2.14 THE MINNI PROJECT

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INTRODUCTION

The MINNI (Integrated National Model in support to the International Negotiation on Air Pollution) project aims to develop, verify and validate a modeling system dealing with air pollution dynamics (transport and dispersion) and multiphase chemical transformations, to evaluate concentrations and deposition fluxes of the pollutants involved in national and international air quality policies (SO2 , NOx , NH3 , VOC, O3, and PM), with a spatial resolution of few tens of km^2.

At the moment abatement goals in international negotiation are assigned on the basis of continental-scale models, allowing to fix the broad picture, but with some limitations in capturing specific sub-national features. Examples are given by stagnation inside the Po Valley, south of the Alps, and local circulation induced by the complex coastal features of the Italian paeninsula, both affecting pollutant dispersion and transformation.

The MINNI project aims to help to fill this gap, setting up a modelling system detailing the description over the Italianarea. Different simulation models are being integrated in a coherent framework: a 3D Eulerian pollution transport and chemistry model, fed with meteorological fields reconstructed with a non-hydrostatic meteorological model, with emissions prepared from national and international inventories, and boundary conditions from continental-scale simulations.

At least, the results from the atmospheric simulation system will be included in RAINS-Italy, a national-scale version of the RAINS Integrated Assesement model (IIASA, 2004), including Italian-specific energy, costs and effects data, that will be applied to evaluate the abatement strategies and their relative costs. Matrices of source-receptor relationships for the Italian regions will be calculated, allowing to detail the overall national abatement targets to the single Regions.

The atmospheric simulation system is being set up taking 1999 as the base meteorological year for calculations. Successive extensions dealing with other years, including also different abatement options or zooming on specific areas will be possible.

THE ATMOSPHERIC MODEL

The atmospheric modelling system, including meteorology, emissions and pollutants dispersion/ chemistry modules, refer to a 20 km × 20 km grid (Figure 1).

Meteorology

The meteorological fields have been obtained by means of the prognostic and non-hydrostatic model RAMS (Cotton et al., 2003) using a 2 way nested grid system (Figure 2), with an outer grid covering large part of central Europe and the Mediterranean Sea, with a resolution of 60 km × 60 km and an inner grid including the target area (Figure 1 and having the same horizontal resolution. ECMWF analysis fields and surface synoptic observations have been employed as input data for RAMS simulations. Nudging has been employed to assimilate data analyses during the whole model simulation. The model has been run on a PC cluster at the CINECA (Interuniversity Consortium for High Performance Computing) supercomputing centre in Bologna and has produced the hourly meteorological fields of interest for the whole year 1999. Monthly average fields are being checked versus available analyses and observations to verify if they coherently describe the typical seasonal weather conditions on the Italian area. Possible inconsistencies relevant for air quality simulations will be corrected on the basis of available data.The meteorological subsystem is completed by SURF*PRO* (ARIANET, 2003), a diagnostic module computing the PBL scaling parameters, the diffusivities and deposition velocities of the chemical species of interest, on the basis of the meteorological fields and the landuse information.

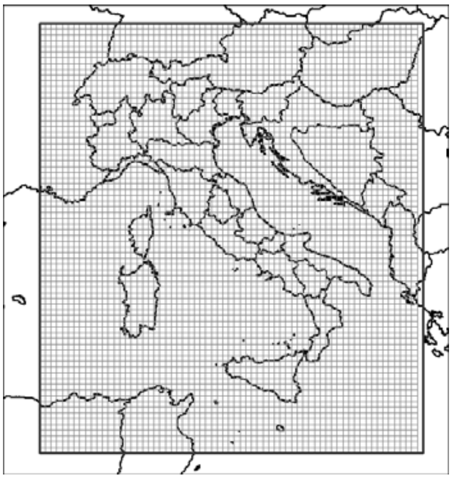

Figure 1. The 20 km × 20 km grid used in the MINNI project.

	Grid 1	Grid 2
Nx	**41**	**71**
Ny	**46**	**80**
Nz	**35**	**35**
Δxy (km)	**60**	**20**
Δt (sec)	**90**	**45**

Figure 2. Nested grids and computational parameters for the meteorological simulations.

Emissions

The emission subsystem is based on the Italian and European emission inventories. As far as the Italian territory is concerned, the 1999 national emission inventory has been disaggregated at NUTS3 level ("Province") by means of a number of specific activities indicators. Then, the hourly input needed by the air quality model on the computational grid for the chemical species of interest has been computed by the inventory on the basis of a set of activities specific thematic *layers*, time modulation and speciation profiles. A similar procedure has been applied to the emissions of the neighbouring countries, starting from the EMEP European inventory. Emissions from maritime activities included in the inventories are also considered, and allocated on the grid on the basis of ports and traffic routes proxy data. Diffuse emissions are then injected in the air quality model in the lowest layers of the computational grid, whereas some 140 Italian large point sources are treated separately taking directly into account plume rise effect.

Pollutants dispersion and chemistry

The subsystem aimed at simulating the dispersion and the chemical evolution of the pollutants is based on the FARM model (ARIANET, 2004), derived from STEM (Carmichael *et al.*, 1998). FARM is a three-dimensional Eulerian model dealing with the transport and the multiphase chemistry of pollutants in the atmosphere, including an aerosol module and different chemical schemes.

Acid pollutants are treated by means of the (Hov *et al.*, 1988) chemical scheme whereas photochemical reactions will be described by the SAPRC-90 chemical scheme (Carter, 1990). As far as particulate matter is concerned, the Models-3/CMAQ Aero-3 module (Binkowski, 1999), based on the modal approach, will be employed.

Time-varying chemical boundary conditions are assigned from the three-dimensional fields produced by the continental scale EMEP Eulerian model (EMEP, 2003). An example of model-calculated concentration field is shown in Figure 3.

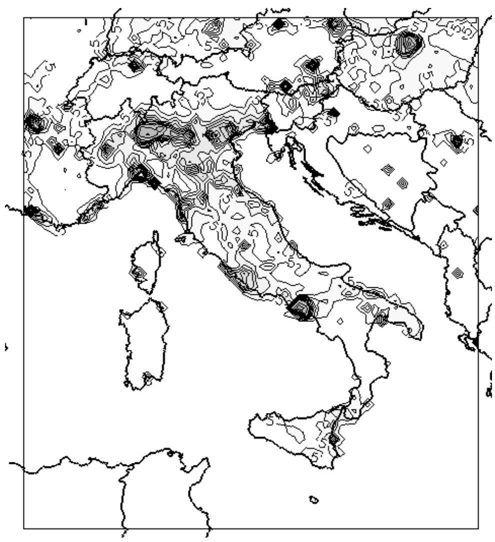

Figure 3. Example of ground level NO_2 concentrations, computed for October 1, 1999, 19 UTC (isolines every 5 ppb)

A number of air concentration and deposition data have been collected, to allow a quantitative validation of the model. As far as the Italian territory is concerned, hourly concentrations data in background national stations have been obtained from the BRACE national data base (APAT, 2003) whereas weekly wet deposition have been given by the ConEcoFor monitoring network (ConEcoFor, 2003).

Data from the EMEP monitoring network have also been collected both for national stations in Ispra and Montelibretti and foreign stations included in the MINNI domain.

Preliminary comparisons involving the acidifying pollutants (SO_2, NO_x and NH_3) in typical winter and summer situations show a satisfactory agreement between model and measurements and a detailed validation is in progress.

Runs of the photochemical and aerosol modules are scheduled for the second half of 2004 and 2005, respectively.

Source-receptors relationships

After model verification against monitoring data, source-receptors relationships will be computed for the reference meteorological year, simulating the reduction in pollutants emissions in each of the 20 Italian Regions, and on a limited set of metropolitan areas and large point sources. A preliminary example of the deposition changes for different pollutants obtained by means of a 25% emission reduction in Lombardy region during a winter week is shown in Figure 4.

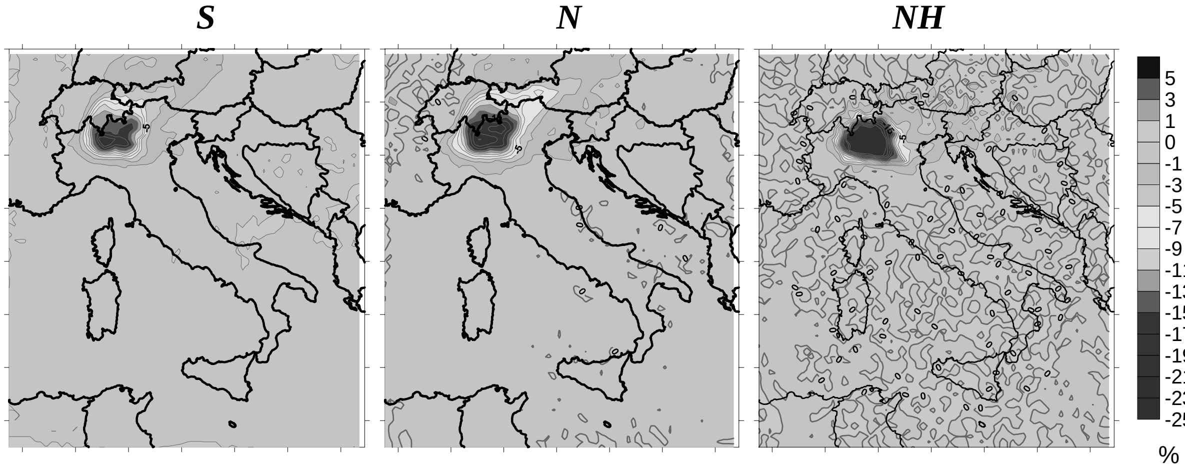

Figure 4. Changes in deposition of sulphur (left), oxidised nitrogen (centre) and reduced nitrogen (right) as a consequence of 25% reduction of emissions of SO_x, NO_x and NH_3, respectively, in the Lombardy region (total deposition in a winter week)

RAINS Italy

The RAINS-Italy model, developed within a joint research project ENEA-IIASA, has been thought with the aim of developing emission scenarios, cost curves and deposition/concentration maps to support the policy-makers in the definition of strategies for air pollution reduction both at national and regional level. The RAINS-Italy model includes the Atmospheric Transfer Matrix derived by the calculations performed by the atmospheric model, for the purposes of its Deposition Module, allowing the development of deposition/concentration maps with a 20x20 km spatial resolution. The DEP module also provides comparison between the deposition/concentration maps and the critical loads/level maps, for estimations of exceedances and for identifying the environmental targets. Such targets, (e.g. 95% of the ecosystems protected from acidification) are then used by the Optimization Module of Rains-Italy, to compute the optimal allocation of abatement measures, among the 20 regions, to achieve the desired target, at the lowest cost. The user (e.g. the policy maker) may approach the overall problem by defining the desired emission, cost, or effect based targets.

One of the innovative aspects offered by the system is the possibility of developing independent emission scenarios and related environment impact analysis, at the level of the administrative region, which, due to the wide autonomy granted to local regional authorities, may have its own regulatory approach to deal with the atmospheric pollution

CONCLUSIONS

A three-dimensional atmospheric simulation system being set up on the Italian area has been outlined. The system will be used to generate source-receptor relationships to be included in a national scale version of the RAINS integrated assessment model. This is expected to be an important tool to support the Italian policy makers in the field of air pollution management, both in the international negotiations on transboundary pollution and in the regional breakdown of national abatement targets. As well, MINNI provides a powerful tool for estimation and comparison of the effect-based impact of the local environmental policies, allowing also cost evaluation and their optimised allocation

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