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Long-term Monitoring Plan of Venus using Earth-orbiting CubeSats

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Venus has long been considered the twin sister of Earth due to their physical similarities, such as mass, radius, and distance from the Sun [1]. This resemblance makes the comparative study between Venus and Earth important to understand an evolution turning point that caused these twin planets to be very different at present [2]. Interestingly, not only Earth experiencing global warming, but also Venus is experiencing ongoing temporal changes. Long-term remote sensing observations of Venus show considerable temporal variations of Venus. Such observations were conducted using spectral intensity, polarization, and imaging measurements. They revealed variations of the SO_2 gas abundance, zonal wind speeds, ultraviolet (UV) brightness, cloud top altitude, and the upper haze vertical structures above the cloud top level (~70 km altitude) [3,4,5,6,7]. The main drivers of the reported variations are unclear but may be associated with surface volcanic activities, the solar cycle, or large-scale oscillations in atmospheric dynamics. To understand possible mechanisms, a long monitoring period is necessary, and reliable data calibration is mandatory. We propose a continuous monitoring project, CLOVE (Chasing the Long-term Variability of Our Nearest Neighbor Planet Venus), utilizing a combination of ground- and space-based facilities to overcome the limitations of using a single dataset. In this project, firstly, we plan a low-Earth orbit CubeSat that will monitor Venus to investigate the cloud top vertical structure, the unknown absorber(s), and the SO_2 gaseous abundance, using bandpass and polarization filters at four selected wavelengths and a total 8 channels including polarization filters. We aim for our first CLOVE CubeSat to be launched in 2026. With its successful operation, we aim to proceed with the subsequent CubeSats that will continue Venus monitoring, replacing the old Sat with a new one to cover at least 15 years of time to complete one Solar Cycle. Secondly, we plan to collaborate with ground-based observation teams to perform coordinated Venus dayside observations with space-based CLOVE observations. The data will be used for cross-check validation and supplementary data to interpret our analysis. In this talk, I will explain what we have seen in the past and current data sets of Venus and the future plan with the CLOVE mission with an emphasis on polarization measurements.

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