# P 3. ASSESSMENT OF THE SNOW PRODUCTS USING IN-SITU DATA

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**ABSTRACT** Ecology is the study of the complex ways that living things interact with their environment Deciduous plants handle the lack of water by shedding their leaves, which tend to evaporate water into the air. During cold winter months, most deciduous plants drop their leaves and go dormant. Evergreen plants keep their foliage, but their leaves and needles have a thick, waxy coatings to reduce water loss. In areas that receive frequent snow and may have cold weather year-round, such as in the Arctic, plants have adapted in other ways. Trees may grow close to the ground or grow in shapes that help them shed heavy snow more easily. Plants may hold onto dead leaves for insulation or use deep snow like a blanket to protect against the cold. Some evergreens also have a special valve in their cells. This valve automatically seals off individual frozen cells to prevent a chain reaction of freezing. Satellites are well suited to the measurement of snow cover because the high albedo of snow presents a good contrast with most other natural surfaces except clouds. NOAA has a variety of snow products including those based on satellite passive microwave sensors such as JPSS AMSR2 and ATMS. Snow information: Snow Cover Area, Snow Depth and Snow Water Equivalent (SWE) - is an important input to numerical weather and climate prediction models. The objective of this project is to evaluate the performance of satellite-based snow products over regions that have sparse in-situ data. Of special interest and mountain regions and remote areas including those over US and elsewhere. To accomplish the goal of the project, the following activities will be carried out: Collect regional historical snow data not available via public networks. Do a quantitative evaluation of the snow products use in-situ data.

***Keywords***: *Ecology, assessment, snow products, snow information*

## 1. INTRODUCTION

Current NOAA's National Centers for Environmental Prediction (NCEP) operational weather prediction models rely on snow depth observational data for their land surface model initializations. A new snow depth analysis system based on the optimal interpolation method of station and satellite-based snow depth is being developed with improved spatial resolution and utilization of multiple sources of observational data. Figure 1 presents a high-level diagram of the new blended analysis scheme and its components that will generate two *global* snow depth products for NCEP models: at 12-and 1-km resolution. Provided below are summary description and results for bias-correction and snow melt and accumulation model, the latter being developed to generate initial snow depth estimates.

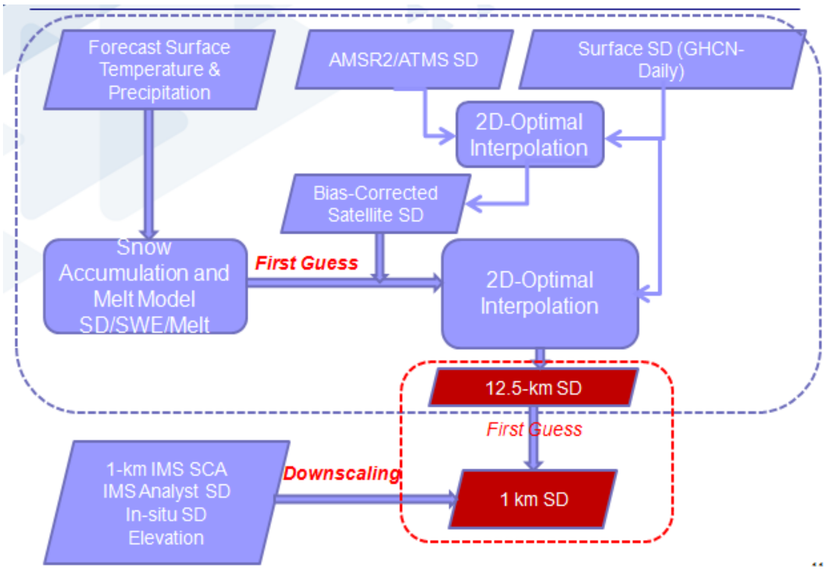


**Figure 1.** The new snow depth analysis scheme (by C. Kongoli)

## 2. MATERIAL AND METHODS

### *Bias Correction of Satellite-derived Snow Depth*

Bias correction should be an essential component of any satellite monitoring algorithm. Thus, it is imperative that new satellite bias correction methods for snow depth be developed and tested to improve utilization of this precious observing system. A brief description of the method is provided below:

The method is applied to AMSR2 snow depth using optimal interpolation following the study by Liu et al., 2015. In this application, the satellite snow depth is the first guess, and a correction factor is computed for each valid AMSR2 snow depth value using surrounding in-situ snow depth (in a box approx. 300 km in size) for days prior to the analysis day. Adjustments are thus computed dynamically from the in-situ data collected in the previous days and applied to satellite snow depth at analysis time.

Station snow depth measurements are extracted from the Global Historical Climatology Network (GHCN). Figure 2 shows an AMSR2 snow depth map over Northern Hemisphere (top) on January 1, 2017 and the bias-corrected AMSR2 snow depth (bottom). Overall the AMSR2 product shows a reasonable large-scale snow depth distribution. The largest corrections and improvements occur over Northern Europe, western Siberia, along the north-west coast of US/ Canada and over Alaska.

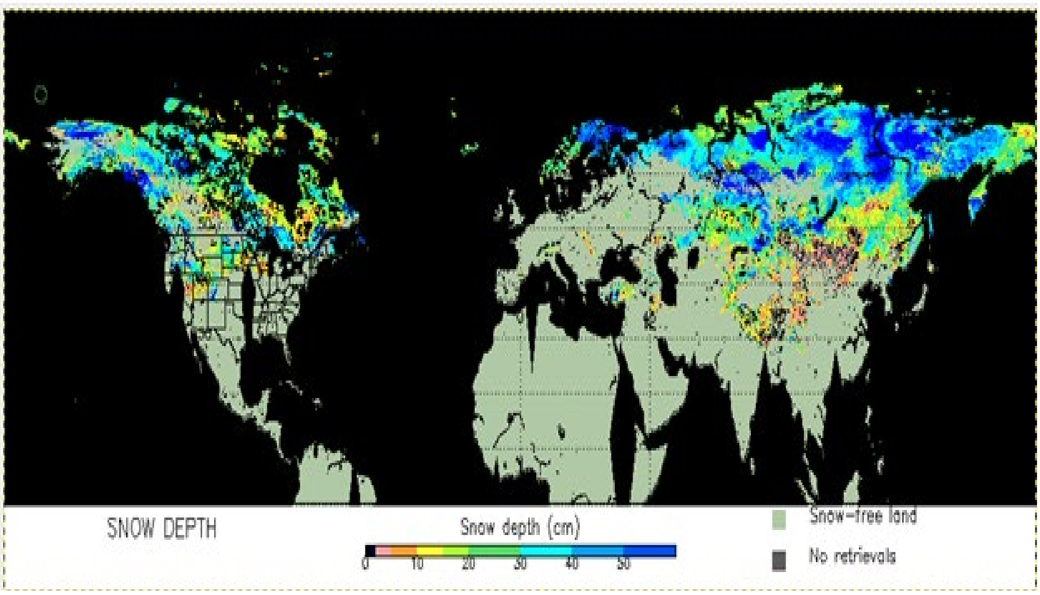


**Figure 2.** AMSR-2 Snow Depth before (top) and after (bottom) bias correction applied to in-situ data from GHCN-Daily using optimal interpolation (by C.Congoli).

## 3. RESULTS

Reasonable first guess estimates are especially important in areas with sparse snow depth or erroneous satellite data. The snow model developed also computes snow density, snow water equivalent and liquid water and ice content, which would be useful to have for future expansion, e,g, to global SWE estimations. The model developed here was adopted from existing methods. However, putting together a snow model and testing it in a short time is a major accomplishment. A brief description of the model is provided below:

The snow model is a one-layer model driven by precipitation and temperature inputs at hourly or daily intervals. Routines include snow accumulation, compaction, melt and refreezing. Melt and refreezing rates are computed using a simple degree-day factor approach, as in the operational seNorge model (Solantra, 2012). Compaction is modeled using Anderson (1976) parameterizations. Model prognostic outputs are snow depth, density, SWE, ice and liquid content.

Testing of the model was carried out using daily snow observations at a first-order station located in Dane County Regional Airport, Madison, Wisconsin over a 16-year period (2000-2016). Data were obtained from the Midwestern Climate Center (http://mrcc.isws.illinois.edu/). A correction factor of 1.3 was initially applied to solid precipitation inputs to account for gauge under-catch. This value was taken from Kongoli and Bland (2000) study, which included long-term testing of a detailed snow model. It was found that a correction factor of 1.1 improved overall statistics compared to the previously established mean value of 1.3. A melt degree-day factor of 5 mm $day^{-1}$ $^{o}C^{-1}$ was found to produce reasonable snow depth simulations during melt. The values reported in Solantra (2012) gave unrealistic results: much delayed ablation and snow disappearance. Figure 3 shows daily time series of modelled versus measured snow depth at the Madison, Wisconsin first-order station between January 1, 2000 and December 31, 2016. Snow depth evolution is simulated well. Bias is -2.1 cm and Root Mean Square Error (RMSE) is 7.6 cm.

## 4. CONCLUSIONS

Satellites are well suited to the measurement of snow cover because the high albedo of snow presents a good contrast with most other natural surfaces except clouds.

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