MONITORING SNOW COVER WITH MULTISENSOR AUTOMATED SNOW MAPPING SYSTEM AT NOAA/NESDIS

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Snow cover is an important element of the Earth's climate system. Information on the snow cover extent and spatial distribution is highly important for the numerical weather prediction, hydrological analysis and climate change studies. Owing to a short revisit time, global coverage and operational availability of data from meteorological satellites, satellite observations are seen as a primary tool for continental to global scale monitoring of snow cover for meteorological and climatological applications.

In the past most automated techniques to identify and map snow from satellite data have used observations from a single satellite instrument. The developed algorithms utilized observations either of passive microwave sensors (e.g. Kelly et al., 2003; Grody and Basist, 1996) or optical sensors (e.g., Hall et al, 2002; Romanov et al., 2003). In recent years the attention has turned to a "synergetic" approach to satellite snow mapping which consists in combining information from observations of the two types (e.g., Foster et al., 2008; Romanov et al., 2000),. The main idea of the synergy is to minimize the effect of limitations of the two techniques (in particular, coarse spatial resolution of microwave instruments and inability to "see" through clouds in the visible and infrared) and to make maximum use of their advantages (e.g., all-weather capability of microwave sensors and high spatial resolution of observations in the visible and infrared). The primary objective of these innovations is to better satisfy the needs of numerical weather prediction and climate modeling communities which require continuous global snow cover maps generated daily at the spatial resolution equal to or higher than the model grid cell size.

The synergetic approach combining snow retrievals from passive microwave and optical satellite sensors is the primary feature of the NOAA Automated Multisensor Snow and

Ice Mapping System. This system was implemented at NOAA/NESDIS in 2006 to provide routine operational monitoring of the global snow and ice cover. In the developed technique we use observations in the visible, middle infrared, infrared and microwave spectral bands from both polar orbiting and geostationary meteorological satellites. The list of satellite sensors currently incorporated in the system includes DMSP F-15 -16 and -17 SSMI(S), GOES-East and –West Imager, NOAA-17 and -18 AVHRR, and MSG SEVIRI.

Within the system snow/ice maps are first generated from each sensor data individually. Snow/ice identification is performed with threshold-based decision-tree image classification algorithms which utilize satellite-observed scene spectral features. Besides the spectral features, the algorithm for geostationary satellites includes image compositing to retain the most cloud-clear observations obtained during the day and the temporal variability test for the scene reflectance and temperature to better separate snow and clouds. Individual sensor snow/ice maps are then combined with maps derived from all sensors of the same type (optical or microwave). At the last step the snow map for the previous day is updated with the current day snow retrievals to produce a new blended continuous snow and ice cover distribution. The primary output of the system is a global snow and ice cover map generated at a spatial resolution of 4 km. An example of the map is presented in Fig. 1.

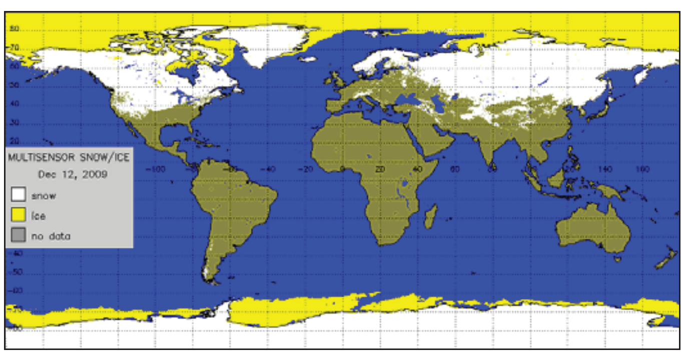

Fig. 1. Example of the daily snow and ice cover map generated with NOAA Automated Multisensor Snow and Ice Mapping System. Maps are available since January 2006.

To assess the accuracy of the product we routinely compare it with surface observations of snow and with snow cover maps drawn interactively by NOAA analysts. The overall rate of agreement on snow or no snow between ground-based station data and satellite snow maps ranges from about 85% in the middle of winter to more than 95% in late spring and summer. In the middle of the winter season up to 2500 reports on the snow depth from WMO and US Cooperative stations may be available daily for comparison and validation of the satellite-based product. For an express qualitative analysis of the correspondence of the derived snow cover distribution to in-situ measurements we produce snow maps with surface observation data overlaid. As an example, the picture in Fig. 2 demonstrates a good agreement between the two datasets in North America.

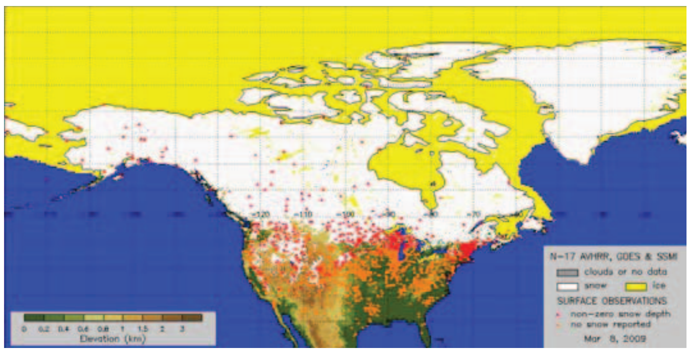

Fig. 2 Example of the snow cover map for North America with surface observations data overlaid. Triangles in the map indicate stations which reported at least some snow (red) and no snow on the ground (yellow).

In the presentation we will give a detailed description of the developed snow detection and mapping algorithms and of the technique to combine snow retrievals from different satellite sensors. We will present the results of snow cover monitoring during four years of system operation and will compare them with other snow cover maps derived with different techniques and from other satellite data.

References

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