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Constraints on N_2O budget changes since pre-industrial time from new firn air and ice core isotope measurements

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Abstract. A historical record of changes in the N_2O isotope composition is important for a better understanding of the global N_2O atmospheric budget. Here we have combined measurements of trapped gases in the firn and in ice cores of one Arctic site (North GReenland Ice core Project - NGRIP) and one Antarctic site (Berkner Island). We have performed measurements of the ^{18}O and position dependent ^{15}N isotopic composition of N_2O. By comparing these data to simulations carried out with a firn air diffusion model, we have reconstructed the temporal evolution of the N_2O isotope signatures since pre-industrial times. The decrease observed for all signatures is consistent from one pole to the other. Results obtained from the air occluded in the ice suggest a decrease of about -2.8, -2.4, -3.2 and -1.6 for $\delta^{15}N$, $^1\delta^{15}N$, $^2\delta^{15}N$ and $\delta^{18}O$, respectively, since 1700 AD. Firn air data imply a decrease of about -1.1, -1.2, -1.0 and -0.6 for $\delta^{15}N$, $^1\delta^{15}N$, $^2\delta^{15}N$ and $\delta^{18}O$, respectively, since 1970 AD. These results imply consistent trends from firn and ice measurements for $\delta^{15}N$ and $\delta^{18}O$. The trends for the intramolecular distribution of ^{15}N are less well constrained than the bulk ^{15}N trends because of the larger experimental error for the position dependent ^{15}N measurements. The decrease in the heavy isotope content of atmospheric N_2O can be explained by the increasing importance of agriculture for the present atmospheric N_2O budget.

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