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Continuation of PANDA forecasts and EMEP model improvement in China

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How the forecasts are set-up?

www.marcopolo-panda.eu/forecast

- Forecast for $PM_{2.5}$, PM_{10}, NO_2, O_3
- 6 models:

5 from Europe:
CHIMERE v2013 (KNMI)
SILAM (FMI)
WRF-Chem (MPI)
EMEP (Met.no)
LOTOS-EUROS (TNO)
1 from China: WRF-Chem (SCUEM)
+ Ensemble (median/mean)

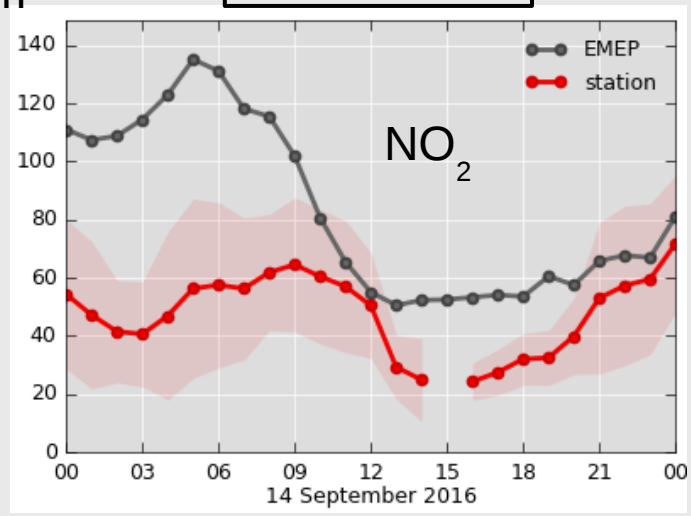
Set up for EMEP

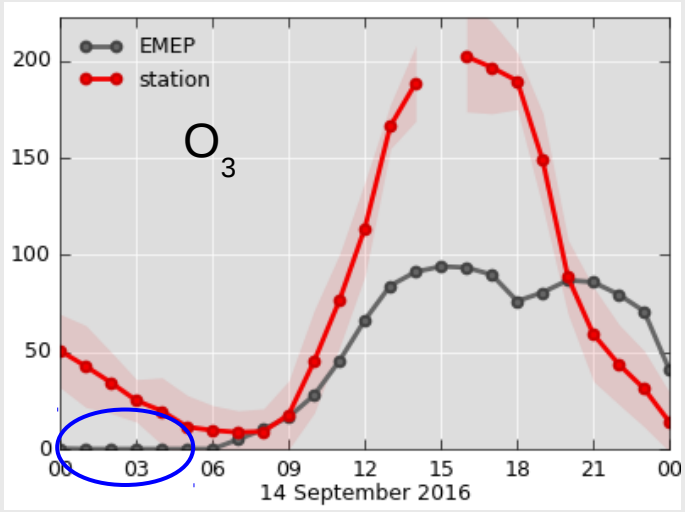
- Meteorological data: C-IFS (ECMWF) 0.1°x 0.1°
- BCs from ECMWF
- Emission: PanHam = HTAP + MEIC 2012 (Chinese inventories) - 0.1°x 0.1°
- Domain: 15-55°N, 90-135°E
- Forecast delivers at 02:00 UTC

What do we learn with the forecasts?

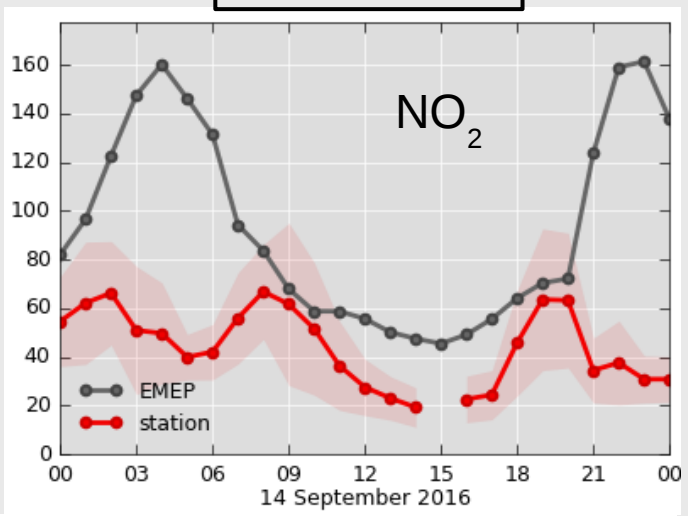
Unit: µg/m^3

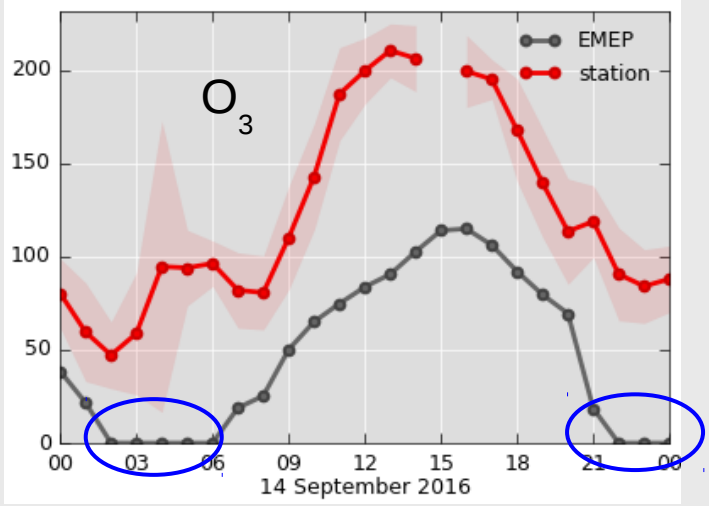
Beijing





Wuhan





No O_3 during the night

Difficulty with NO_2-O_3: for these cases, overestimation in NO_2 leads an underestimation in O_3

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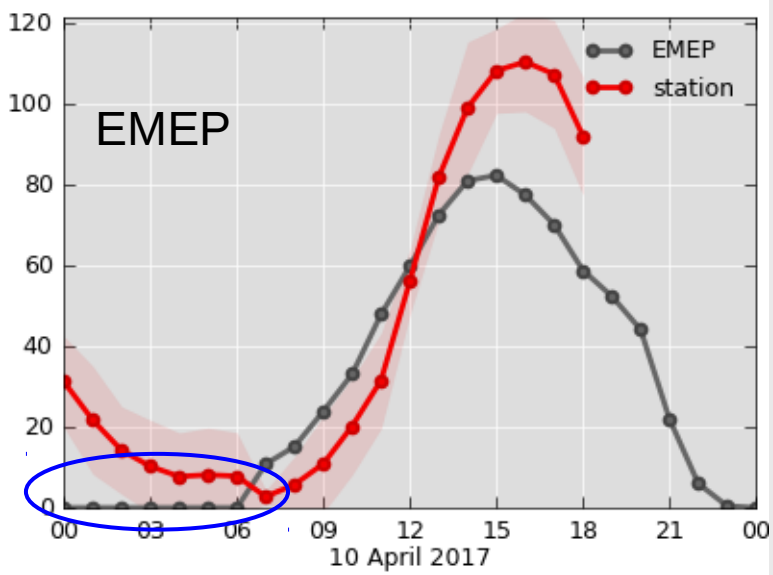
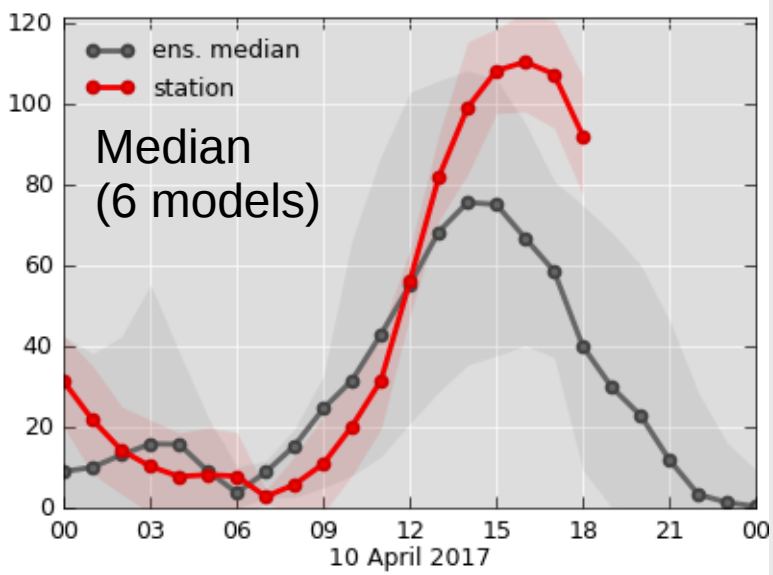
What do we learn with the forecasts?

Some days, O_3 works better in comparison with observations:

Beijing





Still no O_3 modelized during the night

Since March 2017, a version with NO_x reduced by 35% is also running → a comparison can be done.

FMI does this reduction in their forecast.
This number comes from their comparison with NO_2 from GOME2

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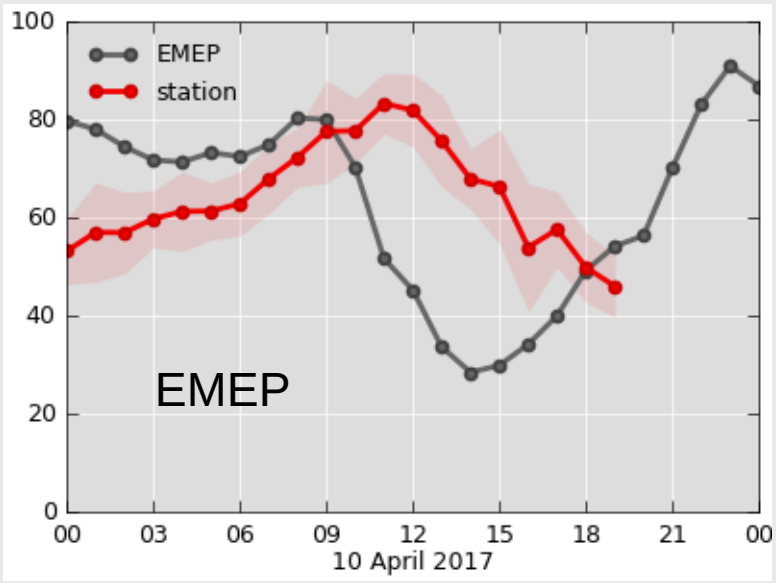
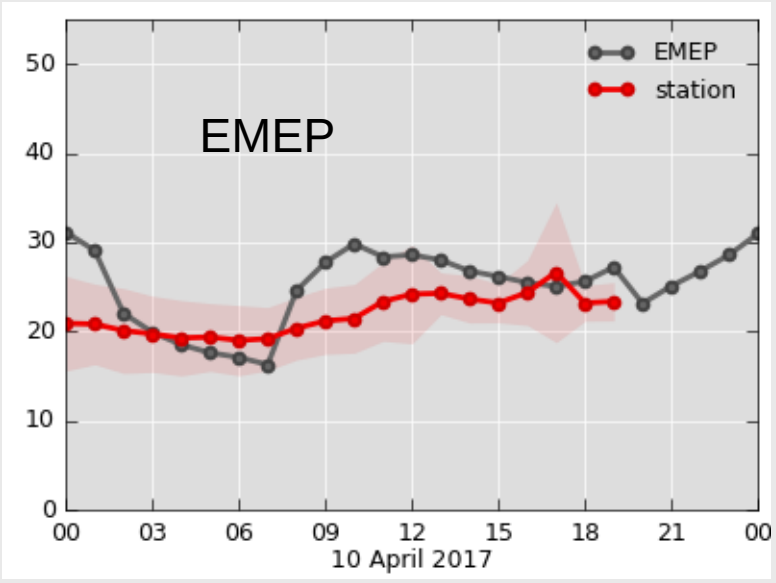
What do we learn with the forecasts?

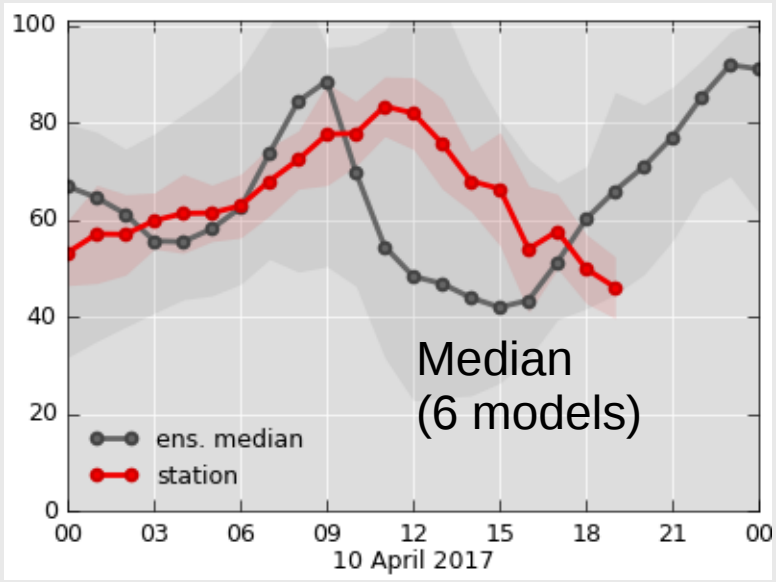
$PM_{2.5}$ ($\mu g/m^3$)

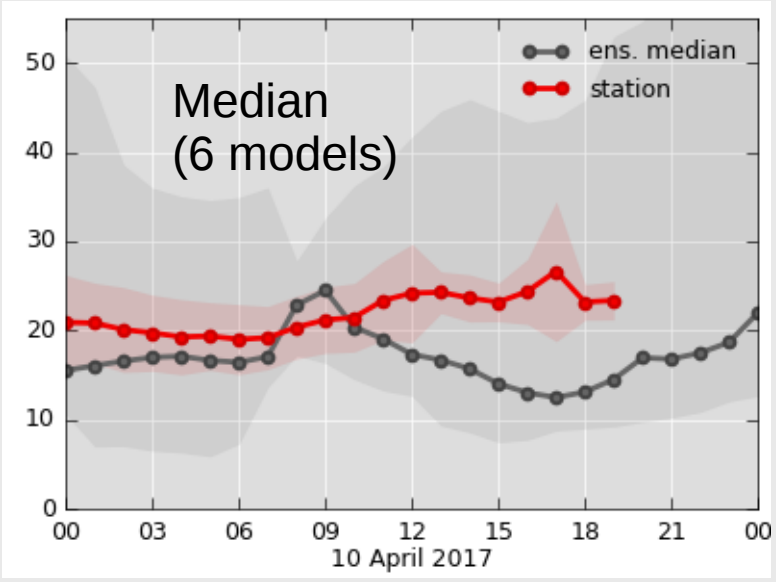
Beijing



Guangzhou







First evaluation of the model

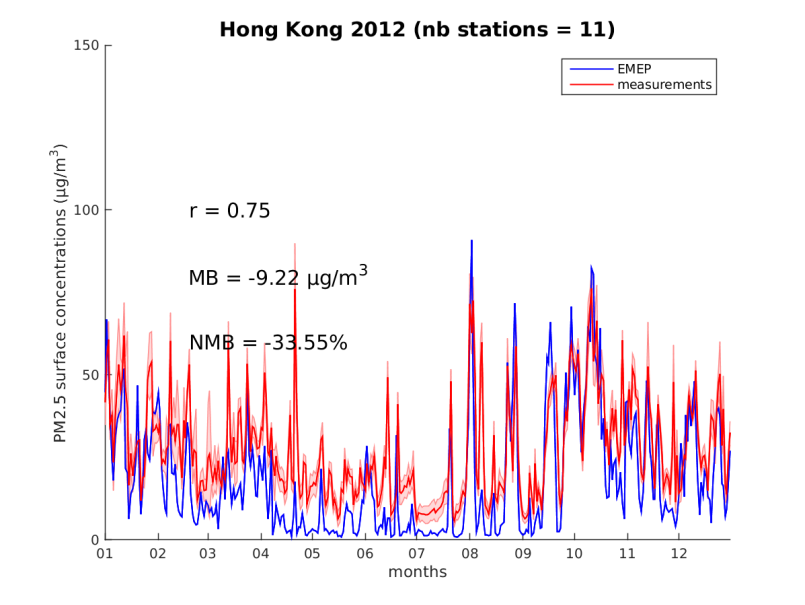
... before to get the data for 2016 and 2017 to compare the forecast outputs.

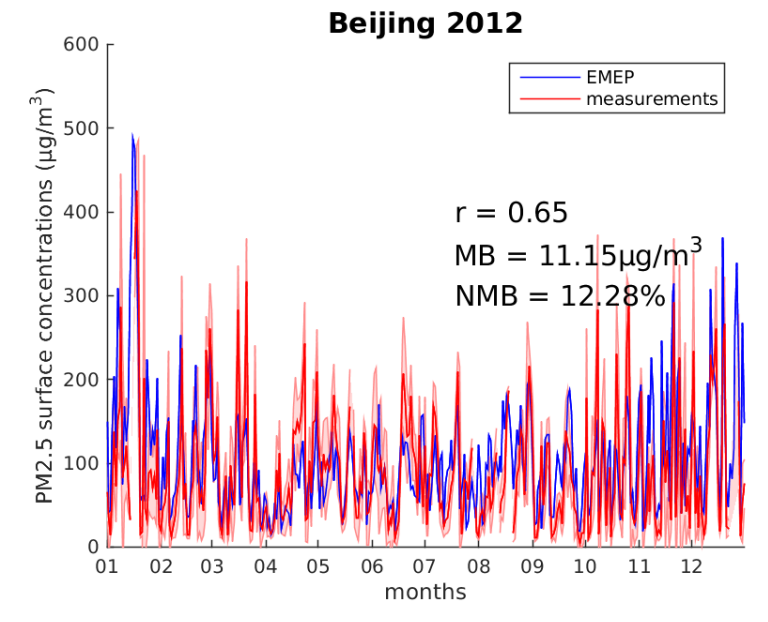
Example for 2012:
- runs using the same emissions as the forecasts - 0.1°x 0.1°
- BCs from a globlal run (EMEP at 0.5°x 0.5°)
- wind fields from ECMWF - 0.1°x 0.1°

$PM_{2.5}$ (µg/m³)

Data from http://epic.epd.gov.hk/EPICDI/air/station/?lang=en

Data from US embassy





Good agreement with $PM_{2.5}$

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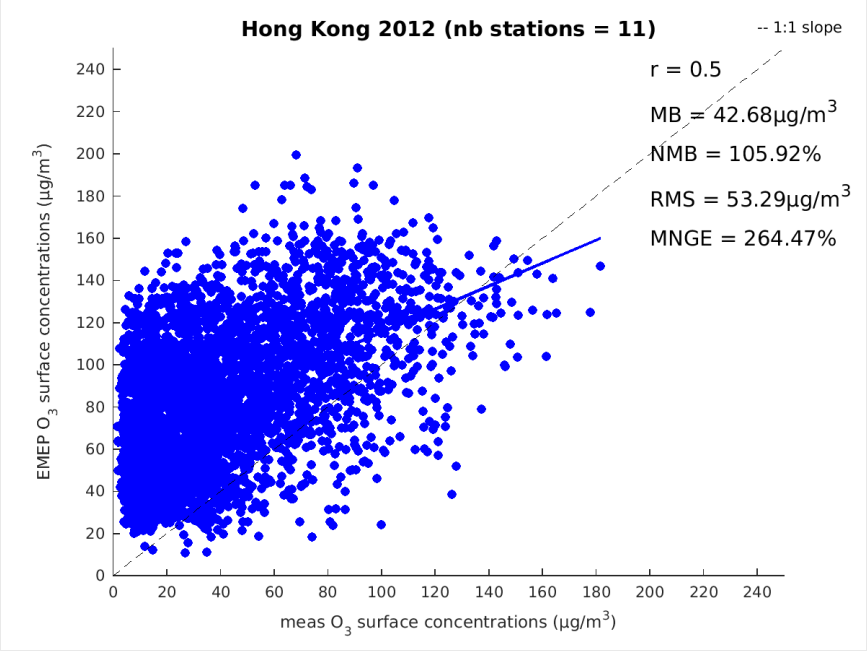
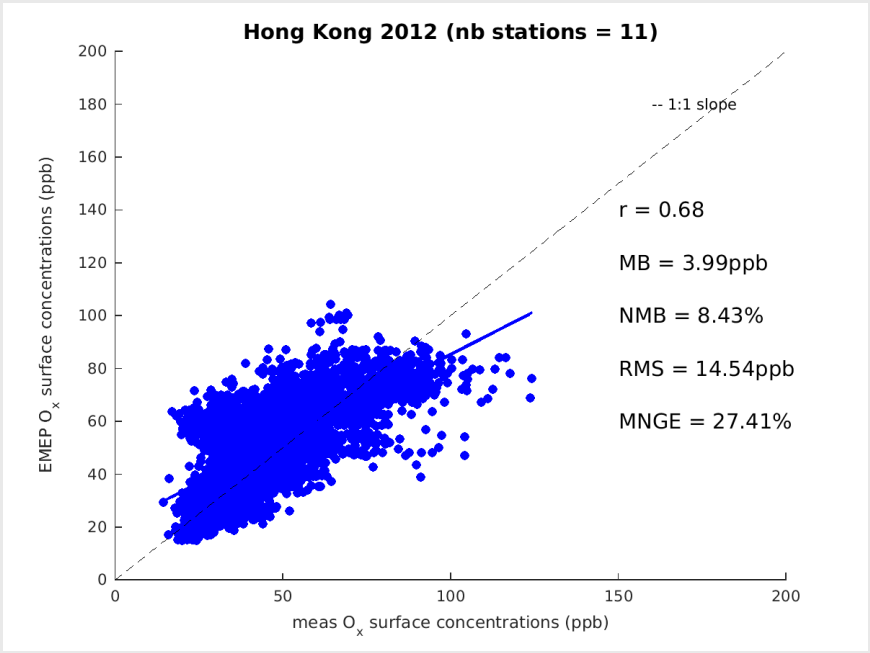
First evaluation of the model

Example for 2012:

O_3 (µg/m^3)



O_x (ppb) = O_3+NO_2



Overestimation in O_3 → clear link with the titration of O_3

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First evaluation of the model

IASI instrument on board MetOp-A used for this comparison

Example of comparsion done:

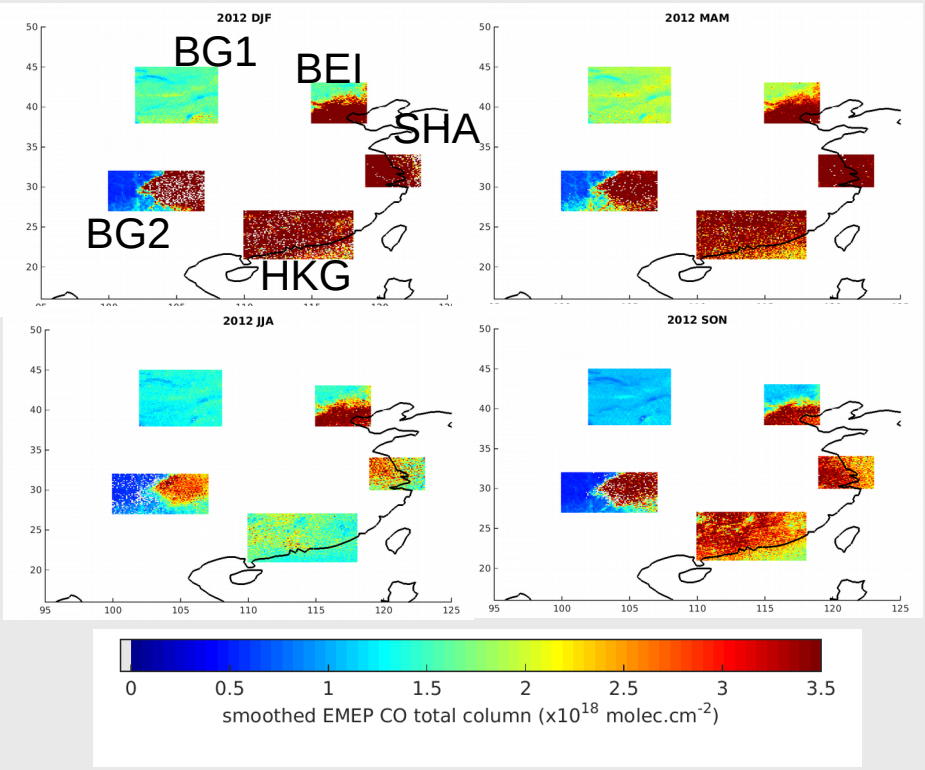
CO total column (IASI): IASI only sensitive to the total column (George et al., ACP 2009 & Pommier al., ACP 2010).

First evaluation of the model

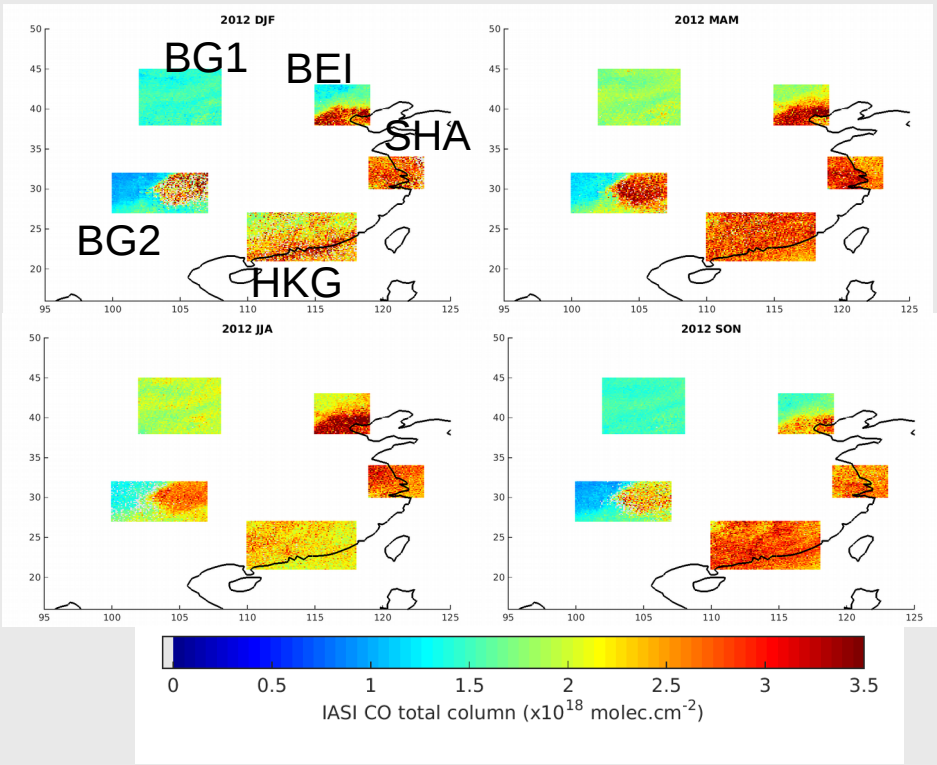
- EMEP outputs are co-located to the overpasses.
- EMEP outputs are interpolated to the satellite altitude levels and then convolved.

→ hourly 3d outputs from EMEP used: time and space demanding!
→ select 5 regions

EMEP CO



IASI CO



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First evaluation of the model

	DJF	MAM	JJA	SON
HKG	r=0.08 NMB=107.31 %	r=0.5 NMB=67.43%	r=0.74 NMB=-26.9%	r=0.47 NMB=2.27%
SHA	r=0.38 NMB=147.1%	r=0.05 NMB=78.32%	r=0.61 NMB=-16.99%	r=0.13 NMB=15.28%
BEI	r=0.8 NMB=101.22 %	r=0.72 NMB=29.3%	r=0.74 NMB=-4.88%	r=0.75 NMB=15.87%
BG1	r=0.31 NMB=7.68%	r=0.39 NMB=1.47%	r=0.66 NMB=-31.04%	r=0.46 NMB=-28.38%
BG2	r=0.78 NMB=167.28 %	r=0.81 NMB=41.58%	r=0.88 NMB=-22.1%	r=0.75 NMB=23.5%

Lower bias

High r
Low bias

DJF corresponds to the most misrepresented season by the model, in comparison with the satellite measurements

→ IASI may also be probably blamed

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Source receptor runs

- **EMEP MSC-W** has been used for **decades to calculate source-receptor** relationships between European countries (including Russia).
- Currently: calculations done for 28 **European cities** on a daily basis for O_3 and PM_{10}

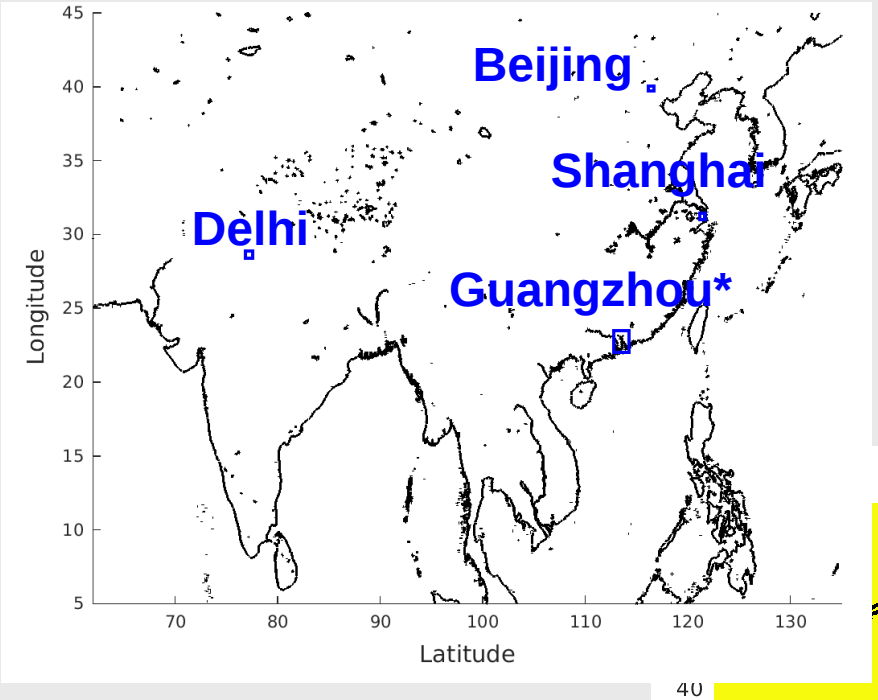
(http://policy.atmosphere.copernicus.eu/CitySourceAllocation.html).

→ **give policy makers an indication of how much of their local air pollution is due to indigenous (local) sources and how much is imported from outside.**

→ **compliance monitoring**; ex: on a particular day, calculations show if local policy is efficient or not

► Similar runs are done over Asia (Delhi, Beijing, Shanghai and Guangzhou)**: first results**

Source receptor runs

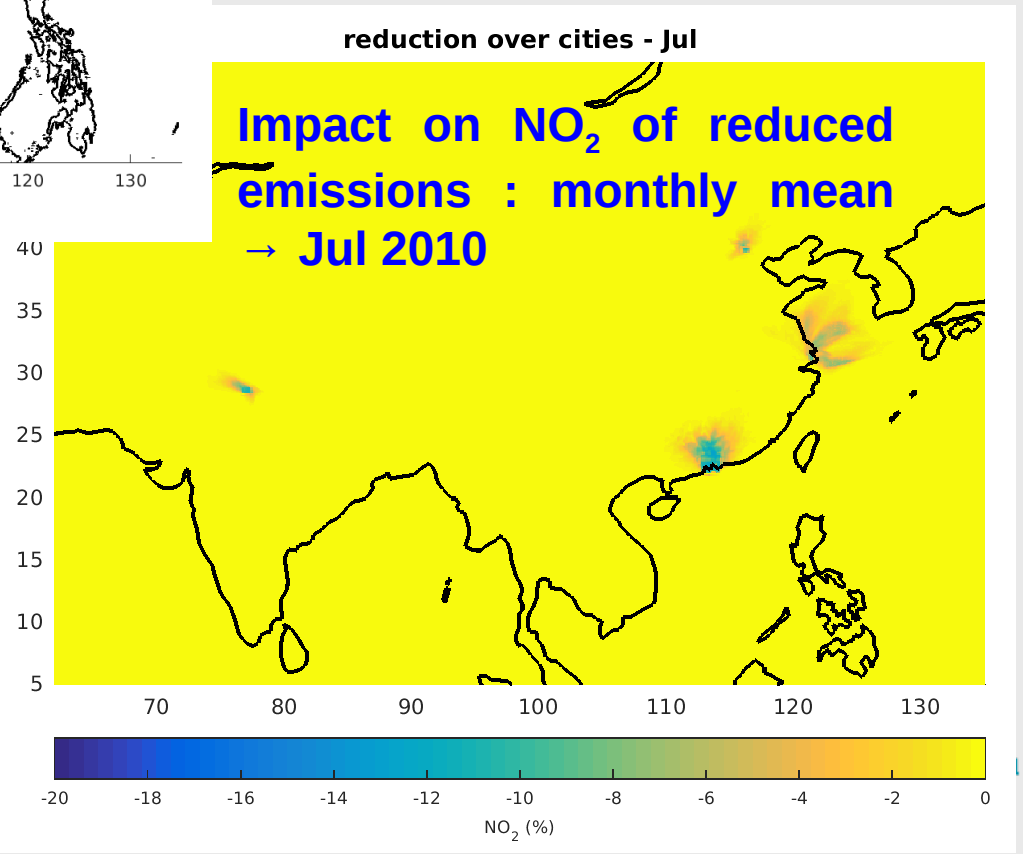


2 tests:

- 15% reduction in **external** emissions (all anthropogenic emissions outside the region)
- 15% reduction in **local** emissions (all anthropogenic emissions inside the region).

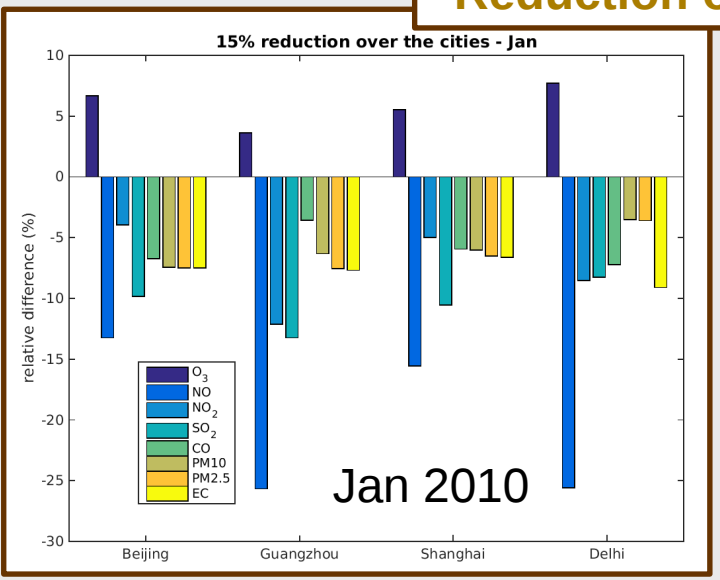
→ **Look on results for each city**

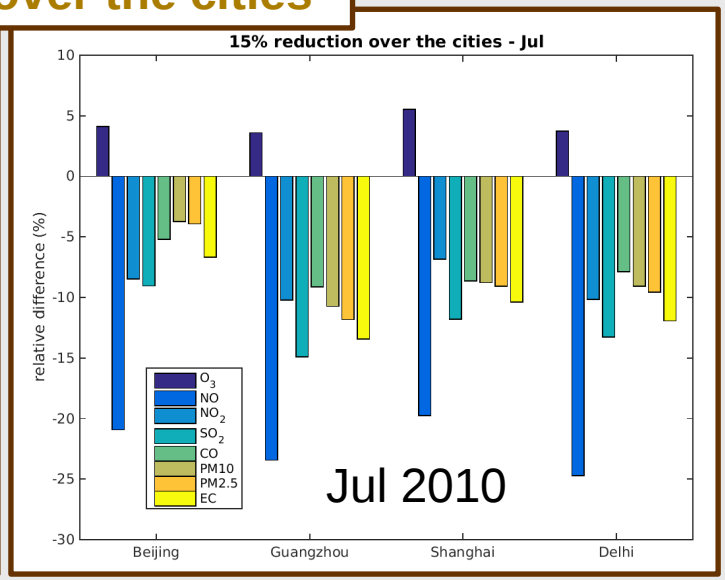
**Guangzhou = area gathering also Hong Kong and Macau*

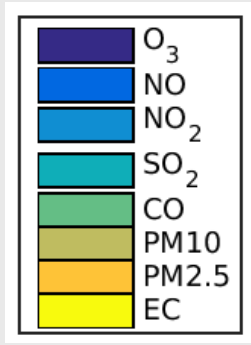


Source receptor runs

Reduction over the cities

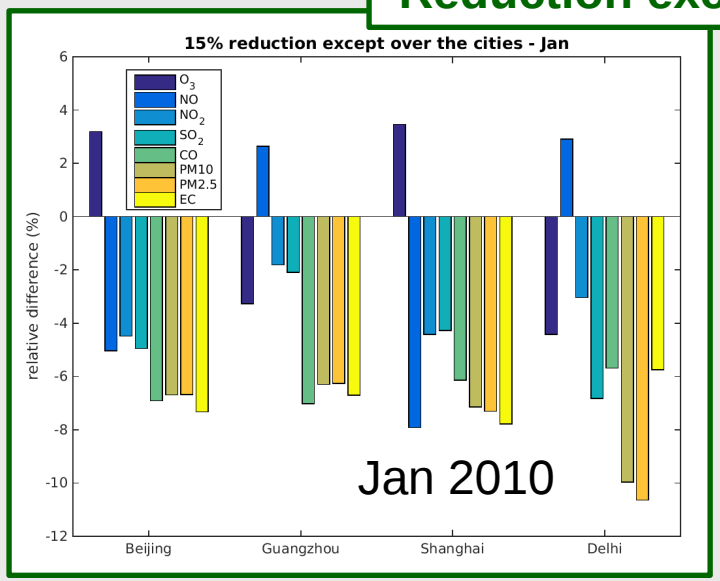


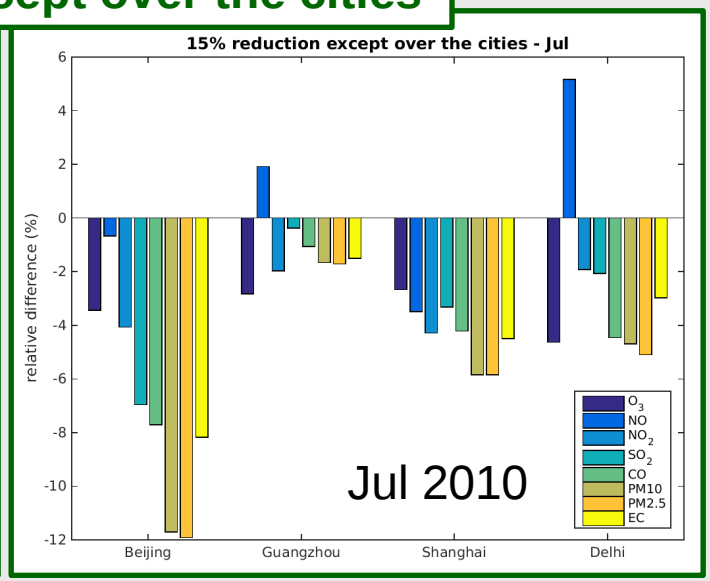




Large **decrease in NO** but **increase in O_3** (reduced titration)

Reduction except over the cities





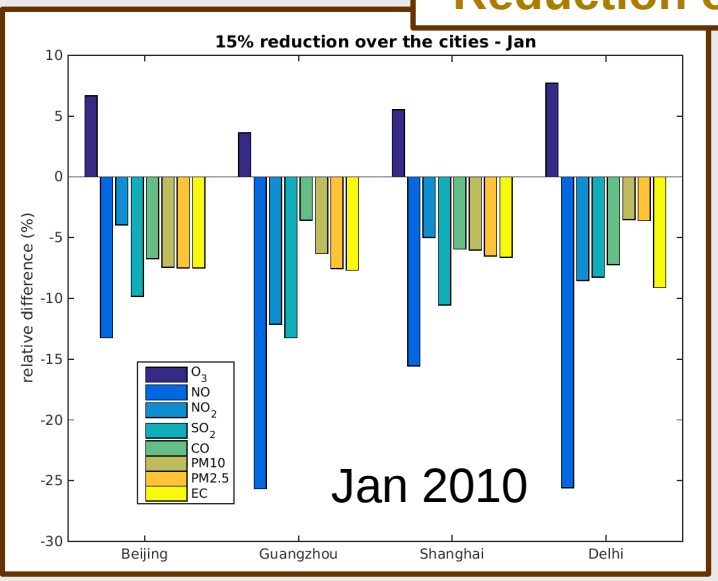
Jan: Large **impact on PM** for Delhi, **Increase in O_3** in Beijing and Shanghai

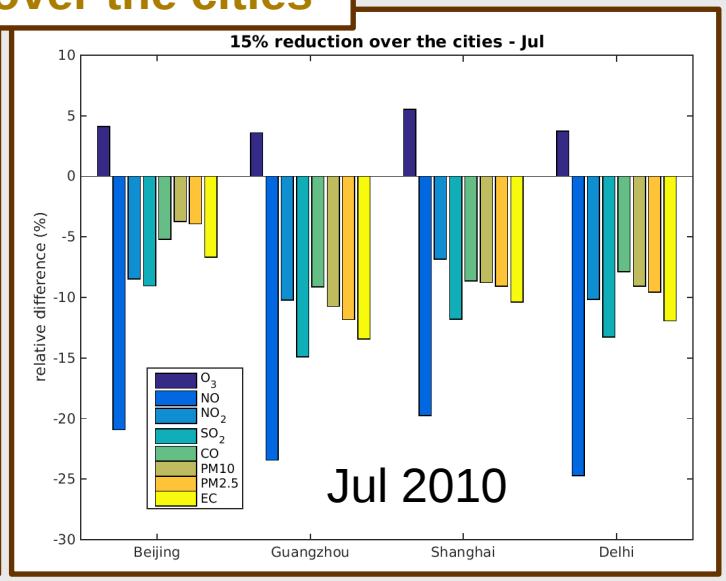
Jul: Beijing largely impacted by external emissions (obvious for PM)

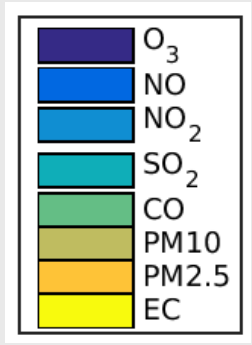
Increase in NO for both months in Guangzhou and Dehli

Source receptor runs

Reduction over the cities







Local chemistry in cities will often be affected by titration: NO and O_3 well anti-correlated

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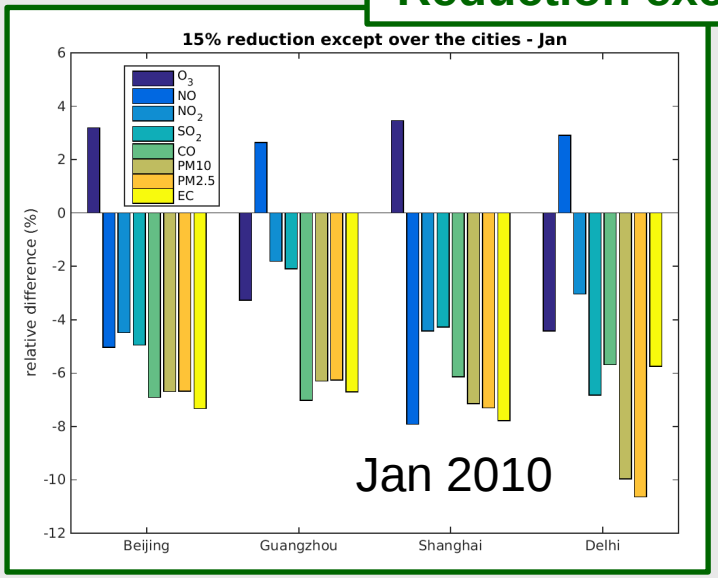
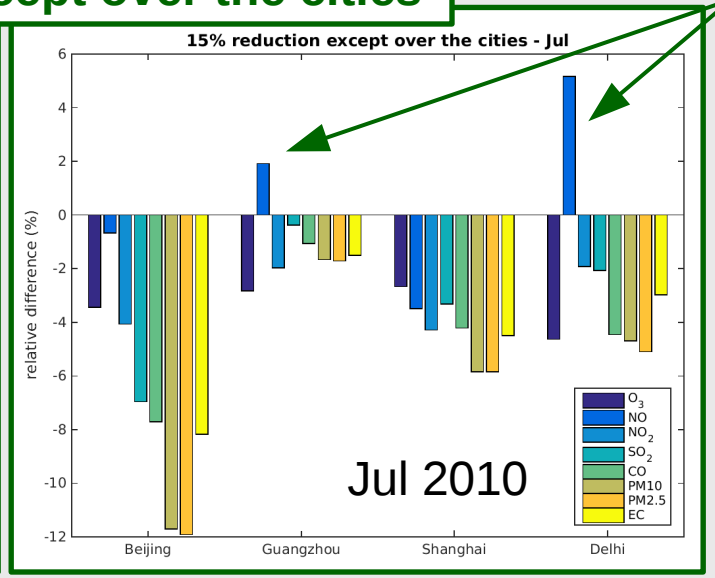
Source receptor runs

outside the cities (clean areas) there is no titration, and O_3 is reduced there when emissions are reduced → reduction signal from outside is then transported into the cities

Winter: **titration signal tends to dominate** (photochemical production is much weaker but the $NO+O_3$ reaction also proceeds during winter close to emission sources)
Summer: transport signal tends to dominate (photochemical production of O_3 is also much stronger because of more sunlight and largely sensitive to the precursors)

Reduction except over the cities





Increase in NO in Guangzhou and Dehli not clear for July:
- Linked to titration, maybe increase in NO due to decrease of O_3
- Not seen over Beijing and Shanghai due to surrounding environment (desert, sea) ?

Conclusions

- Start to have a good experience with the forecast over China thanks to the PANDA project
- Simulation of $PM_{2.5}$ works well →of course larger peaks still mis-represented by EMEP
- Issue with the O_3 →titration probably main cause, especially with a regional model for a urban comparison

→ test with reduced NO_x will be informative

→downscaled output with uEMEP will certainly improve the comparison and so the forecasts

- Improved emissions and observations for the comparison will be also important materials.

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