Cross-link Radio Occultation measurements of Venus Atmosphere by using multiple small satellites

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By imaging measurements using a spectrometer onboard Venus Express and a camera onboard Akatsuki and ground-based observations using a telescope, the knowledges about the Venusian atmospheric structure in the horizontal direction are steadily being accumulated by imaging measurements using a spectrometer onboard Venus Express, a camera onboard Akatsuki and ground-based observations using a telescope. However, they enable us to observe only the atmosphere at the specific altitude. On the other hand, the progress of modelling studies using GCM is also remarkable, but we cannot confirm the validity of modelling results sufficiently; the optical measurements can only observe the atmospheric structure at the cloud level, and then we cannot compare the modelling results with them globally. In particular, the knowledges about the vertical structure are insufficient.
Radio occultation measurements are usually conducted concurrently with optical measurements. Radio waves are transmitted from the spacecraft, refracted in the planetary atmosphere, and received at a ground station. From the measured atmospheric Doppler shift, we can obtain a vertical temperature profile with a high accuracy (measurement error ~ 0.1 K) and a high vertical resolution (~1 km). Therefore this method is useful for us to investigate the atmospheric structure in the vertical direction. However, the observational region and chance are limited because such a conventional radio occultation measurement highly depends on the configuration of the spatial positions of a spacecraft, a planet and the Earth. In the case of a conventional radio occultation measurement, however, the observational region and chance are limited by the orbit of a spacecraft and the spatial positions of a spacecraft, a planet and the Earth. One of the methods to overcome this weak point is a cross-link radio occultation technique among the multiple spacecraft.
We consider the cross-link radio occultation measurements of the Venus atmosphere by using multiple small satellites, one main satellite and two sub satellites, in terms of both engineering and science. It is assumed that they are conducted by one main satellite and two sub satellites. As a result of the trade-off between the fuel consumption for based on Venus orbit insertion and orbit transfers for the optimal satellite configuration and the number of observation points, it is expected that the number of measurements would be 179 in the rotation period of Venus super-rotation (4 Earth days) and the observation points could distribute globally. This enables us to obtain four-dimensional data of temperature and pressure. If the submillimeter, ultra-violet and infrared imaging measurements were also conducted, we would investigate the cloud physics and the photochemistry as well as the atmospheric structure and dynamics. In addition, we might be able to create a more precise Venusian meteorological model by using a data assimilation technique. In this presentation, we are going to talk about the current status and the future prospect of this conceptual study.

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