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A new constraint on HCl abundance at the cloud top of Venus

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We provided a new constraint on HCl abundance at the cloud top of Venus by infrared spectroscopy using a cross-dispersed high-resolution echelle spectrograph, iSHELL, mounted on the NASA Infrared Telescope Facility (IRTF). This study aimed to investigate the inconsistency in HCl abundance reported by previous ground-based observations and solar occultation measurements by Venus Express. Venusian dayside observations at a solar phase angle of ˜90 deg were conducted during August 6-7, 2018 and August 18-20, 2020 (UT), when the Venusian afternoon and morning sides were visible, respectively. The high spectral resolving power of ˜80,000 and large Doppler shift (˜13 km/s) enabled us to measure the Venusian lines with less contamination by terrestrial ones. We analyzed the $H^{35}Cl$ P(5) and $H^{37}Cl$ P(6) lines at 2775.8 and 2750.1 cm^{-1}, respectively in the 1-0 band together with $^{16}O^{12}C^{18}O$ P- and R-branch lines of the 20001-00001 band, which fell in the same spectral orders as the HCl lines. The $^{16}O^{12}C^{18}O$ lines were used to derive the cloud top altitude, as the upper clouds had a significant impact on retrieving HCl abundance. The cloud top had an equatorially symmetric structure. The average altitude was 70.8 $\pm$ 0.6 km in the region equatorward of 30 deg and decreased toward higher latitudes. HCl volume mixing ratio was derived as 0.379 $\pm$ 0.013 ppm at an effective altitude of 70.6 $\pm$ 1.1 km and showed no significant latitudinal dependence over latitudes of $\pm$ 70 deg. A small difference of ˜0.02 ppm between 2018 and 2020 would result mainly from a temporal variation. The $H^{35}Cl/H^{37}Cl$ abundance ratio was 3.01 $\pm$ 0.16, with no prominent latitudinal dependence. The obtained HCl volume mixing ratio agreed with the results of previous ground-based measurements, which were approximately one order of magnitude larger than those derived from the solar occultation measurements by Venus Express. This significant inconsistency cannot be explained by systematic uncertainties in our retrieval analysis. To solve this issue, the impact of forward scattering by aerosols on the retrieval method for solar occultation measurements should be investigated further.