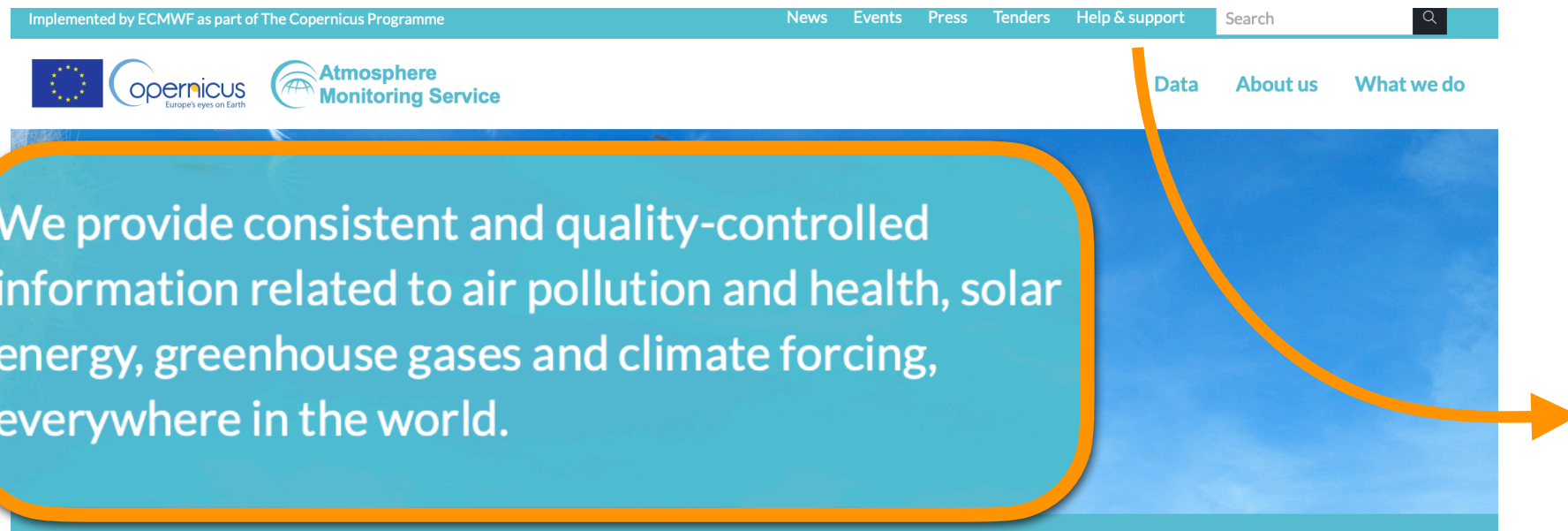




Systematic use of NDACC data for monitoring the performance of the CAMS o-suite and reanalysis models

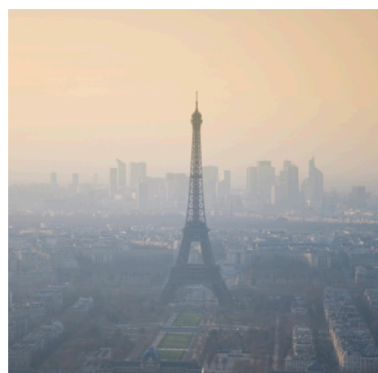


- Copernicus Atmosphere Monitoring Service
- <https://atmosphere.copernicus.eu>
- global and regional model data: “o-suite”, reanalysis (2003>now), dedicated high resolution GHG “o-suite”



- Monitoring of performance using comparisons against reference data
- Quarterly reporting for o-suites
- Evaluation of o-suite upgrades
- Validation server used for online monitoring

Today's air quality forecasts



Europe



Worldwide

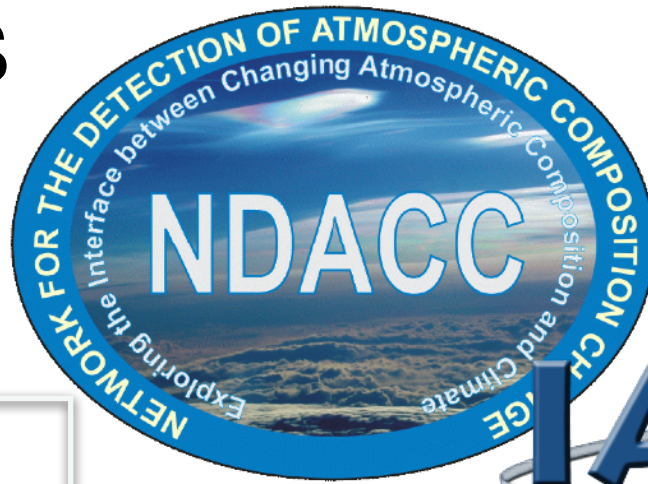
In Focus



Global carbon dioxide and methane monitoring



CAMS



GAW



<https://global-evaluation.atmosphere.copernicus.eu>

Evaluation of global forecasts

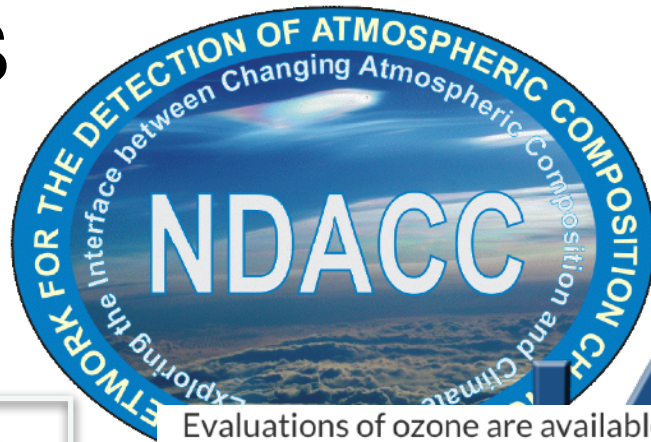
Evaluations of the CAMS global forecasting system using independent observ:

Aerosol
CH4 (Methane)
CO (Carbon Monoxide)
CO2 (Carbon Dioxide)
H2O (Water Vapour)
HCHO (Formaldehyde)
NO (Nitrogen Monoxide)
NO2 (Nitrogen Dioxide)
O3 (Ozone)
PM10
PM2.5
SO2 (Sulfur Dioxide)

- Monitoring of performance using comparisons against reference data
- Quarterly reporting for o-suites
- Evaluation of o-suite upgrades
- Validation server used for online monitoring



CAMS



<https://global-evaluation.cams.org/>
Evaluation of global forecasting system

Evaluations of the CAMS global forecasting system using

Aerosol
CH4 (Methane)
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NO2 (Nitrogen Dioxide)
O3 (Ozone)
PM10
PM2.5
SO2 (Sulfur Dioxide)

Evaluations of ozone are available for the following independent observations.

ACE-FTS stratospheric column
Aircraft profile (IAGOS)
Dobson total column (NDACC)
FTIR profile (NDACC)
IASI total column
LIDAR profile (NDACC)
MWR profile (NDACC)
Ozonesonde
SAGE-III stratospheric column
Surface insitu (EIONET repr. stations)
Surface insitu (EIONET)
Surface insitu (ESRL)
Surface insitu (GAW)
Surface insitu (IASOA)
ZSL-DOAS total column (NDACC)



Monitoring of performance using comparisons against reference data

Quarterly reporting for o-suites

Evaluation of o-suite upgrades

Validation server used for online monitoring



NDACC contract

- dedicated contract between CAMS(ECMWF) and NDACC(BIRA-IASB):
 - ▶ increase frequency of data delivery from yearly to monthly
 - ▶ monitoring of incoming data (QA/QC)
- follow up of EU FP7 NORS project (2011-2014): demonstration for NDACC data in global model validation
- setup:
 - ▶ provide support (financial/technical) to PI's for "rapid" delivery of quality data to NDACC
 - ▶ open to all NDACC PI's (for selected data products)
 - ▶ data is publicly available on NDACC
 - ▶ data formatted in GEOMS metadata standard



NDACC instruments

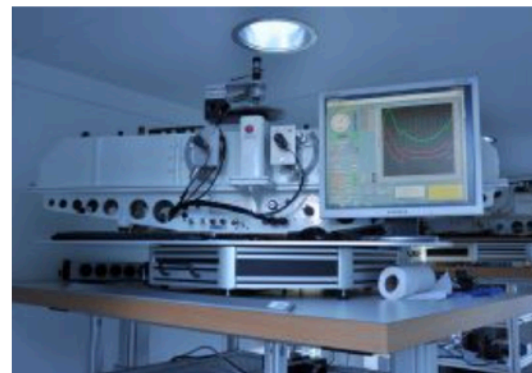
Instruments

Brewer



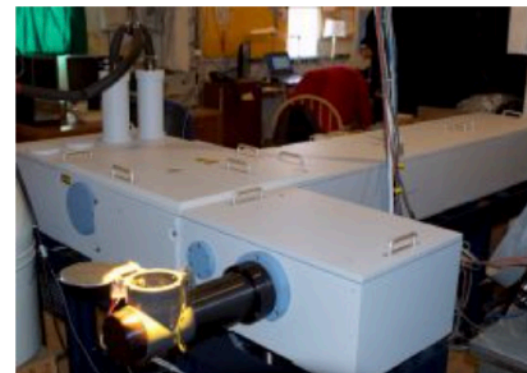
Visit Working Group website

Dobson



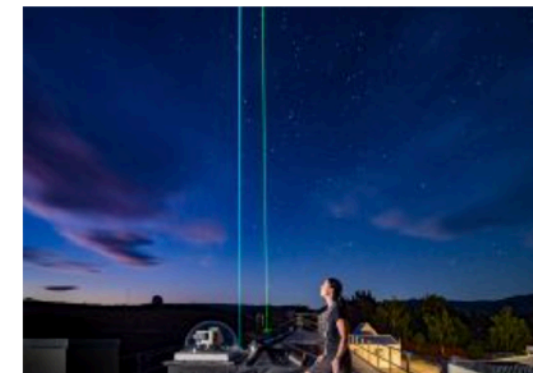
Visit Working Group website

FTIR Spectrometer



Visit Working Group website

Lidar



Visit Working Group website

Microwave Radiometer



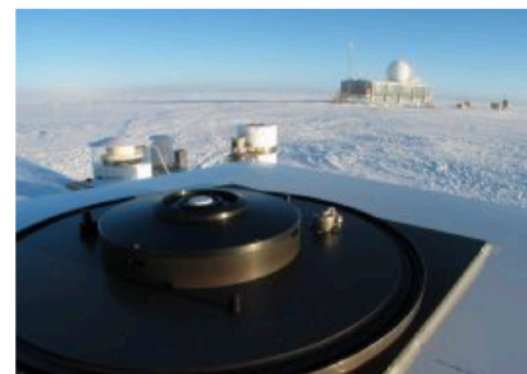
Visit Working Group website

Sonde



Visit Working Group website

UV Spectroradiometer



Visit Working Group website

UV/Visible Spectrometer



Visit Working Group website

from ndacc.org



NDACC instruments

Instruments

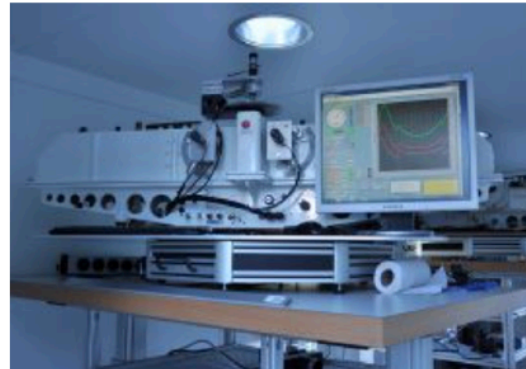
supported in CAMS27

Brewer



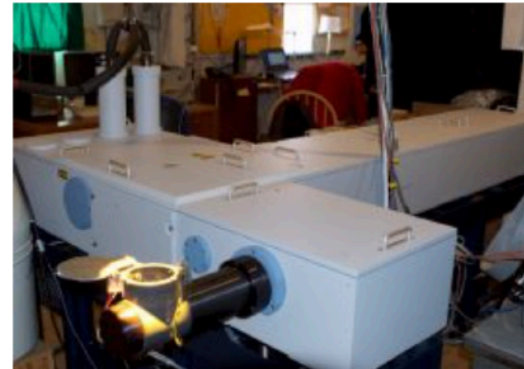
Visit Working Group website

Dobson



Visit Working Group website

FTIR Spectrometer



Visit Working Group website

Lidar



Visit Working Group website

Microwave Radiometer



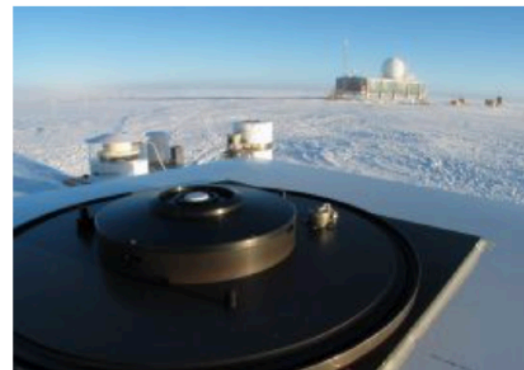
Visit Working Group website

Sonde



Visit Working Group website

UV Spectroradiometer



Visit Working Group website

UV/Visible Spectrometer



Visit Working Group website

from ndacc.org

also used in CAMS84
done by DLR<2022<BIRA-IASB



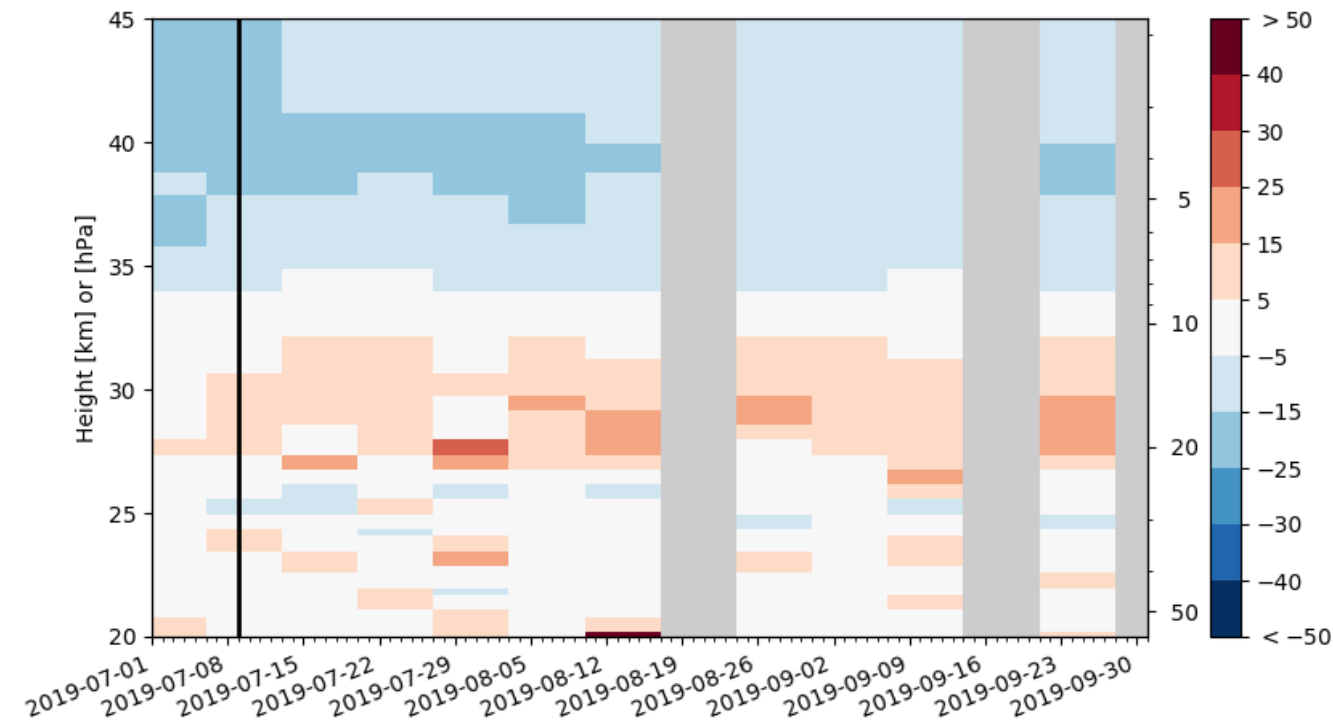
NDACC instruments

- variety of instruments, each with a dedicated comparison methodology
 - DOBSON: direct column comparison
 - LIDAR: direct profile comparisons (strato)
 - MWR: comparison uses MWR AVK (upper strato)
 - UVVIS: zenith measurement geometry, AVK + effective location, O₃ and NO₂ (strato)
 - UVVIS: maxdoas profiles, comparison uses AVK + effective location, H₂CO, NO₂ (lower tropo)
 - FTIR: comparison uses AVK, model profile extracted along measurement line of sight: ozone, CO, CH₄, H₂CO different vertical resolution: tropospheric/stratospheric

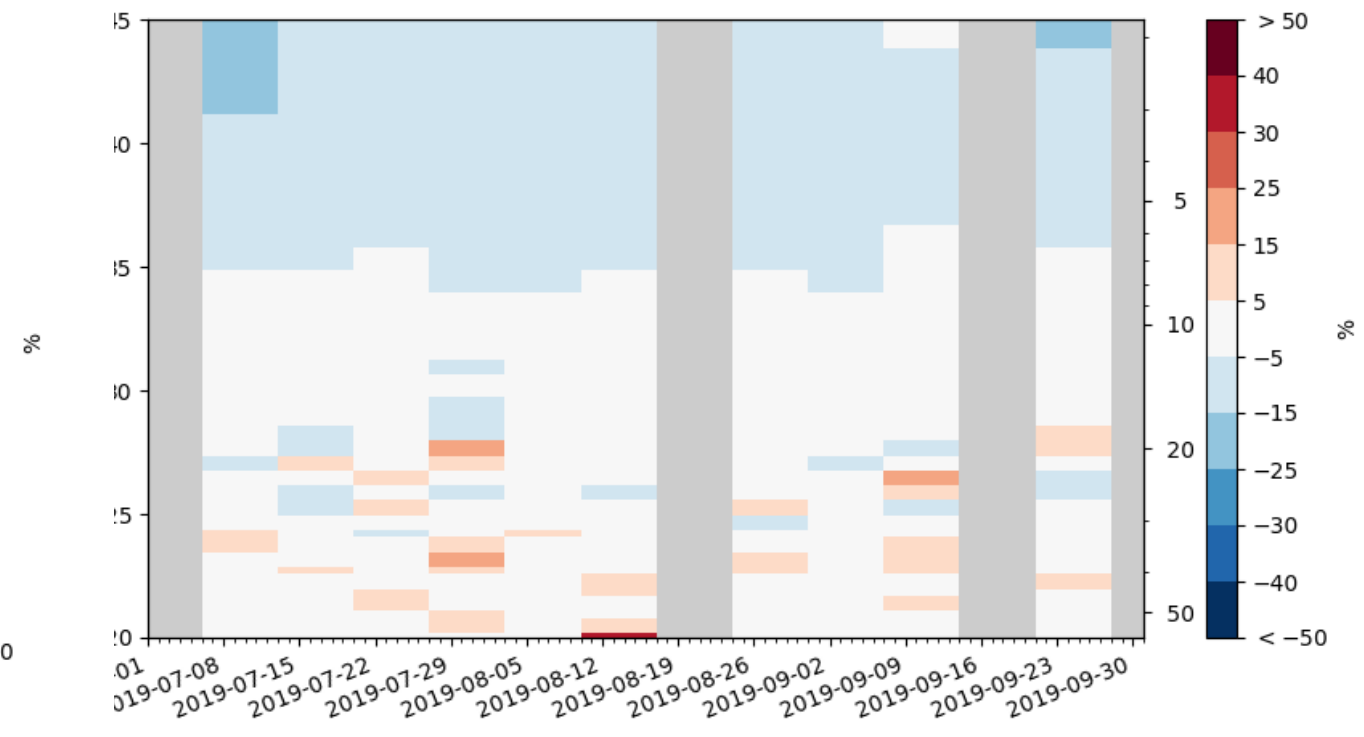


Example: LIDAR data used to check candidate o-suite upgrade (called “e-suite”)

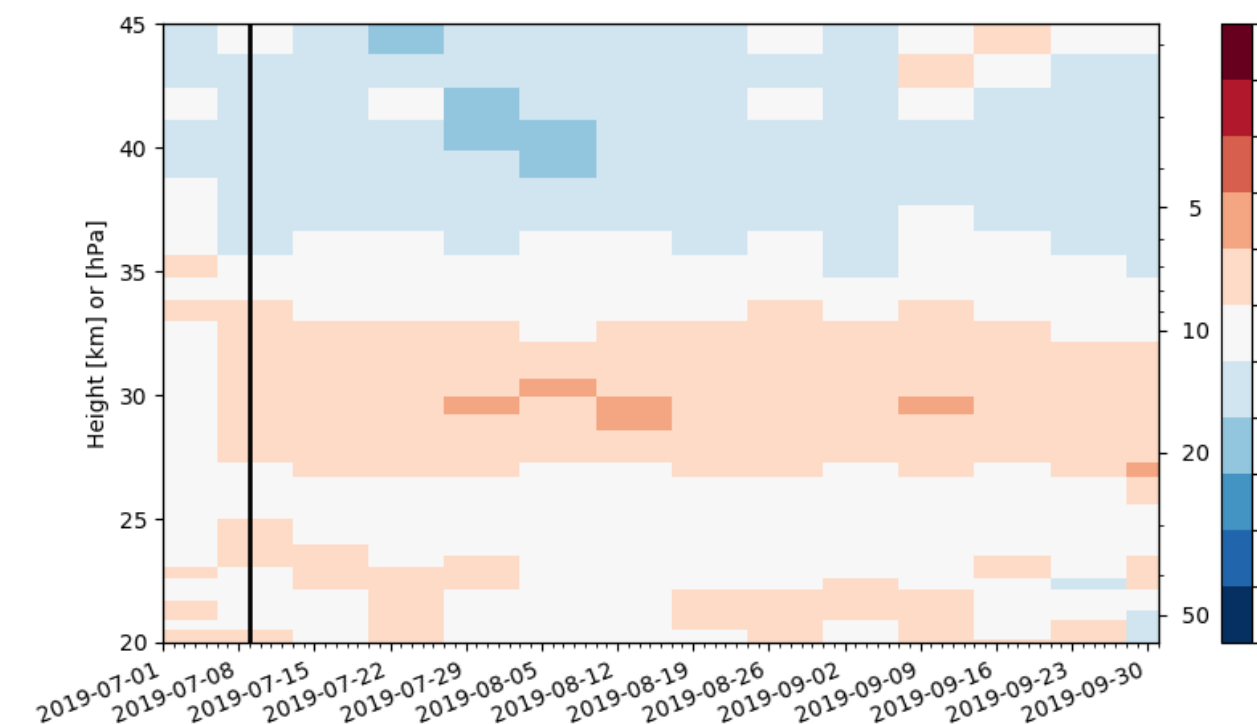
LIDAR.O3 number density profile differences (M-O)/O
(weekly mean, 20.0km - 45.0km, o-suite AN, HOHENPEISSENBERG (lat.=47.8°), 2019-07-04 till 2019-09-21, 21 meas.)



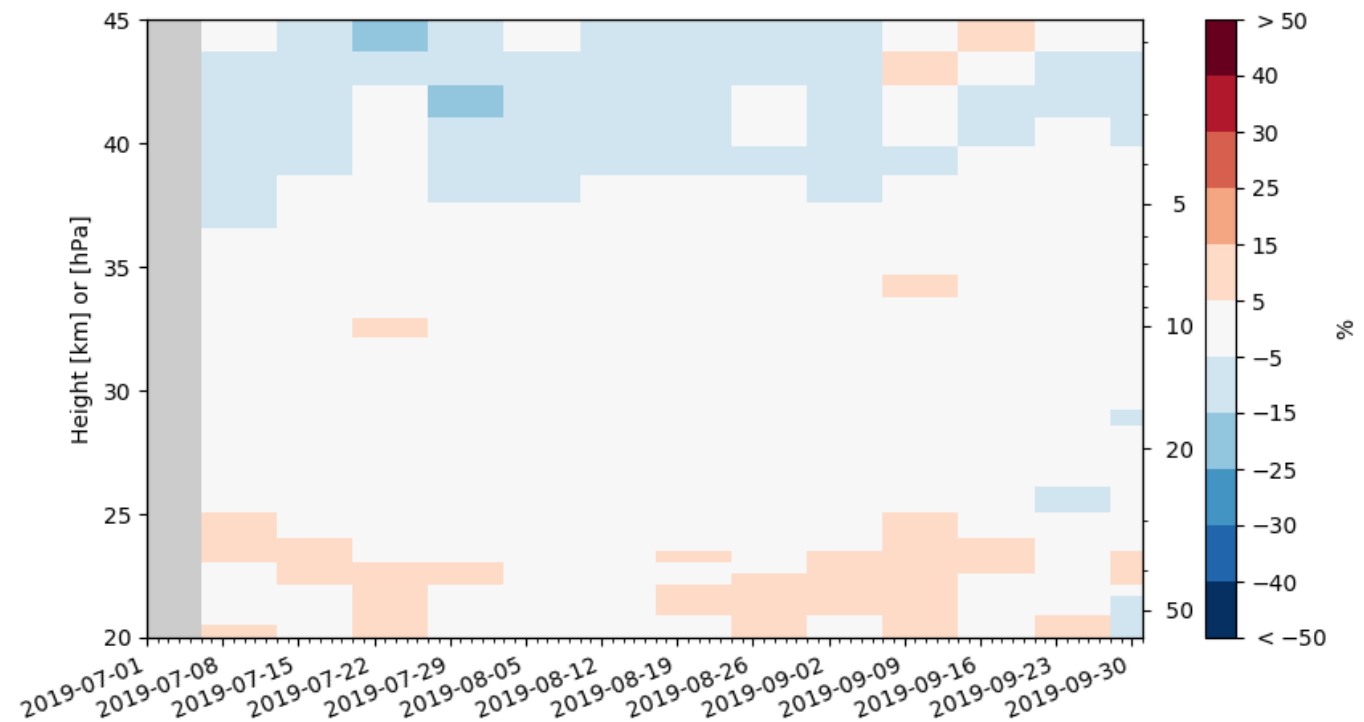
LIDAR.O3 number density profile differences (M-O)/O
(weekly mean, 20.0km - 45.0km, e-suite 47R1 AN, HOHENPEISSENBERG (lat.=47.8°), 2019-07-10 till 2019-09-21, 19 meas.)



LIDAR.O3 number density profile differences (M-O)/O
(weekly mean, 20.0km - 45.0km, o-suite AN, TABLE.MOUNTAIN.CA (lat.=34.4°), 2019-07-02 till 2019-09-28, 54 meas.)



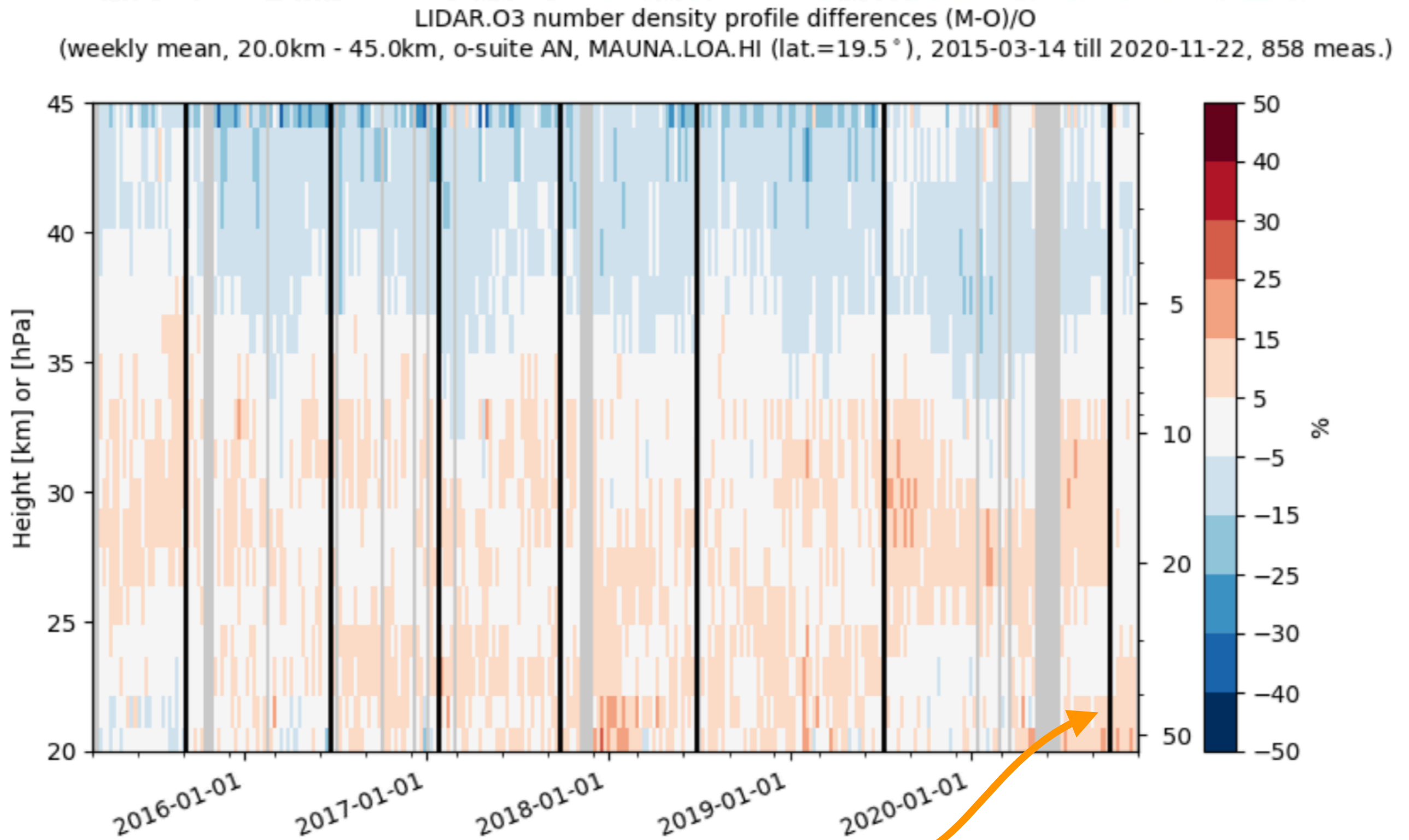
LIDAR.O3 number density profile differences (M-O)/O
(weekly mean, 20.0km - 45.0km, e-suite 47R1 AN, TABLE.MOUNTAIN.CA (lat.=34.4°), 2019-07-10 till 2019-09-28, 54 meas.)



positive bias at 20hPa is removed in e-suite



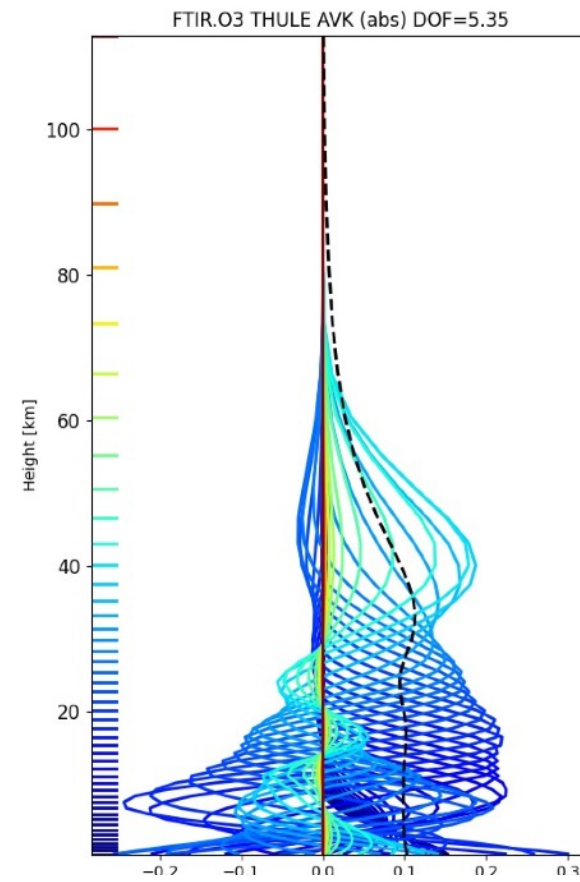
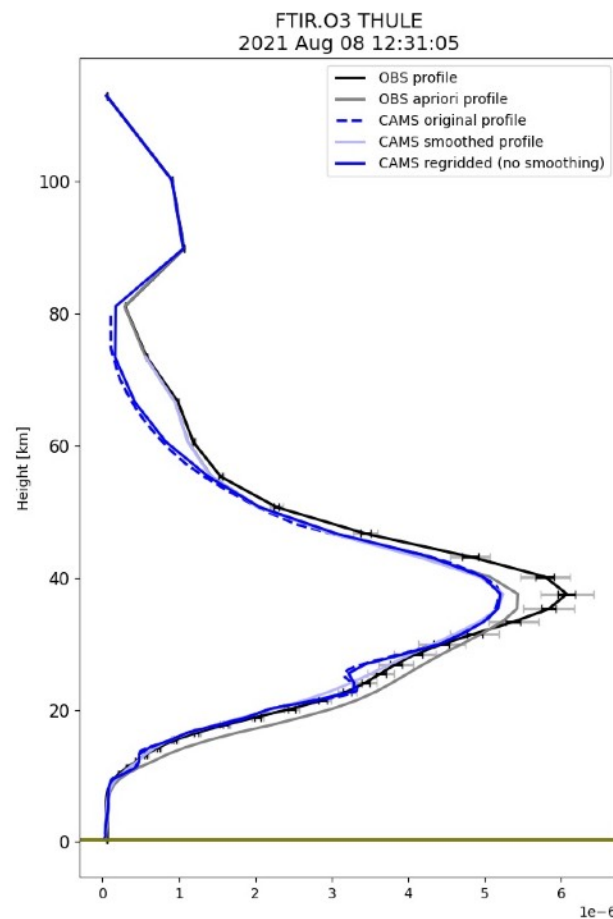
Example: LIDAR data used to check candidate o-suite upgrade (called “e-suite”)



upgrade implemented in 2021



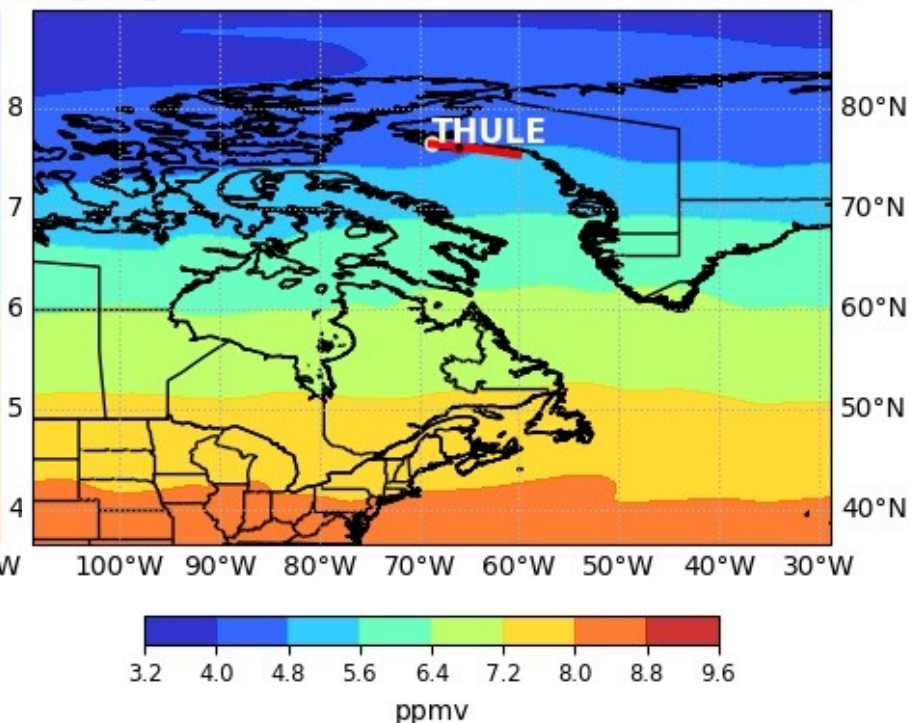
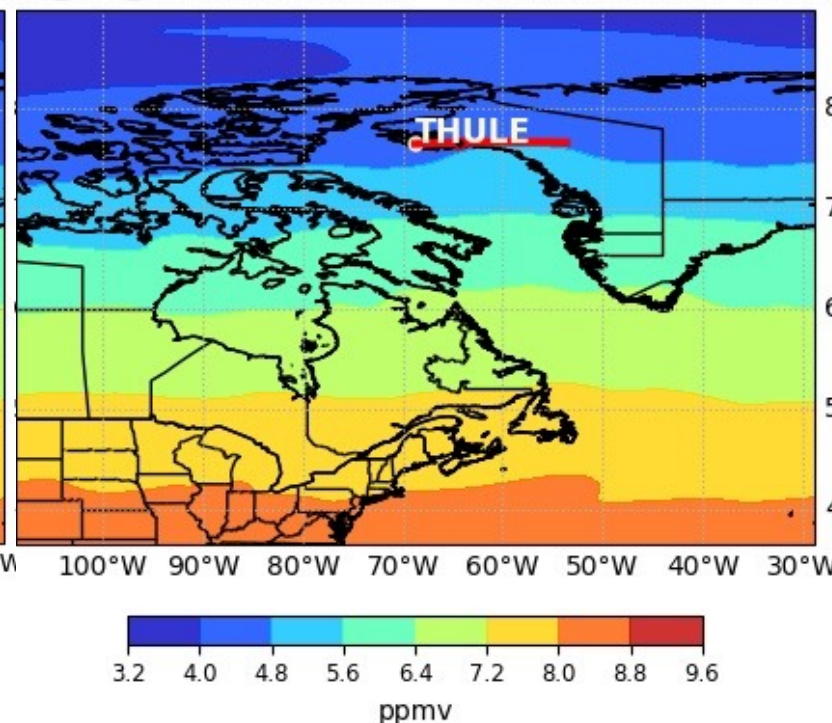
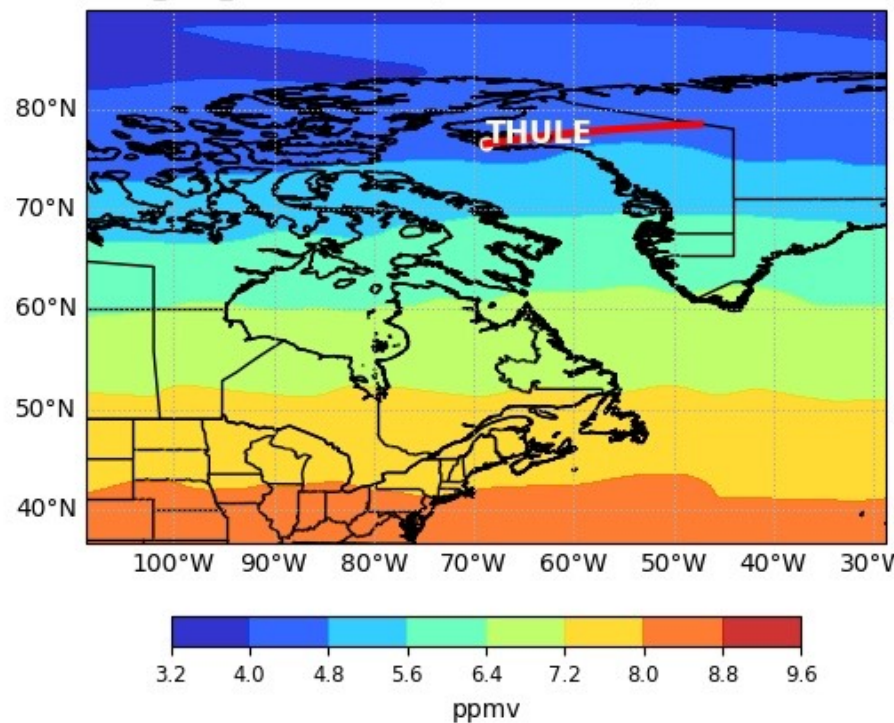
Example: FTIR measures direct sunlight, take into account line of sight



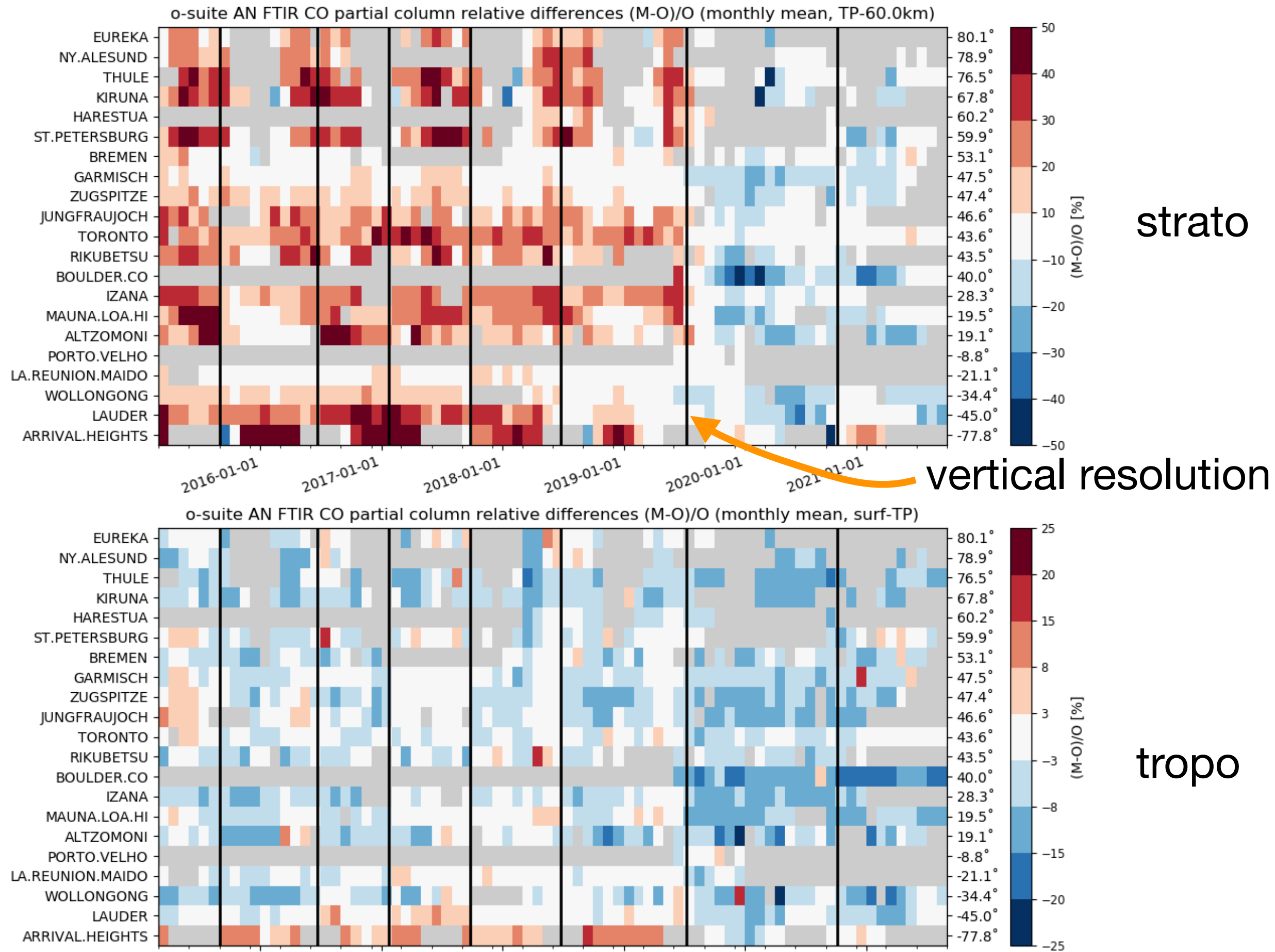
03.MIXING.RATIO.VOLUME_ABSORPTION_SOLAR [ppv]
0001_GO3_202108080600.grib Level height at site ~31.3km

CAMS osuiteAN level 30 plot at THULE (225.0m)
001_GO3_202108081200.grib Level height at site ~31.3km

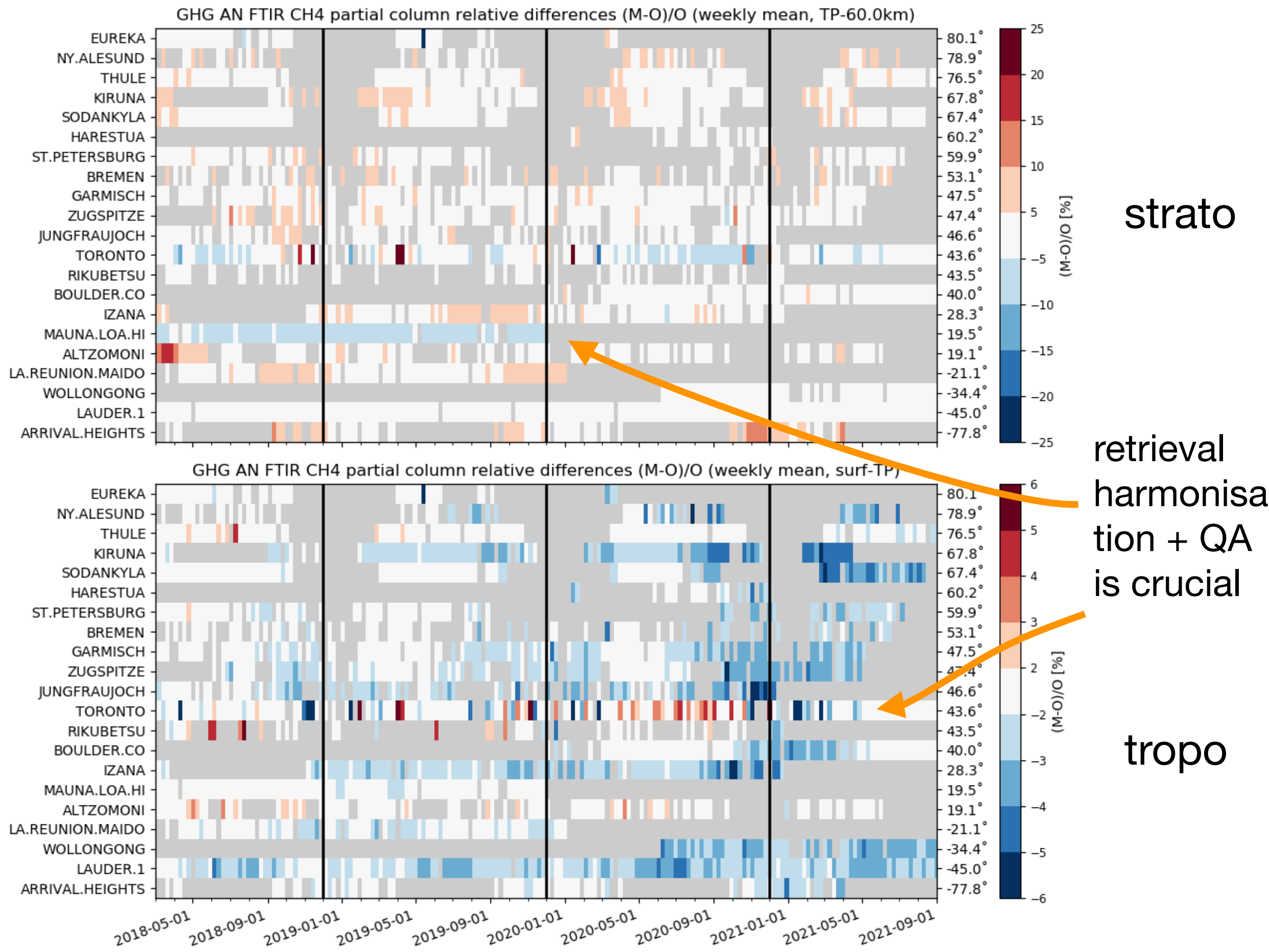
CAMS osuiteAN level 30 plot at THULE (225.0m)
001_GO3_202108081200.grib Level height at site ~31.3km



Other examples: FTIR network wide comparisons for CO



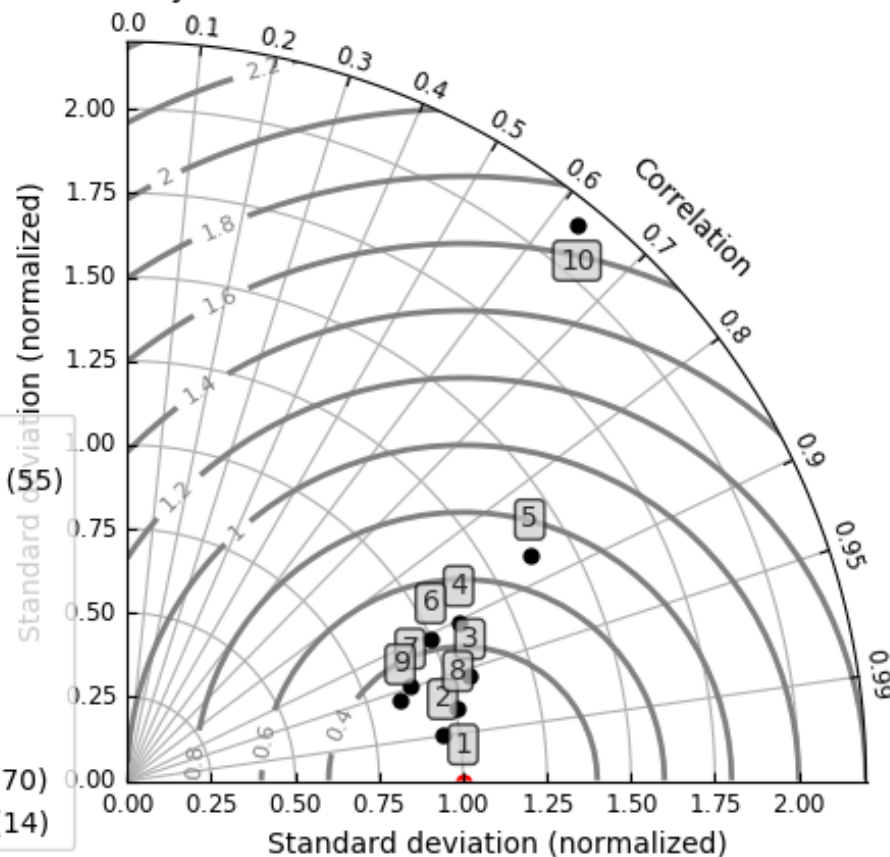
Other examples: FTIR network wide comparisons for CH₄





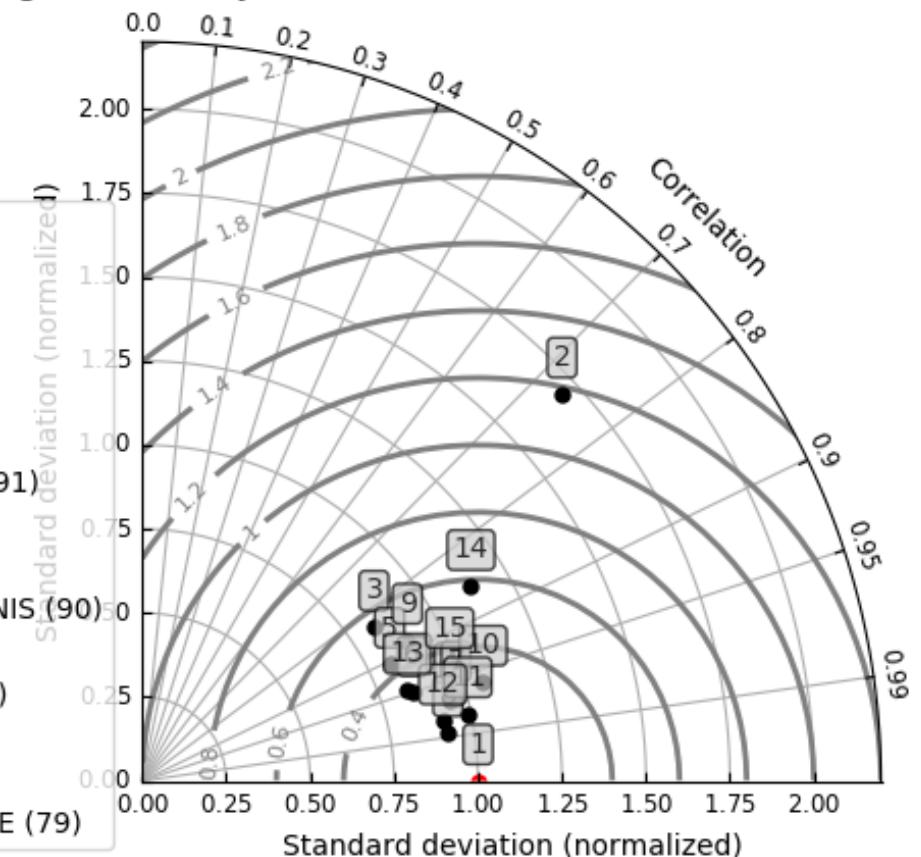
Example of visualisation for the network performance

Taylor diagram for daily mean UVVIS DOBSON timeseries



- 1: o-suite AN
- 2: HOHENPEISSENBERG (55)
- 3: BOULDER.CO (83)
- 4: MAUNA.LOA.HI (88)
- 5: DARWIN (93)
- 6: BRISBANE (86)
- 7: MELBOURNE (89)
- 8: LAUDER (79)
- 9: MACQUARIE.ISLAND (70)
- 10: AMUNDSEN.SCOTT (14)

Taylor diagram for daily mean UVVIS O3 timeseries



- 1: o-suite AN
- 2: EUREKA.PEARL (78)
- 3: NY.ALESUND (90)
- 4: SODANKYLA (62)
- 5: HARESTUA (67)
- 6: BREMEN (90)
- 7: HAUTE.PROVENCE (91)
- 8: ATHENS (90)
- 9: IZANA (92)
- 10: LA.REUNION.STDENIS (90)
- 11: KERGUELEN (92)
- 12: RIO.GALLEGOS (92)
- 13: USHUAIA (92)
- 14: MARAMBIO (80)
- 15: DUMONT.D.URVILLE (79)



More on performance measures (in development)

- measure evolution of model performance: instead of direct statistics (model/ref) look at “score”
- skill = compare “error” model vs “error” climatology

$$\text{use FGE: } E = \mu \left(\left| \frac{2(f - o)}{f + o} \right| \right) \text{ in CSS}^* = \frac{E_c - E_m}{E_c + E_m}$$

