A NEW GLOBAL SNOW EXTENT PRODUCT BASED ON ATSR-2 AND AATSR

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The European Space Agency (ESA) Data User Element (DUE) GlobSnow project is developing new Snow Water Equivalent (SWE) and Snow Extent (SE) products for global coverage. One of the key goals of the project is to produce SE products for the seasonally snow covered parts of the Earth for the years 1995 – 2010 based on ERS-2 ATSR-2 and Envisat AATSR. The product time series spanning these about 15 years is expected to be produced by August 2010 and will be made freely available.

The current snow prototype product set covers the pan-European region and is now available for review by the user community. The products contain information on snow coverage retrieved from Envisat AATSR for the period January 2003 – June 2006 (3.5 years). There are three types of products available:

- Daily Fractional Snow Cover (FSC): snow fraction (%) per grid cell for all satellite overpasses 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
- Aggregated Fractional Snow Cover: FSC for all satellite passes within a given time period. (This is an experimental product currently covering ten days.)

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 mountain areas above the tree line (Norwegian Linear-Reflectance-to-snow cover,

NLR, algorithm; Solberg et al. 2006, Solberg and Andersen 1994), and another developed for forests and plains (SCAmod; Metsämäki et al. 2005, Salaminen et al. 2009). 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°. 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 the prototype version.)

Both layers are in 8 bit format.

A comprehensive 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 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 stations) 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%.

The GlobSnow SE product is a 'first-time endeavour' for the remote sensing community in Europe. 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, like calibration for the two SE 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 planned to be introduced in the operational products of global coverage.

Furthermore, cloud detection needs to be studied more 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.

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