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Dynamics of Antarctic ozone hole dissipation revealed by ground-based and satellite observations

Kaoru Sato[1]; Yoshihiro Tomikawa[2]; Gen Hashida[3]; Akira Kadokura[3]; Hideaki Nakajima[4]; Takafumi Sugita[4]

[1] U. Tokyo; [2] Earth and Planetary Phys., Univ. of Tokyo; [3] NIPR; [4] NIES

http://www-aos.eps.s.u-tokyo.ac.jp/~kaoru/

In order to examine the dynamics of Antarctic ozone hole dissipation processes in detail, an intensive observation was performed using 97 ozonesondes at Syowa Station (39.6{¥degree}E, 69.0{¥degree}S) in late June 2003 through early January 2004 when the ozone hole was developed to the second largest in the past.

Observed ozone partial pressure increased earlier at higher altitudes in the dissipation phase of the ozone hole, which is marked contrast with the developing phase when it decreased almost simultaneously in the ozone layer with a center of about 17km altitude until late September.

The earlier ozone recovery at higher altitudes started in late August at the latest, suggesting the existence of ozone recovery processes other than isentropic mixing in association with the polar vortex breaking in November. The decent rate around 20km (ozone mixing ratio of 1.0 ppmv) is estimated about 1.1$¥pm$0.2km per month in late September through late October. The most dominant process is downward transport by diabatic circulation but it is not only the process.

Using satellite data by ILAS-II covering wide longitudinal regions, it is shown that the decent rate of ozone is highly dependent on longitude having maximum around the longitude of 210¥degree E and minimum around 30¥degree E in the polar vortex.

The decent rate accords well with that of isentropes at each longitude region modified by wavenumber 1 quasi-stationary wave, whose phase propagates gradually eastward.

This result suggests that downward transport is not uniform but faster at particular longitudes with warmer phase where radiative cooling is more effective.

The data of N$_2$O density by ILAS-II observation is also analyzed as one of long-lived species to examine the decent rate due to diabatic circulation. The estimates around 20 km (N$_2$O mixing ratio of 30 ppbv) are only half of the decent rate that of isentropes and ozone mixing ratio, indicating that the ozone is recovered faster than expected by diabatic transport even in the polar vortex.

It is discussed that lateral transport of ozone rich air across the polar vortex edge and chemical production of ozone in late spring are possible processes to explain the faster ozone recovery.