

Direct Evidence of Nitrate Aerosol Formation in Summer Antarctic Stratosphere Obtained by a Balloon-Assisted Unmanned Aerial Vehicle Using Two-Stage Separation Method

Masahiko Hayashi¹, Shin-Ichiro Higashino², Takuya Okada³, Shuji Nagasaki², Koichi Shiraishi¹, Keiichi Ozuka⁴

¹Fukuoka University, ²Kyushu University, ³Graduate Student, Kyushu University, ⁴Nippon Tungsten Co., Ltd.

The system for the stratospheric aerosol observation and sample-return in Antarctica using the combination of a rubber balloon and an Unmanned Aerial Vehicle (UAV) has been developed. The balloon-UAV system reaches 20km to 30km in altitude, but it becomes difficult for the UAV to directly glide back autonomously after separating from the balloon at higher altitudes because the aerodynamic characteristics necessary for the control system design at higher altitude is difficult to obtain. In order to avoid the problem, the two-stage separation method is proposed in which the UAV first descends down to a flyable altitude of the UAV by a parachute after separating from the balloon, then it separates the parachute for autonomous gliding back to the released point (Figure. 1).

An optical particle counter and an aerosol sampler installed in the UAV were launched on January 24, 2015 from S17 (69.028S, 40.093E, 607 m a.s.l.) near Syowa Station in Antarctica (Figure. 2). A stratospheric aerosol layer composed of three sub-layers is quite distinctive compared with a typical stratospheric aerosol layer (Figure 3), which suggests the effect of the eruption of Mt. Kelut on February 14, 2014. An electron micrograph of the stratospheric aerosol sampled at 14.2-15.7km in altitude suggests the existence of nitrate particles with sub-micrometer diameters in spite of the high temperature around -45 degrees Celsius (Figure 4). The details of the observation method and the results of the observation in Antarctica in 56th JARE summer activities are shown in presentation.

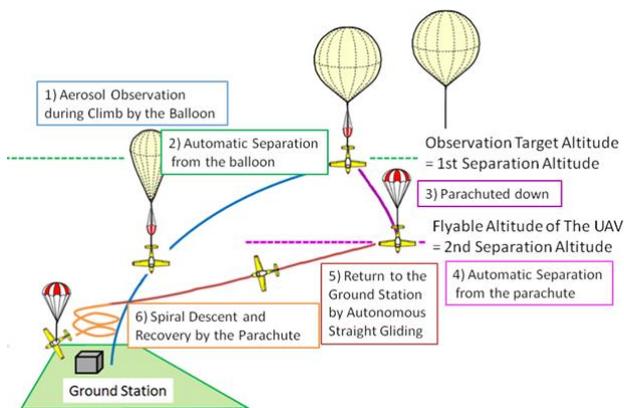


Figure 1. Mission profile using the two-stage separation method.



Figure 2. Phoenix-S UAV climbing by a balloon.

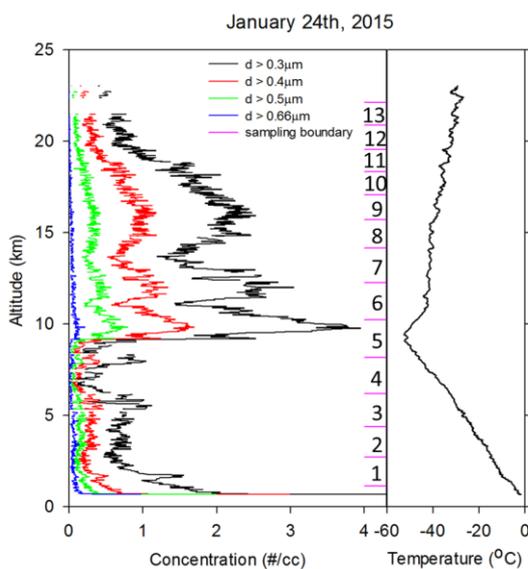


Figure 3. Aerosol profiles (left) and temperature (right) observed by UAV borne OPC on January 24, 2015
Numbers in left panel show sample ID and sampling altitude.

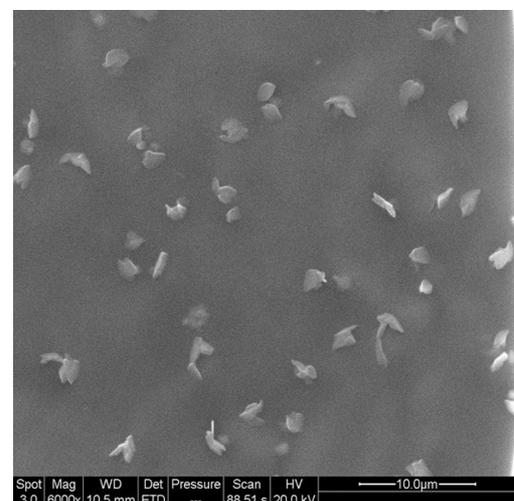


Figure 4. Morphology of aerosols sampled on nitron thin film at 14.2 ~ 15.7km, on January 24, 2015