ABSTRACTS (MASTER THESIS)

Interannual variability in the seasonal evolution of the stratospheric circulation in the southern hemisphere

(Graduate School of Science, Laboratory of Atmospheric Environment Information Analysis, RISH, Kyoto University)

Shinya Nino

In the winter polar stratosphere there exists a strong cyclonic circulation, called the polar vortex, with cold temperatures. In the southern hemisphere, the polar vortex is stronger than in the northern hemisphere, and consequently it lasts long until November or December. During the transition period from winter to summer around September to November, zonal wavenumber 1 anomalies in the meteorological fields are dominated at high latitudes. It is reported by Hitchman and Rogal (2010) that the wavenumber 1 anomalies in temperature move eastward along with the seasonal evolution. Moreover, Hassler et al. (2011) pointed out that the phase of temperature anomalies in October tends to locate eastward year by year. Thus, the phase of temperature anomalies in the southern hemisphere stratosphere moves eastward from the view point of the seasonal evolution and the year-to-year variation, but previous studies only focused on the seasonal variation in climatologically averaged fields or on the year-to-year variation at the fixed time of the seasonal evolution in the southern hemisphere. In this study, using the reanalysis meteorological data for the period of 1957 to 2010, we made analyses on the wavenumber 1 temperature anomalies during the transition from winter to summer to grasp the characteristics of the seasonal evolution and its year-to-year variability. Based on the results about the eastward movement seen in the seasonal evolution and in the year-to-year variability, we try to propose that the seasonal evolution from winter to summer could be getting earlier in the southern hemisphere stratosphere.

First we investigated the zonal temperature anomalies along the seasonal evolution. In addition to the eastward movement of the phase shown by Hitchman and Rogal (2010), the latitude where the temperature anomaly is maximum moves poleward. Consequently, the temperature anomalies move eastward and poleward as the season goes by. Next we investigated the year-to-year variability in the phase and amplitude of the temperature anomalies. We found that the latitude where the temperature anomaly is maximum moves poleward in the seasonal evolution from September to October. During this period the amplitude of the wavenumber 1 temperature anomalies tends to become large, suggesting that planetary wave activity becomes vigorous. The year-to-year variability in the poleward movement of maximum temperature anomalies is similar to that seen in the seasonal evolution from September to November. These results suggest that the structure of the zonal temperature anomalies in October is getting close to that in November; in other words, the seasonal evolution of the stratospheric circulation in the southern hemisphere is getting earlier.

We further investigated the year-to-year variability in the total ozone field. The phase relation between the temperature and total ozone fields show clear relation with a correlation coefficient over 0.9. This indicates that enriched ozone and higher temperature could be observed coincidentally because of the stranger downward motion. Up to recent years it has been observed that the polar ozone is decreasing, so it is suggested that resulting cooling by ozone decrease may speed up the seasonal evolution during the transition period from winter to summer in the southern hemisphere.

References

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[2] Hassler, B., G. E. Bodeker, S. Solomon and P. J. Young (2011), *Geophys. Res Lett.*, 38, L01805, doi:10.1029/2010GL045542, 2011