EMS Annual Meeting Abstracts,
Vol. 6, EMS2009-353, 2009
9th EMS / 9th ECAM

9th EMS Annual Meeting
9th European Conference on Applications of Meteorology
High resolution meteorology
- applications and services

Gravito-photophoresesis and lidar observations

A. Cheremisin (1), I. Shnipov (1), V. Marichev (2), S. Nikolashkin (3), and V. Bychkov (4)

(1) Siberian Federal University, Krasnoyarsk, Russia (cher@akadem.ru / Phone: +7 290-5199), (2) Institute of Atmosphere Optics SB RAS, Tomsk, Russia, (3) U.G. Shafer Institute of Cosmophysical Iinvestigations and Aeronomy SB RAS, Yakutsk, Russia, (4) Institute of Cosmophysical Researches and Radio Wave Propagation, Kamchatka, Russia

The atmospheric aerosol is an important climatic factor. Meanwhile there are many unresolved problems concerning mechanisms of aerosol layers formation. An interpretation of known facts of aerosol stratification in the upper atmosphere can be done within the framework of existing models which are based on the idea of a sedimentation–diffusion equilibrium in the gravity field. But certain difficulties remain. An alternative concept is based on photophoretic forces to explain the existence of aerosol layers and to correctly describe the vertical transport of aerosol particles. This concept is based first of all on the results of laboratory observations of levitating particles sustained by absorbed light. Now it is possible to replace qualitative explanations of many photophoretic effects with theoretical ones.

Based on a Monte-Carlo method and a free-molecule kinetic regime approximation the effective algorithm for calculation of molecular heat and mass transfer in aerosol systems have been developed. Molecular heat transport, photophoretic forces and torques, four tensors describing viscous forces and torques, can be calculated. Complex rotational-translational motion of non-spherical aerosol particles or many-particle clusters absorbing both visible and infra-red radiations, can be theoretically described. The investigations have shown the significant potential of gravito-photophoresesis. The obtained aerosol stratification under the influence of gravito-photophoresis qualitatively corresponds to the vertical distribution of aerosol scattering in the stratosphere and the mesosphere observed in the visible and ultraviolet wavelength range. In particular, it is true for layers at altitudes of about 20 km, 50, 70 and 80–83 km. In development of these works the seasonal- latitudinal distribution of aerosol layers levitating under the influence of gravito-photophoretics forces, has been investigated. The atmosphere model and data on Earth's IR radiation from satellite were used at calculations.

Some feature of aerosol layers occurrence in the upper atmosphere observed by Siberian-Far-Eastern lidar stratospheric stations network, correspond to the theoretical seasonal-geographical pattern of mesospheric aerosol layers levitation under the influence of gravito-photophoretic forces. This network includes the lidar stations in Tomsk, Yakutsk and on Kamchatka. Lidar observations of vertical distribution of stratospheric aerosol were started in Tomsk in 1986. Lidar stratospheric station in Yakutsk was created in 2004. Creation of lidar stratospheric station in Kamchatka was finished in 2007. The meteorological data from satellites, the data of back trajectories analysis and the sounding balloon data were involved into the analysis of the lidar data.

This investigation is supported under grant 07-05-00734a by the Russian Fund of Basic Research.