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Towards a chemical weather forecast – model evaluation in the EU-project GEMS

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The EU-Project GEMS (Global and Regional Earth-system (atmosphere) Monitoring using Satellite and in-situ data) will extend the Integrated Forecasting System (IFS) of the European Centre for Medium Range Weather Forecast (ECMWF) by a pre-operational forecast of atmospheric gases and particles. Regional air quality models will refine these forecasts to small scales of few km. During the development phase and the following pre-operational service the models are evaluated and improved by (not assimilated) observation data of reactive gases and particles. Tests of the global chemistry-transport- (CTM) and aerosol models and their coupling to the IFS were performed with reanalyses for the years 2003 and 2004. As primary indicators for the models' skill the bias, correlation and standard deviation as well as diurnal and annual variations are evaluated with respect to observations. Specific case studies are performed on processes occurring along with photosmog, wildfire plumes and stratospheric ozone depletion.

An up-to-date global statistical evaluation of the performance of the GEMS global models and a summary of findings from the three case studies will be given. At present, the individual models' skills still vary significantly with period and region. Biases for monthly surface ozone and carbon monoxide mixing ratios are up to 30% and are larger in source regions, indicating deficits in the emission inventories. Surface ozone mixing ratios during the central European heatwave in early August 2003 are simulated about 20-30% too low in the global models which do not capture the photo-

smog culmination and underestimate the afternoon peak values. Increasing the model resolution improves the results significantly. Long-range transport and processing is assessed with observations of the Siberia (May 2003) und Portugal (Jul/Aug 2003) fire plumes at Global Atmosphere Watch (GAW) stations. To evaluate the performance of the global models in the stratosphere, airborne O_3-DIAL (Differential Absorption Lidar) observations of ozone depletion in the Arctic during the winter 2002/03 are used. While the simulated stratospheric ozone distributions clearly exhibit the signature of depletion, the losses are too low and seem to be displaced vertically.

Though the GEMS aerosol model presently only covers the primary processes and aerosol-types (sea-salt, dust, black and organic carbon, sulfate), the simulated global distribution of aerosol optical depth (AOD) already reflects many important features. However, near-source comparisons with observed AOD and particle mass reveals deficits in specific processes like dust mobilisation, vertical transport of sea-salt particles and possibly also the model's mass-to-AOD conversion scheme. Time series of AOD at different GAW stations are used to discuss the comparability of point observations with global models but representative comparisons suggest that the AOD bias in the model is moderate and has already been significantly reduced over the hitherto runs.