Snow remote sensing at Finnish Meteorological Institute

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Finnish Meteorological Institute (FMI) participates in several projects involving remote sensing of snow in close co-operation with Finnish Environment Institute and Helsinki University of Technology.

In these projects research are done in snow detection (Hydro-SAF, Land-SAF), fractional snow cover (Hydro-SAF), snow dry/wet classification (Hydro-SAF), snow freeze/thaw cycle (Snowclim), and Snow depth and water equivalent (Hydro-SAF, Polarview, Snowclim).

Some of the projects aim at operational services (Hydro-SAF, Land-SAF) and some are more focused on pure research (SnowClim). The data used for the studies range from optical and microwave remote sensing instruments to in situ observations of snow, for example snow course measurements. Also wide snow and albedo experiments are ongoing (SNORTEX), which give valuable information for validation purposes.

This poster overviews the products in which the author has been participating either in development and/or implementation.

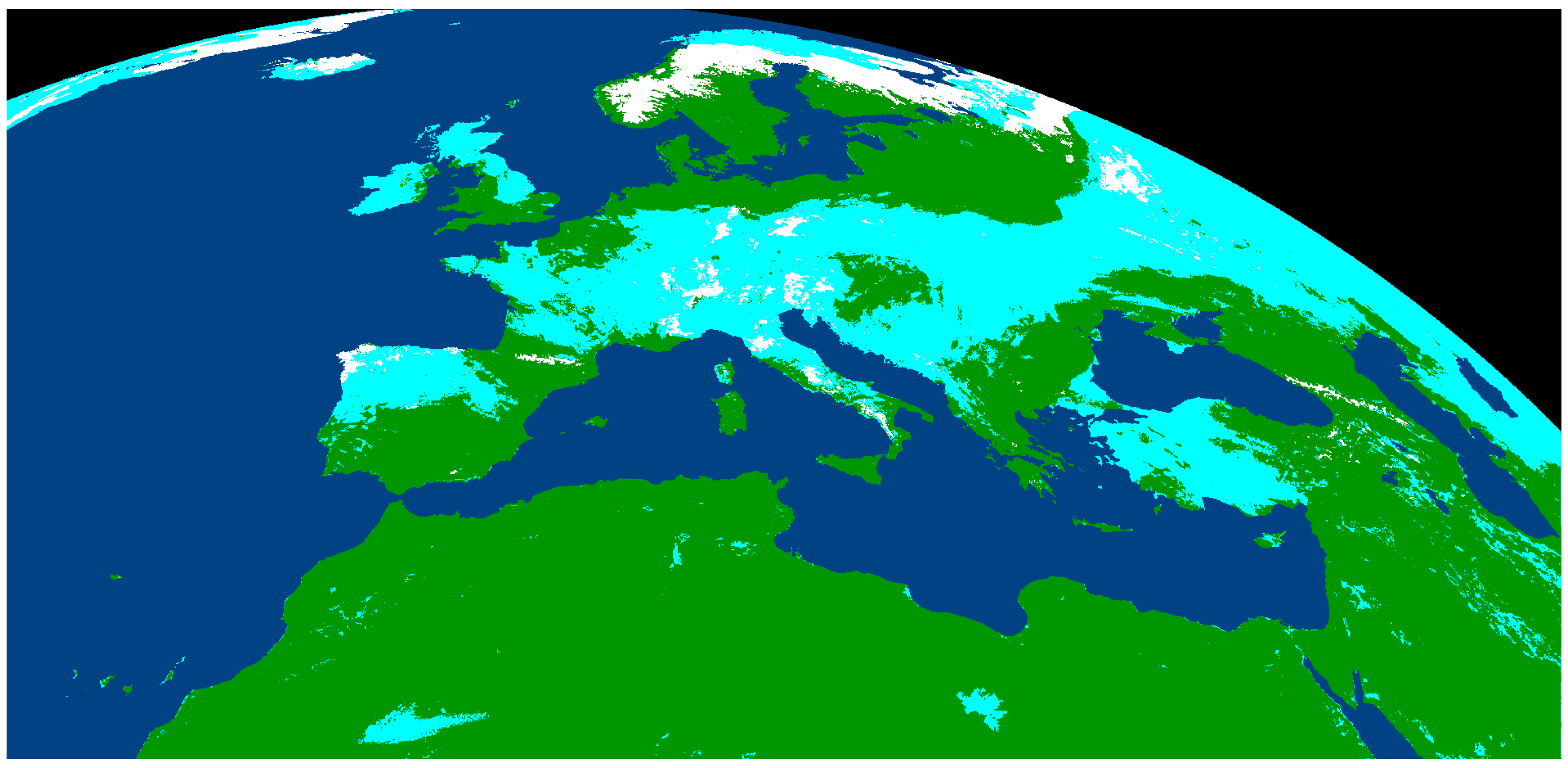

Figure 1: H-SAF snow cover for 22 April, 2008 from MSG/SEVIRI. White: snow, green: bare ground, cyan: clouds, blue water.

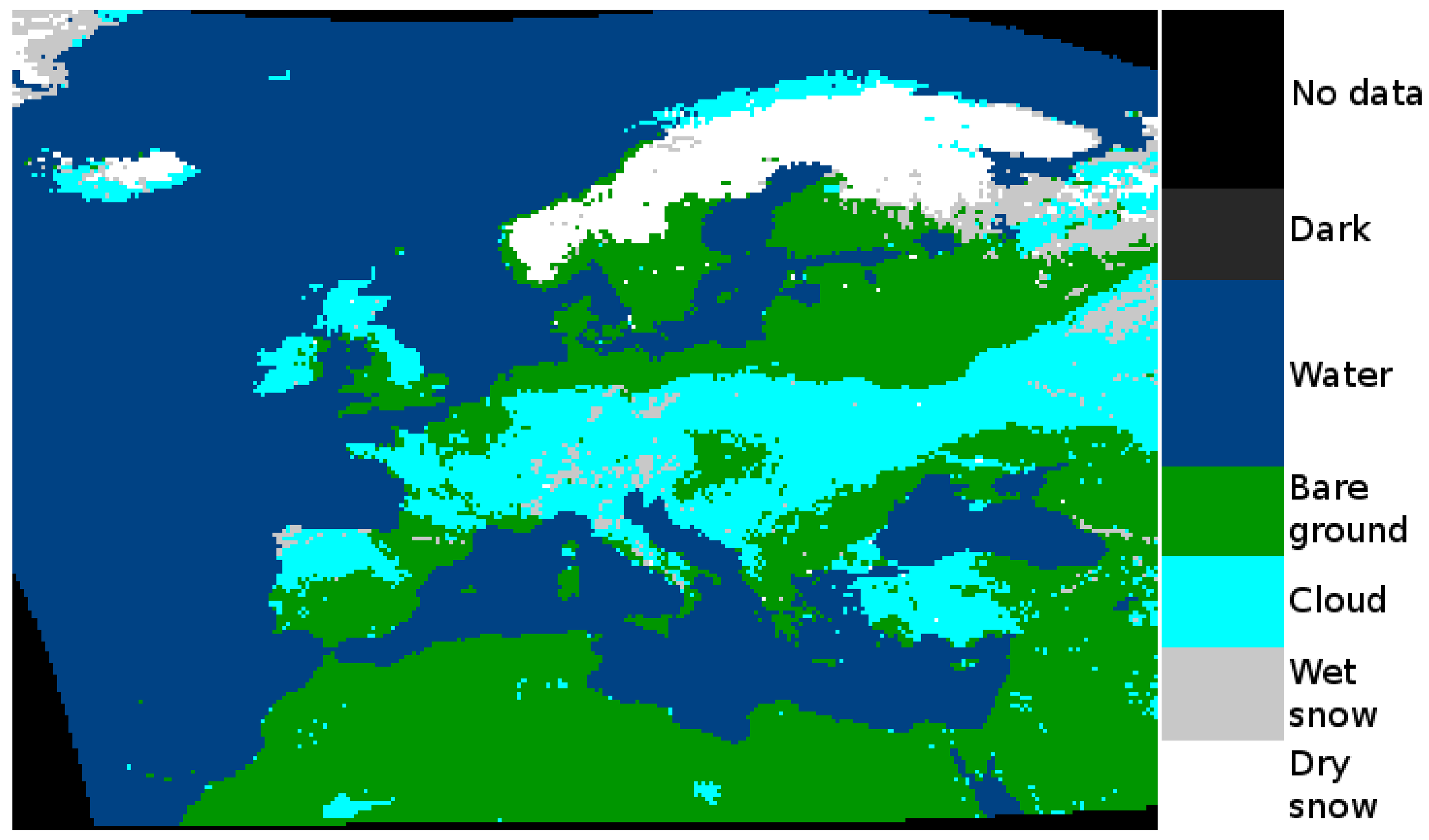

Figure 2: H-SAF snow status (dry/wet) for 22 April, 2008 from MSG/SEVIRI and EOS-AQUA/AMSR-E.

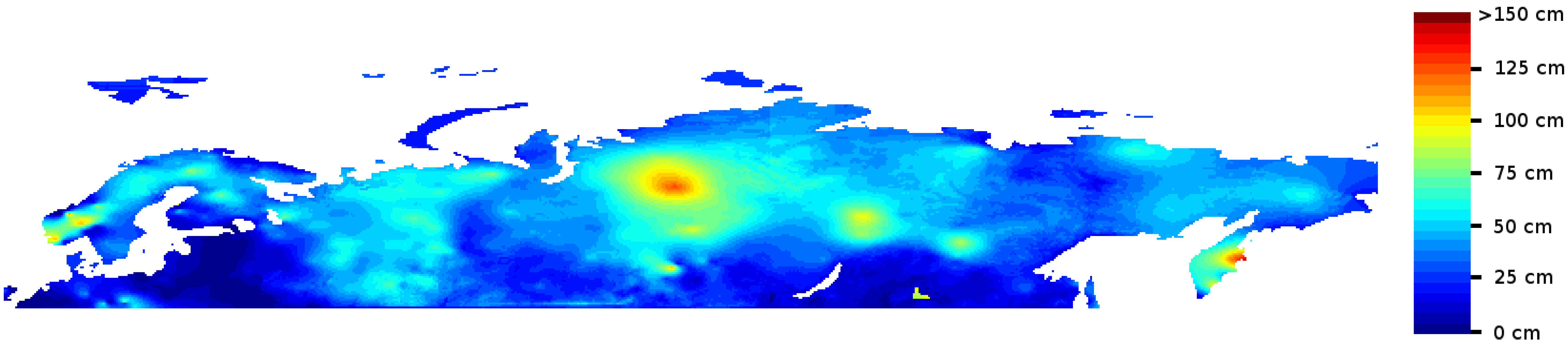

Figure 3: Snow depth in Northern Eurasia on 9 February, 2008. Based on assimilation of weather station and AMSR-E radiometer data.

Figure 1 shows the first version Hydro-SAF snow cover product. The product is based on MSG/SEVIRI. The algorithm is based on simple thresholding of channel differences and ratios. The good temporal resolution of the data is utilised for reducing the misclassification of clouds to snow, and to make use of the cloud movement to reduce the fraction of cloud covered area. To further eliminate the misclassifications, the sun azimuth angle could be used to take into account the BRDF of snow.

With microwave radiometry it is possible to distinguish dry snow from other surface types (Rees). When we combine this with the daily snow cover product, we can separate dry snow from wet snow, *Figure 2*. During the deepest winter there is very little or no sunlight in the high latitudes, thus it is not possible to use optical instruments for snow detection and only dry snow is detected with the coarse resolution of the microwave instrument.

Assimilation of interpolated ground-based snow depth measurements (on weather stations) with satellite radiometer data can increase the quality of snow depth estimation for large areas (Pulliainen, 2006), *Figure 3*. The estimate from satellite is based on inversion of HUT snow emission model (Pulliainen et. al., 1999). To further enhance the estimate, more novel interpolation methods could be used instead of ordinary kriging.

References:

Pulliainen, J., Grandell, J., Hallikainen, M. (1999). *HUT snow emission model and its applicability to snow water equivalent retrieval*. IEEE Transactions on Geoscience and Remote Sensing, 37, 1378-1390.

Pulliainen, J. (2006). *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, 101, 257-269.

Rees W. G. (2005). *Remote sensing of snow and ice.* CRC Press. 285 pages. ISBN-0415298319.