ON THE DYNAMICAL BEHAVIOR OF THE DUST AND ITS VAPORIZED ELEMENTS IN THE UPPER ATMOSPHERE INFERRED FROM THE OBSERVATION BY LASER RADAR

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ABSTRACT

Observations of the scattered resonance lines[1] and rocket-borne mass spectrometer measurements have indicated the presence of metallic atoms and ions in the upper atmosphere at a height of 80 - 120 km. The abundance of neutral sodium atoms near the altitude of 90 km shows distinct seasonal variation with a striking winter maximum at high- and mid-latitudes. On the other hand, the number density of metallic ions is thought to be maximum in the summer season, which would explain a summer maximum in the appearance of the Es-layer in the ionosphere. Gadsden[2] proposed a model, in which the metallic atoms are produced from ablating meteors, but he encountered a difficulty in explaining the seasonal variation. On the other hand Donahue and others have attributed the origin of sodium atoms to the presence of dust in those regions. Recently Fiocco and Visconti[3] put forward the dust hypothesis in further detail. It is shown that in the daytime the dust temperature Tp can be higher than the ambient gas temperature, and the seasonal variation of the abundance of sodium atoms may be explained by the variation of the sublimation due to the seasonal variation of Tp. Their theory, however, contains several uncertain rate constants, which must be confirmed in future investigations. We propose an interpretation for the height-distribution and its seasonal variation of metallic atoms and ions from the ablated meteorites, taking account of (i)

Chimonas-Axford's "corkscrew effect" (ii) the effect of the vertical ion transport caused mainly by the seasonal zonal wind system in the height range of 90 - 110 km and (iii) the meridional ion transport caused by the global atmospheric circulation above 110 km[4]. Recently Mitra[5] showed that the influx of meteorites may be the cause of the superrotation of the upper atmosphere above the altitude of about 200 km. Thus the study of the sodium atoms is very important for the investigation of the dynamical behavior of the upper atmosphere above about 80 km.

On the next stage, we discuss comparative experiments on the stratospheric aerosols by laser radar and other method. Pilipowskyj et al.[6] required a large number of Aitken particles to explain discrepancies between infrared and laser radar data. The observed results of such particles have been reviewed by Remsberg[7]. We compared the laser radar results and the small ion concentrations from the radio sonde in Japan[8] Here we examined the data further in detail and have shown the existence of a large number of Aitken particles in the stratosphere. The results are compared with those by Russel et al.[9] and others.

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