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Chemical weather forecasting: new concept and service for meteorological centers

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During the last decade a new field of atmospheric modelling - the chemical weather forecasting (CWF) - is quickly developing and growing. This was possible mostly due to quick growing supercomputer capability and operationally available high-resolution numerical weather prediction (NWP) data as a driver for atmospheric chemical transport models (ACTMs). However, in the most of current studies and publications this new direction is considered in a simplified concept. It includes only operational air quality forecast for the main pollutants significant for health effects and uses numerical ACTMs with operational NWP data only as a driver. However, such a way is very limited due to the off-line way of coupling the ACTMs with NWP models (which are running completely independently and NWP does not get any benefits from the ACTM) without a possibility to consider any feedback mechanisms. Many experimental studies and numerical research simulations show that atmospheric processes (meteorological weather, including the precipitation, thunderstorms, radiation budget, cloud processes and PBL structure) depend on concentrations of chemical components (especially aerosols) in the atmosphere. Therefore ACTMs have to be run together at the same time steps using online coupling and considering two-way interaction between the meteorological processes, from one side, and chemical transformation and aerosol dynamics, from other side.

Proceeding from the above mentioned limitations, a new concept and methodology considering the chemical weather as two-way interacted meteorological weather and chemical composition of the atmosphere is suggested and discussed. The CWF should include not only health-effecting pollutants (air quality components) but also GHGs and aerosols effecting climate, meteorological processes, etc. Such the concept of CWF requests a strategy of new generation integrated meteorology and ACT modelling systems for predicting atmospheric composition, meteorology and climate change. The on-line integration of meteorological or NWP models and atmospheric aerosol and chemical transport models gives a possibility to utilise all meteorological 3D fields in ACTM at each time step and to consider feedbacks of air pollution (e.g. urban aerosols) on meteorological processes and climate forcing. This very promising way for future atmospheric simulation systems (as a part of and a step to Earth Modelling Systems) will lead to a new generation of models for meteorological, environmental and chemical weather forecasting by national meteorological centers.

The methodology how to realise the suggested integrated CWF concept is demonstrated on examples of the European Enviro-HIRLAM and American WRF-Chem integrated systems. Importance of different feedback mechanisms for CWF is also discussed in the paper.