ESTIMATING THE PRESSURE CEILING OF THE JUNE 2018 MARS GLOBAL DUST STORM. T. A. Livengood[1], J. R. Kolasinski[2], T. Kostiuk[2], T. Hewagama[3], [1]University of Maryland/GSFC/CRESST (timothy.a.livengood@nasa.gov), [2]NASA Goddard Space Flight Center, [3]University of Maryland.

Introduction: The global dust storm on Mars that developed in June 2018 obscured the surface completely. We can estimate the air pressure at the top of the dust cloud, which gives an idea of how high above the surface the weather extends on Mars.

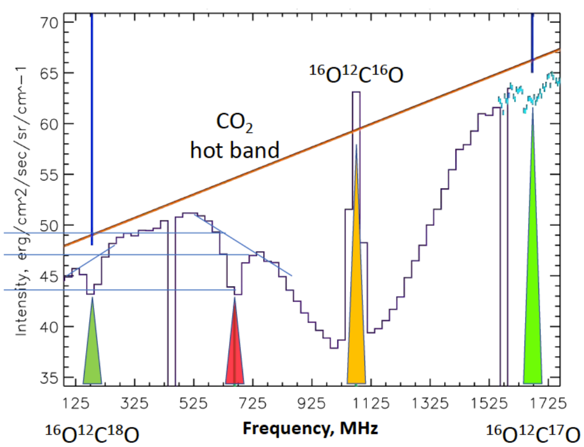


Fig. 1: Features in the CO_2 spectrum of Mars at 949.4793 cm^{-1} (10.5321 μm). This Mars spectrum was obtained in October 2007 from the NASA Infrared Telescope Facility on Mauna Kea, Hawaii, using the Goddard Space Flight Center (GSFC) Heterodyne Instrument for Planetary Winds and Composition (HIPWAC), with resolving power R=10^6. New spectra reported here were acquired with R=3×10^7.

Details: We observed the spectrum of a single rovibrational transition of carbon dioxide in Mars atmosphere within the 10.6 μm lasing band, using the Goddard Space Flight Center (GSFC) Heterodyne Instrument for Planetary Winds and Composition (HIPWAC) from the NASA Infrared Telescope Facility (IRTF) on Mauna Kea, Hawaii. Observations were acquired on June 9-13, 2018 (UT). The measurements were acquired targeting 42°, 37°, or 47° south latitude on the region of Hellas Planitia at several local times from late morning through nearly dusk. The measured spectrum differed significantly from previous Mars apparitions, in that a hot band transition of normal isotope CO_2 and a transition of ^{18}O-CO_2 that primarily form near the surface did not appear due to the reduced atmospheric path length and opacity above the areographic surface. The major absorption feature at the normal isotope transition of CO_2 was greatly reduced in breadth and depth, indicating that the dust cloud became optically thick at high altitude at a relatively warm temperature. We will infer the altitude at which dust rendered the atmosphere optically thick, and explore effects on the thermal profile.

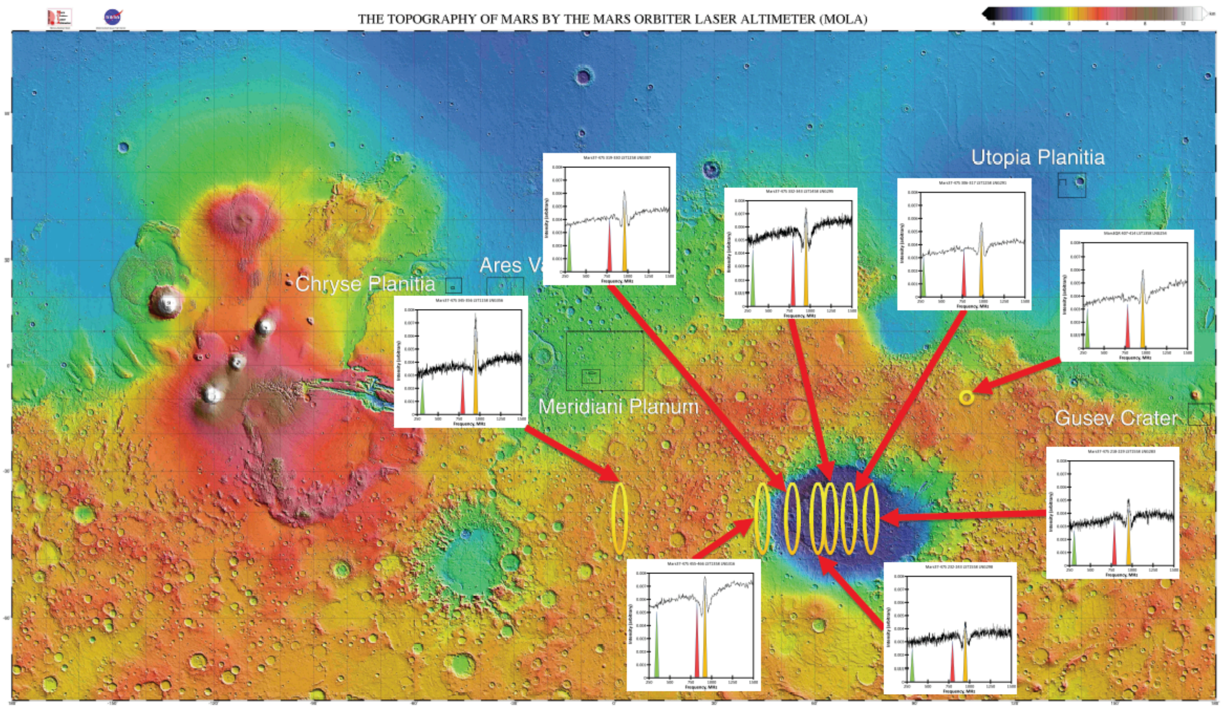
Spectrum: Figure 1 displays an example measured spectrum of Mars obtained with HIPWAC in 2007, through clear air near Mars equator at disc center. This spectrum is used as an example of what can be detected in the absence of a global dust event (GDE) or storm. The spectrum has five major structures:

1. Overall slope (orange line) due to the wings of the telluric CO_2 transition at 0 MHz frequency;
2. Doppler-shifted CO_2 transition in Mars (orange triangle) with core emission in broad tropospheric absorption feature;
3. ^{18}O-substituted CO_2 absorption formed at low altitude (dim green triangle);
4. ^{17}O-substituted CO_2 absorption formed at low altitude (bright green triangle);
5. Normal isotope hot band transition formed at low altitude (red triangle). The absorption depth is ~14.6% from the lower-sideband continuum, at surface pressure ~5.6 mbar.

The spectrum measured by HIPWAC represents spectral power distribution vs. difference frequency relative to a selected CO_2 transition. Currently available lasers have enabled investigations of CO_2 and O_3 in Mars as probes of chemistry, dynamics, and temperature, and similarly for Venus; hydrocarbons in outer planet atmospheres for similar purposes; and stellar atmospheres and circumstellar material for astrophysical purposes. Quantum Cascade Lasers (QCLs) are being studied to replace CO_2 gas lasers to access spectral intervals with no CO_2 transitions, with tunability to account for Doppler shift and desired target frequencies.

Although the 2018 data have not been fully reduced or numerically analyzed, certain features are immediately obvious. The isotopologue features and the hot band feature from 2007 are greatly reduced over the upper surface of the dust cloud. The tropospheric absorption feature is narrow and shallow, consistent with formation at significantly reduced pressure compared to the surface. Estimating the reduced depth of the hot band transition suggests air pressure at $\tau\sim1$ is 1.7–2.9 mbar. Pressure over the dust cloud on the equator is ~3.7 mbar. Variations between the spectra suggest that variability in estimated values is due to actual variability in the depth of the dust cloud rather than noise, consistent with convective processes.

Fig. 2 Mars spectra were collected over Hellas Planitia in 2018. These spectra were acquired at a natural resolution of R=3×10^7, rebinned to R~10^7. The majority of the spectra for this effort were collected over Hellas Planitia at local solar time 12:00, 13:00, 14:00, 15:00, 16:00 LST. Limited measurements were acquired on the equator at the sub-Earth meridian at 14:00LST.



Short abstract summary:

Mars HIPWAC spectra,
super-high resolution,
reveal height of dust.
Global dust obscures the ground,
hides the CO_2 features.