REGIONAL AIR QUALITY MANAGEMENT ASSESSMENT BY USING CHIMERE AIR QUALITY MODEL

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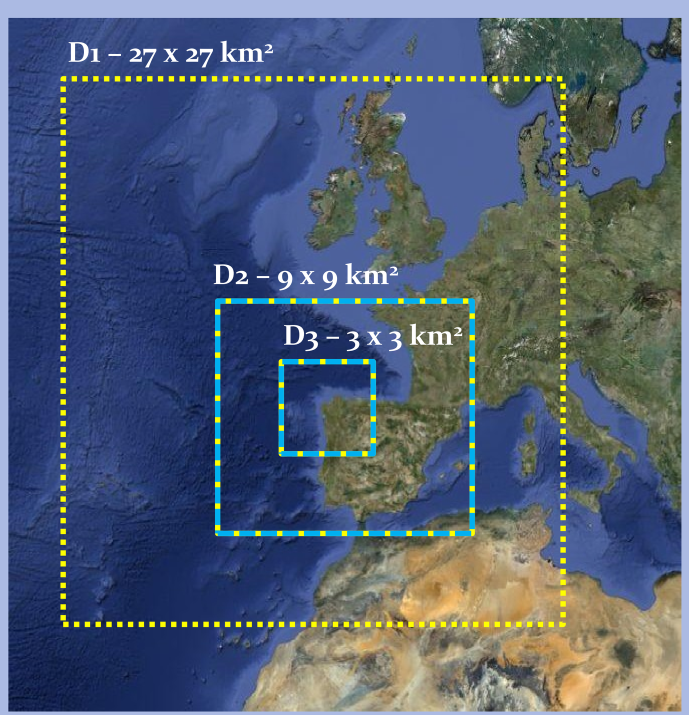
ABSTRACT

Air quality models have been developed to better understanding the behavior of the pollutants in the atmosphere, among other applications. One of them is about the influence of emission inventories and large sources on local and regional air quality; another one is the optimal design and assessment of air quality monitoring networks. In this work, different simulations was built coupling WRF-ARW meteorological model to CHIMERE v. 2008c air quality model (validated with DELTA Tool), using 2008 year as meteorological basis. Two different EMEP inventories (2002 and 2008) and a detailed regional emission inventory, based in a combination of the Portuguese (area sources) and Galician (EMIGAL, point and area sources) emission inventories, were applied. These different simulations were done with three different goals,

1. Future optimal design of a regional air quality network: One-year air quality simulation results over Northwest of Iberian Peninsula (NWIP) established the future most polluted areas.
2. Effect of European air pollutants emissions changes between 2002 and 2008 over surface ozone levels in NWIP region, during typical photochemical production conditions:.
3. Impact of the largest Spanish coal-fired power plant (1400 MW) over surface ozone: Changes in local surface ozone are observed, without any effects at regional scale.

MODELS AND METHODS



Meteorological WRF domains D1, D2, D3
Air Quality CHIMERE domains D2, D3

EMISSIONS INVENTORIES

Air quality network for future scenario
Reference scenario: 2008 year regional emissions inventory (Dios et al., 2012a)
Projected scenario: 2012 year projected inventory, with maximum industrial activity.

Impact of European emissions changes
EMEP 2001 and EMEP 2008 inventories.

Impact of large coal-fired power plant
2008 year regional emissions inventory, with vs. w/o As Pontes Power Plant emissions. Specific emissions factors (Dios et al., 2013), different than EMEP emissions (Dios et al., 2012b) were applied.

METEOROLOGICAL MODEL: WRF-ARW v. 3.2 (Skamarock et al., 2008)

3 one way nested domains, 27, 9 and 3 km² resolution, 30 vertical layers (Borrego et al., 2012).
MYU PBL scheme.
Kain-Fritsch cumulus scheme (outer & medium domains).
WSM 3-class microphysics scheme
RRTM longwave and Dudhia shortwave radiation scheme.
5-layer soil model.
Initial and boundary conditions: NCEP GFS analysis data, (1º x 1º and 3-hour time periods).
Digital Terrain Model from the United States Geological Survey (USGS, 2008).

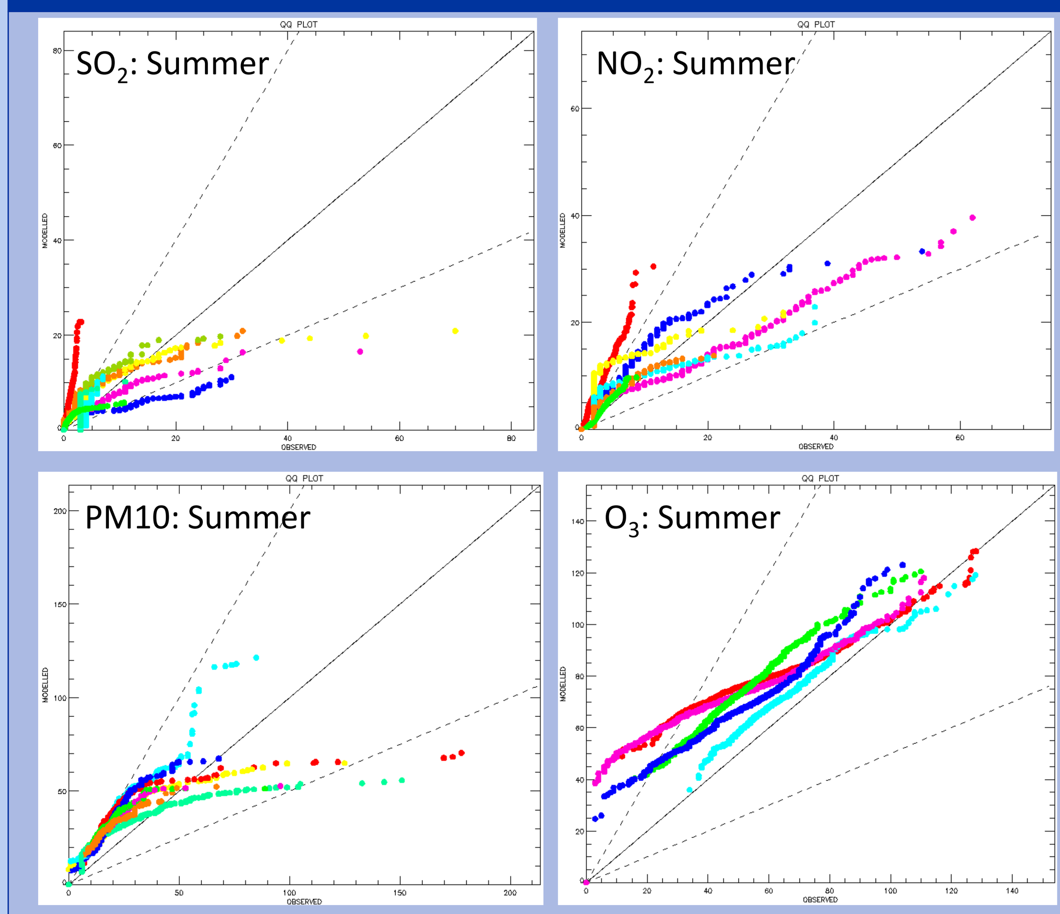
AIR QUALITY MODEL: CHIMERE v. 2008c (Menut et al., 2010)

2 one-way nested grids, 9 km² resolution over Iberian Peninsula (IP) and 3 km² over NWIP.
Vann Leer advection scheme.
Aero flag 8 bins size distribution.
Secondary Organic Chemistry (SOA): Medium scheme computing .
Biogenic emissions: MEGAN model (Guenther et al., 2006) using interface to WRF model.
Initial and boundary conditions: Monthly MOZART model results for gases and GOCART model results for aerosols.

Air quality modelling results along 2008 year validated over NWIP against AirBase dataset, using DELTA Tool software (Thunis et al., 2010).

RESULTS

CHIMERE model validation (Souto et al., 2013)



SO_2 - Underestimation at the NW sites, in summertime; over the background sites (at South) slight underestimation.

NO_2 - Underestimation at the NW of sites, mainly in wintertime. Except around As Pontes Power Plant (at the North).

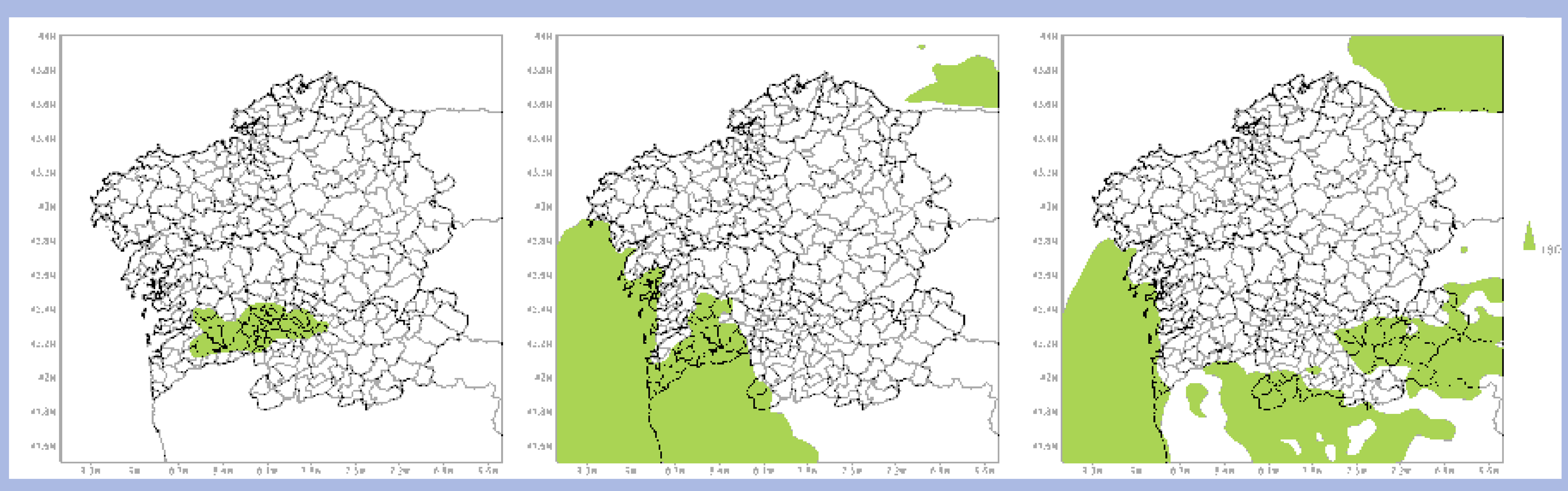
PM10 – Strong underestimation, with results only valid to identify relative polluted areas.

O_3 - Good agreement, especially for daily maxima.

Validation of CHIMERE model – Q-Q diagrams (DELTA Tool) (conc. in µg/m³)

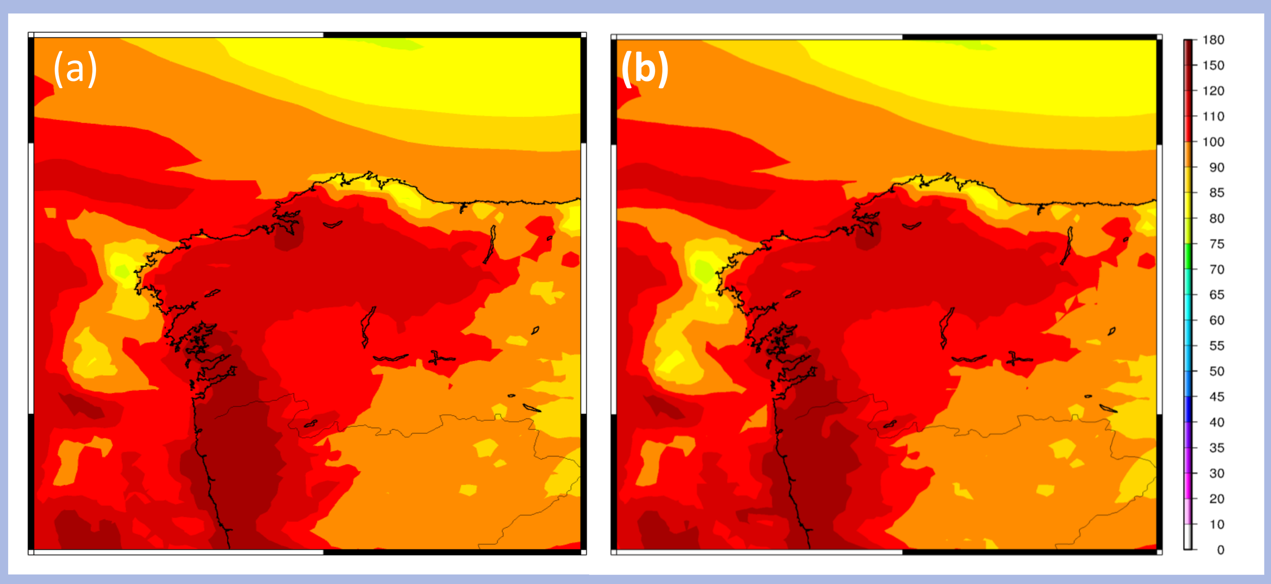
Optimal air quality network design (O_3)

Areas with any exceedances in O_3 thresholds



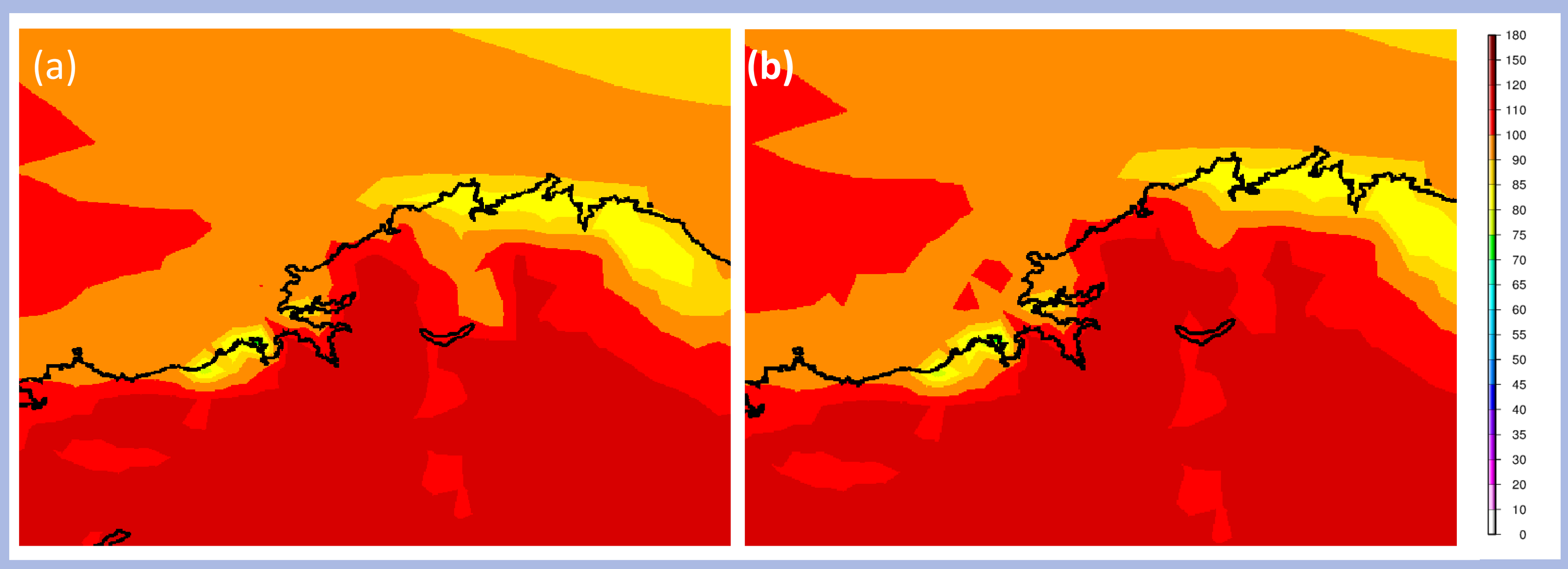
(a) O_3: Report to people (b) O_3: Health (c) O_3: Vegetation (AOT40)

Impact of EMEP emissions changes (2002 vs. 2008) over tropospheric O_3 levels



12:00 UTC - O_3 glc on July, 18th (Saavedra et al., 2012) using:
(a) 2002 and (b) 2008 EMEP emissions over NWIP (conc. in µg/m³)

Large coal-fired power plant impact over tropospheric O_3 levels



12:00 UTC – Local O_3 glc results on July, 18th 2002 conditions:
(a) with and (b) w/o As Pontes Power Plant emissions (conc. in µg//m³)

CONCLUSIONS

CHIMERE model was applied to support air quality management over the Northwest of the Iberian Peninsula. First, design of a regional air quality network is supported by air quality simulations (using a regional emissions inventory projection) to identify the most affected areas by primary pollutants (SO_2, NO_x, CO, PM) and O_3. These results confirm that O_3 exceedances are related to: local NO_x emissions (especially, from the urban coastal areas) and, also, O_3 transport from neighbourhood regions (Portugal, South; Iberian Plateau, SE). Second, simulations over a typical regional O_3 episode show that EMEP European emissions reduction from 2002 to 2008 reduce O_3 levels at the region borderline, especially at the SW border close to Portugal. Third, NO_x emissions of a large coal-fired power plant located in the North of this region produce a local reduction of O_3 levels, without any effect over O_3 levels far from it.

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