Lower troposphere thermal inversion as source of seasonal disruption in stable water isotope profiles in the Filchner-Ronne Ice Shelf

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Abstract

Antarctic ice shelves have shown to be thinning at increasing rates. Although the Filchner-Ronne Ice Shelf resides in the south of Weddell Sea, where cold conditions prevail, it has been suggested that changing ice conditions during the next century will affect its stability. To know the current state of this ice shelf, it is necessary to consider how it has evolved in the recent time. This can be achieved by studying different proxy records. This records can be used to produce accurate chronologies of variations in meteorological parameters, which in turn can be used to precisely estimate snow accumulation rates in the recent past.

In the eastern part of the Ronne Ice shelf, more than twenty firn cores and snow pits were made between 1983 and 1995, providing valuable information to reconstruct variations for over half of a century. Their resolution and their gridded spatial distribution make them suitable to obtain trends in the snow accumulation rate, based on the $\delta^{18}O$ content over a wide region of the Ice Shelf. However, the lack of a consistent seasonal cycle in a suite of species, the development of post-depositional processes (such as erosion and deposition) and the presence of alternate peaks during the year cycle, can induce to errors in the age models.

In this work, we use meteorological data (station and radiosonde measurements) and stable water isotope profiles from snow pits and firn cores to explore the relation between a deep thermal inversion over the ice shelf and the development of intra-seasonal peaks in the stable water isotope record. A significant direct relation exists between both parameters during the 80's decade, suggesting that the intensity of the thermal inversion is, in part, a driver in the disruption of the seasonal cycle recorded in the stable water isotopes in the snow.

In spite of their ambiguous nature, recognizing these peaks can be a source of information to reconstruct the intensity of the thermal inversion in the recent past. Identifying the presence of these peaks and understanding the processes behind their apparition is essential to avoid inaccurate chronologies in records with high temporal resolution in this region. In this work, we present an interpretation of how the thermal inversion can affect the stable isotope record, as well as the possible relation with the Amundsen Sea Low (ASL) and the Southern Annular Mode (SAM). Furthermore, we highlight the importance of incorporating several chemical species in the process of building a chronology as some of them could be influenced by processes that affect a distinctive seasonal cycle.

Keywords: Stable isotopes, firn cores, thermal inversion, Filchner-Ronne Ice Shelf