Proposal of balloon-borne hygrometer measurements at Syowa Station

Yoshihiro Tomikawa[1]; Naohiko Hirasawa[1]; Masatomo Fujiwara[2]; Kaoru Sato[3]

[1] NIPR; [2] EES, Hokkaido Univ.; [3] U. Tokyo

The stratosphere is characterized by a very low amount of water vapor of about 2-7 ppmv. In spite of that, a small increase of stratospheric water vapor has a large radiative forcing. Its impact on the surface temperature is comparable to other greenhouse gases (Shindell, 2001). On the other hand, the increase of stratospheric water vapor brings about a cooling in the stratosphere. Both of the increase of water vapor and the cooling in the stratosphere enlarge the ozone hole through formation of polar stratospheric clouds. Thus a variation of amount of the stratospheric water vapor is closely related to both the ozone hole and global warming.

The water vapor measurement in the stratosphere is very difficult because of the low concentration of stratospheric water vapor. Since the water vapor concentration in the stratosphere is lower than that at the ground by 4-5 orders, its ground-based measurement is especially difficult. Radiosonde observations all over the world provide vertical profiles of relative humidity twice a day. However, reliable data are obtained only up to 8-12 km. A Laman lidar can measure a vertical profile of water vapor concentration, but up to about 10 km. Satellite measurements give a global distribution of water vapor, but its vertical resolution (larger than about 2 km) is not sufficient around the tropopause. Furthermore, the satellite measurements are affected by aerosol amounts, so that reliability and continuity of the data drop in case of volcanic eruption. Thus in-situ observations are the best way to measure the water vapor concentration in the stratosphere with high precision and high vertical resolution. The in-situ observations of water vapor on aircrafts have been performed regularly on a commercial basis and several times on a campaign basis. However, the campaign observations cannot capture its long-term variations, and the observations by commercial aircrafts have not been performed around Antarctica. Regular and long-term observations of water vapor by balloon-borne hygrometer have been performed only at Boulder (USA) by NOAA (+NRL).

Satellite measurements and balloon-borne hygrometer measurements at Boulder showed an upward trend of stratospheric water vapor from 1970s to 2000 (SPARC, 2000). On the other hand, it is reported that the stratospheric water vapor is decreasing since 2001 (Randel et al., 2006). Future prediction of stratospheric water vapor is difficult because it is caused by nonlinear superposition of several kinds of effects. No chemistry climate models can reproduce the interannual variations of stratospheric water vapor, which is one primary reason for uncertainty of the future ozone prediction.

These backgrounds promoted us to propose balloon-borne hygrometer measurements at Antarctic Syowa Station. The water vapor concentration in the polar stratosphere depends not only on the processes in the tropics and midlatitude but also on those specific to the polar region. In addition, the observations in the polar region is fewer than those in the tropics and midlatitude, which encourages the stratospheric water vapor observations in the polar region. The balloon-borne hygrometer observations at Syowa Station will not only provide scientific outcomes but also contribute to the development of middle atmosphere research.