Analysis of short-term Variation of Stratospheric Ozone Connected with Dynamical Variations over the Rikubetsu, Japan

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It is well known that short-term variations of the stratospheric ozone are caused by dynamical changes such as vertical and/or horizontal transport. Recent studies suggest that a long-term trend of ozone in the stratosphere may be influenced by these short-term variations (SPARC Report 2002). In order to understand the dynamical effects to the short-term variations of the stratospheric ozone in detail, we investigated the altitudinal dependence of the relationships between the ozone mixing ratio and the dynamical parameters. In the present analysis, we used the vertical ozone profile data obtained from November 1999 to December 2001 with a ground-based millimeter-wave radiometer at Rikubetsu, Japan (43.5N, 143.8E) operated by National Institute for Environmental Studies (NIES) since November 1999. We assumed that the short-term variations of ozone are mainly caused by two independent dynamical processes; one is the horizontal transport on an isentropic surface and the other is the vertical displacement of the isentrope. We used potential temperature and potential vorticity as indices of the horizontal transport and the vertical displacement, respectively. We applied a multiple regression model in order to evaluate the contribution of the two dynamical processes to the short-term variations of ozone. As a result, almost 80% of the short-term variations of ozone at four altitudes (20, 22, 24, 26 km) can be explained by the two dynamical processes, but we have found that the breakdown of the dynamical processes that cause the short-term ozone variation are different among the four altitude levels At 20km, the vertical displacement is the major factor, while the role of the horizontal transport becomes important and its contribution is comparable with that of the vertical displacement at 26km.

After the analysis described above, we started reanalysis of the relationship by using equivalent latitude as an index of the horizontal transport instead of the potential vorticity, because the equivalent latitude is more straightforward to interpret the original location of the air parcel in the meridional direction, when equivalent latitude is used, From the preliminary analysis, we have found that the contribution of the horizontal transport evaluated from the equivalent latitude appears to be larger than that derived from the potential vorticity. We note, however, that the equivalent latitude may not be a good indicator because of its seasonal difference in the sensitivity to the horizontal transport. Especially in summer, the equivalent latitude is oversensitive to the horizontal transport when the latitudinal variation of the potential verticity is small, i.e., the changes of the equivalent latitude is magnified if the potential vorticity changes by the same amplitude in summer. We will present the details of the analysis method and the results of the comparison between the potential vorticity analysis and the equivalent latitude analysis.