Introduction

Reanalyses in the Arctic are widely used for model evaluation and for understanding contemporary climate change. Nevertheless, differences among reanalyses in fundamental meteorological variables including surface air temperature are large. A review of surface temperature differences is presented with a particular focus on differences in contemporary reanalyses. An important consideration is the significant differences in Arctic surfaces, including the central Arctic Ocean, the Greenland Ice Sheet, and non-glaciated land (Fig. 1).

While there is significant correlation among reanalyses in annual time series, there is substantial disagreement in mean values. For the period 1980-2013, the trend in annual temperature ranges from 0.3 to 0.7K per decade. Over the central Arctic Ocean, differences in mean values and trends are larger.

Most of the uncertainty is associated with winter months. This is likely associated with the constraint imposed by melting processes (i.e. 0°C), rather than seasonal changes to the observing system.

Greenland Ice Sheet (GrIS)

Observed surface melting over the last decade lend importance to the use of reanalyses for the GrIS for understanding processes in the context of regional and hemispheric circulation changes. Averaged temperatures indicate considerable differences in both winter and summer. Deficient topography is significant in some reanalyses. In comparisons with Summit station, discrepancies in transitional seasons are suggestive of solar zenith angle dependency issues with surface albedo.

Discussion

Differing treatments of Arctic cloud radiative processes likely influence temperature differences among reanalyses. Nevertheless, the treatment of ice sheet surfaces and sea ice in particular remain overly simplistic in reanalyses. The use and blending of sea ice data sets as boundary conditions leads to trouble. Current reanalyses do not account for spatial or interannual variability in sea ice albedo or sea ice thickness. These may both be significant factors in recent temperature trends.

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Figure 1. Different areas considered in the study. The central Arctic Ocean encompasses the region of perennial sea ice cover. The land mass for each reanalysis is used for averaging the regions on native grids.

Figure 2. Time series of annual 2m air temperature (K) from nine global reanalyses averaged for (left) the north polar region (60°N-90°N) and (right) the central Arctic Ocean.

Figure 3. Average annual cycle for the north polar cap (60°N - 90°N) for common period 1980-1993.

Figure 4. Average annual cycle for (left) 1980-1993 for the full GrIS, and (right) differences with Summit Station, 2008-2012.

Figure 5. Average wintertime temperature for 1980-1993 overlapping period.

Figure 6. Time series of sea ice data sets used in reanalyses.

Figure 7. MERRA-2 Minus ERA-I temperature for DJF (left) 1980-2004, and (right) 2010-2016. In the latter period, both reanalyses used the same boundary data.

Figure 8. Scatter of MERRA-2 minus ERA-I temperature, versus MERRA-2 minus ERA-I sea ice concentration. Each point indicates an average over the central Arctic Ocean for an individual month.