A study of the martian atmosphere using OMEGA/Mars Express and IR ground-based data


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The data sets

- **OMEGA/Mars Express**
  - Spectral range: 0.3-5.2 μm
  - Spectral resolution: 14nm at 1.0-2.7μm
  - IFOV: 1.2 mrad (300m at the surface near periapsis)
  - Results: H₂O mapping, study of CO over Hellas

- **TEXES, 3m-IRTF, Mauna Kea (Lacy et al.,2002)**
  - Spectral range: 1230-1245 cm⁻¹ (8.1 μm), 1348-1353 cm⁻¹ (7.4 μm)
  - Spectral resolution: 0.016 cm⁻¹ (R = 7.7 10⁴)
  - Spatial resolution: 1.5x1.5 arcsec after convolution
  - Dates: (1) June 2003 (Ls = 206°); (2) Dec.2005 (Ls = 332°)
  - Results: First H₂O₂ IR detection, H₂O and H₂O₂ mapping
H₂O mapping with OMEGA Mars Express

- Monitoring of H₂O band depth at 2.6 µm
- H₂O column density retrieved through a grid of curves of growth
- The surface pressure is taken from GCM/MOLA data base

**Results:**
- Ls = 330-40°: H₂O mapping with latitude and longitude
- Ls = 93-126°: H₂O mapping of the north polar cap

**References:**
- Encrenaz et al., Astron. Astrophys. 441, L9-L12, 2005
- Melchiorri et al., submitted to Plan. Space Sci., 2006
CO$_2$ and H$_2$O signatures in the OMEGA spectral ratios (Foot/Summit)

Strongest H$_2$O band at 2.6 µm

H$_2$O = 1.5 $10^{-4}$, 3 $10^{-4}$, 6 $10^{-4}$
H$_2$O column density, Ls = 330 -40°
(Maximum value = 20 pr-µm)
H$_2$O column density (max. value: 70 pr-µm) - Ls =101-115°

H$_2$O column density is underestimated where small icy grains are present
H$_2$O maximum is lower than reported by MAWD and TES(2002)
Monitoring of CO over Hellas

• CO (2-0) band at 2.35\( \mu \)m is measurable only for low altitude regions (Hellas)
• CO mixing ratio is expected to be enhanced over Hellas during southern winter (Forget et al., 2006)
• CO monitoring with OMEGA does confirm this effect

• **Reference:** Encrenaz et al., submitted to Astron. Astrophys., 2006
Determination of the CO mixing ratio over Olympus

CO = 750 +/- 100 ppm
$L_s = 335.7^\circ$

$L_s = 48.5^\circ$

$L_s = 132.0^\circ$

$L_s = 295.9^\circ$
Variations of the CO mixing ratio over Hellas with Ls
TEXES: The 1237-1243 cm\(^{-1}\) spectrum of Mars (June 2003)  
All lines identified down to depths of 0.3%  
S/N > 1000 in the continuum

H\(_2\)O\(_2\), 10\(^{-7}\) synthetic

TEXES data
Ts on Mars - June 2003 (Ls = 206°)

TEXES

GCM
$H_2O_2$ and $CO_2$ lines at 1241.6 cm$^{-1}$
H$_2$O$_2$ mapping on Mars (Ls = 206°)
Encrenaz et al. Icarus 170,424, 2004

TEXES
\[ Q(H_2O_2)_{\text{max}} = 4 \times 10^{-8} \]

GCM
\[ Q(H_2O_2)_{\text{max}} = 4 \times 10^{-8} \]
$H_2O_2$ on TEXES data - Dec. 2005, Ls = 332°
Mean $H_2O_2$ Mixing Ratio = 15 +/- 5 ppb

$H_2O_2/CO_2 = 10, 15, 20$ ppb
$\text{H}_2\text{O}_2/\text{CO}_2$ Line Depth Ratio
Dec. 2005 - Ls = 332°

$\text{H}_2\text{O}_2$ is less abundant than expected from the GCM
Suggests possible heterogeneous chemistry (Lefèvre et al., 2006)
H₂O mapping from HDO line at 1240 cm⁻¹
H₂O mixing ratio = 300 +/- 100 ppm
June 2003, (Ls = 206°)

H₂O/CO₂ = 200, 300, 400 ppm
$Q(H_2O)_{max} = 3 \times 10^{-4}$
TEXES - 30 Nov. 2005 - Ls = 332°
HDO line, 1236.3 cm-1

H$_2$O = 150 ppm, 200 ppm, 250 ppm
TEXES - 30 Nov. 2005 - Ls = 332°
HDO/CO$_2$ line depth ratio