The impact of stratosphere-troposphere exchange on atmospheric nitrous oxide (N_2O) and its isotopic budget in the troposphere

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Nitrous oxide (N_2O) is the third most important anthropogenic greenhouse gas (GHG) in the atmosphere and a major ozone depleting substance (ODS) in the stratosphere. Although major N_2O sources are known, the magnitudes of individual sources, *i.e.*, ocean, natural soil, and anthropogenic activities, are highly uncertain. N_2O isotopologues increasingly have been used to investigate the magnitudes of N_2O sources and sinks. Balloon and aircraft measurements show that stratospheric N_2O is isotopically enriched because the light N_2O isotopologue is preferentially photolyzed compared to the heavier isotopologues. On the other hand, terrestrial N_2O sources contain relatively more of the lighter isotopologue than mean tropospheric N_2O.

An accurate model representation of stratospheric photochemical loss and stratosphere-troposphere exchange (STE) is critical for the atmospheric budget of N_2O and emissions estimates. The inclusion of N_2O isotopes in 3-D model simulations will provide key additional elements in constraining the N_2O emissions using the atmospheric N_2O isotopic budget. We will conduct a 3-D model simulation of N_2O, its primary isotopologue (($^{14}N^{14}N^{16}O$) and three heavier isotopologues ($^{14}N^{14}N^{18}O$, $^{14}N^{15}N^{16}O$ and $^{15}N^{14}N^{16}O$) using the NASA Goddard GEOS-5 Chemistry Climate Model. The modeled N_2O will be compared with observations collected during the NASA Atmospheric Tomography Mission (ATom) available deployments, as well as early airborne missions, to evaluate the representation of STE on N_2O and its impact on atmospheric distribution and variability of N_2O. We will use the N_2O STE isotopologue tracers to track the stratospheric enrichment variations through the tropopause to the surface. These isotopologues will provide information on the stratospheric influx contribution to the tropospheric isotopic composition for $\delta^{18}O$ and $\delta^{15}N^{bulk}$.

Key words: N_2O, nitrous oxide, isotope, stratosphere-troposphere exchange