Carbon monoxide retrieved from ground based FTIR remote sensing in the mid- and near infrared spectral region

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CO data assessment

- Task: find a recommendation regarding data in the NDACC-TCCON overlapping region e.g. for satellite validation.
- Assessment of overall comparability of the different instruments and retrieval strategies of the FTIR measurement networks NDACC and TCCON.

<table>
<thead>
<tr>
<th>Site</th>
<th>Network</th>
<th>Lat</th>
<th>Lon</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bremen</td>
<td>NDACC &amp; TCCON</td>
<td>53.10 ° N</td>
<td>8.85 ° E</td>
<td>27 m</td>
</tr>
<tr>
<td>Izana (Tenerife)</td>
<td>NDACC &amp; TCCON</td>
<td>28.30 ° N</td>
<td>16.48 ° W</td>
<td>2367 m</td>
</tr>
<tr>
<td>St. Denis (La Réunion)</td>
<td>NDACC &amp; TCCON</td>
<td>20.90 ° S</td>
<td>55.49 ° E</td>
<td>87 m</td>
</tr>
<tr>
<td>Jungfraujoch</td>
<td>NDACC</td>
<td>46.55 ° N</td>
<td>7.98 ° E</td>
<td>3580 m</td>
</tr>
</tbody>
</table>
Overview

• Comparison between TCCON and NDACC regarding CO:
  • NDACC FTIR stations
    • Bruker 120M instruments or better
    • 3 narrow retrieval windows in the mid infrared
    • Profile retrieval algorithm
  • TCCON FTIR stations
    • Bruker 125HR instruments
    • 2 wide retrieval windows in the near infrared
    • Profile scaling algorithm
Retrieval windows

- **NDACC:**
  
<table>
<thead>
<tr>
<th>Window [wavenumbers]</th>
<th>Width [wavenumbers]</th>
<th>Interfering gases</th>
</tr>
</thead>
<tbody>
<tr>
<td>2057.70 - 2058.00</td>
<td>0.30</td>
<td>O₃, CO₂, OCS</td>
</tr>
<tr>
<td>2069.56 - 2069.76</td>
<td>0.20</td>
<td>O₃, CO₂, OCS</td>
</tr>
<tr>
<td>2157.50 – 2159.15</td>
<td>1.65</td>
<td>O₃, CO₂, OCS, N₂O, H₂O</td>
</tr>
</tbody>
</table>

- **TCCON:**
  
<table>
<thead>
<tr>
<th>Window [wavenumbers]</th>
<th>Width [wavenumbers]</th>
<th>Interfering gases</th>
</tr>
</thead>
<tbody>
<tr>
<td>4233.00</td>
<td>48.60</td>
<td>CH₄, H₂O, HDO</td>
</tr>
<tr>
<td>4290.40</td>
<td>56.80</td>
<td>CH₄, H₂O, HDO</td>
</tr>
</tbody>
</table>
Timeseries at Bremen station

- Very good agreement in seasonal variations.
- Mean NDACC value is \(\sim 5\%\) higher than TCCON.

- Postcorrections for the official data products are not taken into account.
SD-WACCM comparison

- Model comparison also shows a very good agreement.
- SD-WACCM data by the Douglas Kinnision group, UCAR, Boulder.
CO time series at Izana station

- Slightly different windows for NDACC are used (C. Rinsland).
- Lower values are in close agreement.
- For higher values NDACC is more sensitive.
CO time series at St. Denis

- NDACC is ~2.5% lower than TCCON.
- Southern hemisphere → seasonal cycle vice versa.
CO time series at Jungfraujoch

- Retrival of both wavenumber areas with profile retrieval.
- Better agreement, 4200 cm\(^{-1}\) area has higher DOF’s and less residual.
SD-WACCM comparison

- Model comparison also shows a very good agreement.
- SD-WACCM data by the Douglas Kinnision group, UCAR, Boulder.
Lokal events

- Local events show a different sensitivity for NDACC and TCCON.
- Trajectories coming directly from industrial zone in Germany.
Lokal events

- Only the lowest point changes significant.

NDACC apriori and retrieved profile
Lokal events

- Only the lowest point changes significant.

NDACC apriori and retrieved profile
Contemporary measurements

- Lower values are in close agreement.
- For higher values NDACC is more sensitive than TCCON.
Contemporary measurements

• Lower values are in close agreement.
• For higher values NDACC is more sensitive than TCCON.
• Similar slope for all NDACC/TCCON sites

• Jungfraujoch has a slope of ~1.
Contemporary measurements

- Relative difference with a clear seasonal cycle cause of higher values in spring.
- Vice versa for St. Denis
Cross retrieval

- GFIT retrieval in mid infrared gives same results as SFIT for total columns
Lokal events

- Local events show a different sensitivity for NDACC and TCCON.
- Trajectories coming directly from industrial zone in Germany.
Cross retrieval

- SFIT retrieval in near infrared gives lower results as GFIT for total columns
SFIT averaging kernels
GFIT averaging kernels
Residuals for NDACC MW‘s

- Using the recommended HITRAN 2008 database, residuals indicate non perfect spectroscopic data of $O_3$. 
Summary and Outlook

• Satisfying agreement of both retrieval strategies.
• Mid infrared aera reacts more sensitive to lokal events:
  – Different sensitivity of the wavenumber aeras.
• Spectroscopic issues.
• Using both networks for satellite validation could be a benefit due to the increased number of sites.
• Including aircraft campaigns.
• Rerun SFIT retrievals using new linelist (Toon).
Thank you for your attention!