Atmospheric controls on water stable isotopes in Antarctica

The project aims at a better understanding of the complex relationship between stable isotopes in Antarctic precipitation and the air temperature at the deposition site in order to improve both the paleclimatic interpretation of ice core data and the parameterization of isotopic fractionation in models of various scales.

At the German Antarctic wintering base "Neumayer", continuous measurements of water vapor stable isotopes will be carried out using a cavity ring-down spectrometer (CRDS) during Austral summer 2017/18. These measurements will be complemented by sampling of surface snow twice daily both during precipitation and between precipitation events. Neumayer is a fully equipped meteorological station including a meteorological mast and daily radiosonde launches. Thus the measured isotope data can be related to the meteorological conditions. To put these field measurements into a long-term temporal perspective, the unique data set of isotope ratios of Neumayer fresh snow samples will be used. Fresh snow samples have been taken at the end of major precipitation events since 1981. Since 2013, an extra sample for the analysis of the 17O excess has been taken. So far, the 17O excess is poorly understood, and this study under well-known meteorological conditions will yield a deeper insight into the relationship between 17O excess of Antarctic snow/ice and moisture source conditions.

The stable isotope ratios of the snow samples can be related to the meteorological data, too, in particular to the conditions at the moisture source, which is determined by calculating back-trajectories from 2001 on also with a mesoscale atmospheric model (AMPS and RIP4). This model, organized in AMPS (Antarctic Mesoscale Prediction System), is also used for an analysis of the synoptic situation associated with the precipitation events. AMPS employs Polar WRF, a high-resolution mesoscale atmospheric model that was adapted for polar regions and is run by the National Center for Atmospheric Research, Boulder, Colorado, and the Polar Meteorology Group of The Ohio State University. (Possibly, parallel trajectory calculations with FLEXTRA, a Lagrangian transport model.) The isotope data will also be compared to simulations with isotopic General Circulation Models (GCM) (ECHAM 5, LMDZ-iso).

in the context of the synoptic analyses and trajectory studies also an investigation of humidity and temperature inversions will be carried out. In ice core studies, often the stable isotope ratio is related to the temperature at the top of the inversion layer, which is supposed to be close to the condensation level. This is a very strong simplification as in only about 50% of the cases the vertical temperature and humidity profiles were parallel and also advection seems to play a much more importan role than previously thought.

The project will be carried out in close cooperation with Valérie Masson-Delmotte and Amaelle Landais (LSCE), Hans Christian Steen-Larsen (NBI), Jordan Powers and Kevin Manning (NCAR), and Martin Werner (AWI).

The results of the project will ultimately lead to a better quantitative interpretation of ice core data.