WP9 – Validation of Copernicus products for O_3, NO_2, CO, CH_4, HCHO and aerosol

Summary

With inputs from WP9 and WP8 participants

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WP9 Objectives

- Make use of the NVS reports to evaluate the MACC forecasts and models
- Conclude about the NORS/NDACC-like products usefulness and relevance
- Identify possible additional candidates for systematic validation of the MACC products
- => D9.2 document (Assessment of GAS products quality, on the global scale or for specific conditions or seasons)

[Started on month 18; fed by several NORS WPs]

Available products and techniques

	fnyp	fkya	fsd7
Ozone	DOAS & MAX-DOAS, FTIR, LIDAR, MWR	DOAS & MAX-DOAS, FTIR, LIDAR, MWR	DOAS & MAX-DOAS, FTIR, LIDAR, MWR
NO_2	--	--	DOAS & MAX-DOAS, FTIR
CO	FTIR	FTIR	FTIR
CH_4	FTIR	FTIR	FTIR
HCHO	MAX-DOAS	MAX-DOAS	MAX-DOAS
aerosol	MAX-DOAS		

Since October 2014, the f* models have been replaced. The new "g*" models are handled by the NVS. However, given the limited statistics atm (< 2 months with coincidences), we will present results for the previous ensemble of model results, available for ~2013-2014, providing statistics for at least a complete seasonal cycle

Some statistics…

- Based on the possible combinations (techniques, models, targets) and available time period, we can anticipate a very large number of comparisons/monthly reports… and it is indeed the case!

Inventory of NVS reports (31/10/14)

Per year / per technique	2013	2014
DOAS.ZENITH	66	51
DOAS.OFFAXIS	74	13
FTIR	866	551
LIDAR	44	40
MWR	355	122

Per year / per target	2013	2014
Ozone	571	358
NO2	130	68
CO	323	223
CH4	167	103
HCHO	44	0
Aerosol	10	5
TOTAL	**>1400**	**>770**

Inventory of NVS reports (ctd)

- How to deal with so many comparisons?
- => Taylor plots have been implemented!

- **Ozone.FTIR**
- **Ny Alesund**
- **May 2013**

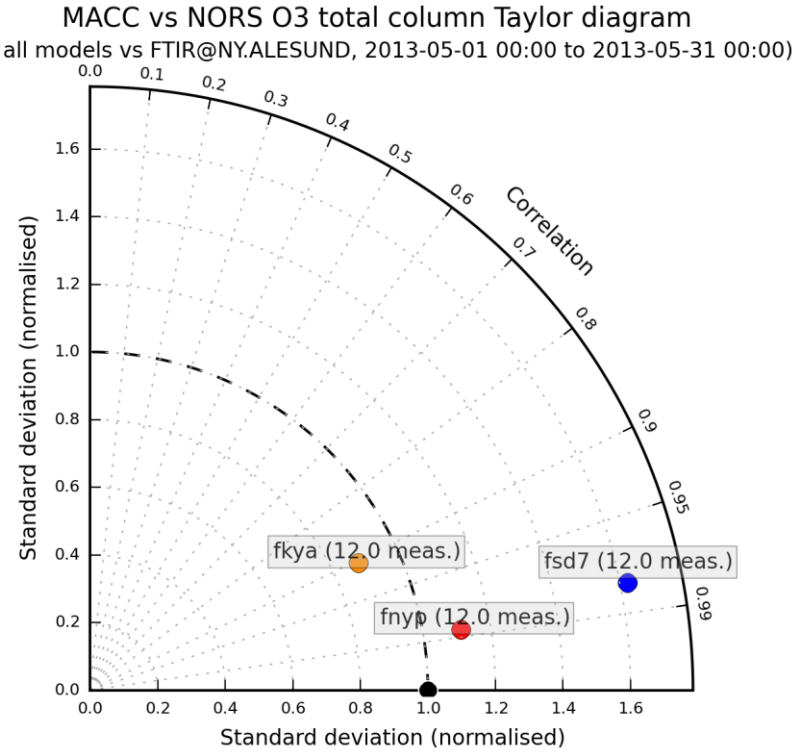


Figure 1. Taylor plot showing the statistical comparison results between ozone total columns measured by the FTIR instrument at Ny Alesund and as forecasted by the fkya, fsd7 and fnyp MACC models.

Ozone:

Correlation often > 0.9

- **fnyp**: performs really well (correlation and variability)
- **fkya**: some poor comparisons (e.g., in May)
- **fsd7**: overestimation of the O_3 variability on [April-August]

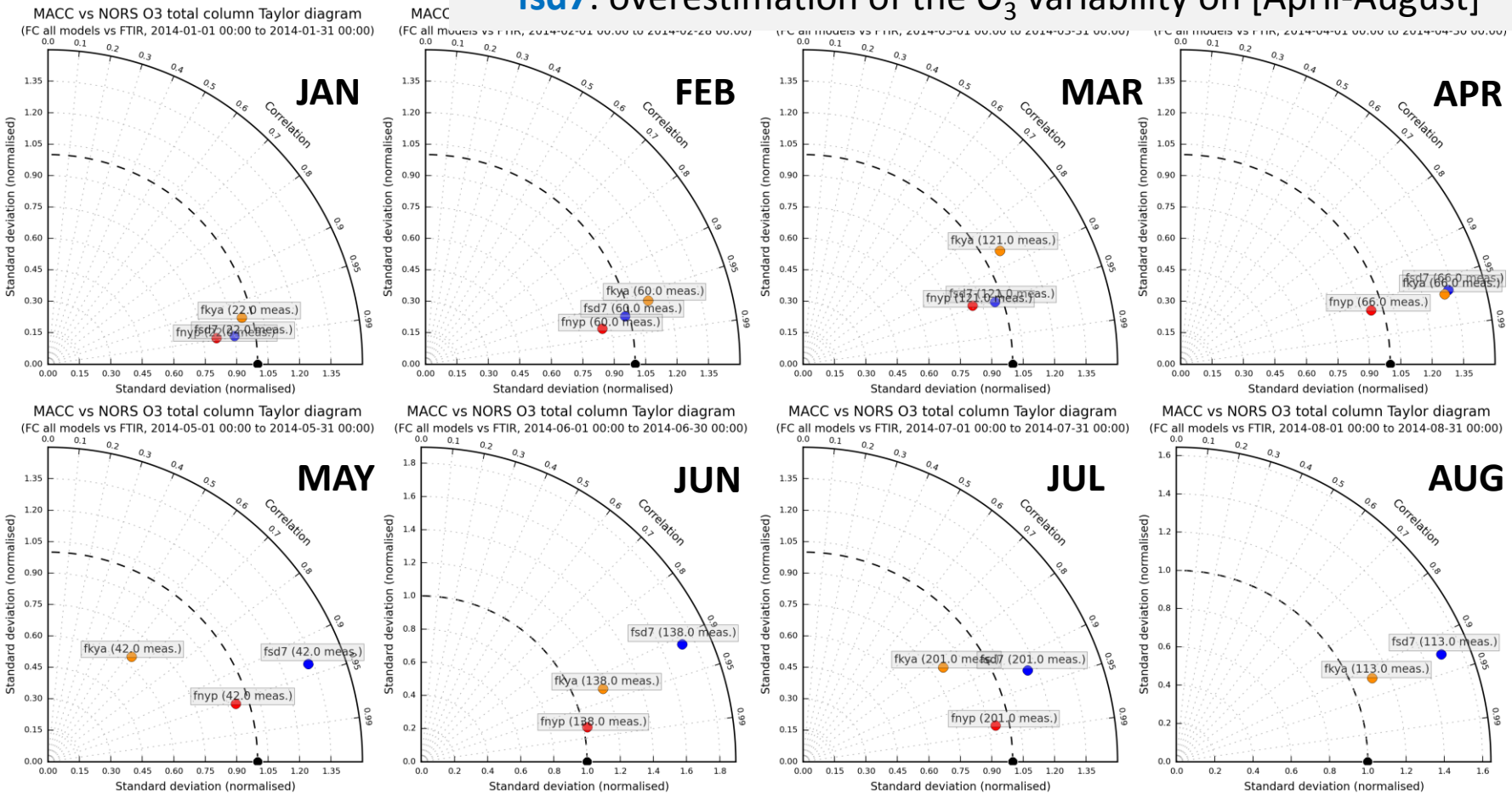


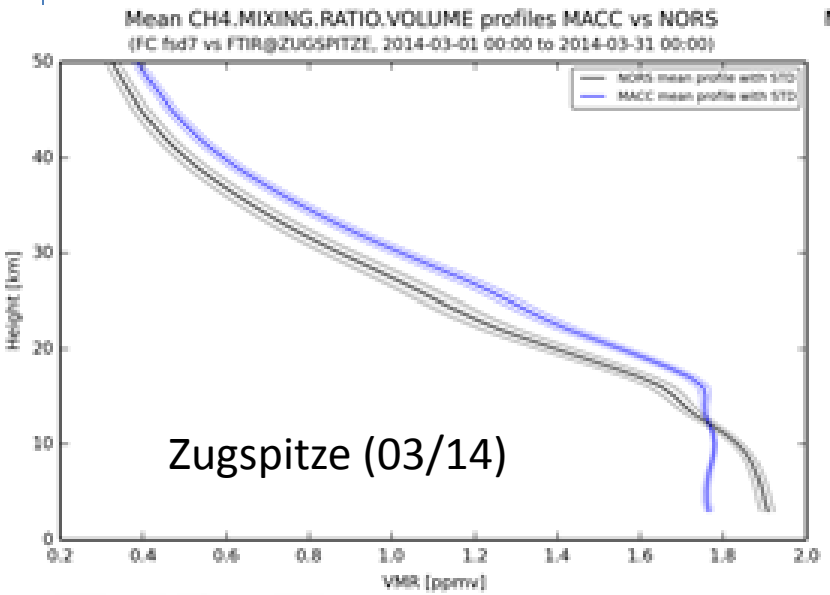
Figure 2. Relative performance of the MACC models in reproducing the FTIR ozone total columns for January to August 2014 (from left to right and top to bottom).

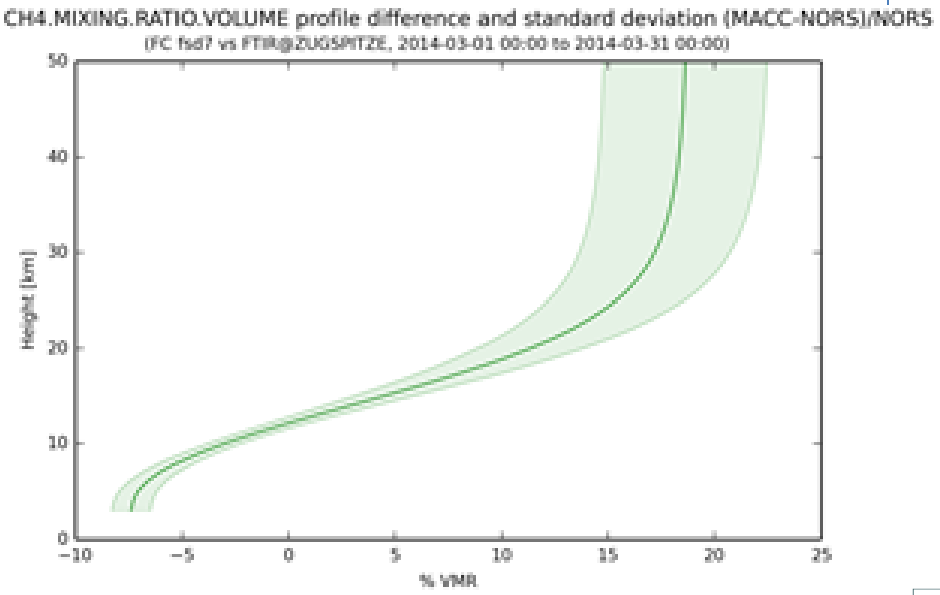
Ozone (ctd)

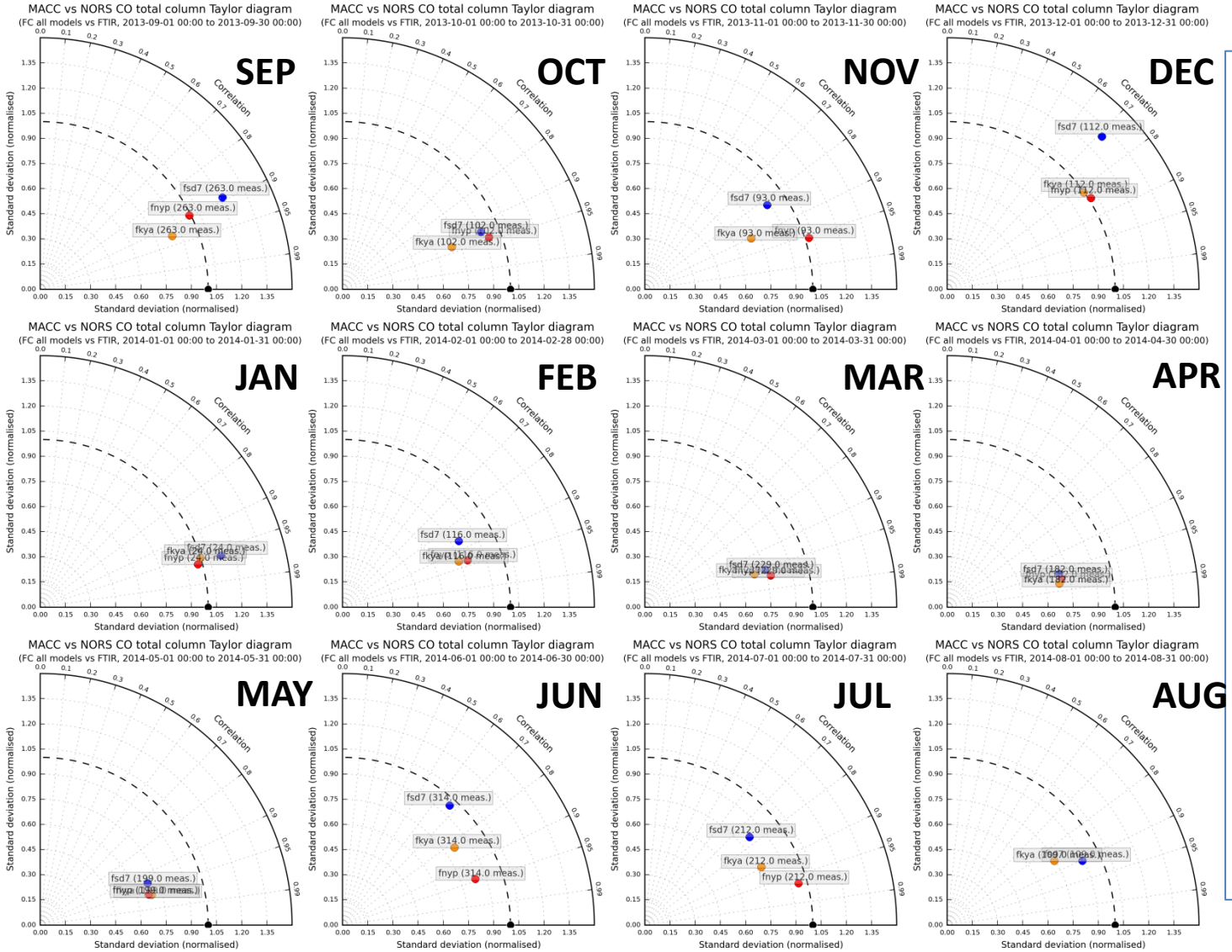
- The overall picture is confirmed when looking at single site comparisons
- Except for Reunion, with low correlations (<0.4) for **fsd7** and **fnyp** in August 2014; ozone variability poorly represented by the models (norm. std. dev. of 2.5 in 08/13 (**fkya**), or 0.45 for 06/14 (**fnyp**))

Methane: FTIR vs **fsd7**

- Taylor diagrams indicate very good statistics (>0.95) at all sites
- CH_4 atmospheric "variability" well captured by the **fsd7** model
- FTIR columns higher (~3% for NYA, JUN and ZUG, ~5% for IZA and REU.M)
- Typically, the FTIR profiles often suggest a slope in the lower troposphere and larger concentration at surface







CO.FTIRs

- 09/13 – 08/14
- As for O_3, **fnyp** performs well (correlation and variability)
- CO variability often underestimated in spring
- **fsd7** is the only model suggesting CO variability larger than observed (SEP, DEC)

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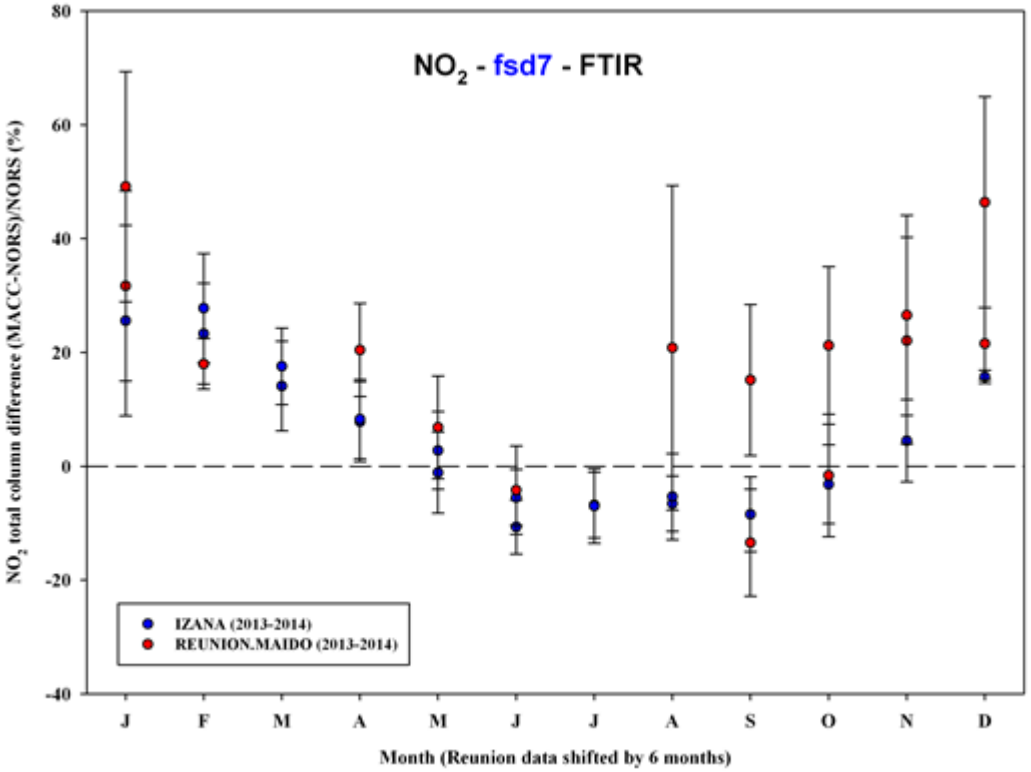
NO_2



Strong diurnal and seasonal variations (maximum time difference: <1h)

FTIR Total columns

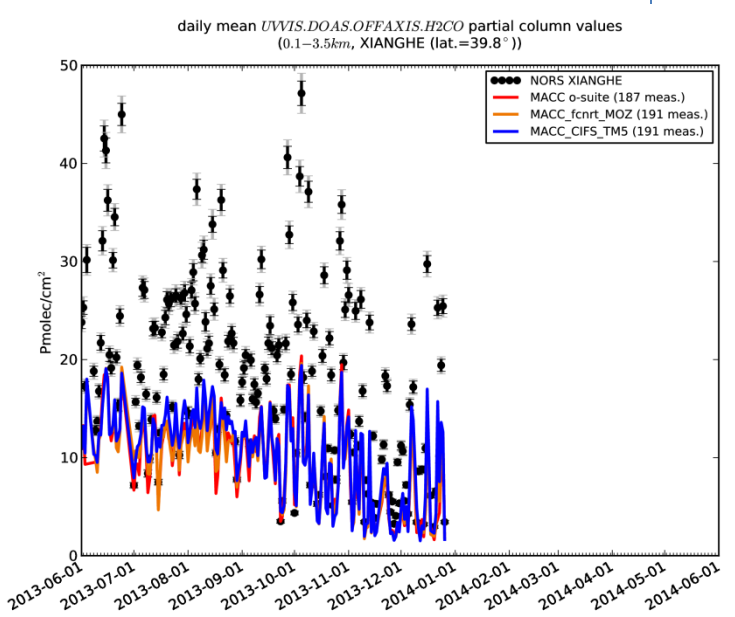
- Good statistics for IZA & REU.M (2013 & 2014)
- Mean biases show a seasonal signal, consistent for both sites
- Overestimation by **fsd7** of up to 50% in winter
- Underestimation by 5-10% in summer, at the limit of statistical significance (1σ)

MAX-DOAS (Xianghe, CHI)

- Sens. to near-surface NO_2
- Correlation: [0.1 – 0.7]
- Atmospheric variability systematically underestimated (missing emission events)
- Large scatter in the biases (no seasonal pattern in the differences)
- Overall bias 1±40 % (1σ)

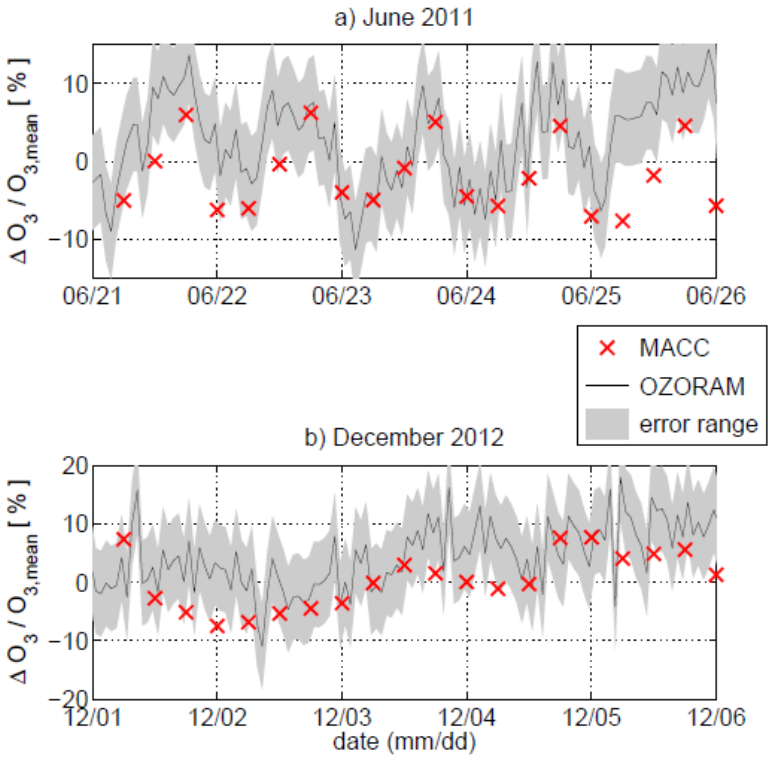
HCHO & aerosol

- Available for **Xianghe** (MAX-DOAS)
- Specific investigations have been/will be conducted for inclusion in the MACC validation reports
- **HCHO**: background columns well captured, high emission events are not (by up to a factor 2-3)



Usefulness & relevance

- NVS results shown here (in D9.2) and in previous talks
- Specific contributions to MACC reports, using the server architecture (cfr Bavo's talk)
- Also demonstrated in scientific investigations (study of the diurnal ozone variation in the stratosphere; cfr Ansgar's talk)



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Suggestions for improvement

- After intensive use of NVS, we identified changes or features that could be implemented in a future version of the server, allowing still increasing its usefulness for the validation of MACC forecasts (list and description of these suggested changes are provided in D9.2)

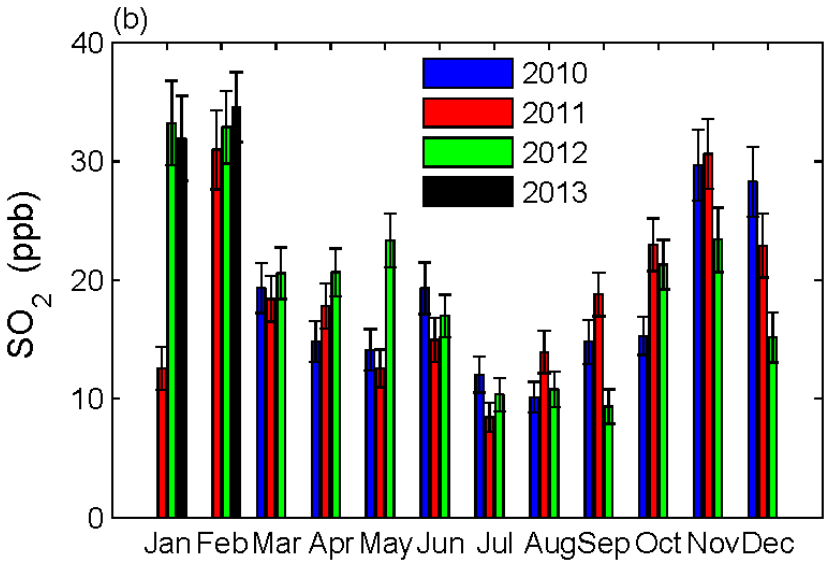
Possible new species

- **H_2O** has been added and reports are generated by NVS (MWR in the stratosphere, FTIR in the troposphere)
- **HCHO.FTIR**: given the complementarity between the MAX-DOAS and FTIR techniques (sensitivity ranges), the addition of HCHO from the NDACC-FTIRs would able checking the MACC model capacity to capture HCHO in the upper troposphere (cfr Bruno's talk and Franco et al., AMTD, 2014)
- **SO_2**: an indicator of Air Quality =>

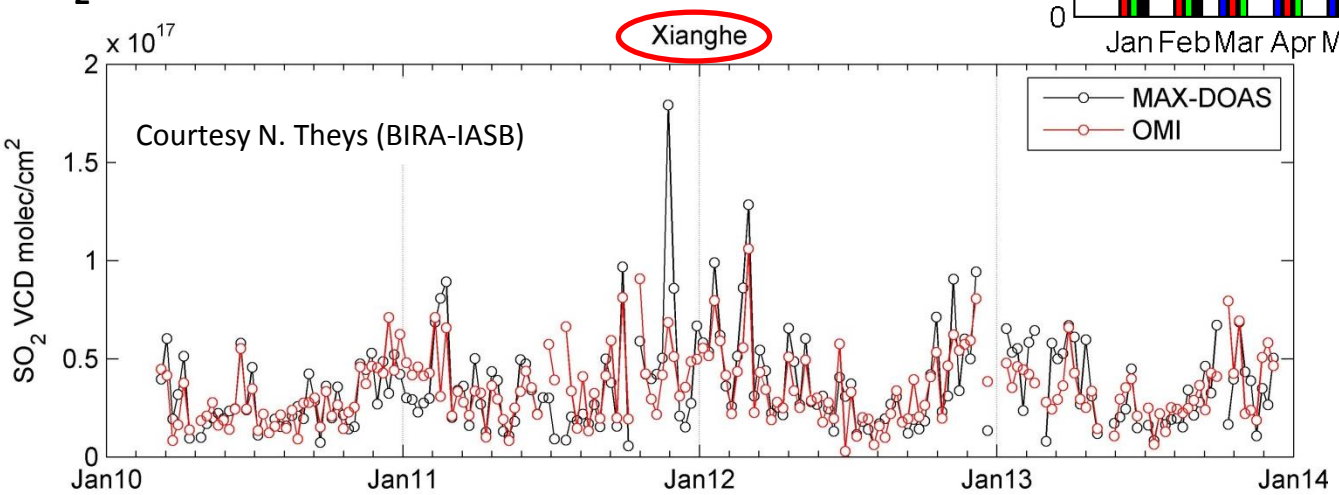
SO_2 MAX-DOAS measurements at Xianghe (China)

MAX-DOAS retrieval → Vertical profiles → Surface concentrations; Vertical columns

Time-series of SO_2 surface concentrations



SO_2 vertical columns: satellite validation



Wang et al., ACP, 2014

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NORS partners

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THANK YOU!