Data Assimilation for Arctic System Reanalysis

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\textbf{Abstract}

The Arctic System Reanalysis (ASR) [Bromwich et al. 2010], which is approaching the operational stage, includes atmospheric, sea ice and land surface representations. Through atmospheric, land and sea ice data assimilation a broad-based set of historical data streams from the surface and space are combined with measurements of the physical components. The domain of the ASR (Figure 1) includes all of the northward flowing rivers that empty into the Arctic Ocean.

\textbf{ASR Components}

The polar-optimized version of the Weather Research and Forecasting model (Polar WRF) which includes an improved Noah land surface model and specifications for the following sea ice attributes:

- Observation data (in-situ surface and upper air data, remotely sensed retrievals and satellite radiance data).

High Resolution Land Data Assimilation System (HRLDAS) (Chen et al. 2004). HRLDAS is a high resolution land data assimilation system used for the data assimilation.

\textbf{Reduced Resolution (60km) Data Assimilation Test Runs}

ASR data assimilations with reduced resolution over a single domain (60 km, 71 vertical levels and model top at 10 mb) have been performed from 2000 to 2008 on the Ohio Supercomputer Center’s Glenn Cluster; this is known as ASR-Interim. Polar WRF (V3.2.1), WRF-Var(V3.2.1) and HRLDAS are used for the data assimilations. Full 3-hourly cycling is used.

\textbf{Data Assimilation Results}

The annual total accumulated precipitation from the ASR data assimilation and from ERA-Interim are very similar (Fig. 2). The added benefit of higher resolution with the ASR-Interim data assimilation (60 km for ASR versus ~80 km for ERA-Interim) can be seen along the mountainous west coast of North America, southeast Greenland, southeast Iceland, and western Scandinavia where more detailed and realistic features are evident in ASR. The results of the ASR data assimilation for 9 years are compared with 3-h surface observations from across the ASR domain (Table 2). Comparisons of results from ERA-Interim with 3-h surface observations are also made (Table 1). The high skill in resolving surface pressure is seen (Tables 1 and 2, Fig. 3), along with good skill for 2-m temperature (Fig. 4 and Table 1). The 10-m wind speed skill is much higher than ERA-Interim during summer (Fig. 5 and Fig. 6). The 2m temperature correlation of ASR is higher than ERA-Interim during winter time (Tables 1 and 2). ASR has better performance than ERA-Interim. These comparisons are based on observations from more than 5,000 surface stations obtained from the National Climatic Data Center (NCDC).

\textbf{Summary}

A 60 km reduced-resolution prototype assimilation of Arctic for 2000–2008 has been completed. The test results look very encouraging. To engage the community in early ASR evaluation and use, a 36-km, 3-h assimilation is planned to be completed for 2000–2010 by August 2011. Based upon the very encouraging results with the single domain data assimilation for 11 years (ASR Interim), the ASR team will perform 11 years (2000-2010) with a single domain at 10 km resolution. New versions of Polar WRF, WRF-3DVar improved by NCAR and Noah Land Data Assimilation will be used for the final run.