EVALUATION OF THE PRESAXIO AIR QUALITY FORECASTING SYSTEM: PBL SCHEMES WRF COMPARISON AND AIR QUALITY MODELING VALIDATION

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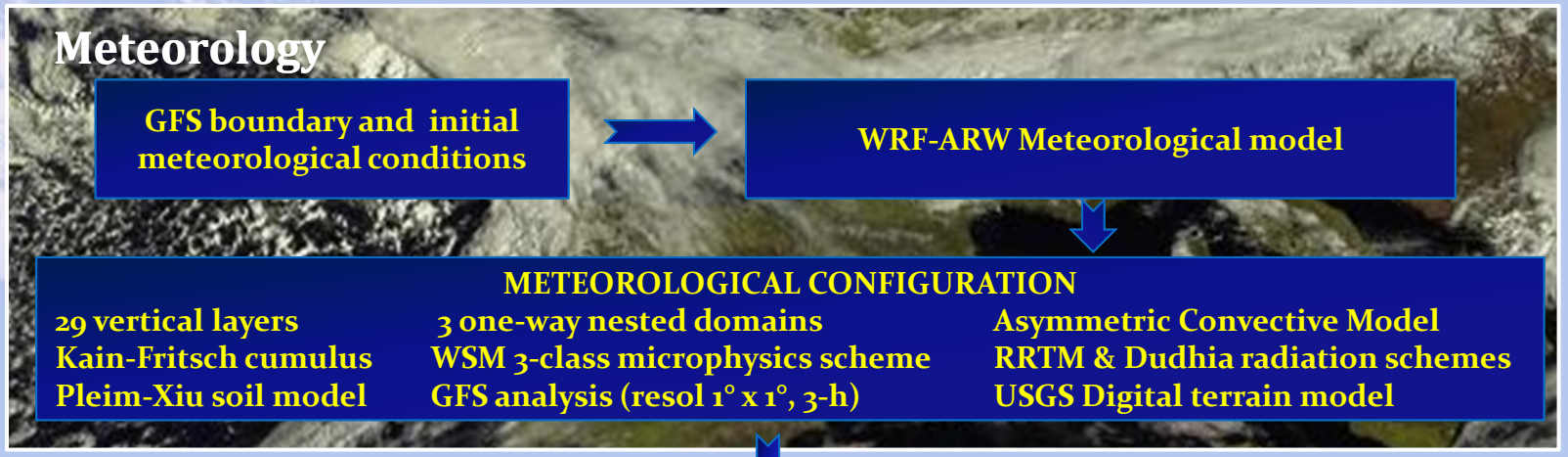
Overview

- **PRESAXIO** air quality modelling system
- Models and datasets
  - Simulation domains — WRF model
  - Emissions inventories — CHIMERE model
- WRF PBL schemes
- Air quality forecast validation
- **PRESAXIO** website
- Concluding remarks

PRESAXIO AQM system

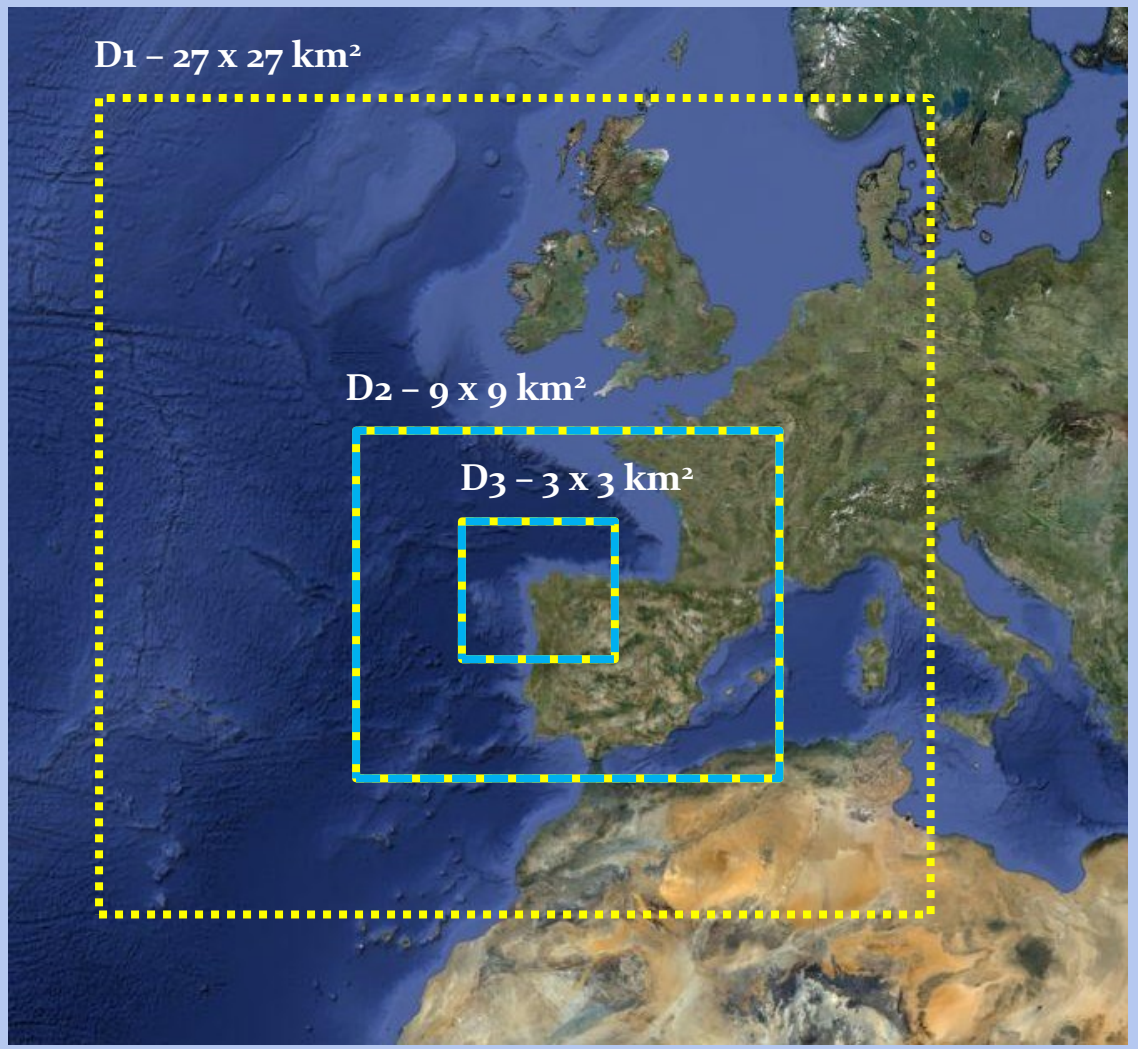


http://www.presaxio.es

Simulation domains

Meteorological WRF simulation domains D1, D2, D3

Air Quality CHIMERE simulation domains D2, D3



Emissions Inventories

D2 domain: EMEP top-down

D3 domain: EMIGAL - Mixed bottom-up / top-down inventory

S1, S3, S4, S10: E-PRTR bottom-up

11 industrial plants (point sources)

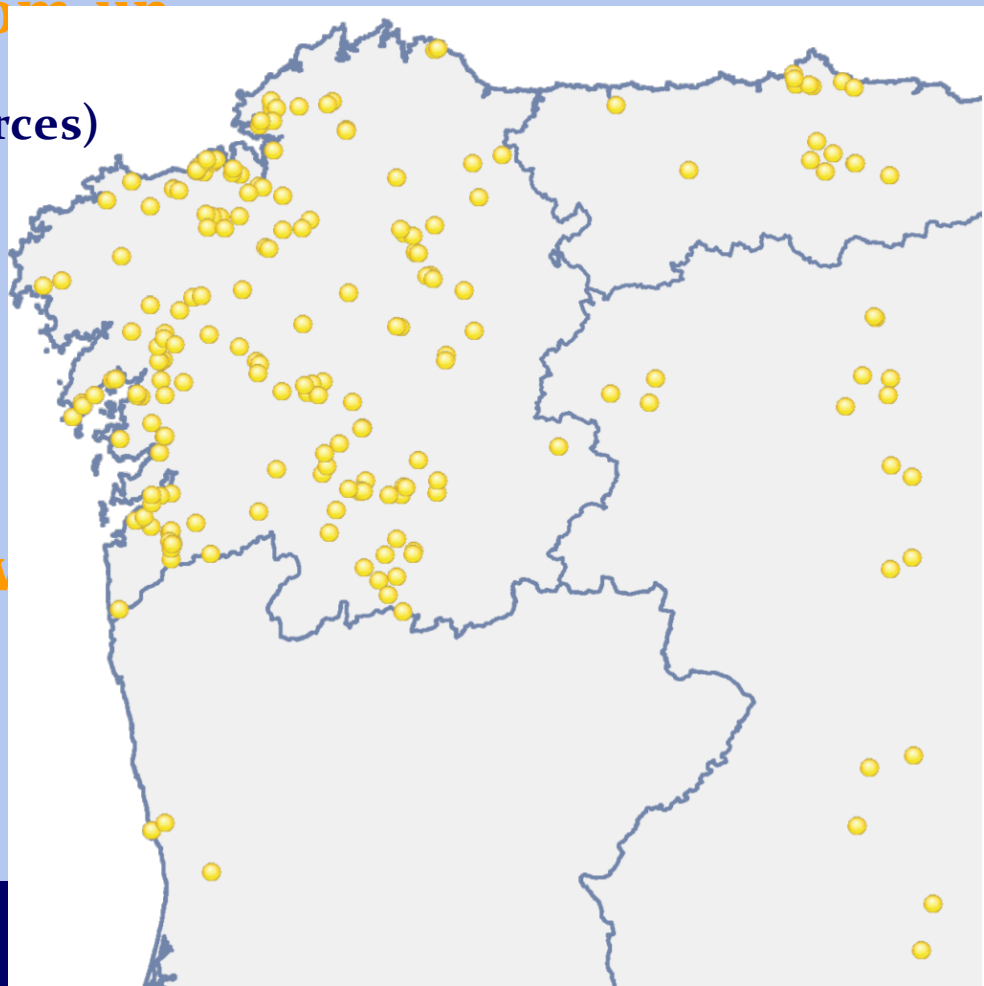
S7: Road traffic bottom-up

Main cities (> 50000 inhab.)

Highways

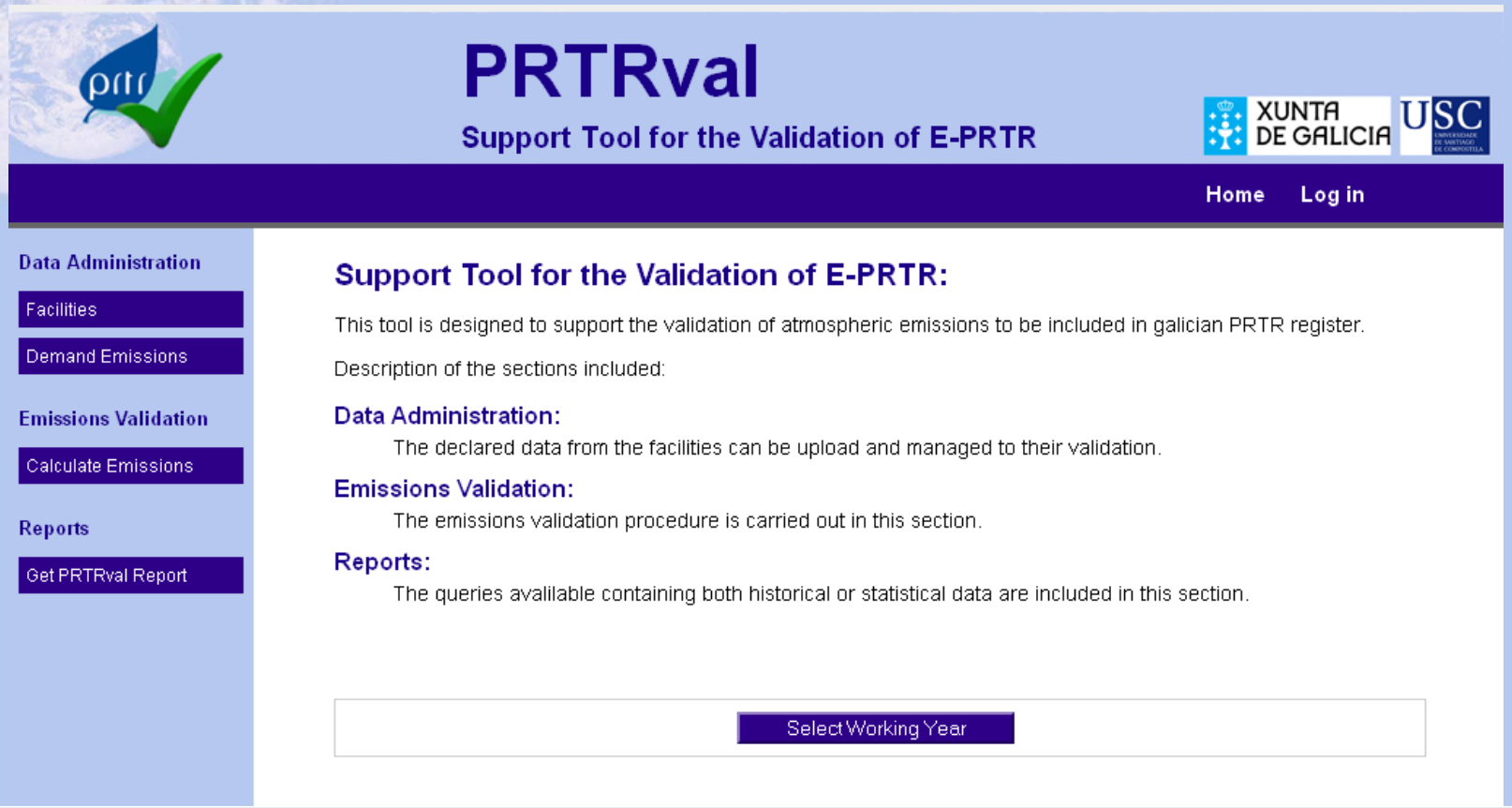
Rest of SNAPs: EMEP top-down

Portugal: GEMAC top-down



EMIGAL - Industries: PRTRval software tool

S1, S3, S4, S10: E-PRTR bottom-up

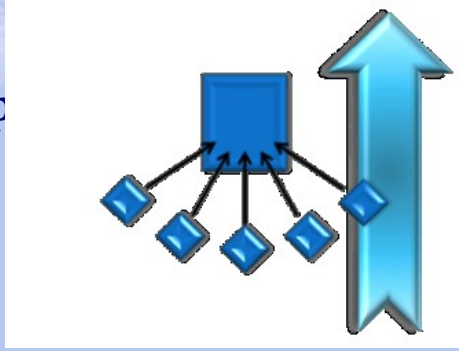


Dios, M. et al. PRTRVal: A Software tool for the validation of E-PRTR emissions data
HARMO 15, May 9th, 15:00, Main Room, Madrid, Spain.

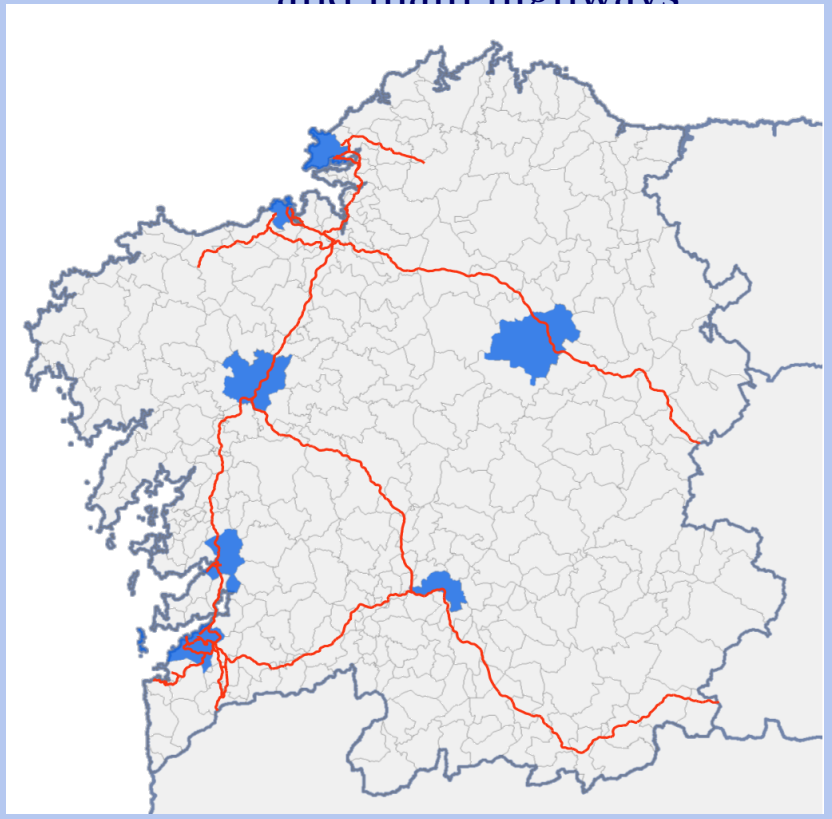
EMIGAL - Road traffic

S7: Road traffic bottom-up

Bottom-up ap



Road traffic: Cities over 50 000 inhab. and main highways



Cities over 50 000 inhabitants

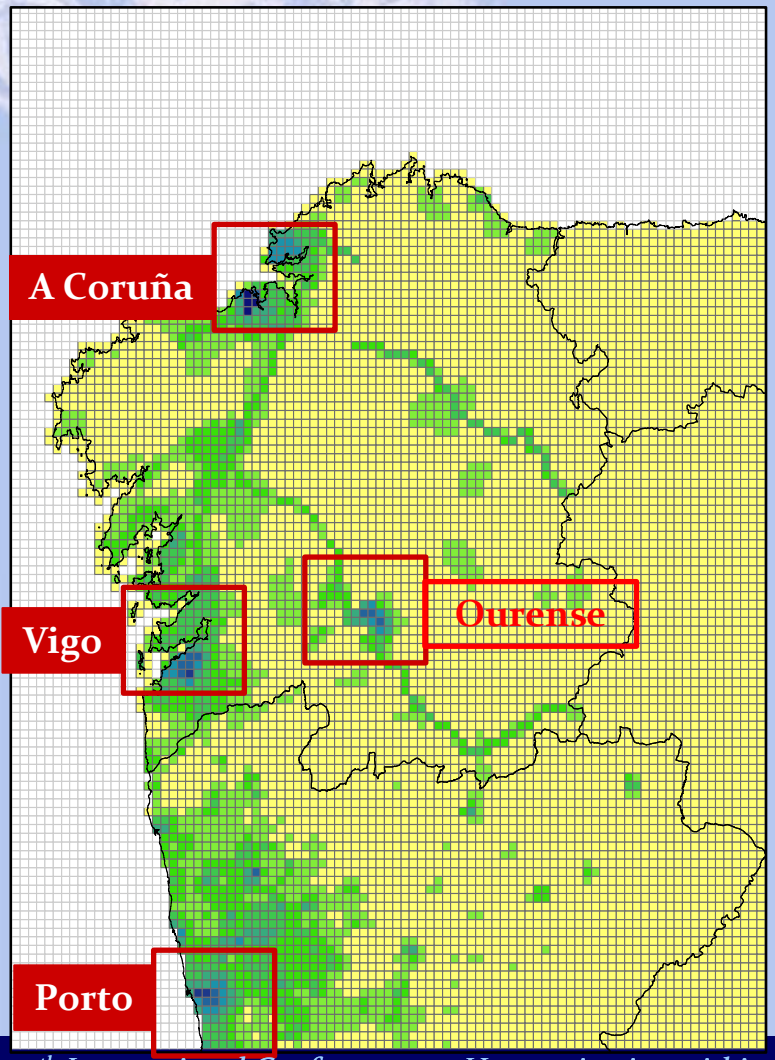
7 cities: [72963 – 297241 inhabitants]

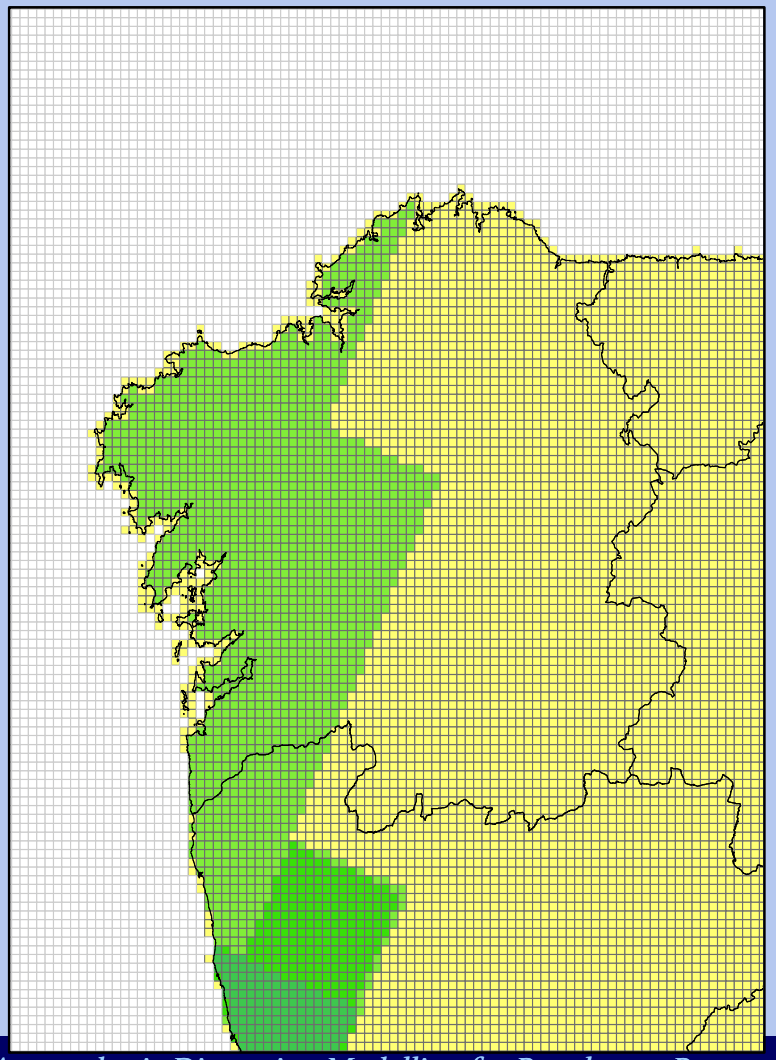
Highways (9)

795 km of highways
+ 694000 vehicles/day
Stretches with 27.6 % heavy vehicles

EMIGAL - Road traffic emissions results

D3 domain inventory vs. EMEP inventory





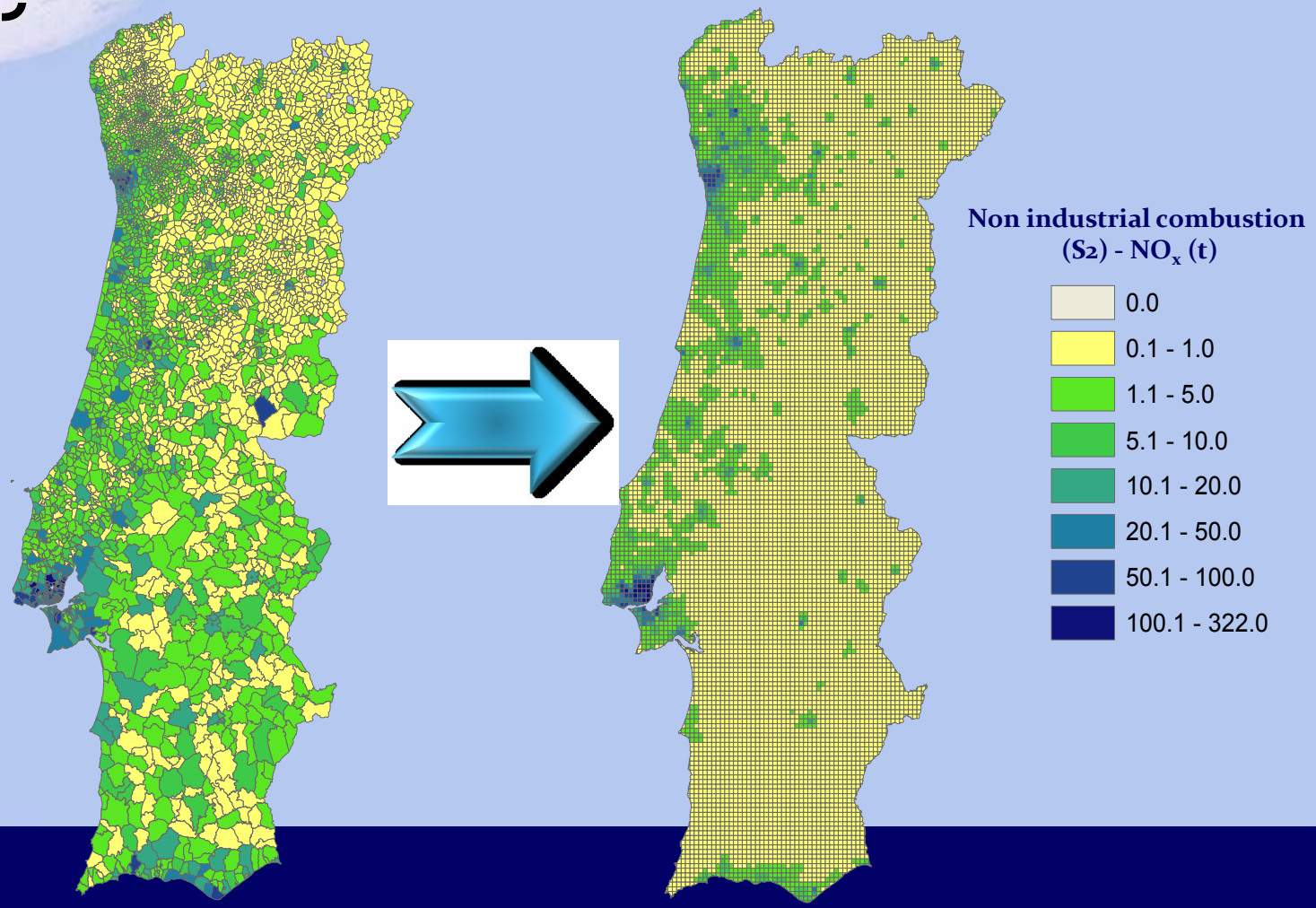
Traffic emissions (S_7) - NO_x (t)

- 0.0
- 0.1 - 10.0
- 10.1 - 25.0
- 25.1 - 50.0
- 50.1 - 100.0
- 100.1 - 200.0
- 200.1 - 300.0
- 300.1 - 400.0
- 400.1 - 500.0
- 500.1 - 759.2

D3 domain - Portugal

Portugal: GEMAC top-down (U. Aveiro)

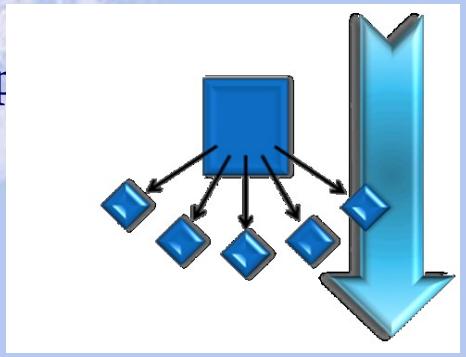
Segregation of sub-municipal inventory (3 x3 km² resolution)



EMIGAL – Rest of SNAPs

Rest of SNAPs: EMEP top-down

Top-down ap



Industry: Remainder EMEP emissions uniformly distributed

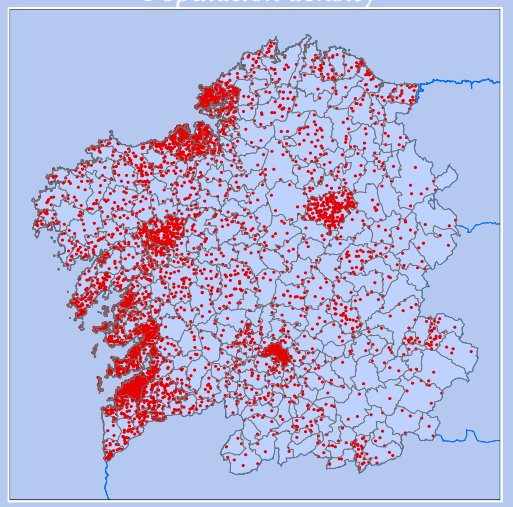
Traffic: Secondary roads emissions distributed by official fleet of vehicles

Domestic: EMEP allocated by population

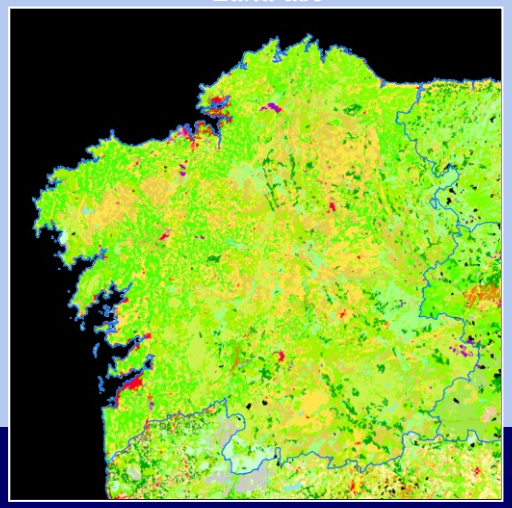
Agriculture: EMEP allocated by land use

Other: EMEP uniformly distributed

Population density



Land use



WRF model – PBL schemes

PBL schemes for testing and soil model

PBL scheme	Name	Soil model
Yonsei University-Pleim-Chang	YSU	5 layers
Mellor-Yamada-Janjic	MYJ	5 layers
Mellor-Yamada-Nakanishi-Niino Level 2.5 PBL	MYNN	5 layers
Asymmetric Convection Model 2	ACM2	Pleim-Xiu soil model

WRF model – PBL schemes

Meteorological simulations along air pollution episodes

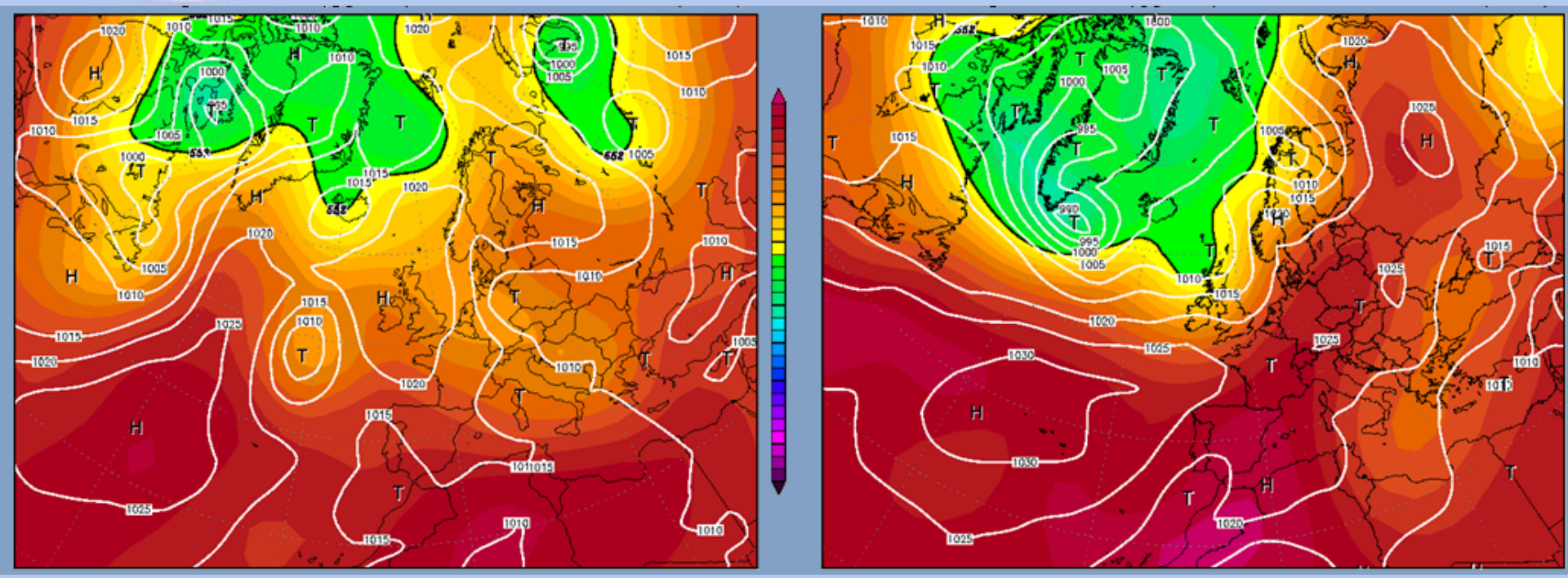
Episode	Air pollutant	Peak hourly glc ($\mu g/m^3$)
16-18 July 2002	O_3	201.0
19-21 March 2003	O_3	148.0
14-16 September 2003	O_3	193.0
13-15 July 2005	SO_2	304.0
01-03 June 2006	SO_2	324.0
09-11 July 2006	SO_2	174.0

WRF model – PBL schemes

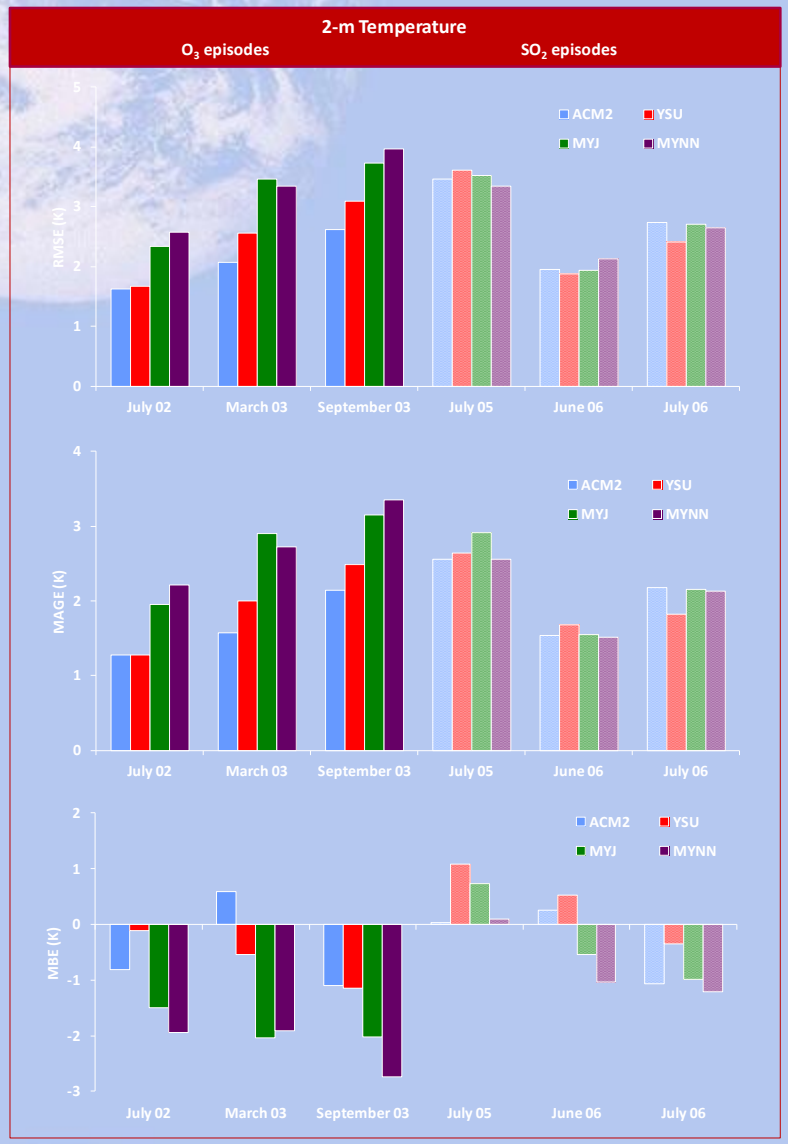
Air pollution episodes – Synoptic conditions

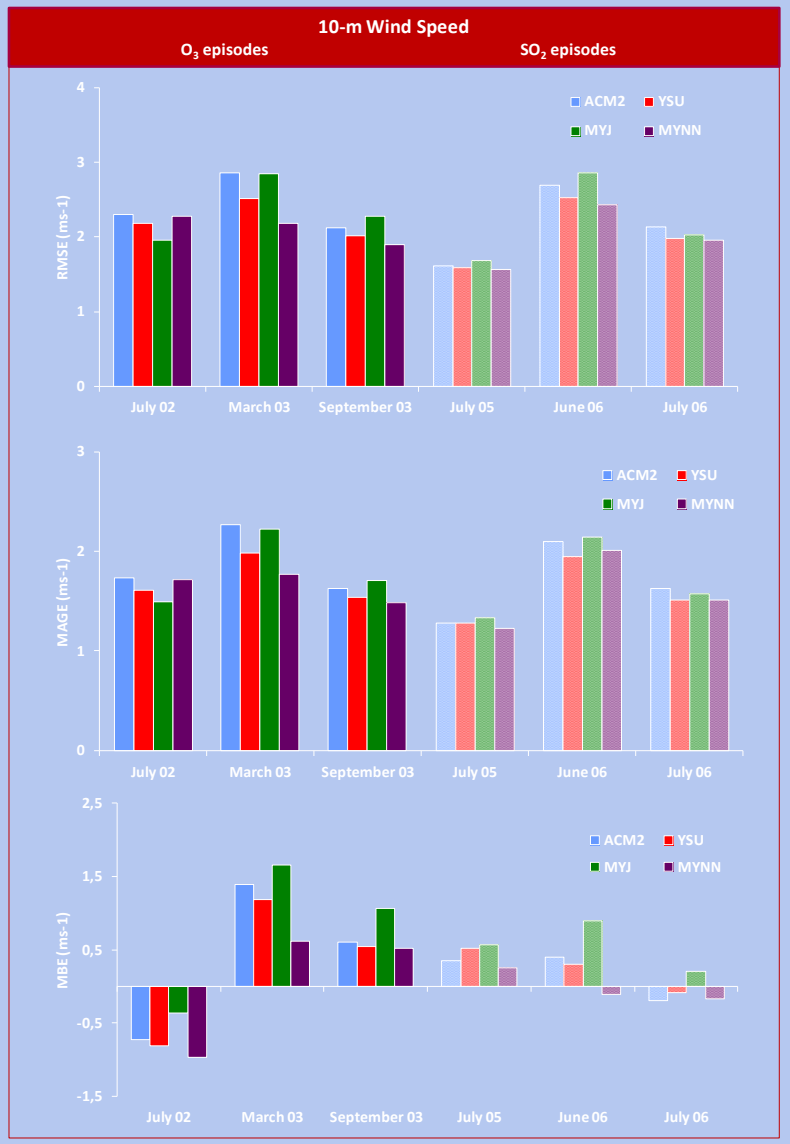
O_3

Primary pollutant (SO_2)



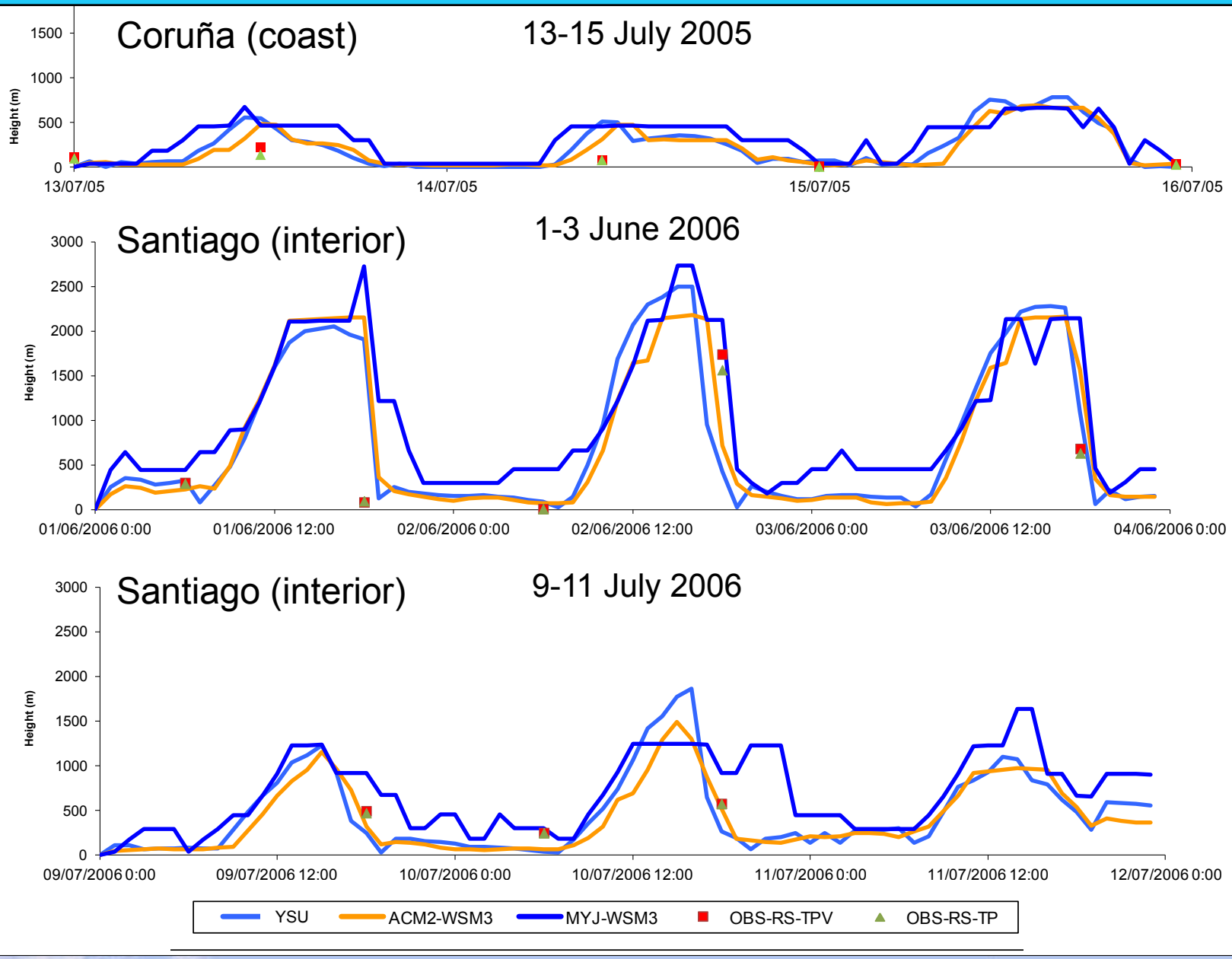
WRF model – Surface temperature and wind





Emery, C.A., 2001: Enhanced meteorological modeling and performance evaluation for two Texas ozone episodes. Prepared for the Texas Natural Resource Conservation Commission, by ENVIRON International Corporation.

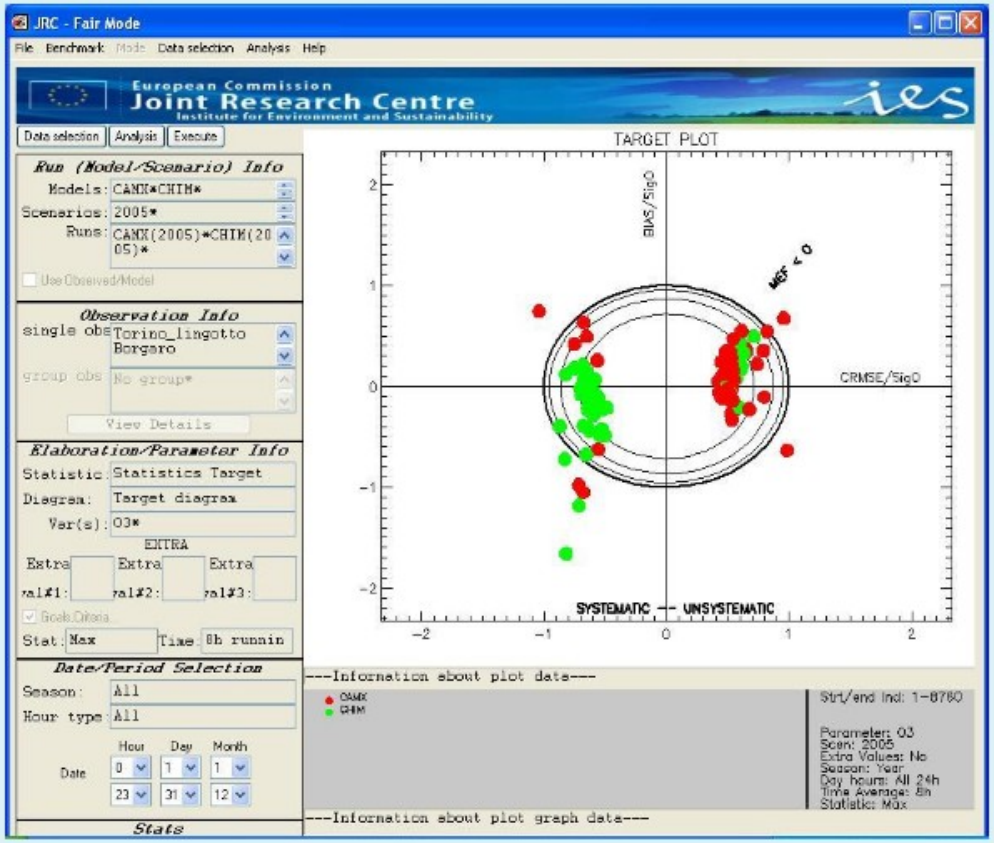
WRF model – PBL height in SO_2 episodes



Results: PRESAXIO Air Quality Forecast

The DELTA tool

A tool for air quality models benchmarking



FAIRMODE WG2-SG4

(Air Quality Directive 2008)

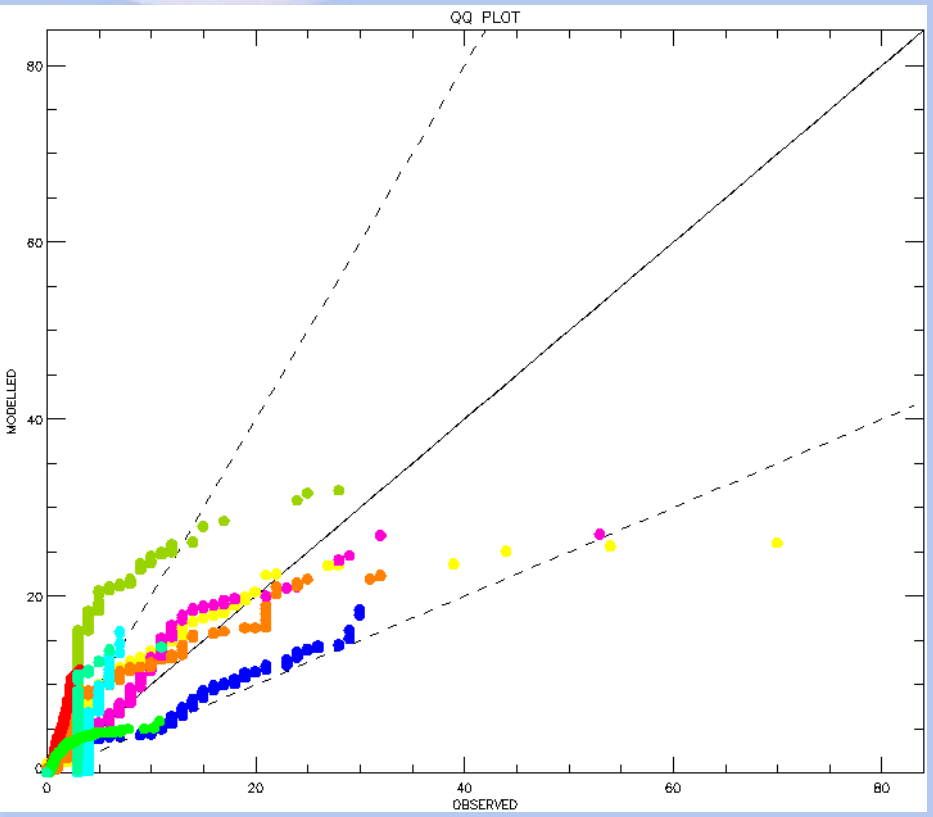
Models Benchmarking

(Thunis et al 2011)

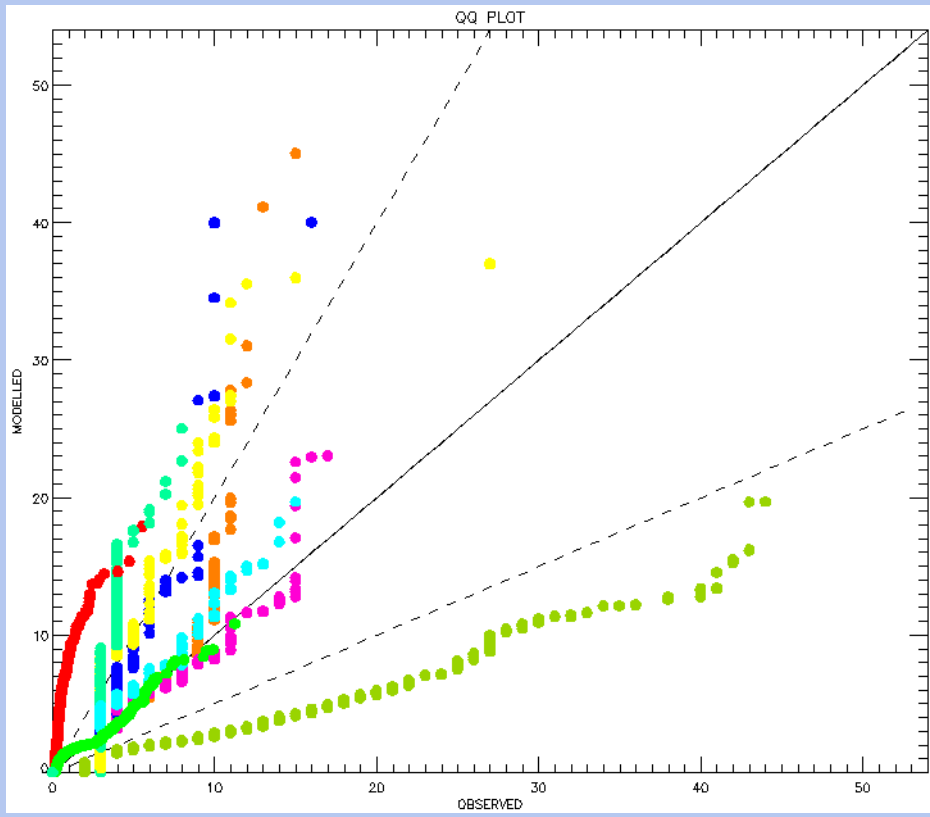
Results: PRESAXIO Air Quality Forecast

SO_2 ($\mu g/m^3$)

July 2008



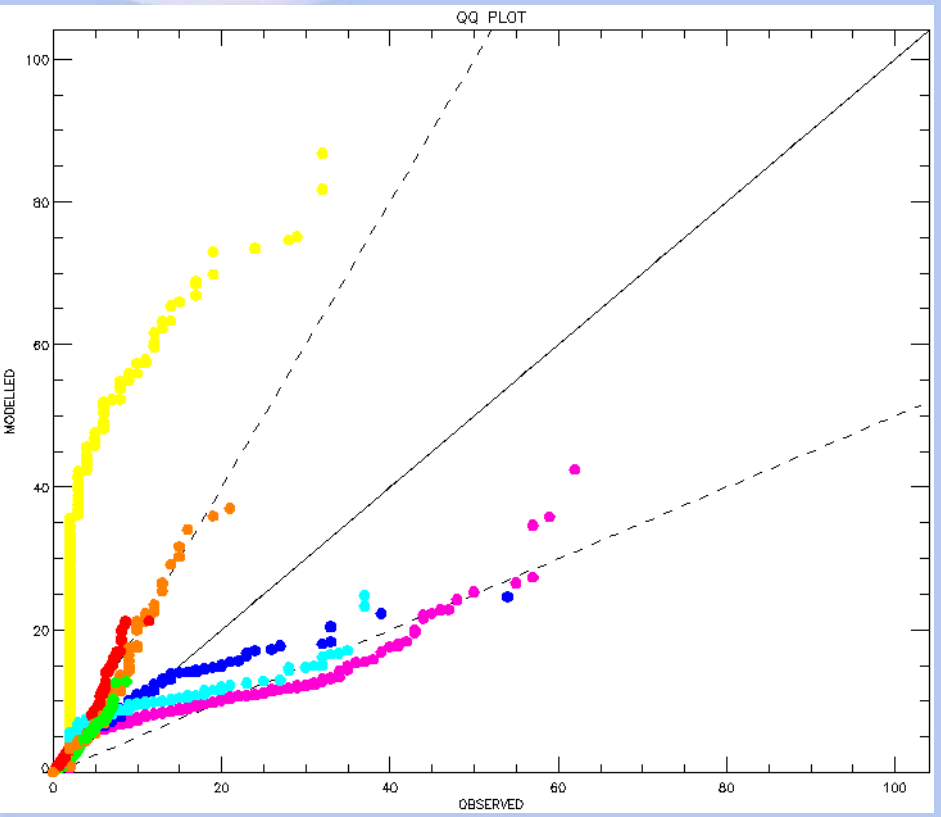
December 2008



Results: PRESAXIO Air Quality Forecast

NO_2 ($\mu g/m^3$)

July 2008



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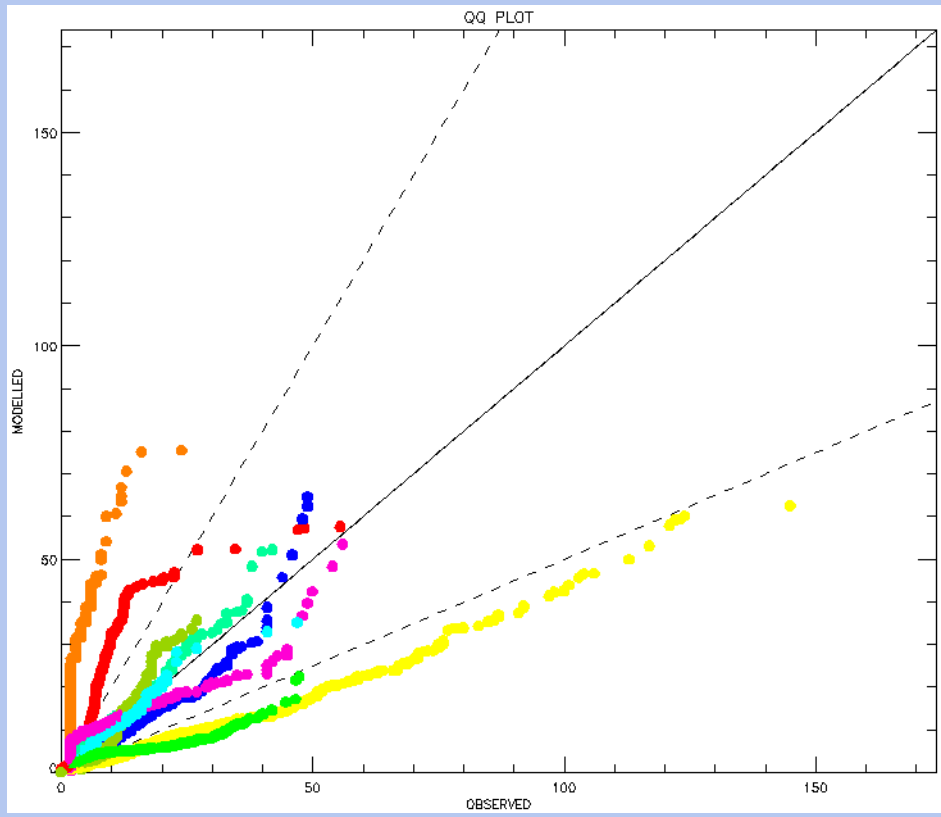
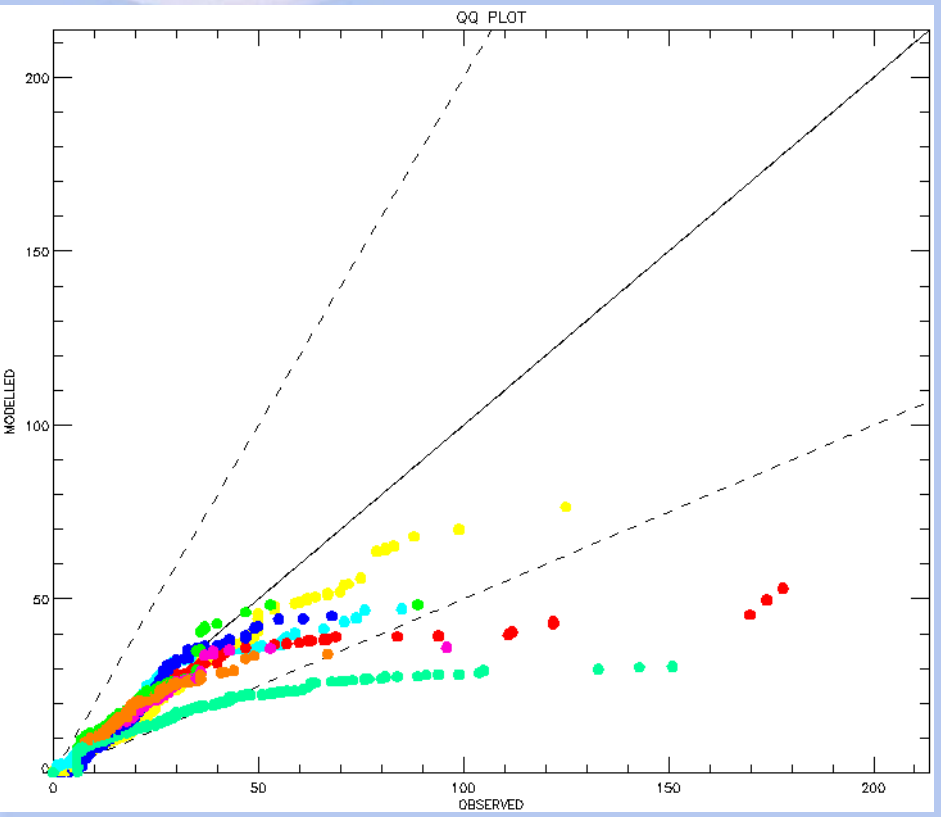


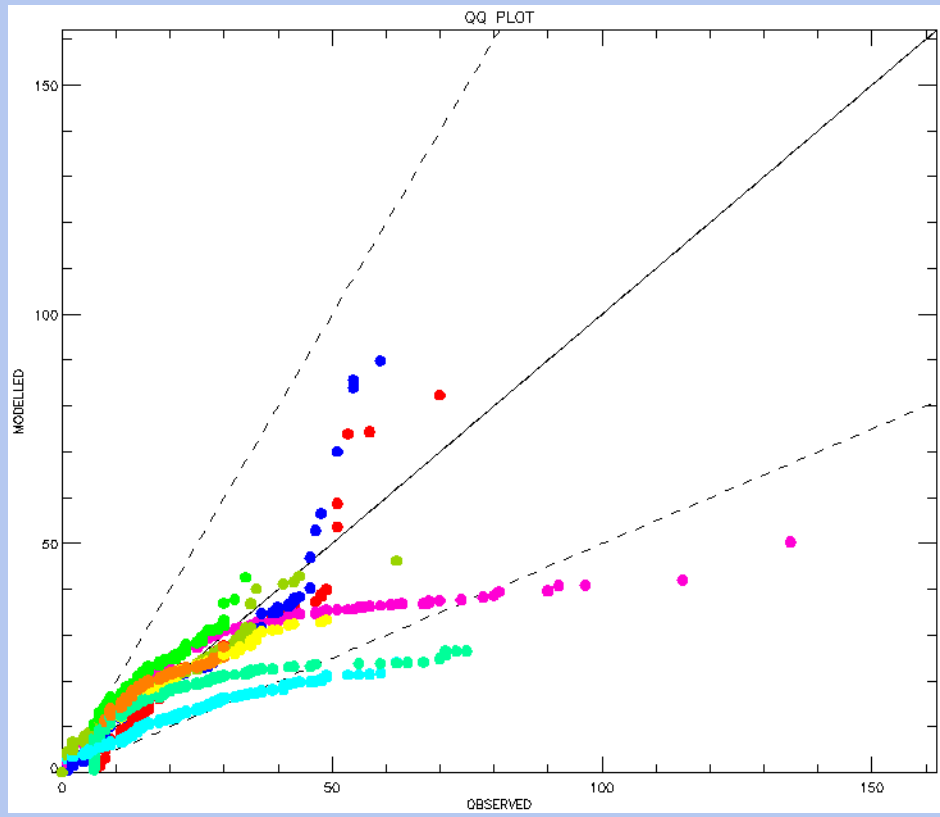
Results: PRESAXIO Air Quality Forecast

PM10 (μg/m^3)

July 2008



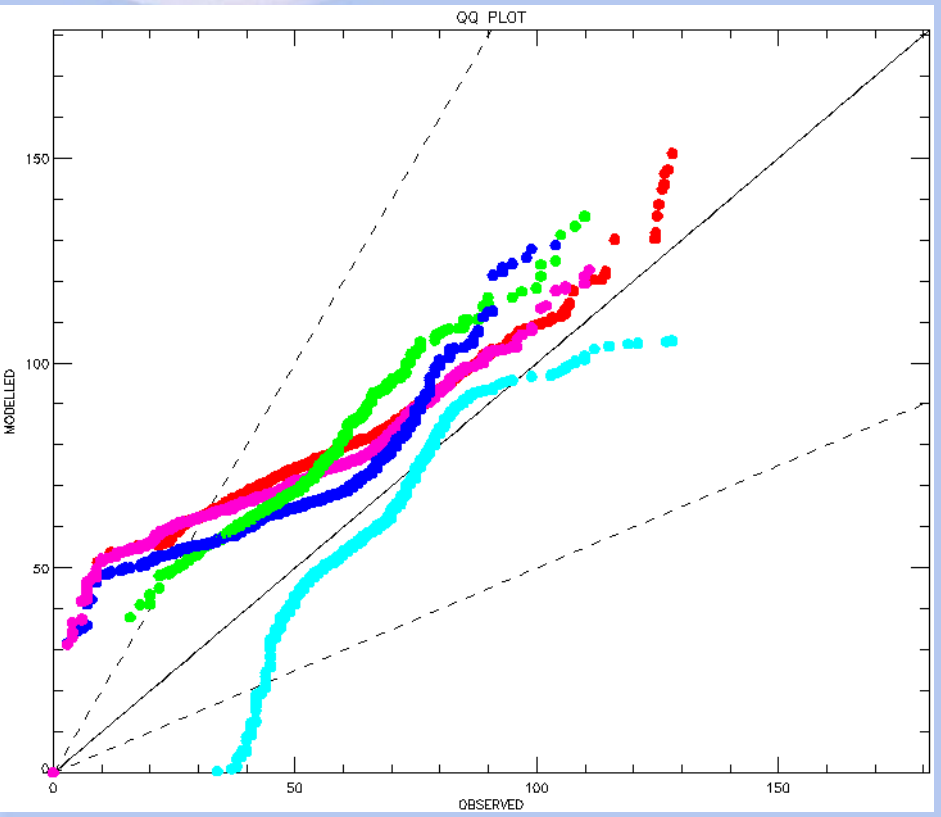
December 2008



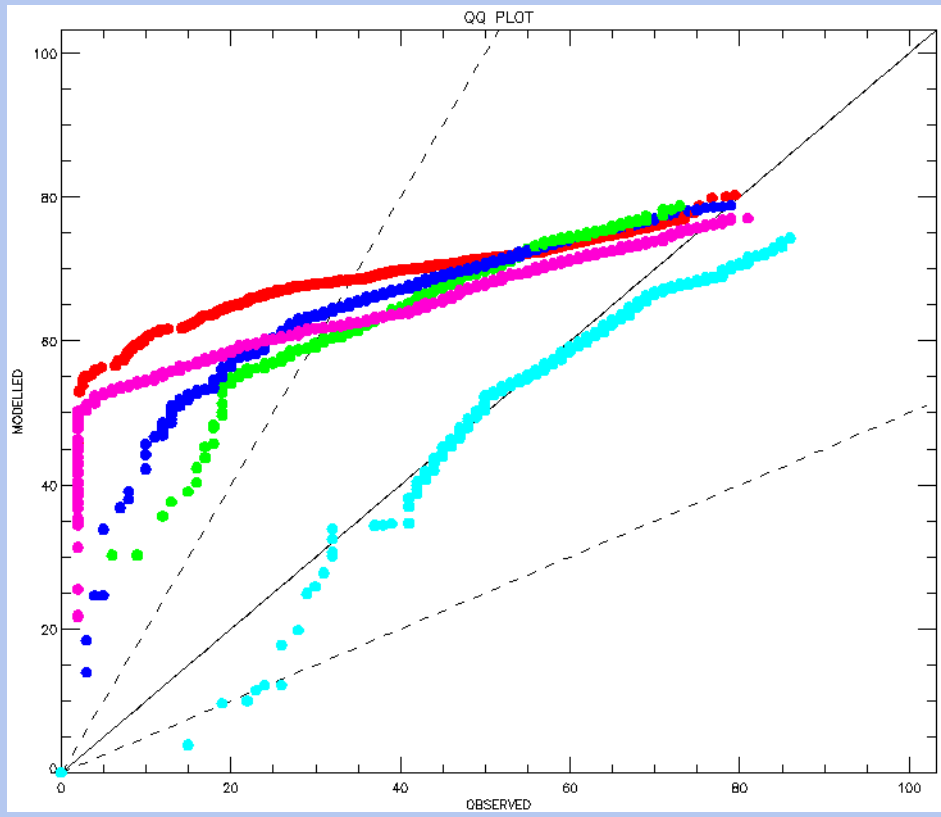
Results: PRESAXIO Air Quality Forecast

O_3 ($\mu g/m^3$)

July 2008



December 2008



Results: PRESAXIO Air Quality Forecast

Mixed regional emissions vs. EMEP top-down inventories

July 2008

STATISTICS SUMMARY *Max 8h mean Ozone glc*

Using Mixed Regional Emissions Inventory

Nb of stations: 5 valid / 8 selected

INDIC	(c/a - obs)	90% percentile	Min	Mean	Max
MFB	(0.30–0.15)	0.13	0.09	0.14	0.22
FAC2	(0.50–0.80)	1.00	1.00	1.00	1.00
R	(0.85–0.78)	0.52	0.52	0.62	0.70
TARGET	(1.00–0.80)	1.47	1.03	1.34	1.77
RDE	(0.50–0.40)	0.14	0.06	0.12	0.20
RPE	(0.50–0.40)	0.14	0.06	0.11	0.17

✓ FIVE CRITERIA ACCOMPLISHED

Using only EMEP inventory

Nb of stations: 5 valid / 6 selected

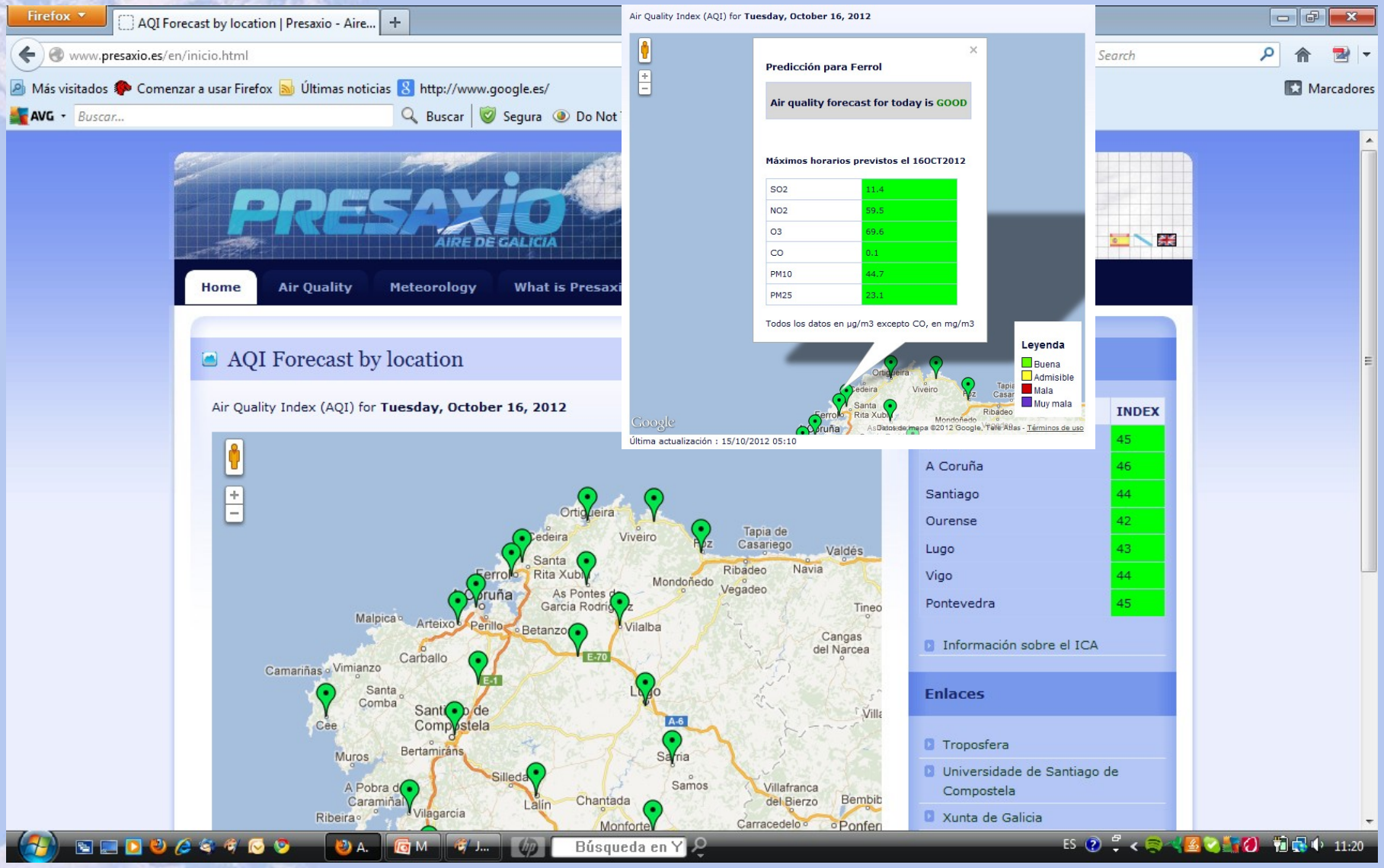
INDIC	(c/a - obs)	90% percentile	Min	Mean	Max
MFB	(0.30–0.15)	0.16	0.07	0.14	0.24
FAC2	(0.50–0.80)	1.00	1.00	1.00	1.00
R	(0.85–0.78)	0.80	0.60	0.67	0.74
TARGET	(1.00–0.80)	1.64	0.95	1.35	1.96
RDE	(0.50–0.40)	0.21	0.04	0.14	0.22
RPE	(0.50–0.40)	0.22	0.00	0.14	0.27

✓ 4+1 CRITERIA ACCOMPLISHED

WORSE THAN CRITERIA BETWEEN CRITERIA AND GOAL BETTER THAN GOAL

PRESAXIO website

http://www.presaxio.es



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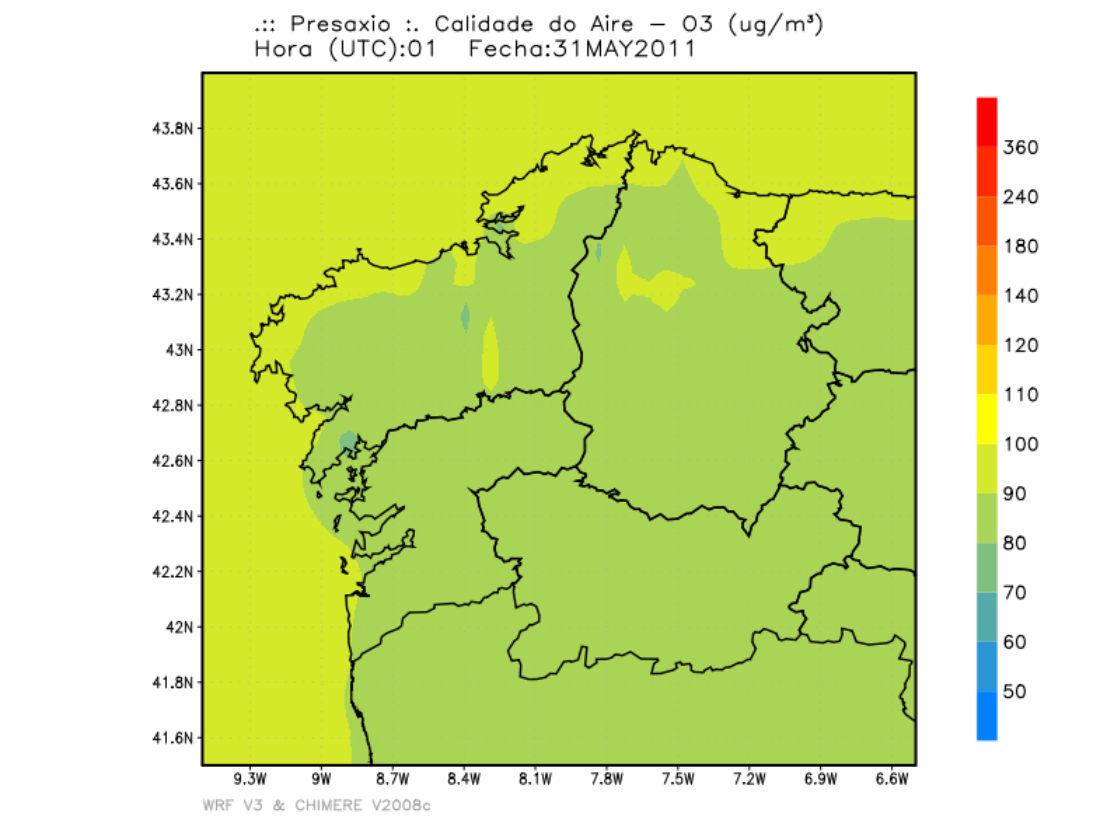
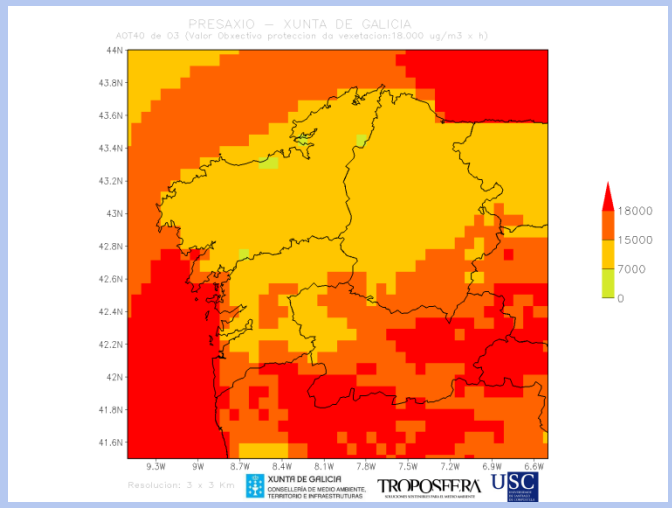
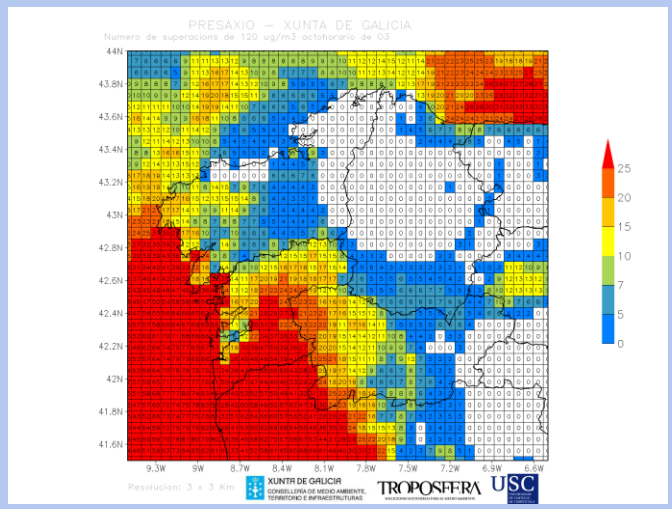


Ozone glc (μg/m³)

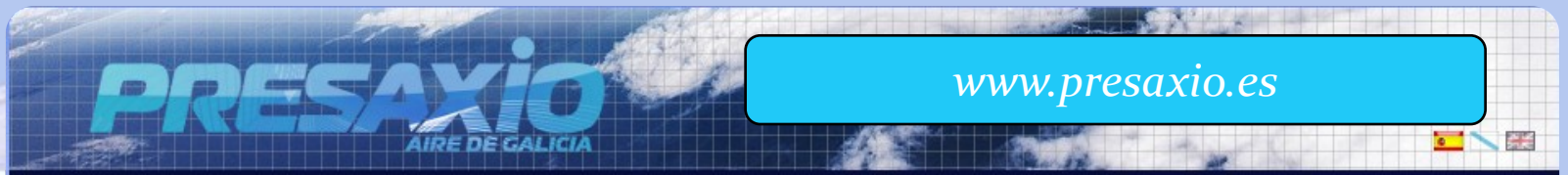


ozone threshold limit value - Maximum daily 8 hour mean (up) and AOT40 (down)



Concluding remarks

- ✓ **PRESAXIO AIR QUALITY MODELLING SYSTEM**
- ✓ **New bottom-up & top-down mixed regional emissions inventory, including validated E-PRTR industrial emissions**
- ✓ **PBL WRF best schemes:** Temperature – ACM2 & YSU
  Wind – MYNN & YSU
  PBL height – ACM2 & YSU
- ✓ **PRESAXIO AIR QUALITY FORECAST VALIDATION:**
  - ✓ SO_2 : Underestimated at industrial sources; overestimated at background sites
  - ✓ NO_2: Underestimated close to industrial and urban sources
  - ✓ PM10: Usually underestimated
  - ✓ O_3: Hourly maximum in agreement. 5 DELTA Tool 8-hr. stats accomplished



Future work

- ✓ **UPDATING THE REGIONAL INDUSTRIAL EMISSIONS INVENTORY, USING THE LAST VALIDATED PRTR INVENTORY.**
- ✓ **VALIDATION OF A ONE-YEAR PRESAXIO FORECAST**

THANK YOU FOR YOUR ATTENTION

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USC UNIVERSIDADE DE SANTIAGO DE COMPOSTELA

TROPOSFERA SOLUCIONES SOSTENIBLES PARA EL MEDIO AMBIENTE