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Transport of Pinatubo Aerosols to Arctic Region Lidar Measurements at Alaska, Winter 1991/1992

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The concentration of stratospheric aerosols observed with a lidar at Alaska increased from December of 1991 to March of 1992. The measurements suggested that particulate matter injected into the stratosphere accumulated in high latitudes through the long range transport of volcanic materials from mid- and low-latitudes to polar region and descending motion of thosematerials to the troposphere.

The global dispersion of aerosols injected into the stratosphere through major volcanic eruptions has becomea matter of great concern from the viewpoint of volcanic impact on atmospheric chemistry and transfer of solar radiation.

The volcano Pinatubo in the Philippine Islands (15° 05'N, 120° 1 1'E) underwent a number of eruptions duringJune 1991. These climaxed in a massive eruption on June 15, 1991, which injected a

large cloud of volcanic debris into the stratosphere.

Lidar measurements on stratospheric aerosols were made at Poker Flat, Alaska (64° 49'N, 147° 52'W) in winter 1991/1992.

Enhanced aerosol layers are identified at 15~20 km (layer 1) and 22~23 km (layer 2) during the observational periods. Only the profile of December 15, 1990 showed an additional enhenced layer at 25~27 km (layer 3).

The profile of December 15, 1991 showed an enhanced layer at 25~27 km (layer 3) (about 16 km above the local tropopause).

Trajectory of air mass corresponding to the layers 1, 2, and 3 of the measurements of December 15, 1991 was calculated using the 3-dimensional twice-daily NMC data set. The 10 days indicates that the layer of 24~27 km on 15 December only is due to the air mass which rapidly moved from low latitudesto the polar region.

During the observational period noticeable increase in aerosol content was observed upper part and lower part of the aerosol layer. However, the mixing ratio of the layer peak observed at about 17 km on 15 December did not increase after then, although other layer peak showed noticeable increase. The increasing rate in mixing ratio (scattering ratio) is about 42.2 (7.04), 0.27 (0.19), and 5.93 (2.22) %/day at 20, 17, and 13 km, respectively.

The centroid hight of aerosol layer, Hc, can be defined by,

$$Hc = \int z\beta\, 2(z)dz / \int \beta\, 2(z)dz$$

The value of Hc varied from 17.2 to 14.8 km from 15 December 1991 to 2 March 1992, and the speed of descending motion estimeted from those is about 52 m/day. This value is apparently larger than the results obtained over Japan in the period of the El Chichon disturbance of 1982/1983. According to the lidar measurements at Nagoya, the descending speed was about 20 m/day in the early decay phase. When we use this speed for the equation, $F = V(Z) \cdot \beta\, 2(Z)$ in order to estimate roughly the rate of sedimentation loss, we obtaine F = 4.2x10-5sr-1day-1 above the tropopause on the basis of measurements.

More detailed calculations are necessary to estimate acculately loss of volacanic aerosol from the polar stratosphere, since those estimations are based only very limited observations.