Long-Term Behavior of the Concentration of Minor Constituents in the Mesosphere/Lower Thermosphere Calculated by Means of the Real Date Model LIMA

G. R. SONNEMANN[1,2], M. GRYGALASHVYLY[2], P. HARTOGH[1], and U. BERGER[2]
[1]*Max-Planck-Institute for Solar System Research, Max-Planck-Str. 2, D-37191 Katlenburg-Lindau, Germany*
[2]*Leibniz-Institute of Atmospheric Physics at the University Rostock in Kühlungsborn, Schloss-Str.6, D-18225 Ostseebad Kühlungsborn, Germany*

We investigate the influence of rising concentrations of methane, nitrous oxide and carbon dioxide upon the chemistry of the mesosphere since 1961. Calculations were performed with our global 3D-model LIMA (Leibniz-Institute Middle Atmosphere), designed for the investigation of the MLT-region and particularly for the extended mesopause region. LIMA uses real tropospheric and lower stratospheri temperature and horizontal wind data up to 35 km altitude obtained by assimilating ECMWF/ERA-40 (European Center for Medium Weather Forecast/Re-analysis Version 40) data. Real Lyman-α flux values are employed to determine the water vapor dissociation rate. The analysis of the long-term behavior of water vapor also utilizes real methane measurements. One unsolved problem for the model calculations consists of the water vapor mixing ratio at the hygropause during the trend calculation. The solar influence on the water vapor mixing ratio is insignificant below about 75-80 km within high latitudes in summer, but it becomes increasingly more important above this domain. The model calculations show that the water vapor mixing ratio increases without considering the real changing dynamics due to the rising methane concentration. Surprisingly, the effect of rising water vapor mixing ratios becomes stronger with increasing height. The reason lies in a positive feedback process called autocatalytic water vapor production. However, in the mesopause region the behavior of the water vapor mixing ratio is indefinite, partly even decreasing, when considering the real dynamics. Increasing CO_2 concentration slightly enhances the concentration of CO in the mesosphere, but its direct influence upon the chemistry is small and its main effect is connected with a cooling of the upper atmosphere. We discuss the long-term behavior particularly of water vapor with regard to the impact on the NLC region.

Keywords: MLT-region; long-term behavior; water vapor; NLC region; autocatalytic water vapor production.