The Effect of the Arctic Ozone Depletion Observed at Tsukada, Japan in February 2001 (Extended Abstract)

Tôhoku Geophys. Journ. (Sci. Rep. Tôhoku Univ., Ser. 5), Vol. 36, No. 4, pp. 498-500, 2003

The Effect of the Arctic Ozone Depletion Observed at Tsukuba, Japan in February 2001 (Extended Abstract)

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(Received February 10, 2003)

1. Introduction

Considerable ozone depletion has been observed in the Arctic polar vertex since 1990s [e.g., Newman *et al.*, 1997]. Because of the strong planetary wave activity in the Arctic region, the edge of the polar vortex occasionally attains to mid-latitudes. In this paper, we investigated the effect of the Arctic ozone depletion in the mid-latitude region from the correlation analysis of O_3, HCl, HNO_3 and HF vertical column densities observed at Tsukuba, Japan (36.0°N, 140.1°E) with a high-resolution Fourier transform infrared spectrometer (FTIR).

2. Observation and Analysis

The vertical column densities of O_3, HCl, HNO_3, and HF were observed since December 1998. The spectral resolution of the FTIR (Bruker 120M) is 0.0035 cm^{-1}. The spectral fitting algorithm to derive the vertical column densities is based on SFIT [Rinsland *et al.*, 1984, 1996] and is improved with a vertical shift procedure of the initial profile to minimize the residual of the spectral fitting. The derived O_3 vertical column densities agree with those observed by the Dobson spectrometer at the nearby (1 km apart) station within differences of 2 to 3%. The spectra measured from December 1998 to October 2001 are used in this analysis.

3. Results and Discussions

Correlations of column density variations between pairs of O_3 and HF, HCl and HF, and HNO_3 and HF are good indicators of the chemical changes of O_3, HCl, and HNO_3. These four species are all distributed mainly in the stratosphere. One of these species, HF is chemically very stable and hence a good tracer of the transport process. The other species, O_3, HCl, and HNO_3 are also relatively stable in the chemical processes in

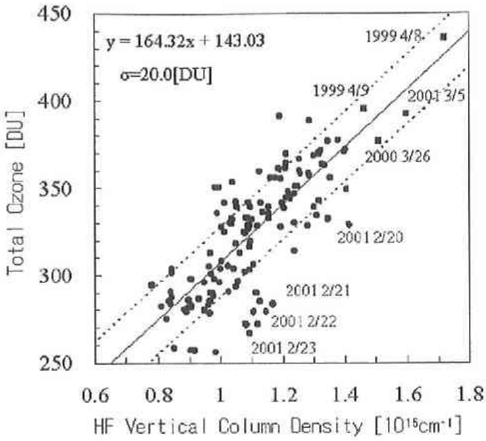

Fig. 1. Correlation of O_3 and HF.

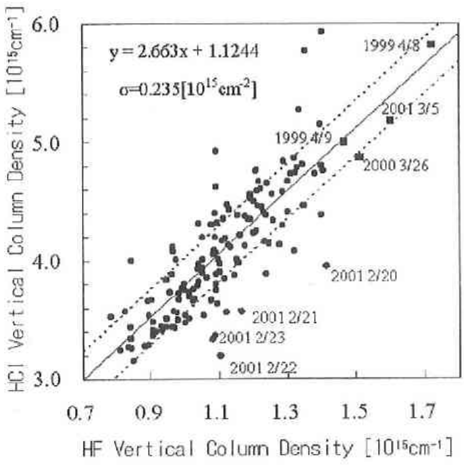

Fig. 2. Correlation of HCl and HF.

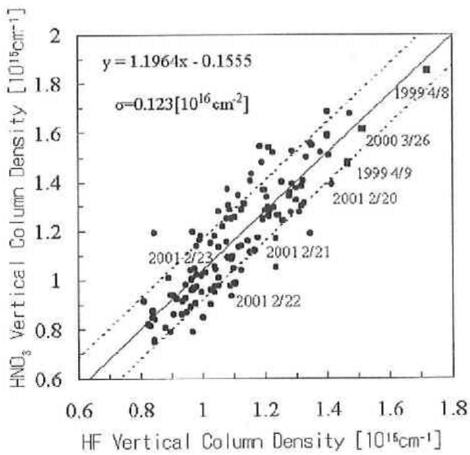

Fig. 3. Correlation of HNO_3 and HF.

mid-latitudes. Therefore, variations in the column densities of these three species and HF usually show positive correlations. Figures 1 to 3 show the correlation plots of O_3 and HF, HCl and HF, and HNO_3 and HF, respectively. Generally we can find positive correlations in all three figures. Blue squares and red circles represent the events when the edge of the polar vortex attained around Japan. The larger column densities were observed in all four species on April 8 and 9, 1999, March 26, 2000, and March 5, 2001 but the correlations showed no significant variations (blue squares), indicating no chemical ozone depletion. The correlations of O_3 and HCl to IIF on February 20 to 23, 2001 (red circles) are found to be lower than in other periods. It is indicated that O_3 and HCl on these days were chemically depleted. However, the correlation between HNO_3 and HF showed no significant variations, which means that there remained no evidence of denitrification. A potential vorticity analysis showed that Tsukuba was located in the boundary region of the polar vortex on these days. Figure 4 shows the potential vorticity maps at the potential temperature of 475 K on February 20 and February 10, 2001 with the 10 days backward trajectory from February 20 in an example. The backward trajectory analysis indicated that the observed air masses at the potential temperatures of 475 K and 550 K came from inside the polar vortex. It is suggested that the chemically perturbed air masses arrived above Japan due to the

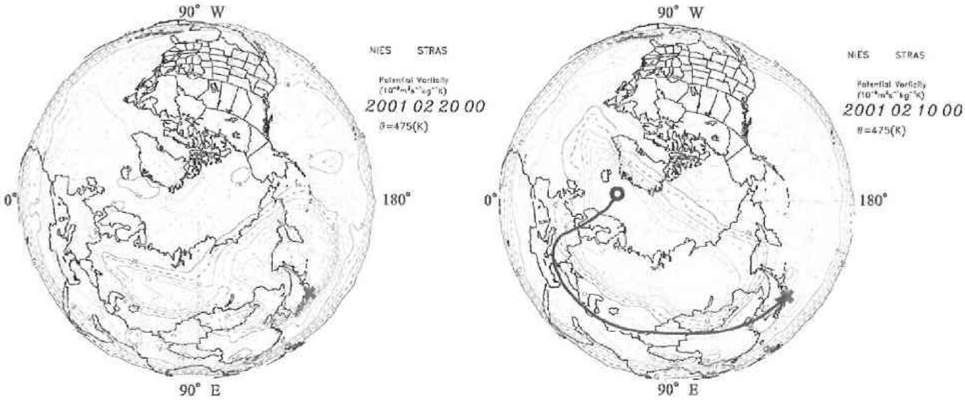

Fig. 4. The potential vorticity maps at the potential temperature of 475 K on February 20 (left panel) and on February 10 (right panel), 2001. Red cross indicates the location of Tsukuba. Blue line shows the 10 days backward trajectory from February 20 and the blue circle shows the location of the air mass on February 10. Note that only the blue circle corresponds to the potential vorticity map on February 10.

distortion of the polar vortex and it can be said that Arctic ozone depletion affected the ozone amount in mid-latitudes.

References

Newman, P.A., J.F. Gleason, R.D. McPeters, and R.S. Stolarski, 1997 : Anomalously low ozone over the Arctic, *Geophys. Res. Lett.*, **24**, 2689.

Rinsland, C.P., R.E. Boughner, J.C. Larsen, G.M. Stokes, and J.W. Brault, 1984 : Diurnal variations of atmospheric nitric oxide : ground-based infrared spectroscopic measurements and their interpretation with time-dependent photochemical model calculations, *J. Geophys. Res.*, **89**, 9613-9622.

Rinsland, C.P., *et al.*, 1996 : Comparison of infrared and Dobson total ozone columns measured from Lauder, New Zealand, *Geophys. Res. Lett.*, **23**, 1025-1028.