Development of an Upgrade Urban Source Emission Model for Atmospheric Pollutants

A contribution to subproject SATURN/GENEMIS

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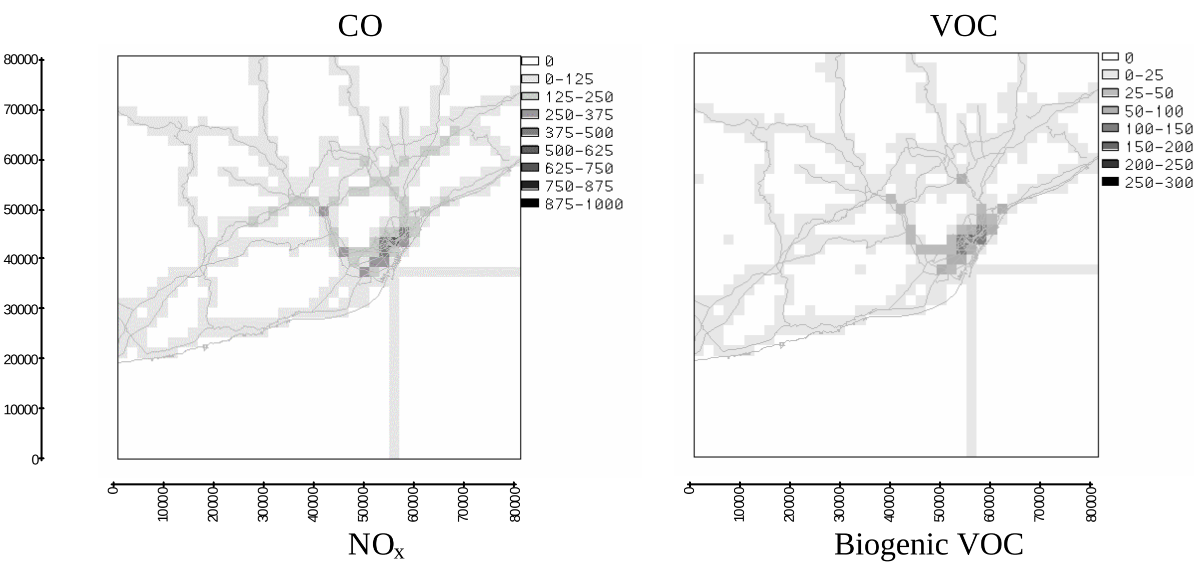
Aim of the research

The contribution of *Laboratory of Environmental Modeling* from the Technical University of Catalonia (UPC) has been focused to develop specifications of emission data for emission modelling and development of methodologies for emission inventories models, an applied that to the Barcelona-Catalonia area; and especially methodologies for the estimation of traffic and biogenic emissions. Application of emission estimates into a photochemical model applied to the Barcelona area to reproduce ozone episodes. The work was mainly included in the following Working Groups (WG):VAL and INT.

Activities during the year and Principal results

Highly disaggregated emission inventory

An inventory of gaseous emissions from road traffic in Catalonia (Spain) has been developed for year 1994. The work area has been divided into 1x1 km2 cells (space resolution). The model allows several time scales for the calculation of the emissions on an annual, monthly, daily or hourly basis. For each of the cells we have determined the emissions of CO, NOx (NO and NO2), SO2, particles and several VOC from road traffic (see figure 1 and 2). The emission inventory model (EIM-LEM) estimates this spatially disaggregated emissions from road transport using the ARC/INFO geographic information system (GIS).



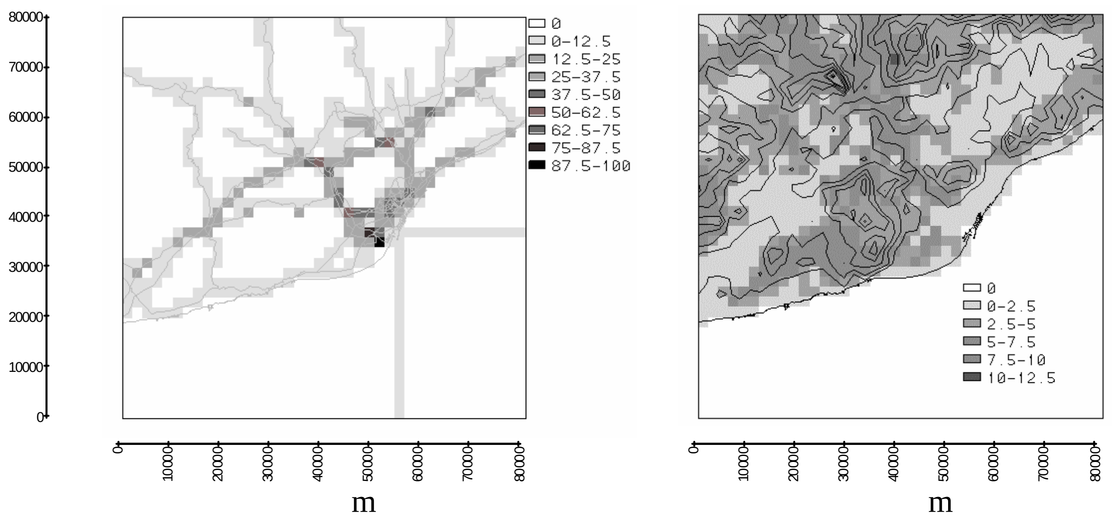
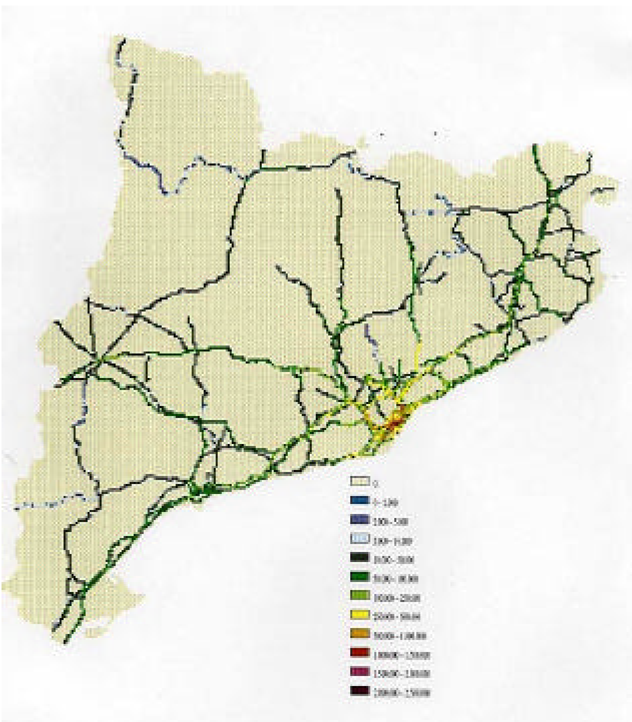


Figure 1. Geographical distribution of calculated estimated VOC, NO_x, CO and BVOC emissions (kg/2x2 km^2) at 15 LST in the first layer of the model

A model has been developed to estimate BVOC (Biogenic Volatile Organic Compounds) emissions from 11 different covers from the categories in the land-use map of Catalonia-1992 (see figure 3). The BVOCs considered in the model are isoprene, monoterpenes and other biogenic volatile organic compounds (OBVOCs). Emission factors were computed using the most recent data about biogenic VOCs emissions from Mediterranean native species and cultures (mostly from Pío et al., 1993 and BEMA project, 1995).

Landscape-average biogenic emission factors were obtained for different covers (natural vegetation, crops and high density urban areas) from a modified land-use map with a 1 km2 resolution as cartographic and thematic base, using taxonomic and floristic composition criteria to structure those emission factors for natural vegetation.



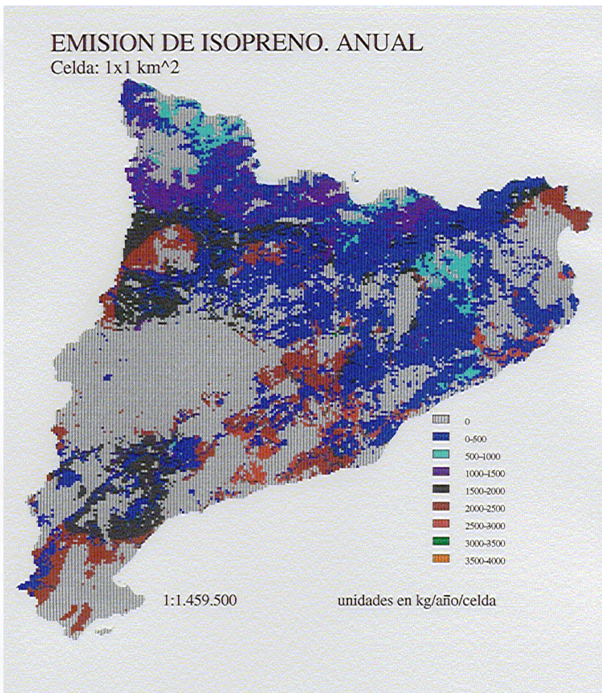


Figure 2. CO traffic emissions (t/year)

Figure 3. Isoprene biogenic emissions (kg/year/m^2)

Major emissions tend to occur on the coastal range areas where solar radiation and surface air temperature are high in relation with more inland areas, main BVOC sources correspond to shrublands, irrigated herbaceous crops, sclerophyllous forests and some spots with conifers. Inland BVOC sources are mainly represented by coniferous and sclerophyllous forests at the Pyrinees and in the mid-mountain, on one hand. On the other hand, inland BVOC sources are constituted by shrublands and by irrigated herbaceous crops.

Hourly distribution of VOC and NOx (see figure 4) indicate that highest emissions from road traffic occurred at 12 and 19 LST, when the volume of traffic was at its highest. The highest BVOC emissions took place between 15 and 17 LST, when the intensity of solar radiation and the air temperature were highest.

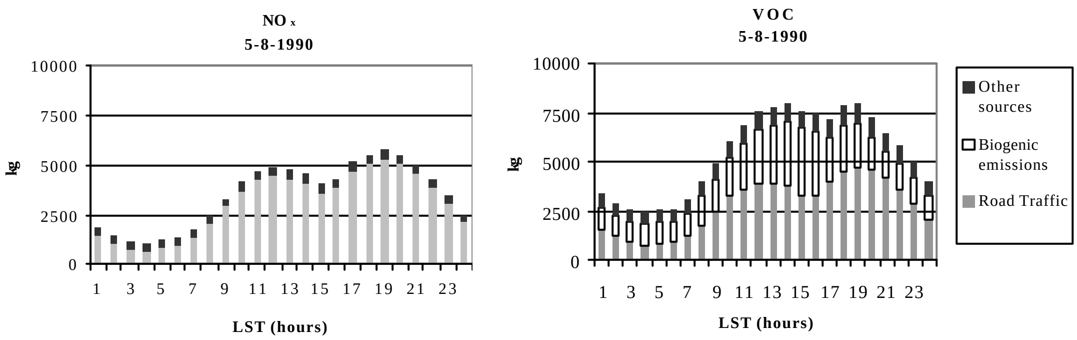


Figure 4. Hourly NO_x and VOC emissions in the 80x80 km^2 domain on 5 August 1990

Photochemical Dispersion Simulation

The application of the meteorological non-hydrostatic mesoscale model MEMO in the area of study reproduced the land and sea breeze flows typically developing under weak summer synoptic pressure gradients, as well as the katabatic (downslope) and anabatic (upslope) winds on the main mountains in the domain (Toll and Baldasano 2000).

The combination of mesoscale circulations (such as sea and land breeze, convection cells and topographic injections) and local emissions strongly influence the production and spatial distribution of ozone in the region. It has been observed how ozone is formed over vegetated areas, where VOCs are emitted, due to the inland advection of NO_x from the city with to the sea breeze flow. Orographic injections from the surrounding mountains cause the formation of elevated ozone layers. These elevated layers are dispersed according to the synoptic-scale flow, which is responsible of the orientation of the surface-height decoupled layers. Results from the emission model showed above where introduced as input in the prognostic meteorological/photochemical modelling system MEMO/MARS and are shown in figure 5.

Acknowledgements

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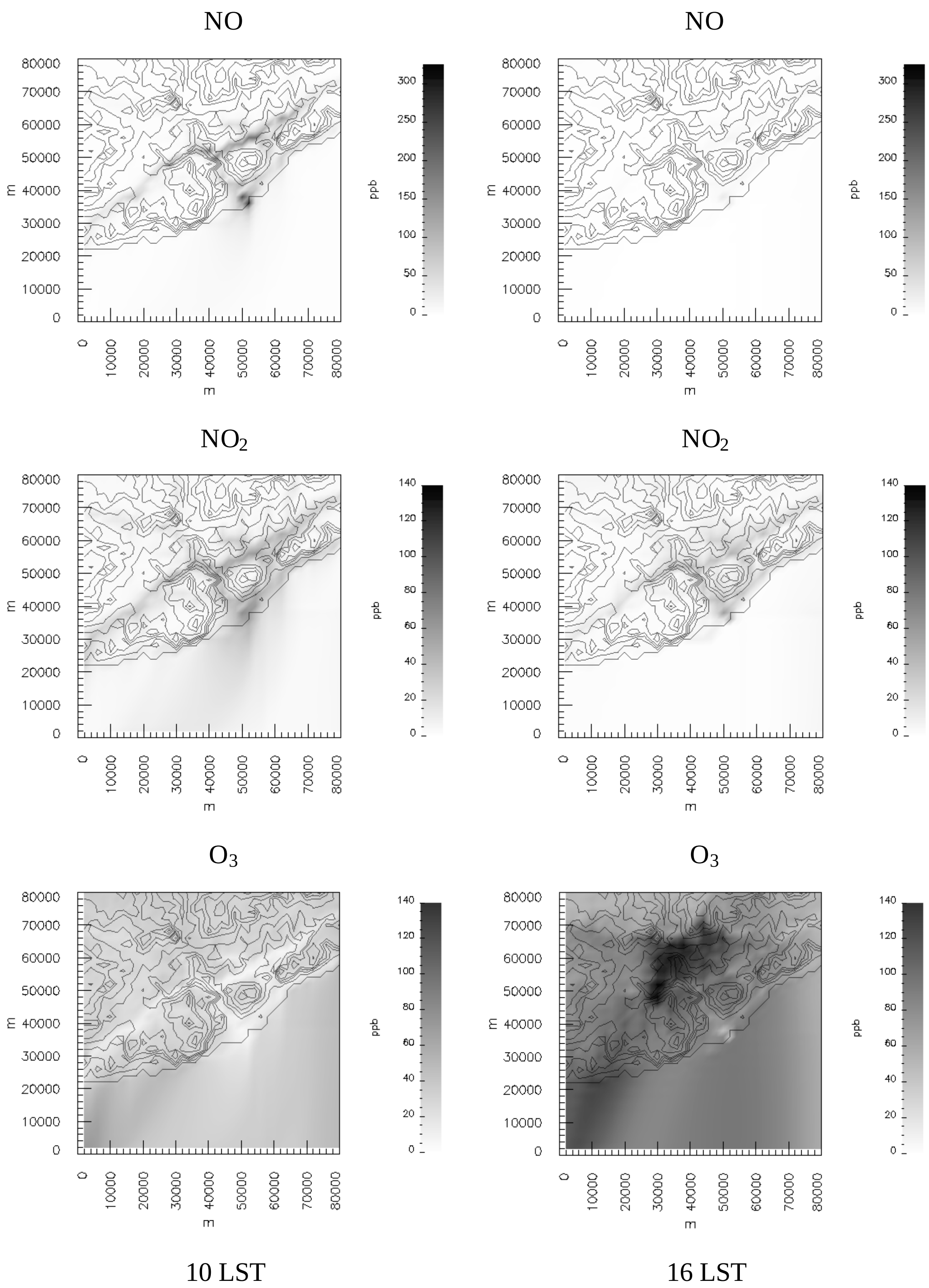

Figure 5. Horizontal cross-sections of simulated NO, NO_2 and O_3 at 10LST (left) and 16LST