Evaluation of Model Assimilated and Satellite Observed Snow Cover Products

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EXTENDED ABSTRACT

NASA's Modern Era Retrospective-analysis for Research and Applications (MERRA) was developed to support NASA's Earth science objectives, by applying the state-of-the-art Global Modeling and Assimilation Office (GMAO) data assimilation system that includes many modern observing systems such as the Earth Observing System (EOS) in a climate framework. MERRA is a reanalysis for the satellite era using a major new version of the Goddard Earth Observing System Data Assimilation System Version 5 (GEOS-5). MERRA/GEOS is driven by observations, it does not assimilate snow observations, model physics then determine if snow was produced by a weather event. Snow depth and snow cover are among the myriad outputs of MERRA. We compare the MERRA snow outputs to the joint Air Force Weather Agency and NASA (ANSA) daily snow product generated by blending the MODIS daily global snow product and the AMSR-E daily SWE product, generated from EOS sensors. The ANSA melds the strengths of those products to produce an enhanced snow map. An objective of the evaluation is to verify the modeled snow output based on the observed snow product. Evaluation of the MERRA snow products as compared to the ANSA observational snow product for January 2006 is presented.

Keywords: MODIS; snow; MERRA; modeling; assimilation

ANSA and MERRA data products

The ANSA snow product (Foster et al., 2007) is in Lambert Azimuthal projection at 25 km resolution and was reprojected to the MERRA geographic grid of 0.667° longitude and 0.5° latitude (540x181 grid size) resolution for comparison. Nearest neighbor sampling was used in the reprojection of ANSA data.

The land snow fractional snow cover and the snow depth outputs from the MERRA suite of outputs were used in this initial comparison. The draft MERRA File Specification Document is available and open for comment. That documentation describes the output variables and files that are available from the MERRA reanalysis (http://gmao.gsfc.nasa.gov/research/merra/).

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Evaluation

Smooth continuous maps of snow depth and fractional snow land cover produced from MERRA are in striking contrast to the discontinuous satellite observed snow cover and snow water equivalent (SWE) derived maps. Evaluation was limited to qualitative comparison of the maps for 1, 15 and 31 January 2006. Comparisons of snow maps for 31 January 2006 are shown in Figure 1. In the regions where snow cover is deep and continuous there is general spatial agreement between the satellite maps and MERRA maps. However there are also remarkable dissimilarities. For example, on 1 January in central and Eastern Europe and Northern Plains of the U.S., snow cover was not observed but was modeled in MERRA (image not shown). On 31 January the snow extent and amount are similar where snow extent is interpreted to be mostly continuous and not shallow but the MERRA generates maps of sparse snow extent and shallow depth that appear to be far too extensive compared to the satellite observations used in ANSA (Fig.1). The Atlas Mountains along northern coast of Africa are sometimes snow covered in winter, but MERRA places extensive snow cover in that region; this snow cover extent not supported by satellite observations.

Evaluation has thus far focused on identifying regional similarities and differences between the ANSA and MERRA snow maps. The difference in extent of sparse and shallow snow between the ANSA and MERRA is quite evident. A possible source of differences may be the relatively high spatial resolution of the satellite data compared to the MERRA spatial resolution. Changes in snow cover, short term and long term events, are also being investigated to evaluate how accurately changes can be observed and if they are also modeled by MERRA. An anticipated outcome of this evaluation is an increased understanding of how assimilating satellite observations into climate models will contribute to better simulations. Additionally, our evaluation may show how modeled data could be used to fill gaps in the observation maps, caused by orbit gaps, darkness or cloud cover, which will result in snow maps having complete coverage.

REFERENCES

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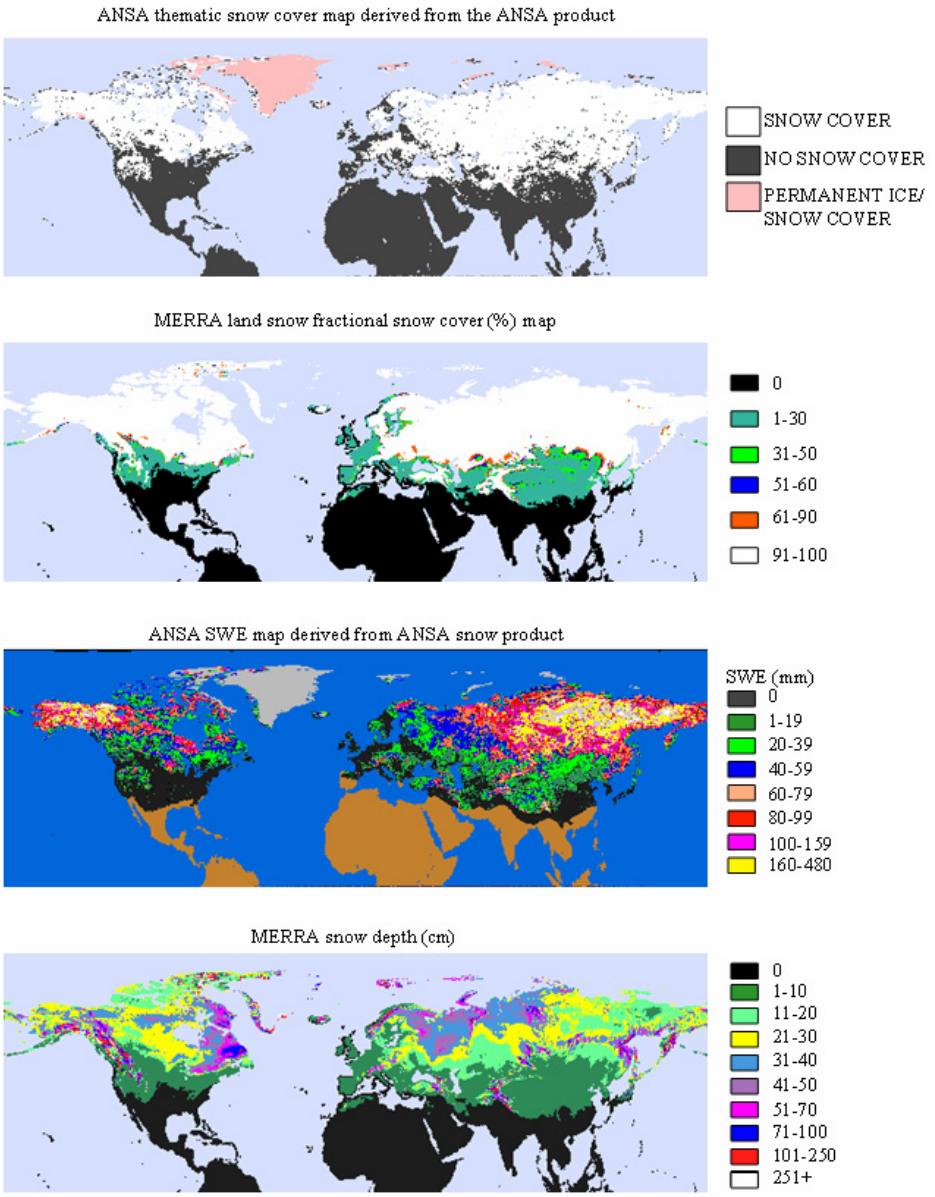

Figure 1. Comparison of snow maps from the ANSA and MERRA products for 31 January 2006.