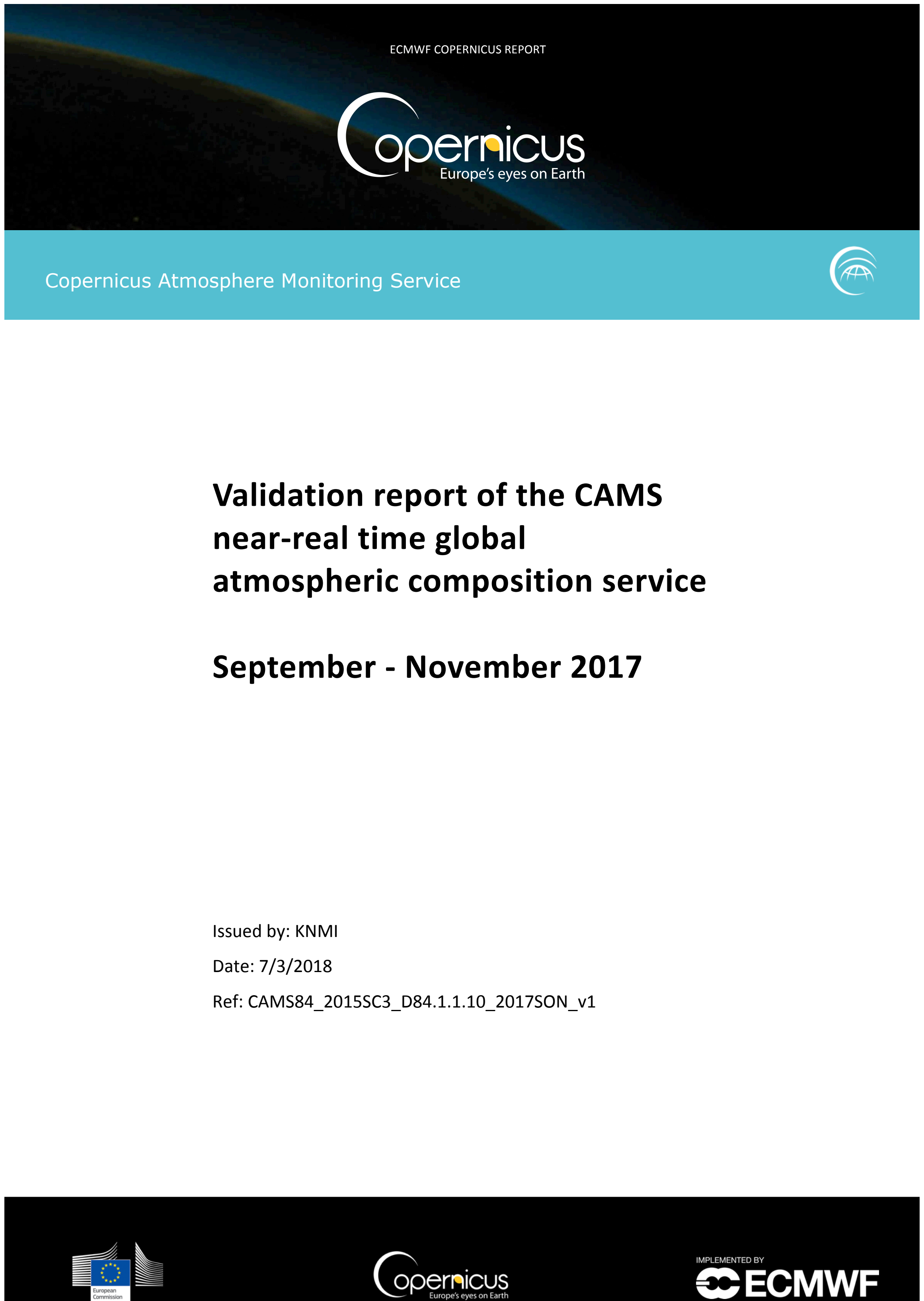
# CAMS27: CAMS funding for NDACC

Bavo Langerock & Martine De Mazière

# CAMS



ECMWF COPERNICUS REPORT

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Copernicus Atmosphere Monitoring Service

**Validation report of the CAMS near-real time global atmospheric composition service**

**September - November 2017**

Issued by: KNMI

Date: 7/3/2018

Ref: CAMS84_2015SC3_D84.1.1.10_2017SON_v1

Copernicus
Europe's eyes on Earth

IMPLEMENTED BY ECMWF

- copernicus atmosphere monitoring service

- http://atmosphere.copernicus.eu/

- NDACC data is used for in quarterly validation reports
requires data of
1/ sufficient quality (QC)
2/ delivered within 1 month after measurement (RD)

### 4.3 Validation against FTIR observations from the NDACC network

In this section, we compare the CO profiles of the CAMS models with FTIR measurements at Maido (21°S, 55°E, i.e. southern tropics, altitude 2.2km) and Lauder (46°S, 169.7°E, altitude 370m'. These ground-based, remote-sensing instruments are sensitive to the CO abundance in the troposphere and lower stratosphere, i.e. between the surface and up to 20 km altitude. Tropospheric CO profiles and columns are validated (up to 10km). A description of the instruments and applied methodologies can be found at http://nors.aeronomie.be.

Table 4.3.1 and Fig. 4.3.1 show that the tropospheric columns of CO agree well. The o-suite underestimates CO at Lauder with values around 2%, which is within the measurements uncertainty range (6%). At Maido the o-suite underestimates the CO abundance (approx. -6%, underestimation seems to decrease in time). The mean uncertainty on these measurements is 5%, so the observed o-suite biases are now only slightly larger than the measurement uncertainty). During the biomass burning season (SON) the bias of the control run decreases. For both stations, the control run overestimates the background CO with MBs between 20%-30%, clearly showing the positive effect of assimilation.

Table 4.3.1: Seasonal relative mean bias (MB, %), standard deviation (STD, %) for the considered period and number of observations used (NOBS), compared to NDACC FTIR observations at Lauder and Maido (mean bias and stddev in %). The overall uncertainty for the CO measurements at Lauder and Maido is approximately 5%.

| | | DJF | | | MAM | | | JJA | | | SON | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MB | stddev | nobs | MB | stddev | nobs | MB | stddev | nobs | MB | stddev | nobs |
| o-suite | Lauder | 0.93 | 6.27 | 168 | -0.29 | 6.65 | 160 | 5.89 | 3.94 | 135 | 0.01 | 4.61 | 221 |
| control | Lauder | 44.32 | 10.46 | 168 | 54.65 | 7.04 | 160 | 42.47 | 7.63 | 133 | 20.80 | 8.28 | 221 |
| o-suite | Maido | -5.14 | 10.12 | 324 | -2.04 | 5.64 | 457 | -5.06 | 3.67 | 234 | -3.20 | 3.93 | 337 |
| control | Maido | 42.79 | 6.77 | 324 | 43.05 | 7.86 | 457 | 24.95 | 7.78 | 234 | 6.44 | 11.34 | 337 |

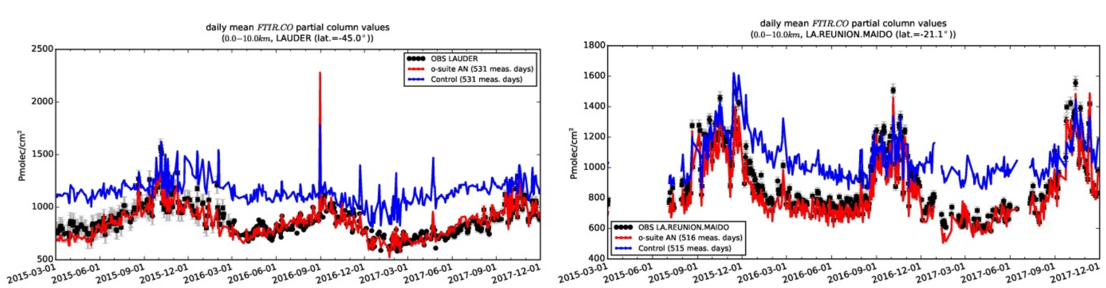

Figure 4.3.1: Daily mean values of tropospheric CO columns (till 10km) by the o-suite (red) and the Control run (blue) compared to NDACC FTIR data at Lauder, New Zeeland (45°S, 169.7°E) (left) and Maido (21°S, 55°E) (right) for the period March 2015-December 2017. The number of measurement days is indicated in the legend. In Lauder a spike is seen at the end of August 2016. This is caused by a drifting fire source in the model, as discussed in a previous report.



- Limited number of stations in reports: CO -> Lauder (Dan Smale) & Maido
- O3: 2 MWR and 2 LIDAR
- ...

# CAMS27

Support for The Provision Of NDACC Observations

- CAMS provides support to NDACC for **rapid delivery** of **quality** data to NDACC DHF for
  - **FTIR**: $CH_4$, CO, $O_3$
  - **MWR**: $O_3$
  - **LIDAR**: $O_3$
  - **UVVIS zenith:** $NO_2$, $O_3$
  - **UVVIS offaxis**: HCHO, $NO_2$, Aerosol
- Start/End = July 2017 - July 2021
- First Service Contract: July 2017 - December 2018
- NDACC data stream monitoring in place since March 1 2018
- funding for submission (x€/y) and for development (5k€)
- **QC because differences in site-to-site biases must be due to model performance (not retrieval settings eg)**

During Jan 2018:

- 80% out of 256 submitted files were QC ok
- 40% out of 256 submitted files were RD ok
- 16 instruments actively contributing

During March 2018:

- 95% out of 544 submitted files were QC ok
- 96% out of 544 submitted files were RD ok
- 32 instruments actively contributing (will increase)
- PI’s can consult the status of their submission on cams27.aeronomie.be

# FTIR March - June 2018: 53/1800 files

- 96% out of 53 submitted files were QC ok
- 90% out of 53 submitted files were RD ok
- 9 instruments actively contributing (will increase)

- ftir.co_awi001(Ny-Ãlesund): 2/2 = 100.00%
- ftir.co_awi028(Paramaribo): 7/7 = 100.00%
- ftir.co_bira.iasb003(Mt Maido): 9/9 = 100.00%
- ftir.co_iup001(Bremen): 6/6 = 100.00%
- ftir.co_niwa001(Lauder): 2/2 = 100.00%
- ftir.co_niwa004(Arrival Heights): 0/2 = 0.00%
- ftir.co_spbu001(St Petersburg): 4/4 = 100.00%
- tir.co_ulg002(Jungfraujoch): 2/4 = 50.00%
- ftir.co_unam001(Altzomoni): 4/4 = 100.00%
- ftir.co_utoronto001(Eureka): 5/6 = 83.33%
- ftir.co_utoronto002(Toronto): 5/7 = 71.43%

cams27.aeronomie.be

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Atmosphere Monitoring Service

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# online QC check


Dr. Bavo Langerock ( bavol@oma.be )

| | |
|---|---|
| Period | 2018-01-23 - 2018-05-10 |
| Succesfull reports/Total Reports | 1361/2497: 55% |
| Failed Quality Assurance checks/Total Reports | 422/2497: 17% |
| Failed Rapid Delivery checks/Total Reports | 972/2497: 39% |

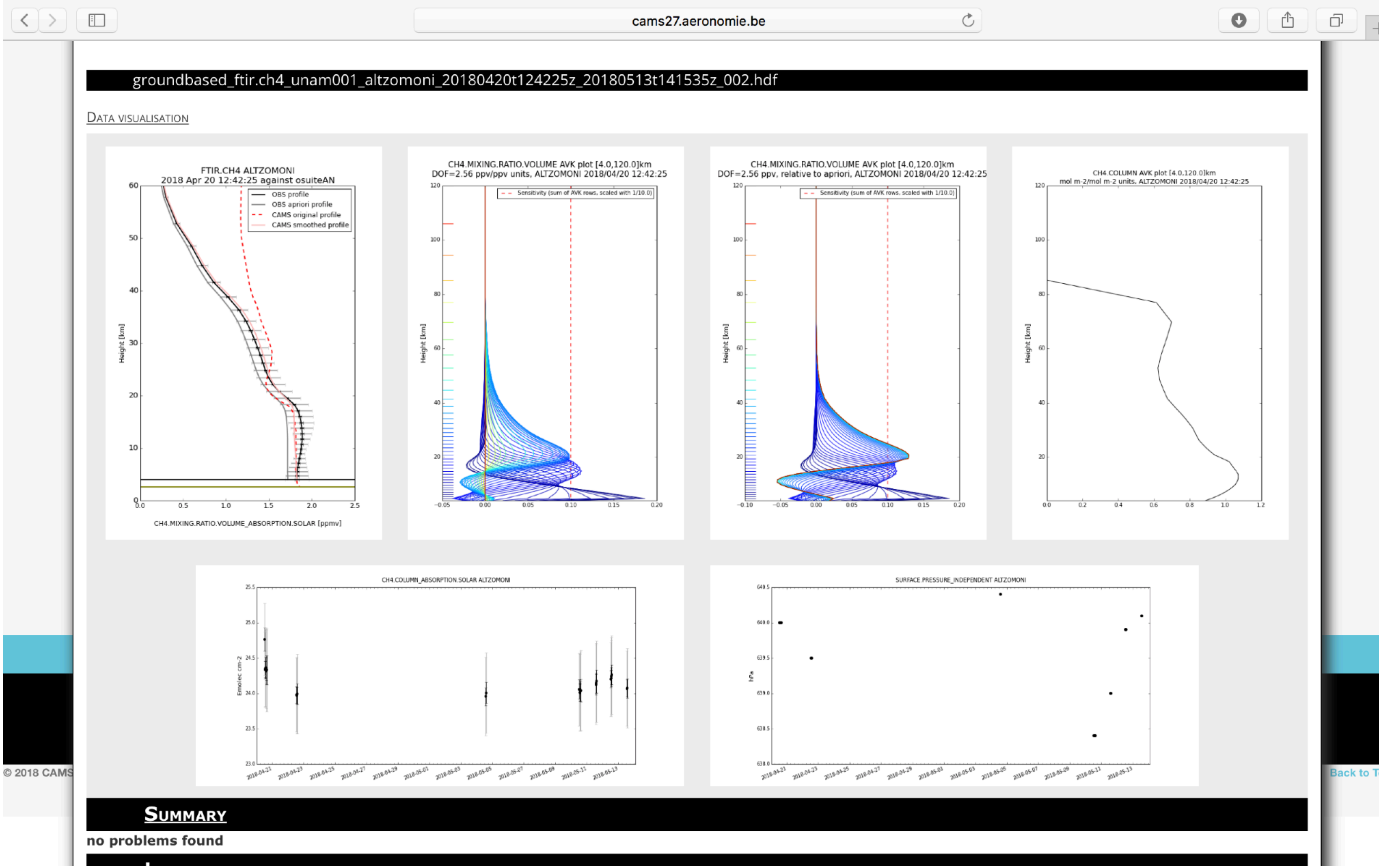
# QC Reports in HTML format

| Station | Country | Target | Network | DataProduct | Week |
|---|---|---|---|---|---|
| -- Select Station -- | -- Select Country -- | -- Select Target -- | -- Select Network -- | -- Select DataProduct -- | Latest weekly data |

**Filters:**

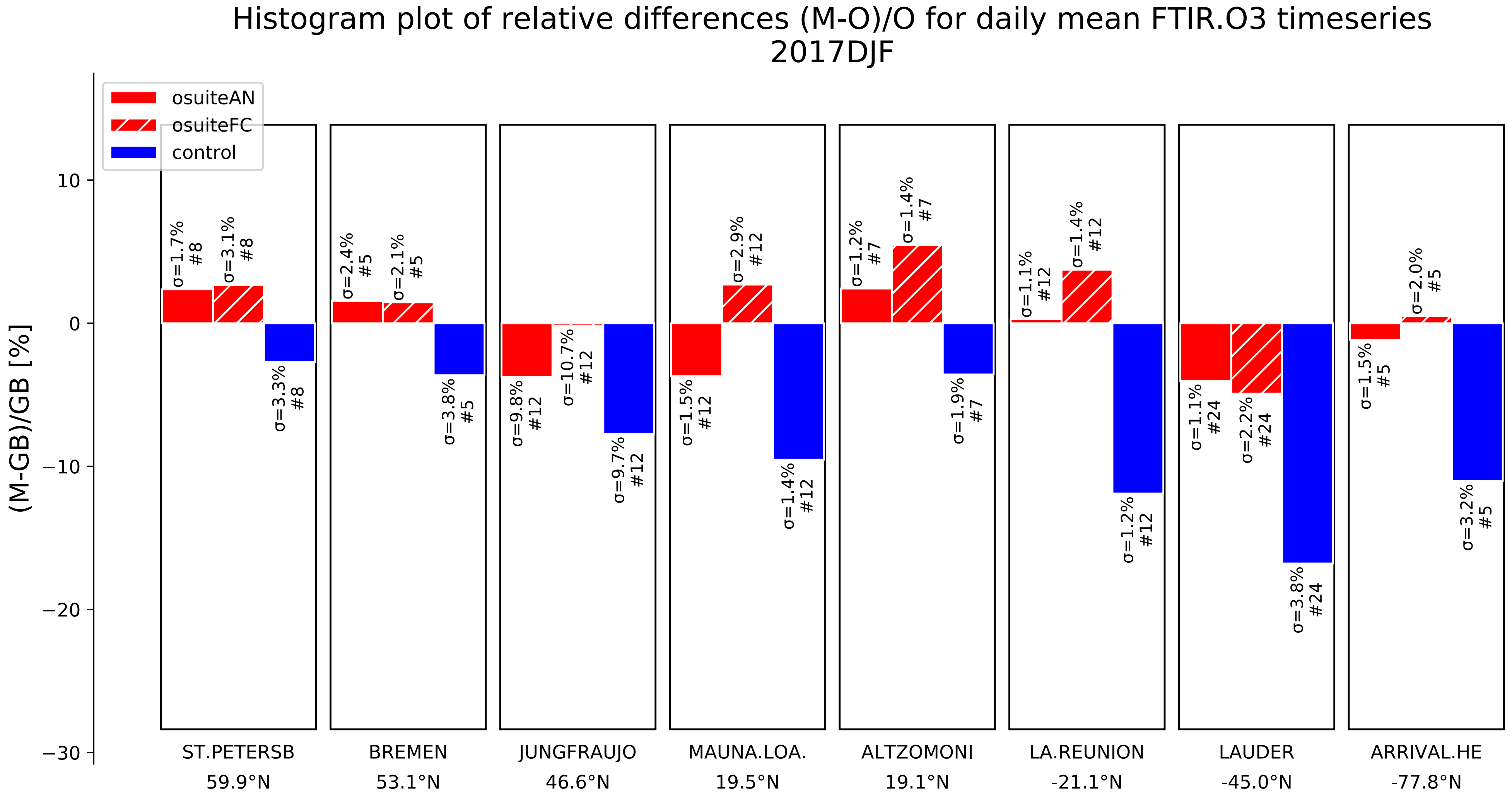
REPORTS

| Submission date | Product ID | Filename | RD | QA | Report |
|---|---|---|---|---|---|
| 2018-05-10 | ftir.ch4_ulg002 | groundbased_ftir.ch4_ulg002_jungfraujoch_20180308t073904z_20180325t090506z_005.hdf | 👎 | 👍 | 📄 |
| 2018-05-10 | ftir.co_ulg002 | groundbased_ftir.co_ulg002_jungfraujoch_20180314t072523z_20180325t112154z_005.hdf | 👎 | 👍 | 📄 |
| 2018-05-10 | lidar.o3_dwd001 | groundbased_lidar.o3_dwd001_hohenpeissenberg_20180506t194449z_20180507t024704z_001.hdf | 👍 | 👍 | 📄 |
| 2018-05-10 | lidar.o3_dwd001 | groundbased_lidar.o3_dwd001_hohenpeissenberg_20180507t195759z_20180508t024457z_001.hdf | 👍 | 👍 | 📄 |
| 2018-05-10 | uvvis.doas.zenith.no2_cnrs.latmos013 | groundbased_uvvis.doas.zenith.no2_cnrs.latmos013_haute.provence_20180504t043000z_20180504t183835z_013.hdf | 👍 | 👍 | 📄 |
| 2018-05-10 | uvvis.doas.zenith.no2_cnrs.latmos020 | groundbased_uvvis.doas.zenith.no2_cnrs.latmos020_la.reunion.stdenis_20180504t023954z_20180504t134934z_013.hdf | 👍 | 👍 | 📄 |
| 2018-05-10 | uvvis.doas.zenith.o3_cnrs.latmos013 | groundbased_uvvis.doas.zenith.o3_cnrs.latmos013_haute.provence_20180504t043000z_20180504t183835z_013.hdf | 👍 | 👍 | 📄 |
| 2018-05-10 | uvvis.doas.zenith.o3_cnrs.latmos020 | groundbased_uvvis.doas.zenith.o3_cnrs.latmos020_la.reunion.stdenis_20180504t023954z_20180504t134934z_013.hdf | 👍 | 👍 | 📄 |
| 2018-05-09 | ftir.ch4_awi001 | groundbased_ftir.ch4_awi001_ny.alesund_20180417t061717z_20180503t180524z_005.hdf | 👍 | 👍 | 📄 |
| 2018-05-09 | ftir.co_awi001 | groundbased_ftir.co_awi001_ny.alesund_20180417t064107z_20180426t124855z_005.hdf | 👍 | 👍 | 📄 |
| 2018-05-09 | mwr.o3_ubern001 | groundbased_mwr.o3_ubern001_bern_20180422t000017z_20180422t235935z_009.hdf | 👍 | 👍 | 📄 |
| 2018-05-09 | mwr.o3_ubern001 | groundbased_mwr.o3_ubern001_bern_20180423t000003z_20180423t235953z_009.hdf | 👍 | 👍 | 📄 |
| 2018-05-09 | mwr.o3_ubern001 | groundbased_mwr.o3_ubern001_bern_20180424t000023z_20180424t235958z_009.hdf | 👍 | 👍 | 📄 |
| 2018-05-09 | mwr.o3_ubern001 | groundbased_mwr.o3_ubern001_bern_20180425t000028z_20180425t235939z_009.hdf | 👍 | 👍 | 📄 |

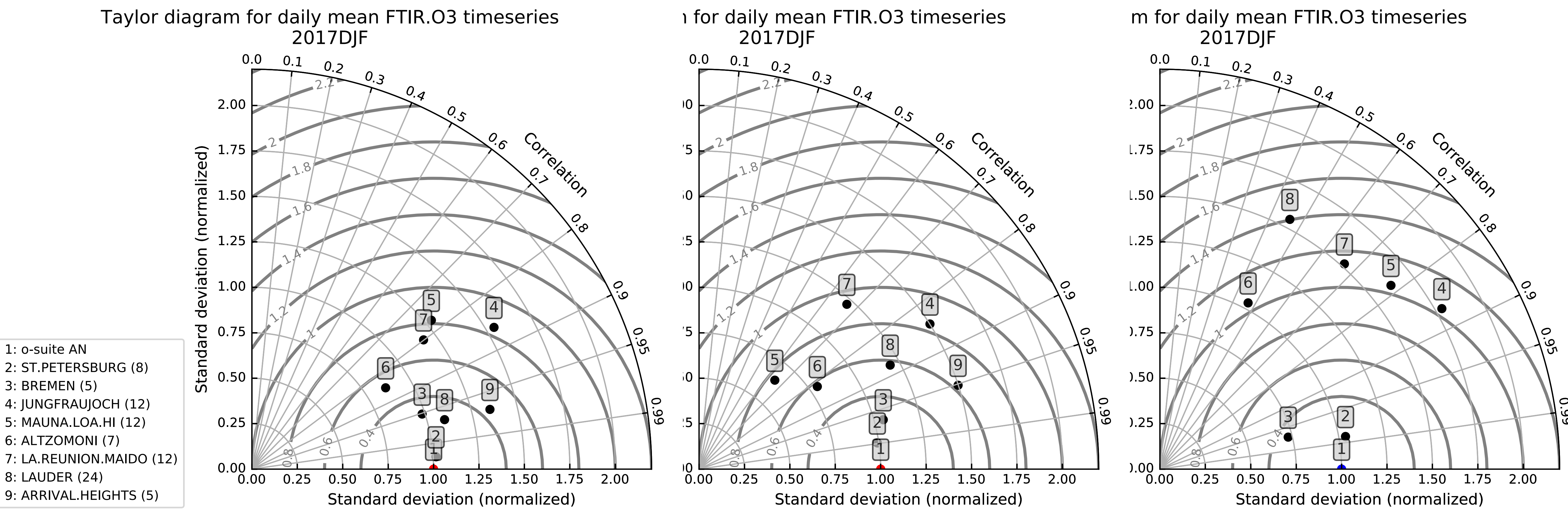



## check on data contents:

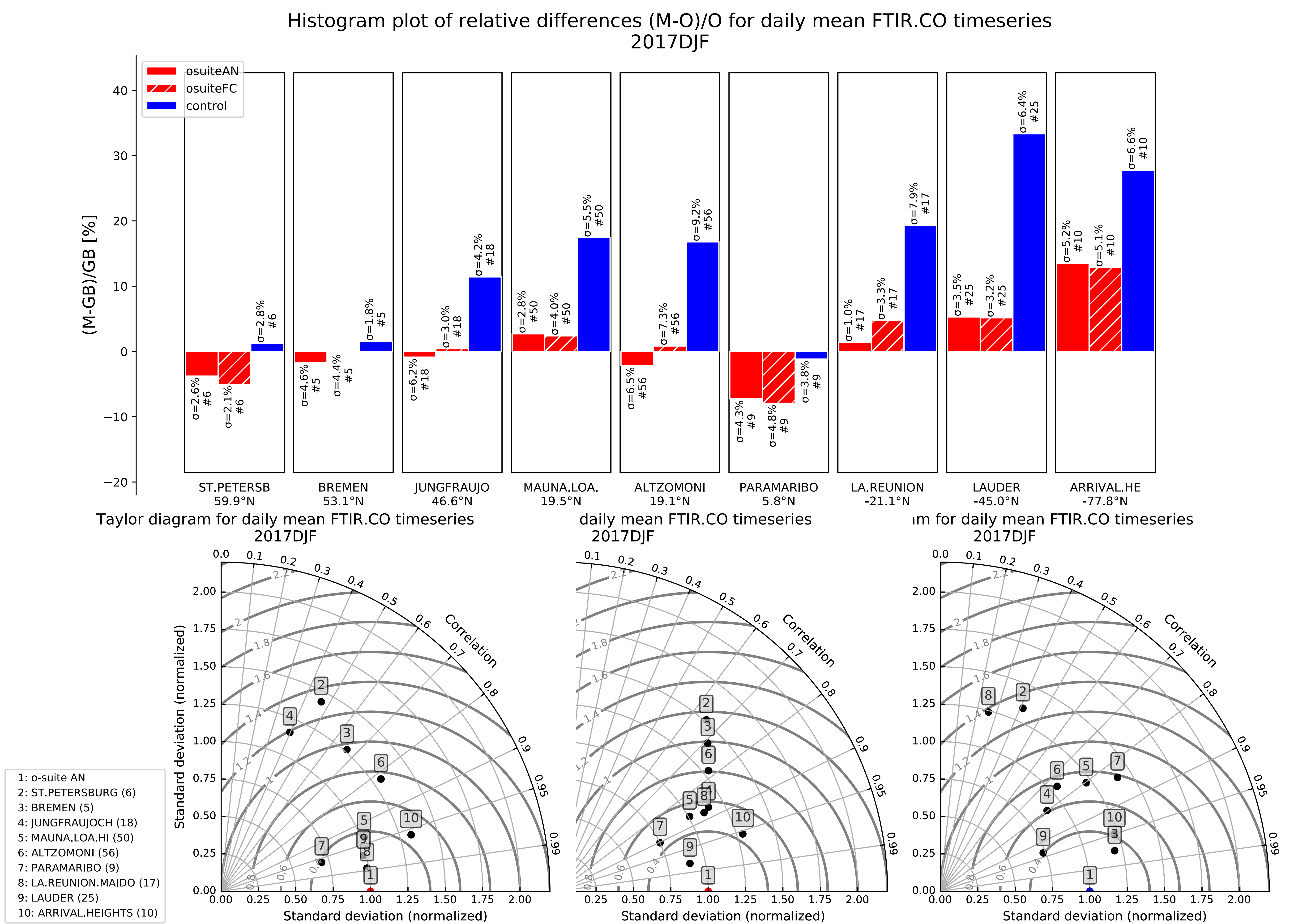
- consistency between solar position & time
- uncertainties
- AVK shape
- conversion (profile -> columns) ….



Histogram plot of relative differences (M-O)/O for daily mean FTIR.O3 timeseries
2017DJF
osuiteAN
osuiteFC
control
(M-GB)/GB [%]
ST.PETERSB 59.9°N
BREMEN 53.1°N
JUNGFRAUJO 46.6°N
MAUNA.LOA. 19.5°N
ALTZOMONI 19.1°N
LA.REUNION -21.1°N
LAUDER -45.0°N
ARRIVAL.HE -77.8°N

Taylor diagram for daily mean FTIR.O3 timeseries
2017DJF
Standard deviation (normalized)
Correlation
1: o-suite AN
2: ST.PETERSBURG (8)
3: BREMEN (5)
4: JUNGFRAUJOCH (12)
5: MAUNA.LOA.HI (12)
6: ALTZOMONI (7)
7: LA.REUNION.MAIDO (12)
8: LAUDER (24)
9: ARRIVAL.HEIGHTS (5)



Histogram plot of relative differences (M-O)/O for daily mean FTIR.CO timeseries
2017DJF
osuiteAN
osuiteFC
control
(M-GB)/GB [%]
ST.PETERSB 59.9°N
BREMEN 53.1°N
JUNGFRAUJO 46.6°N
MAUNA.LOA. 19.5°N
ALTZOMONI 19.1°N
PARAMARIBO 5.8°N
LA.REUNION -21.1°N
LAUDER -45.0°N
ARRIVAL.HE -77.8°N
σ=2.6% #6
σ=2.1% #6
σ=2.8% #6
σ=4.6% #5
σ=4.4% #5
σ=1.8% #5
σ=6.2% #18
σ=3.0% #18
σ=4.2% #18
σ=2.8% #50
σ=4.0% #50
σ=5.5% #50
σ=6.5% #56
σ=7.3% #56
σ=9.2% #56
σ=4.3% #9
σ=4.8% #9
σ=3.8% #9
σ=1.0% #17
σ=3.3% #17
σ=7.9% #17
σ=3.5% #25
σ=3.2% #25
σ=6.4% #25
σ=5.2% #10
σ=5.1% #10
σ=6.6% #10
Taylor diagram for daily mean FTIR.CO timeseries
2017DJF
daily mean FTIR.CO timeseries
2017DJF
m for daily mean FTIR.CO timeseries
2017DJF
Correlation
Standard deviation (normalized)
Standard deviation (normalized)
1: o-suite AN
2: ST.PETERSBURG (6)
3: BREMEN (5)
4: JUNGFRAUJOCH (18)
5: MAUNA.LOA.HI (50)
6: ALTZOMONI (56)
7: PARAMARIBO (9)
8: LA.REUNION.MAIDO (17)
9: LAUDER (25)
10: ARRIVAL.HEIGHTS (10)

# FTIR RD status

- altzomoni
- AH, lauder
- bremen, ny alesund, paramaribo
- ~~**Garmish/zugspitze**~~
- eureka/toronto
- ~~**harestua**~~
- jungfraujoch
- maido
- **Mauna loa / thule** (wip)
- sodankyla
- st petersburg
- **wollongong** (wip)

## Status of 5k€ funding for tool development

| Payment | Activities covered by payment | |
|---|---|---|
| 1 | Development for KNMI sites (PI is A. Piters) | 5000,00 € |
| 2 | Development for UToronto sites (PI is K. Strong) | 5000,00 € |
| 3 | Development for Eureka LIDAR (PI is A. Tikhomirov) | 5000,00 € |
| 4 | ~~Development for Harestua FTIR (PI is J. Mellqvist)~~ | 5000,00 € |
| 5 | Development for Hohenpeissenberg LIDAR (PI W. | 5000,00 € |
| 6 | Development for Jungfraujoch FTIR (PI E. Mahieu) | 5000,00 € |
| 7 | Development for NIWA sites (PI R. Querel) | 5000,00 € |
| 8 | Development for Lauder LIDAR (PI D. Swart) | 5000,00 € |
| 9 | Development for Mauna Loa UVVIS (PI R. Volkamer) | 5000,00 € |
| 10 | Development for UBremen sites (PI M. Palm) | 5000,00 € |
| 11 | Development for Rio Gallegos LIDAR (PI J. Salvador) | 5000,00 € |
| 12 | Development for LATMOS sites (A. Pazmino) | 5000,00 € |
| 13 | Development for Wollongong FTIR (PI N. Jones) | 5000,00 € |
| 14 | ~~Development for Zugspitze FTIR (PI R. Sussmann)~~ | 5000,00 € |
| ** ECMWF* | | |

# QC check

- **<u>Consistency of reported variables</u>**:
  conversions of VMR profile -> partial column profile
  profiles -> integrated data
  uncertainty covariances -> standard deviations on integrated data
  AVK's acting on profile -> column AVK's
  conversions and reported ancillary data (eg partial column of air and pressure/temperature)

- **<u>Uncertainties:</u>**
  covariances should be symmetric and semi-positive definite
  std's should be strictly positive
  std's should be within expected values (to be defined)
  random and systematic uncertainty variables must contain physical data (no fill values!)

# QC check

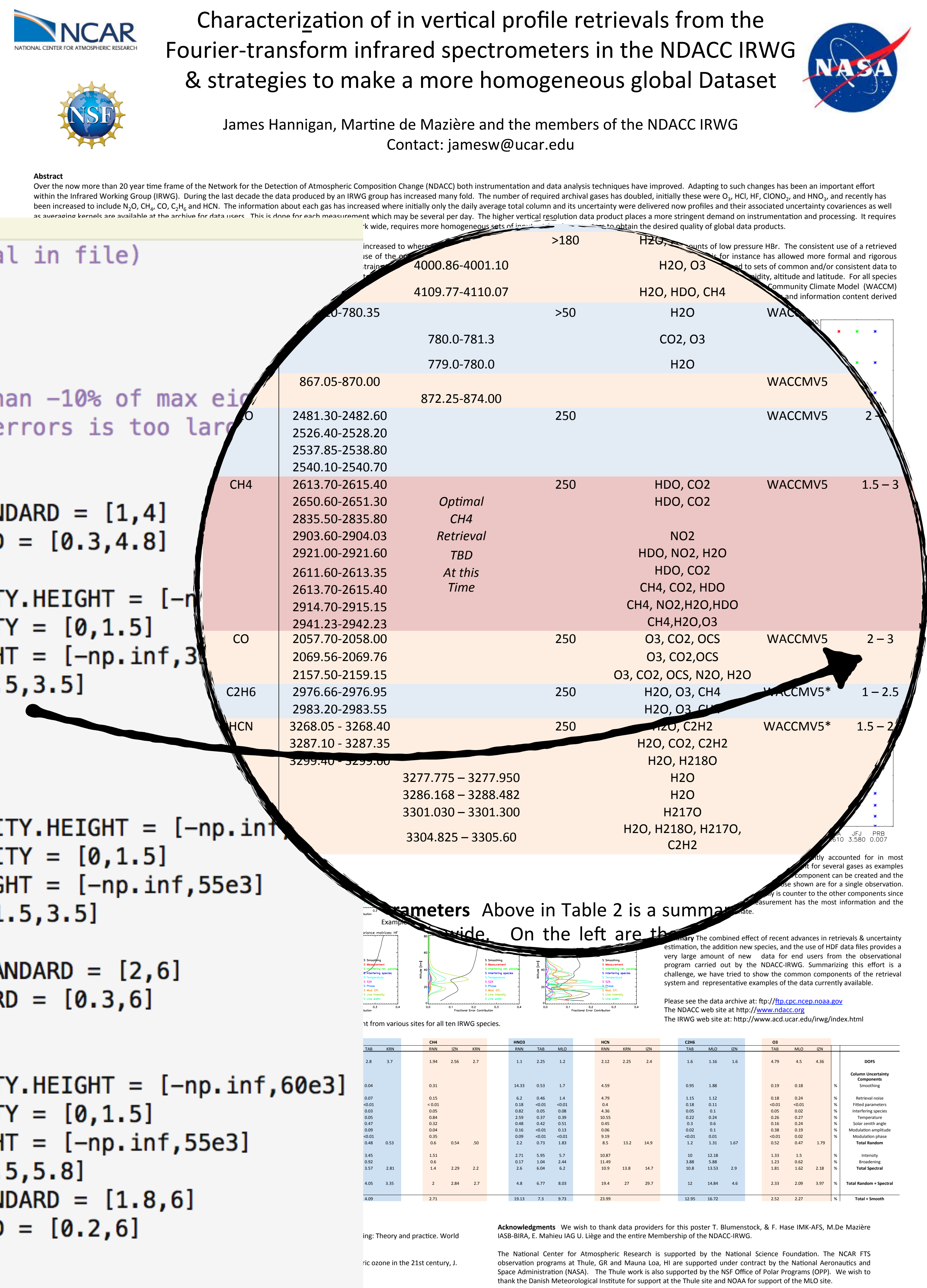
- **Location:**
  consistency between solar position variables and reported measurement time
  consistency between altitude grid and instrument's height
  no fill values in any lat/lon/time variable

- **Averaging kernels**:
  sensitivity curve for 2D AVK should not go wild (0<:<1.5)
  DOF should be within expected thresholds (DOF > 0.8)
  1D column AVK data should not go wild (0<:<1.5)
  availability of apriori profiles (not only fill values!)

**properties of the AVK are used to check the quality of the retrieval!**

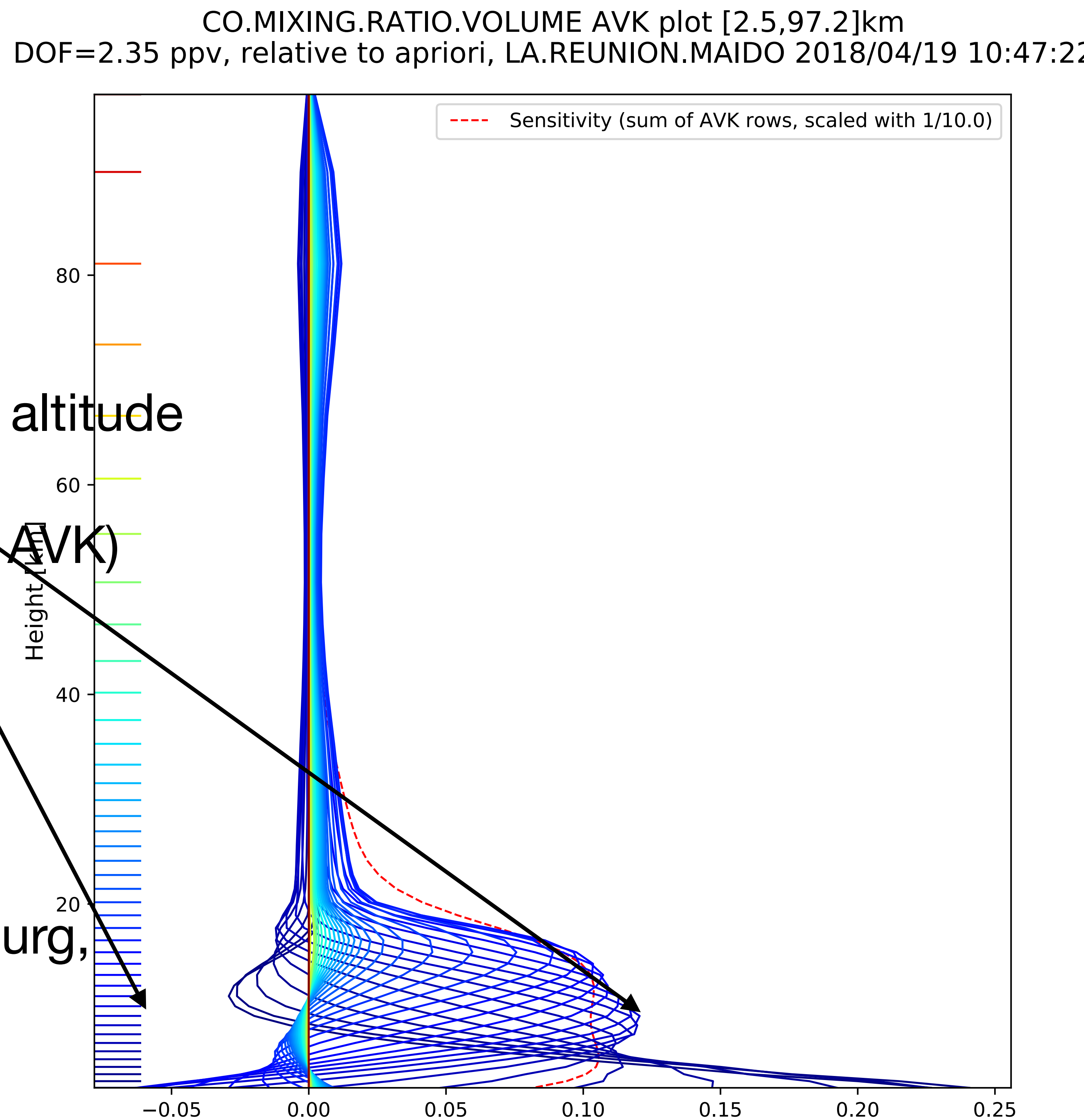
# QC trhesholds

```
[DEFAULTS]
#tolerance how many outliers allowed (relative to total in file)
TOL_AVK_CAVK=0.5
TOL_AVK_SENS=0.2
TOL_AVK_DOF=0.2

TOL_EIG_COV=-0.1 #eigenvalues should not be smaller than -10% of max eig
TOL_REL_STD = 0.5 #generate error if 50% or relative errors is too larg

[FTIR.CO]
CO.COLUMN_ABSORPTION.SOLAR_UNCERTAINTY.SYSTEMATIC.STANDARD = [1,4]
CO.COLUMN_ABSORPTION.SOLAR_UNCERTAINTY.RANDOM.STANDARD = [0.3,4.8]
#sensitivity height limit for AVK
CO.MIXING.RATIO.VOLUME_ABSORPTION.SOLAR_AVK.SENSITIVITY.HEIGHT = [-n
CO.MIXING.RATIO.VOLUME_ABSORPTION.SOLAR_AVK.SENSITIVITY = [0,1.5]
CO.MIXING.RATIO.VOLUME_ABSORPTION.SOLAR_AVK.DOFS.HEIGHT = [-np.inf,3
CO.MIXING.RATIO.VOLUME_ABSORPTION.SOLAR_AVK.DOFS = [1.5,3.5]
CO.COLUMN_ABSORPTION.SOLAR_AVK.HEIGHT=[-np.inf,60e3]


[FTIR.CH4]
CH4.MIXING.RATIO.VOLUME_ABSORPTION.SOLAR_AVK.SENSITIVITY.HEIGHT = [-np.inf
CH4.MIXING.RATIO.VOLUME_ABSORPTION.SOLAR_AVK.SENSITIVITY = [0,1.5]
CH4.MIXING.RATIO.VOLUME_ABSORPTION.SOLAR_AVK.DOFS.HEIGHT = [-np.inf,55e3]
CH4.MIXING.RATIO.VOLUME_ABSORPTION.SOLAR_AVK.DOFS = [1.5,3.5]
CH4.COLUMN_ABSORPTION.SOLAR_AVK.HEIGHT=[-np.inf,60e3]
CH4.COLUMN_ABSORPTION.SOLAR_UNCERTAINTY.SYSTEMATIC.STANDARD = [2,6]
CH4.COLUMN_ABSORPTION.SOLAR_UNCERTAINTY.RANDOM.STANDARD = [0.3,6]

[FTIR.O3]
O3.MIXING.RATIO.VOLUME_ABSORPTION.SOLAR_AVK.SENSITIVITY.HEIGHT = [-np.inf,60e3]
O3.MIXING.RATIO.VOLUME_ABSORPTION.SOLAR_AVK.SENSITIVITY = [0,1.5]
O3.MIXING.RATIO.VOLUME_ABSORPTION.SOLAR_AVK.DOFS.HEIGHT = [-np.inf,55e3]
O3.MIXING.RATIO.VOLUME_ABSORPTION.SOLAR_AVK.DOFS = [2.5,5.8]
O3.COLUMN_ABSORPTION.SOLAR_UNCERTAINTY.SYSTEMATIC.STANDARD = [1.8,6]
O3.COLUMN_ABSORPTION.SOLAR_UNCERTAINTY.RANDOM.STANDARD = [0.2,6]
O3.COLUMN_ABSORPTION.SOLAR_AVK.HEIGHT=[-np.inf,80e3]
```



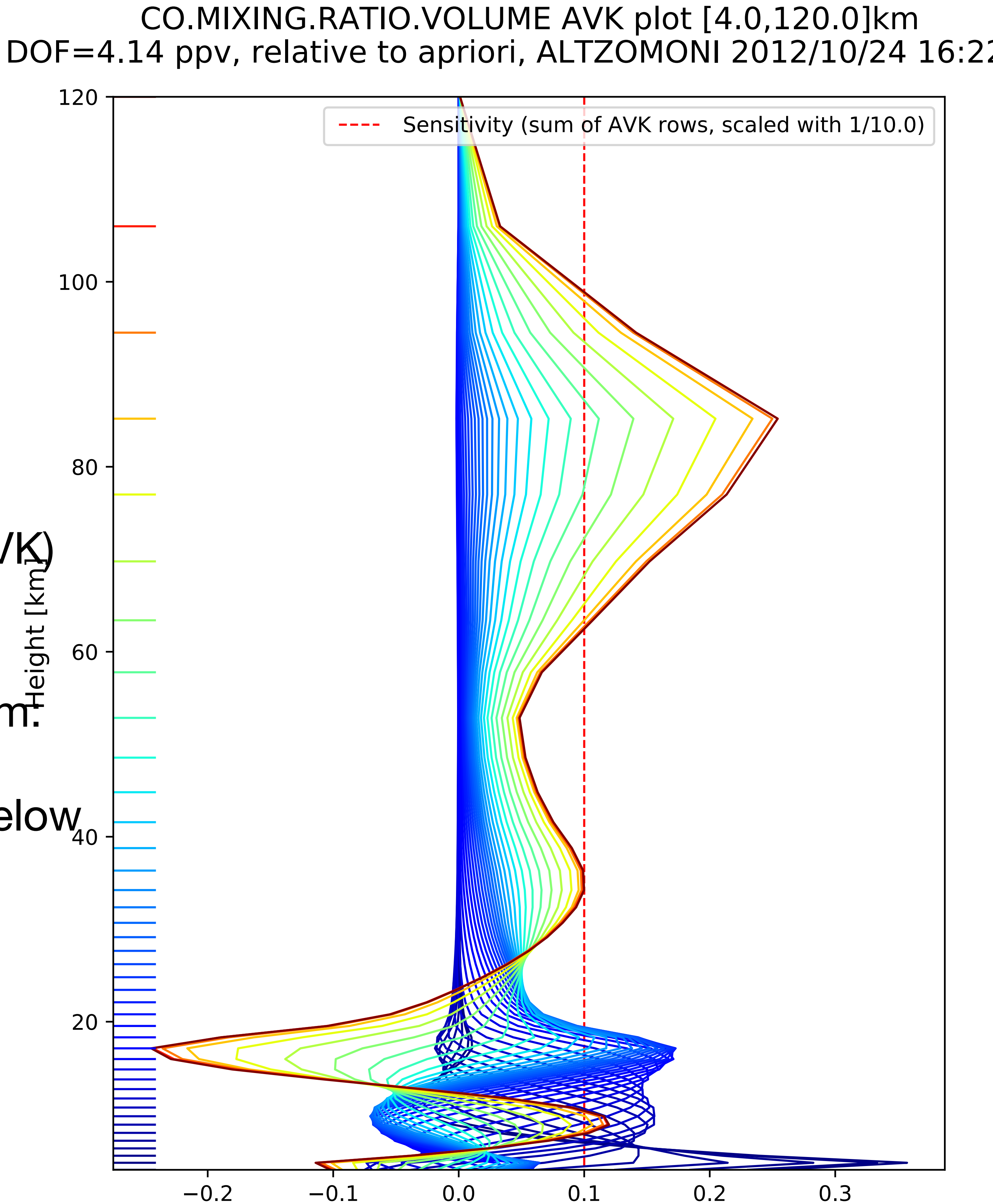
# Quality of the retrieval from AVK

- Column AVK: shows how each layer contributes to the column: 0<:<1.5
- Each kernel (=row of the AVK) should peak at its corresponding altitude
- Sensitivity (som of the row of the AVK) should be between 0 and ±1
- Maido retrievals are blind above 20km
- similar avk in Bremen, St petersburg, Jungfrau, Eureka, Toronto,…



# Altzomoni

- Tikhonov retrieval: sens=cst=1
- Each kernel (=row of the AVK) should peak at its corresponding altitude: OK
- Sensitivity (som of the row of the AVK) should be between 0 and 1: OK
- Altzomoni is not blind to CO at 80km: orange kernels peak at that altitude (but negative correlation with CO below 20km,
  which is typical for Tikhonov)
- Zugspitze has similar AVK



- Each kernel (=row of the AVK) should peak at its corresponding altitude: not OK
  blue kernels should not extend to 80km…

- Sensitivity (som of the row of the AVK) should be between 0 and 1: not OK
  at 30km light blue kernels extend to 80km…

- Is this retrieval sensitive to CO at high altitudes?
  Not clear to me: CO at 80km will be smoothed to altitudes below 40km