28/07/2015

Dynamic Evaluation

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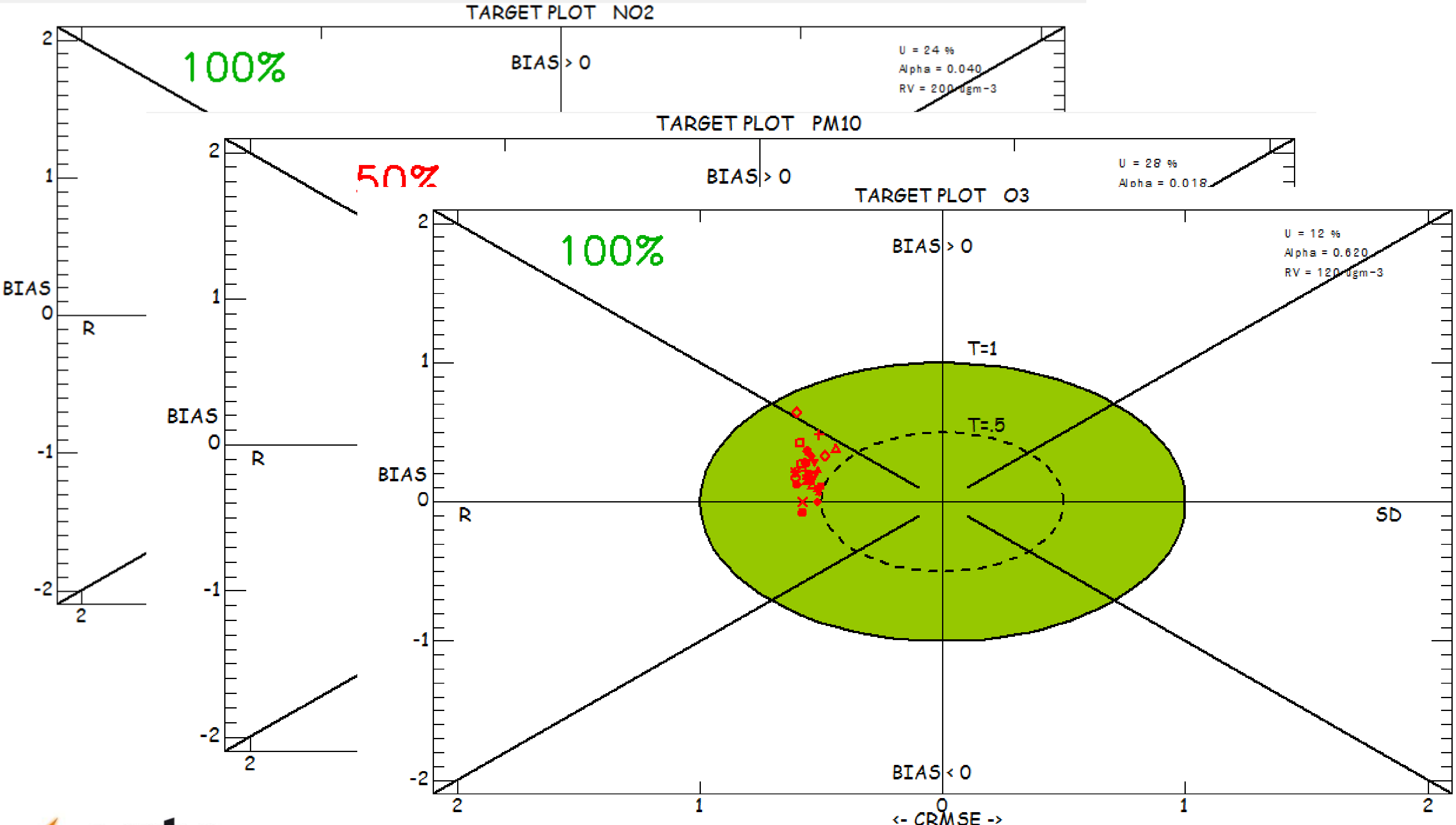
AURORA Modelling setup

- 3D Eulerian Chemical Transport Model
- **MDS - Model Documentation System:** http://pandora.meng.auth.gr/mds/showlong.php?id=167
- **Mensink et al. ,2001, Computational aspects of air quality modelling in urban regions using an optimal resolution approach (AURORA). Large-Scale Scientific Computing – Lecture Notes in Computer Science, 2179, 299-308.**
- **Lauwaet, et al., 2013, Impact of nesting resolution jump on dynamical downscaling ozone concentrations over Belgium Atmospheric Environment, Volume 67, 46-52**.

Gas phase chemistry	CB V mechanism
Heterogeneous chemistry	N_2O_5 hydrolysis: RH dependent
Aerosol size distribution	2 bins: < 2.5 µm and 2.5 – 10 µm
Inorganic aerosols	Thermodynamic equilibrium with ISORROPIA
Organic aerosols	Not included
Secondary aerosols in the coarse fraction?	No
Aqueous chemistry	RH dependent sulfuric acid formation
Dry deposition/sedimentation	Resistance approach
Wind blown dust	Not included
Sea salt	Not included
Biogenic emissions	MEGAN v. 2.04
Boundary conditions coarse domain	nested inside CHIMERE

AURORA Modelling setup



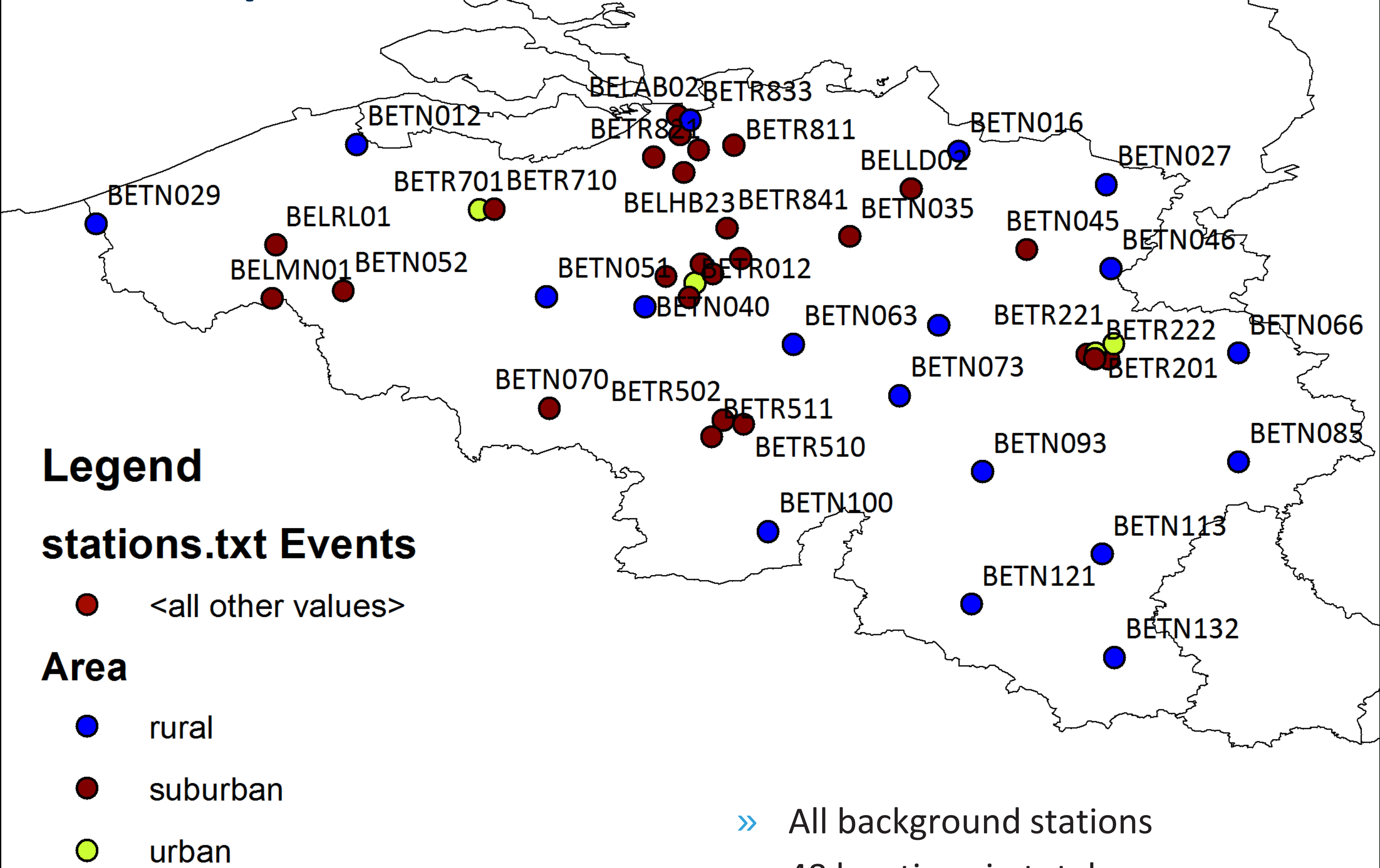
AURORA run setup

- 20 % and 40 % reduction scenario
- Comparisons total emission density AURORA modelling vs test using EMEP (presentation Alain Clapier) :
- NH3#NOx#PPM#SOx#VOC # : 2.10#7.81#1.01#2.27#4.27#

	kTon/1000 km2
NOX	7.81
SOX	2.27
PPM	1.01
VOC	4.27
NH3	2.10
ALL	17.45

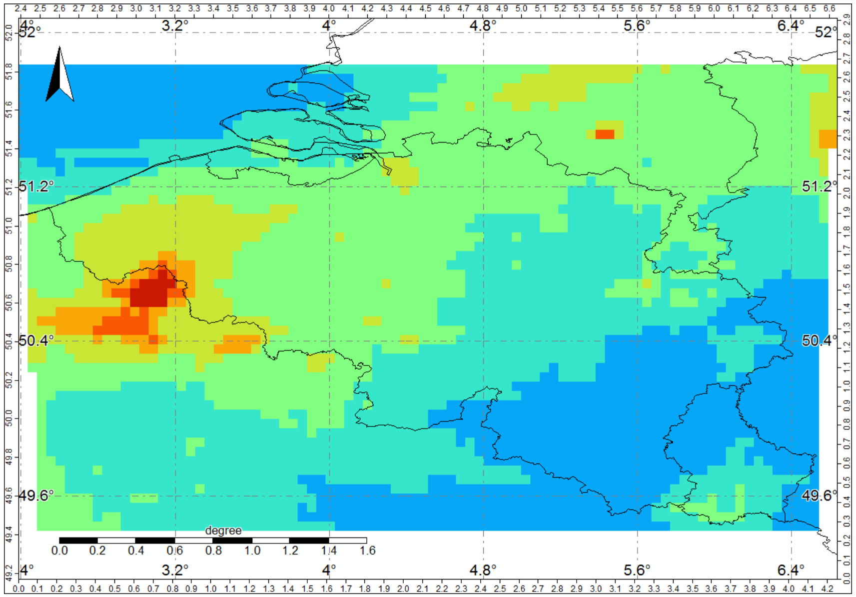
	IT	FR	DE	UK	BE
PPM10	0,51	0,40	0,61	0,46	1,30
NH3	1,34	1,01	1,53	1,14	2,27
SO2	0,59	0,35	1,20	1,75	1,63
NOx	2,80	1,46	3,57	4,35	6,50
VOC	2,84	1,06	2,67	3,41	3,47

Station/location selection…

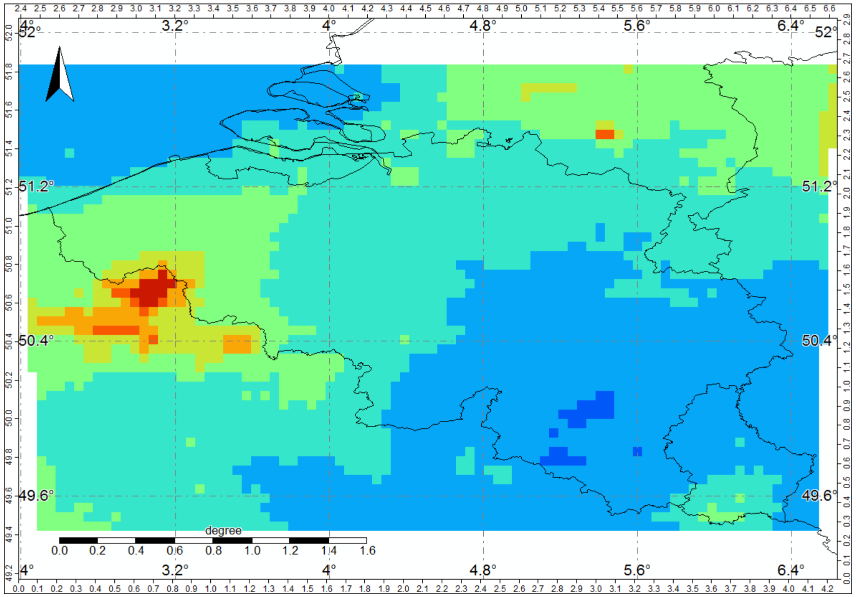


- All background stations
- 48 locations in total

Emission reduction scenario’s



reference



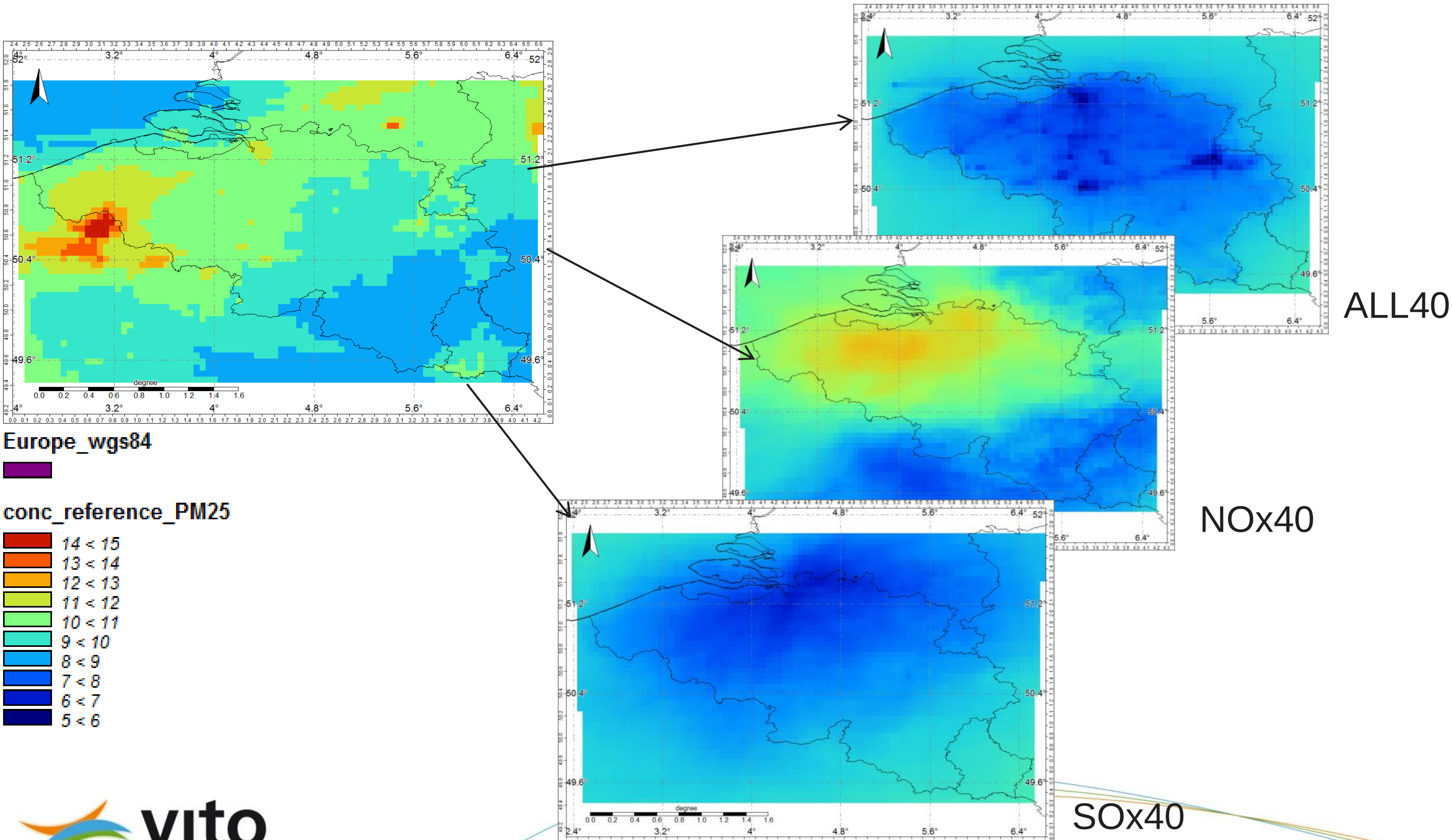
ALL40

Europe_wgs84

conc_reference_PM25

- 14 < 15
- 13 < 14
- 12 < 13
- 11 < 12
- 10 < 11
- 9 < 10
- 8 < 9
- 7 < 8
- 6 < 7
- 5 < 6

Emission reduction scenario's
Differences



Results (4 km)

Abs. potency

$$P = -\frac{dC}{dE} \approx -\frac{\Delta C}{\Delta E} = -\frac{C_{E_\alpha} - C_{E_{0\%}}}{E_\alpha - E_{0\%}}$$

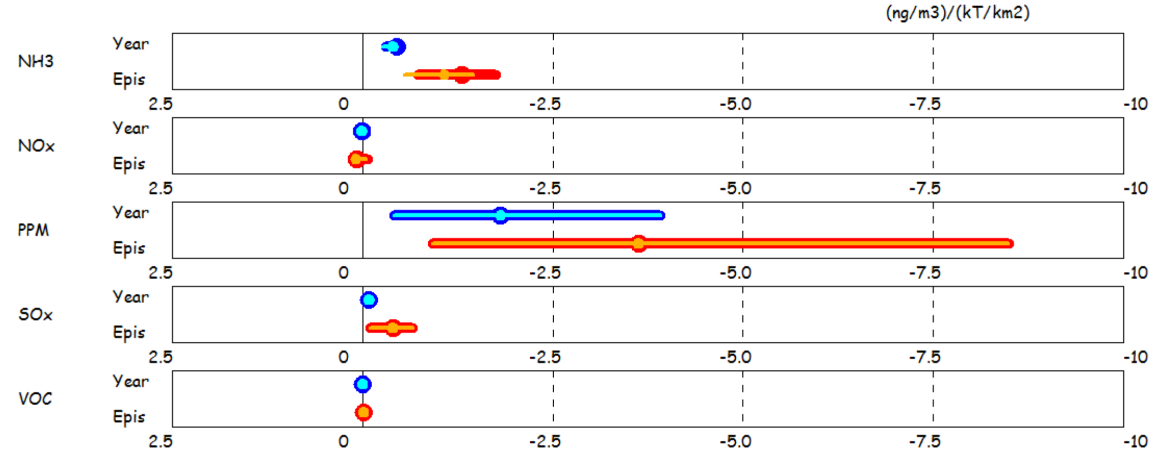
Abs. potential

$$\Pi = C_{E_{100\%}} - C_{E_{0\%}} \approx \frac{C_{E_\alpha} - C_{E_{0\%}}}{\alpha}$$

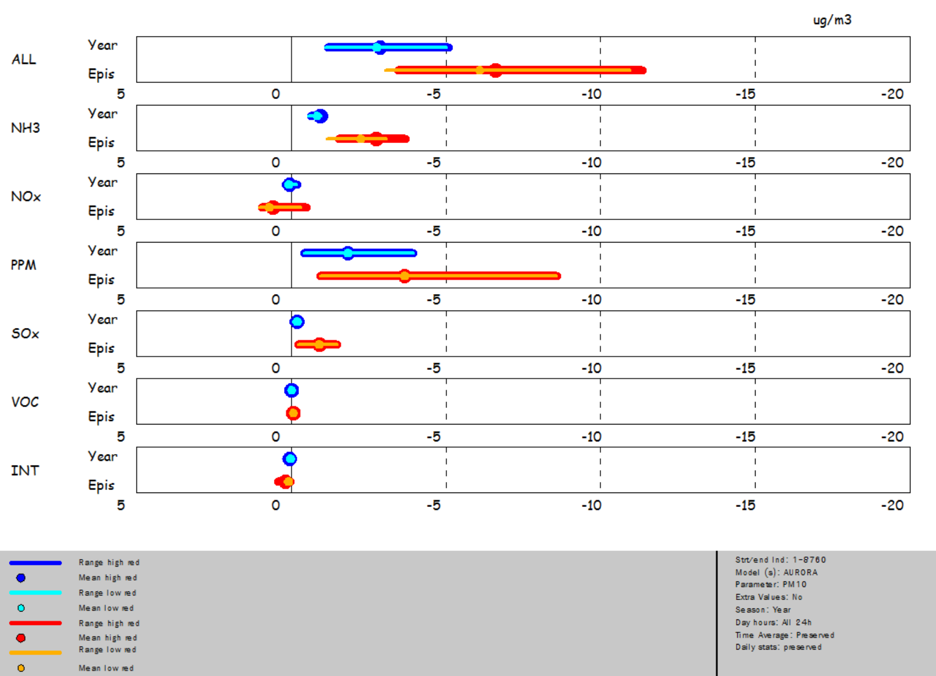
Rel. Potential

$$\pi = \frac{\Pi}{C_{E_{0\%}}} = \frac{C_{E_{100\%}} - C_{E_{0\%}}}{C_{E_{0\%}}} \approx \frac{C_{E_\alpha} - C_{E_{0\%}}}{\alpha C_{E_{0\%}}}$$

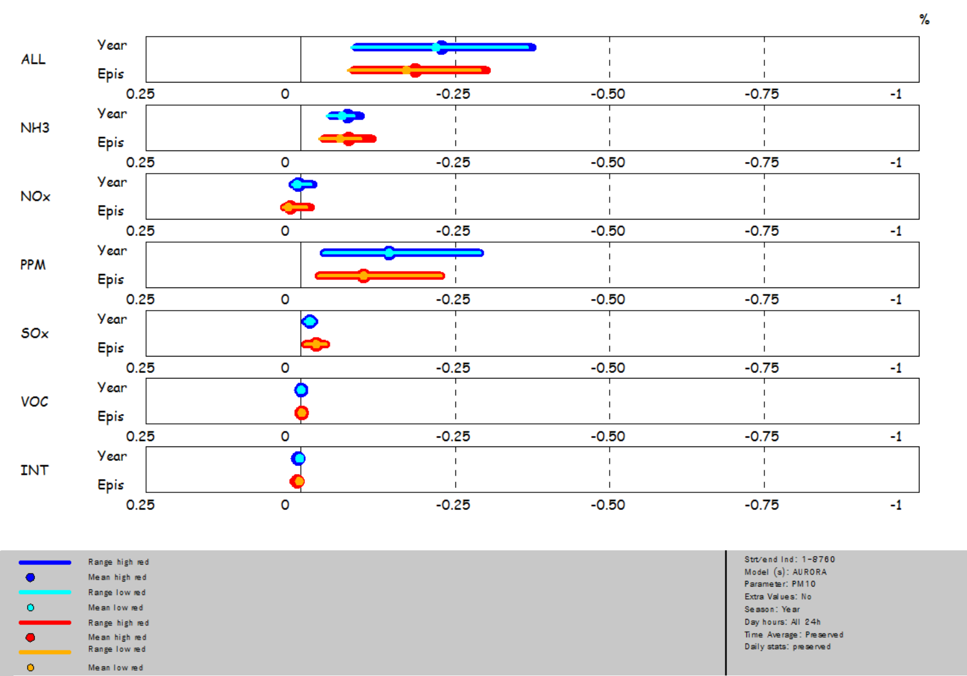
PM_{10}



(ng/m3)/(kT/km2)
NH3
NOx
PPM
SOx
VOC
Year
Epis
2.5
0
-2.5
-5.0
-7.5
-10

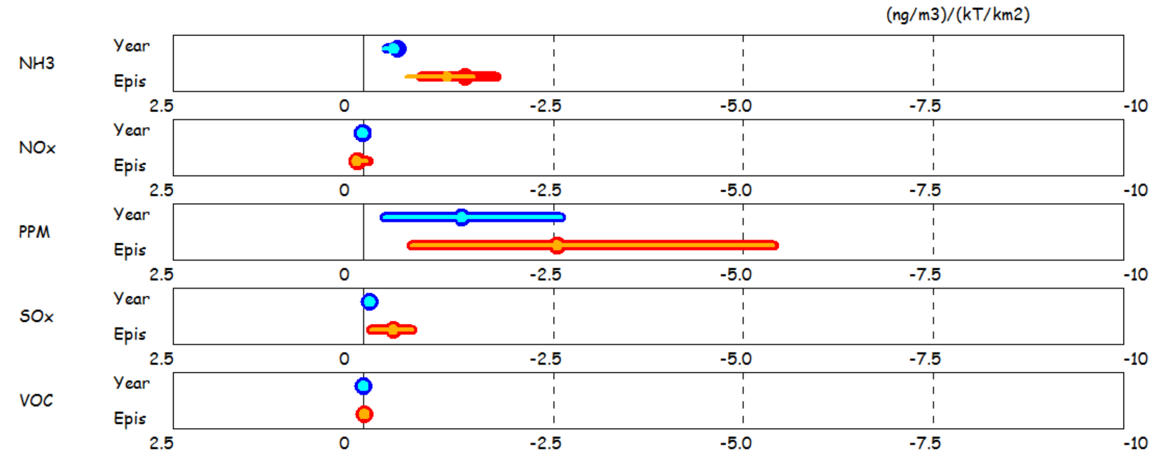


ug/m3
ALL
NH3
NOx
PPM
SOx
VOC
INT
Year
Epis
5
0
-5
-10
-15
-20
Range high red
Mean high red
Range low red
Mean low red
Range high red
Mean high red
Range low red
Mean low red
Str/end Ind: 1-8760
Model (s): AURORA
Parameter: PM10
Extra Values: No
Season: Year
Day hours: All 24h
Time Average: Preserved
Daily stats: preserved

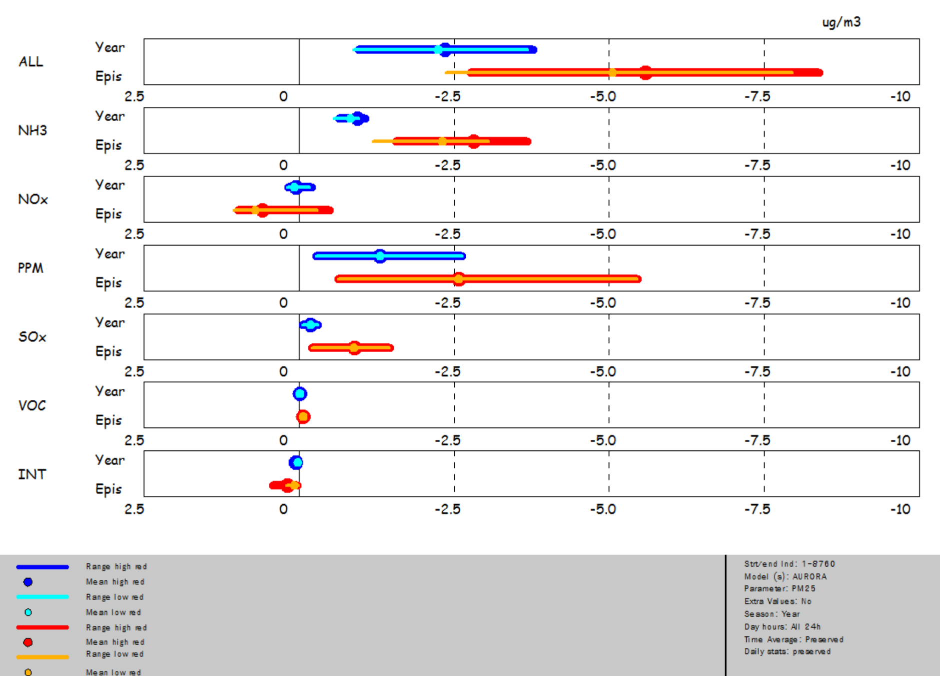


%
ALL
NH3
NOx
PPM
SOx
VOC
INT
Year
Epis
0.25
0
-0.25
-0.50
-0.75
-1
Range high red
Mean high red
Range low red
Mean low red
Range high red
Mean high red
Range low red
Mean low red
Str/end Ind: 1-8760
Model (s): AURORA
Parameter: PM10
Extra Values: No
Season: Year
Day hours: All 24h
Time Average: Preserved
Daily stats: preserved

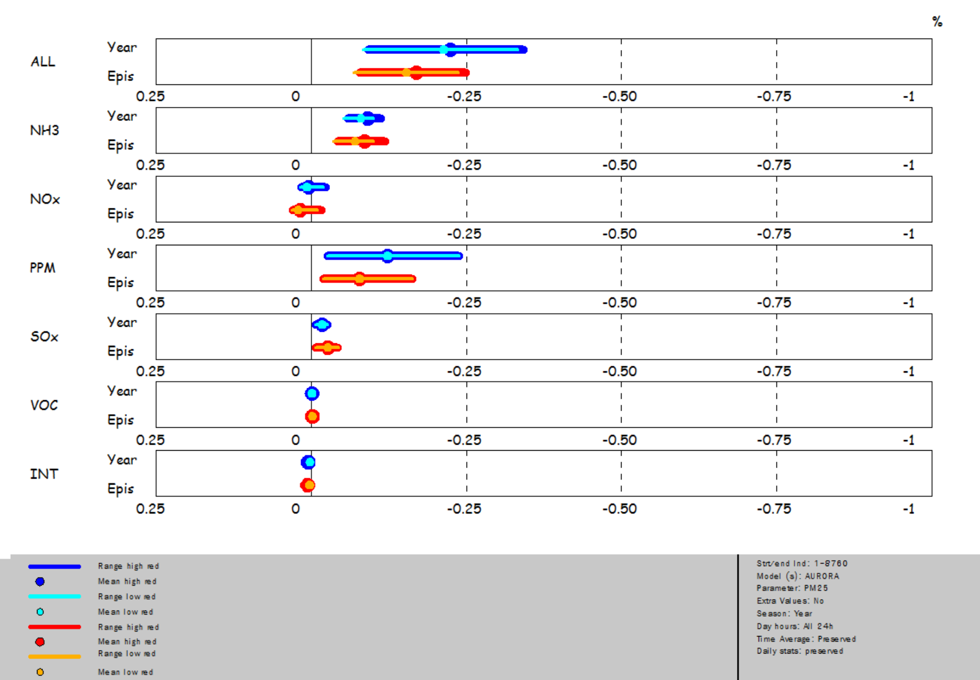
$PM_{2.5}$



(ng/m3)/(kT/km2)
NH3
NOx
PPM
SOx
VOC
Year
Epis
2.5
0
-2.5
-5.0
-7.5
-10

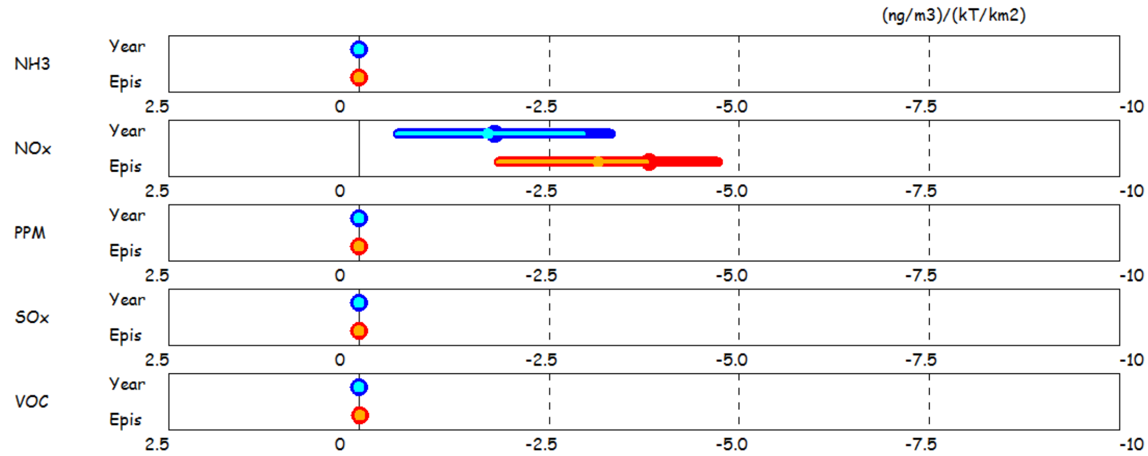


ug/m3
ALL
NH3
NOx
PPM
SOx
VOC
INT
Year
Epis
2.5
0
-2.5
-5.0
-7.5
-10
Range high red
Mean high red
Range low red
Mean low red
Range high red
Mean high red
Range low red
Mean low red
Strt/end Ind: 1-8760
Model (s): AURORA
Parameter: PM25
Extra Values: No
Season: Year
Day hours: All 24h
Time Average: Preserved
Daily stats: preserved

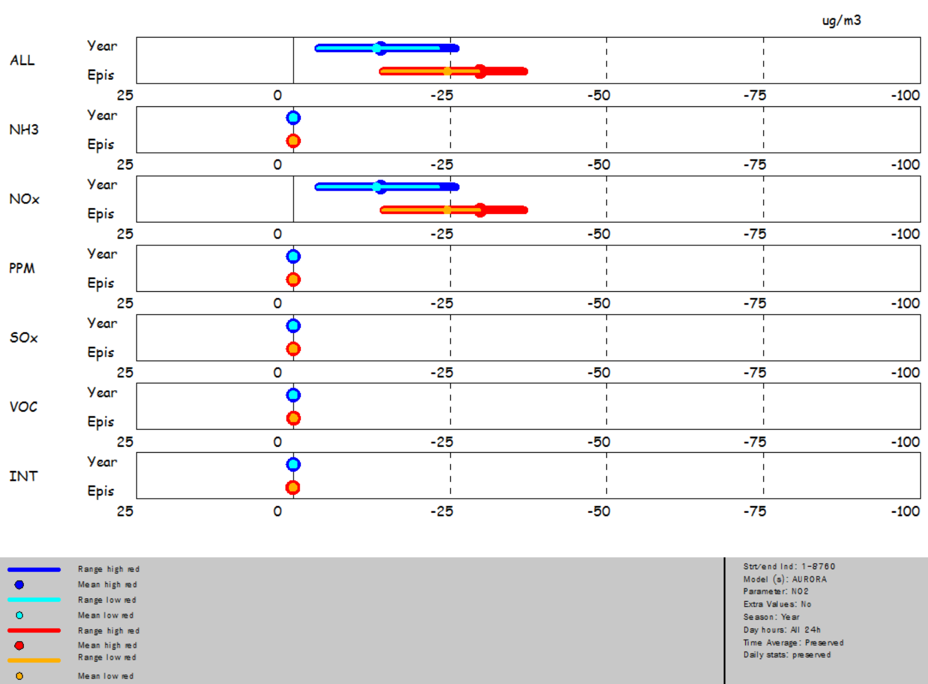


%
ALL
NH3
NOx
PPM
SOx
VOC
INT
Year
Epis
0.25
0
-0.25
-0.50
-0.75
-1
Range high red
Mean high red
Range low red
Mean low red
Range high red
Mean high red
Range low red
Mean low red
Strt/end Ind: 1-8760
Model (s): AURORA
Parameter: PM25
Extra Values: No
Season: Year
Day hours: All 24h
Time Average: Preserved
Daily stats: preserved

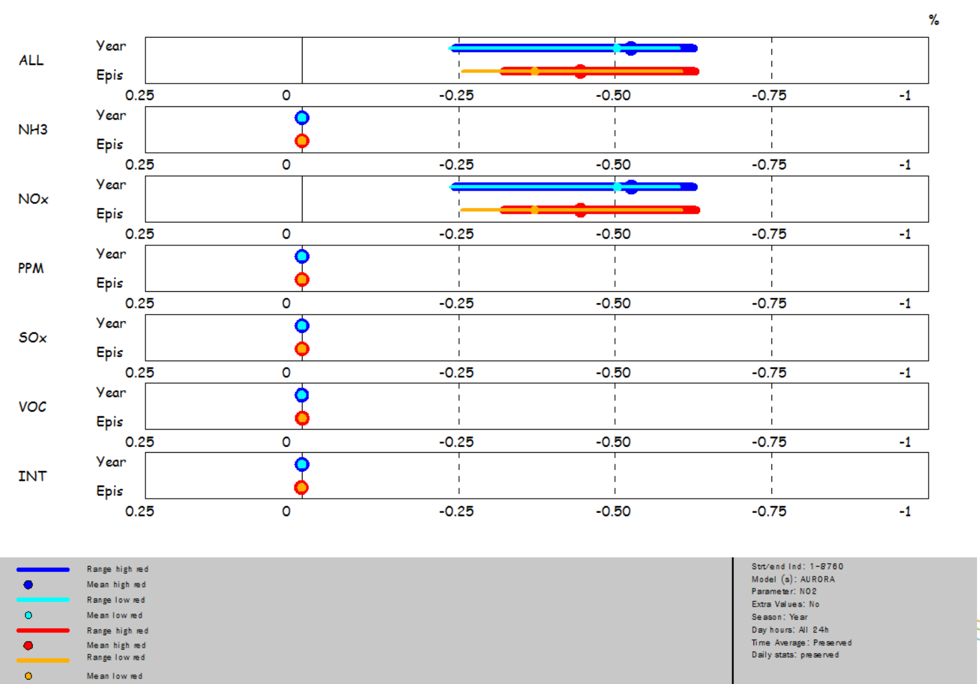
NO_2



(ng/m3)/(kT/km2)
NH3
NOx
PPM
SOx
VOC
Year
Epis
2.5
0
-2.5
-5.0
-7.5
-10

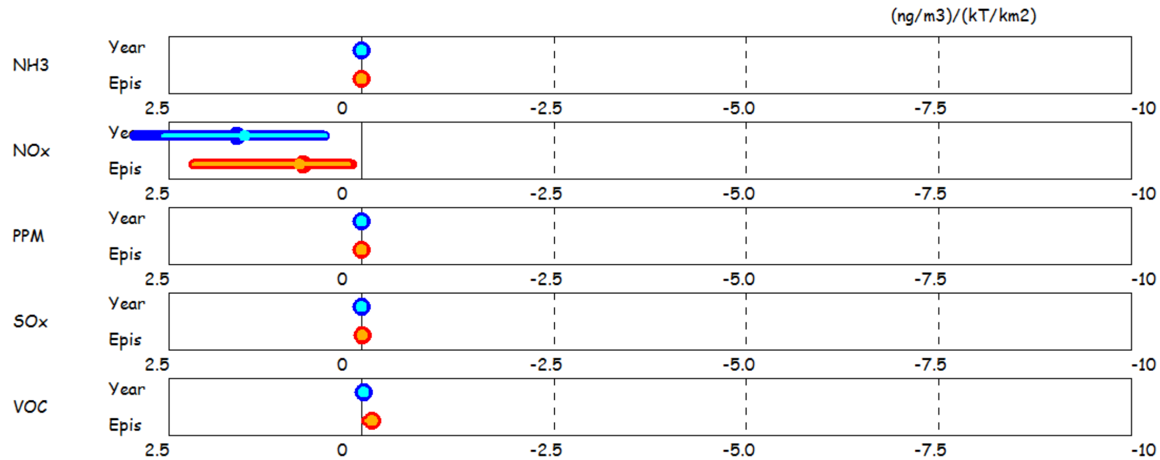


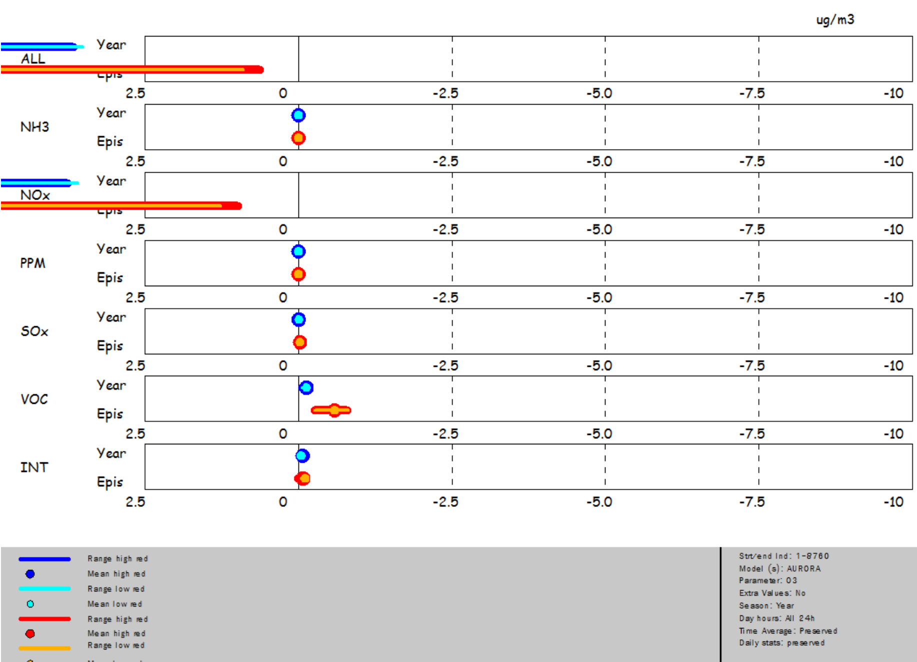
ug/m3
ALL
NH3
NOx
PPM
SOx
VOC
INT
Year
Epis
25
0
-25
-50
-75
-100
Range high red
Mean high red
Range low red
Mean low red
Range high red
Mean high red
Range low red
Mean low red
Strt/end Ind: 1-8760
Model (s): AURORA
Parameter: NO2
Extra Values: No
Season: Year
Day hours: All 24h
Time Average: Preserved
Daily stats: preserved

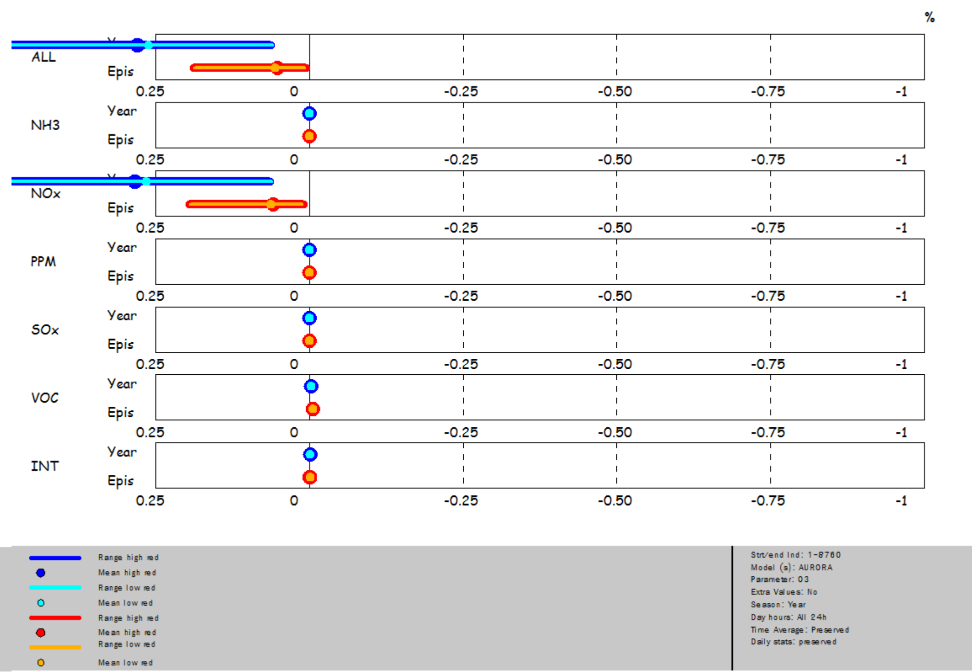


%
ALL
NH3
NOx
PPM
SOx
VOC
INT
Year
Epis
0.25
0
-0.25
-0.50
-0.75
-1
Range high red
Mean high red
Range low red
Mean low red
Range high red
Mean high red
Range low red
Mean low red
Strt/end Ind: 1-8760
Model (s): AURORA
Parameter: NO2
Extra Values: No
Season: Year
Day hours: All 24h
Time Average: Preserved
Daily stats: preserved

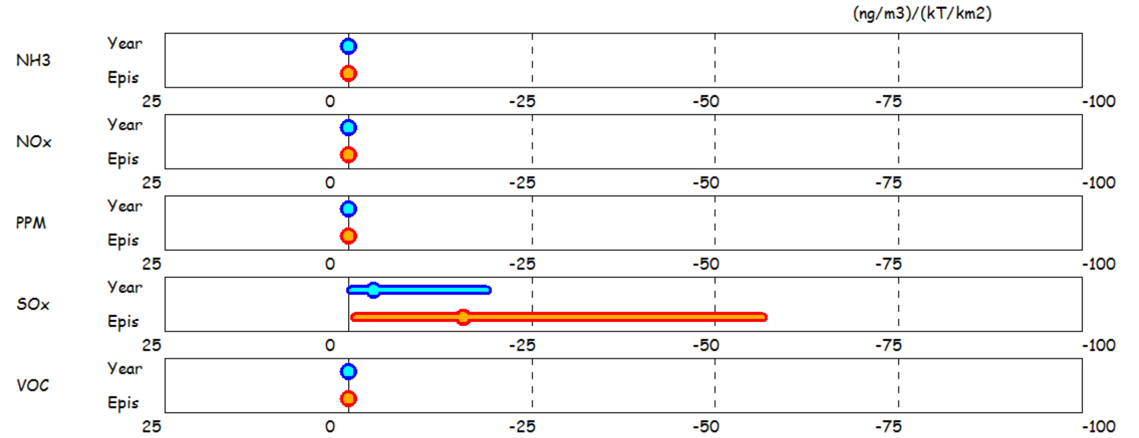
O_3


(ng/m3)/(kT/km2)
NH3
NOx
PPM
SOx
VOC
Year
Epis
2.5
0
-2.5
-5.0
-7.5
-10

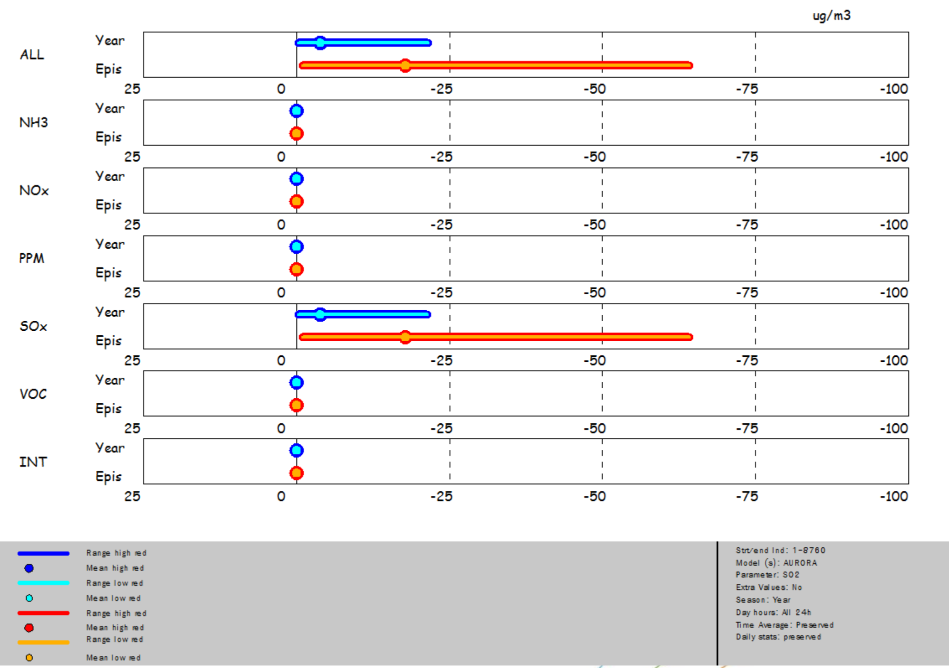

ug/m3
ALL
NH3
NOx
PPM
SOx
VOC
INT
Year
Epis
2.5
0
-2.5
-5.0
-7.5
-10
Range high red
Mean high red
Range low red
Mean low red
Range high red
Mean high red
Range low red
Mean low red
Strt/end Ind: 1-8760
Model (s): AURORA
Parameter: O3
Extra Values: No
Season: Year
Day hours: All 24h
Time Average: Preserved
Daily stats: preserved


%
ALL
NH3
NOx
PPM
SOx
VOC
INT
Year
Epis
0.25
0
-0.25
-0.50
-0.75
-1
Range high red
Mean high red
Range low red
Mean low red
Range high red
Mean high red
Range low red
Mean low red
Strt/end Ind: 1-8760
Model (s): AURORA
Parameter: O3
Extra Values: No
Season: Year
Day hours: All 24h
Time Average: Preserved
Daily stats: preserved

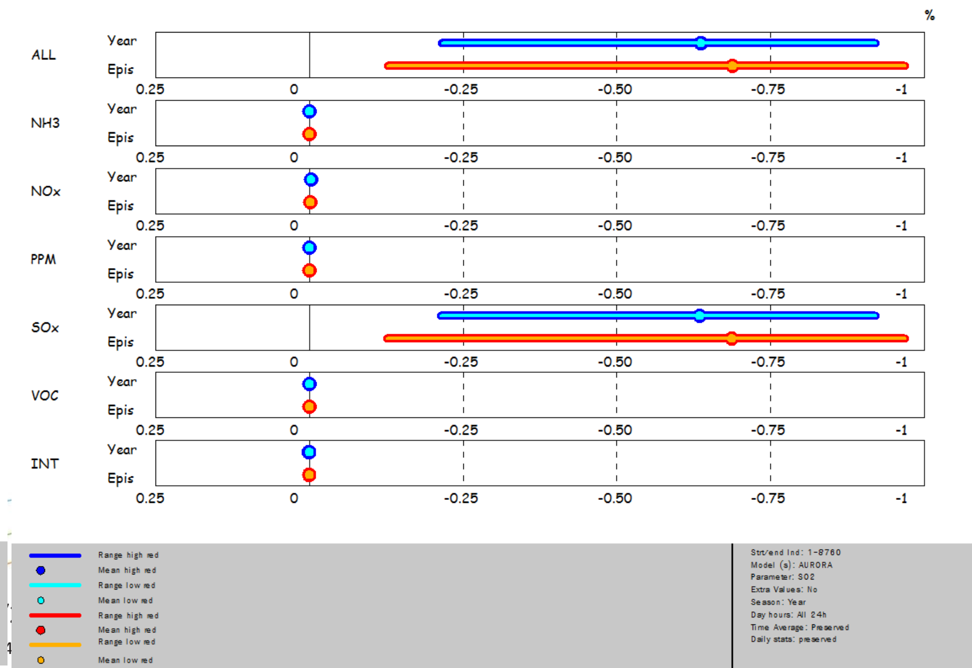
SO_2



(ng/m3)/(kT/km2)
NH3
NOx
PPM
SOx
VOC
Year
Epis
25
0
-25
-50
-75
-100

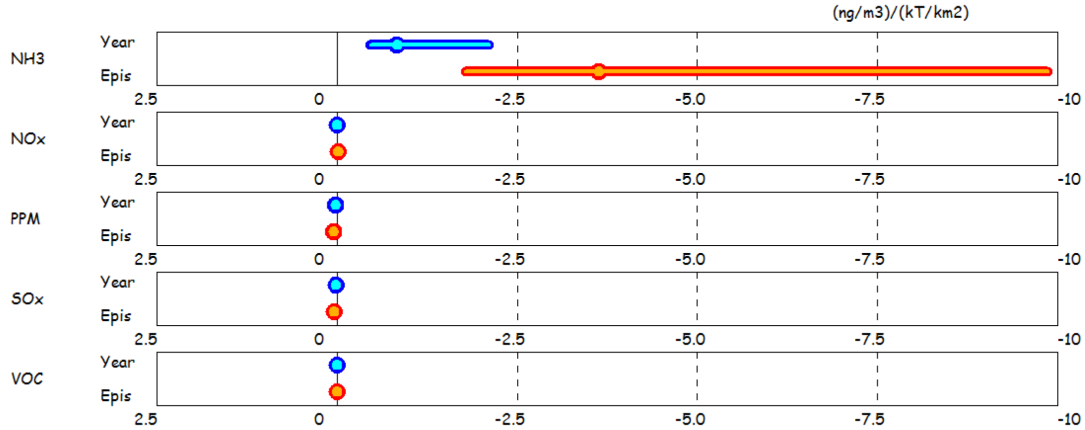


ug/m3
ALL
NH3
NOx
PPM
SOx
VOC
INT
Year
Epis
25
0
-25
-50
-75
-100
Range high red
Mean high red
Range low red
Mean low red
Range high red
Mean high red
Range low red
Mean low red
Strt/end Ind: 1-8760
Model (s): AURORA
Parameter: SO2
Extra Values: No
Season: Year
Day hours: All 24h
Time Average: Preserved
Daily stats: preserved

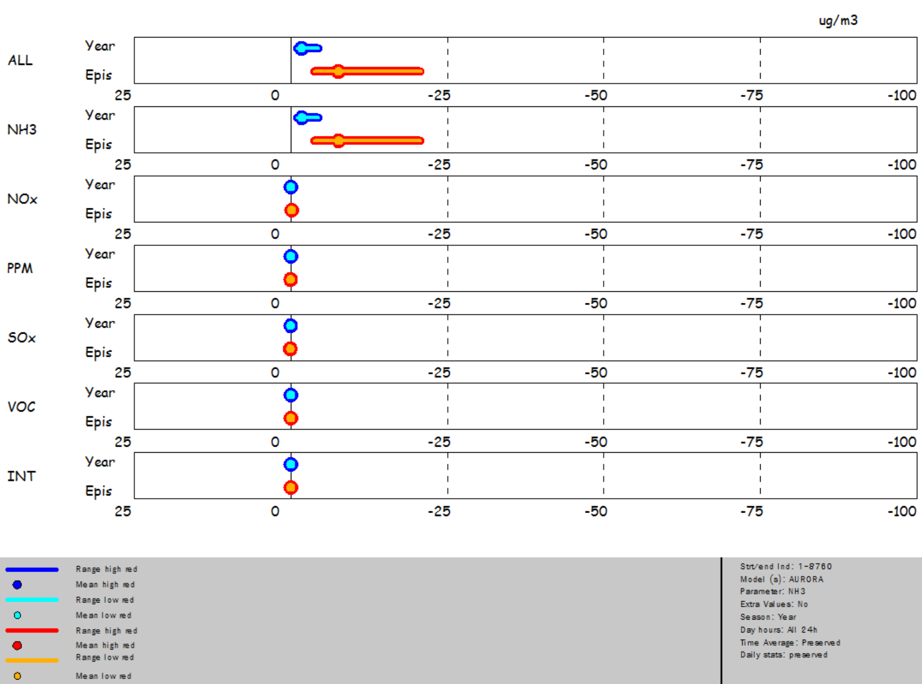


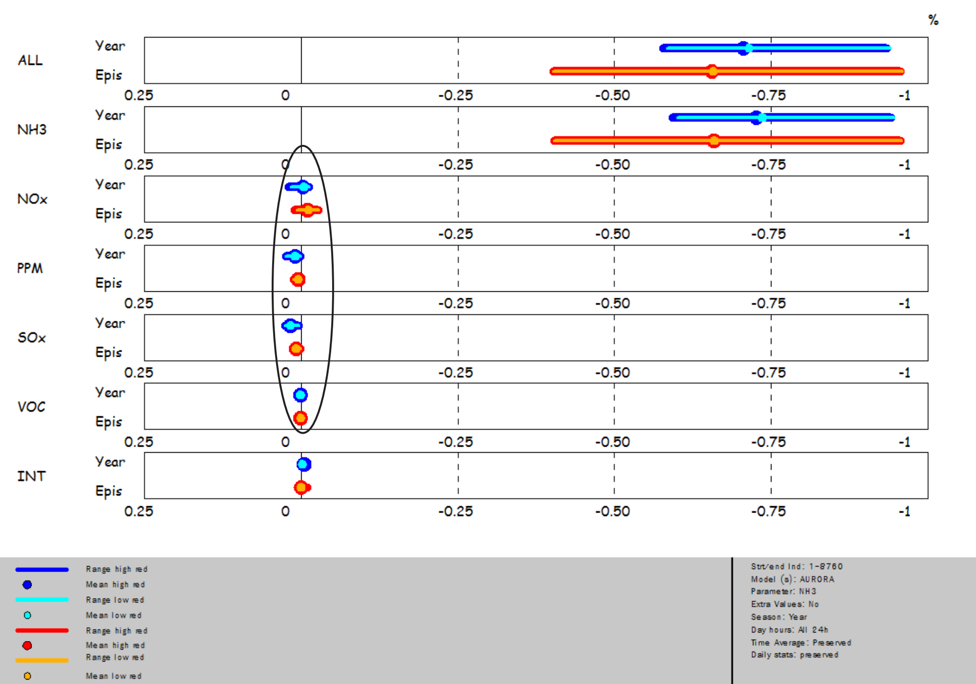
%
ALL
NH3
NOx
PPM
SOx
VOC
INT
Year
Epis
0.25
0
-0.25
-0.50
-0.75
-1
Range high red
Mean high red
Range low red
Mean low red
Range high red
Mean high red
Range low red
Mean low red
Strt/end Ind: 1-8760
Model (s): AURORA
Parameter: SO2
Extra Values: No
Season: Year
Day hours: All 24h
Time Average: Preserved
Daily stats: preserved

NH_3



- Reduction of PPM, SO_x → increase in NH_3 ?
-





PPM 2.5 split

SNAP	1	2	3	4	5	6	7	8	9	10
PPM_25	0.51	0.15	0.28	0.8	0	0.46	0.07	0.06	0.76	0.13
SO4_25	0.05	0.05	0.05	0.02	0	0.05	0.05	0.02	0.05	0
NH4_25	0	0	0	0	0	0	0	0	0	0
NIT_25	0	0	0	0	0	0	0	0	0	0
EC_25	0.11	0.21	0.25	0	0.85	0	0.48	0.52	0.004	0.17
OC_25	0.33	0.5	0.33	0	0.15	0.4	0.4	0.4	0.1	0.7
CRUST_25	0	0.09	0.09	0.18	0	0.09	0	0	0.09	0

Small amount of SO4 (< 2.5 µm) introduced by PPM

PPM ↓ => SO_4 ↓ => $(NH_4)_2SO_4$ ↓ => NH_3 ↑

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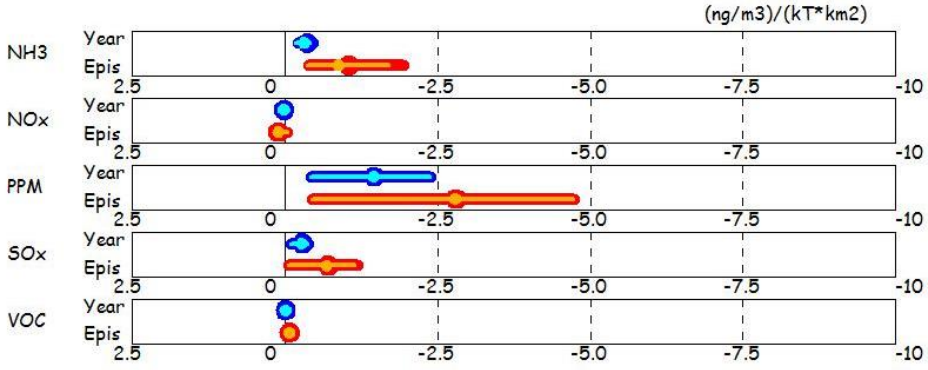
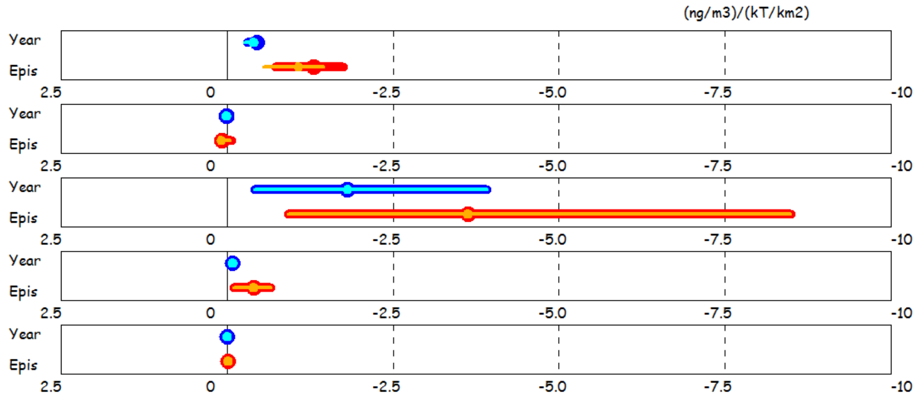
Abs. Potency

PM10

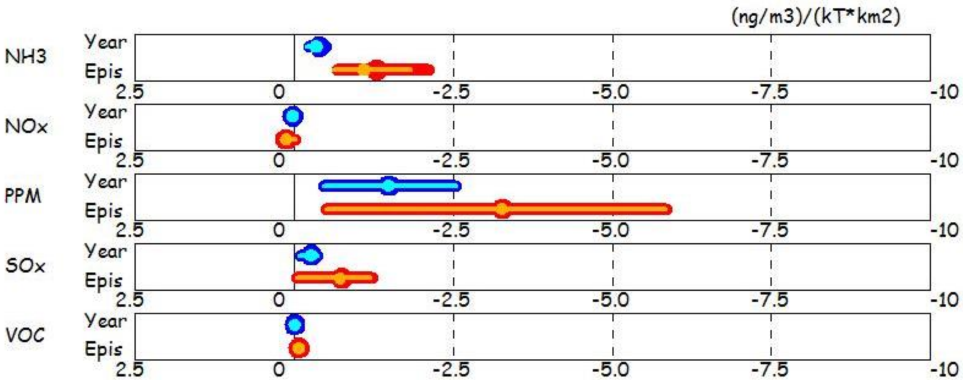
EMEP, all stations

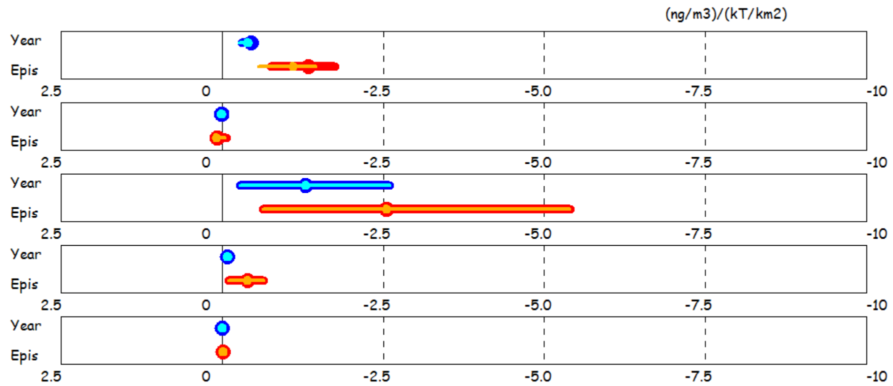


AURORA, all stations



PM2.5





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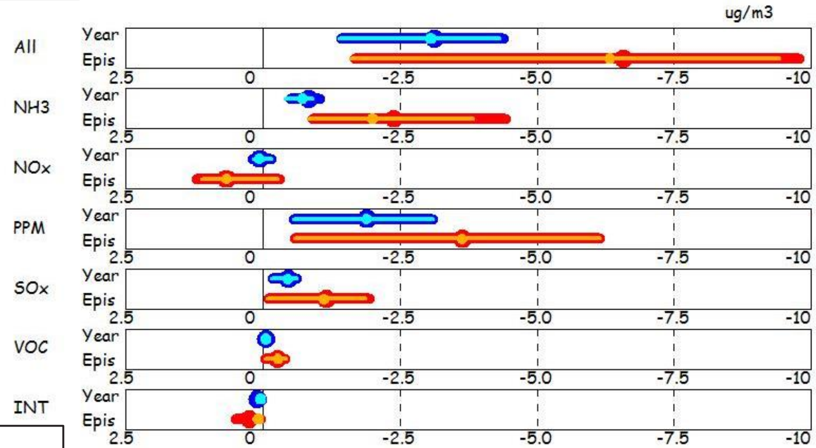
Abs. Potential

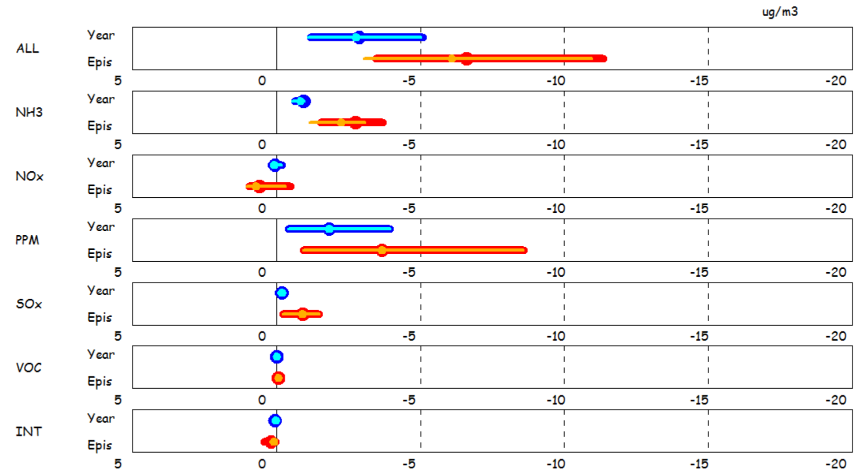
Note axis scale !!

PM10

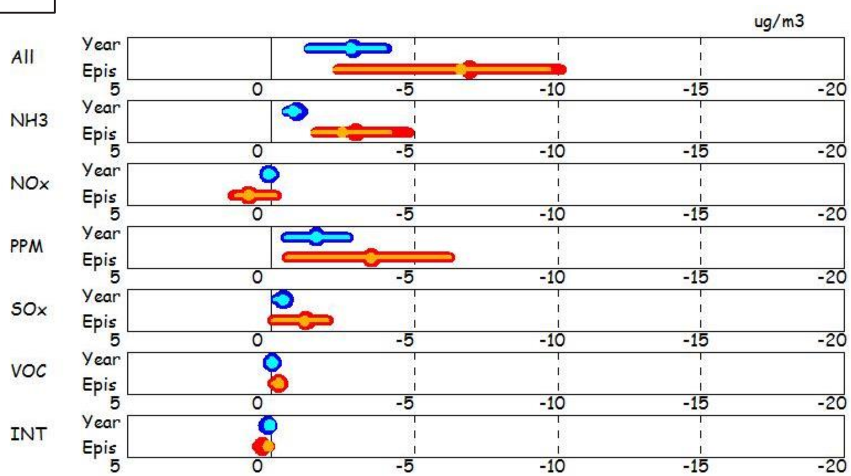
EMEP, all stations

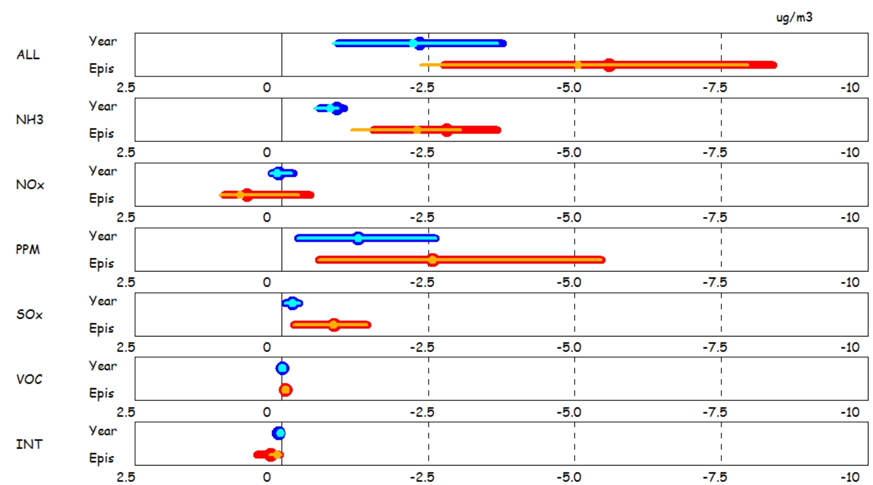


AURORA, all stations



PM2.5





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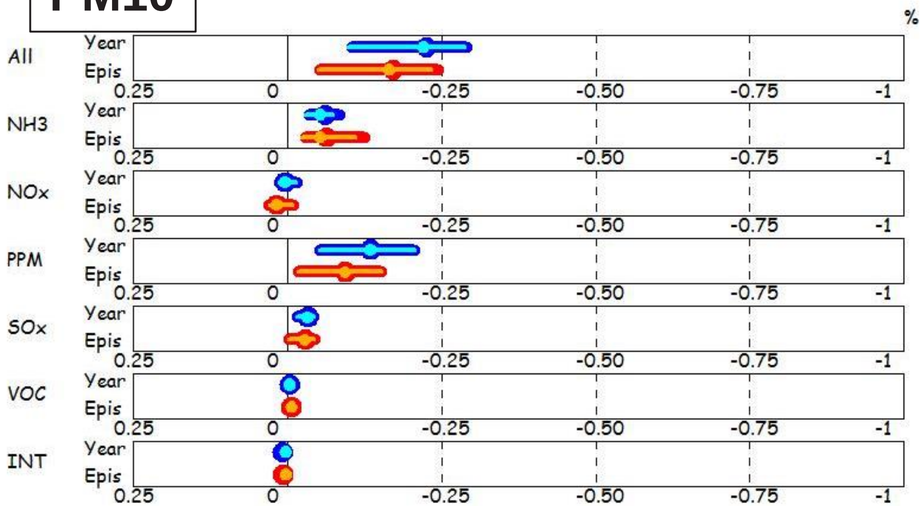
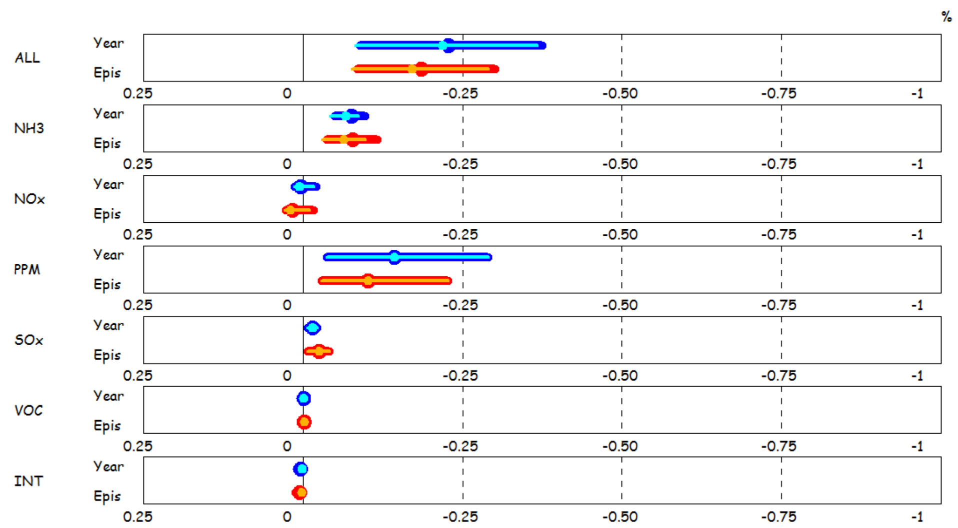
Rel. Potential

PM10

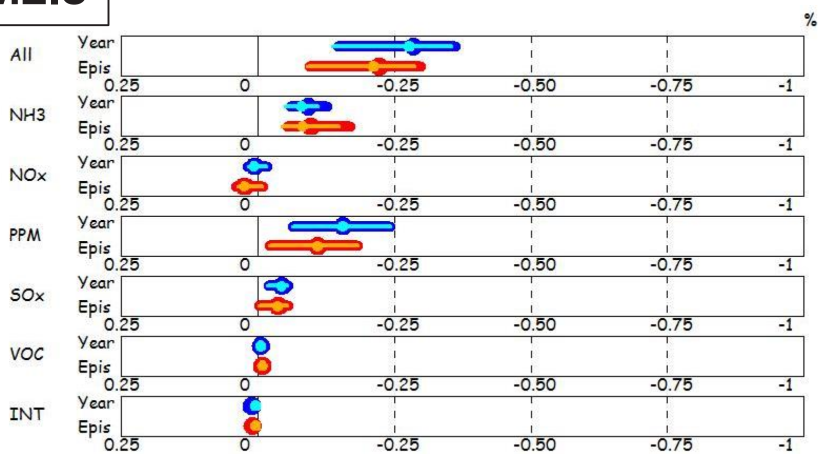
EMEP, all stations

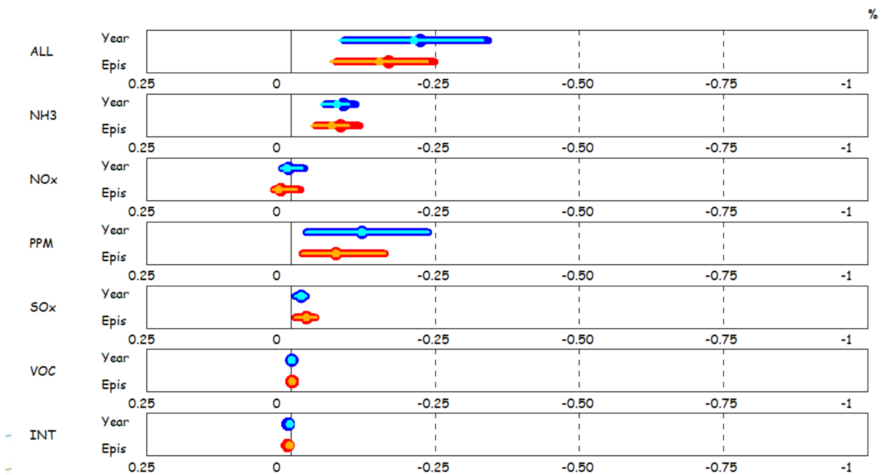


AURORA. all stations



PM2.5





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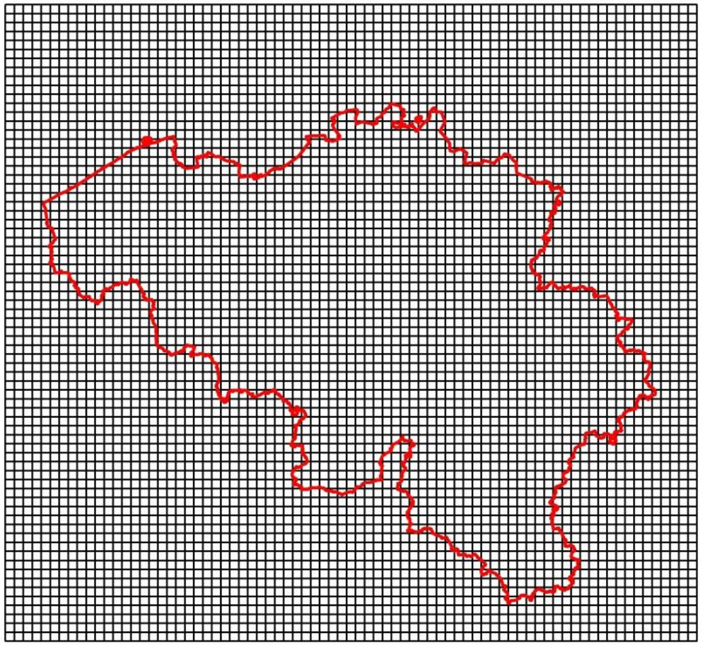
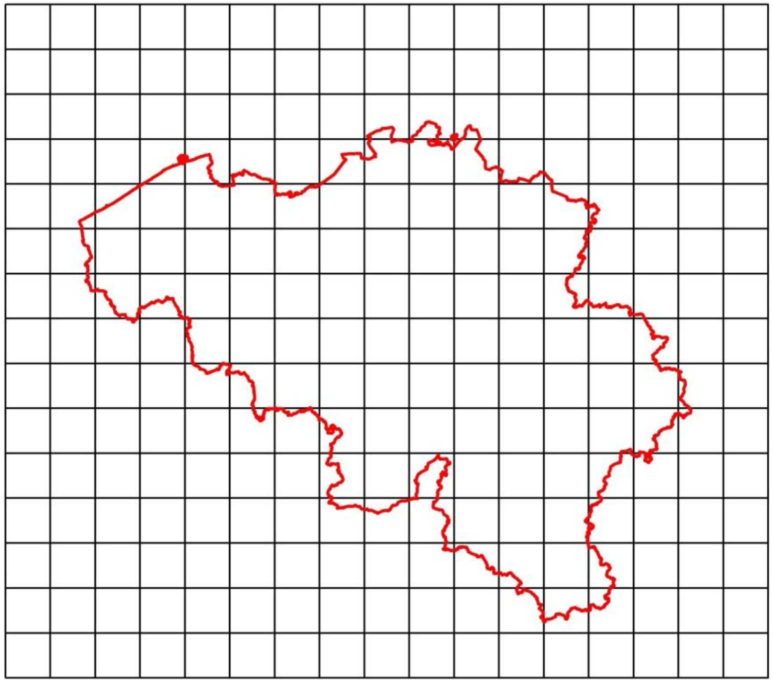
AURORA Modelling setup

Δ x = Δ y = 4 km
77 x 71 cells



Δ x = Δ y = 20 km
17 x 15 cells

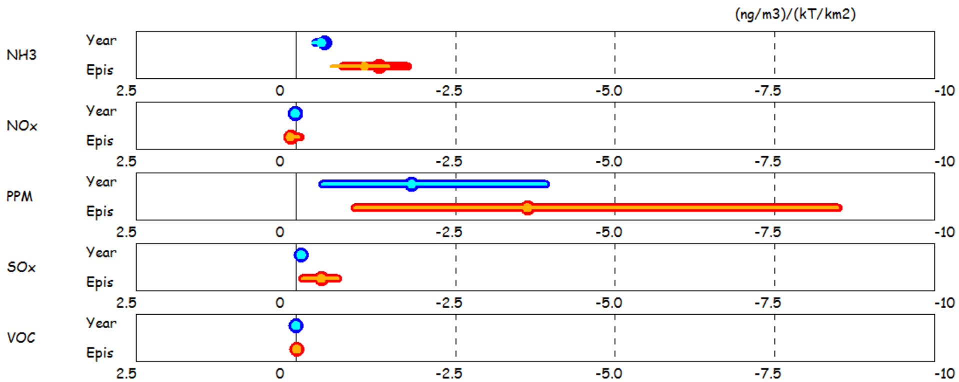


Vertical resolution	17 layers:average thickness 27 m (bottom) to 612 m (top)
Projection	Lambert Conformal Conic

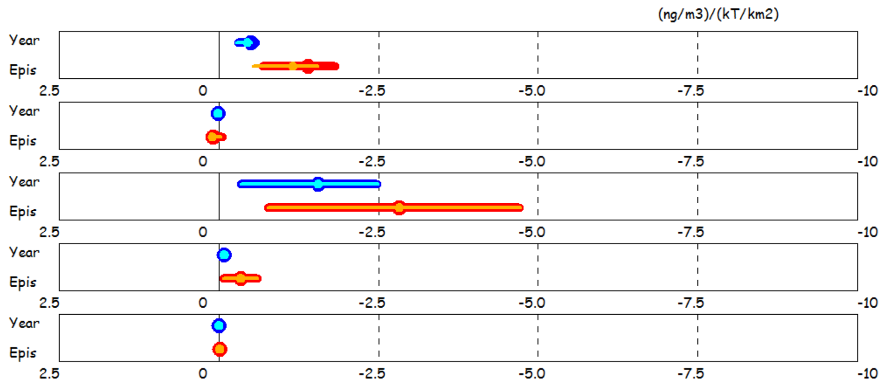
Impact of spatial resolution on non-linearity ? Abs. Potency PM_{10}

- Non – linearity seems to be equally present
- Potency seems stronger for PPM at higher resolution

4 km



20 km



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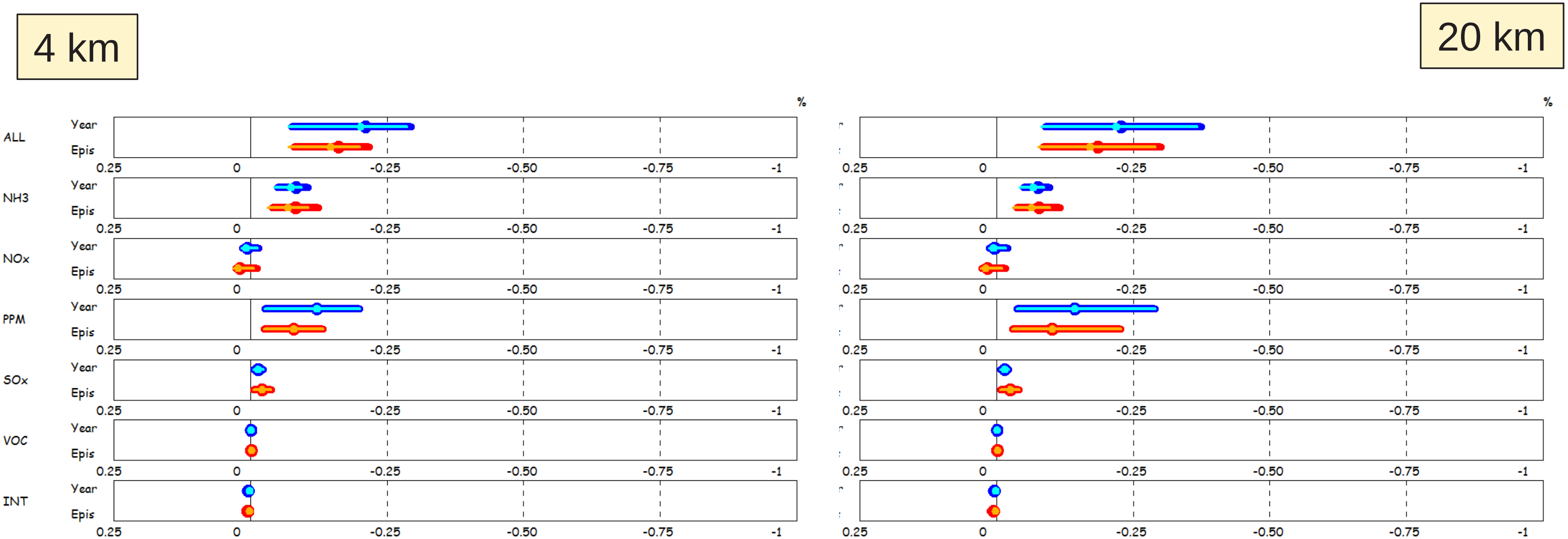
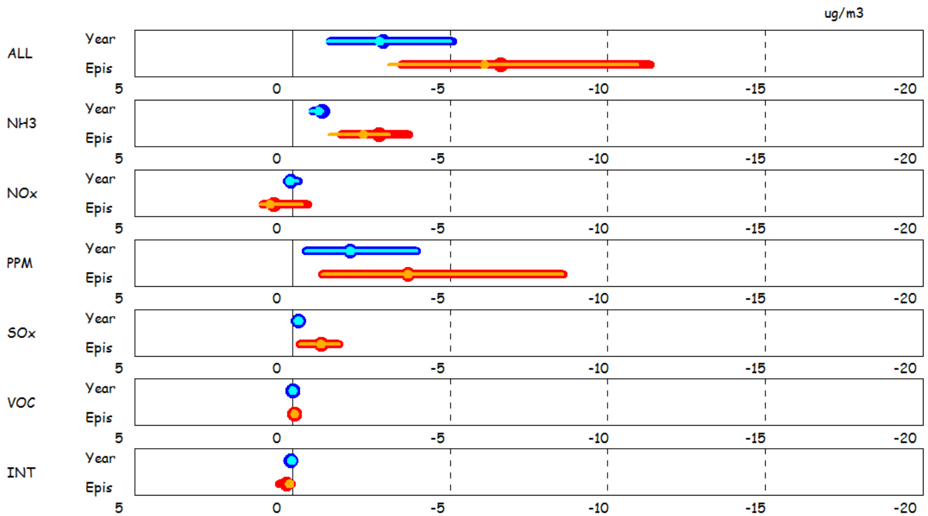
Impact of spatial resolution on non-linearity ?
Rel. potential PM_{10}

- Non linearity seems to be equially present

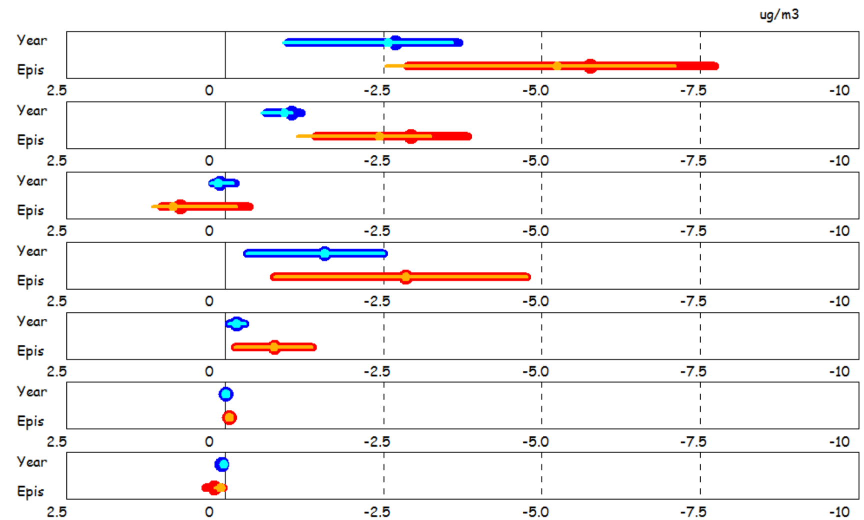


Impact of spatial resolution on non-linearity ? Abs. Potential PM_{10}

4 km



20 km



note: scale difference

PM_c increase with reduced NH_3

- Fagerli, H., Aas, W., 2008. Trends of nitrogen in air and precipitation: Model results and observations at EMEP sites in Europe, 1980-2003. Environ. Pollut. 154. 448–461. doi:10.1016/j.envpol.2008.01.024

$$2NH_3(g) + H_2SO_4(g) \rightarrow (NH_4)_2SO_4(s)$$

$$NH_3(g) + HNO_3(g) \leftrightarrow NH_4NO_3(s)$$

$$NH_3(g) + H_2SO_4(g) \rightarrow NH_4HSO_4(s)$$

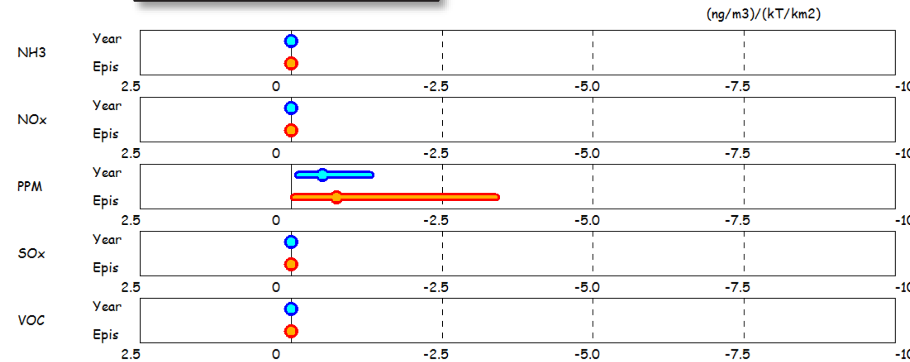
constant. Furthermore, reactions of gaseous nitric acid on soil and sea salt particles produce coarse nitrate-containing particles (Pakkanen, 1996).

- AURORA : doesn't contain this process → no effect on PM_c.

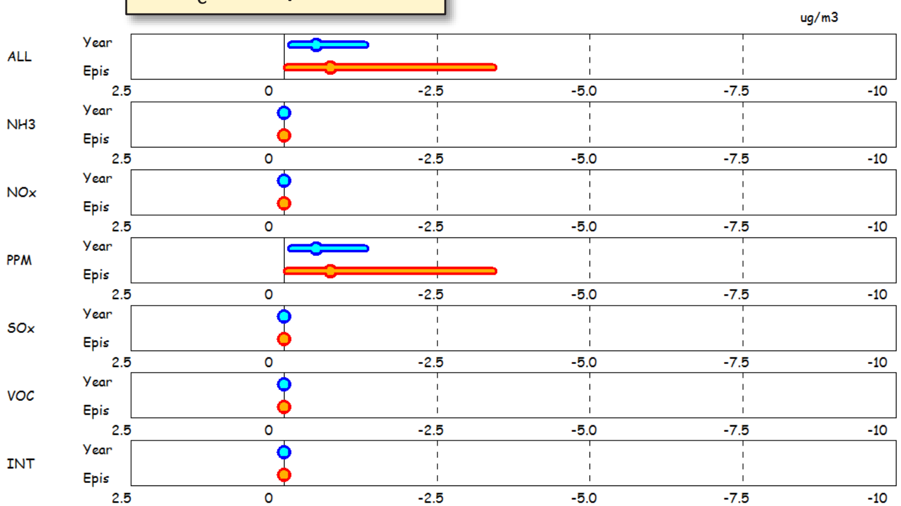
PM_{coarse} results

- Postproc. as PM_{10}-$PM_{2.5}$
- Only impact of PPM in AURORA

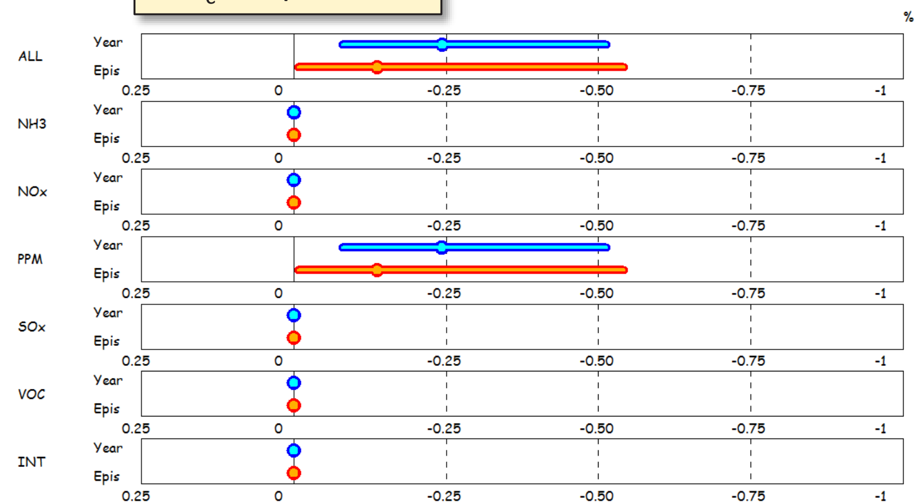
PM_c abs. potency



PM_c abs. potential



PM_c rel. potential



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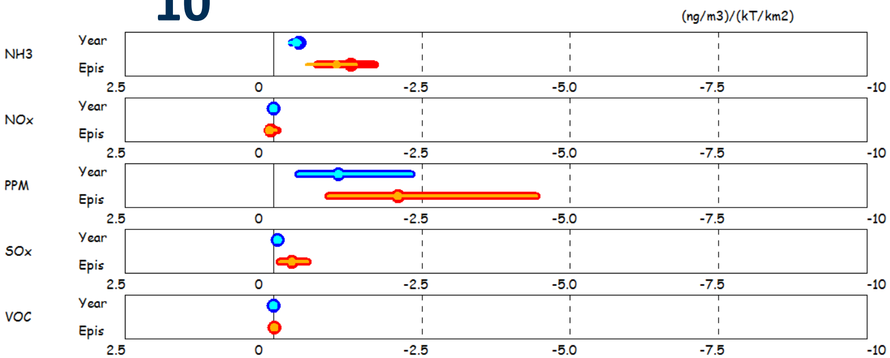
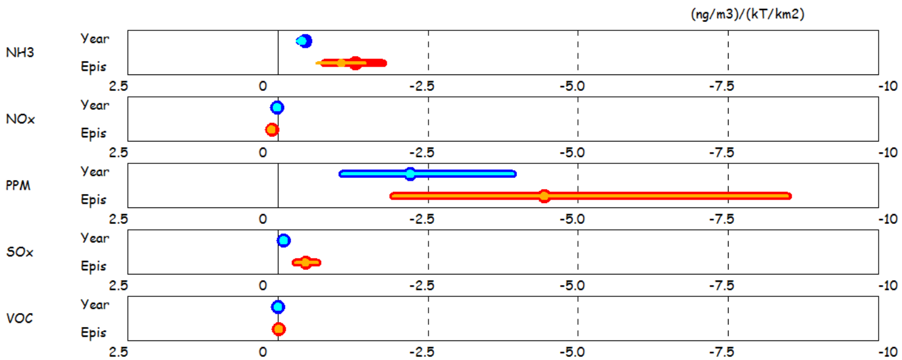
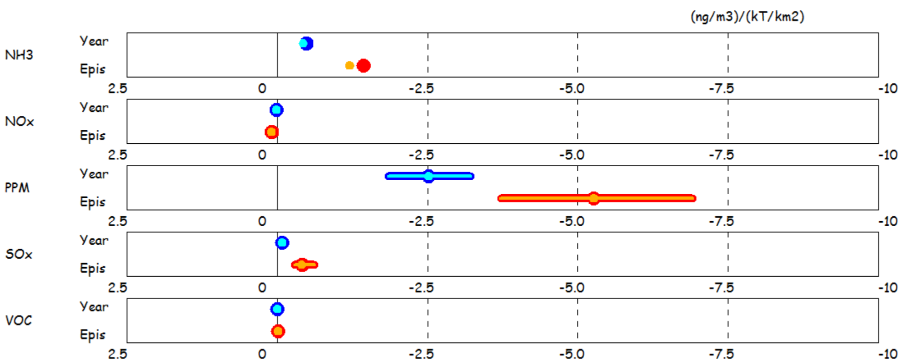
Abs. potency - rural/suburban/urban PM_{10}



rural

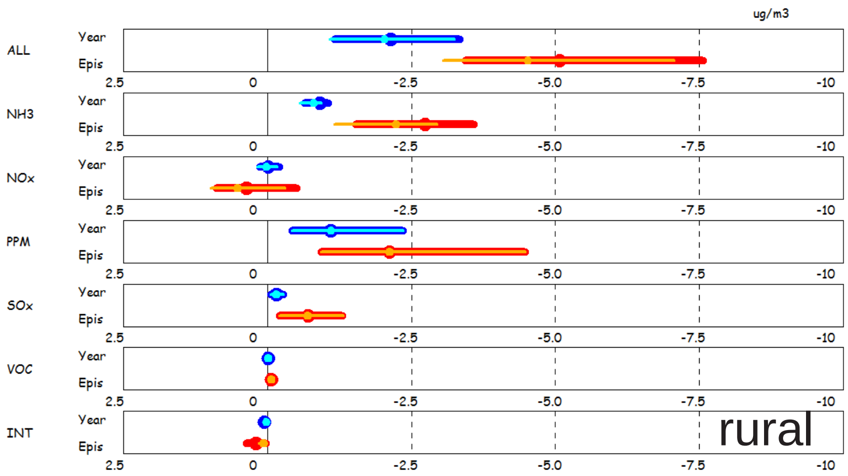


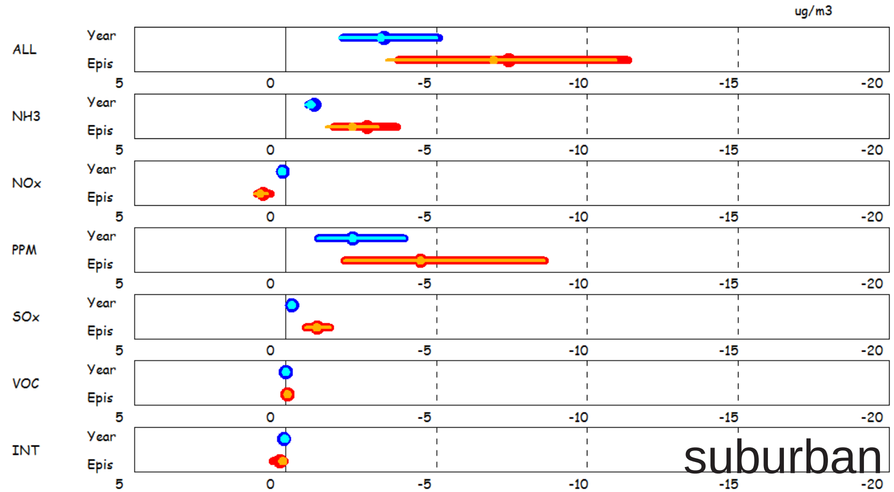
suburban

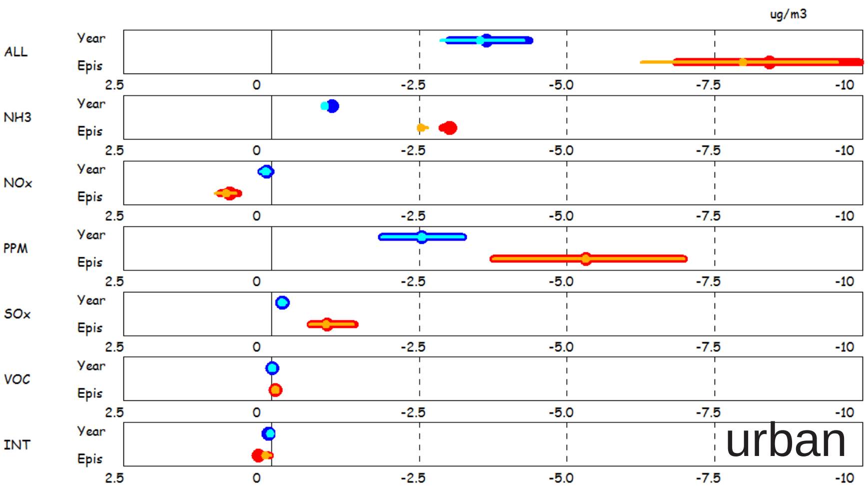


urban

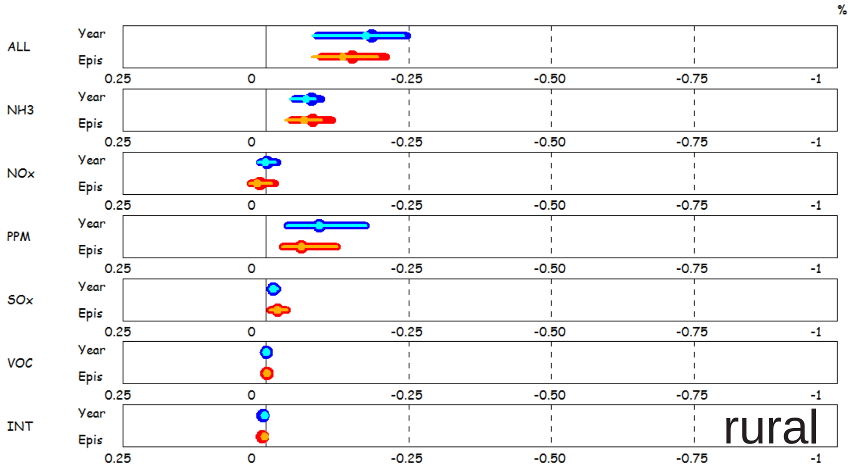
Abs. Potential – rural/suburban/urban PM_{10}

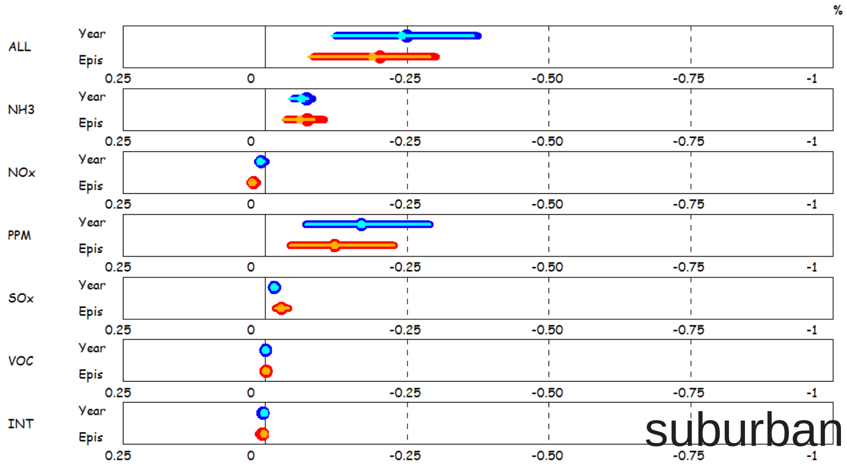


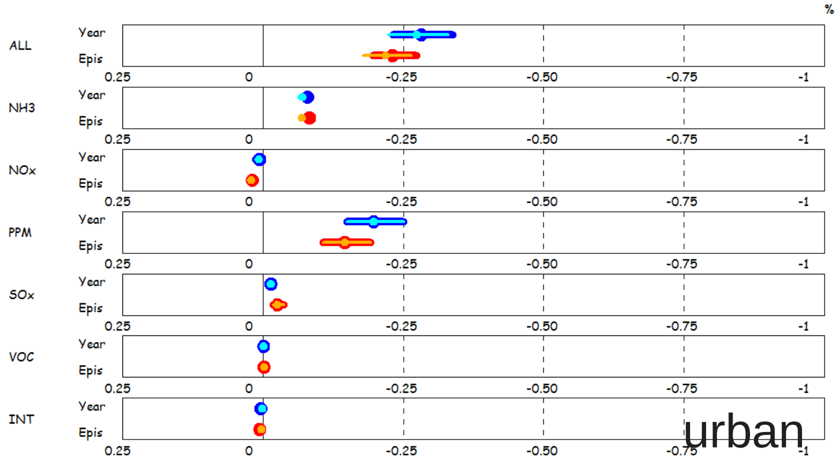




Rel. Potential – rural/suburban/urban PM_{10}







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Additional remarks

- Interesting perhaps to look at effect of emission reduction during episodes..
  - Now emission reduction over entire year & look afterwards to episodes.