Variabilities of clouds and chemistry in the Venus atmosphere

Wencheng Shao (Technical University of Denmark)
Joao Mendonca

In the last few decades, thanks to the Venus Express mission and other ground- and space-based observations, we have learned that the Venus atmosphere has significant variabilities in chemistry and cloud properties. However, the atmospheric processes that cause these variabilities remain unclear. Here, we will present our new state-of-the-art model developed to understand these variabilities. First, we investigate the local-time variability of chemistry in the mesosphere of Venus through the combination of a 3D GCM and a 2D chemical-transport model (Shao et al. 2022). We find that the local-time distribution of SO2 in the upper cloud can be explained by the thermal tides and the zonal winds, while in the upper mesosphere, it can be explained by photochemistry and the day-night circulation. Other species, including H2O and CO, possess different local-time patterns, resulting from the competition between dynamics and chemistry. Nevertheless, some species, like OCS, still require more observations to confirm their local-time variations. Second, we study cloud's spatial structure and temporal variations on Venus. We are developing a 3D Venus climate model that includes a representation of the sulfuric acid cloud physics (Dai et al. 2022), based on the virtual planet laboratory OASIS (Mendonca et al. 2016; Mendonca and Buchhave 2020). We will show the comparison between our simulations and the observations from Venus Express or Akatsuki and uncover the underlying atmospheric processes responsible for the observed cloud structure and variations. The two works above also provide predictions for cloud properties and chemistry in the unobserved atmospheric region. Our results can be combined with future observations from the upcoming missions, such as EnVision, DAVINCI+ and VERITAS, to help us better understand the Venus climate system.