

Regional and continental scale Antarctic climate variability over the last 2,000 years

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Abstract

Climate trends in the Antarctic region remain poorly characterised, owing to the brevity and scarcity of direct climate observations and the large magnitude of interannual to decadal-scale climate variability. Here, within the framework of the PAGES Antarctica 2k working group, we build an enlarged database of ice core water stable isotope records from Antarctica, consisting of 112 records. We produce both unweighted and weighted isotopic ($\delta^{18}\text{O}$) composites and temperature reconstructions since 0 CE, binned at 5 and 10-year resolution, for 7 climatically-distinct regions covering the Antarctic continent. Following earlier work of the Antarctica 2k working group (PAGES 2k Consortium, 2013), we also produce composites and reconstructions for the broader regions of East Antarctica, West Antarctica, and the whole continent. We use three methods for our temperature reconstructions: i) a temperature scaling based on the $\delta^{18}\text{O}$ -temperature relationship output from an ECHAM5-wiso model simulation nudged to ERA-interim atmospheric reanalyses from 1979 to 2013, and adjusted for the West Antarctic Ice Sheet region to borehole temperature data; ii) a temperature scaling of the isotopic normalized anomalies to the variance of the regional reanalysis temperature and iii) a composite-plus-scaling approach used in a previous continental scale reconstruction of Antarctic temperature since 1 CE but applied to the new Antarctic ice core database. Our new reconstructions confirm a significant

cooling trend from 0 to 1900 CE across all Antarctic regions where records extend back into the 1st millennium, with the exception of the Wilkes Land coast and Weddell Sea coast regions. Within this long-term cooling trend from 0-1900 CE we find that the warmest period occurs between 300 and 1000 CE, and the coldest interval from 1200 to 1900 CE. Since 1900 CE, significant warming trends are identified for the West Antarctic Ice Sheet, the Dronning Maud Land coast and the Antarctic Peninsula regions, and these trends are robust across the distribution of records that contribute to the unweighted isotopic composites and also significant in the weighted temperature reconstructions. Only for the Antarctic Peninsula is this most recent century-scale trend unusual in the context of natural variability over the last 2000-years. However, projected warming of the Antarctic continent during the 21st Century may soon see significant and unusual warming develop across other parts of the Antarctic continent. The extended Antarctica 2k ice core isotope database developed by this working group opens up many avenues for developing a deeper understanding of the response of Antarctic climate to natural and anthropogenic climate forcings. The first long-term quantification of regional climate in Antarctica presented herein is a basis for data-model comparison and assessments of past, present and future driving factors of Antarctic climate.

Keywords: Ice cores, Antarctica, last 2000 years, stable water isotopes

References

PAGES 2k Consortium, 2013. Continental-scale temperature variability during the past two millennia, *Nat. Geosci.*, 6, 339-346, Published online 21 April 2013, doi: 10.1038/NGEO1797.