R009-24
B 会場 ：9/27　AM2 （10:45-12:30）
11:45〜12:00

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A study of the Venusian cloud structure and condensational gas distribution using a 1-D cloud microphysics model

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Venus is completely shrouded by thick sulfuric acid clouds. The clouds significantly influence the distribution of condensational gas species, including H2O and H2SO4. The distributions of these gases are determined by a delicate balance among the efficiency of condensation into droplets, eddy transport, and chemical production/loss. It is important to understand the distribution of H2O vapor through these cloud-mediated processes because the H2O vapor abundance beneath the homopause regulates the diffusion-limited escape rate of hydrogen (Catling and Kasting, 2017), hence the history of water on Venus. Furthermore, H2SO4 vapor distribution is important for atmospheric chemistry above 80 km altitude, as suggested by Zhang et al. (2010). They argued that sulfur species, including SO, SO2, and SO3, could be generated from H2SO4 vapor provided by the upper haze layer. However, the transport process of these gaseous species and their interaction with the clouds are not well understood above the cloud top altitude.

To investigate Venusian cloud microphysics and its interaction with the background atmosphere, we developed a 1-D microphysics model based on Imamura and Hashimoto (2001). The model takes into account cloud microphysics and vertical transport of gaseous species (H2SO4 and H2O) as well as those of cloud particles. On top of the previous work, we extended the model top altitude from 70 km to 100 km. As a result of this enhancement, the model can now simulate the structure of the upper haze and the distribution of gaseous species above the main cloud layer. We also updated the sulfuric acid production rate profile in accordance with recent photochemical studies (Krasnopolsky, 2013), whose production peak altitude is located 5 km higher (˜66 km) compared to the previous work. Finally, we conducted cloud microphysics simulation using the abovementioned settings under different eddy diffusion profiles above the cloud top altitude (˜70 km).

The resulting cloud structure and the H2SO4 distribution around the cloud deck align closely with previous observations (e.g., Knollenberg and Hunten, 1980; Oschlisniok et al., 2021). The H2O profile above the cloud top agrees well with the past observation (e.g., Fedorova et al., 2009) within an observed range of eddy diffusion profiles. The updated H2SO4 production rate profile improved the H2O profile by altering the time scale of H2O loss due to chemical reactions and condensation. We also found that H2O abundance above the cloud top is highly sensitive to the eddy diffusion profile. Higher eddy diffusion results in an increased H2O abundance above the cloud top, as eddy transport becomes more efficient in supplying H2O compared to losses through chemical reactions and condensation. Furthermore, we observed an increasing concentration of H2SO4 with altitudes above 80 km within a wide range of eddy diffusion profiles, although it remains inadequate to account for the elevated SO2 concentration, as shown by Zhang et al. (2010). In our upcoming presentation, we aim to provide a more detailed investigation to gain a better understanding of the mechanisms that dictate the cloud structure and the distribution of gaseous species.