EA1) Ozone and Aerosols in the Tibetan Plateau Atmosphere during Asian Summer Monsoon : Balloon-Borne Measurements

Y. Iwasaka[1], Y.-S.Kim[2], G.-Y. Shi[3], K. Kawahira[4], T. Shibata[1], D. Zhang[5], T. Ohashi[2], K. Tamura[2], Y.-B. Bai[3] & X. Zhou[6]

[1]Graduate School of Environmental Studies, Nagoya Univ., Nagoya 464-8601, Japan
[2]Graduate School of Science, Nagoya Univ., Nagoya 464-8601, Japan
[3]Instit. of Atmospheric Physics, Chinese Academy of Science, Beijing 1000291, China
[4]Faculty of Bioscience, Fukui Prefectural Univ., Matsuoka, Fukui 910-1195, Japan
[5]Faculty of Environm. and Symbiotic Sci., Pref. Univ. of Kumamoto, 862-8502, Japan
[6]Chinese Academy of Science, Beijing 100291, China

1. Introduction

Active upwelling air motion in every summer over the Tibetan plateau is an essential process controlling activities of asian summer monsoon which affects water cycle and precipitation in eastern Asia. Large heating rate of surface air on the high plateau with average height of 4000m is considered to cause such large scale upwelling over the plateau. Recently it was suggested that Tibetan plateau area becomes minimum region of total ozone distribution during summer (Tibetan ozone valley) by Zhou and Luo (1994) and Zou (1996), who pointed this dynamical motion as important process forming total ozone minimum over the Tibetan plateau through transport of tropospheric ozone poor air to the stratosphere. The upwelling air motion can transport not only ozone poor air but also various kinds of atmospheric constituents. Additionally, adiabatic cooling of upwelling air can activate gas to particle conversion processes, and consequently disturb chemistry in the summer plateau atmosphere through heterogeneous processes. The balloon-borne measurements of ozone and aerosols made in 1999 at Lhasa (30 N, 90 E) Tibet, China to obtain better understanding atmospheric chemical feature during asian summer monsoon.

2. Cold Tropopause and Enhancment of Tropopause Aerosols in Summer

Adiabatic changes in air upwelling in summer can cause changes in temperature distribution and aerosol behavior. Very cold tropopause frequently appeared during the observational campaign, especially in August, which is caused by active upwelling motions over the plateau, and became lower than the frost point temperature of nitric acid trihydrates (NAT) (Fig. 1). Form of NAT particles can cause chemical disturbance such as low concentration of NOx and increase in active Cl constituents and has been considered to be important step of ozone destruction in the polar stratosphere (Carslaw et al., 1997).

Balloon-borne measurements with an optical particle counter and ground-based lidar measurements showed noticeable enhancement of aerosols near the local tropopause which was possibly due to activation of gas-to-partivle-conversion under very cold atmospheric condition. Lidar measurements interestingly showed that liquid aerosol noticeably enhanced near the local tropopause where atmospheric temperatures were lower than the frost point of nitric acid droplet.

3. Summary and Conclusion

Recently ozone loss heterogeneous reactions in not only the polar region but also the mid latitude stratosphere arouse investigators' interest in ozone depletion. Solomon (2000) suggested that the reaction of HCl + $ClONO_2$ on atmospheric aerosols becomes more efficient for lower percentage of sulfuric acid, and rather effective chlorine activating reactions can occur irrespective of particle phase. Behavior of NOx and ClOx was not clarified in the present observations and further investigation is necessary

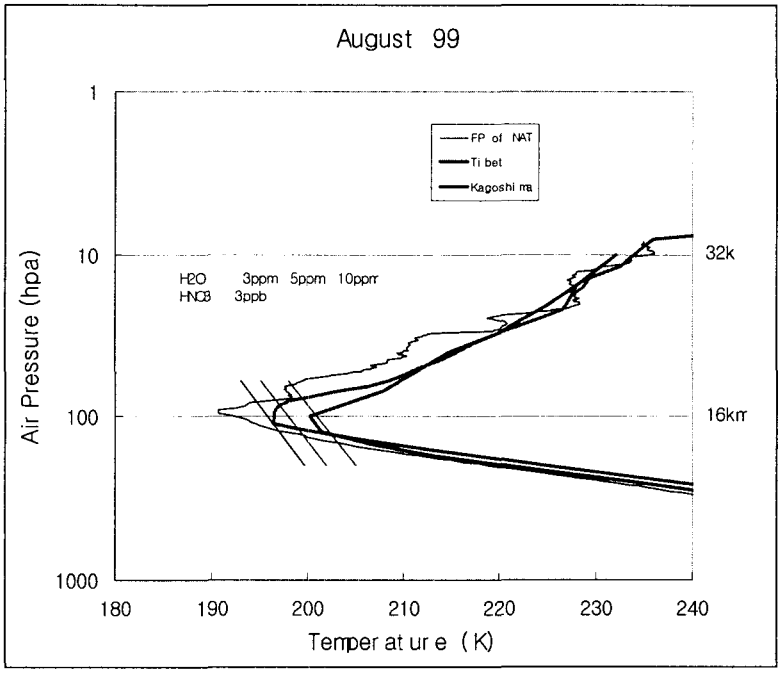

Fig.1 Temperature distributions measured at Lhasa, Tibet. The tropopause temperature is frequenly, especially in summer, lower than the frost point of nitric acid trihydrates (NAT type 1 polar stratospheric clouds). Monthly average temperature of August at Lhasa, China and at Kagoshima, Japan shows difference of about 5 K near the troppause.

References

Carslaw, K. S., T. Peter, and S. L. Clegg, Modeling the composition of liquid stratospheric aerosols, Rev. Geophysics, 35, 125-154, 1997

Solomon, S., Stratospheric ozone depletion: A review of concepts and history, Rev. Geophys., 37, 275-316, 2000

Zhou, X. and C. Luo, Ozone valley over Tibetan plateau, Acta Meteorol. Sinica, 8, 505-506, 1994

Zou, H., Seasonal variation and trends of TOMS ozone over Tibet, Geophys. Res. Lett., 23, 1029-1032, 1996