# Task 1.5: Model-based assessment of gaps

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# Task 1.5: Model-based assessment of gaps

- Partners represent expertise in and will provide data from a wide range of atmospheric modelling: chemistry-climate modelling, air-quality modelling, aerosol modelling, greenhouse-gas modelling
- What do these modelling studies tell us about gaps in surface-based and sub-orbital observing capabilities?
- Are they telling us where additional measurements would add most interpretative value to satellite dataset characterization?
- Are they quantifying the tradeoffs between coverage, scheduling and quality?
- For the purposes of satellite dataset uncertainty characterization, are there instances where gaps in in-situ and ground-based observations can be filled by model-based fields?

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BIRA-IASB aeronomie.be

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Max Planck Institute
for Biogeochemistry

ECMWF


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# Task 1.5: Model-based assessment of gaps

- **Timeline**:
  - Define model scenarios/simulations

    *Deliverable report D1.2 submitted October 2015*
  - Report on model based assessment of gaps:

    *Initial results: Report D1.5 submitted June 2016*

    *Final Report D1.10 due in Month 34 (aim: Summer 2017)*
- **To be addressed:**
  - Strenthening connection to GAID and other WPs:

    *Making sure that Task 1.5 is well connected to GAID and gaps addressed in other WPs*


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# Sub-sampling O – B statistics at GRUAN sites

**Background:**

•NWP background fields for temperature and humidity are very useful for performing satellite cal/val (work package 4)

•GRUAN radiosonde data can provide a reference to validate the NWP fields (work package 4)

•However are GRUAN sites in the right locations to help assess the sources of bias in O – B statistics for satellite temperature & humidity data?

**Method:**

1.Review different types of bias seen in Observation minus ECMWF Background (O – B) for key instruments (AMSU-A, MHS): global biases, geographical biases, inter-satellite biases

2.Sub-sample O – B statistics at GRUAN sites to assess geographical representativeness: can we recover global biases, geographical biases, etc for a small number of sites?


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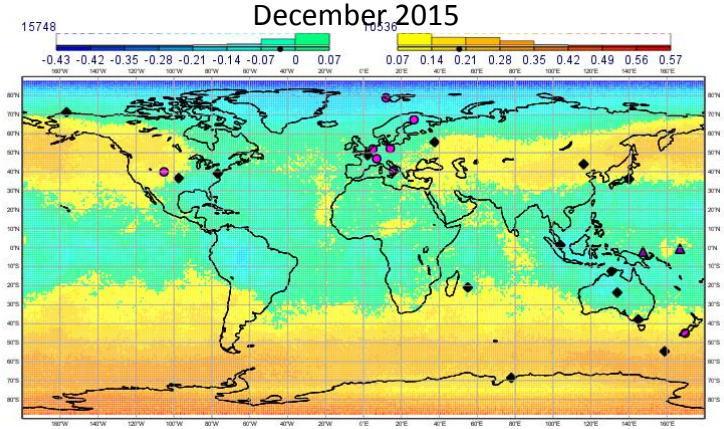
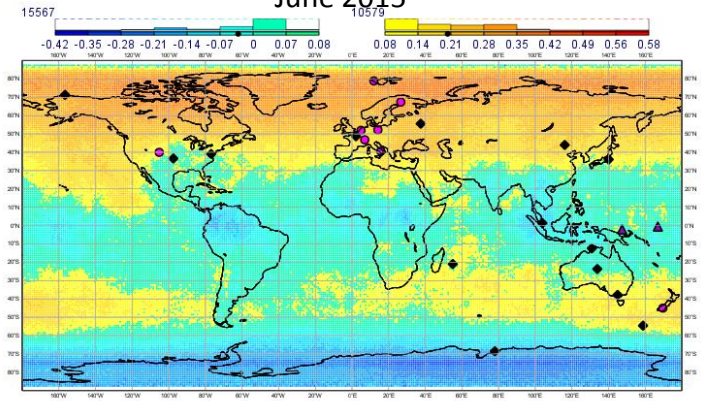
# AMSU-A: seasonally-dependent geographical biases for channels 7 - 10

## e.g. MetOp-B AMSU-A Channel 9: Mean(O – B) minus global average

December 2015




June 2015




Certified GRUAN  Non-Certified GRUAN  Inactive GRUAN

- Possible explanations for this type of bias: radiative transfer errors (pass-band shift, line modelling), instrument non-linearity corrections…
- Is some of the bias also due to seasonally-varying biases in the NWP background? GRUAN reference data could help assess this

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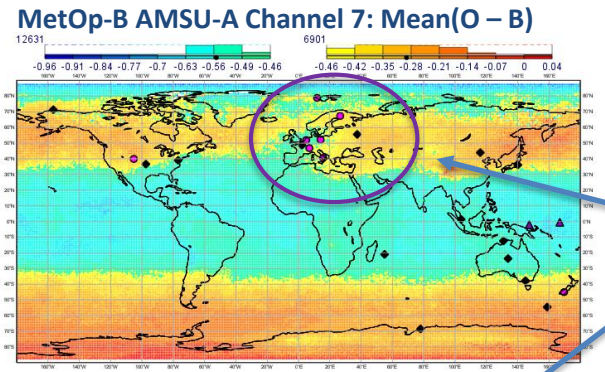
# AMSU-A: seasonally-dependent geographical biases for channels 7 - 10

**December 2015**

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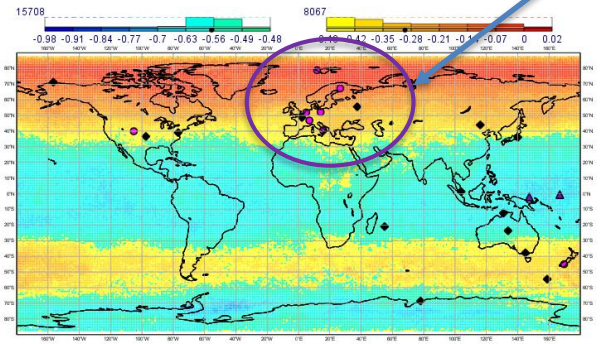


GRUAN sites in Europe could be used to assess if there are seasonally-varying NWP model biases in Northern Hemisphere

However sites in the Tropics and Southern Hemisphere would also be needed, especially to capture large-scale geographical biases…

e.g. GRUAN expansion to sites in: Antarctica, New Zealand, Australia, La Reunion…

## Future work subsampling O – B statistics to see if they capture:

- Global and inter-satellite biases for AMSU-A
- Global and inter-channel biases for MHS (geographical biases are dominated by cloud)

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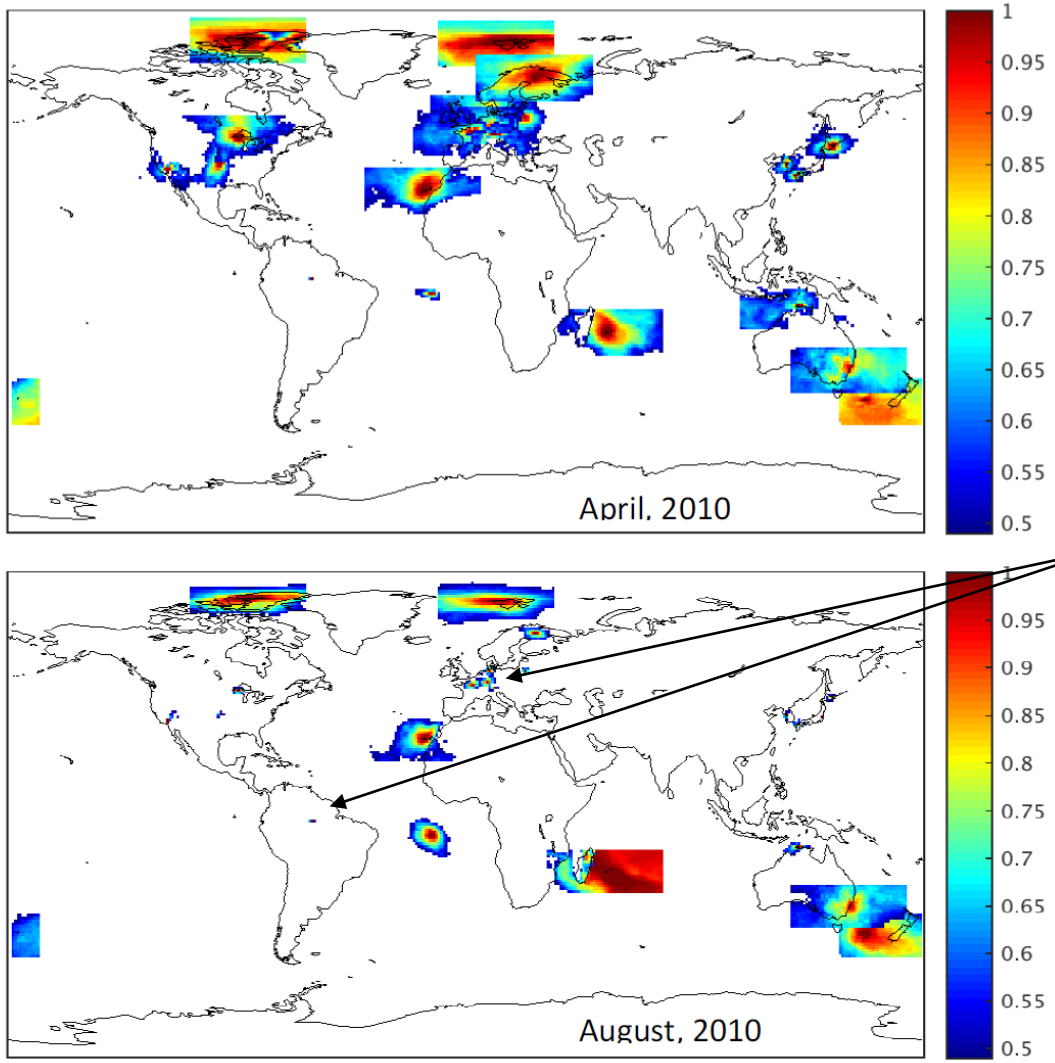
# Representativeness of TCCON GHG measurements




**XCO2**

Fraction of potential colocations

Deep convection leads to very small colocation areas

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# Gaps in the aerosol observation system

Background:

- Satellite observations are not intended to provide information of the diurnal variations of AOD
- However, AERONET measurements show that such variations exist at many locations

Aim:

- Use aerosol-climate model ECHAM-HAM fill the gaps regarding diurnal variation in AOD.

Method:

- First, compare the diurnal AOD cycles simulated by ECHAM-HAM with data from 108 AERONET stations




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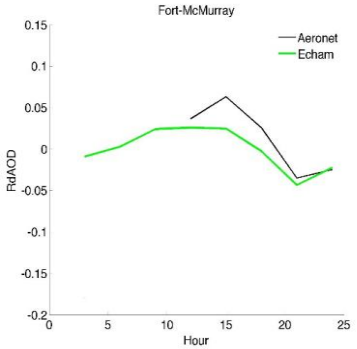
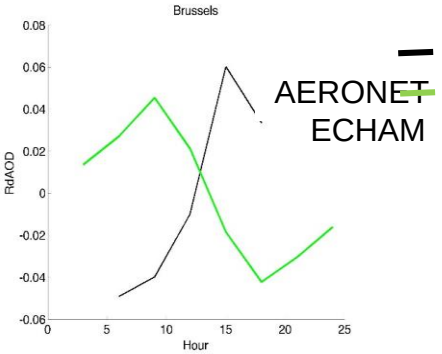
# Gaps in the aerosol observation system

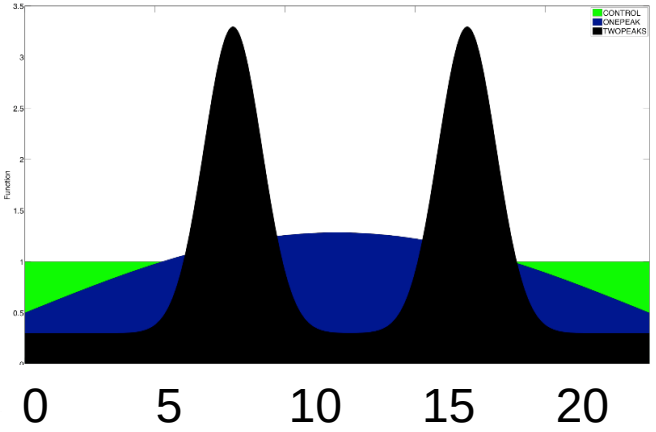
- Control runs with standard ECHAM emissions:
- at some locations (e.g. Fort-McMurry, top plot) ECHAM captures the diurnal cycle relatively well
- at most locations (e.g. Brussels, middle plot) the model performance is poor




- Control runs assumed constant anthropogenic emissions throughout the day (bottom plot).

- Test simulations with anthropogenic emissions peaking
- at noon or during traffic rush hours did not improve the modelled diurnal cycle.
- poor model performance likely due to BL dynamics, missing emissions etc (out of scope of GAIA-CLIM)
- this research line discontinued in July




- Next, look at spatial correlation lengths of AOD in satellite and model data.

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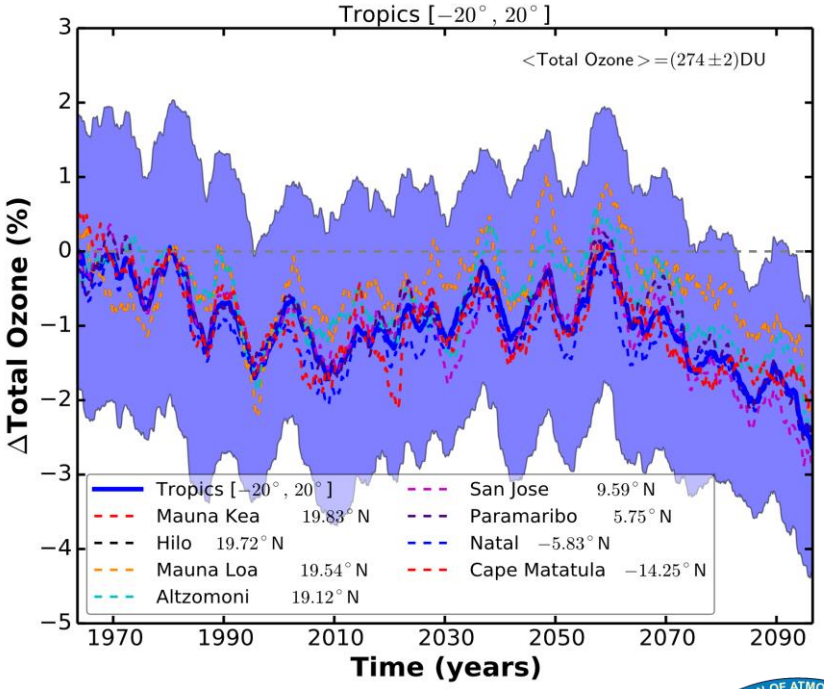
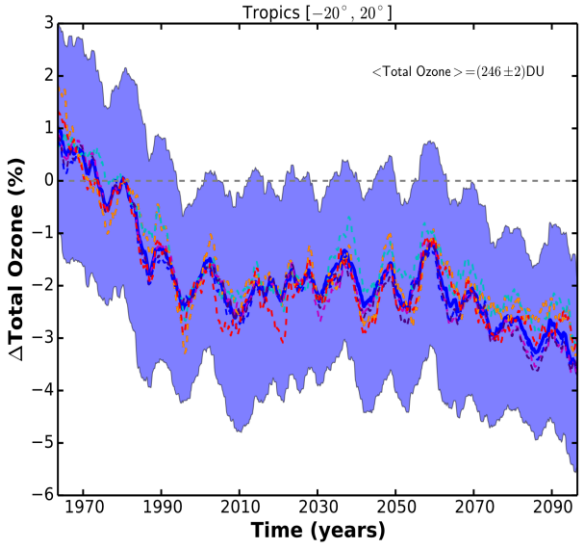
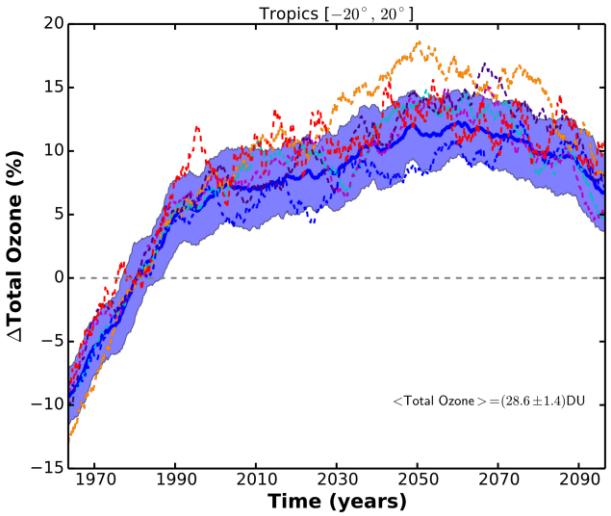
# Representativeness and attribution of tropical ozone column changes




stratospheric contribution




tropospheric contribution

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# Representativeness and attribution of tropical ozone column changes

- Tropical ozone columns affected by
  - Recovery from decreasing halogens
  - Changes in Brewer-Dobson circulation
  - Changes in tropospheric ozone
- Existing stations representative for tropical stratospheric ozone changes, less so for tropical wide tropospheric ozone changes

**Next steps:**

- Quantify these findings
- Idea: Use combination with HCl column measurements to separate changes due to halogen recovery, changes in transport and tropospheric ozone


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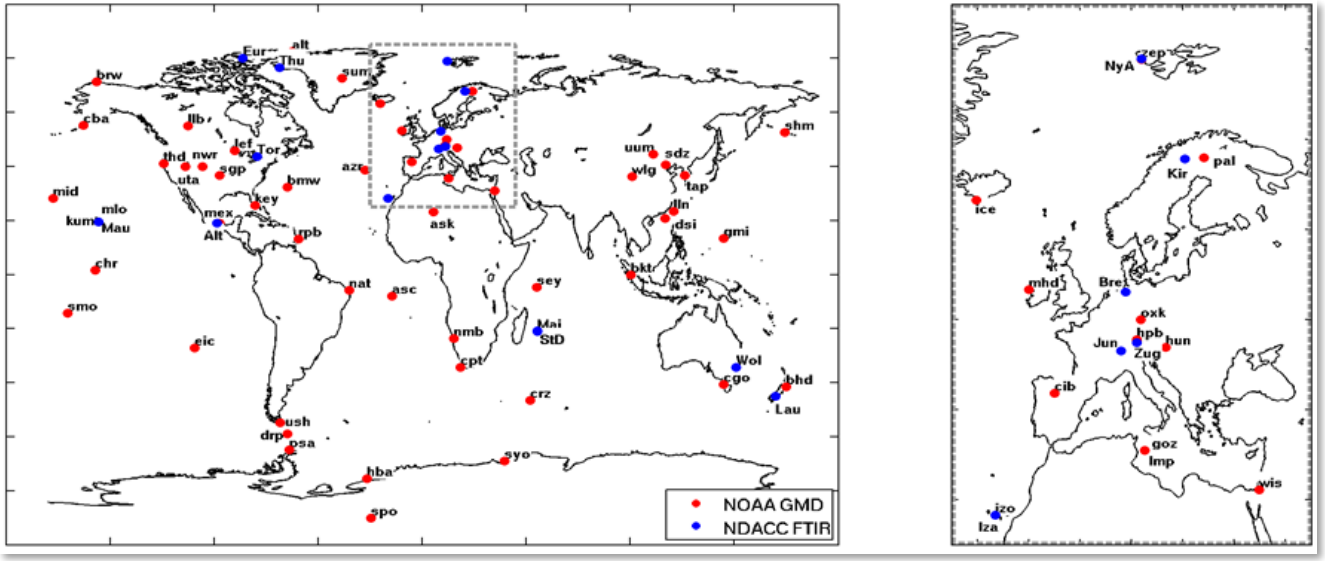
# Carbon monoxide sources and sinks

- Vertical profile information for CO abundance available from only few NDACC sites
- Vertical profile information also available from satellite sensors but limited verification makes their use uncertain

**IS THIS GAP CRITICAL FOR ASSESSING THE SOURCES & SINKS OF CARBON MONOXIDE?**

**OBJECTIVE: ASSESS ADDED VALUE OF VERTICAL PROFILES FOR CONSTRAINING THE BUDGET OF CO BY INVERSE MODELLING OF SATELLITE DATA**

- Use satellite CO data + FTIR station data
- Evaluate against in situ NOAA/GMD CO measurements
- Explore potential benefit of additional stations




FTIR and GMD stations with available measurements in 2013

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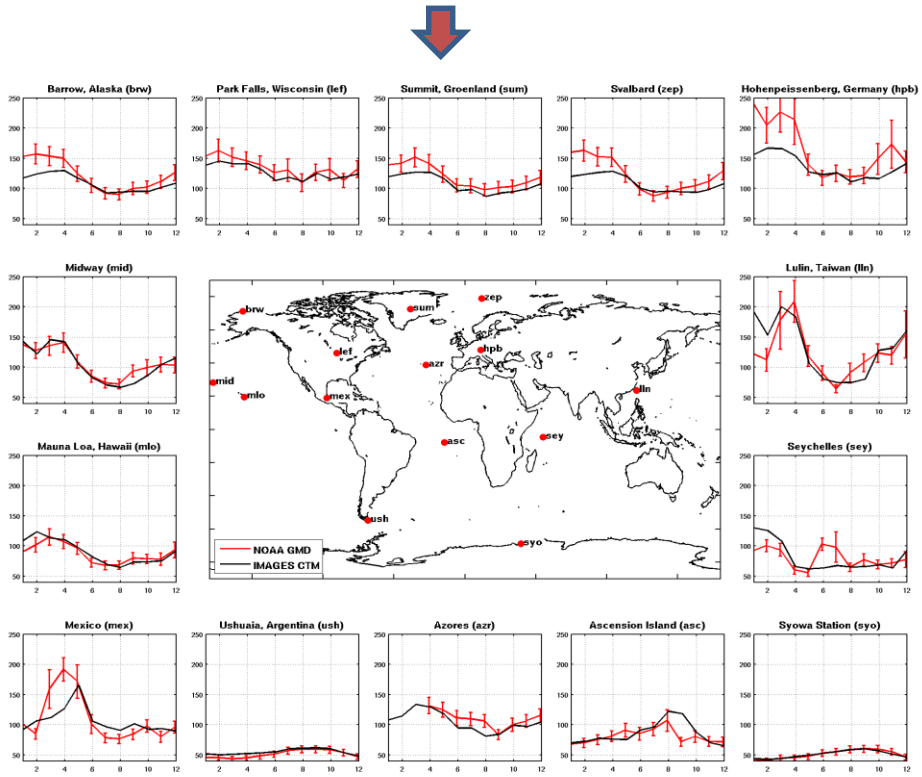
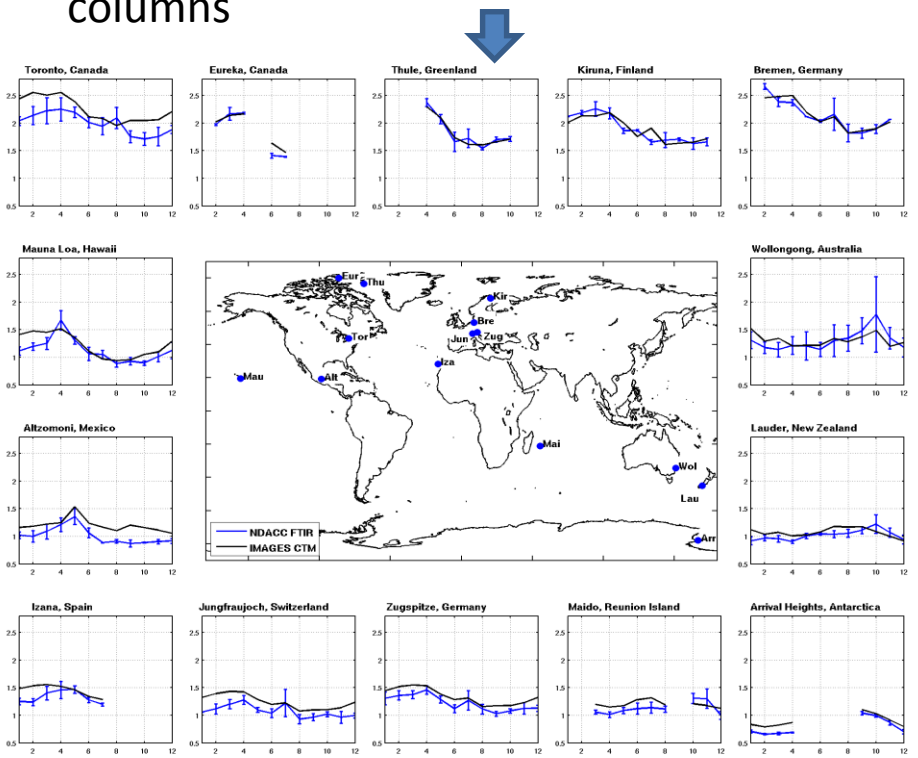
# Carbon monoxide sources and sinks: Current progress

- Built the observation operator in the IMAGES CTM (satellite/FTIR/GMD)
- Used the OH distribution provided by the climatology from Spivakovsky et al. (2000) and scale it separately at each hemisphere according to Patra et al. (2014) : this adjustment leads to lower [OH] in the Northern Hemisphere and a good agreement between the model and GMD observations




- Performed comparisons with FTIR CO columns

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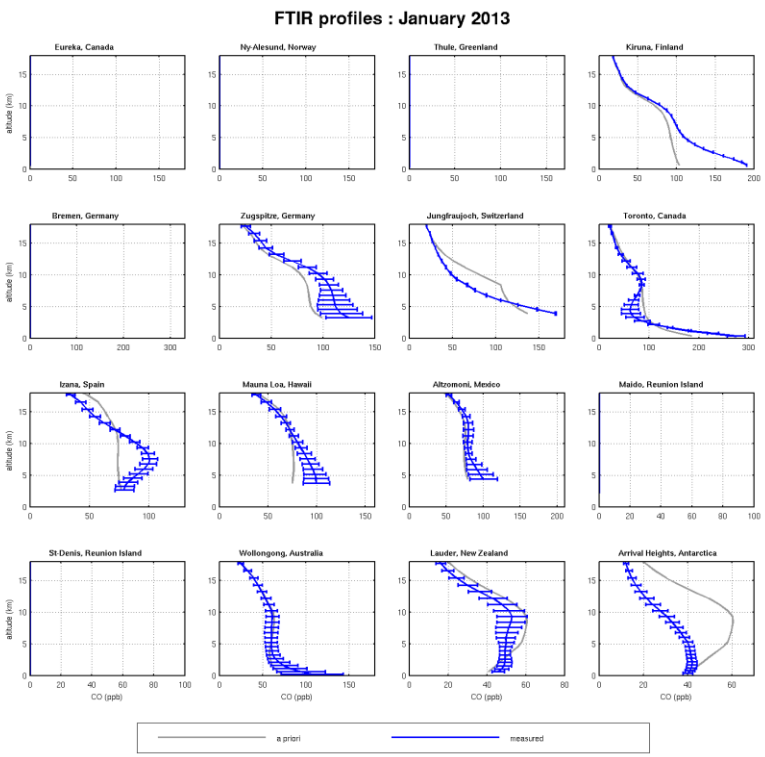
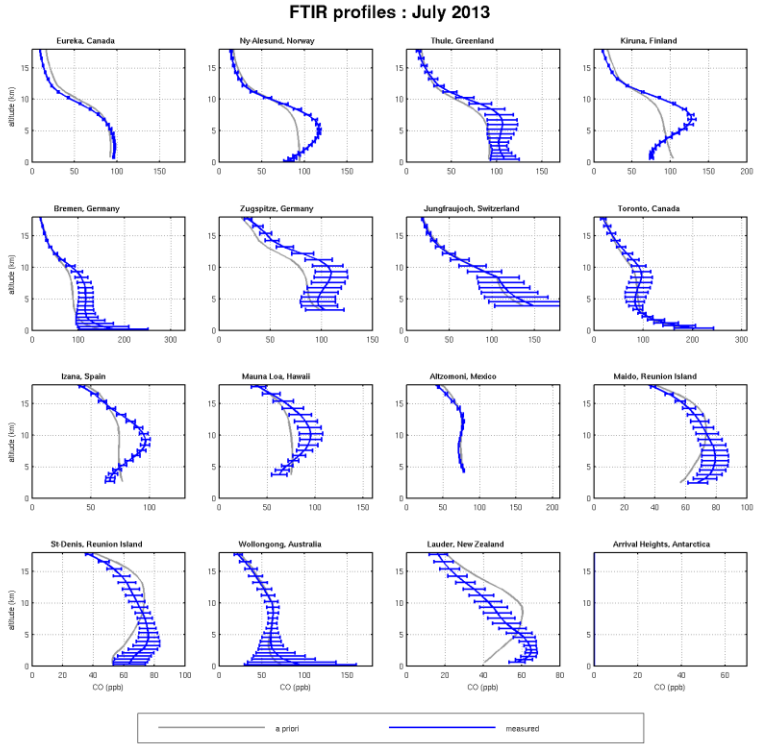
# Carbon monoxide sources and sinks: Current progress

- Designed an inversion system constrained by IASI CO observations
- Defined sensitivity inversions accounting for the uncertainties in the [OH] in both hemispheres → provide an ensemble of CO fields minimizing the mismatch between the model and the observations within the given uncertainties




CO profiles @ FTIR stations in January and July 2013

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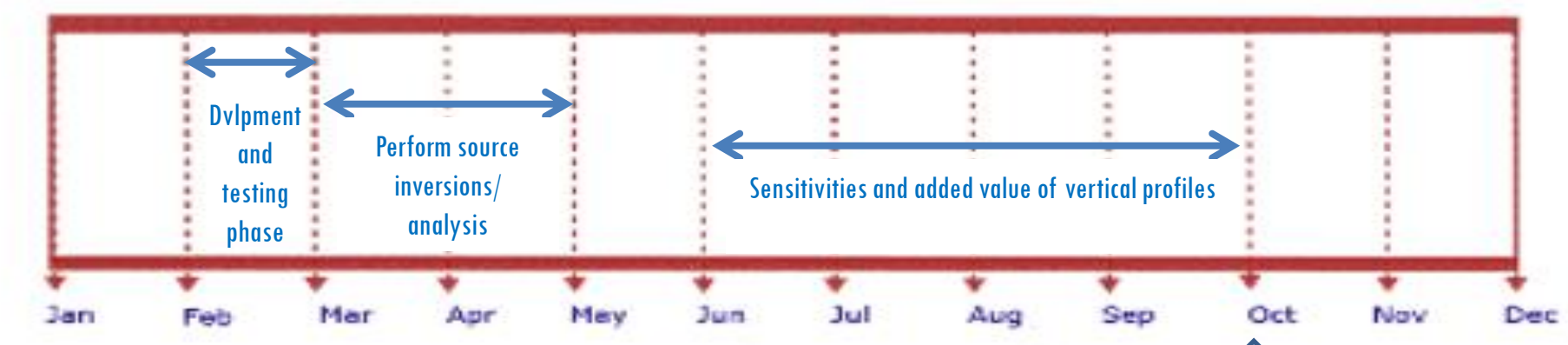
# Carbon monoxide sources and sinks: Work plan for 2017

- Improvements in the inversion design
- Analysis of the inversion results focusing on their performance against vertical CO profiles at NDACC FTIR sites and in situ observations
- Sensitivity studies exploring the effects of alternative a priori emissions, vertical mixing parameterizations
- Determination of the added value represented by vertical CO profiles at FTIR stations
- Provide recommendation regarding the CO vertical profile gap




- Presentation of results at GEIA Conference (Hamburg, 13-15 September)

D1.11 due on M34

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