



On the chain length in O_x , HO_x , NO_x , ClO_x and BrO_x cycles in the middle atmosphere

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Analysis of chain mechanisms of ozone depletion in O_x , HO_x , NO_x , ClO_x and BrO_x cycles has been performed. The carried out analysis has allowed to get analytical expression for calculation of the rate of limiting stage of chain prolongation, as well as chain breaking and chain length in cycles specified. It has been shown, that the correct estimation of ozone depletion in the chain processes is possible only through definition of the rate of limiting stage with taking into account of all reactions of chain prolongation, instead of the unique reaction possessing the least rate as it usually became earlier. It has been shown also, that choice of one reaction means ignoring a chain character of the process and leads to overestimate of real rate of ozone destruction. The role of null chain processes in the cycles specified above has been considered. It has been shown, that these processes play a defining role in formation of families of odd oxygen, nitrogen, chlorine and bromine. By means of methods developed, data of IPCC scenario RCP 4.5, and two-dimensional model Socrates the rate of ozone destruction and chain length in O_x , HO_x , NO_x , ClO_x and BrO_x cycles for modeling conditions of April 2013 at 50 N and height diapason 15-120 km has been calculated. It has been shown, that in the middle stratosphere ozone destruction is due mainly to NO_x cycle, whereas in the mesosphere and low thermosphere it is due mainly to HO_x one. It has been also shown that ClO_x and BrO_x have the greatest chain length in the upper stratosphere which exceeds 106 and HO_x cycle in the low thermosphere has a chain length exceeding 1011.