Density and temperature measurements with SPICAM stellar occultation

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Solar / Stellar occultation
Available occultations: 238 usable observations
Distribution in latitude and season
Available occultations: 238 usable observations
Distribution in Local time and Latitude
Solar / Stellar occultation
Model Transmission as a function of wavelength of CO2
(integrated slant density in molecules per cm²)

Transmission as a function of Integrated slant density of CO₂

Atmospheric transmission of CO₂

wavelength (nm)

0.0 0.2 0.4 0.6 0.8 1.0

10⁻¹⁸ 10⁻¹⁸ 10⁻¹⁹ 10⁻¹⁹ 10⁻²⁰ 10⁻²⁰

n=19 20 21 22 23 24 25

10^n
CO2 line density

Altitude (km)

CO2 line density ($10^{16}$ molec)
In some cases: very good match with model prediction

- **Black**: observations
- **Blue**: clear atmosphere
- **Green**: nominal dust
- **Red**: dusty atmosphere

orbit = 0245  lat = 16.8  lon = -136.0  Ls = 10.7  LST = 22.67
Inversion of line density

Density

Good match with model: only 28/238 cases

Temperature

Black: observations
Blue: clear atmosphere
Green: nominal dust
Red: dusty atmosphere

Lat = 16.8  Ion = -136.0
Ls = 10.7  LST = 22.67

Thermal tide
A few cases: warmer, denser high atmosphere
A few cases: warmer, denser atmosphere

 Density

 Temperature
Most cases: low density / cold atmosphere above
Most cases: low density / cold atmosphere above
Trends in the characteristic of the observations – model disagreement

- Good fit: 12%
- Cold upper atmosphere: 25%
- Very cold upper atmosphere: 38%
- Cold upper atm. + cold lower atm: 6%
- Cold lower atm.: 14%
- Warm atmosphere: 5%
Why low density / cold temperature?

- Problem with data…
- Strong decrease of CO2 mixing ratio above the homopause? Unlikely
- Actual low temperature?
  ⇒ Energy balance
Why so cold?
Energy balance of the upper atmosphere

![Energy balance diagram showing heating rates with labels for molecular conduction, EUV, IR (CO2), and NIR (CO2).]
Conclusions

• Hundreds of good quality profile of the Mars atmosphere. Work in progress:
  – CO2 cross section poorly known at low temperature
  – Inversion must be improved

• If one believe the observations : upper atmosphere (> 100 km) much less dense or colder than expected.