EMS Annual Meeting Abstracts
Vol. 10, EMS2013-420, 2013
13th EMS / 11th ECAM

Online integrated meteorology-chemistry models: needs and benefits for Numerical Weather Prediction, Air Quality and Climate communities

A. Baklanov (1), K.H. Schluenzen (2), S. Joffre (3), P. Suppan (4), J.M. Baldasano (5), D. Brunner (6), M. Gauss (7), A. Maurizi (8), C. Seigneur (9), X. Kong (10), O. Jorba (5), and the COST ES1004 EuMetChem team ()

(1) Danish Meteorological Institute, Meteorological Research, Copenhagen, Denmark (alb@dmi.dk, +45 391 57460), (2) University of Hamburg, Germany (heinke.schluenzen@zmaw.de), (3) Finnish Meteorological Institute, Helsinki, Finland (sylvain.joffre@fmi.fi), (4) Karlsruhe Institute of Technology, Germany (peter.suppan@kit.edu), (5) Barcelona Supercomputing Center, Spain (jose.baldasano@bsc.es), (6) EMPA, Swiss Federal Laboratories for Materials Science and Technology, Switzerland (Dominik.Brunner@empa.ch), (7) Norwegian Meteorological Institute, Oslo (michael.gauss@met.no), (8) Institute of Atmospheric Sciences and Climate, Italy (a.maurizi@isac.cnr.it), (9) CEREA, France (seigneur@cerea.enpc.fr), (10) University of Hertfordshire, UK (x.kong@herts.ac.uk)

The prediction and simulation of the coupled evolution of atmospheric dynamics, pollutant transport, chemical reactions and atmospheric composition will remain one of the most challenging tasks in environmental modelling over the next decades, but is of great importance for air quality assessment, climate change studies and weather forecasting as they all involve strongly integrated processes. It is well accepted that weather strongly influences air quality and atmospheric transport of hazardous materials. It is also recognized that atmospheric composition can influence both weather and climate by directly changing the atmospheric radiation budget or indirectly affecting cloud formation. Until recently, however, because of the scientific complexities and lack of computational power, atmospheric chemistry and weather forecasting have developed as separate disciplines, leading to the development of separate modelling systems that are only loosely coupled.

The dramatic increase in computer power during the last decade is enabling us to couple online regional meteorological models (MetM) with atmospheric chemical transport models (CTM). The COST Action ES1004 (2011-2015) - European framework for online integrated air quality and meteorology modelling (EuMetChem, see: eumetchem.info) - is focusing on a new generation of online integrated Atmospheric Chemical Transport and Meteorology (Numerical Weather Prediction and Climate) models with two-way interactions between different atmospheric processes including chemistry (both gases and aerosols), clouds, radiation, boundary layer, emissions, meteorology and climate.

The focus on integrated systems is timely, since recent research has shown that meteorology and chemistry feedbacks are important in the context of many research areas and applications, including numerical weather prediction (NWP), air quality (AQ) forecasting as well as climate and Earth system modelling. However, the relative importance of online integration and of the priorities, requirements and level of details necessary for representing different processes and feedbacks can greatly vary for these related communities: (i) NWP and MetM, (ii) AQ forecasting and assessments, (iii) Climate and Earth System modelling.

This study summarises the current status of European modelling practices towards online coupled modelling of meteorology and atmospheric chemistry including feedback mechanisms and tries to give some answers on the above questions. For example, NWP might not depend on detailed chemical processes but considering the cloud and radiative effects of aerosols can be important for fog, visibility and precipitation forecasting. For climate modelling, feedbacks from greenhouse gases (GHGs) and aerosols become extremely important. However in some cases (e.g., for long-lived GHGs), fully online integration of full-scale chemistry and aerosol dynamics is not critically needed. For chemical weather forecasting and prediction of atmospheric composition in a changing climate, the online integration definitely improves AQ and chemical atmospheric composition projections.

The different modelling communities had different targets with respect to temporal as well as spatial scales, but also to processes under focus. For AQ forecasting, the key issue is usually the ground-level concentration of pollutants, whereas for weather and climate studies model skill is typically based on screen level temperature, wind speed and precipitation. However, several applications are likely to benefit from online modelling though they do not clearly fall under one of these four above mentioned main communities, e.g.: bio-weather forecasting, volcano eruption or forest fires plumes, pollen warnings, dust storms, oil/gas fires, assessing geo-engineering techniques that involve changes in the radiation balance (e.g. input of sulphate aerosols, artificially increased albedo), nuclear war, nuclear accidental releases, etc.