Ground-based observations using IRTF/iSHEL for monitoring trace gases near the cloud tops of Venus

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The Venusian atmosphere serves as a natural laboratory for understanding atmospheric chemistry that cannot be observed in the terrestrial atmosphere. Different chemical processes occur at different altitudes: photochemistry driven by solar UV radiation in the upper atmosphere, cloud formation- and dissipation-related chemistry in the cloud layer, and thermodynamic equilibrium controlled by high temperatures in the lower atmosphere. Another categorization can be made in terms of chemical cycles, such as, sulfur oxides (SO_x), carbon oxides (CO_x), and chlorides (Cl_x). Observational constraints on the spatial and temporal variability of trace gases associated with these cycles can help us better understand atmospheric chemistry.

We have observed high-resolution (R ~ 75,000) spectra of the Venusian dayside using iSHELL mounted on the 3.2-m NASA Infrared Telescope Facility (IRTF) on Mauna Kea since 2018. The iSHELL instrument is a cross-dispersed high-resolution echelle spectrograph operating in the wavelength range of 1.06–5.3 μm. Twenty standard modes with different wavelength coverages are available by selecting one of the six cross-dispersing gratings (J, H, K, L, L’, and M) and adjusting the tilt position. By fully exploiting the capabilities of iSHELL, we can retrieve the abundances of HDO, CO, HF, HCl, OCS, and their isotopologues near the cloud tops. As of today, we have accumulated 23 days of successful observations over four years (2018, 2020, 2023, and 2025). Among them, our first results focusing on the HCl abundance near the cloud tops have already been published (Sato and Sagawa, 2023).

In this presentation, we provide an overview of our observations conducted so far. We will present initial results on the retrieval of CO and its isotopologues near the cloud tops.

Keywords: Venus, trace gas, IRTF/iSHELL, radiative transfer

