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The effect of local sources on the isotopic composition of nitrous oxide in the tropical free troposphere and tropopause layer

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We present measurements and analysis of the complete isotopic composition of nitrous oxide ($\delta^{15}N^{bulk}$, $\delta^{15}N^{\alpha}$, $\delta^{15}N^{\beta}$, and $\delta^{18}O$) in whole-air samples collected in the tropical free troposphere and the tropical tropopause layer (TTL) aboard the NASA DC-8 and WB-57 aircraft as part of the Costa Rica Aura Validation Experiment (CRAVE) and Tropical Composition Cloud and Climate Coupling (TC4) campaigns in 2006 and 2007, respectively. The measurements show that for $\delta^{18}O$ the vertical profile has structure throughout the troposphere, implying a significant local influence. Using a modified Keeling plot approach, we determine that the isotopic composition of the local source during the 08 August 2007 DC-8 flight from the TC4 campaign is more consistent with an ocean source than with a soil source. Further evidence of the influence of the ocean on the isotopic composition of N_2O in the tropical troposphere is obtained through tracer-tracer plots of the isotopic composition, especially $\delta^{18}O$, with common tracers of marine influence that were measured in the whole-air samples. We further demonstrate that there is a strong and significant anti-correlation between the isotopic composition and ethane in samples influenced by an industrial plume. This set of measurements demonstrates that useful measurements of the variability of the isotopic composition of tropospheric N_2O are possible at currently attainable precision and that this variability is a useful tool in investigating the sources of this important greenhouse gas. This suggests that a large scale measurement campaign of N_2O isotopic composition would be useful in constraining the N_2O budget and its biogeochemical cycling.