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Temporal variations of O3 and NO in the middle atmosphere above Syowa Station observed by a millimeter-wave radiometer

OHYAMA, Hirofumi[1*] ; ISONO, Yasuko[1] ; UEMURA, Miku[1] ; NAGAHAMA, Tomoo[1] ; MIZUNO, Akira[1] ; TSUTSUMI, Masaki[2] ; EJIRI, Mitsumu[2] ; NAKAMURA, Takuji[2]

[1]Solar-Terrestrial Environmental Laboratory, Nagoya University, [2]National Institute of Polar Research

Precipitation of energetic particle into the atmosphere impacts abundances of atmospheric constituents in the middle atmosphere. Highly energetic solar protons, which directly enter the middle atmosphere, cause increase of HOx and NOx species. Energetic electrons also increase NOx in the thermosphere, and the downward transport in the polar vortex moves the produced NOx to lower altitudes. These NOx species cause a decrease of O_3 in the middle atmosphere through catalytic reactions [Seppälä et al. 2006; Daae et al., 2012]. To investigate the effect of NOx on O_3 variation in the polar region, a ground-based millimeter-wave spectroscopic radiometer was installed at Syowa Station, Antarctica in March 2011. The instrument has recorded brightness temperature spectra of rotational emission from the atmospheric O_3 and NO molecules. From the NO spectra, both multiple short-term enhancements and seasonal variation of NO column are observed [Isono et al., 2014]. The short-term enhancements are correlated with the energetic particle precipitation. In the present study, O_3 profiles are retrieved from the brightness temperature spectra between 238.94-239.24 GHz, whose spectral range has sensitivity to the O_3 abundance between 20 and 70 km. The optimal estimation scheme is used for the O_3 profile retrieval, along with radiative transfer calculation through the use of the NCEP reanalysis data and spectroscopic parameters. Since the O_3 spectra are integrated over 1 hour every 6 hours, we usually derive four O_3 profiles in a day. We present the result of O_3 retrieval and discuss how the O_3 mixing ratios at given altitudes response to the short-term NO column enhancement.

Keywords: ozone, nitric oxide, remote sensing