"A high spatial resolution record of near-surface temperature over WAIS during the past 5 decades"

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A network of instrumental temperature records has been available over Antarctica since the International Geophysical Year in the late 1950s. Most of the records are in coastal regions, with only a few in the interior. It has been difficult to assess temperature variability in the large gaps that exist between observing stations.

Over the past 25 years, since about 1980, atmospheric numerical models and infrared satellite measurements have allowed scientists to fill in the voids between observing stations, resulting in a spatially coherent depiction of temperature across the continent. Prior to 1980, atmospheric model temperature data are not reliable, and satellite measurements are sparse. It is clear from these techniques that temperature variability is large over a range of timescales. This noise makes it difficult to elucidate what trends exist, if any, and what may be causing them. It is desirable to extend the Antarctic temperature record back in time over the entire continent, with high-spatial resolution, so that temperature variability and trends can be assessed at regional and larger scales. For instance, a 50-year record of temperature in the Pine Island Bay region (where there are only a few years of instrumental measurements) may help glaciologists understand the large ice sheet wastage occurring there over the past decade, and to place it in a longer-term context.

Our method uses meteorological model reanalysis fields to determine zones of temperature coherence that correlate with the individual records at annual and seasonal timescales. Assuming these zones adequately cover most of the continent given the available observational records, this information can be employed to synthesize the observations into a continent-wide record of near-surface temperature in a self-consistent manner. The model reanalysis temperature dataset we use is the European Centre for Medium-Range Weather Forecasts 40-y Reanalysis (ERA-40). ERA-40 temperature is compared to independent observed records and satellite measurements for overlap periods and shown to reproduce the interannual temperature variability and trends, justifying its use for this study. Figure 1 shows a composite map of the maximum correlation coefficient obtained by correlating the ERA-40 simulated percentage annual temperature anomaly at the grid point closest to each measurement station with every other grid point. Correlations greater than 0.6 ($p<0.01$) occur over most of the grounded ice sheet, indicating that the zones of spatial coherence from the available observational records cover nearly the entire continent. We employ this robust relationship to synthesize the observational data into a series of high-spatial resolution temperature maps over all of Antarctica back to 1960. The result is a nearly 5-decade time series of near-surface temperature over the grounded ice sheet that extends our current high spatial resolution record by 2 decades.

In this study we focus on temperature variability over WAIS during the past 50 years. Basin- and regional-scale trends and time-series will be presented. The temperature reconstruction will also be compared with a recently published 50-year record of snowfall variability to assess the coherence between temperature and precipitation at basin- and larger space scales and interannual-to-interdecadal timescales. Addressing this relationship has consequences for understanding how Antarctic snowfall will change -- and thus contribute to or mitigate sea level rise - in the coming century, assuming Southern Hemisphere and Antarctic climate will warm as projected.

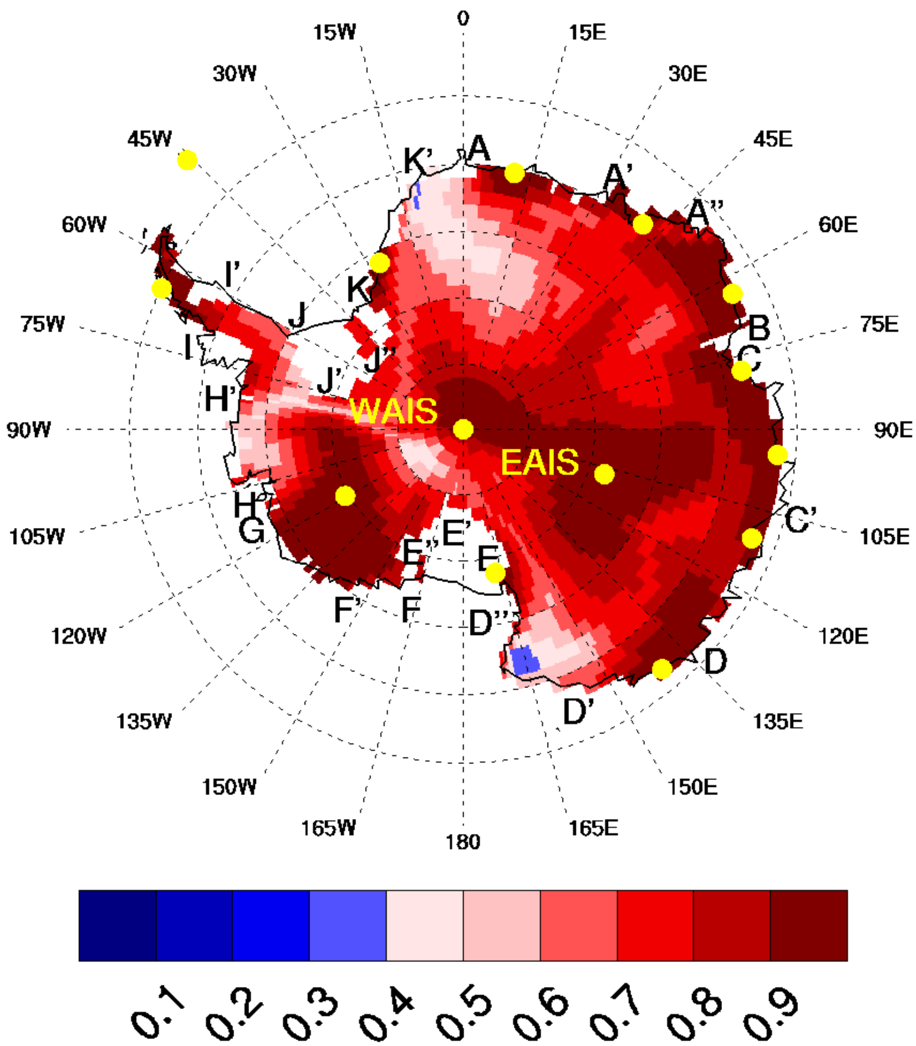

Fig. 1. The composite map of the maximum absolute value of the Pearson's correlation coefficient (|r|) resulting from correlating the ERA-40 1980-2001 percentage annual near-surface temperature change (with respect to the 1980-2001 mean) for the grid box containing each of the 14 observation sites (yellow dots) with every other 1 deg. x 1 deg. grid box over Antarctica (i.e., this map is a composite of 14 maps). Pink/red colors have correlations at $p<0.01$. The black lines delineate ice drainage basins, which are identified alphabetically by the black letters where they intersect the grounding line.