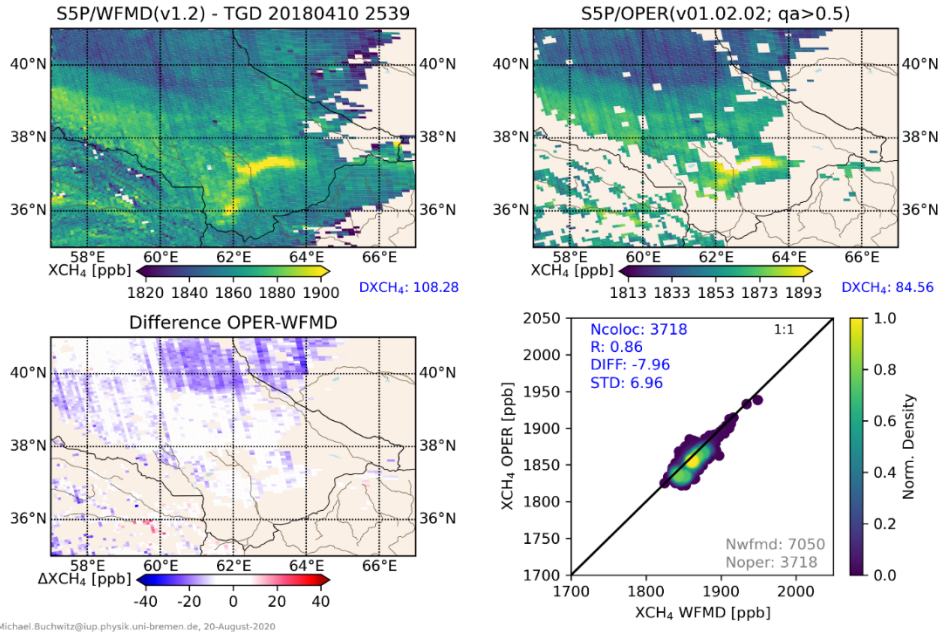
Comparison of operational and scientific Sentinel-5-Precursor XCH_4 retrievals over methane emission hotspot areas

M Buchwitz[1], O Schneising[1], S Vanselow[1], M Reuter[1], H Bovensmann[1], J P Burrows[1], I Aben[2], J Landgraf[2], A Lorente[2], T Borsdorff[2], C Retscher[3]

(1) Institute of Environmental Physics (IUP), University of Bremen, 28334 Bremen, Germany
(2) SRON Netherlands Institute for Space Research, 3584 CA Utrecht, the Netherlands
(3) Directorate of Earth Observation Programmes, European Space Agency (ESA), ESRIN, 00044 Frascati, Italy

- Methane (CH_4) is an important atmospheric greenhouse gas (GHG) with many localized emission sources
- Sentinel-5-Precursor (S5P) provides XCH_4 (= column-averaged methane mole fractions) at good spatial (7 km) and temporal (daily) resolution



- S5P XCH_4 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 XCH_4 data products over areas with locallally elevated XCH_4:
  - **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)

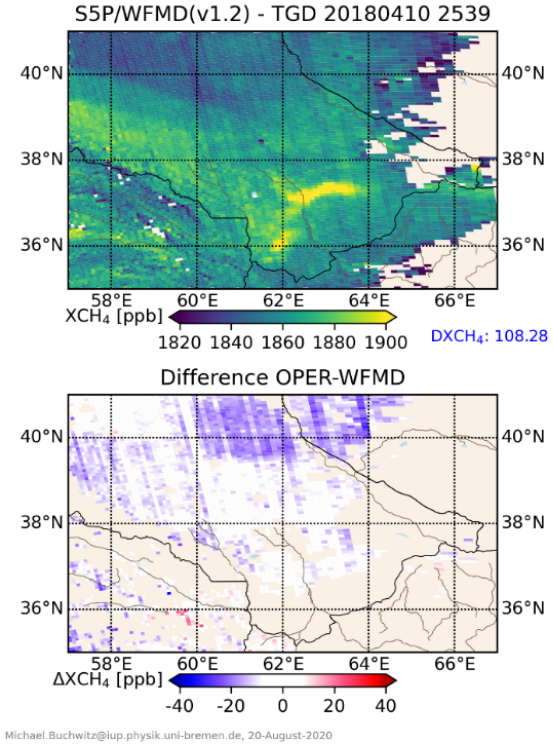
Universität Bremen

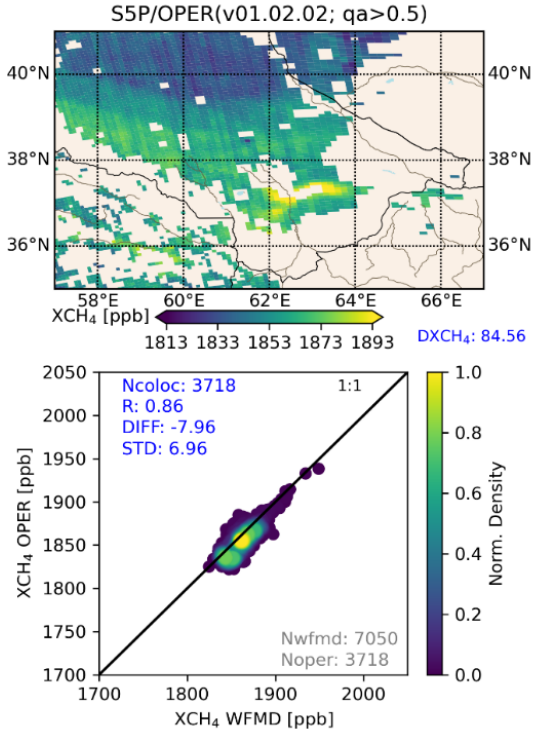
Michael Buchwitz
Institute of Environmental Physics (IUP)
University of Bremen, Germany

TGD = Galkynysh & Dauletabad gas and oil fields, Turkmenistan

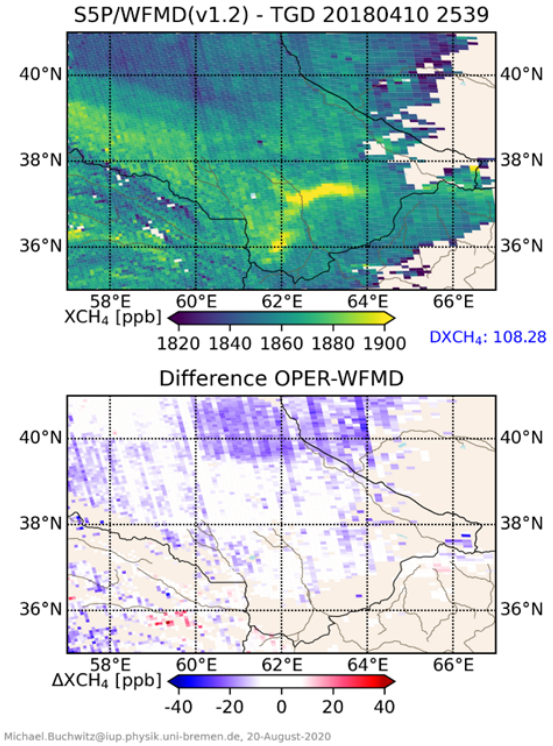
10-April-2018

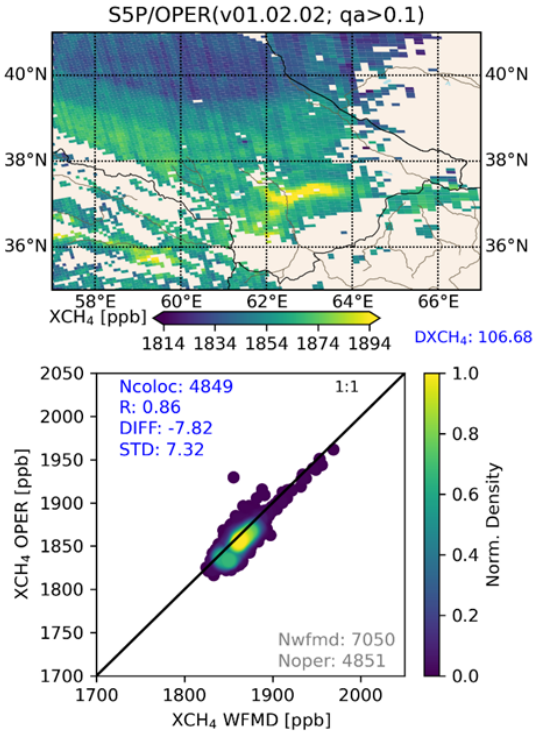
OPER: recommended filter:





OPER: relaxed filter:





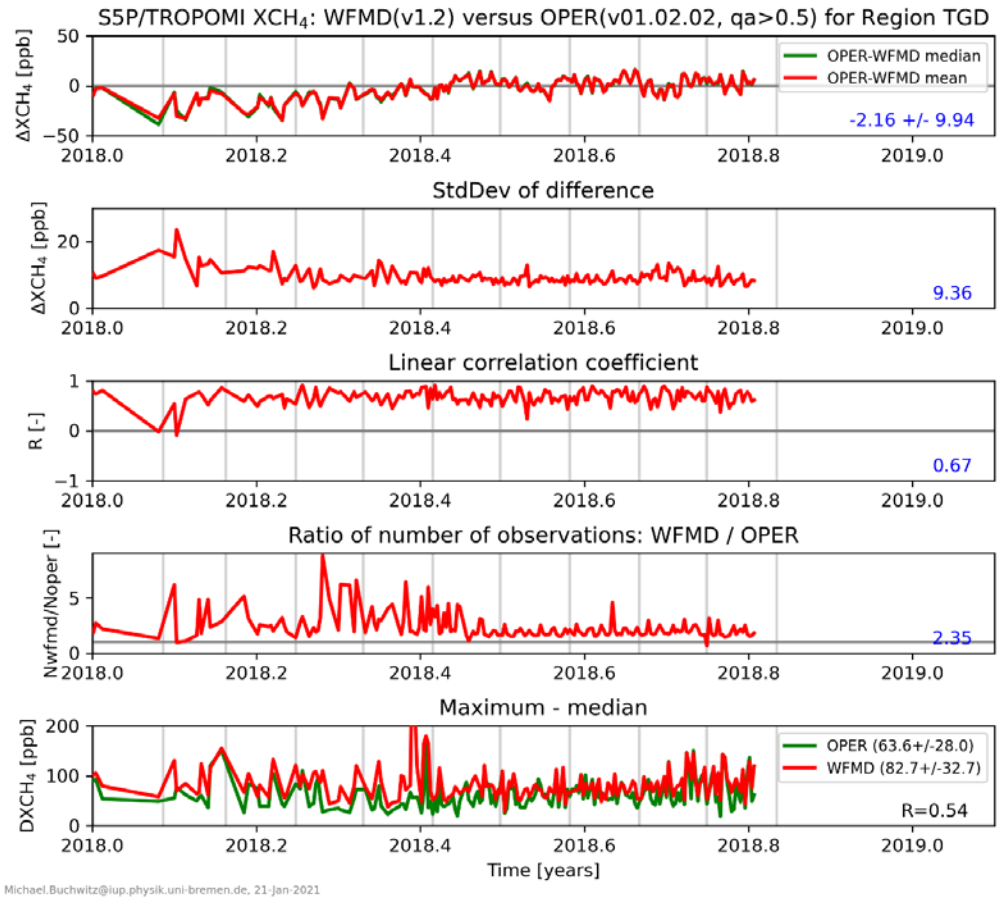
OPER sparser, even with relaxed quality filter
Methane pattern similar (e.g., (yellow) emission plume) but difference pattern complex and not well understood

Universität Bremen

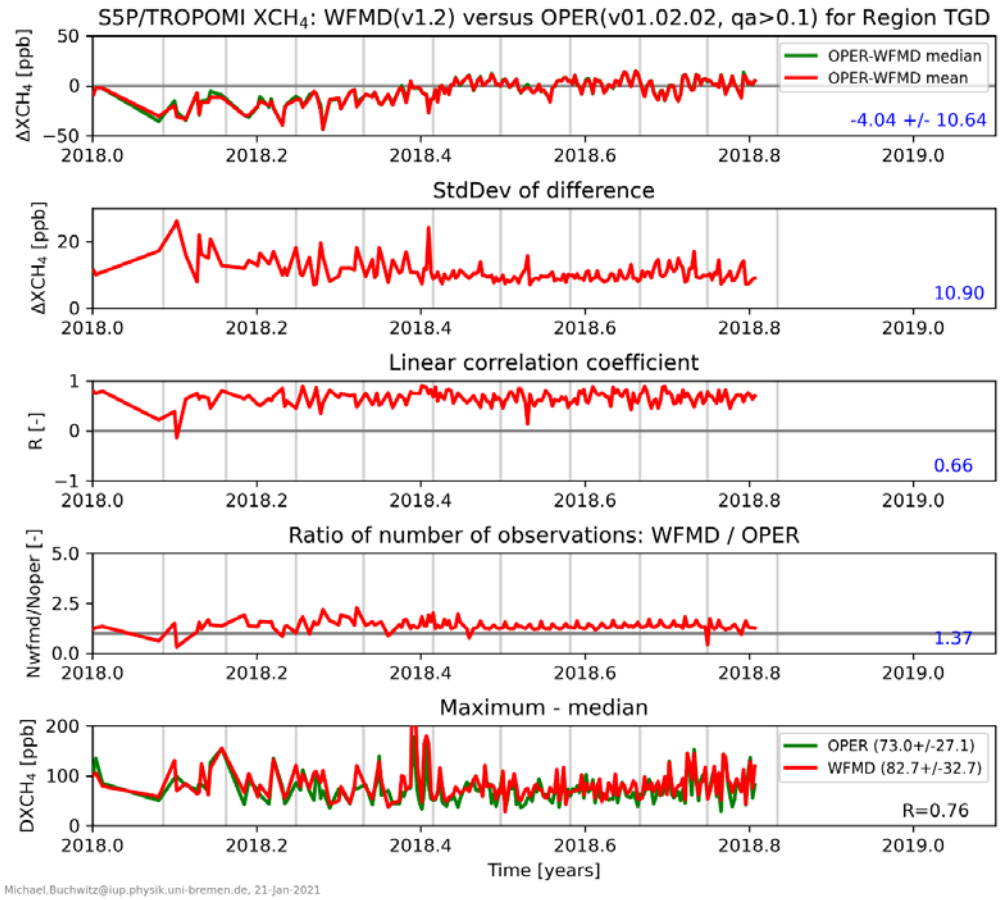
Michael Buchwitz
Institute of Environmental Physics (IUP)
University of Bremen, Germany

TGD = Galkynysh & Dauletabad gas and oil fields, Turkmenistan

OPER: recommended filter:



OPER: relaxed filter:



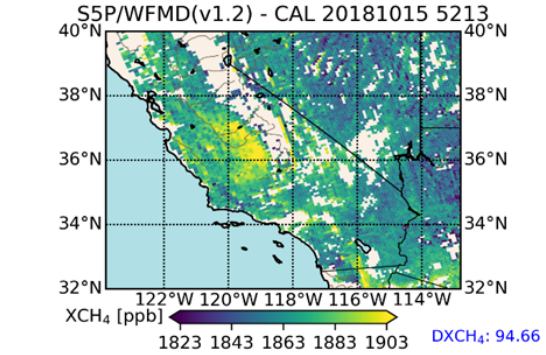
Universität Bremen

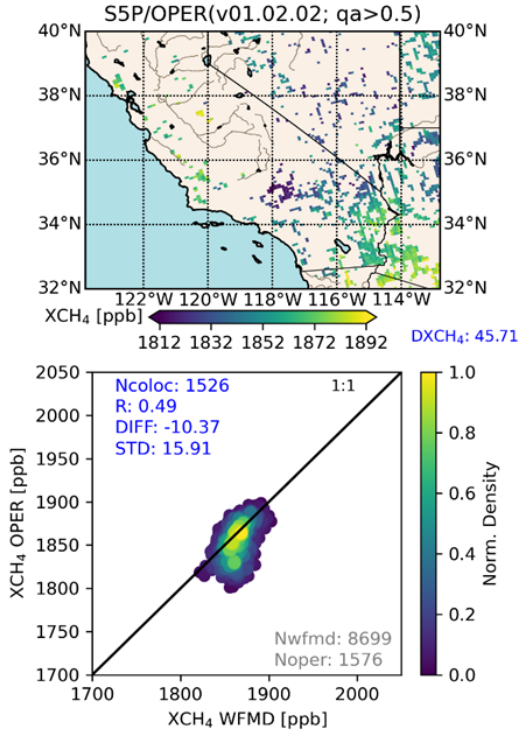
Michael Buchwitz
Institute of Environmental Physics (IUP)
University of Bremen, Germany

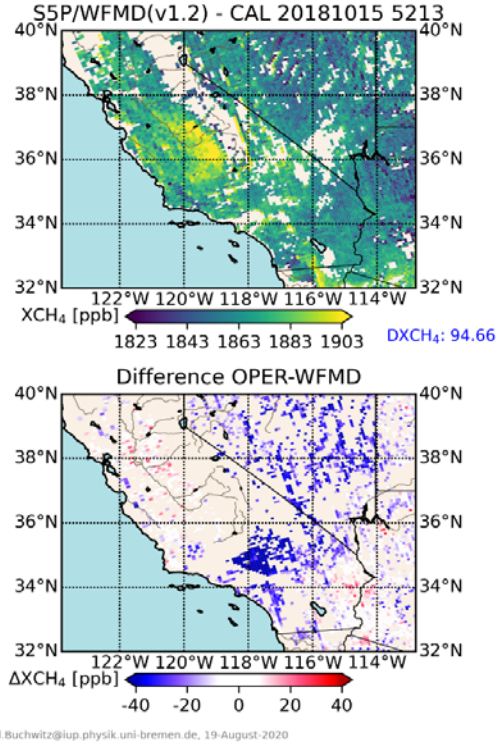
CAL = Central Valley & surrounding, California, USA

15-October-2018

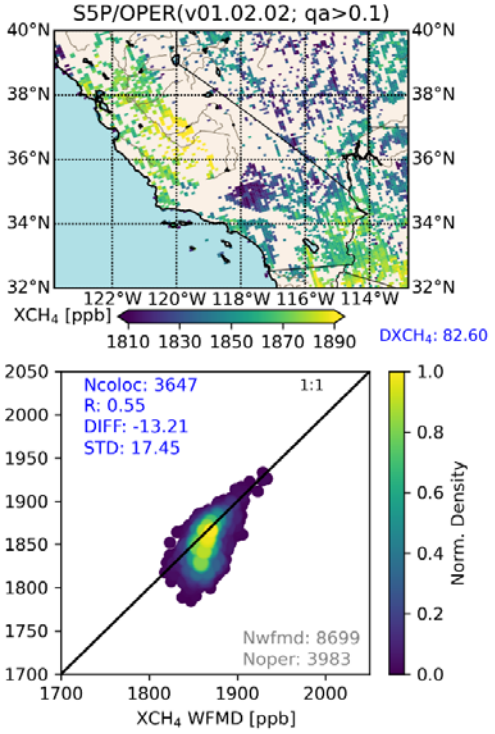
OPER: recommended filter:







OPER: relaxed filter:



OPER (much) sparser, even with relaxed quality filter
Methane pattern similar but difference pattern complex and not well understood

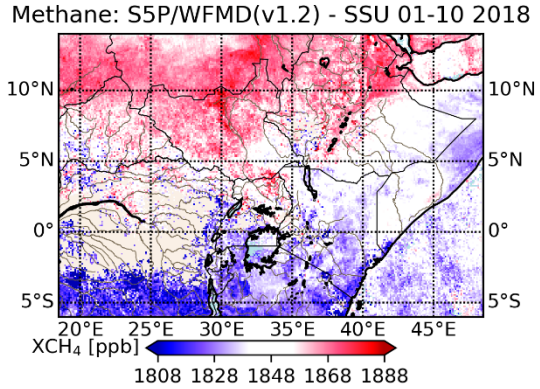
Universität Bremen

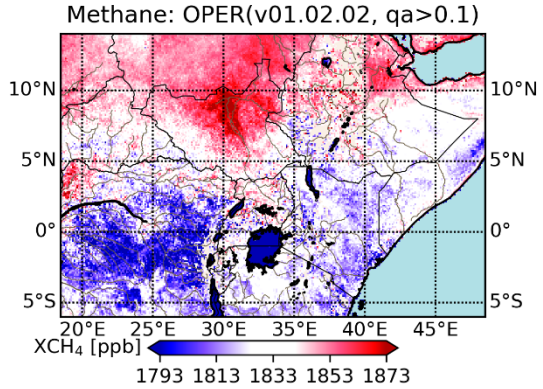
Michael Buchwitz
Institute of Environmental Physics (IUP)
University of Bremen, Germany

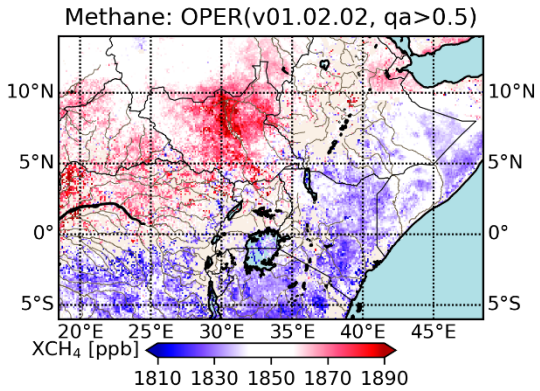
SSU = South Sudan, Africa

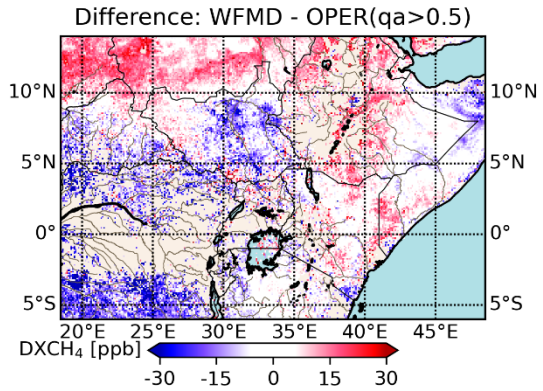
January-October 2018

Mean XCH_4



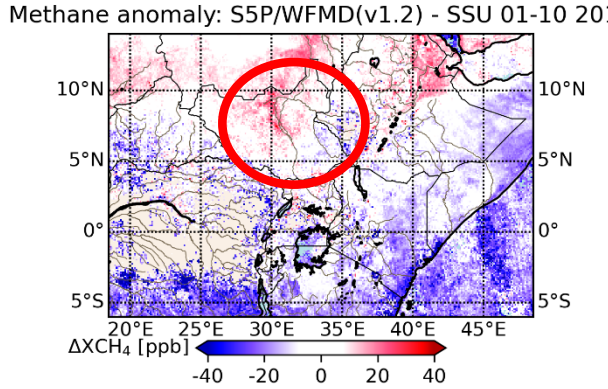


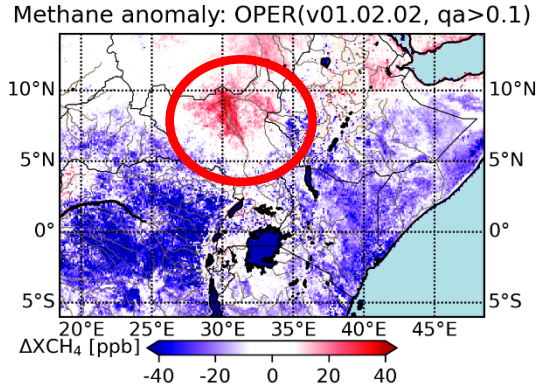


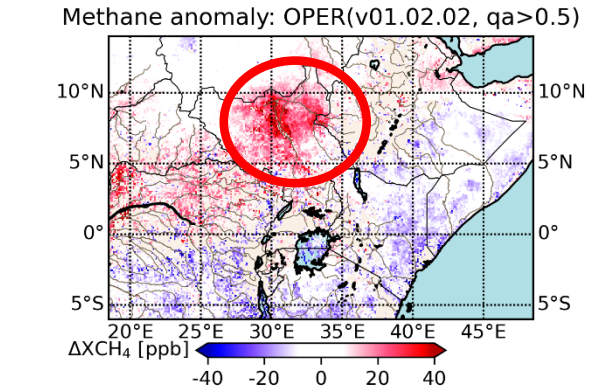


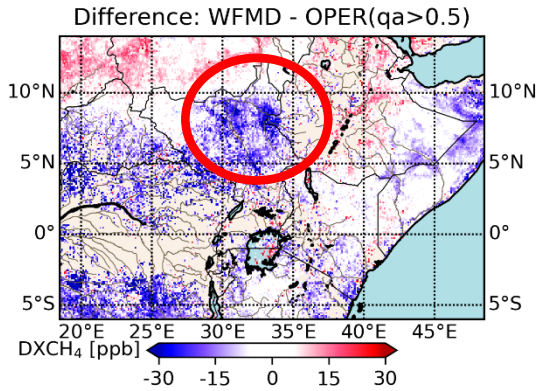
Michael.Buchwitz@iup.physik.uni-bremen.de, 22-August-2020

DAM (= averaging daily XCH_4 anomalies)









Michael.Buchwitz@iup.physik.uni-bremen.de, 22-August-2020

Universität Bremen

Michael Buchwitz
Institute of Environmental Physics (IUP)
University of Bremen, Germany

Comparison of operational and scientific Sentinel-5-Precursor XCH_4 retrievals over methane emission hotspot areas

No	Target	Day in 2018	Orbit	Nobs			Correlation with WFMD		Diff (OPER-WFMD) ± StdDev	
				WFMD	OPER	OPERbeta	OPER	OPERbeta	OPER	OPERbeta
1	TGD	10-Apr	2539	7050	3718	3749	0.86	0.89	-8.0 ± 7.0	-15.3 ± 5.9
2	-"-	8-May	2936	7564	2469	2918	0.63	0.76	-11.2 ± 14.4	-18.1 ± 11.4
3	-"-	4-Jun	3319	9209	5190	5342	0.77	0.79	+0.1 ± 8.5	-5.7 ± 8.1
4	CAL	15-Oct	5213	8699	1576	1981	0.49	0.60	-10.4 ± 15.9	-13.8 ± 11.5
5	SSU	1-Jan	1136	21780	8491	10657	0.60	0.65	-4.2 ± 10.4	-4.7 ± 8.9
6	-"-	9-Aug	4257	8742	1476	1592	0.90	0.93	-4.7 ± 8.4	-4.7 ± 7.9
7	-"-	7-Oct	5094	6370	1652	1998	0.77	0.78	+0.7 ± 17.8	-0.9 ± 19.1

qa > 0.5 (recommended filter)

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

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.

Universität Bremen

Michael Buchwitz
Institute of Environmental Physics (IUP)
University of Bremen, Germany