Joint Research Centre

CITY-DELTA

A European model-intercomparison study in support to the CAFE programme

organised by

JRC-IES, CONCAWE, IIASA, EMEP, TNO-MEP

P. Thunis and C. Cuvelier

9th Harmonisation Conference, Garmisch Partenkirchen, 1-4 June 2004

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Objective:

To explore changes in air-quality (DELTA) in cities (CITY) due to changes in emission as predicted by atmospheric models with different scales, i.e:

- Identify differences between regional and urban model answers (scale delta)
- How are these differences depending on emissions (emission delta)
- How these deltas vary across cities (city delta)
- What is the range of variability in model answers? (model delta)

Goal: Implementation of urban signal into the RAINS model

Focus:

The focus is on the integrated assessment of the impact on human health and ecosystems.
WHO recommendations: Long term exposure to O3 (6 month hourly) and PM (12 months daily)

Cities:

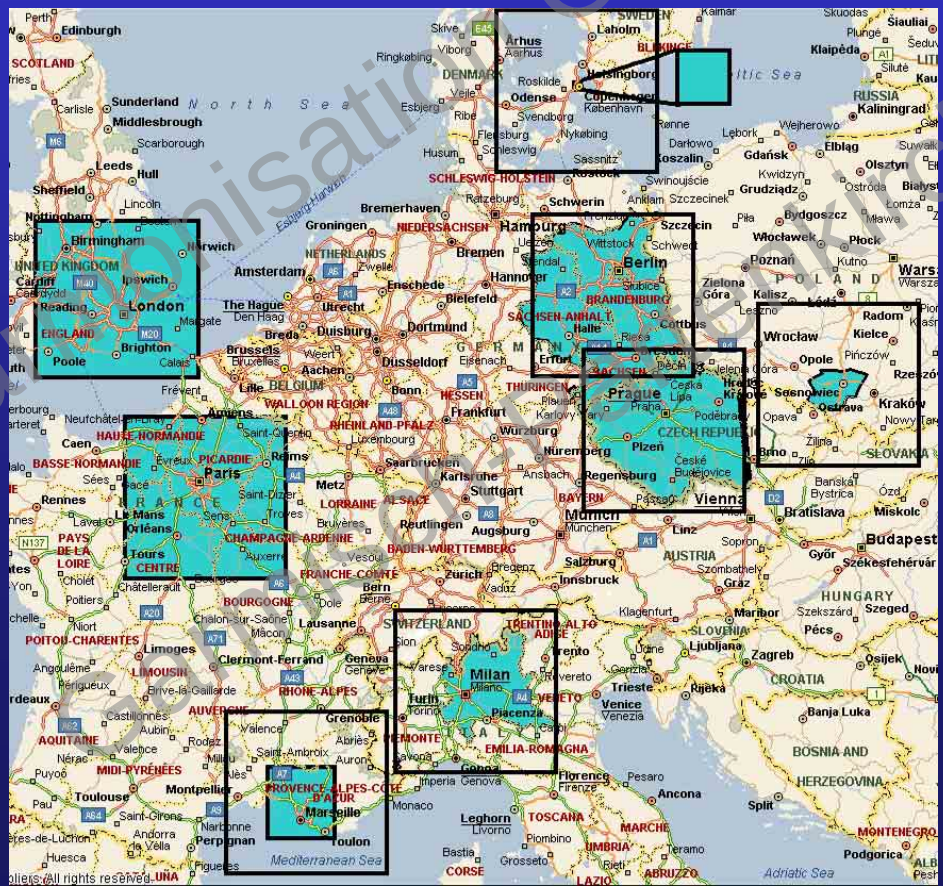
Comparisons are conducted for a number of European cities with distinct differences in climatic conditions, geographical settings, and emission densities.

London

Paris

Prague

Berlin



Input Data:

Monitoring data:

For the 8 cities delivered by the city-authorities:
O3, NO2, PM2.5, PM10

Meteorological data:

Provided to CityDelta by Meteo-France, or by the modelling group themselves for reference year 1999.

Emission inventories:

- High-resolution (1 km to 5 km) city-emission inventories
- Low-resolution (50 km) EMEP-TNO emission inventory

Boundary conditions:

Provided by EMEP, or by the modelling group themselves

Emission Scenarios

0 --- 1999

1 --- 2010 CLE: Current LEgislation

2 --- 2010 NOx MFR: Maximum Feasible Reduction

3 --- 2010 NOx (CLE+MFR)/2

4 --- 2010 VOC MFR

5 --- 2010 NOX and VOC MFR

6 --- 2010 PMcoarse MFR

7 --- 2010 PM2.5 MFR

NOx	CLE-1999	MFR-1999
Prague	-34%	-62%
Milan	-36%	-53%
Paris	-42%	-65%
Berlin	-38%	-50%

Output requested:

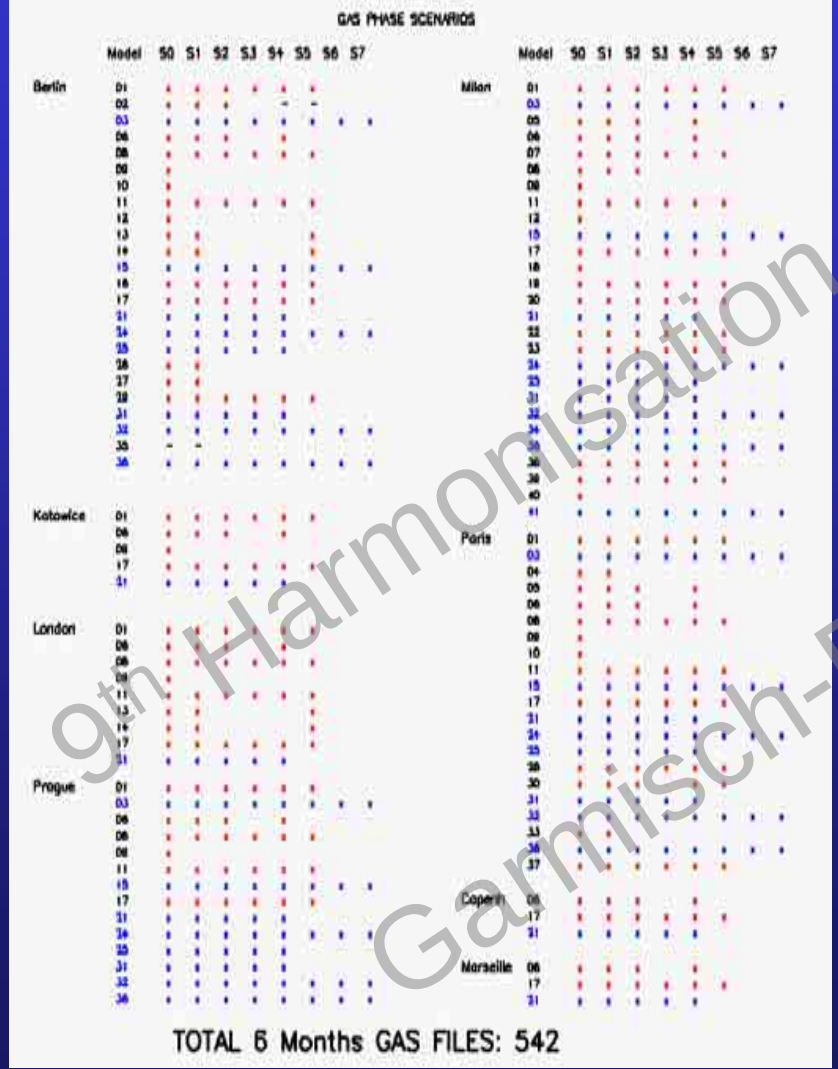
- **Hourly values for O3 (and NO2) for 6 months (Summer)**
- **Daily values for PM2.5 and PM10 for 12 months**

40 different model configurations

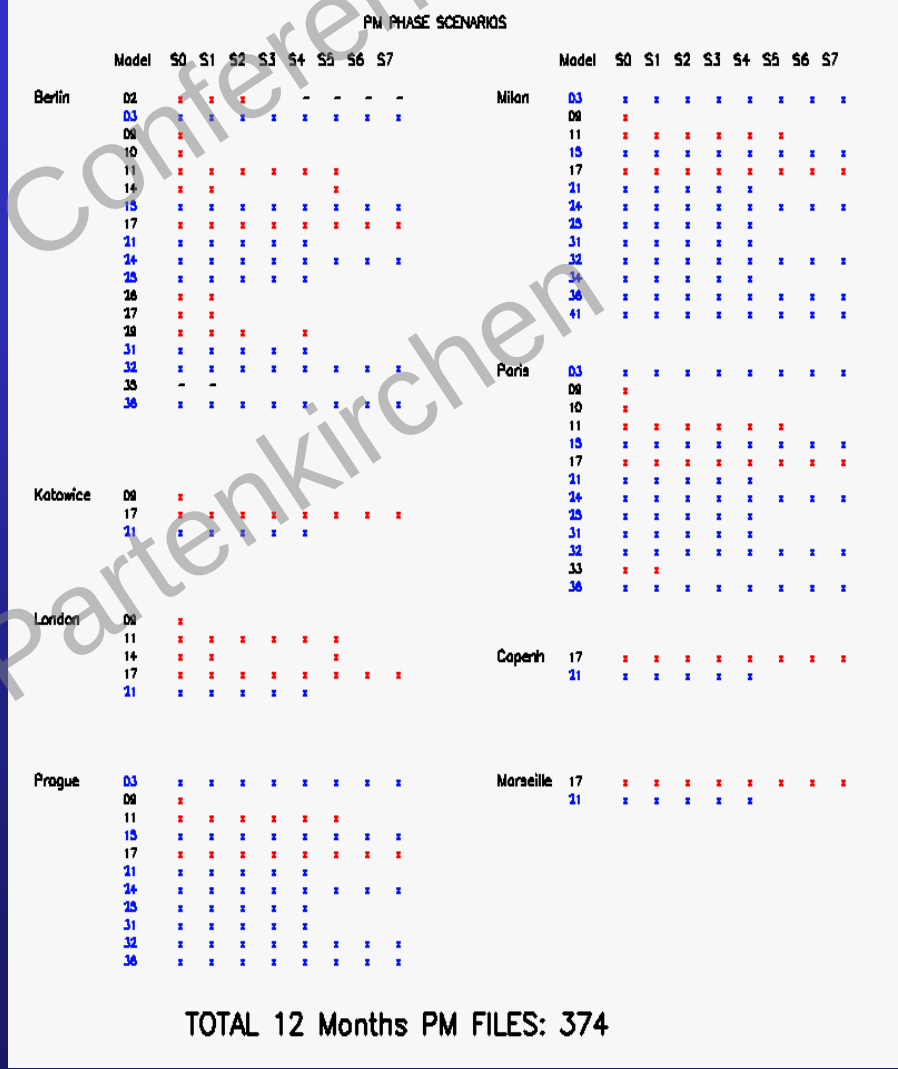
CALGRID	Univ. Brescia (Italy)
CAMX	Ag. Mobilita Ambiente (Italy)
CHIMERE	INERIS-IPSL (France)
EMEP	EMEP (Norway)
EPISODE	NILU (Norway)
EUROS	RIVM (Netherlands)
LOTOS	TNO (Netherlands)
MOCAGE	Meteo-France (France)
MUSCAT	IFT (Germany)
MUSE	AUT (Greece)
OFIS	AUT (Greece)
REM	FU Berlin (Germany)
SMOG	Univ. Prague (Czech R.)
STEM	CESI (Italy)
THOR	NERI (Denmark)
TRANSCHIM	CORIA (France)

Delivery

GAS PHASE SCENARIOS



PM PHASE SCENARIOS



Interpretation of the results

- First, each modelling group evaluates its own model results before submission to JRC using its own tools based on personal criteria
- Second, intercomparison is performed of all results with a common graphical visualisation tool on a preselected data sub-set

  1. Same selection of locations, indicators,…
  2. Each group can compare its results against others

- Third, city/model overviews are constructed through specific approaches (Ensemble, Taylor, …)

The JRC tool

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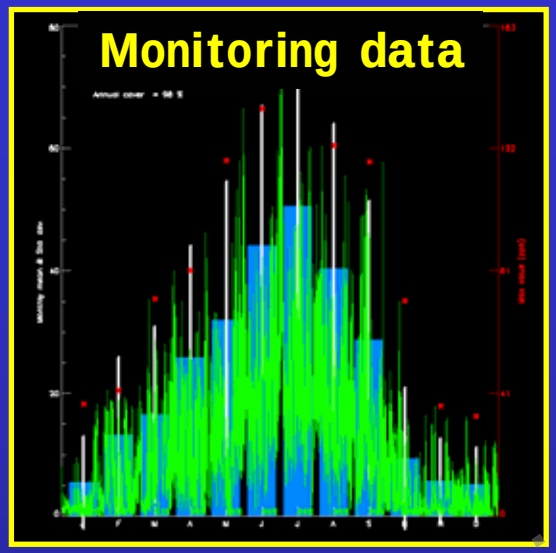
Monitoring data



Monit --> View Monitoring Data

Valid --> Model/Observation comparison

Delta --> Scenario model results

Plane --> 2-D surface model results

Emis --> City vs EMEP emissions

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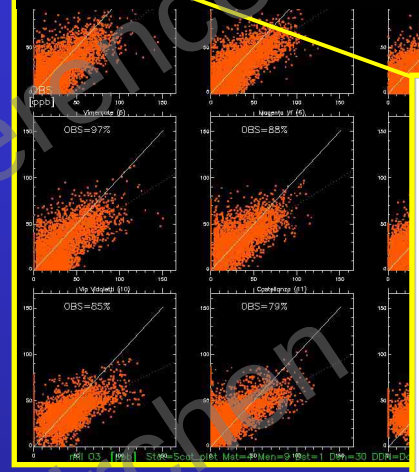
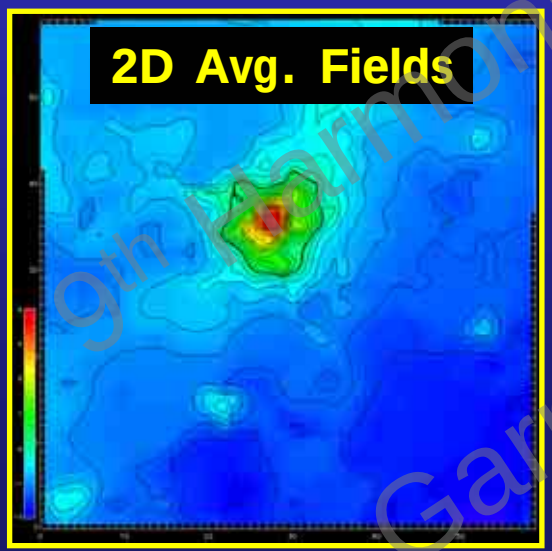
Validation with Obs.

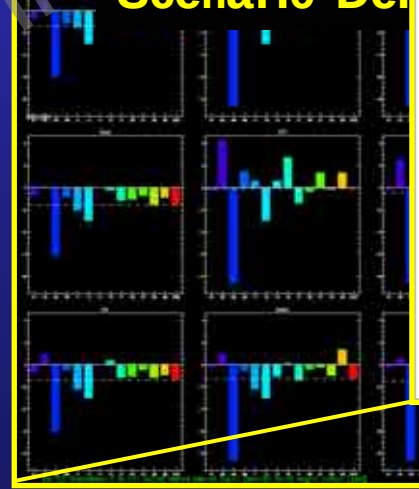


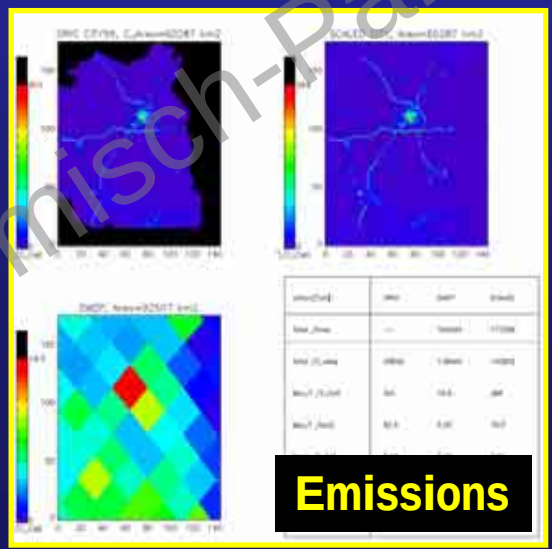
- Time series
- Max-ddn
- Min-ddn
- Mean-ddn
- Max-ddnT
- Min-ddnT
- Max-T
- Mean-T
- Stddev-T
- NMSE-T
- RMSE-T
- CRMSE-T
- Scat_plot
- Corr_coef
- SigM/SigO
- Bias-T
- NBias-T
- FBias-T
- NBias
- NBias_abs
- FBias
- FBias_abs
- Foex-T
- Freq_A
- Freq_A_Err
- Exc days
- AOTx
- Taylor

2D Avg. Fields



Scenario Del





Emissions

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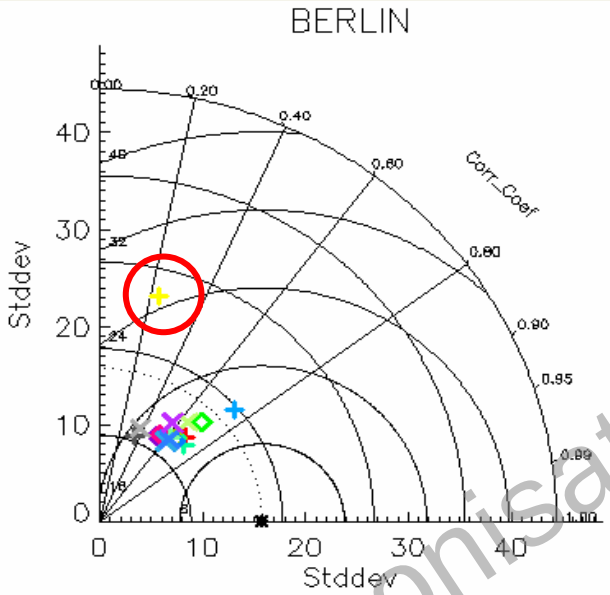
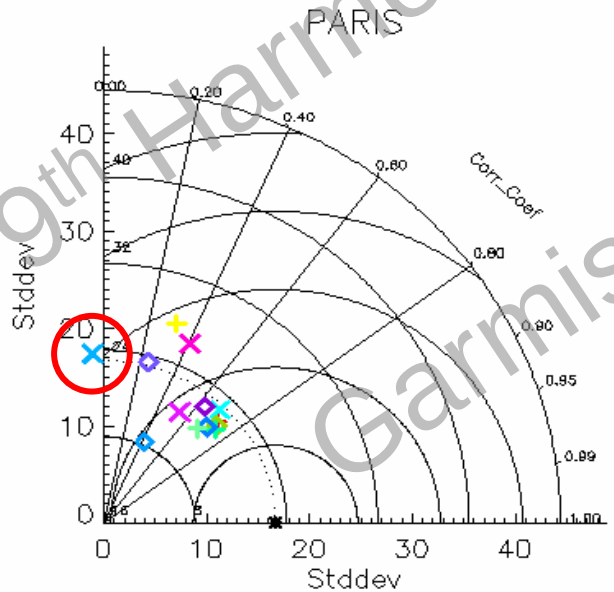
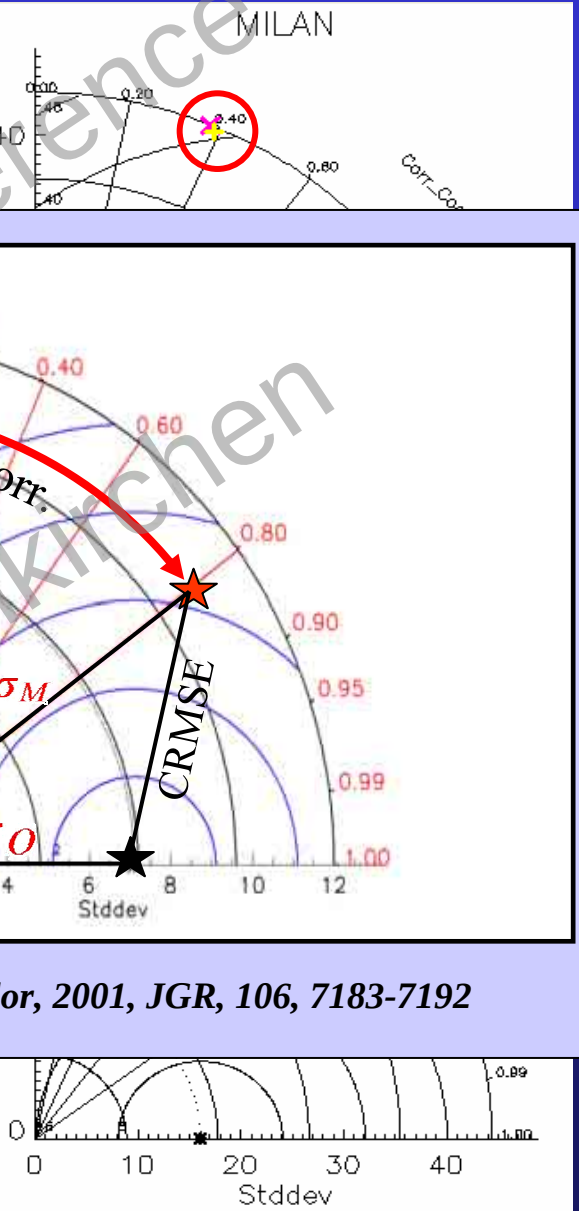
O3 Taylor plots

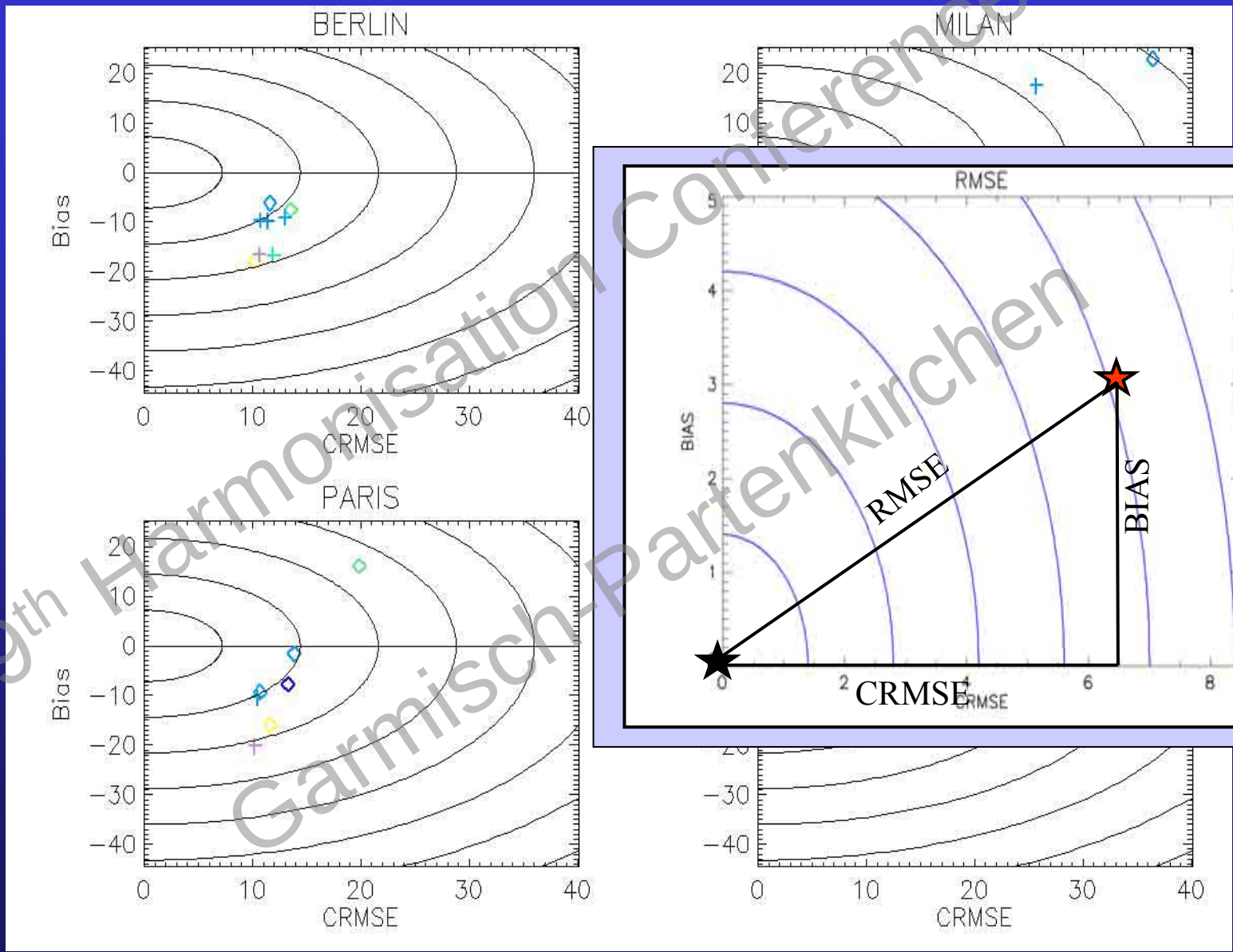




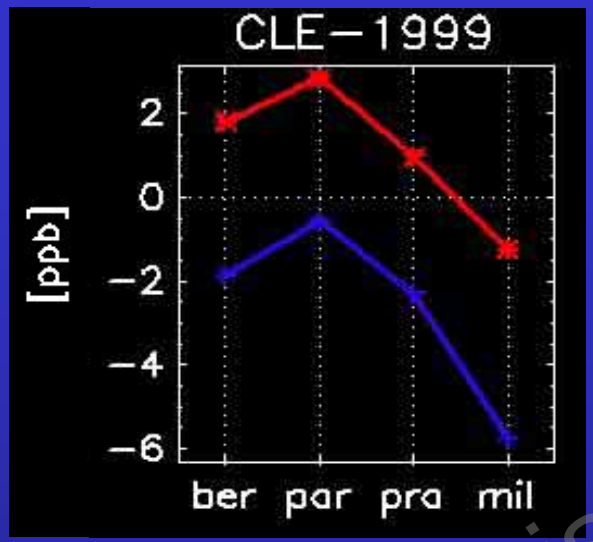


K.E.Taylor, 2001, JGR, 106, 7183-7192

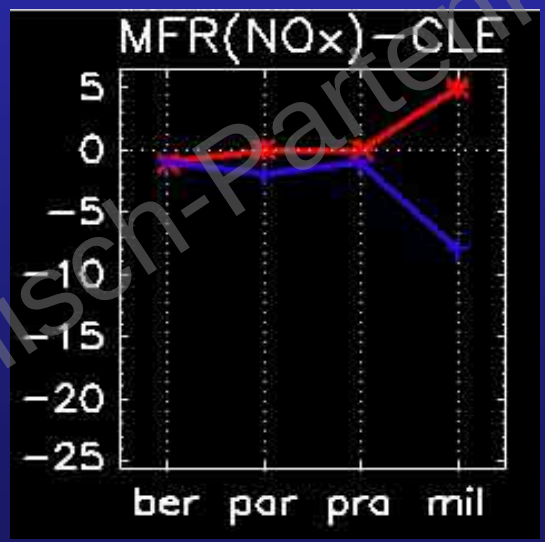
PM10 Taylor Plots + Bias

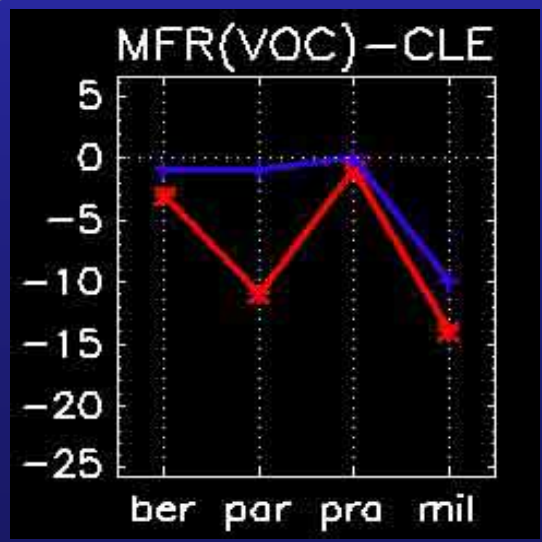


ENSEMBLE: O3 mean daytime in City Centre



O3 exceedance days over 60 ppb

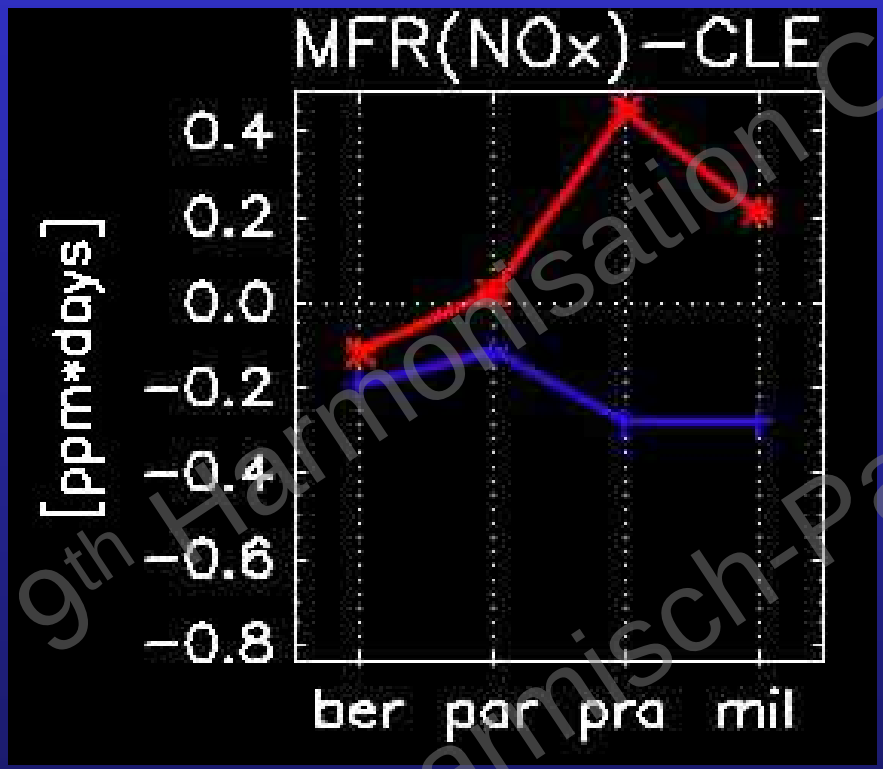




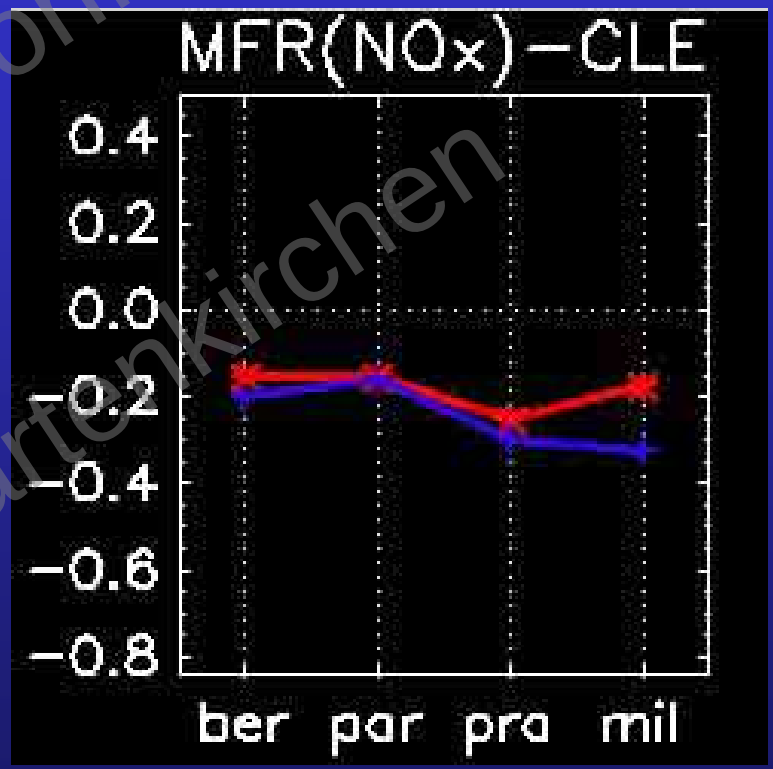
Fine S models
Coarse S models

ENSEMBLE: O3 WHO 35 Indicator

City Centre



Whole domain

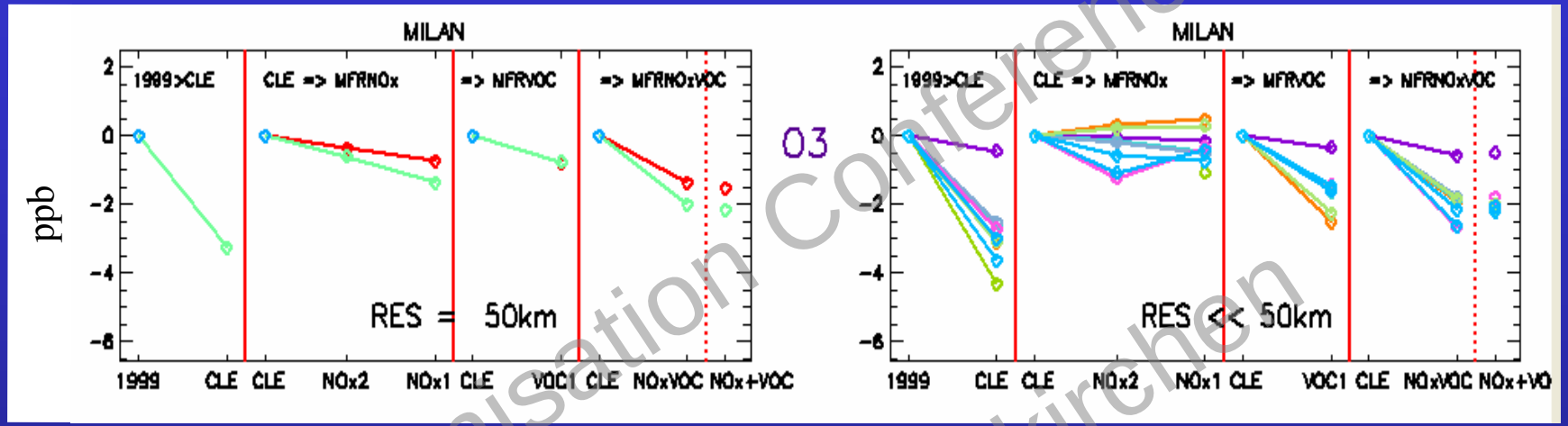


$$WHO_{35} = \sum_{365days} \max[O3_{av8} - 35;0]$$

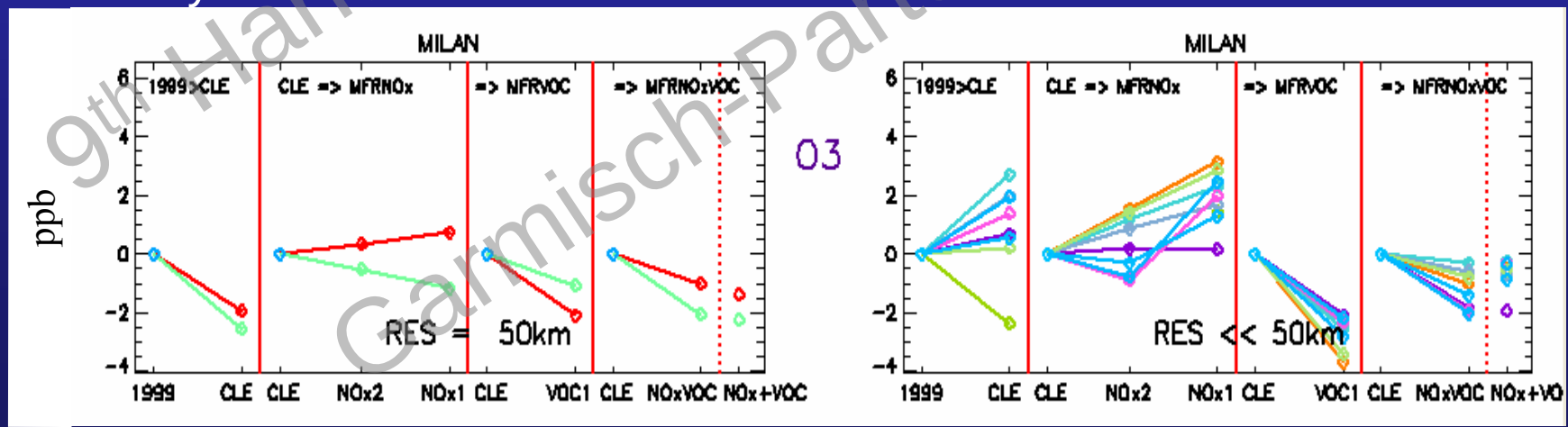
Fine S models
Coarse S models

O3 Delta Overview: daily mean in Milan

Whole domain



City Centre



Conclusions

- Emission inventories are crucial. Local inventories are not always compatible with regional emissions
- Consistent pattern of difficulties in night time: model predictions are too high, especially LS models in the city area. Day time predictions show less variability between models
- LS models tend to underestimate the impact of VOC emission reductions and to overestimate the impact of NOx emission reductions on O3.
- Impacts of emission reductions from 1999 to CLE are significantly larger than those from MFR to CLE
- Milan shows the largest differences between LS and FS models.
- Further scenarios were required for PM deltas to be analysed (CityDelta Phase 2). Under review.
- Final CityDelta workshop: 14-15/10/2004, Ispra

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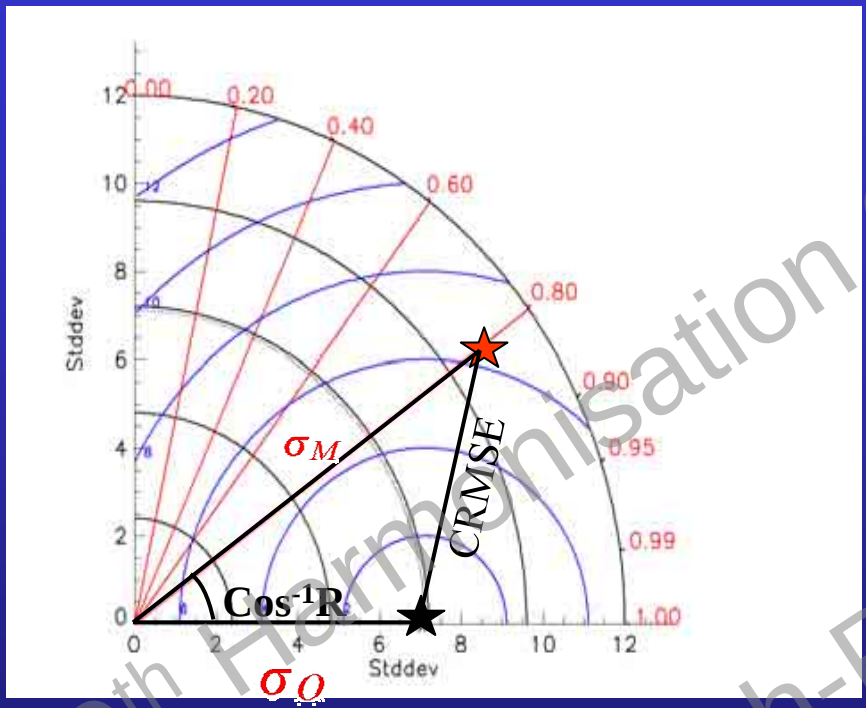
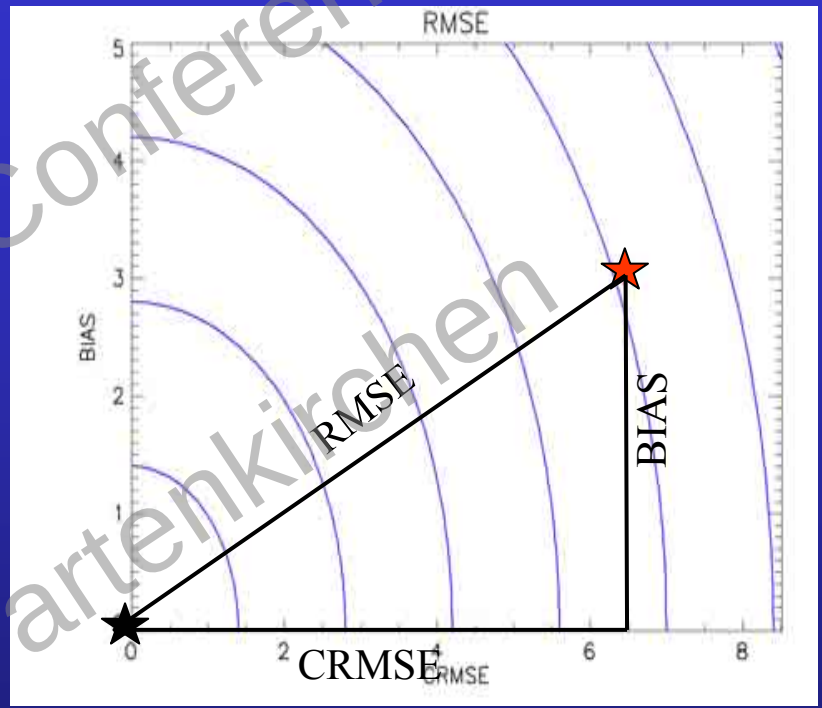
http://rea.ei.jrc.it/netshare/thunis/citydelta

K.E.Taylor, 2001: Summarizing multiple aspects of model performance in a single diagram JGR, 106, 7183-7192





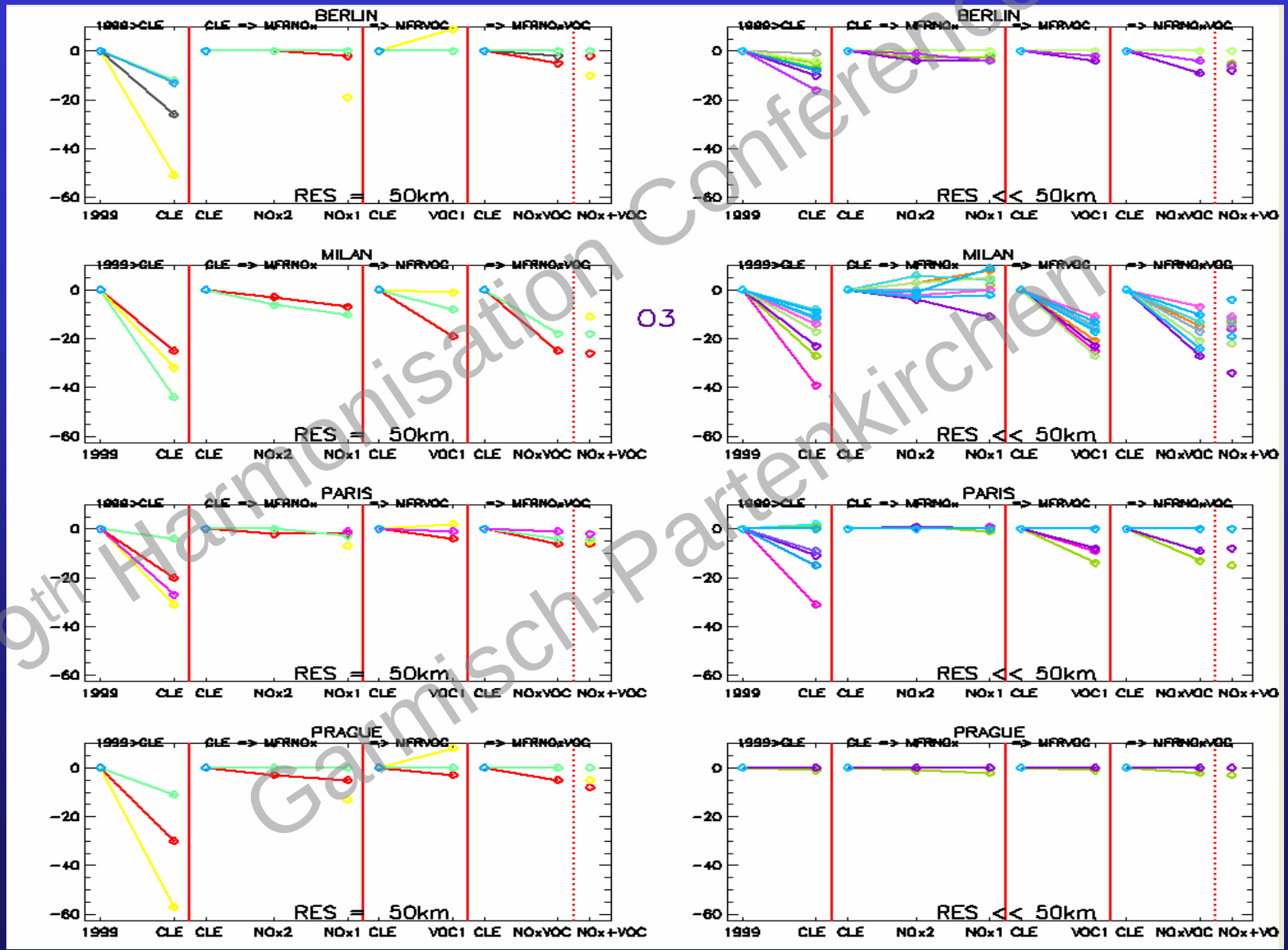
$$\text{CRMSE}^2 = \frac{1}{N}\sum_{n=1}^{N}\left[(M_n - \overline{M})^2 - (O_n - \overline{O})^2\right]$$

$$\text{CRMSE}^2 = \sigma_M^2 + \sigma_O^2 - 2\,\sigma_M\sigma_O R$$

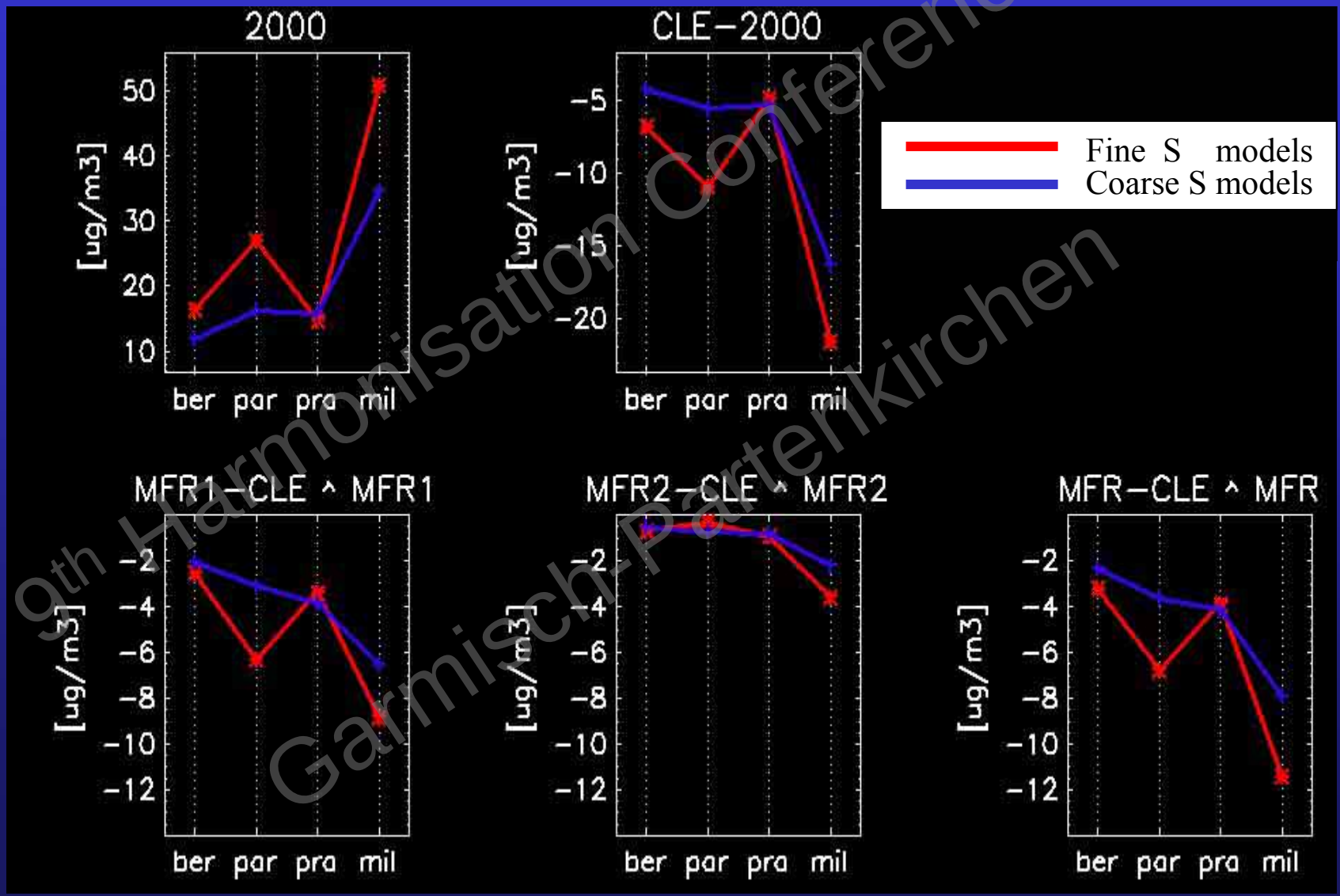
$$c^2 = a^2 + b^2 - 2ab\cos\Phi$$

$$\text{CRMSE}^2 + \text{BIAS}^2 = \text{RMSE}^2$$

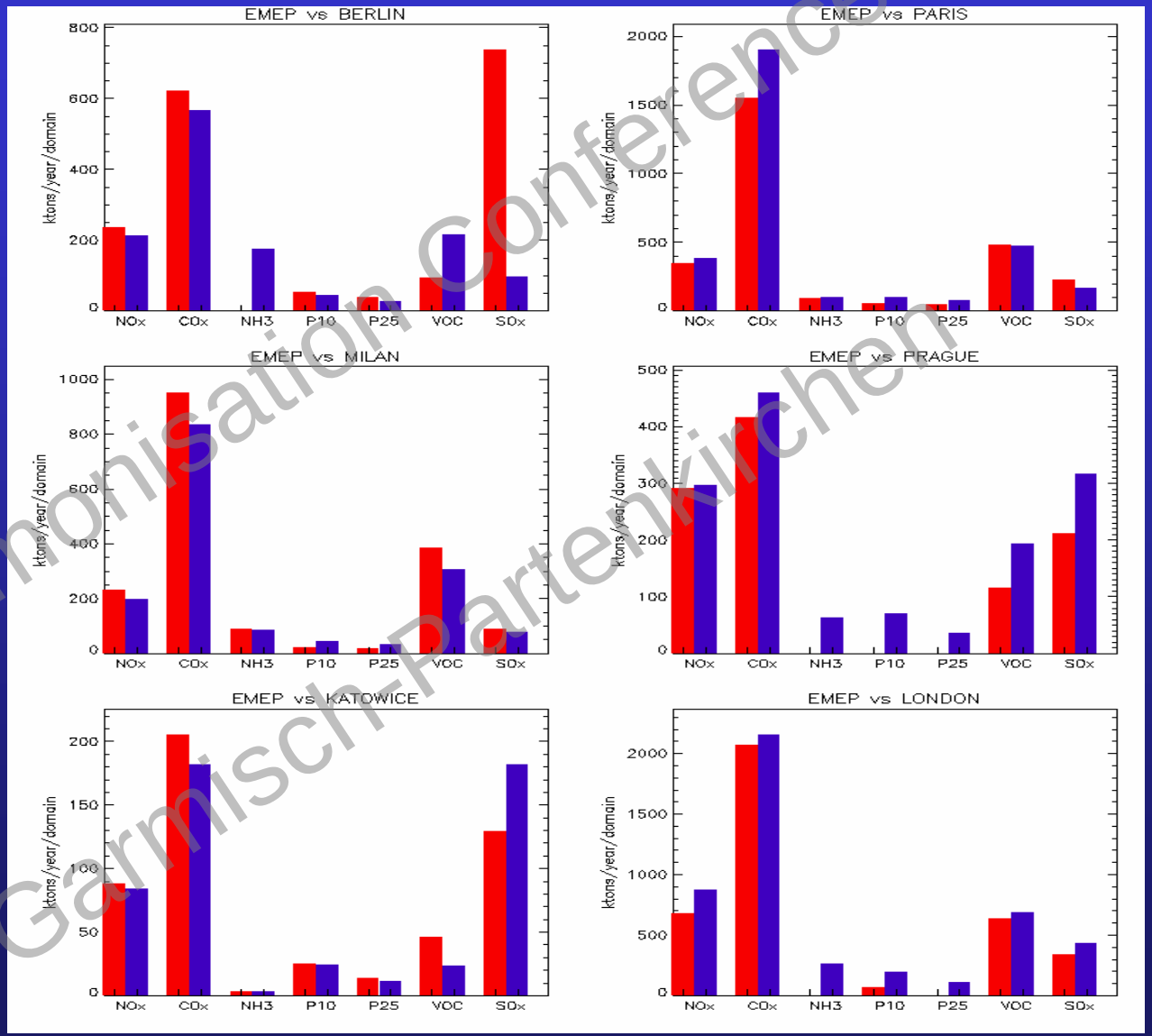
Delta in O3 exceedance days over 60 ppb



ENSEMBLE: PM10 daily mean



Domain Emissions: City vs EMEP



CITY
EMEP

O3 Taylor Plots + Bias