

*9th International Conference on Harmonisation within
Atmospheric Dispersion Modelling for Regulatory Purposes*

SENSITIVITY ANALYSIS OF OZONE LONG TERM SIMULATIONS TO GRID RESOLUTION

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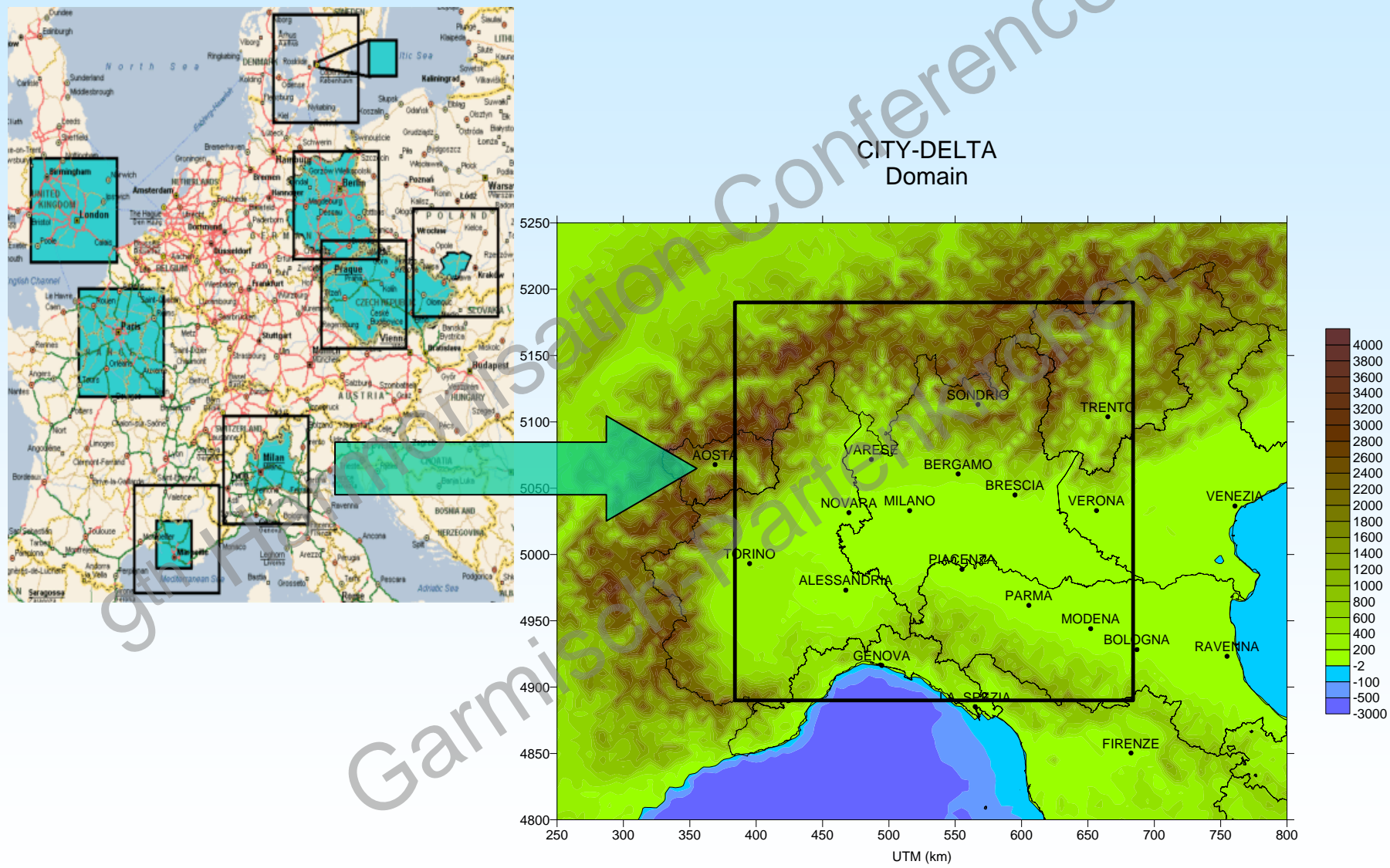
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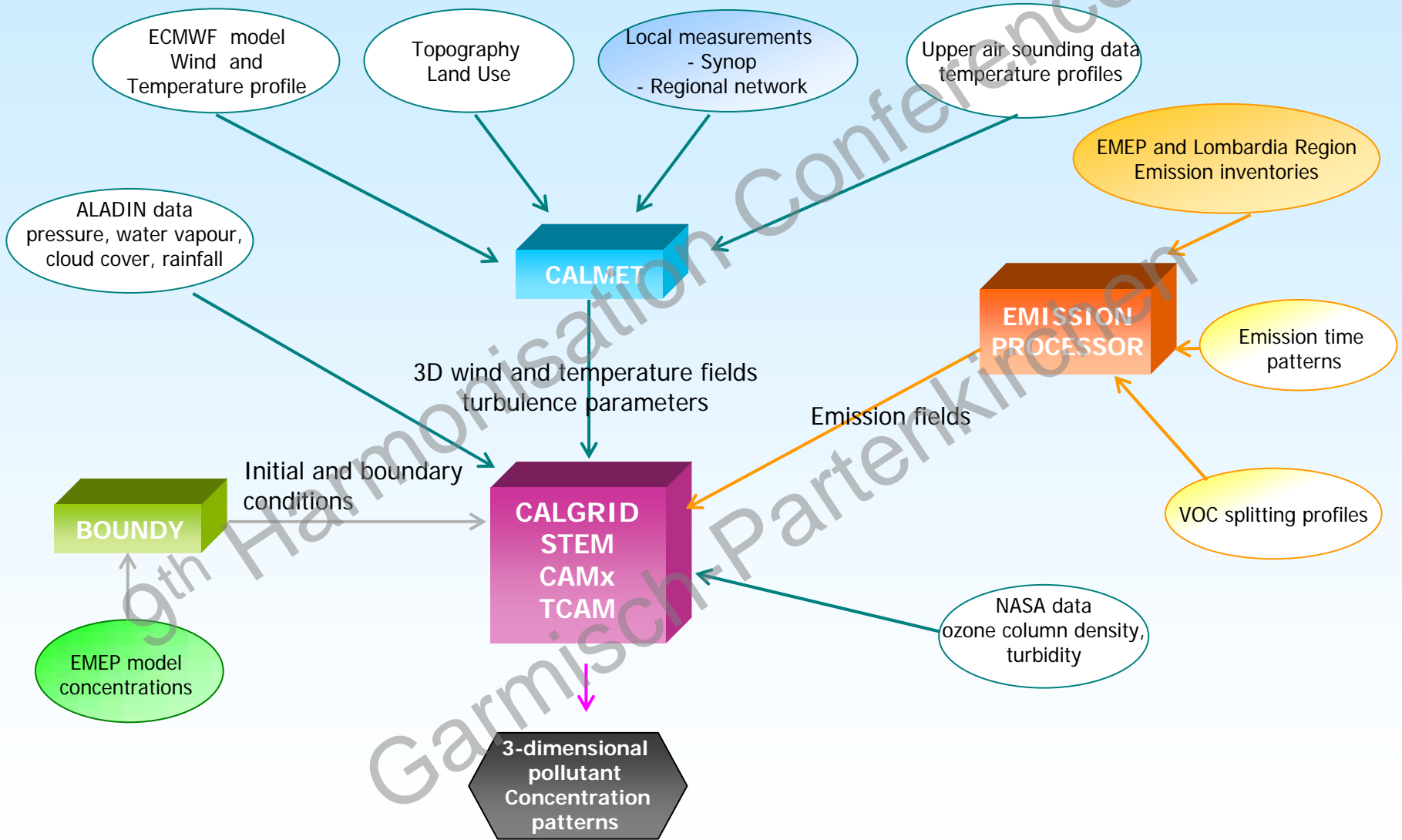
CityDelta Milan Domain



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Model Description





Models Description

Eulerian photochemical transport and dispersion models

CALGRID

- Modules for horizontal and vertical **advection/diffusion** (Chapeau Function)
- Resistance Based **Dry Deposition** Scheme
- Chemistry
 - Mechanism: **SAPRC90** and **CBIV90**
 - Solver: **QSSA**

STEM-FCM

- Modules for horizontal and vertical **advection/diffusion** (Chapeau Function)
- Resistance Based **Dry Deposition** Scheme
- Photolysis rates adjusted as a function of cloud cover
- Wet Deposition
- Chemistry
 - Mechanism: **SAPRC90** (with explicit isoprene)
 - Solver: **IEH**



Models Description

Eulerian photochemical transport and dispersion models

CAMx

- Modules for horizontal and vertical **advection/diffusion** (Bott Scheme)
- Resistance Based **Dry Deposition**
- Wet Deposition
- Photolysis rates adjusted as a function of cloud cover, total ozone column and turbidity
- Chemistry
 - Mechanism: **SAPRC99** and **CBIV99**
 - Solver: **CMC** and **IEH**

TCAM

- Modules for horizontal and vertical **advection/diffusion** (Chapeau Function)
- Resistance Based **Dry Deposition**
- Chemistry
 - Mechanism: **SAPRC90**, **SAPRC97**, **COCOH97** and **CBIV90**
 - Solver: **IEH**



Configuration (CityDelta phase I)

- 11 vertical layers (up to 3,900 m a.g.l.)
- 300 x 300 km² model domain
- 5 km and 10 km resolution
- O₃ and NO₂ simulations (April – September 1999)

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Garmisch-Partenkirchen

Monitoring stations

- 2- Agrate Brianza (urban)
- 3- Limoto (urban)
- 4- Meda (urban)
- 5- Vimercate (urban)
- 6- Magenta (urban)
- 7- Motta Visconti (rural)
- 10- Vidoletti (suburban)
- 11- Castellanza (urban)
- 12- Cossato (suburban)

no data are shown for monitoring stations displayed in grey



City of Milan

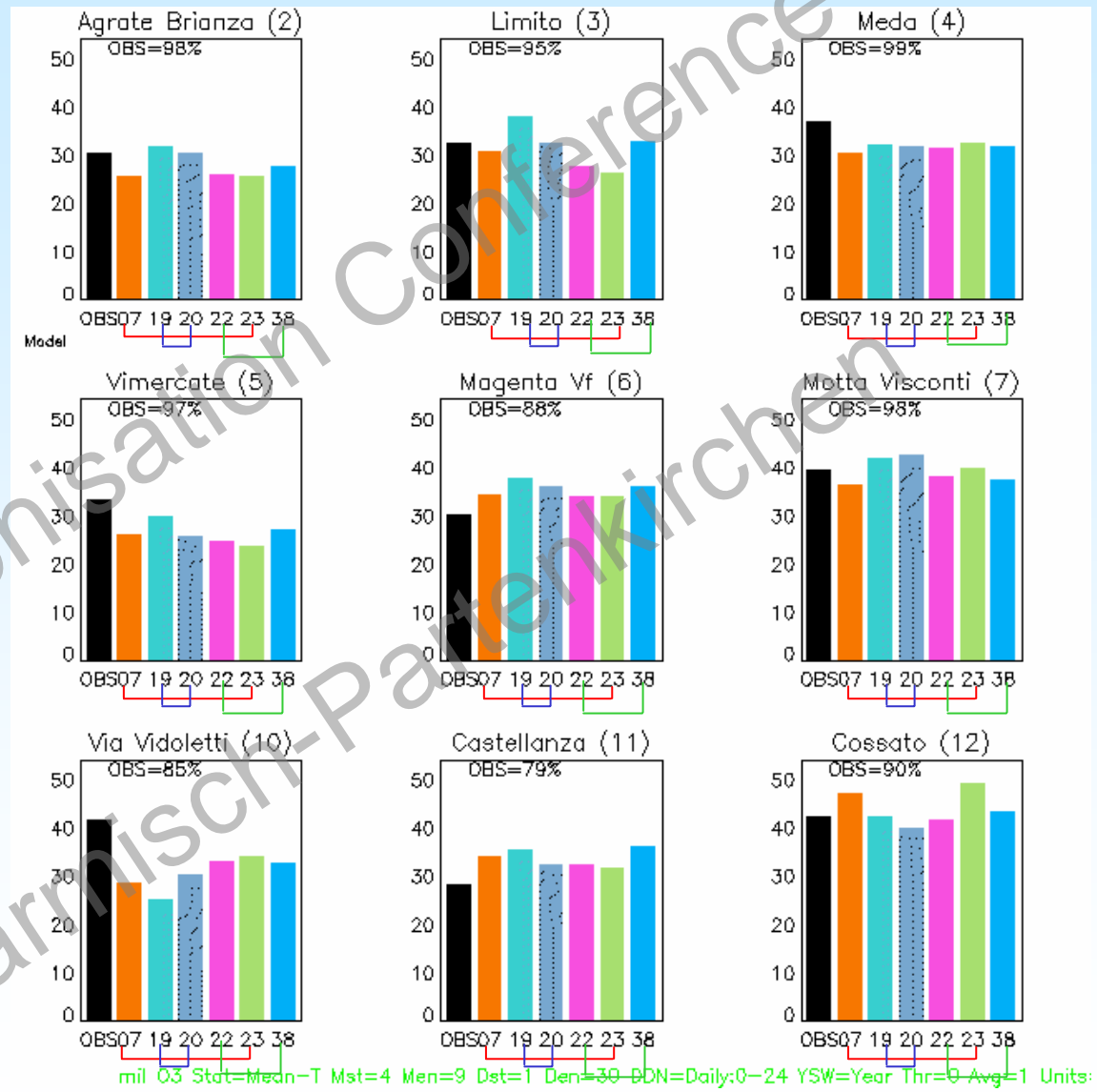


Base Case - Ozone Mean Concentration

5 km resolution, models n° 20 (Stem), 22 (Calgrid), 23 (CAMx).

10 km resolution, models n° 7 (CAMx), 19 (Stem), 38 (Calgrid).

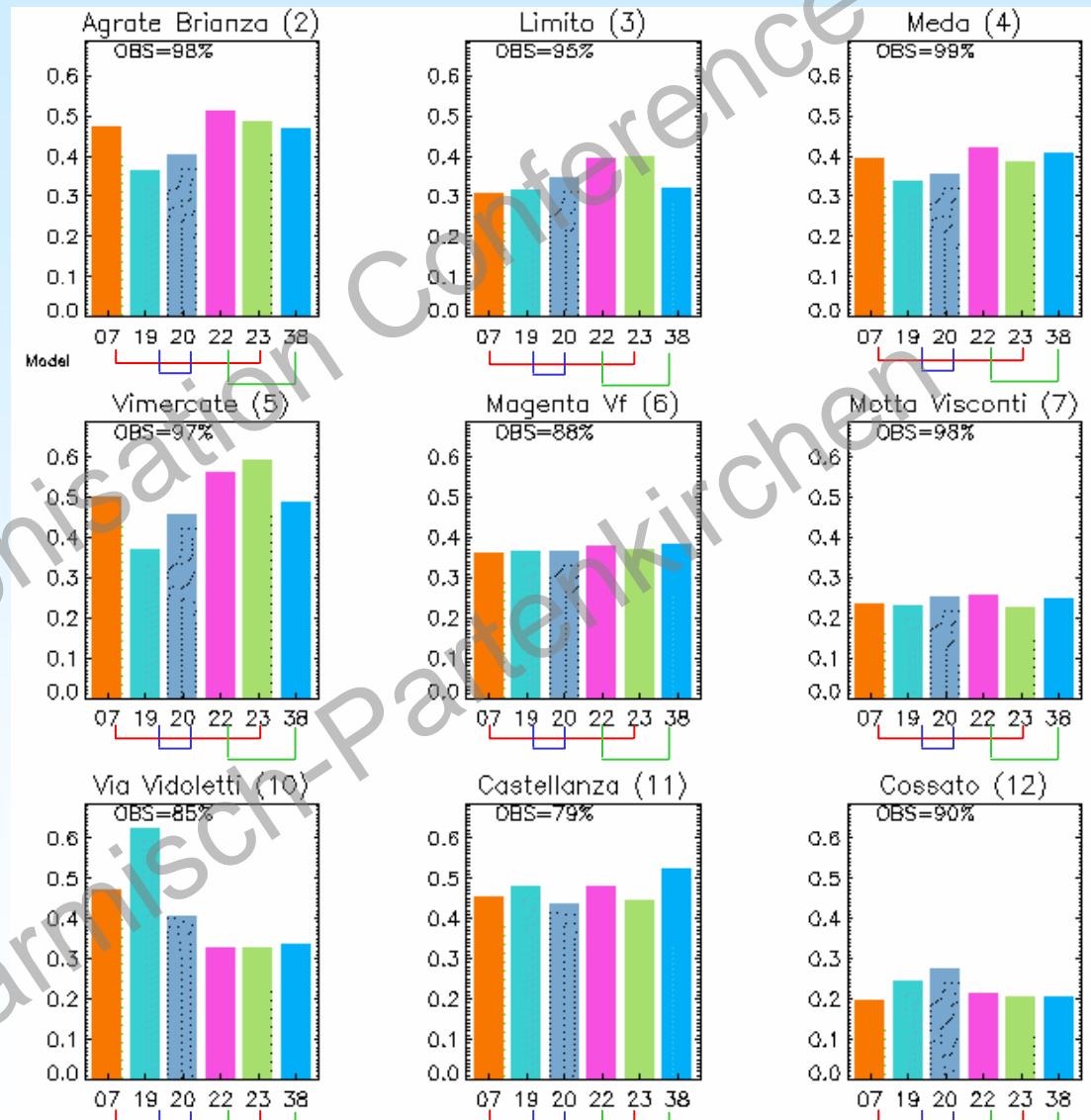
No significant differences.





Base Case - Ozone - NMSE

5 and 10 km resolution:
generally no significant
differences.



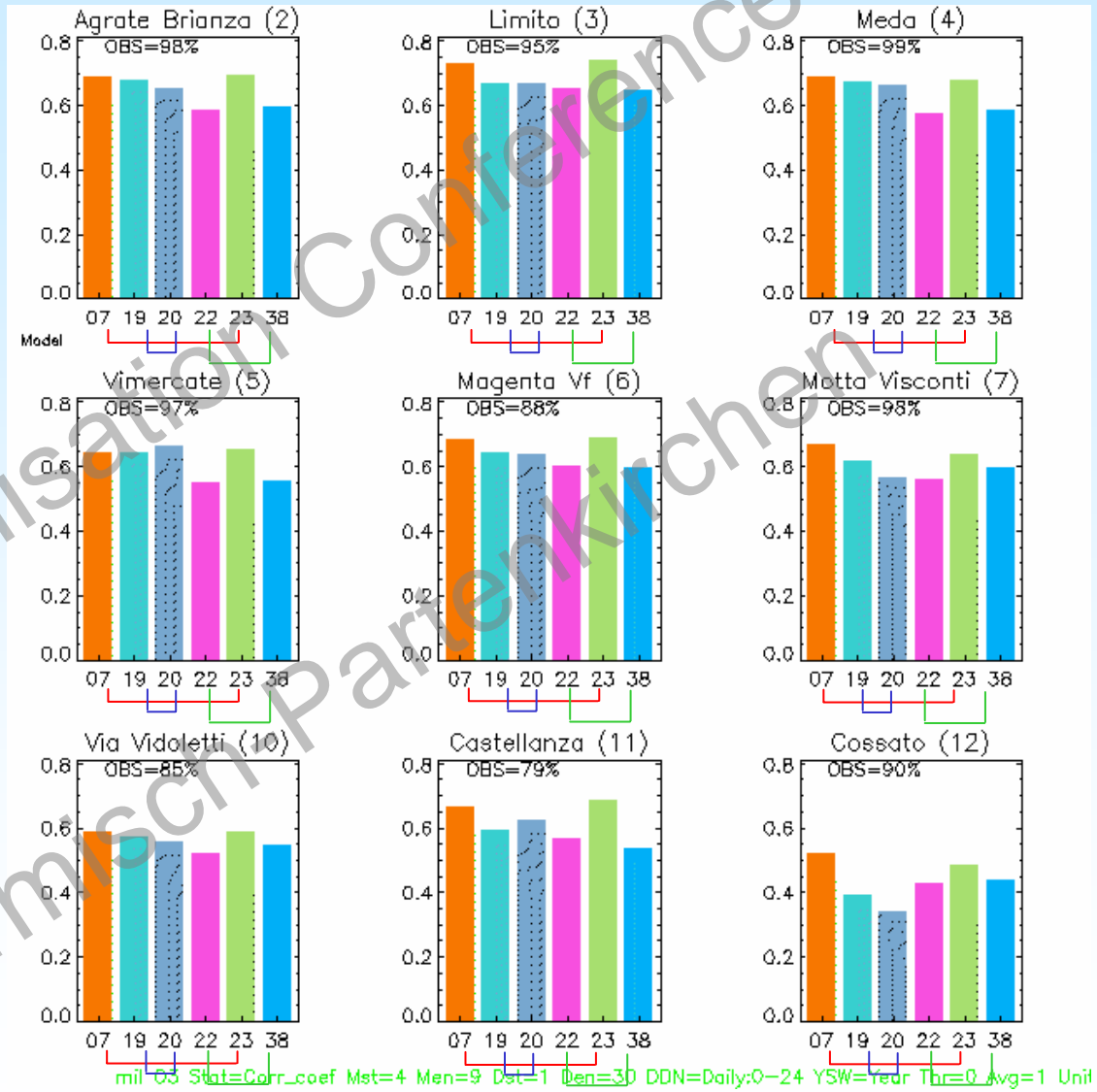
mil 03 Stat=NMSE-T Mst=4 Men=9 Dst=1 Del=30 DDN=Daily:0-24 YSW=Year Thr=0.0 Avg=1 Units

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Base Case - Ozone - Correlation Coefficient

5 and 10 km resolution:
no significant differences.

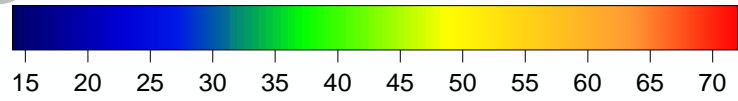
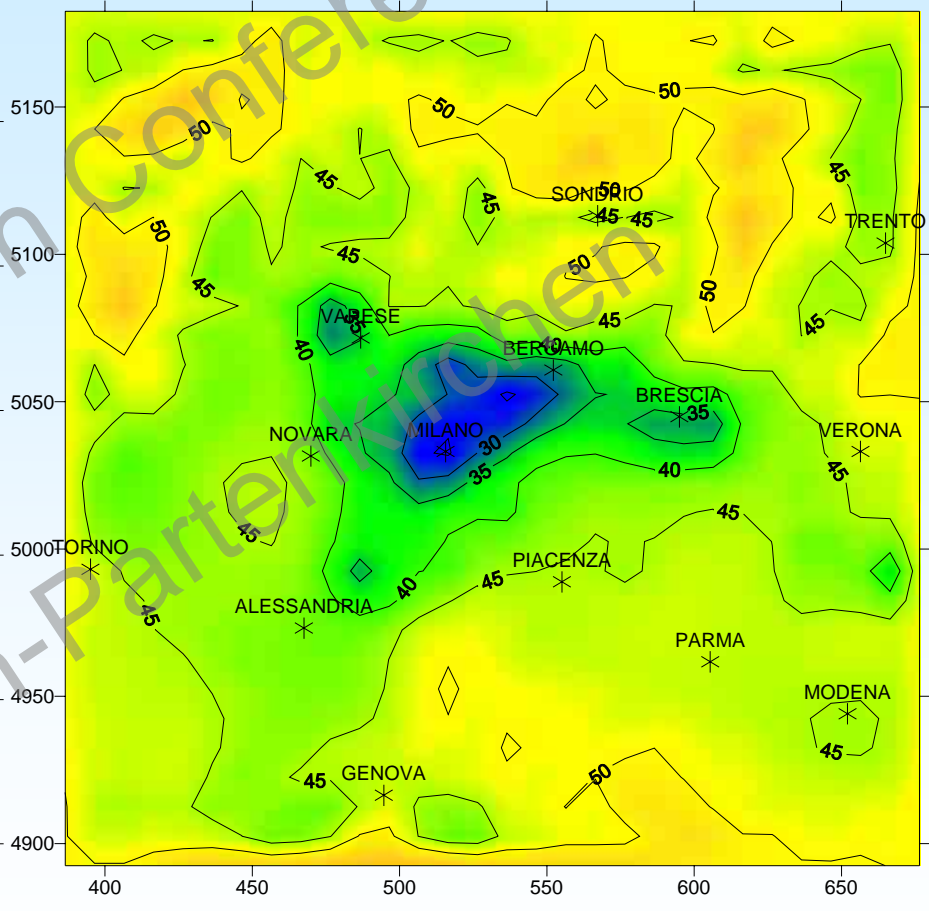
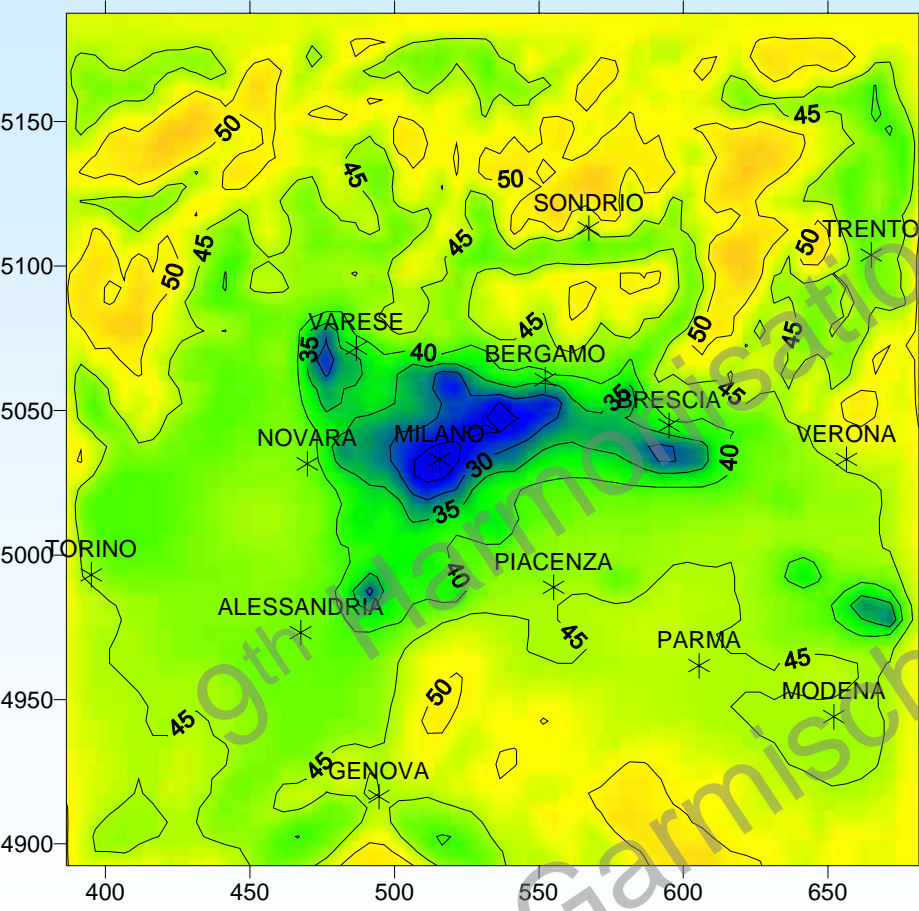




Base Case - Calgrid - Ozone mean concentration

5 km grid resolution

10 km grid resolution

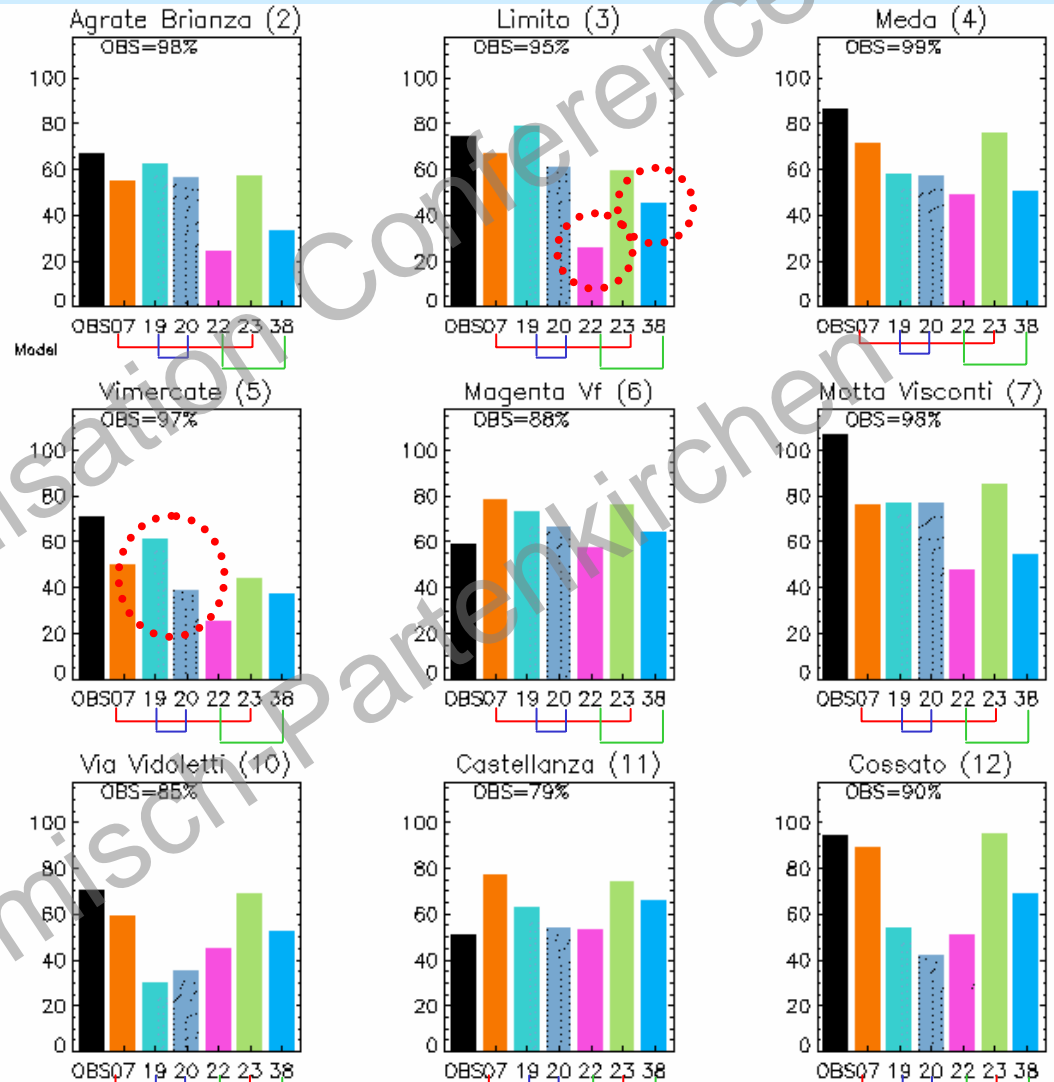


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Base Case - Ozone - Exceed. days over 60 ppb (8 hr av.)

5 and 10 km resolution:
the total number of exceedances is almost the same for one model but for the two other models the total number of exceedances is different.

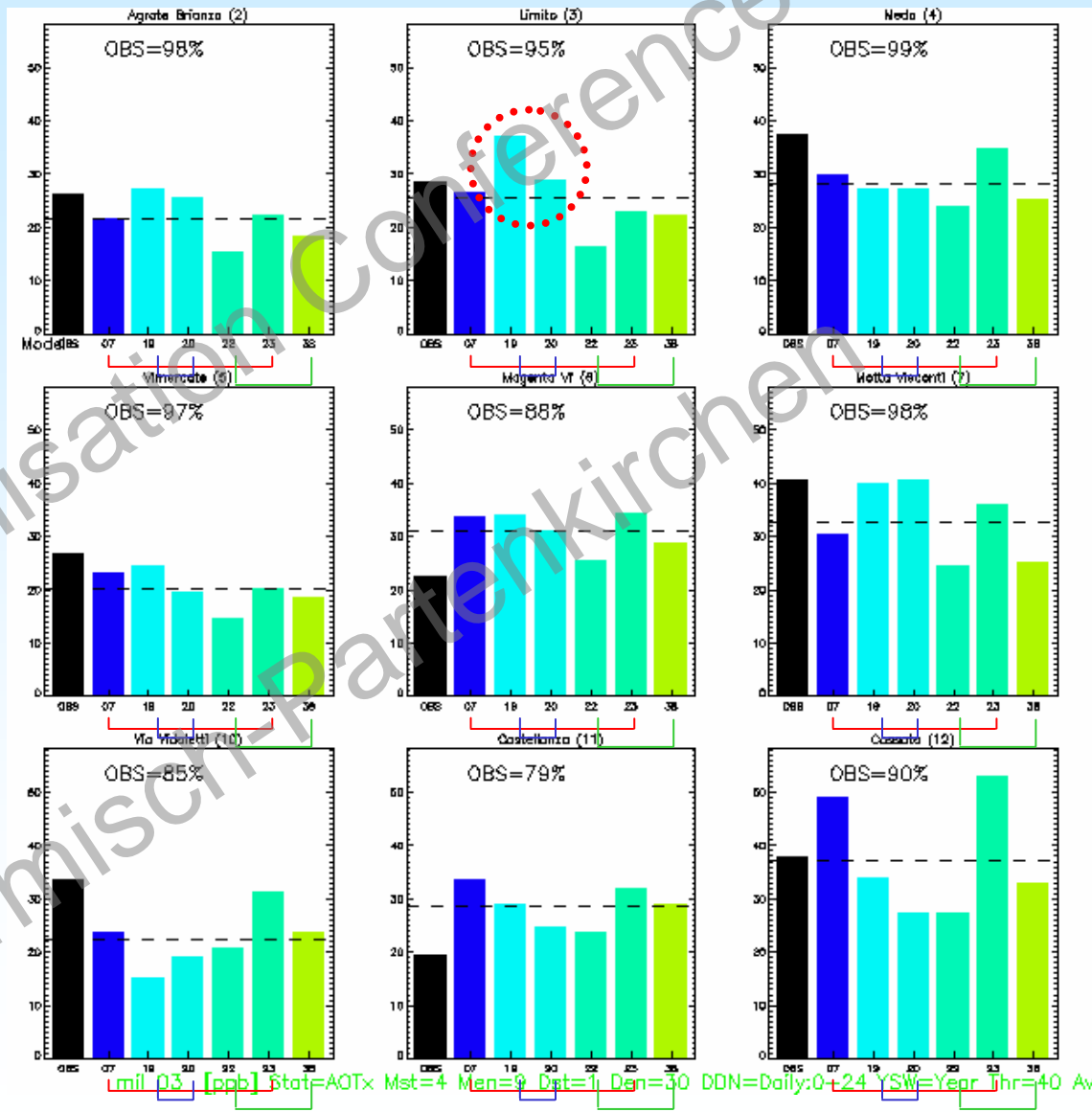


mil O3 Stat=Exe days Mst=4 Men=9 Dst=1 Den=30 DDN=Daily:0-24 YSW=Year Thr=60 Avg=8 Uni



Base Case - Ozone - AOT40

5 and 10 km resolution:
similar to exceedances case
but with weaker differences



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Base Case - Ozone validation - Summary

statistics variation as a function of grid resolution (5 km vs 10 km)

Statistics	CALGRID	CAMX	STEM
mean concentration	- 5%	1%	- 4%
NMSE	5%	1%	- 1%
correlation	- 1%	-1%	- 2%
60 ppb 8 hr exceed. days	- 22%	2%	- 13%
AOT40	- 15%	5%	- 10%

statistics variation as a function of model type

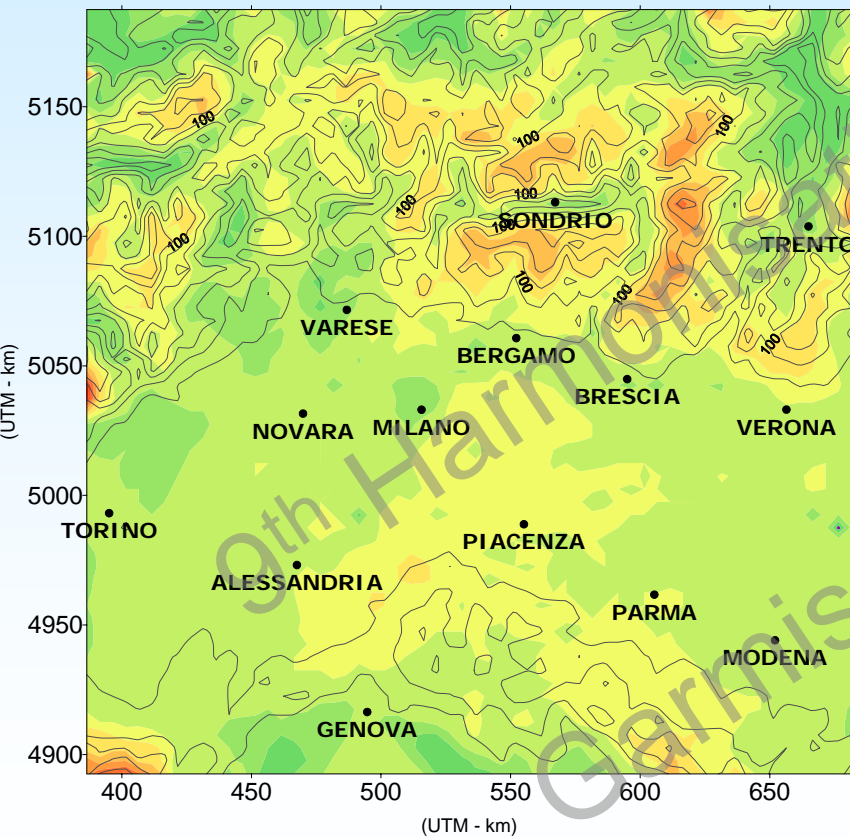
Statistics	5 km	10 km
mean concentration	5%	7%
NMSE	7%	2%
correlation	15%	14%
60 ppb 8 hr exceed. days	51%	26%
AOT40	39%	19%

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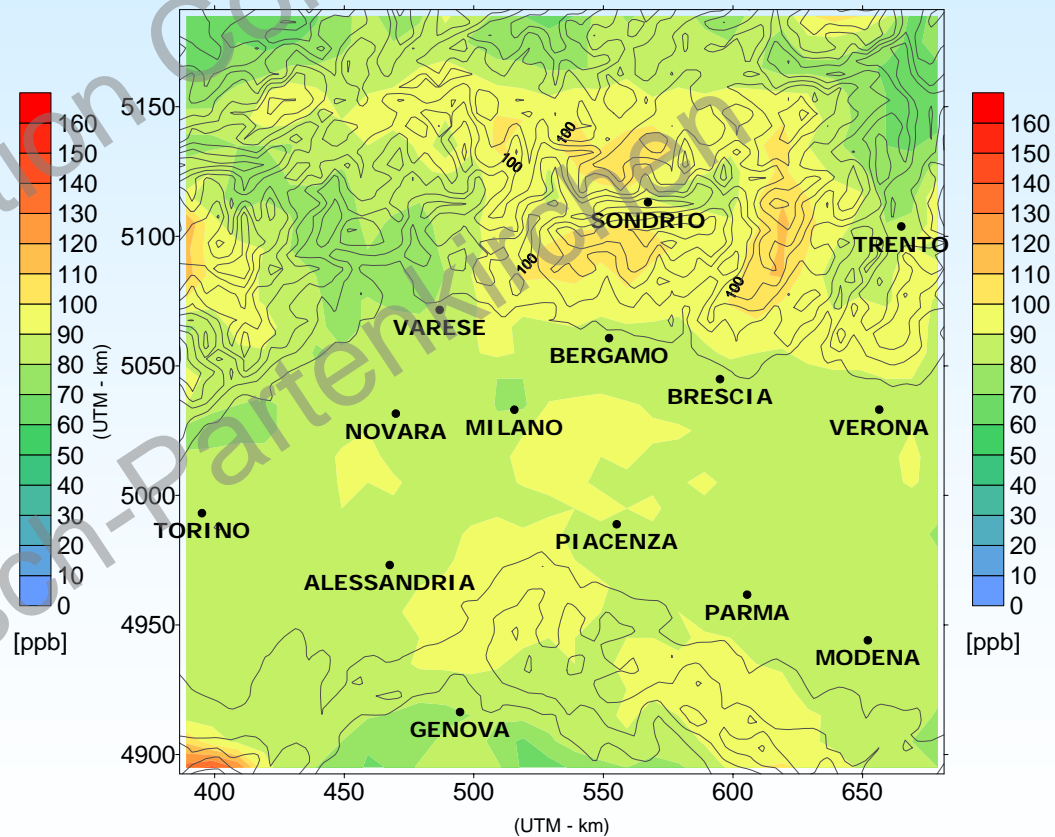


Base Case - STEM - Ozone 95° percentile (8 hours maximum)

5 km grid resolution



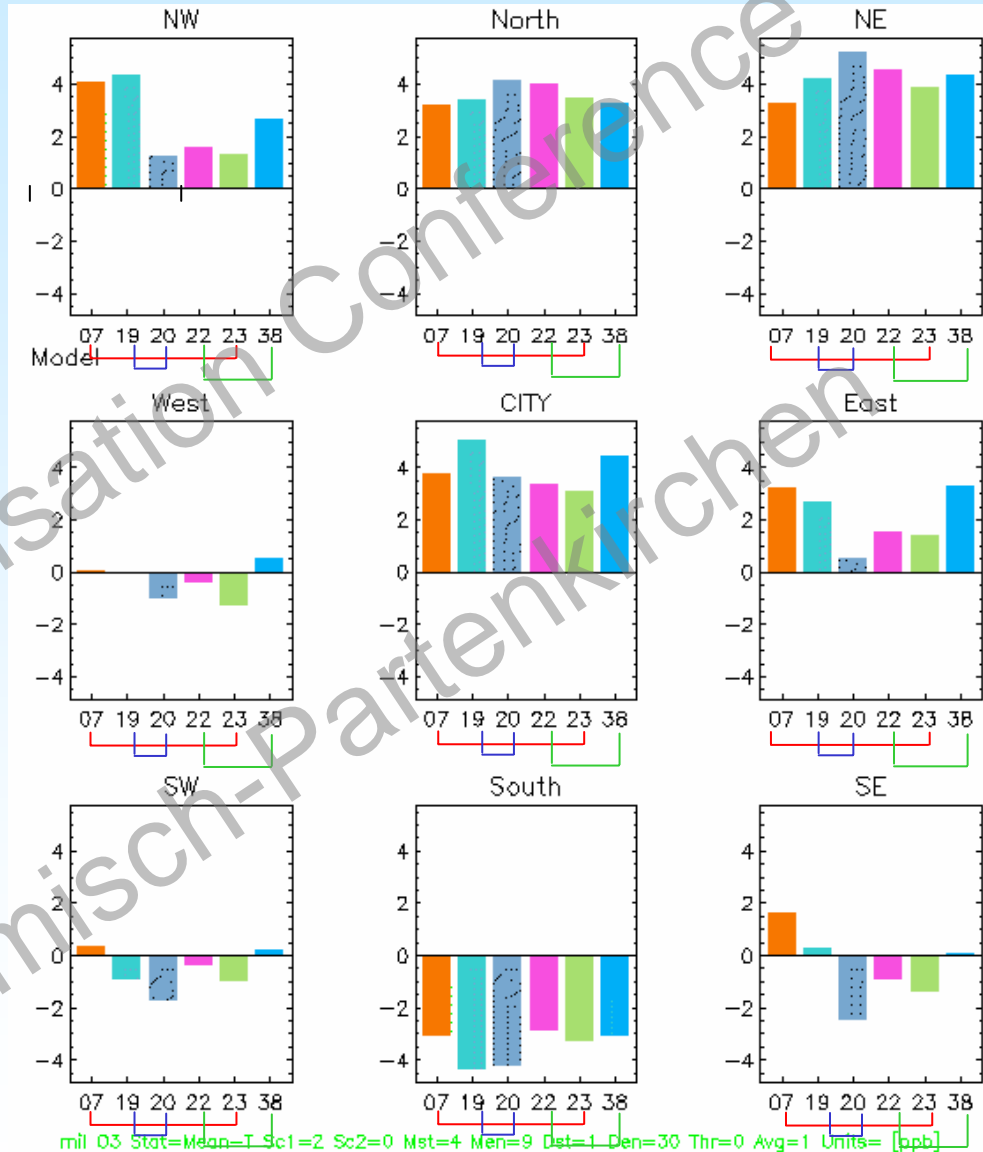
10 km grid resolution





Scenario 2010 NO_x(MFR) - Base Case: Ozone - Mean concentrations

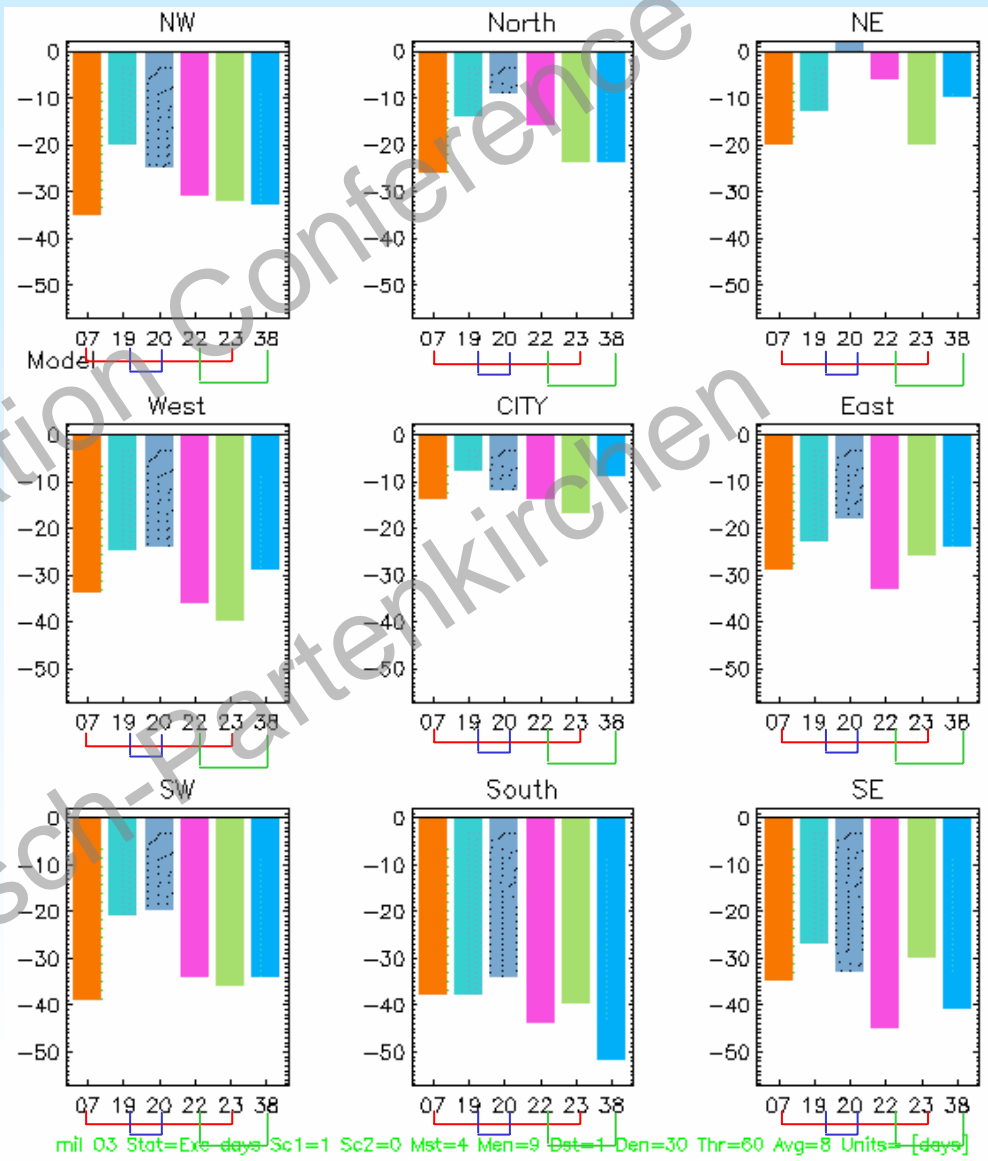
5 and 10 km resolution:
in general no significant
differences





Scenario 2010 CLE - Base Case: Ozone - Exceed. days over 60 ppb (8 hr av.)

5 and 10 km resolution:
in general no significant
differences



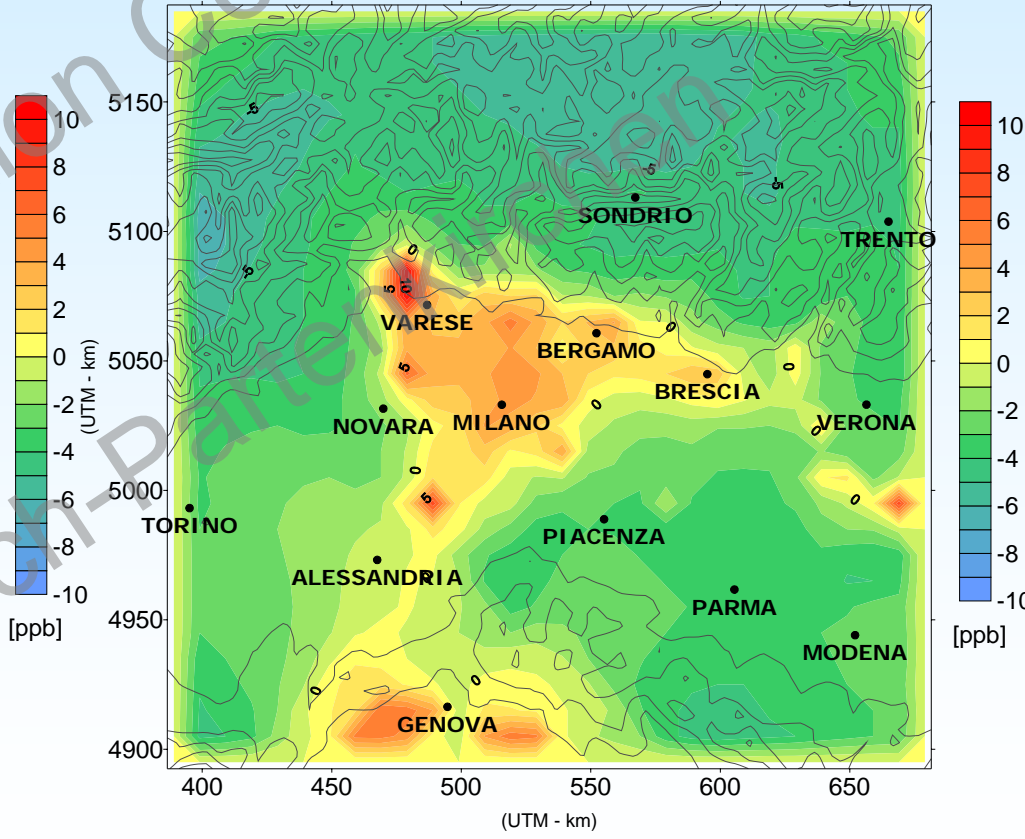
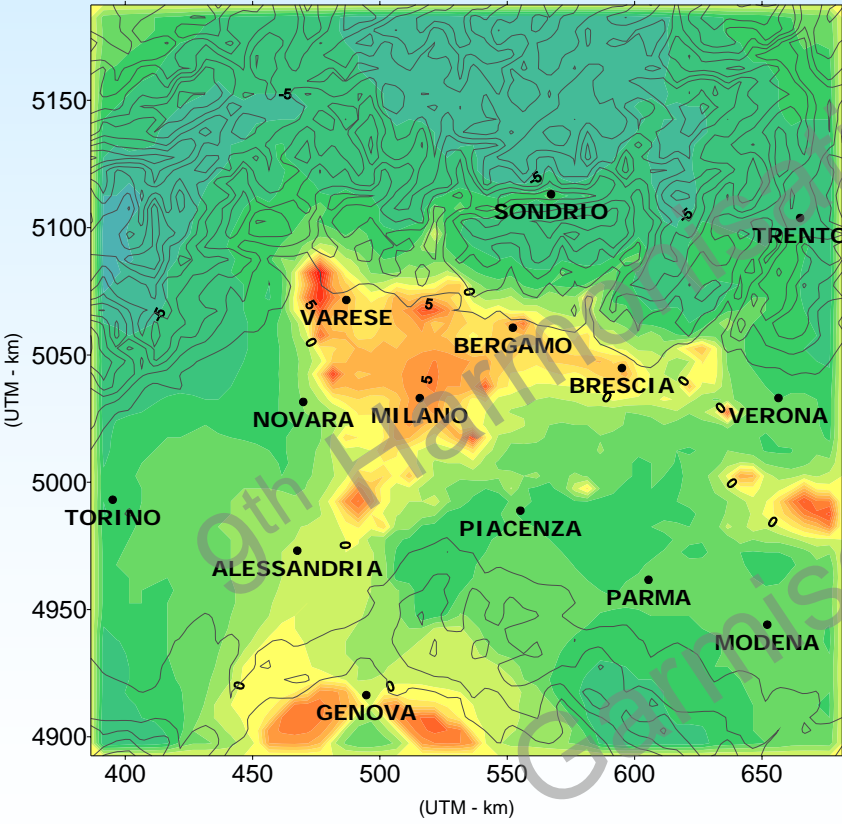


Scenario 2010 NO_x(MFR) - Base Case: CAMx

Ozone mean concentration

5 km grid resolution

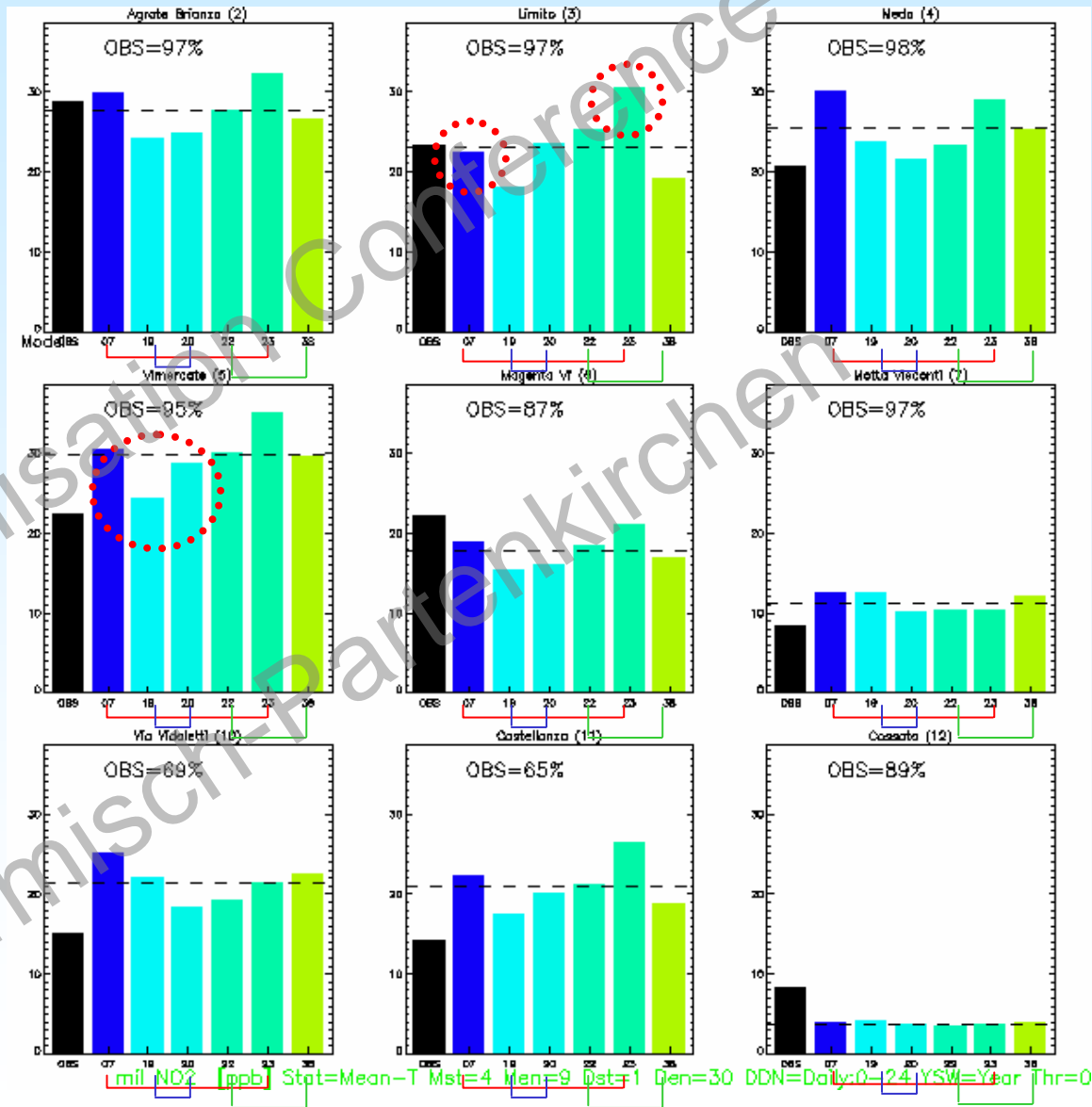
10 km grid resolution





Base Case - NO₂ Mean Concentration

Generally nitrogen dioxide seems to be more sensitive to grid resolution



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Conclusions

ABOUT THE COMPARISON BETWEEN 5 KM AND 10 KM GRID RESOLUTION RESULTS OF CALGRID, CAMx AND STEM MODELS:

- ✓ in general varying horizontal grid resolution from 5 to 10 km doesn't induce significant variations in ozone models performance for statistical indicators like correlation, NMSE, RMSE, BIAS etc.
- ✓ some difference for the "threshold" indicators, like number of exceedance days, AOTx etc., but observed variations don't put in evidence a clear worsening in model ozone performances due to a reduction of spatial resolution
- ✓ generally nitrogen dioxide seems to be more sensitive, suggesting that (in case of flat terrain) grid resolution could be more influent on emission reconstruction than on transport or chemical transformations
- ✓ it seems that the result variations induced by grid resolution are lower than the variations due to the model choice
- ✓ increasing grid step reduces computational resources requirement
- ✓ modifying spatial resolution can represent a rational decision on condition that full model sensitivity has carried out taking into account different chemical species and performance indicators, in order to correctly set grid configuration