

### **WG3 Mesoscale models for air pollution and dispersion applications**

There are various air pollution situations that require the use of complex mesoscale models to adequately describe the processes and dynamics as well as incorporate chemistry and emissions in an adequate manner. For example, many cities in Europe are influenced by the surrounding complex orography which determines to a large extent the flows of air masses and hence the movement of pollution. In cases of cities located in the vicinity of rivers, estuaries and coastal regions wind reversals with diurnal cycles can be expected, even in climatic regions where neutral atmospheric conditions dominate. In all of these cases, wind reversals, and thus oscillations of any polluted air masses, can also be expected under some or most meteorological conditions. Wind reversals caused by orography-driven processes are also associated with the formation of return flows and stratified layers aloft, and these can play a much more important role in the regional transport of photo-oxidants than hitherto considered. The recirculations can become "large natural photo-chemical reactors" where most of the NO<sub>x</sub> emissions and other precursors are transformed into oxidants, acidic compounds, aerosols and O<sub>3</sub>, which exceed EC directives for several months during the year. Under these conditions, feedback processes dominate, and a further important aspect relating to tropospheric chemistry is that air mass aging can go on for days within these recirculations while new emissions are continuously being added to it. The regional and long-range transport (LRT) of air pollution in stratified layers over flat terrain, mountain regions, and particularly over the land-sea transition, is a much more frequent phenomenon than is usually acknowledged. The various processes involved in layer formation, the transport of these layers to hundreds of km with little or no vertical diffusion, and the possible chemical transformations within each layer, are still very difficult to include in existing dispersion and photochemical models. Similar comments could be made for modelling trajectories in recirculatory flows; that is, after deep convective or convectiveorographic injection, and stratification aloft by compensatory subsidence, the aged pollutants can be incorporated into the surface flows several days later. Levels of pollutants, such as, O<sub>3</sub> and PM10 are significantly influenced by mesoscale flows and processes. A large fraction of O<sub>3</sub>, in particular, may result from fumigation pollutants emitted a few hundred km upwind on the previous day (s) and, maybe, from different places. Similarly, the transport of fine particles from LRT can often lead to exceedances of air quality standards (e.g. Malcolm et al 2000). It is, therefore, important to include the appropriate driving processes in meso-scale models for the correct interpretation and/or forecast of O<sub>3</sub> concentrations, both of which are now required by the European Directives (Beck et al., 1999).

Other aspects that are important include conditions of stratification with little or no vertical diffusion and with low wind speeds. Layering of air masses have been shown to transport material such as Saharan dust and pollutants over Europe (e.g. Alonso et al., 2000). Meteorological processes can, hence, influence tropospheric chemistry (e.g. ozone and air quality changes) and its interactions with the biosphere, in several ways including:

- The nitrogen cycle within regions of Europe,
- Particulate matter via the formation of secondary organic aerosols,
- Climate/chemistry interaction via additional photochemical heating of the lower troposphere at the local scale (e.g. change in the frequency of summer storms in a region) and feedback mechanisms involving particulate matter,
- Climate/chemistry interaction at the larger scale, via deep orographic venting (upper troposphere lower stratosphere) of the polluted boundary layer along the upper branch of the ITCZ.

Thus, the aim of this WG is to develop strategies to improve existing mesoscale meteorological models and

their dispersion modules, for these and other atmospheric applications. This activity will look at mesoscale (1-200 km) features, processes, situations that should be successfully modelled by CTMs together with meteorological mesoscale NWP in order to address the needs and requirements of air pollution stakeholders, such as, scientists, emergency monitoring bodies and environmental authorities.

The main activities of the WG will include:

- a) Collation and review of the capabilities of current individual or class of models to simulate given situations or processes.
- b) Review of selected MetM-CTM systems according to applications in terms of various factors including input/operational conditions/resolution/data availability.
- c) Identification, through sensitivity analysis, of the meteorological parameters and physics schemes that are important for air pollution (including deposition) and other dispersion applications.
- d) Examination of the ability and the limitations of MetM-CTMs to adequately predict air pollution episodes such as during stagnant and low wind conditions for a range of orographic situations and heterogeneous situations.
- e) Identification of improvements in MetM-CTM for air pollution and emergency forecasting purposes.
- f) Assessment of meteorological parameters that have a critical influence on chemical mechanisms (e.g for O<sub>3</sub> and PM) and emissions (e.g for biogenic VOCs).
- g) Examination and documentation of operational procedures and protocols for employing MetMCTMs for assessing real-world air pollution and dispersion problems including model configuration and initial/boundary conditions.

This activity will draw upon projects such as FUMAPEX, AIR4EU and CITY DELTA as well as past and current programmes in including SATURN, MESOCOM and ESCOMPTE. It is expected that consensus will be reached on the areas that require improvements as well as strategies for implementing these improvements. Interaction will be established with other relevant research communities, including NWP modellers. Examples where interaction will be developed with other groups/networks are given in Section F.

### ***Inputs to the Activity***

Member partners will input the data and information on CTM and Met models used and developed by different research groups. Dataset will include meteorological data, chemical pollutant data as well as emission inventories for selected pollutants (such as NO<sub>x</sub>, VOCs and PM<sub>10</sub>). It is expected that there will be input from end users in relation to their requirements for air quality assessment and management applications.

### ***Deliverables***

- 1) Review of the capabilities of selected MetM and CTMs for air pollution and dispersion applications.
- 2) Documentation of the capabilities of MetM-CTM for describing and predicting air pollution episodes.
- 3) Identification of improvements of MetM-CTM systems for prognostic and diagnostic applications.
- 4) Documentation of procedures and protocols for using MetM-CTMs for real air pollution and dispersion applications.