Stable Isotopes in Antarctic Firn

The study of ice cores from the Greenland and Antarctic ice sheets is one of the most successful methods in climatological research. To be able to understand a possible ongoing climatic change and the possible anthropogenic element in it, a thorough knowledge and understanding of the climatic changes of the past is required. One of the crucial ice core properties for climate studies is the ratio of stable oxygen isotopes (different types of oxygen molecules) of the snow and ice, the so-called delta-18-O. This ratio is fairly well correlated to the annual mean air temperature of the deposition site, although it depends in a complex way on the source and distance to the source of precipitation and physical processes during the moisture transport to the deposition site of the snow. However, for a correct interpretation of the delta-18-O profiles of the cores in terms of temperature, we need to gain more insight into the atmospheric conditions and transport mechanisms that lead to the stable isotope ratio observed in the cores. The main problem is here, that ice cores are usually taken in remote areas, for which no meteorological data are available. At the German Antarctic base "Neumayer", extensive glacio-meteorological studies have been carried out during the past two decades. Weekly readings of snow height were complemented by sampling snow pits and shallow firn cores as well as freshly fallen snow, whose isotope contents were analysed. Neumayer is also a meteorological observatory for which routine observations of all important meteorological parameters including radiosonde (weather balloons) measurements are available. Thus here we could study the relationship between stable isotopes in firn/ice and the meteorological conditions of the drilling/sampling site, the latter meaning both the prevailing weather at the site and the general weather situation and thus the atmospheric transports. To study the transports, a computer model was used that calculated the transport paths of an air particle, so-called trajectories, for five days backwards, thus yielding information about the origin of precipitation which is important for the relationship between temperature and stable isotopes.

In the frame of the European ice core project EPICA, an ice core is taken on the high plateau about 550km SSE of Neumayer. For the interpretation of this core our study will be helpful. It was found that, at Neumayer, the distribution of snowfall during the year has a large influence on the annual mean delta-18-O value (e.g. a higher contribution of winter snow to the annual mean leads to a too low delta-18-O value and v. v.) This can be important for the interpretation of deep ice cores at the transition between an ice age to a warmer climate, since systematic changes in the atmospheric circulation might have changed precipitation patterns which results in misinterpretations of the delta-profile in the core.

The relationship between temperature and isotopes is also influenced by the origin and transport paths of the moist air. The calculated trajectories were divided into five different classes. The best correlation between temperature and delta-18-O was found for short trajectories and those ones that were situated over sea ice or the

continent. The worst correlation was seen for long trajectories from the NW that led above open water for longer time periods, since above the ocean, more evaporation and condensation processes occur that alter the isotope ratio. This is important especially for the EPICA core, since weather situations with such long transports of warm, humid air from the NW can bring a large percentage of the yearly snowfall at the drilling site, which can cause errors in the temperature interpretation.