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Water vapour in the Martian atmosphere from PFS/Mars express data.
Original $\text{H}_2\text{O}$ retrieval technique

$N = \int_{0}^{\infty} n(z) dz$  Column density

$Z = \frac{1}{N} \int_{0}^{\infty} z n(z) dz$  Effective altitude or scale height

$\left\{ \begin{array}{l} W_{SW} = W_{SW}(N, Z) \\ W_{LW} = W_{LW}(N, Z) \end{array} \right. \Rightarrow N, Z$

Has not been applied yet: PFS SWC calibration problems caused by MEX spacecraft vibrations.
Atmospheric water vapour bands in the PFS spectrum

<table>
<thead>
<tr>
<th>Channel</th>
<th>Band</th>
<th>Status</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>LWC</td>
<td>20 - 50 µm</td>
<td>OK</td>
<td>Calibrated orbits: up to 683 (Feb 2005).</td>
</tr>
<tr>
<td></td>
<td>6.3 µm</td>
<td>Noise, unusable</td>
<td></td>
</tr>
<tr>
<td>SWC</td>
<td>2.56 µm</td>
<td>OK ??</td>
<td>More dust sensitive. Dayside only.</td>
</tr>
<tr>
<td></td>
<td>1.87 µm</td>
<td>Noise, distorted</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.38 µm</td>
<td>Noise</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
- T-profile sensitive.
- More dust sensitive.
- Dayside only.
Examples of spectrum fitting

Averaging by 19 individual spectra

Small systematic misfits

LWC

SWC
SWC picture, orbits 10-538, $L_s=330-50^\circ$, ppm
Seasonally averaged SWC picture, orbits 10-538, $L_s=330-50^\circ$, prc. $\mu$m scaled to $p_s = 6$ mb
Seasonally averaged LWC picture, calibrated orbits of 10-612, $L_s=330-60^\circ$, scaled prc. $\mu\text{m}$
Disagreement of the LWC & SWC
Physics or instrument calibration?

- Calibration (spectrum distortion caused by MEX spacecraft vibrations)?
- Wrong spectroscopic data, in particular line broadening?
- True difference?
Comparison PFS LW, SW 2.56 & 1.38 µm H$_2$O band & 1.38 µm in SPICAM AOTF spectra

Poor S/N, but useful for diagnostics when averaged

- PFS SW 2.56
- PFS LW Ignatiev
- PFS LW Fouchet
- SPICAM 1.38, PFS algorithm
- SPICAM 1.38, Fedorova
- PFS SW 1.38

Example: orbit 278
See also the today presentations by E. Lellouch, D. Titov, and A. Fedorova

Such a big difference between 2.56 & 1.38 µm bands can hardly be explained by physical reasons (e.g. by dust optical properties).

Incorrect spectroscopic data can be partially responsible for the difference.

LWC is more reliable now, while SW channel requires careful re-calibration for quantitative analysis.

A very rough correction: a factor of 3.
SWC 2.56 µm H₂O column scaled by 1/3

orbits 10-538, \( L_s=330-50^\circ \)

orbits 987-1331, \( L_s=106-152^\circ \)

MGS TES, M. Smith
Water vapour column abundance (SWC scaled by 1/3) as a function of season and latitude

TES & MAWD data
M. Smith, JGR, 2002
Summary

- Global picture of water vapour as seen by PFS is close to MAWD & TES.
- PFS LW gives ~ 30% less water than TES (see also talks by E. Lellouch and by A. Fedorova).
- Detailed quantitative analysis requires careful PFS SWC data re-calibration and/or correction of spectroscopic data.
- Complete picture is to be obtained from joint study of PFS, SPICAM AOTF, and OMEGA.