Ground-based sub-mm observations of Venus upper atmosphere using JCMT in coordination with Akatsuki Radio Science experiment

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The upper atmosphere (>~60 km altitude) of Venus is of great interest for being a transient region in terms of temperature field, atmospheric dynamics, and atmospheric chemistry. The Radio Science (RS) instrument onboard Akatsuki spacecraft provides unique observational data set to constrain the thermal structure of this altitude region. Akatsuki RS uses the change in radio transmission between the spacecraft and Earth, caused by the Venus atmosphere when the spacecraft is occulted by Venus, to retrieve the vertical profile of temperature over an altitude range of ~40-95 km. It is noted that Akatsuki RS has the limitation on horizontal coverage of the observation: the temperature profile is obtained only at one localized area per each ingress and egress of occultation.

Complementary information can be obtained by ground-based heterodyne spectroscopic observations at sub-mm wavelength. Using the heterodyne technique, the pressure-broadened line shapes of molecular absorption/emission lines in the sub-mm region are spectrally resolved. The accurate measurements of such a line shape tell us the abundance of the absorbing species and temperature at several different pressure levels along the observing line-of-sight.

We conducted the ground-based sub-mm observations of CO in Venus atmosphere using the James Clerk Maxwell Telescope (JCMT), at Hawaii, in coordination with Akatsuki RS experiments. Four dates in May and June, 2017, were carefully arranged in order to realize the "simultaneous" observations. The temperature profiles at altitudes of ~70-110 km, which nicely overlap with (and extend) the sensitivity attitude range of Akatsuki RS, are retrieved from the observed CO spectra. The spatial resolution of JCMT observations is 14 arcsec. This resolution is, of course, not as fine as those of Akatsuki RS experiments. However, the advantage of the JCMT observations is that we could spatially "map" the temperature profiles on Venus disk with approximately 9 positions (the apparent disk diameter was 25-20 arcsec), which provides complementary information to the spatially localized measurements of Akatsuki RS.
In this study, we discuss the detail comparison of the temperature profiles obtained from the Akatsuki RS and JCMT observations.

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