Models of Atmospheric Composition and Chemistry on Venus

Vladimir A. Krasnopolsky[1]

[1] Department of Physics, Catholic University of America, Washington, DC 20064, USA

The broad range of temperatures and pressures and inclusion of the chlorine and sulfur chemistries to the standard CO-O-H chemistry typical of Mars make chemical modeling of Venus atmosphere a challenging task.

Photochemical models for the middle atmosphere (58-112 km) involve the ClCO cycle and the related chemistry. The major problem for these models is to couple the rather high abundance of CO at the cloud tops (~40 ppm) with the very low column density of O_2 ($<10^{18}$ cm^{-2}). Long-term, of the order of a decade, variations of SO_2 and global variations of H_2O with a time scale of a few months are the other problems for observations, photochemistry, and dynamics. The models should be updated for the recent detections of NO and OCS at the cloud tops.

The VEX observations of the nigh airglow of NO, O_2, and the discovery of the OH nightglow as well as the ground-based and PV observations of these emissions are the main objectives of the model for nighttime photochemistry at 80-130 km. The model involves CO-O-H-Cl-N chemistry with influxes of O, N, and H as free parameters. It agrees with the VEX nightglow observations. However, the model does not support the O_2 nightglow intensities ~1 MR and more in some ground-based observations. Comparing this model with VTGCM, the expected NO nightglow near solar maximum is smaller than that observed by PV by a factor of ~2.

According to the chemical kinetic model for the lower atmosphere (0-47 km), there are three sources of chemistry at these altitudes: fluxes of H_2SO_4, CO, and S_x from the middle atmosphere, thermochemistry in the lowest 10 km, and photolysis of S_x. The sulfur bonds in OCS and S_x are the weakest, and the chemistry is sulfur-driven. The model is in reasonable agreement with the observations. However, two key reactions in the model between OCS and SO_3 have not been studied in laboratory.

The nightside spectroscopy results are incompatible with the traditional concept of the sulfur atmospheric cycles, and some updating of those cycles is briefly discussed.