11W – 75E. The product file for SE includes two data layers: The snow variable represented either as FSC (%) or 4CL (4 category labels) The reliability of FSC retrieval. This is not included in version 0.9.1. Both layers are in 8 bit format.

Validation

A preliminary evaluation of the prototype products has been carried out within the pan-European region. However, the region – limited as it is in its extent – does necessarily not cover all natural variability worldwide. Therefore, the following results are only preliminary as a global validation has to be carried out when the global coverage is established.

The SE product evaluation work focussed on 1) a set of dedicated experiments to investigate algorithm performance etc. and 2) a pan-European experiment in order to obtain experience with SE mapping on a larger scale (as a stepwise

Example of the daily Fractional Snow Cover (FSC) L3A product, 1 April 2004. The green-to-white colour nuances represent the snow fraction (%) per grid cell (from bare ground to full snow cover, respectively). Clouds are shown in yellow and anomalous satellite data in orange. The product includes all satellite overpasses of the day.

approach to global SE mapping). Three evaluation sites were chosen in order to cover the most important nature types and variability. These sites were Norway (high-mountain terrain, not alpine), the Alps (alpine terrain) and Finland (boreal forest and some open plains). Comprehensive reference data were available for the three sites. For the mountain sites, the reference data were mainly semi-automatically and separately validated high-resolution snow maps based on Landsat TM or ETM+

and Terra-1 ASTER. For the forest site, the reference data consisted of snow profiles (typically 80 observations) along the 4-km long course and point (weather station) measurements (in Finland providing a particular e-code describing snow coverage).

For mountainous terrain and FSC using the NLR algorithm, the root-mean-squared deviation (RMSD) for the summer months were typically in the interval 10-15%, while 15-25% in

the winter (dark months). For forest terrain and FSC using the SCAmod algorithm, the RMSD values were typically around 25%.

Further work

The GlobSnow SE product is a 'first-time endeavour' for the remote sensing community in Europe. Such a high spatial resolution time series of snow products of global coverage has never been produced before.

An experimental aggregated Fractional Snow Cover (FSC) product including all satellite passes within a given time period. This product of 8 April 2004 covers all observations the last ten days.

Algorithms had to be evaluated against each other, and the chosen algorithms had to be improved and tailored to the global application. This work is still ongoing and will include focus on a few issues, including calibration for both algorithms and validation of cloud detection at the global level.

Experience with pan-European maps showed, in particular for south-east Europe, that different bare-ground reflectance values is an issue. The SCAmod algorithm uses bare ground reflectance values derived from the boreal forest region. The NLR algorithm uses bare ground reflectance values that are assumed to be valid at a regional scale. Both algorithms will need a modified reflectance calibration scheme based on local reflectance values. A new scheme is currently investigated and is planned to be introduced in the operational products of global coverage.

Furthermore, cloud detection needs to be studied more carefully and might give surprises later at the global level due to much larger global variability than what could be found within Europe. This might be related to higher aerosol concentrations as well different temperature regimes between clouds and the ground. The cloud detection performance will be checked carefully when moving from European to global-scale SE mapping.

The ultimate goal of the project is eventually to produce SE products for the whole seasonally snow-covered Earth for the years 1995 – 2010. The global and final SE product set spanning 15 years is expected to be produced by August 2010 and will be made freely available. The SE product has been developed and produced by the GlobSnow consortium.

The main responsible partner for the production of pan-European prototype SE product set is the Norwegian Computing Center (NR). The product has been developed jointly by NR, Finnish Environment Institute (SYKE) and ENVEO IT GmbH (ENVEO) with

support from Finnish Meteorological Institute (FMI), GAMMA Remote Sensing AG (GAMMA) and Northern Research Institute (Norut).

The future work will naturally be partly based on the outcome of the

first user Workshop. We expect to receive recommendations and requests from the user community based on the prototype products and the work conducted so far by the consortium.

Sample Glob-Snow SE prototype products have been produced for Labrador, Canada, as well. This example of a day product is from 1 April 2004. Clouds are shown in yellow.

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 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.

GlobSnow consortium

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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)
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Co-operative partners

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