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Vertical profile and diurnal variation in ozone isotopic enrichment from the middle stratosphere to lower mesosphere

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Ozone has the largest oxygen isotopic enrichment of approximately 10–15 % in oxygen-included species in the atmosphere. The oxygen isotopic enrichment transfers to other species including CO_2, N_2O, NO_2, NO, ClO, HO_2, and OH via chemical reactions [e.g., Lyons, 2001], thus ozone is a source of oxygen isotopic enrichment in the atmosphere. Oxygen isotopic enrichments in ozone in the lower and middle stratosphere were observed by in-situ measurements using mass spectroscopy and FTIR spectroscopy [e.g., Krankowsky et al., 2007, Irion et al., 1996]. To use oxygen isotopic enrichment as a strong tracer for atmospheric chemical and physical processes, it is required to understand distribution and behavior of ozone isotopic enrichment in global scale. Satellite remote sensing of ozone isotopic enrichment is essential for this purpose.

We derived the vertical profile of oxygen isotopic enrichment in asymmetric 18 ozone (δ^{18}OOO) from the middle stratosphere to the lower mesosphere using the atmospheric limb emission spectra acquired by the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES). The retrieval algorithm was optimized for ozone isotopic enrichment which is named TOROROS [Sato et al., 2014]. The TOROROS algorithm was based on the least-squares method with a stringent a priori constraint from knowledge of ozone isotopic enrichment. The spectral frequency region was set for each ozone isotopomers and isotopologues to minimize interference from spectral lines of other molecules.

The vertical profile of the δ^{18}OOO showed an increase and decrease with increasing altitude in the stratosphere and mesosphere, respectively. The δ^{18}OOO peak, of about 20 %, was located at the stratopause. The values and behaviors of the δ^{18}OOO are consistent with the past measurements and theoretical predictions in the stratosphere. The diurnal variation in δ^{18}OOO was also observed from the middle stratosphere to the lower mesosphere. In the middle stratosphere, δ^{18}OOO increased during the day with amplitudes of approximately 3.5 % and 2.2 % at 32 and 37 km, respectively. No significant variation was observed in the upper stratosphere and lower mesosphere, although δ^{18}OOO tended to decrease during the day with increasing altitude. This trend was opposite to that observed in the stratosphere and was reproduced by the estimation with isotopic fractionation due to the ozone photolysis.

The retrieval algorithm was improved for derivation of oxygen isotopic enrichment in asymmetric 17 ozone (δ^{17}OOO). The primary results of δ^{17}OOO are also shown in this presentation.