Reconstructing annual Antarctic accumulation from water isotopes

C. Genthon, G. Delaygues, LGGE
C. Risi, S. Bony, LMD

There are large discrepancies in the predictions of Antarctic precipitation change by the IPCC climate models (Genthon et al. 2009). There are also very few records of the present Antarctic precipitation or accumulation that resolve the annual time scales, to verify models ability to reproduce precipitation variability at such time scales. In addition, “small scale noise” (SSN, Genthon et al. 2005) due to deposition and post-deposition processes limits the spatial significance and reliability of a record from a single site.

The new laser spectroscopy techniques (cavity enhanced absorption spectroscopy, CEAS) make possible on-the-field water isotopes analyzes of shallow snow or ice cores. By avoiding the shipping of large quantities of frozen samples back to the laboratory for conventional (i.e. mass spectrometer) analyzes, this allows for a much larger number of time series retrievals. More series can thus be averaged to smooth out SSN. Also, the strategies for optimal spatial sampling may be adapted on the field based on the records being obtained.

LMDZ-ISO is an atmospheric general circulation model which simulates the hydrological cycle of various stable water isotopes in addition to plain H2O (Risi et al. 2010). The model shows that the isotopes clearly trace seasonality in Antarctic precipitation, albeit not with the same amplitude everywhere (figure below). If this is preserved in the snow, then it is possible to reconstruct annual accumulation from isotopes in the surface snow. Although the model yet ignores most of the processes that blur the isotopic signature during and after deposition, it provides a preliminary insight at where in Antarctica the annual accumulation is most likely to be accurately evaluated from the isotopic composition of shallow cores. Although the isotope seasonality is stronger in the remote interior of the ice sheet, it is likely that the clearest signals can be found near the coasts where accumulation is largest. This is also where climate models need be most urgently validated since this is where changes in snow accumulation will most affect sea-level (Genthon et al. 2009).

Genthon et al. 2005. Interannual variability of the surface mass balance of West Antarctica from ITASE cores and ERA40 re-analyses, Climate Dyn. 24, 759-770, DOI: 10.1007/s00382-005-0019-2.

Genthon et al. 2009. Antarctic precipitation and climate change predictions: Horizontal resolution and margin vs plateau issues, Annals of Glaciology 50, 55-60.

Risi et al. 2010. Water stable isotopes in the LMDZ4 General Circulation Model: model, evaluation for present day and past climates and applications to climatic, interpretations of tropical isotopic records, J. Geophys. Res., doi:10.1029/2009JD013255, in press.