Determination of internal distribution of 17O in ozone: Implication for Earth's atmosphere

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In the Earth's atmosphere, mass independent isotope effect in oxygen was first observed in two isotopomers of ozone: 50O3 and 49O3 in which one 16O-atom is substituted by 18O and 17O respectively. Both stratospheric and laboratory ozone shows this unique isotope effect where both d17O and d18O are highly and equally enriched. In the atmosphere, this strange isotope effect gets transferred from ozone to various other oxygen bearing species like CO2, N2O, nitrate and sulfate aerosol. In order to explain the mass independent anomaly in these molecules quantitatively, the isotopic composition of O atom coming from O3 dissociation needs to be known.

Earlier studies show that the internal distribution of 18O is different at the central and terminal position within a triangular ozone molecule. For 50O3 species, the d18O enrichment in asymmetric species (when 17O/18O present at the terminal position) is more than the symmetric species (when 17O/18O present at the central position) but with a large uncertainty in data. But there is no study for 17O because of its very small abundance.

We have investigated the internal distribution of 17O isotope in ozone isotopomers by oxidation reaction of ozone with silver. In this method, the isotopic composition of starting ozone and oxygen collected from silver oxide was used to calculate the 17O distribution.

Our result shows that the 17O-distribution inside ozone molecule is not uniform. The abundance of 17O is higher at terminal position as compared to the central position. Moreover, the distribution is not same for both 18O and 17O. It has been shown for the first time that, at the terminal position the abundance of 17O is more than that of 18O. This study shows that the isotopic composition of O atom coming from ozone (either during photo dissociation or chemical reaction) is not same as that of ozone composition. This result would be helpful in developing the new models to explain the anomalous enrichment in other oxygen bearing species in the atmosphere.