Arctic System Reanalysis: Land Surface Parameter Assimilation and Model Updates

Michael Barlage
National Center for Atmospheric Research

David Bromwich, Lesheng Bai, Keith Hines
The Ohio State University

The Arctic System Reanalysis (ASR), a blend of modeling and observations, will provide a high resolution description in space (10-20 km) and time (3 h) of the atmosphere-sea ice-land surface system of the Arctic for the period 2000 - 2010. The ASR will provide a resource for the detection and diagnosis of change in the coupled Arctic climate system. The widespread applications of existing global reanalyses (e.g., ERA-40, NCEP/NCAR, JRA-25, NASA DAS) demonstrate the high impact that can be expected on Arctic research.

Structural changes to the existing land model (Noah LSM) in the Weather Research and Forecasting (WRF) model have been made to improve the performance of the model in Arctic environments. The most important of these is the increase in the depth and number of soil layers along with implementing a zero-flux boundary condition at the bottom of the soil column. The increased soil depths makes it necessary to do long-term model spin-up. Land surface states, such as soil temperature and moisture, are initialized using multi-year simulation of an offline version of the Noah LSM, the High-Resolution Land Data Assimilation System (HRLDAS). The forcing conditions for this spin-up are provided by the ECMWF ERA-40 reanalysis.

Land data assimilation is a vital component to ASR. Several time-varying surface properties are regularly observed by satellite sensors. The timing and amount of snow is a crucial component to both the energy and water cycles. Currently, a combination of Interactive Multisensor Snow and Ice Mapping System (IMS) and Air Force SNODEP model analysis are used to determine snow cover extent and snow amount. The IMS snow product provides a binary representation of snow presence at 24km (pre-2004) and 4km (post-2004). The SNODEP analysis is only used when the model snow becomes significantly far away from observations.

The extent of the ASR domain also requires the accurate specification of vegetation condition. A weekly vegetation cover product created by NESDIS/STAR is used to specify the current vegetation state. Observed albedo provides a constraint on the surface energy. The structure of the Noah LSM is suitable for direct use of satellite albedo products. However, care must be taken so that the satellite albedo is consistent with the surface snow cover. Two new time-varying datasets are created from MODIS observed albedo to describe the snow-free and snow-covered albedo. MODIS snow cover and cloud cover are also used in the creation of these datasets. Therefore, the current ASR system incorporates several NASA, NESDIS, and NOAA satellite observations to prescribe the time evolution of surface properties during the full ASR period..

An overview of the ASR system will be shown along with the methodology for the application and/or creation of land surface products used in the reanalysis. Multi-year test results using the offline HRLDAS will be shown along with introductory results from 10-year tests within the variational coupled atmosphere-ocean-land system.

Corresponding Author:

Name:	Michael Barlage
Organization:	National Center for Atmospheric Research
Address:	3090 Center Green Dr Boulder, CO 80301 USA