

The role of charged particles in ozone depletion in the polar stratosphere

Yu.E. Belikov (1) and S.Sh. Nikolayshvili (2)

(1) Fedorov Institute of Applied Geophysics 9, Rostokinskaya Str., 129128, Moscow, Russian Federation

(yury_belikov@mail.ru), (2) Fedorov Institute of Applied Geophysics 9, Rostokinskaya Str., 129128, Moscow, Russian Federation (ser58ge@gmail.com)

The analysis of various experiments in Arctic shows that ozone and some other compounds destruction as well as the chlorine monoxide ClO accumulation take place not inside the aerosol layers but outside them near their boundaries. That means that heterogeneous reactions proceeding is impossible on the surface of the PSCs particles because of the absence, or strong reduction of their surface in the regions of the enhanced formation of the products usually attributed to those reactions. At the same time there is the increased concentration of the condensation nuclei over the aerosol layers and between them, and consequently, the increased concentration of ions in those regions, because of the positive correlation between condensation nuclei and ions concentrations. In SOLVE (1999-2000) and AAOE (1987) experiments the negative correlation between ozone and condensation nuclei (ions) concentrations is observed in fact along the whole ER-2 aircraft route including those parts of it where ClO concentration is either absent, or low. The specific features of the condensation nuclei (ions) and charged aerosols vertical distributions indicate that due to the global electric circuit work the charge accumulation takes place at the boundaries of the aerosol and cloud layers. At that the excess of the positive ions is observed at the upper boundaries of the layers and the excess of negative ions on the lower ones. By our assumption, ozone and other compounds destruction is a result of the dipole interaction of molecules with the charged particles, primarily with ions, which leads to the adhesion and disintegration of a number of molecules, including ozone and chlorine reservoirs. Molecules acquire additional energy on the surface of the charged particles, enabling reactions that are not possible in ambient space. The main role can be played by the hydronium ions $H_3O^+(H_2O)_n$. The degree of the ion hydration n is different inside and outside aerosol layers. In a case of small n values ($n < 10$) which are observed outside the aerosol layers the ion electric field is weakly shielded by water molecules, and the ozone and other compounds penetrate to the effective surface of H_3O^+ , where some of them can be destructed, or interact with other molecules. Galactic cosmic rays are the main source of ions in the polar stratosphere, their equilibrium concentration at altitudes from 15 to 25 km can reach up to $\sim (1-5) \times 10^3$ ions/cm³. Our estimations show that if ozone destructs in the regime of 'collision' with ions then the ozone lifetime will vary from 10 days to 2 months. We suppose that alongside with the chlorine mechanism there is also a mechanism of the ozone decay on charged particles. The stratospheric dynamics is a key process in the ozone holes formation. The air flow containing the species which would be disintegrated by ions descends from the altitudes with the low ion concentration to the levels with the relatively high ion concentration. Here, we demonstrate a close connection of the photochemistry with the dynamic, electrical and condensation phenomena in the polar stratosphere.