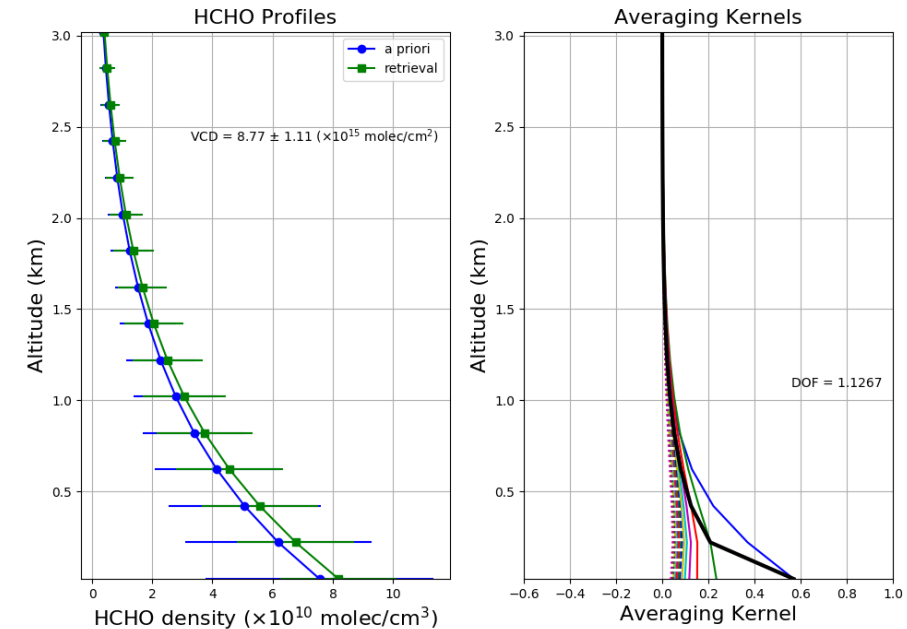


Formaldehyde OFFL Validation

Validation Method:

- Satellite: OMI/EOS-AURA (QA4ECV product)
 - I. De Smedt(BIRA-IASB)
- Ground-based: MAX-DOAS and NDACC-FTIR (S5PVT AO)
 - G. Pinardi, C. Vigouroux (BIRA)
- Satellite: GOME-2/MetOp (Operational product)
 - K. L. Chan (DLR)
- Satellite: IUP DOAS HCHO columns from S5P verification algorithm
 - K. Lange, A. Richter, L. Alvarado (IUPB)
- VDAF routine validation (S. Compernelle, B. Langerock, BIRA)
- Satellite: OMI, OMPS PCA approach (S5PVT AO)
 - N. Krotkov (NASA GSFC)
- Model: IMAGES/Magritte (S5PVT AO)
 - J. Stavrakou (BIRA)



(MAXDOAS results,
see talk: K.L. Chan)

S5P TROPOMI L2_HCHO data available for validation

- RPRO (reprocessed) data, processor 01.01.02: 30 April – 1 August 2018
- OFFL data, processor 01.01.02: 2 August 2018 - now
- NRTI data, processor 01.01.02: 8 August – now (not considered here)

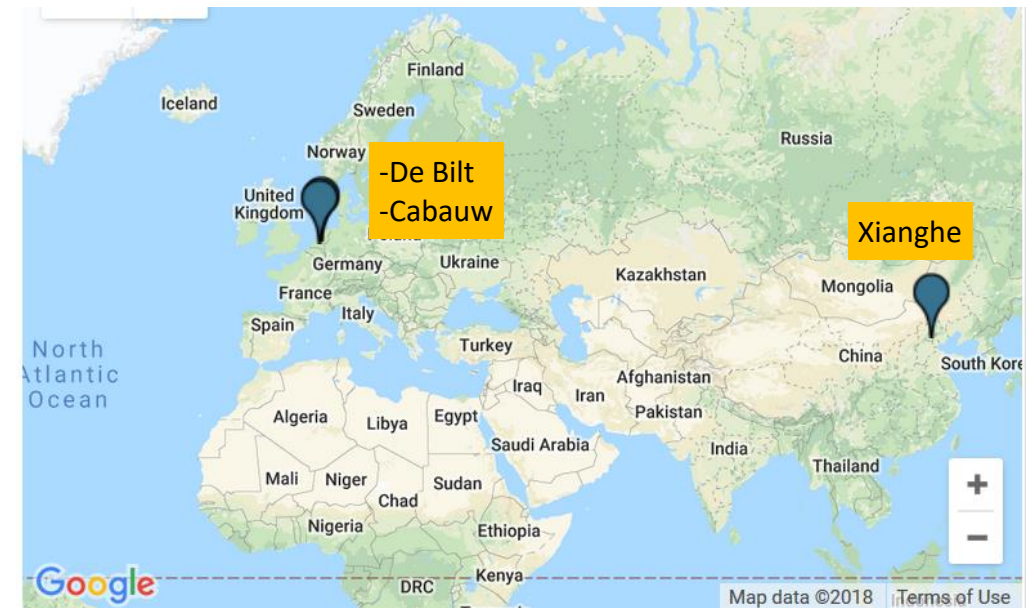
Overpass files obtained from PDGS@DLR

Filter: qa_value > 0.5

FRM data available for validation

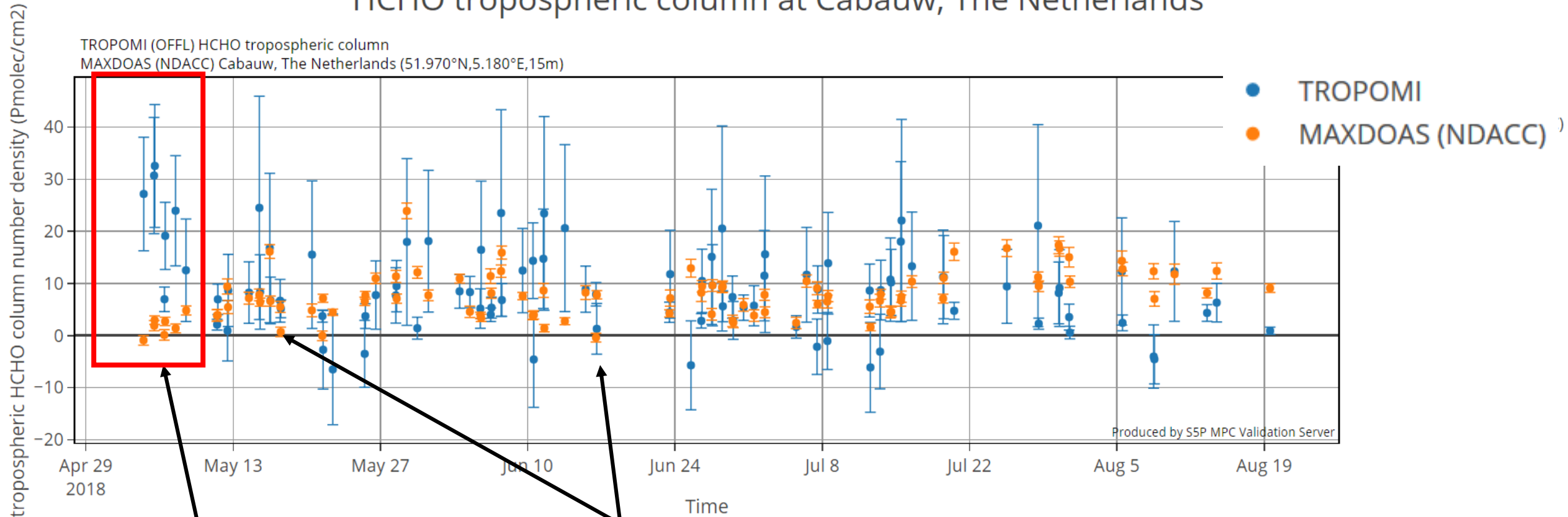
NDACC MAXDOAS measurements

- Rapid delivery data
- 3 stations: 2 NL (KNMI), 1 CN (BIRA-IASB)
- Also available through EVDC



HCHO OFFL on AVS

HCHO tropospheric column at Cabauw, The Netherlands



Early May elevated HCHO.
Known issue (BG correction)

Low ref values: they blow up mean((SAT-REF)/REF). Especially problem at Cabauw.

Filter on early May values (known issue) and, for relative diff, on REF<1Pmolec cm-2

Results: bias

Formaldehyde 	Total HCHO	total column	bias 40-80%	Precision 1.2e16 (4e15)
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Bias

Site	Cabauw	De Bilt	Xianghe
Count	85	109	45
Mean((SAT-REF)/REF)	29%	-42%	-29%
median((SAT-REF)/REF)	4%	-47%	-35%
SEM	24%	8%	6%

Caveats:
Only 3 sites!
Limited amount of data!
Short time range!

Precision of comparison too low to judge

Statistically significant negative bias, but below 80%, the upper bias limit requirement

Results: precision

Formaldehyde 	Total HCHO	total column	bias 40-80%	Precision 1.2e16 (4e15)
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12 (4) Pmolec cm-2

Comparison spread

Site	Cabauw	De Bilt	Xianghe
Count	88	110	45
STD(SAT-REF) [Pmolec cm-2]	8	10	10
IQR(SAT-REF) [Pmolec cm-2]	12	11	13
Norm IQR(SAT-REF)* [Pmolec cm-2]	9	8	9

Caveats:
Only 3 sites!
Limited amount of data!
Short time range!

Comparison spread below 12 Pmolec cm-2.
SAT precision is only one component of comparison spread (probably dominant one)
So SAT is compliant with upper precision limit requirement.

*Norm IQR=IQR*0.7413. For normal distribution, Norm IQR =STD

Conclusions

- Within the limited amount of comparison data available, and
- even without correcting for comparison error and reference error
 - Bias requirement seems to hold
 - Upper precision requirement seems to hold
- Future work: investigate impact of
 - Spatial averaging
 - A priori profile harmonization
 - Constraining reference data to the assumed satellite sensitivity

HCHO: MPC Product Summary

Kai-Uwe Eichmann, Isabelle de Smedt, Andreas Richter, Steven Compernelle, Ka Lok Chan



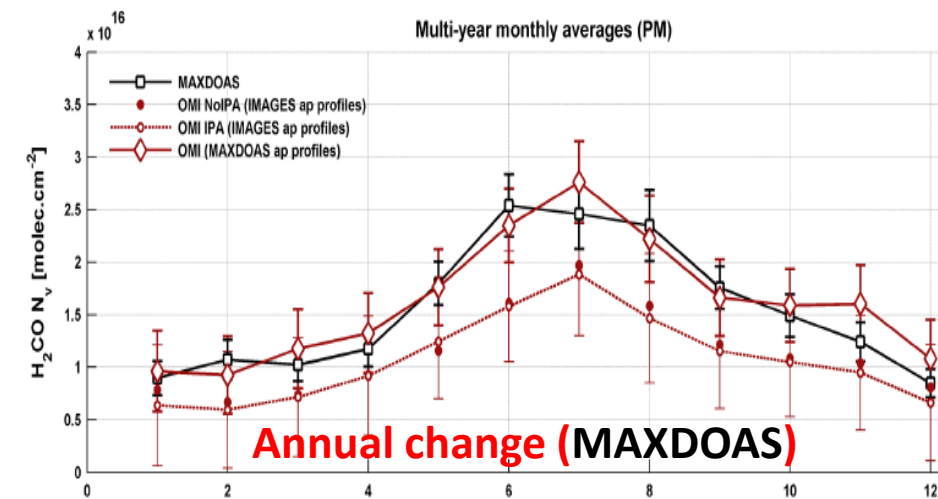
S5p Second Products Release Workshop
September 28, 2018



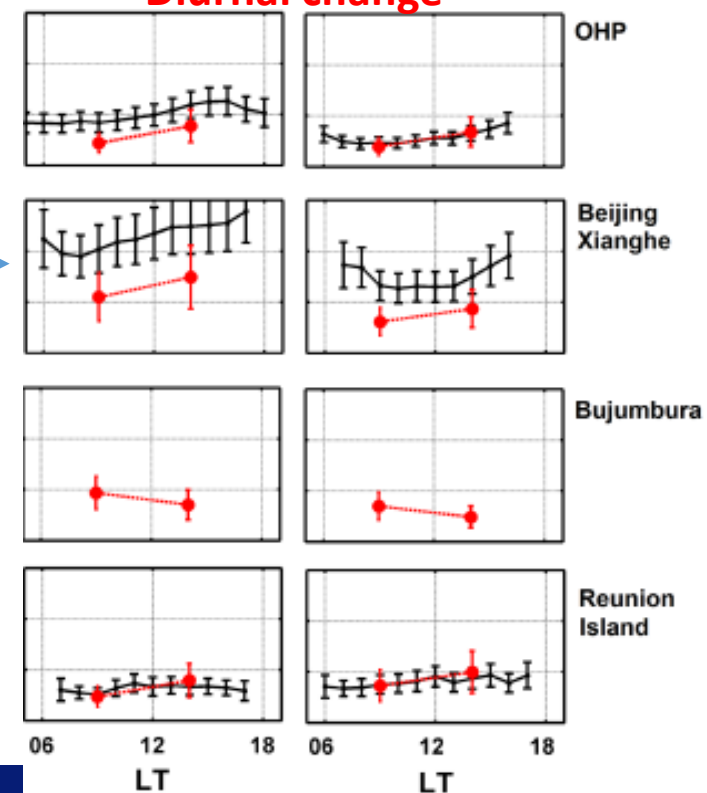
Formaldehyde: Overview

(deSmedt, 2015)

- Product requirements:
 - Accuracy: 40-80%
 - Precision: 12 Pmol/cm²
- HCHO has an **annual cycle** with highest values in the summertime (e.g. in Xianghe 15 Pmc).
- HCHO is rather constant during the day in clean areas. Larger changes over urban areas are possible. The **diurnal changes** are below 4 Pmol/cm² between morning and afternoon.
- While the satellite HCHO is quite close to independent measurements in rural areas, an underestimation can be expected for polluted areas. This might get larger for **higher spatial resolution** of TROPOMI (spatial smearing).

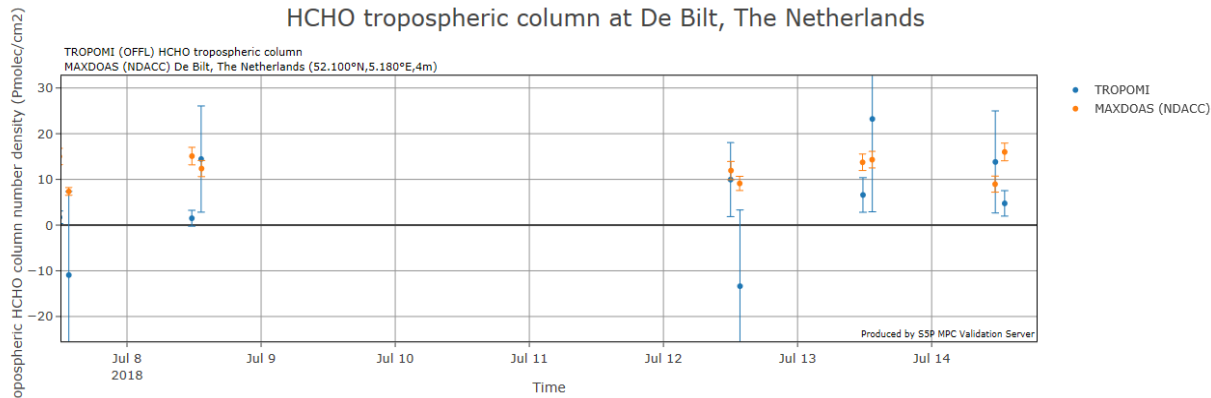


Diurnal change

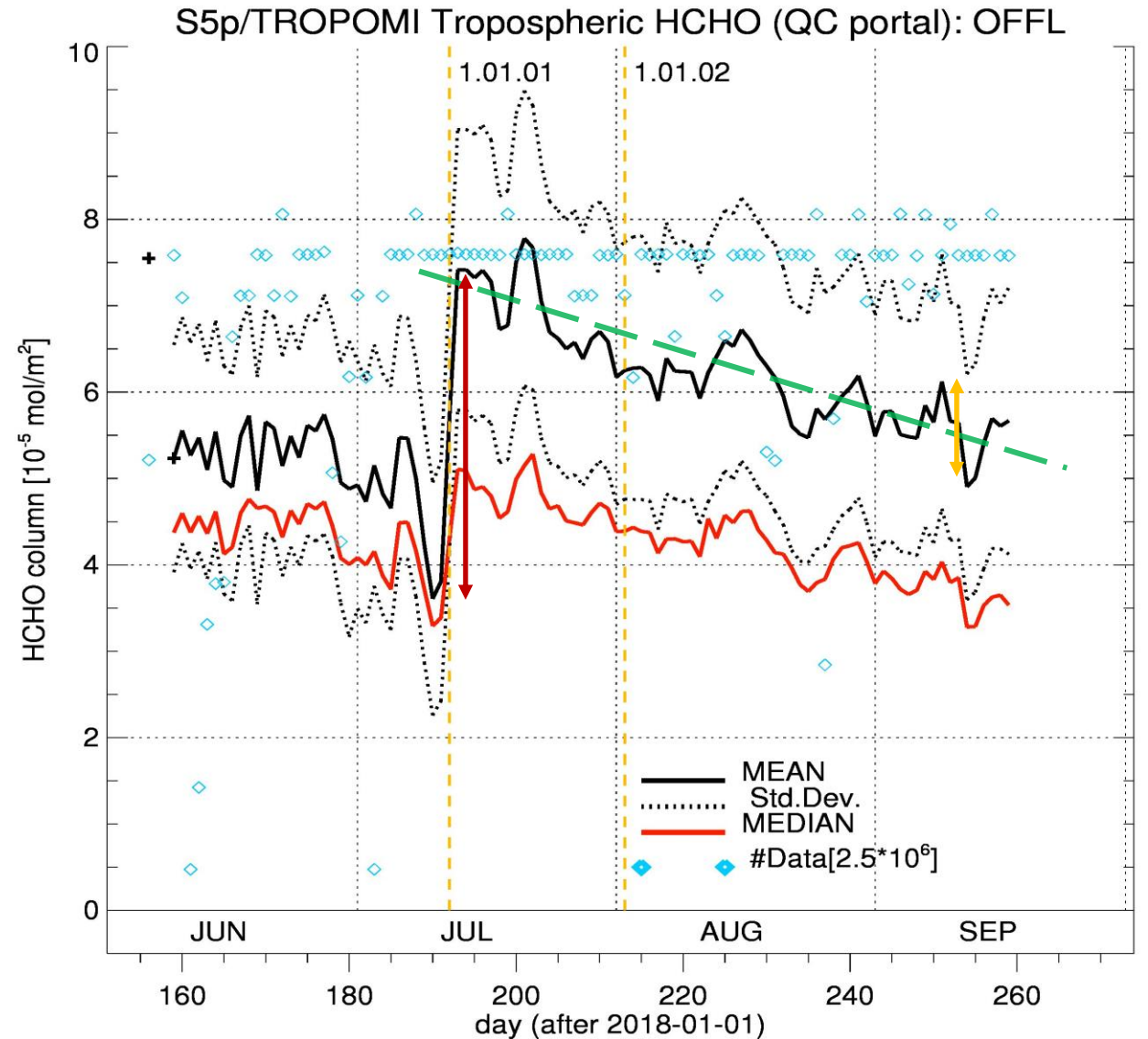


HCHO global mean (MPC L2QC portal)

- *Jump* in the mean from processor version 1.00.00 to 1.01.01 (2018-07-11) by $3.6E-6$



- General *decline* of HCHO from July onwards.
- Day to day *variations* can be in the range of 13% (2018-09-10 vs 09-11).



Summary: HCHO results

HCHO		Bias, Precision	Scatter, Accuracy					
	Troposphere	40-80% (<12 PMC) (educated guess)	12 PMC					
Product	Method	Dataset	Spatial	Temporal	Bias	Scatter	Comments	Validator
SCD	SCD vs IUP	RPRO/OFFL	global	2018	good	OK	QA problems, cloud top pressure dependency	IUP
VCD	MAXDOAS	RPRO/OFFL	3 stations	Mid-May - now	<80%	<12PMC	neg. bias at De Bilt and Xianghe	Validation Server
		OFFL	1 station	Dec-Jul	>-40%	~10PMC	neg. bias at Munich, differences between local retrieval and PDGS ~10 PMC	DLR
	MAXDOAS	RPRO/OFFL	10 stations	Mid-May - now	<40%	nok	neg. bias, mexican sites much lower	BIRA
	FTIR	RPRO/OFFL	18 stations	Mid-May - now	-10%	ok/nok	AK/height correction, scatter ok at unpolluted stations, higher at polluted ones	BIRA
	OMI	RPRO/OFFL	global	2 seasons	>-20%		OFFL better than RPRO (background correction, apriori selection), cloud pressure reason for differences	BIRA
	VCD vs. IUP	RPRO/OFFL	global	2018	good	OK		IUP
	GOME-2	OFFL	global	2 month mean	>-50% (>-15PMC)	~10PMC	neg. bias, dependent on pollution level	DLR