

SCAR Fellowship Report 2005-06

David P. Schneider
University of Washington, Seattle, WA, USA

Institution visited

University of Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre,
Hobart, Australia

Host scientist: Dr. Tas D. van Ommen

Dates

October – December, 2005
One additional visit planned in July, 2006

Work towards scientific objectives of the fellowship: “Developing high-resolution ice core proxies of the Southern Annular Mode”

The purpose of the fellowship was to undertake collaborative work on developing ice core based proxies of the Southern Hemisphere Annular Mode (SAM), which is a major source of climate variability in the Antarctic. Several questions were raised in the proposal as research objectives and these are repeated in italics below. Most of the questions were addressed, as illustrated by the project’s major findings:

How do high-resolution signals in isotopes and chemistry vary between the West Antarctic ice cores and the Law Dome site? What is the relationship between the SAM and the ice core data at each site and how does it differ among sites? Is a more robust SAM proxy gained by combining records from multiple sites and by using multiple species? Do the relationships vary in time over the calibration period? How far back in time can the existing ice cores be used as a basis for reconstruction of the SAM and at what temporal resolution?

(1) The SAM is a dominant source of interannual to decadal scale variability in stable isotopes from cores widely spaced across the continent. Mechanisms associated with the SAM contribute to the covariance of temperature anomalies and isotope anomalies. Furthermore, comparison with independent indicators of SAM variability shows that the SAM signal in isotopes is consistent through time, at least back to 1900.

(2) Certain major ion chemistry species (especially Mg, Na, K) at Law Dome show statistically significant correlation with the SAM index that is as high as the isotope correlation over the overlapping instrumental record period of 1961-1999. However, the relationship is not consistent through time back to 1900. Using the log of the ion concentrations makes little difference, while fluxes were not calculated. Likewise, the

principal component of the suite of chemistry measurements also shows little improvement in the SAM correlation as compared with a single species like Mg or Na.

(3) Combining isotopes from multiple cores and chemistry from Law Dome yields a high correlation with the SAM index that could be the basis for a proxy based reconstruction. However, given the observed change in sign of the chemistry correlation and the lack of currently available chemistry data from other sites, more data analysis and interpretation will be needed before this step can proceed.

(4) There is a compelling decadal scale anti-correlation of the MSA record at Law Dome and the isotope based temperature reconstruction. The MSA record has been interpreted as an indicator of sea-ice extent. Some inconsistency in the measurements previously hindered confidently interpreting the MSA record prior to 1850, a period in which the record shows remarkable changes. However, there is a strong anti-correlation of the temperature reconstruction and the MSA record back to 1800. This suggests a maximum in sea-ice extent and a minimum in temperature in the ~1850 to 1880 period. This timing is consistent with the existing reconstructions of temperatures on hemispheric and global scales.

Milestones and deliverables

Results will be presented at conference talks and papers in progress. We will work towards reconstructions of the SAM. This work is collaborative in nature, and the fellowship has been successful in facilitating the necessary collaboration.

Additional work conducted

Considerable progress was made on revising a paper presenting an isotope based reconstruction of Antarctic temperatures that was started prior to the fellowship period. During the fellowship period, new data from a regional climate model were incorporated into the paper. These data helped tremendously by verifying and illustrating the climate signals found in the stable isotope record. Other work not explicitly included in the plan was led by the host scientist, who worked towards an improved model of isotopic diffusion to estimate the amount of signal loss in high-resolution δD and $\delta^{18}O$ time series. Lastly, an in press paper presented at the SCAR conference in 2004 was finalized for publication.

What SCAR funds were allocated?

\$10000 was awarded to the fellow.

How were the SCAR funds spent?

The original budget request was for \$7750 to cover a ten-week visit to Hobart. About \$6500 was actually spent on the visit, with the greatest categories of expenses being transportation, accommodation, and food. Plans are to spend the remaining funds for

participation in the SCAR Open Science Conference in Hobart in July. This will cost about \$3000. Extra time will be arranged for a follow-up visit with the host scientists, outside of the conference time. Any remaining funds will be allocated to anticipated publication fees resulting from the work.

Future work plans.

Work will continue on investigation of the MSA – isotope connection and the evaluation of the SAM signal in chemistry data. These results will be presented as a poster at the SCAR Open Science Conference and incorporated into a new manuscript for submission to a peer-reviewed publication shortly thereafter. The current line of research can be considerably expanded through the use of general circulation models with isotopic tracers to train reconstructions. An expanded synthesis of ice core isotopic and chemistry data is also recommended, as this would allow the signals in the records relating to the SAM to be fully exploited and combined in a physically defensible and statistically sound multi-proxy reconstruction.

Publications:

Schneider, D.P., E.J. Steig, T. van Ommen, C. Bitz, D. Dixon, P.A. Mayewski, and J. Jones: Temperatures in Antarctica over the past two centuries, in review.

Schneider, D.P., T. van Ommen, and M.A.J. Curran, “On the covariance of Antarctic ice core chemistry and stable isotope records and the Southern Hemisphere Annular Mode,” in preparation.

Talks given:

Schneider, D.P., 2005: Is Antarctica cooling? Ice core records have the answer. Antarctic Climate and Ecosystems Cooperative Research Centre, November, Hobart, Tasmania, Australia.

Upcoming talks:

Schneider, D.P., 2006: Long-term temperature trends in Antarctica: The view from ice cores. Workshop on Antarctic Peninsula climate variability: Observations, models, and plans for IPY research, Boulder, CO, 14-16 May, 2006.

Schneider, D.P., 2006: Ice core based Antarctic temperature reconstruction, SCAR Open Science Conference, Hobart, Australia, 12-14 July, 2006.