Geophysical Research Abstracts
Vol. 16, EGU2014-1943, 2014
EGU General Assembly 2014

Modeling the clouds on Venus: model development and improvement of a nucleation parameterization

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As both the clouds of Venus and aerosols in the Earth's stratosphere are composed of sulfuric acid droplets, we use the 1-D version of a model [1,4] developed for stratospheric aerosols and clouds to study the clouds on Venus. We have removed processes and compounds related to the stratospheric clouds so that the only species remaining are water and sulfuric acid, corresponding to the stratospheric sulfate aerosols, and we have added some key processes. The model describes microphysical processes including condensation/evaporation, and sedimentation. Coagulation, turbulent diffusion, and a parameterization for two-component nucleation [8] of water and sulfuric acid have been added in the model. Since the model describes explicitly the size distribution with a large number of size bins (50-500), it can handle multiple particle modes. The validity ranges of the existing nucleation parameterization [7] have been improved to cover a larger temperature range, and the very low relative humidity (RH) and high sulfuric acid concentrations found in the atmosphere of Venus. We have made several modifications to improve the 2002 nucleation parameterization [7], most notably ensuring that the two-component nucleation model behaves as predicted by the analytical studies at the one-component limit reached at extremely low RH. We have also chosen to use a self-consistent cluster distribution [9], constrained by scaling it to recent quantum chemistry calculations [3]. First tests of the cloud model have been carried out with temperature profiles from VIRA [2] and from the LMD Venus GCM [5], and with a compilation of water vapor and sulfuric acid profiles, as in [6]. The temperature and pressure profiles do not evolve with time, but the vapour profiles naturally change with the cloud. However, no chemistry is included for the moment, so the vapor concentrations are only dependent on the microphysical processes. The model has been run for several hundreds of Earth days to reach a steady state. Preliminary results are evaluated against observations.

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