MODELLING OF LONG-TERM ANTHROPOGENIC CHANGES IN STRATOSPHERIC TEMPERATURE AND THE OZONE LAYER

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A numerical two-dimensional interactive dynamical–radiative–photochemical model including aerosol physics is used to examine the expected long-term changes in stratospheric temperature and the Earth's ozone layer due to anthropogenic pollution of the atmosphere by the greenhouse gases CO_2, CH_4, N_2O and by ozone-depleting chlorine and bromine compounds. The model time-dependent runs were made for the period from 1975 to 2050. The mechanisms of the impact of each of the pollutants on stratospheric temperature have been analysed, their relative contributions to the predicted temperature change have been estimated. The processes, which determine the influence of anthropogenic growth of atmospheric abundance of the greenhouse gases on the dynamics of recovery of the Earth's ozone layer after reduction of anthropogenic discharges of ozone-depleting chlorine and bromine compounds into the atmosphere, have been studied in details. The contributions of different pollutions to the predicted ozone changes have been estimated. The results of the calculations show that the basic mechanism by which greenhouse gases influence the ozone layer is stratospheric cooling accompanied by a weakness in the efficiency of the catalytic cycles of ozone destruction due to temperature dependencies of the photochemical gas-phase reactions. Modification of polar stratospheric clouds (PSCs) caused by anthropogenic growth of the greenhouse gases is important only for the polar ozone. An essential influence of the greenhouse gases on the ozone by a modification of the stratospheric sulphate aerosol is revealed. The aerosol changes caused by the greenhouse gases modify the distribution of the ozone-active gaseous chlorine, bromine and nitrogen components by means of heterogeneous reactions on the aerosol surface, resulting in a significant decrease in springtime polar ozone depletion of the Antarctic ozone hole.

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