Deuterium excess of Antarctic snow and precipitation origin

Investigation and a thorough understanding of the climate of the past are necessary to assess the present or future possible climate changes. Valuable information about the former climate is stored in ice cores from the large ice sheets of Greenland and Antarctica. In particular, the ratio of stable isotopes (different types of water molecules) of snow, 18-O and deuterium, are related to air temperature and are thus used for the climatic interpretation of the ice cores.

However, the isotope content does not depend on the temperature alone; other factors, such as seasonality and origin of precipitation are also important. To resolve this problem, a variable combining 18-O and deuterium information and known as deuterium excess, d, is used to study the source areas of precipitation. The value of d is mainly determined by sea surface temperature, relative humidity, and wind speed in the source area. By testing under which assumptions for the prevailing conditions in the source area the d values found in snow can be reproduced by simple isotope models, information about the source area can be obtained. The range of possible values for these variables is surprisingly small. Most of the studies devoted to deuterium excess are on large time scales (glacial to interglacial changes).

In this study, data from the German Antarctic base „Neumayer" will be used for a study on a small time scale. Samples of freshly fallen snow have been collected over a period of 20 years. High wind speeds at Neumayer often tend to redistribute the fallen snow to a certain extent, leading to some „depositional noise". Therefore, a trajectory model is first used to calculate the pathways of the airmasses that bring precipitation to Neumayer. Different trajectory classes will be defined and the mean deuterium excess of the snow for these classes will be calculated. An isotope model will then be used to model the observed deuterium excess values of the snow samples. Since the deuterium excess depends strongly on water vapor saturation conditions at the source area of precipitation, which are mostly unknown, further the phase difference between deuterium and deuterium excess will be investigated using data from several shallow firn cores that cover the time period 1892-1997. This phase difference is less dependent on the relative humidity in the source area and is thus a more independent constraint from which to infer information on the vapor source contained in the excess. This new approach of combining a trajectory model with an isotope model and studying the deuterium excess on a precipitation-event base will improve the classical interpretation of water stable isotopes in ice cores.