Comparison of operational and scientific Sentinel-5-Precursor XCH₄ retrievals over methane emission hotspot areas

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- Methane (CH₄) is an important atmospheric greenhouse gas (GHG) with many localized emission sources
- Sentinel-5-Precursor (S5P) provides XCH₄ (= column-averaged methane mole fractions) at good spatial (7 km) and temporal (daily) resolution
- S5P XCH₄ permits to detect areas of locally elevated methane, which can be used to quantify emissions, e.g., from oil and gas fields
- Within ESA project Methane+ we compare S5P XCH₄ data products over areas with locally elevated XCH₄:
  - OPER: The operational ESA/Copernicus product (Hu et al., 2016)
  - WFMD: The scientific WFMD algorithm product (Schneising et al., 2019, 2020)
  - OPERbeta: Beta version of next operational version (Lorente et al., 2021)
Comparison of operational and scientific Sentinel-5-Precursor XCH₄ retrievals over methane emission hotspot areas

TGD = Galkynysh & Dauletabad gas and oil fields, Turkmenistan

10-April-2018

OPER: recommended filter:

OPER: relaxed filter:

Methane pattern similar (e.g., (yellow) emission plume) but difference pattern complex and not well understood
Comparison of operational and scientific Sentinel-5-Precursor XCH₄ retrievals over methane emission hotspot areas

TGD = Galkynysh & Dauletabad gas and oil fields, Turkmenistan
Comparison of operational and scientific Sentinel-5-Precursor XCH$_4$ retrievals over methane emission hotspot areas

CAL = Central Valley & surrounding, California, USA

15-October-2018

OPER: recommended filter:

OPER: relaxed filter:

OPER (much) sparser, even with relaxed quality filter
Methane pattern similar but difference pattern complex and not well understood
Comparison of operational and scientific Sentinel-5-Precursor XCH₄ retrievals over methane emission hotspot areas

SSU = South Sudan, Africa
January-October 2018
Comparison of operational and scientific Sentinel-5-Precursor XCH$_4$ retrievals over methane emission hotspot areas

<table>
<thead>
<tr>
<th>No</th>
<th>Target</th>
<th>Day in 2018</th>
<th>Orbit</th>
<th>Nobs</th>
<th>WFMD</th>
<th>OPER</th>
<th>OPERbeta</th>
<th>OPER</th>
<th>OPERbeta</th>
<th>Diff (OPER-WFMD) ± StdDev</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TGD</td>
<td>10-Apr</td>
<td>2539</td>
<td>7050</td>
<td>3718</td>
<td>3749</td>
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<td>-15.3 ± 5.9</td>
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<td>2469</td>
<td>2918</td>
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<td>0.76</td>
<td>-11.2 ± 14.4</td>
<td>-18.1 ± 11.4</td>
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<td>9209</td>
<td>5190</td>
<td>5342</td>
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<td>0.79</td>
<td>-0.1 ± 8.5</td>
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<td>5213</td>
<td>8699</td>
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<td>0.60</td>
<td>-10.4 ± 15.9</td>
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<td>+0.7 ± 17.8</td>
<td>-0.9 ± 19.1</td>
</tr>
</tbody>
</table>

Number of observations:
- OPERbeta > OPER
- Still: WFMD more data

R:
- Slightly higher for OPERbeta

Mean difference:
- OPERbeta typically lower cmp to OPER & WFMD
- Negative bias w.r.t. WFMD larger than before
- StdDev of difference:
  - Mostly smaller now

qa > 0.5 (recommended filter)

**OPERbeta in slightly better agreement with WFMD compared to OPER for Nobs and StdDev but not for regional mean difference. Overall no dramatic change esp. w.r.t. spatial pattern and coverage.**