ESA GlobSnow - Requirements Engineering Review (RER) Geneva, WMO Headquarters, 3 – 4 February 2009

Location: Geneva, WMO headquarters, Room 6L

Present: Richard Armstrong (NSIDC)
Bojan Bojkov (ESA)
Chris Derksen (Environment Canada)
Richard Fernandes (CCRS)
Nando Foppa (MeteoSwiss)
Barry Goodison (WMO)
Kari Luojus (FMI)
Eirik Malnes (Norut)
Sari Metsämäki (SYKE)
Florian Müller (ENVEO)
Jouni Pulliainen (FMI)
Helmut Rott (ENVEO)
Vladimir Ryabinin (WMO)
Roger Saunders (UK Met Office)
Gabriela Seiz (MeteoSwiss)
Rune Solberg (NR)
Tazio Strozzi (GAMMA)
Thomas Voigt (EEA)
Andreas Wiesmann (GAMMA)

The requirements engineering review (RER) meeting of the ESA GlobSnow project was held at Geneva during 3 – 4 February 2009. The purpose of the meeting was to discuss and determine the requirements for the project together with the User community.

Executive Summary:

The main issue of the RER meeting was to decide the baseline requirements and specifications for the GlobSnow snow products. The specifications presented in this summary (and the minutes) are based on the discussions and the overall consensus reached with the User community during the RER meeting.

The Snow Extent (SE) product will be based on ESA ERS-2 AATSR and Envisat AATSR data (utilization of AVHRR data is evaluated if it becomes available on a FCDR level product, evaluation of MODIS-based SE data will be investigated for validation purposes). The SE product will be generated using WGS 84 latitude/longitude grid and a 0.01° resolution. The temporal span of the product is based on the availability of the data: ERS-2 ATSR-2 data starting from 1995. The FCDR and the SE end-product will cover years 1995 to 2010. The SE product will be a weekly composite. The SE product shall 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). For Southern Hemisphere the mountainous areas are the main focus (as there are a few other areas with seasonal snow cover on Southern Hemisphere).

The FCDR for SE will consist of data acquired from ESA:
ERS-2 ATSR-2 data (1995 – 2002) (AT2_TOA_1P)
ENVISAT AATSR data (2002 – 2010) (ATS_TOA_1P)

The Snow Water Equivalent (SWE) product will be based on passive microwave radiometer data acquired from SSM/I and AMSR-E sensors. The spatial resolution of the product will be 25 km on EASE-grid projection. The SWE product will be generated using a daily temporal resolution. The FCDR and the SWE end-product will cover at least the years from 1995 to 2010. The target temporal span is to cover years 1987 to 2010, as the SSM/I data are available starting in 1987. The SWE product shall cover the Northern Hemisphere, excluding the mountainous areas, Greenland, the glaciers and snow on ice (lakes/seas/oceans).

The FCDR for SWE will consist of data acquired from NSIDC:
SSM/I data (1987 – 2002) (L3 EASE-Grid)
AMSR-E data (2002 – 2010) (L2A EASE-Grid)

The users pointed out that information on confidence (or accuracy) would be important for the SE and SWE products. This would be something that is not available on the current products and would clearly be an added value for the end users.

Action Item list

Action	Item #	Responsible	Due
Finalize the Requirements Baseline document according to the RER	1	All parties (FMI & ENVEO lead)	RB (KO + 4)
Define validation test sites and validation protocols for the GDD	2	All parties (ENVEO lead)	GDD (KO + 4)
Investigate the access to readily available validation data for Northern America (both for SE & SWE); including data from Fernandes (CCRS) and D.Hall (NASA)	3	EC & Fernandes (CCRS)	DDS (KO + 5)
Investigate the availability of Aster data for validation purposes (mainly SE)	4	NR	DDS (KO +5)
Determine the resolution for the DDS: 1) global 2) mountainous areas	5	NR & ENVEO & SYKE	DDS (KO + 5)
Check the format, costs and availability of the ATSR-2 and AATSR	6	Bojkov (ESA)	June 2009 (PM 1)
Check the status of the AATSR cloud masking product of ESA	7	Bojkov (ESA)	June 2009 (PM 1)
Check the prize and availability of ASAR data from ESA (both GMM and wide swath)	8	Bojkov (ESA)	June 2009 (PM 1)
Check the availability/inventory of ASAR data for the selected key test sites (The Alps and the Norwegian mountains)	9	ENVEO & Norut	June 2009 (PM 1)
Investigate the availability of "free" SAR data, such as IPY data for GlobSnow	10	Bojkov (ESA) & EC	June 2009 (PM 1)
Determine: 1) cut-off latitude and 2) minimum detection threshold for the SWE product	11	FMI & EC	June 2009 (PM 1)
Determine glacier, mountain and water (lakes/seas/oceans) masks, and the used land cover classification for the SWE product	12	FMI & EC	June 2009 (PM 1)
The definition (masking) of areas that have seasonal snow cover needs to be determined regarding the SE product	13	NR & ENVEO & SYKE	June 2009 (PM 1)
The data processing requirements need to be evaluated for the selected sensors (ATSR-2, AATSR, ASAR)	14	GAMMA	June 2009 (PM 1)
Investigate the production of "coarse background SE" using the radiometer data	15	FMI	December 2009 (Phase 1)
Investigate the extension of SYKE SCAmod for continental scale	16	SYKE	December 2009 (Phase 1)
Investigate the mapping of SE on northern boreal forest zone using SAR data	17	FMI & Norut & SYKE	December 2009 (Phase 1)

The detailed minutes of the RER meeting:

Jouni Pulliainen - general description of the ESA GlobSnow project (Presentation)

Jouni Pulliainen (FMI) opened the Requirements Engineering Review (RER) – meeting at 08:30 o'clock by giving a short description of the GlobSnow project for the attendees.

After the introduction there was discussion about the GlobSnow products, it was stated that the products will be available free of charge for the User community. The availability of the data, after the end of the project is not yet determined; it is relevant and needs to be discussed at a later stage of the project.

The User community inquired about the focus of the project, whether it is on providing input for the climate community or for the hydrologists. After the User presentations and the discussion during the RER-meeting, it was evident that the focus is more on the needs of the climate community.

Another question was the coverage of the snow products. The snow water equivalent (SWE) product will be provided for the northern Hemisphere, for the latitudes above 25 - 45 degrees (the cutoff latitude needs to be decided by the June meeting in Helsinki).

The snow extent (SE) product will cover both the Northern and Southern Hemispheres; for SH the mountains are the main area.

The SWE and the SE snow products will not map the snow conditions on:

- Snow on ice (lakes/seas/oceans)
- Greenland
- Antarctica
- Glaciers

Main focus of the project needs to be in providing a product with clearly improved qualities when compared with the current available products. Validation of each snow product is essential, and at the beginning of the Phase 1, the focus should be on the quality of the products, not on the Near-Real Time aspects.

The quality of the products was stressed by many of the Users as one of the most important aspects. (Since previous snow products already exist, there needs to be an added value for the products in order for users to adopt them.)

Kari Luojus - State of the Art on SWE monitoring (Presentation)

The discussion concerning the SWE monitoring raised several important aspects. Richard Armstrong (NSIDC) informed that the lifetime of the Aqua AMSR-E is at the end of its design life time, and although it might still last for 5-7 years, it might also cease to function at any moment. This needs to be prepared for concerning the SWE product. If AMSR-E would fail, the project team would utilize the data from SSM/I.

Another important fact concerning the possible SWE product utilizing the weather station data is to account for the fact that the ground-based weather station network has been adjusting towards more automatic measurements. Additionally, the changes of the measuring crews may have affected the data and in the future the number of available stations with snow data may become increasingly sparse. Fortunately, the proposed SWE product can be adjusted to assign a figure of accuracy/uncertainty for the weather station measurements, to accommodate for possible inaccuracies on the weather station measurements.

Additionally, Richard Armstrong (NSIDC) reminded that the SMMR data (spanning 1978-1987) may not be feasible to provide global coverage on a daily basis. A weekly product may be more feasible for that time period. It was noted that the proposed SWE product that utilizes the ground-based weather station data can be operated even using data with gaps. Further, to fulfill the 15 years time requirement of GlobSnow, the SMMR data is not required.

Jouni Pulliainen - The Potential SWE product for GlobSnow

Jouni Pulliainen (FMI) presented the FMI Eurasian snow cover product which utilizes the assimilation of radiometer and ground-based weather station data to provide daily SWE estimates for northern Eurasia. This product will be enhanced to cover the northern Hemisphere and is proposed for GlobSnow. The goal is to provide daily SWE data starting from 1987. The minimum temporal requirement is from the beginning of 1995.

The assimilation method provides error estimates for the SWE retrieval.

The GlobSnow SWE product will use the EASE-grid projection and the baseline spatial resolution will be 25 km.

The SWE is evaluated only during the snow accumulation season. This needs to be clearly documented and explained for the User community. Wet snow will be flagged but SWE will not be provided for wet snow conditions.

The minimum detection threshold is not determined currently and needs to be investigated.

The distribution of weather station data along the Diagnostic Data Set (DDS) needs to be negotiated with the data provider ECWMF/WMO. (The data policy may be governed by ECMWF or WMO?, although the data are acquired through ECMWF).

The mountain, water (lakes/seas/oceans) and glacier masks for the SWE product needs to be investigated by FMI and EC and need to be determined by the June PM1 meeting in Helsinki.

Rune Solberg State of the Art in Snow Extent monitoring using optical sensors (Presentation)

Rune Solberg (NR) gave a presentation on the current state of the art methods and the relevant sensors for snow extent monitoring.

Hyperspectral methods have been shown to provide high accuracies in limited regional scales using extensive training data set, these are however not feasible on a continental or global scales.

The accuracy of the current SE methods: 10% - 30% when measuring Fractional snow cover. When the snow extent is monitored using a binary classification (snow / no swow) the key question is how to define the cut-off for the classification. Should we classify 50% of snow as snow covered or as snow free? The discussion concerning this produced a proposal for a new classification method that will be investigated within the GlobSnow project.

The SE classification for GlobSnow could be done using three classes:

- less than 10% of snow
- between 10% and 90% of snow (snow melt season)
- more than 90% of snow

The dataset to be used for Snow Extent product shall be acquired from:

- ERS-2 ATSR-2 (since 1995)
- Envisat AATSR (since 2002)
- Possibly Terra/MODIS (shall be used at least for comparison and validation)
- NOAA/AVHRR will be utilized if it becomes available as a FCDR from other projects. It will not be a primary concern in the first phase of the GlobSnow.

The use of MERIS is problematic because of limited wavelengths suitable for cloud masking on snow covered areas and on mountains. Utilizing AATSR for cloud masking and MERIS for SE would not bring added benefits, when compared with using AATSR alone. Therefore the use of MERIS is not proposed for the GlobSnow SE product.

The main candidates: ATSR-2 and AATSR are not suitable to be used for daily observations due to the limited swath widths. The SE product will be a weekly product. The spatial resolution of the data from ATSR-2 and AATSR are 1 km (in the range of 0.01° on latitude/longitude grid). The spatial resolution for the SE product will be in the same range. The baseline product shall use the WGS 84 latitude/longitude grid with a 0.01° spatial resolution and the products will be weekly composites.

The definition of weekly may be discussed with the Users but the baseline approach is to gather all the data that are available for each week and create a composite of them. The other proposed approach: using a sliding average will not be used at the moment (a daily product could be created that combined the data from within one week from the evaluated day – a sliding average).

A secondary SE product (with 25km x 25km spatial resolution) can be calculated using the passive microwave data (the SWE product).

The baseline test regions For Snow Extent validation (DDS):

- The Alpine region (from the lowlands to the Alps)
- Norwegian mountains (southern Norway)
- Northern Finland
- Russia (INTAS SCONE, snow path data)
- Northern America (data from Richard Fernandes (CCRS)) North Slope

For validation classified aerial imagery and high resolution optical data (Landsat TM) will be used. A clear validation protocol needs to be defined for the project. The use of validation material that is already available will be preferred.

The users pointed out that information on confidence (or accuracy) would be important for the SE (and SWE) products. This would be something that is not available on the current products and would clearly be an added value for the end users. It was agreed to investigate options for specifying confidence during the first project phase.

The resolution of the DDS is not set yet. The resolution needs to be decided by the PM1 in Helsinki June 2009. (a goal of 500m / 0.005° is set)
The resolution is also dependent on the product (higher resolution for SAR data, i.e. for Norwegian mountains 250m / 0.0025° will be investigated).

Solberg (NR) will check the availability of Aster data for validation of the SE product (Aster data may be available from Dorothy Hall (NASA), this should be investigated).

Extension of the SYKE SCAmod method for forests on Global scale will be investigated. Some open question regarding the forest method: the availability of transmission data for the forests? How to discriminate between forest and open areas?

What parameters/limits should be used to classify forested areas? One possibility is to use the GlobCover data, are there alternatives?

The sizes of the test regions are dependent on the region, but for northern Finland and Norway a spatial coverage of 500km x 500km (or 500km x 1000km) would be sufficient.

The current SE algorithms have problem with lakes and these will be masked from the end products.

The low sun angle and cloud cover are limiting factors on SE monitoring during the winter months in the case of optical sensors. (A possible solution: a background SE product could potentially be derived using the microwave radiometer based SWE product. This will be investigated during the GlobSnow project)

Dealing with shadows (clouds & low sun angles) can be problematic. A simple solution to this is extending the cloud mask to cover the shadows; this will be the baseline approach for GlobSnow.

Emphasis on climate aspects should be the producing of the longest possible time series. This would require the use of AVHRR data, which will be investigated at a later stage. A continental scale (western Hemisphere covered) AVHRR FCDR might be available from CCRS. The CCRS AVHRR data set covers years 1985 – 2003.

GlobSnow could also be considered as a project that builds the capacity to utilize the data from the future missions, such as Sentinel-1 and Sentinel-3. Sentinel-1 carries a SAR instruments and the Sentinel-3 carries a sensor comparable to the AVHRR.

The goal of the first phase is to create a European wide diagnostic data set covering three years that is usable for algorithm validation using ATSR-2 and/or AATSR data.

Bojkov (ESA) will check the format, costs and availability of the AATSR data.

Bojkov (ESA) will check the status of the ESA AATSR cloud masking product (ESA project lead by Peter Regner), the current schedule promises a working product in May 2009 in ESA's BEAM tool.

The data formats to be preferred within the GlobSnow project are GeoTIFF, netCDF and metadata following INSPIRE guidelines.

For SE the definition of areas that have seasonal snow cover needs to be determined. Also the areas that are not mapped, water areas, Antarctica and Greenland are that large that it needs to be decided whether a global presentation (with mostly "no data" areas) or several distinct maps (each covering a certain limited region) should be preferred.

For the DDS and validation purposes, several additional classes should be used for the classification (classes TBD), such as: snow, no snow, clouds, no clouds, FSC…

Helmut Rott – State of the Art on Snow Extent monitoring using SAR (Presentation)

SAR can be used to map wet snow; dry snow and bare ground have similar backscattering signatures and are indistinguishable. SAR is typically utilized for snow-melt mapping. During the snow accumulation period the snow pack is typically dry and current SAR methods (using currently available sensors) are not feasible for SWE estimation or the discrimination between dry snow and bare ground.

Due to the varying incidence angles of SAR systems, there are significant difficulties using the data on mountainous regions. The main problems are with layover, foreshortening and shadowing. Additionally, these are portrayed differently on different incidence angles. An accurate DEM and geocoding of the SAR images is therefore mandatory.

The monitoring of wet snow is typically carried out using temporal change detection. A reference scene acquired during dry snow or bare ground conditions is compared with the evaluated image and the areas with significantly lower backscattering coefficients are determined to be from wet snow conditions. The acquisition of reference scenes for large areas is a significant challenge when considering the use of SAR for wet snow monitoring. Additionally for mountainous regions the reference scenes need to be from a similar imaging geometry to produce accurate results. Further, on images with low incidence angles, the loss of information on steep terrain is a significant challenge (layover, shadowing and foreshortening).

Utilizing SAR data for snow monitoring on heavily forested areas is challenging due to the effects of the forest on the SAR signatures. There are methods for compensation of forest effects, but they are dependant on ancillary data, such as forest stem volume distribution maps.

The use of SAR data could be used to enhance the snow climatology data sets in filling gaps in optical snow maps caused by cloudiness along the snow boundaries (mainly during the melting period due to the SAR's limitations of detecting dry snow).

Rune Solberg - Synthesis of SAR and optical data for Snow Extent monitoring (Presentation)

There are several possible ways for the fusion of data from different sensors.

The method utilized by NR: determines a time-dependent confidence level for both SAR and optical SE acquisitions, the current snow conditions determined from the data with highest confidence level. Works well using optical and SAR data, however computationally challenging and may not be usable on a continental or global scale.

The "newer" NR method "HMM fusion algorithm" considers the snow melt season as a state machine and has been shown to function well on Scandinavian mountains, however, computationally even more challenging than the previous NR method and is probably not feasible on a continental or global scale (at least on the scope of the GlobSnow project).

Handling of large amounts of data (as required with multi-sensor approach) is challenging.

Largest issues are with the data flow: gathering and processing all the data. They are currently not feasible on a large scale (or within the scope of Globsnow project).

The SRTM DEM (which would be needed for SAR geocoding) is usable on wide swath resolution up to 60 deg. Latitudes. For the areas north of 60 degrees, other DEMs are available on a regional scale, but not on a continental scale.

The use of Envisat ASAR GMM (Global Monitoring Mode) needs to be investigated within the GlobSnow project. The issue of data availability will be investigated. Additionally, the cost of data and the feasibility of GMM for snow melt monitoring need to be determined before the decision on using GMM data can be made.

The interest areas for SAR monitoring within GlobSnow need to be determined. Based on the discussion during the RER the two main areas in the first phase of the project are the Alps and the Scandinavian mountains.

The availability of SAR data (ASAR wide swath and GMM data) for the interest areas need to be investigated before the next meeting (June 10-11 in Helsinki).

The cost of SAR data (ASAR wide swath and GMM data) for the GlobSnow will be investigated by Bojkov (ESA).

The coverage of the freely available data (such as the IPY data) needs to be investigated; especially if ASAR data will not be free of charge for the project.

Action: ENVEO & Norut will investigate the GMM and wide swath inventory before the June meeting. The period of interest for wet snow monitoring: April – June.

Testing of boreal forest SAR SE will be carried out for the northern Finland.

Providing a weekly (0.01° / 1km) product for the high latitudes using microwave radiometer based data will be investigated. Validation of microwave SE is a key issue.

The main focus for the early phases of GlobSnow project is to use the SAR data for diagnostic and validation purposes and if it seems promising and technically feasible then including it for the operational product.

Andreas Wiesmann – The GlobSnow Processing System (Presentation)

There are certain requirements from the Users and the ESA Statement of Work and in addition to these there are also indirect requirements. There are technical and financial constraints for the processing system and requirements from the products (temporal and spatial resolutions and areal coverage). Fitting all the requirements together is difficult. In order to create a system capable of fulfilling all the technical requirements may not be possible within the budget. On the other hand, in order to stay within the financial parameters for the processing system all the technical requirements might not be able to be met.

Fernandes (CCRS) commented that the processing requirements for a long time series (FCDR) may be several orders of magnitude larger than what is required for a near real time processing system. Processing of an FCDR for 20 years for western hemisphere north of 40 degrees by CCRS took two years with a machine with one or two orders of magnitude higher capacity than currently intended for the GlobSnow.

Data processing times and data transfer times need to be considered when the sensors and algorithms have been selected for the different snow products.

Chris Derksen SWE validation data (Presentation)

The validation data for the SWE products will mainly be the snow course and snow path measurements from Finland, Canada and Siberia, along with the BERMS sites and the long snow traverses conducted in Canada.

The weather station data utilized for the SWE product have their unique features that may not be evident from the raw data. For instance the weather stations are in many places located either near airports or cities and on sparsely populated areas they are often biased towards coastal areas (northern Canada).

All validation data have their own uncertainty characteristics, for example the detection of snow on weather stations may behave inconsistently from region to region especially when the snow pack is very shallow (in the beginning and in the end of the snow melt season). A measurement showing 0-3 cm of snow during the snow melt season may indicate that the snow has been melting away at the exact location of the snow measuring stick, but there may still be significant amounts of snow left. Additionally the snow-melt varies heavily depending on the different geographical

areas, typically the snow measurements are made on open areas, and typically the snow clearance dates for the forested areas are later than those of open areas.
Therefore the validation protocol needs to be well defined and described to the users to understand the limitations that are caused by the measurement conditions.

Some open issues to be considered concerning the SWE products and validation:

- which terrain mask to use
- which water mask to use
- how to define the mountains that are masked (how to define the topography limits for the areas to be considered mountains)
- which topographical information is used to derive the mountain mask
- what should the minimum detection threshold be for SWE
- how to define the parameters for wet snow detection

Some of the issues have been investigated and solutions exist between the GlobSnow partners, the main issue is to determine and document the most suitable approaches for the GlobSnow project. For example terrain masks are available at FMI and EC; mountain masks are available at least at EC. These need to be discussed about and decided about.

Derksen (EC) will ask if suitable validation data for Northern America could be acquired from Richard Fernandes (CCRS) or Dorothy Hall (NASA).

Sari Metsämäki SE validation data (Presentation)

For SE validation the main data will consist of high resolution optical imagery, such as Landsat TM data, snow course data and possibly other relevant data (appropriate data needs to be determined/selected for the different regions).

The processed Landsat TM data are binary with a resolution of approx. 30m these can be aggregated to a coarser resolution FSC data.

Fernandes (CCRS) will check the availability of Landsat TM data at CCRS, and will ask if Dorothy Hall (NASA) has some validation data that could be utilized by GlobSnow.

High resolution optical data is well suitable for medium resolution SE validation. Mountainous regions will mainly use the high resolution optical data for validation. The non-mountainous open and boreal forest regions can additionally use the in-situ data (weather station and snow course data).

One (or several) methodologies shall be selected and documented within the GDD for each region.

The INTAS-SCONE snow path data could be used to validate the consistency and stability of long time series. The INTAS-SCONE data can however **not** be used as a part of the DDS as FMI does not have the rights to distribute the data to third parties outside the project.

One of the best consistent and traceable in-situ measurements is for the time when the snow clears from the ground. Snow clearance is independent (at least on certain regions) regardless of spatial scale.

A list of the selected geographical regions that are included (and which are not included) needs to be discussed in the GDD to assess the geographical scope of the validation dataset.

The End-user presentations

Roger Saunders – The perspective on User requirements from UK Met Office

UK Met Office currently utilizes the NOAA/NESDIS IMS product in their operative numerical weather prediction. The NOAA/NESDIS IMS product covers the Northern Hemisphere, has a 4 km spatial resolution and provides daily snow cover maps.

UK Met Office Requirements:
Improved timeliness (all data within 24 h), since delays in snow data can lead to major problems on weather predictions.
Spatial resolution of 4km is currently adequate for SE, plans to improve this to 1,5km by 2010.
Snow Water Equivalent will be useful to supplement SYNOPS snow-depth assimilation in future.
Target spatial resolution for SWE: 12 km, preferably daily, global data.
For climate applications the monthly data are adequate, and the delivery time is typically not important.
Data confidence map would be valuable for both snow products.
Validation is essential for all the snow products.

Richard Fernandes (CCRS) - The perspective on User requirements from Canada

Richard Fernandes presented the needs of CCRS and 6 additional Canadian users.
For snow extent the preferred spatial resolution varied between 250m and 1 km. Most users would like to have a daily SE product. Accuracy requirements varied between 10% and 20%, the 10% accuracy requirements were for 1-10km averaged products.

As a final conclusion: a 1km spatial resolution would be sufficient for the SE product.
A daily product would be highly recommendable, although a long term (15 years) weekly global product would also be valuable for many users.

Concerning the SWE product and climate monitoring a spatial resolution of 25km would be sufficient.
Stability is very important for climate change applications (<1%yr). High stability is the key prerequisite for trend analyses. In some cases even more important than the thematic accuracy.

The delivery time is typically not critical for climate applications.

Showing that long time series can be done consistently may be more important than the time series itself for some users.

Fernandes (CCRS) raised a question on gap filling (how and if to reduce the gaps in EO data). Some users may prefer to have the data gaps filled using an interpolation (or a similar) approach, while some users would probably want as accurate data as possible and for the regions with no data they should not be constructed. This question is directed for the potential end users, and should be discussed at a later stage (perhaps the first User Workshop December 2009). Richard added that whichever approach is selected it needs to be well informed to the Users (Documentation).

Nando Foppa - The perspective on User requirements from MeteoSwiss

MeteoSwiss has a long tradition in the observation of ground-based snow cover contributing to the Global Climate Observing System GCOS. Snow has been recorded since 1864 at ground-based stations.

The main area of interest for MeteoSwiss: The Alps. The interest of MeteoSwiss and its activities within GCOS Switzerland are primarily on long-term observations of the cryosphere and the climatology of cryospheric variables (e.g. snow cover, SWE, snow depth). For MeteoSwiss the SE product has the highest priority. The temporal span should cover as long time series as possible (> 15 years if possible).

The quality of data is of high concern, validation of the products is important.

Target thematic accuracy for the SE product: 5%
Pixel location accuracy target 1/3 IFOV
Target spatial resolution of 100m although a 1km product would also be sufficient.
Target temporal resolution of 24h - weekly product

Thomas Voigt - The perspective on User requirements from the EEA

A key responsibility of EEA is reporting the status of environment to public.
Detailed Requirements rising from EEA's general reporting issues:

Product/Service: Trend analysis of parameters of the snow cover (extent, duration, thickness, SWE(?))
Use and benefits: Reports to inform policy-makers/public/media
Geographic coverage: Europe; Parts of Asia
Temporal requirements: Data records as long as possible (30-40 years) (monthly and quarterly means fully sufficient)
Spatial resolution: Comparable to grid-scales of regional climate models (>1km)
Accuracy: as accurate as possible in the available records
Data format: No specific data format required

Need for information in terms of graphs or maps demonstrating the long-term change of snow-cover characteristics (extent, duration, thickness).

A 1km spatial resolution would be adequate for SE.

Regional NWP requirements for satellite-based retrievals of snow parameters (FMI NWP department)

Presence of snow has the highest priority for NWP. It is the principal characteristic influencing the surface energy budget. In order to capture all rapid changes along the edges, the observing system should not be sensitive to clouds, darkness, snow state or other external factors. Of special interest is the presence of snow on ice-covered seas and lakes, glaciers and ice-sheets. (snow on ice is however not within the scope of GlobSnow).

Snow Water equivalent has the next highest priority. This is often the only prognostic variable related to snow cover and crucial for predicting the springtime flooding.

Snow Depth also has a high priority. As input, mainly used to infer presence and water equivalent. Output variable of interest e.g. to road traffic.

Snow Density has a medium priority. It can be used to infer water equivalent from observations of snow depth. Prognostic variable of advanced models.

Albedo has a medium-to-high priority. Currently estimated using snow cover data and other available data.

The main interest of FMI NWP is on SE product. The SWE product is also interesting, although not as influential as the SE on NWP.

The spatial resolution should be better than 100km. Daily data would be preferred and for some cases data with even higher frequency would be valuable. NWP has a preference for very short delivery times (less than 1 day and optimally less than 2 hrs).

The discussions on Wednesday 4 February

The meeting on Wednesday was attended by the project partners and the ESA representative. The main discussion concentrated on issues regarding the selection of test regions, the validation of the end-products, the already available reference data and discussion about the data that are available from ESA and the consolidation of the user requirements with requirements from other sources, such as the ESA needs, the requirements from GCOS and IGOS.

The main issues from Wednesday are included in the executive summary and the action item list.