

Antarctic temperatures since 1856

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Antarctic is undergoing notable changes. The rate of warming of the Peninsula is as great as anywhere else on Earth, while cooling observed over much of East Antarctica seems enigmatic compared with the majority of the globe. These changes are significant over recent times, but it is difficult to assess the significance of these trends without long-term climate information. Antarctic is notoriously data poor in this respect. With few exceptions, the ground-based instrumental record is limited to the last ~45 years (since IGY), and satellite observations cover less than half that period. Ice core records have been used to infer longer term climate variability, but until recently have been too limited spatially and too poorly resolved temporally to provide an adequate sampling of the Antarctic atmosphere over the relatively short timescales (~decades) of interest.

Ice cores drilled under the ITASE (International Trans-Antarctic Scientific Expedition) program offer a means to correct this by providing multiple well dated cores covering the instrumental period and extending back more than 200 years. Details on the precision and accuracy of dating obtained for the US ITASE cores is given in an accompanying poster (Steig and others). We have combined oxygen and deuterium isotope records from cores from US ITASE with additional cores from the Australian and Italian programs, and earlier published work, to obtain a reconstruction of Antarctic temperature over the past ~200 years. The reconstruction is based on the calibration of these cores against the instrumental temperature data, described in detail in a second accompanying poster (Schneider and others).

Here, we present additional results from an independent assessment of Antarctic temperature variability, using extrapolar instrumental weather data as our predictor variables. This method takes advantage of the observed covariance between Antarctic temperatures and climate variability at lower latitudes. For example, temperatures in West Antarctica are significantly influenced by El Nino/Southern Oscillation variability, which is associated with large temperature variations in the tropical and subtropical Pacific. North of the Antarctic convergence, there is instrumental temperature data available for most latitudes and longitudes back to 1856 A.D., though not for all years. We filled in missing annual data using a covariance method (from T. Schneider, 2003) that is similar to conventional EOF calibration/reconstruction techniques, but takes advantage of the full covariance information by (effectively) using all EOFs but downweighting higher orders to avoid overfitting. We used the same technique to infill Antarctic instrumental weather station temperatures since 1856. We also used a more conventional reconstruction, using a simple screening of the gridded extrapolar temperature data to isolate those grid points that correlate with Antarctic mean temperature at the >95% significance level during the calibration (1961-2001) interval. These methods resolve the same fraction of interannual variance (20-50%) as the ice-core based reconstruction, and yield the same results for long term temperature change in Antarctica.

On the basis of these two independent results, we find that the last 150 years have on average seen a slight warming. Thus, recent Antarctic cooling does not represent the long-term trend. However, Antarctica appears to have warmed less significantly than the Southern Hemisphere and globe as a whole. This is possibly attributable to the large heat sink provided by the Southern Ocean. The reconstructed temperature histories also show pronounced decadal variability, a characteristic of the record which makes it difficult to demonstrate that recent cooling in the summer has been caused by anthropogenic ozone destruction, as has been proposed by others.