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PEEX Integrated Multi-scales and -Process Modelling for Environmental Applications

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The Pan-Eurasian EXperiment (PEEX; www.atm.helsinki.fi/peex) programme is a long-term programme. One of the PEEX Research Infrastructure's components is the PEEX-Modelling-Platform (PEEX-MP; www.atm.helsinki.fi/peex/index.php/modelling-platform). PEEX-MP includes more than 30 different models running at different scales, resolutions, geographical domains, resolving different physical-chemical-biological processes, etc. and used as research tools providing insights and valuable information/ output for different level assessments for environment and population. These models cover main components - atmosphere, hydrosphere, pedosphere and biosphere. The seamless coupling multi-scale and -processes modelling concept developed is important and advanced step towards realization of the PEEX research agenda presented in the PEEX Science Plan (www.atm.helsinki.fi/peex/images/PEEX_Science_Plan.pdf). Accessibility to infrastructure with High Performance Computing is important for such modelling.

In particular, the Enviro-HIRLAM (Environment – HIgh Resolution Limited Area Model) & HARMONIE (The HIRLAM-ALADIN Research for Meso-scale Operational NWP In Europe) models can be applied for multi-scale and –processes studies on interactions and feedbacks of meteorology vs aerosols/chemistry; aerosols vs. cloud formation and radiative forcing; boundary layer parameterizations; urbanization processes impact on changes in urban weather and climate; assessments for human and environment; improving prediction of extreme weather/ pollution events; etc. All these can be studied at different spatial (urban-subregional-regional) and temporal scales. In addition, added value to analysis is obtained through integration of modelling results into GIS environment for further risk/vulnerability/consequences/etc. studies.

As part of the Enviro-PEEX project (www.atm.helsinki.fi/peex/index.php/enviro), the models were used to study aerosols feedbacks and interactions in Arctic-boreal domain at regional scale & effects of radar data assimilation at mesoscale resolution, respectively.

Enviro-HIRLAM model was run in a long-term mode at 15-5 km resolutions for reference and aerosols effects (direct, indirect, combined included) with ECMWF boundary conditions and anthropogenic/ biogenic/ natural emissions pre-processed. Analysis of differences between model runs for basic statistics (avg, med, max, min, std) showed less pronounced variations of concentrations for average in Arctic regions vs other regions, and more pronounced for maximum concentration in Russian Siberia and Ural. Monthly averaged sulphur dioxide was larger over mid-latitudes (influence of anthropogenic sources) with maximum due to long-range atmospheric transport. For particular matter, it is lower in Arctic compared with mid-latitudes, but their composition is dominated by sea salt aerosols.

HARMONIE model was tested with pre-processing (optimising inner parameters) and data assimilation of radar reflectivity, which minimize a representative error (associated with discrepancy between resolutions in informational sources). The method showed improvement in prediction of precipitation rain rates and spatial pattern within radars' location areas and better reproduction of mesoscale belts and cell patterns of few-to-ten size in precipitation fields. Compatibility between model resolution and smoothed radar observation density was achieved by "cube-smoothing" approach. This ensures equivalent presentation of precipitation (reflectivity) structures in both model and observation in a sense of equally preserving the scales of precipitation patterns.

Moreover, for selected PEEX-MP models, used by UHEL-INAR, such Enviro-HIRLAM, EC-Earth, MALTE-Box a series of science education oriented trainings/schools is organized in April & August 2020 (ums.rshu.ru & worldslargerivers.boku.ac.at/wlr/index.php/ysss.html) which are part of the PEEX Educational Platform activities as well.