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Enviro-HIRLAM aerosol feedback modeling for the Northern Hemisphere

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Aerosol feedbacks have been considered in Coupled Chemistry-Meteorology Modeling (CCMM) during the recent decades. Commonly, the feedbacks comprise direct and indirect aerosol effects on meteorology. Direct aerosol effects (DAE) imply influence of atmospheric aerosols on the short- and long-wave radiation and, as a consequence, air temperature. Indirect aerosol effects (IDAE) denote impact of aerosols on cloud properties and precipitation efficiency.

The online-coupled meteorology chemistry model Enviro-HIRLAM (Environment - High Resolution Limited Area Model) was used to study the aerosol feedbacks for a modeling domain covering the Northern Hemisphere regions with 0.72° horizontal resolution. The model has been run for two case studies: 8th of August, 2010 (DAE run) and July, 2010 (IDAE run). Results of the model simulations were compared with those ones obtained from a reference run (REF., i.e., without any feedbacks) to estimate the aerosol feedbacks on meteorology.

The DAE study showed a reduction of the net downward short-wave surface radiative fluxes due to aerosols with local maximum differences reaching up to and above -100 W/m^2. The net downward surface long-wave radiative fluxes are mostly increased due to DAE in the modeling domain. A cooling effect was found at the lowest vertical model level ($\sim$32 m above ground level) in large parts of the domain. The maximum regional air temperature difference was found to be around 2-3°C.

The IDAE study indicated that cloud-aerosol interactions led to an increase of both total cloud cover and cloud water content. Taking into account the IDAE significantly reduced the total accumulated precipitation in the modeling domain in July, 2010. The precipitation efficiency was also studied by analysis of the modeled (REF and IDAE) and observed time series of the 12-hour accumulated precipitation on example of Arctic meteorological sites: Alert and Ny-Alesund. The analysis showed that inclusion of aerosol-cloud interactions (IDAE run) improved the model score by decreasing the mean precipitation bias from 0.34 to 0.23 mm/12 hours at both measurement stations.