Arctic Precipitation as Represented in MERRA, CFSR and ERA-Interim

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Precipitation plays a key role in determining the freshwater budget of the Arctic Ocean, sea ice growth, surface albedo and the permafrost soil thermal regime. Freshwater discharge to the Arctic Ocean from Eurasian rivers has increased, due to an apparent increase in precipitation. It is recognized that increased winter precipitation, as snowfall, may be a major player in the observed warming of the soil column in parts of the Arctic, potentially hastening permafrost thaw. Experiments with coupled climate models suggest that through providing a local moisture source and by altering regional patterns of baroclinicity, reductions in Arctic sea ice extent are likely to promote altered patterns of Arctic precipitation. However, it is notoriously difficult to obtain accurate estimates of mean Arctic precipitation, let alone assess the regional character of recent trends. Part of the problem is that the station network is quite sparse, with no systemic measurement program over the central Arctic Ocean. Indeed, the station network and data quality have degraded through time due to breakup of the former Soviet Union and an increased use of automated stations. Furthermore, surface measurements are prone to large biases, linked to gauge undercatch of blowing snow and other issues, and bias adjustment procedures are fraught with uncertainty. Given these problems, atmospheric reanalyses are increasingly looked upon to provide information on variability and change in Arctic precipitation. We present here an inter-comparison and validation of Arctic precipitation as depicted in MERRA, CFSR, and ERA-Interim for the period 1979-2010. The focus is on mean annual spatial patterns, recent trends, and comparisons with station data from the Global Historical Climatology Network (GHCN).

All reanalyses capture the major known features of Arctic precipitation, including: 1) peak annual totals over the Atlantic side of the Arctic linked to the Icelandic Low and the North Atlantic storm track; 2) low annual totals over the Canadian Arctic Archipelago, eastern Siberia and the central Arctic Ocean, 3) the contrasting seasonal cycles over land (summer maximum, winter minimum) and the Atlantic sector (winter maximum, summer minimum). Preliminary findings point to generally positive trends in winter precipitation across Arctic land areas in all three reanalyses, but with considerable spatial structure. Trend patterns are most similar between MERRA and CFSR. Precipitation fields in ERA-Interim are much “patchier” in comparison to those from MERRA and CFSR.

Previous work by our group has included comparing time series of observed monthly precipitation based on the sparse Arctic station network with precipitation output from the NCEP-1, ERA-15 and ERA-40 reanalyses and satellite-derived estimates from the Global Precipitation Climatology Project (GPCN). In terms of squared correlations between time series, ERA-15 and ERA-40 were found to perform much better than NCEP-1 or the GPCP dataset. As this abstract was being written, similar analyses were being performed on output from MERRA, CFSR and ERA-Interim to assess whether performance has improved relative to the benchmarks set by ERA-40 and ERA-15. These evaluations acknowledge shortcomings inherent to the observations themselves linked to the aforementioned sparse network and biases associated with issues such as gauge undercatch of blowing snow.

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