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Gas loss effect in deep ice cores: consequences for ice core dating

Content

Deep Ice core chronologies strongly rely on measurements of gas trapped in ice cores. On the one hand, absolute dating constraints can be obtained from the measurements of d40Ar in the air trapped in ice core because of the progressive radioactive decay of 40K leading to 40Ar outgassing in the atmosphere. Because of the small increase in d40Ar with time (0.066 permil / million of years), this method is only useful for old periods and requires a very high analytical precision for the d40Ar measurements. On the other hand, orbital dating constraints can be obtained through the measurements of elemental and isotopic composition of dioxygen (dO2/N2 and d18O of O2) as well as total air content and comparison with insolation curves. These measurements provide dating constraints all along the deep ice cores but matching the records with insolation curves may be complicated during period of low eccentricity. Moreover, it has long been shown that dO2/N2 and d18Oatm are significantly affected by gas loss removing preferentially O2 than N2 during ice storage, an effect which can also affect d40Ar since Ar is also lost during ice storage.
We present here a compilation of published and unpublished data of elemental and isotopic composition of O2 and Ar in deep ice cores which should be used for dating constraints. We show how these data sets are affected by gas loss and how this affects the uncertainty in ice core dating. We present as well some conclusions and recommendations for the coming deep ice core drillings.

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Track Classification: The Oldest Ice challenge, and the preservation of climatic signals in the deepest ice