Integrated systems: on-line and off-line coupling of meteorological and air quality models, advantages and disadvantages

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As strategy of a new generation integrated Meteorology (MetM) and Atmospheric Chemical Transport (CTM) modelling systems for predicting atmospheric composition, meteorology and climate change it is suggested to consider air quality modelling as a combination and integration (at least) of the following factors: air pollution, urban climate/meteorological conditions and population exposure. This combination is reasonable due to the facts that: (i) meteorology is a main source of uncertainty in air pollution and emergency preparedness modelling, (ii) complex and combined effects of meteorological and pollution components on human health (e.g., hot spots in July of 2003 in Paris, France), (iii) effects of pollutants, especially aerosols, on climate forcing and meteorological phenomena (precipitation, thunderstorms, etc.).

In this content several levels of the integration strategy are considered:

1) off-line models:
• separate CTMs are driven by meteorological input data from meteo-pre-processors, measurements or diagnostic models,
• separate CTMs are driven by analysed or forecasted meteodata from Numerical Weather Prediction (NWP) archives/ datasets,
• separate CTMs are read output-files from operational NWP models or specific MetMs with a limited period of time (e.g. 1, 3, 6 hours);

2) on-line models:
• on-line access models, when meteodata is available at each time step (it could be via a model interface as well),
• on-line integration of CTM into MetM, when feedbacks are possible to consider (we will use this definition as on-line coupled modelling).

Main advantages of the on-line and off-line modelling approaches from the first preliminary outlook are the following:

For the on-line coupling:
• Only one grid; no interpolation in space; no time interpolation;
• Physical parameterizations are the same; no inconsistencies; does not need meteo- pre/post-processors;
• All 3D meteorological variables are available at each time step; no restriction in variability of meteorological fields;

• Possibility to consider aerosols and gaseous forcing on atmospheric processes and other feedback mechanisms.

For the off-line coupling:
• Possibility of independent parameterizations;
• Low computational cost (if NWP data - available, no need to run MetM);
• More suitable for ensembles and operational activities;
• Easier to use for the inverse modelling and adjoint problem;
• Independence of atmospheric pollution model runs on
MetM computations;
• More flexible grid construction and generation for CTMs, e.g. within the surface and boundary layer;
• Suitable for emission scenarios analysis and air quality management.

The on-line integration of MetM and CTM models gives a possibility to consider feedbacks of air pollution (e.g. aerosols) on meteorological processes and climate forcing, therefore this is a very promising way for future atmospheric simulation systems leading to a new generation of models for environmental and "chemical weather" forecasting. An overview of on-line coupled MetM and CTM model systems already being used in Europe, based on FUMAPEX and COST728 experience, will be presented in the paper. Activities and investigation requirements are multiple but dispersed in Europe. Thus, a COST Action seems to be the best approach to integrate, streamline and harmonize these national efforts towards a leap forward for new breakthroughs beneficial for a wide community of scientists and users. The discussed European joint system strategy does not necessarily include just one model. It could be an open integrated system with fixed architecture (module interface structure) and with a possibility to incorporate different MetMs/NWP models and CTMs.

References:

Baklanov, A., B. Fay, J. Kaminski (editors), 2007: Overview of existing integrated (off-line and on-line) mesoscale systems in Europe. COST 728 D2.1 Report, April 2007, 108 p.

FUMAPEX: Integrated Systems for Forecasting Urban Meteo-rology, Air Pollution and Population Exposure. EC 5FP project: /http://fumapex.dmi.dk/ <http://fumapex.dmi.dk/>