MODELLING $PM_{2.5}$ CHEMICAL COMPOSITION WITH CAMx IN SOUTHWEST SPAIN

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Introduction

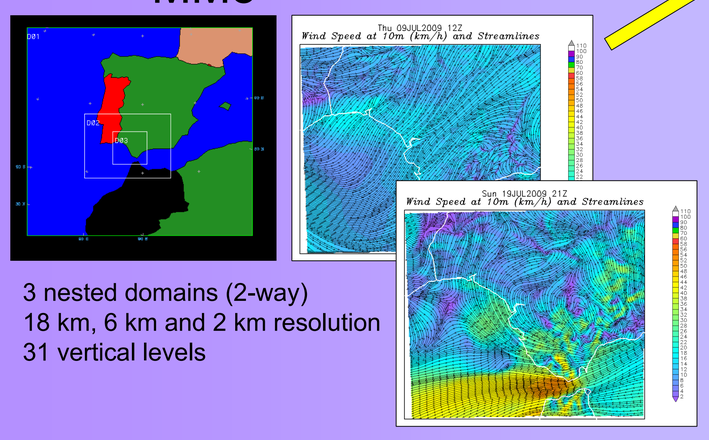
- Background $PM_{2.5}$ concentrations are rather high in the southwest region of Spain (Andalusia).
- The region has high anthropogenic emissions including substantial industrial emissions, on-road and shipping traffic, agricultural emissions and also biogenic emissions.
- Climate factors such as low rainfall & high photochemical activity also contribute to the enhanced concentration of atmospheric aerosols.
- Chemically speciated $PM_{2.5}$ measurements were made at rural and urban sites and photochemical modelling of $PM_{2.5}$ chemical composition was initiated to investigate the complex aerosol formation and transport dynamics in this region.

CAMx MODELLING SYSTEM

Meteorology

ECMWF

MM5

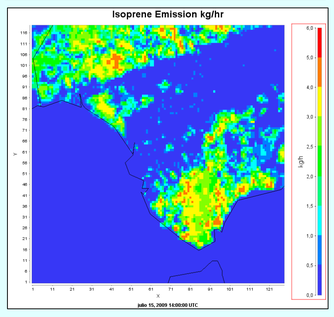


3 nested domains (2-way)
18 km, 6 km and 2 km resolution
31 vertical levels

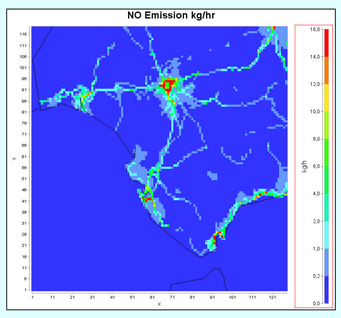
Emission Inventory

Industry: Elevated and area sources (Spanish Pollutant Release and Transfer Register (PRTR))
Shipping Traffic (E-PRTR)

Biogenic NMVOCs

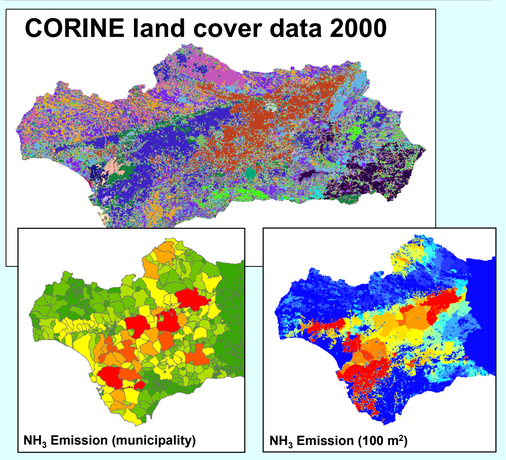


On-road Traffic

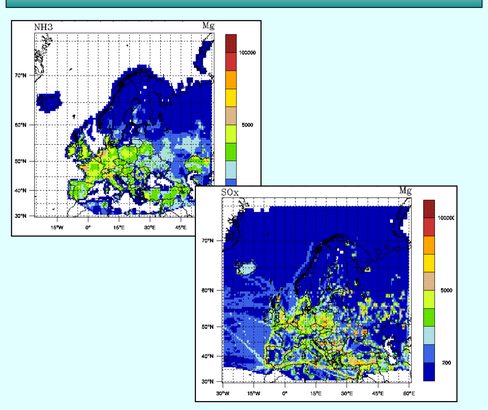


Biogenic emissions of NMVOCs estimated using Guenther´s model (Guenther et al., 1995) with emission factors and biomass factors adapted for Mediterranean vegetation species and hourly meteorology from MM5.

NH_3: fertiliser application



6 & 18 km Domain: EMEP



Post-Processors:

I/O API (Input/Output Applications Programming Interface)

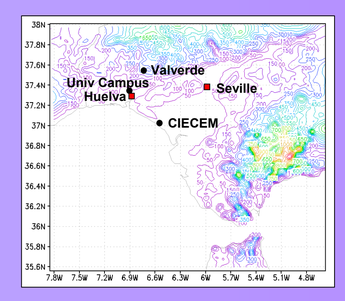
Observations:

CAMx
(**C**omprehensive **A**ir-quality **M**odel with e**X**tensions)

Photolysis: Ozone Column (OMI),Tropospheric Ultraviolet and Visible Radiation Model

Geographic: Terrain Elevation, Land Cover/Land Use

IC/BC Prep



Locations of the measurement sites & topography of the inner domain.

- Daytime & night-time chemically speciated $PM_{2.5}$ measurements of all major aerosol components were made during 2 intensive field campaigns in winter (March 2009) & summer (July-Aug 2009) at 3 sites (1 urban, 2 rural).
- High-time resolution (15 min) measurements of Black Carbon (BC) were obtained using a Multi-Angle Absorption Photometer (Fernández-Camacho et al., 2010).
- Particulate and gas measurements were also obtained from Andalusia Air Quality Network Sites.

Results

$PM_{2.5}$ NH_4

- The model performed well for ammonium in the summer campaign at all sites (Fig.1). The mean bias in conc was: -0.3 μg m^{-3} (CIECEM), -0.4 μg m^{-3} (Valverde) & -0.3 μg m^{-3} (Univ Campus). Correlation coefficient (*r*) ranged between: 0.60 (CIECEM), 0.76 (Valverde) & 0.85 Univ Campus.
- Although the model captured the variability in the concentrations at the urban site (Univ Campus) during the winter campaign (*r* = 0.83), it did not do so well at the rural sites and in general it underestimated the concentrations (Fig.2). The mean bias in conc was: -0.6 μg m^{-3} (CIECEM), -0.9 μg m^{-3} (Valverde) & -1.0 μg m^{-3} (Univ Campus).

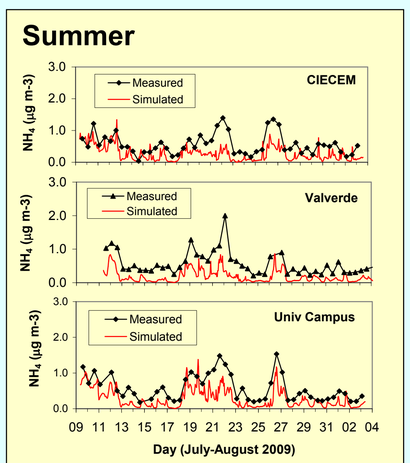


Fig 1. Measured and simulated $PM_{2.5}$ NH_4 conc. at CIECEM, Valverde & University Campus.

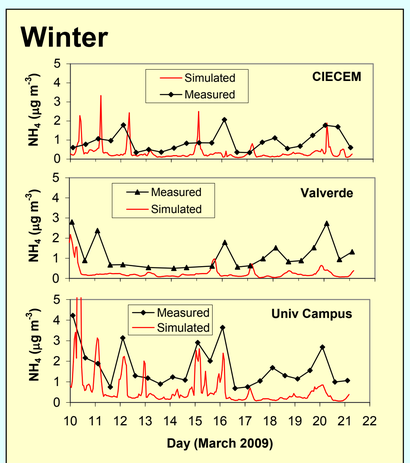


Fig 2. Measured and simulated $PM_{2.5}$ NH_4 conc. at CIECEM, Valverde & University Campus.

$PM_{2.5}$ SO_4

- The model performance for sulphate was good for the summer campaign, capturing the variability in the concentrations (Fig. 3). The mean bias in conc was: -0.6 μg m^{-3} (CIECEM), -0.9 μg m^{-3} (Valverde) & -0.8 μg m^{-3} (Univ Campus). Correlation coefficient (*r*) ranged between: 0.68 (CIECEM), 0.75 (Valverde) & 0.85 Univ Campus.
- The model performance for sulphate was poorer for the winter campaign. The underestimation of concentrations was greater and less correlation was observed (Fig. 4).
- In general in this region, sulphate concentrations are at a maximum in summer due to enhanced photochemistry. However, the March campaign was dominated by winter anticyclonic conditions and higher sulphate concentrations were observed than during the summer campaign.

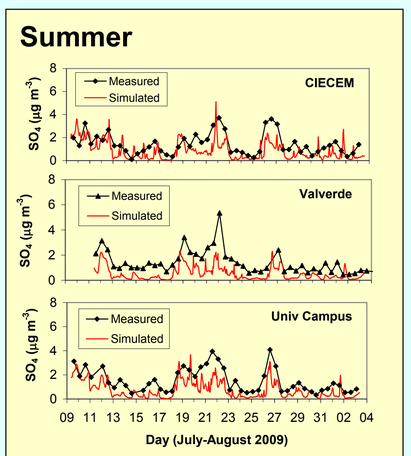


Fig 3. Measured and simulated $PM_{2.5}$ SO_4 conc. at CIECEM, Valverde & University Campus. Measured $PM_{2.5}$ SO_4 is sulphate present as ammonium sulphate

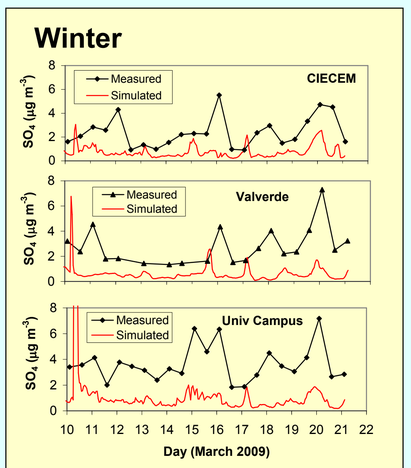


Fig 4. Measured and simulated $PM_{2.5}$ SO_4 conc. at CIECEM, Valverde & University Campus. Measured $PM_{2.5}$ SO_4 is sulphate present as ammonium sulphate

$PM_{2.5}$ BC

- The model performed well in capturing the variability of $PM_{2.5}$ BC concentrations during both the summer and winter campaigns at the urban site (Fig. 5 & 6).

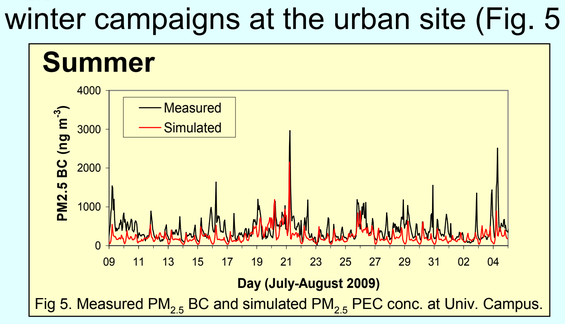


Fig 5. Measured $PM_{2.5}$ BC and simulated $PM_{2.5}$ PEC conc. at Univ. Campus.

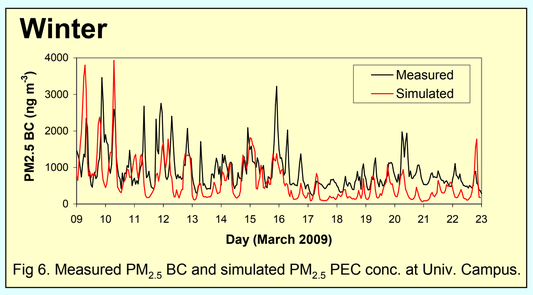


Fig 6. Measured $PM_{2.5}$ BC and simulated $PM_{2.5}$ PEC conc. at Univ. Campus.

Conclusions

A photochemical modelling system consisting of CAMx driven by MM5 has been implemented to study the dynamics of aerosol formation and transport in south-west Spain. For both $PM_{2.5}$ NH_4 and SO_4 concentrations the model performed better for the summertime periods, with reduced bias and higher correlation coefficients than for the wintertime period. The primary aerosol (BC) was better captured than the secondary aerosols during the winter campaign.

References:
Guenther, A. et al., 1995. A global model of natural volatile organic compound emissions. Journal of Geophysical Research. 100 (D5), 8873–8892.
Fernández-Camacho, R. et al., 2010. Ultrafine particle formation in the inland sea breeze airflow in Southwest Europe. Atmos. Chem. Phys., 10, 9615–9630

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