Long-term variations of temperature and H_2SO_4 gas mixing ratio in the Venusian atmosphere investigated by Venus Express and Akatsuki radio occultation measurements

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Introduction: It is well known that planetary atmospheres have a wide range of time-scale variations that have a significant impact on the surface environment of the planet. Taking the Earth as an example, long-term scale atmospheric variations such as ENSO and QBO are affecting the Earth's weather and climate. On the other hand, whether such long-term scale atmospheric variations exist in planetary atmospheres other than Earth has not been much studied in the past.

A change in this situation has been brought by the recent realization of long-term observations of the Venusian atmosphere by Venus Express and Akatsuki: the presence of significance long-term variations in UV albedo and the zonal mean wind speed at cloud levels have been reported [1–3]. In addition, the measurements using ground-based telescopes also have indicated the long-term variations in the mixing ratios of H_2O and SO_2 gases at the cloud top level [4]. In this study, we used the vertical profiles of temperature and H_2SO_4 gas mixing ratio obtained by the Venus Express and Akatsuki radio occultation measurements [5–7] and investigated their long-term variations in the low latitude region.

Method: Radio occultation technique enables us to retrieve the vertical profiles of temperature and H_2SO_4 gas mixing ratio in the Venusian atmosphere (Figure 1). The former is obtained from the temporal variation of received frequency of radio waves emitted from the spacecraft by geometric optics [5–7]. The latter is obtained from that of received signal power [8]. In this study, we analyzed Venus Express and Akatsuki radio occultation data to investigate the annual variations of temperature and H_2SO_4 gas mixing ratio in the Venusian low latitude region in 2006–2022.

Results & Discussion: As shown in Figure 2, both temperature and H_2SO_4 gas mixing ratio around the cloud bottom level (46–50 km altitudes) in 2006–2014 obtained from the radio occultation measurements by Venus Express are generally higher than those in 2016–2022 from the Akatsuki data. In addition, the trend of the annual variation of H_2SO_4 gas mixing ratio almost follows that of its saturated mixing ratio which is mainly determined by the temperature. In this presentation, we are also going to compare our result with other measurements [1–4] and discuss the long-term variation of the Venusian thermal structure.

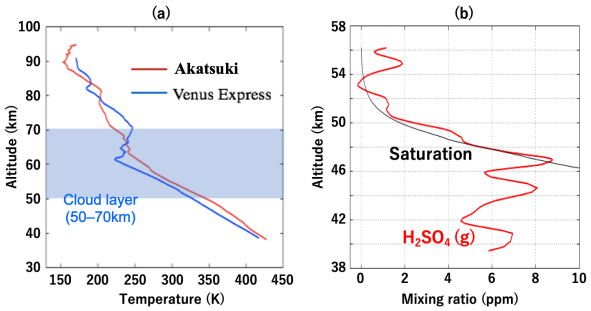

Figure 1. Examples of (a) vertical temperature and (b) H_2SO_4 gas mixing ratio profiles obtained by the radio occultation measurements.

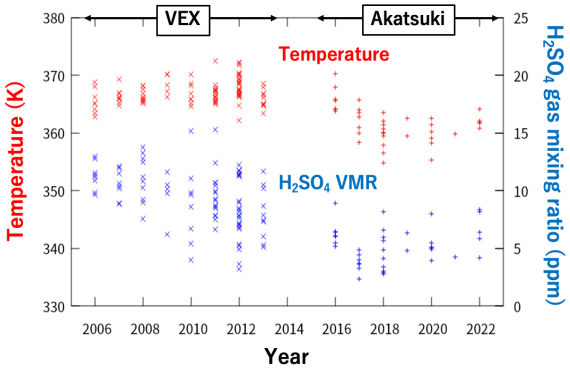

Figure 2. Annual variations of temperature and H_2SO_4 gas mixing ratio obtained by Venus Express and Akatsuki radio occultation measurements. The data are averaged at 46–50 km altitudes.

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