Trace gas detection in the Earth Atmosphere using laser spectrometers

Code S and T ROSES workshop

Hans-Jürg Jost

Bay Area Environmental Research Institute
Sonoma, California

Earth Science Division
Atmospheric Chemistry and Dynamics Branch
NASA Ames Research Center
Moffett Field, CA
Argus Instrument

tunable diode laser

CO at 4.5 \( \mu \text{m} \)

CH\(_4\) at 3.3 \( \mu \text{m} \)

multipass cell 36 m

20 kg

30 cm

40 cm

30 cm
Carbon and Oxygen isotope measurements in CO₂

collaborators:
Prof. Livio Gianfrani
Antonio Castrillo
second University of Naples

1.6 µm
Off-Axis Integrated Cavity Output Spectroscopy (path length 3 km)
simultaneous δ¹³C and δ¹⁸O
few per mil
Water Isotope Ratio Measurements

- 1.4 µm
- optical feedback cavity enhanced spectroscopy
- simultaneous δD, δ17O, δ18O
- per mil precision
How to increase the absorption path...

Multi-pass cell (standard method)

Optical cavity (our solution)

High finesse cavity: 100 \times more passes + 100 \times less volume!

(\sim 10 \text{ ml volume} \rightarrow \text{very fast sample exchange time})
## Near-IR sensitivity of OF-CEAS

<table>
<thead>
<tr>
<th>Species</th>
<th>1Hz detection limit [ppb]</th>
<th>Laser ? [nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide CO₂</td>
<td>300</td>
<td>1600</td>
</tr>
<tr>
<td>Carbon monoxide CO</td>
<td>300</td>
<td>1566</td>
</tr>
<tr>
<td>H₂S</td>
<td>100</td>
<td>1600</td>
</tr>
<tr>
<td>Ethylene C₂H₄</td>
<td>50</td>
<td>1620</td>
</tr>
<tr>
<td>Methane, CH₄</td>
<td>1</td>
<td>1660</td>
</tr>
<tr>
<td>Ammonia, NH₃</td>
<td>2</td>
<td>1530</td>
</tr>
<tr>
<td>Water vapor H₂O</td>
<td>1</td>
<td>1390</td>
</tr>
<tr>
<td>Chloridric Acid HCl</td>
<td>1</td>
<td>1742</td>
</tr>
<tr>
<td>Floridric Acid HF</td>
<td>0.5</td>
<td>1312</td>
</tr>
</tbody>
</table>

courtesy D. Romanini
Near-IR sensitivity for Mars CH4
What’s next?

We would like to collaborate on instrument development for planetary atmosphere in-situ probes or where else our technology is applicable.