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Constraining N_2O emissions over the last century by firn air isotope measurements in both hemispheres

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N_2O is a greenhouse gas that it is responsible for increased radiative forcing of the climate system. In addition to this, it is primarily destroyed in the stratosphere providing an important source of NO_x, which in turn plays an important role in ozone depletion. Large uncertainties remain as to the actual strength of the individual sources of N_2O. Knowledge of the historical record, of the temporal evolution of N_2O emissions, can provide insight on how its sources and sinks altered during the industrial period. Data from air trapped in firn enables us to better determine the source/sink strength emissions over time.

In this study we analyze firn measurements on ^{15}N, ^{18}O and position dependent ^{15}N isotopic composition of N_2O, from both hemispheres, combining new and previously published data, in order to constrain the N_2O budget. From the Northern Hemisphere we use data from North Greenland Ice core Project (NGRIP) and North Eemian Ice core Project (NEEM) and for the Southern Hemisphere we use data from Berkner Island (BI), Dronning Maud Land (DML) and Dome Concordia (DOME C). Results show that the isotopic composition of ^{15}N, ^{18}O of N_2O is presently more depleted which indicates a strong depleting source contribution probably originating from agricultural activities.

The LGGE-GIPSA firn air diffusion model allows single site reconstructions, as well as using all data together in a multi-site inversion, in order to reconstruct the temporal evolution of N_2O and its isotopic composition. We investigate the consistency between the different datasets and present a best-guess isotope history based on the firn air data. A simple two-box atmospheric model is applied in order to simulate the N_2O atmospheric contribution from different sources and sinks.