



European-scale AQ analysis for every hour of the previous day and forecast for every hour of the next time period up to 72h ahead by EURAD-IM

Product and service description

The comprehensive chemical data assimilation scheme EURAD-IM, developed at the Rhenish Institute of Environmental Research at the University of Cologne provides daily 72h AQ forecasts and AQ analyses for the previous day on a domain covering whole Europe with 15 km horizontal resolution using a Lambert conformal projection. Predicted hourly concentrations of O₃, NO, NO₂, CO, SO₂, total NMVOC, PM_{2.5}, PM₁₀, and concentrations of the particulate matter constituents SO₄²⁻, NO₃, NH₄⁺, secondary organics, sea salt, mineral dust and primary anthropogenic material as well as analysed hourly concentrations of O₃, NO, NO₂, CO, SO₂, PM_{2.5}, and PM₁₀ are regularly delivered in NetCDF format. Physical dimension of gas phase and aerosol phase species is ppb and µg/m³, respectively. The air pollutant concentrations are available on 23 non-equidistant terrain following layers between the surface and 100 hPa. Thickness of the near surface layer is about 35 m, 16 layers are below 3000 m.

Hourly concentrations of O₃, NO, NO₂, CO, SO₂, PM_{2.5}, and PM₁₀ are also available in grib2 format on a latitude/longitude grid covering the region from 15° W to 35° E and 35° N to 70° N with a resolution of 0.15° x 0.125° in the near surface layer and at 500 m, 1000 m, 3000 m, and 5000 m. Physical dimension of air pollutants in grib2 format is kg/m³.

The EURAD-IM AQ forecast and analysis is used for the generation of ensemble products and for public information purposes.

Product generation and validation

The European-scale pre-operational air quality forecast has been set up using the continental-to-local scale chemical data assimilation system EURAD-IM (Hass, 1991, Ackermann et al., 1998, Memmesheimer et al., 2004, Friese and Ebel, 2010). This model system consists of 5 major parts: the meteorological driver MM5, the pre-processors ECP and PREP for preparation of meteorological fields and observation data, the emission model EEM and the chemistry transport model EURAD-IM. The data flow of the EURAD-IM system is depicted in Figure 1. EURAD-IM is a meso-scale chemistry transport model involving transport, diffusion, chemical transformation, wet and dry deposition and sedimentation of tropospheric trace gases and aerosols. It includes 3d-var and 4d-var chemical data assimilation (Elbern et al., 2007) and is able to run in nesting mode.

Based upon the IFS operational meteorological forecast from 12:00 UTC of the previous day, a 72h forecast of key air pollutants is regularly delivered. Predicted concentrations of O₃, NO, NO₂, SO₂, PM_{2.5}, and PM₁₀ contribute to a multi-model ensemble forecast. Chemical initial values are provided by the EURAD-IM pre-operational 3d-var analysis for the previous day. Chemical boundary values are taken from the pre-operational global MOZART-IFS air quality forecast (MACC sub-project G-RG). Concentration fields are currently available at about 04:00 UTC at ECMWF for further processing. Results are accessible on the MACC web page.

Based upon the IFS operational meteorological forecast from 00:00 UTC, an analysis of the concentrations of O₃, NO, NO₂, CO, SO₂, PM_{2.5}, and PM₁₀ is daily delivered. Chemical initial values are provided by the EURAD-IM 3d-var analysis of the previous day. Chemical boundary values are taken from the pre-operational global MOZART-IFS air quality forecast. NRT MACC-RAQ surface in-situ measurements of O₃, NO, NO₂, CO, SO₂, PM_{2.5}, and PM₁₀ as well as NO₂ columns retrievals from OMI, GOME-2, and SCIAMACHY are assimilated every full hour using intermittent 3d-var. Concentration fields are currently available at about 02:00 UTC at ECMWF for further processing. Results are accessible on the MACC web page.

For the forecast as well as analysis, emission input data are derived from the newly available 2005 TNO emission inventory.

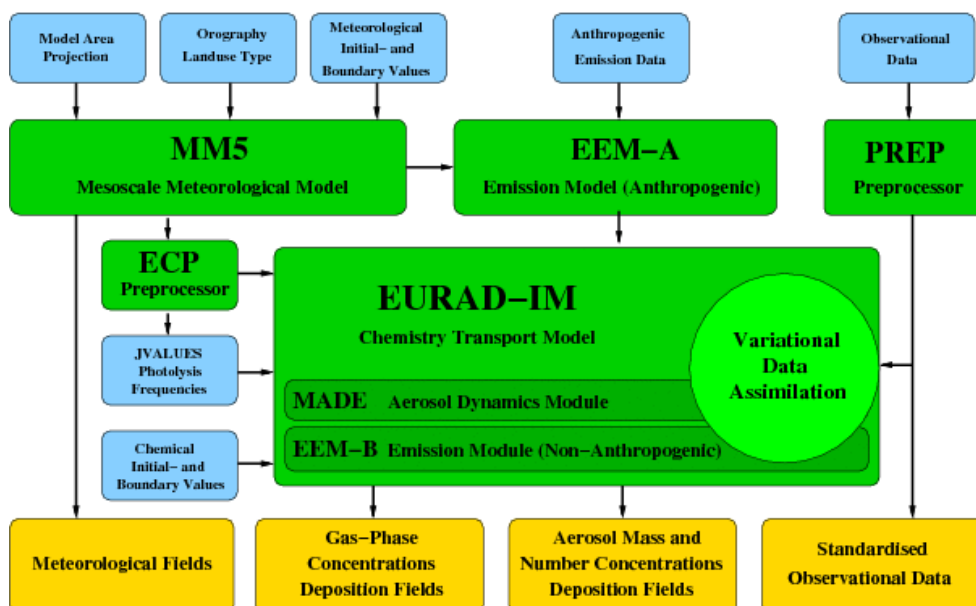


Figure 1: Flowchart of the EURAD-IM model system containing the meteorological driver MM5, the pre-processors ECP and PREP, the emission model EEM and the chemistry transport model EURAD-IM (input parameters are shaded in blue, output parameters are shaded in yellow and procedural parts are shaded in green).

Results of the EURAD-IM AQ forecast are validated on a daily basis on the MACC-RAQ webpage and are compared to results of the ensemble forecast system in quarterly QC/QA dossiers. The MACC-RAQ NRT data is used for verification. This data consists of surface in situ measurements of O_3 , NO_2 , SO_2 , CO , $PM_{2.5}$, and PM_{10} from an increasing number of European countries. Quality indicators used for validation are bias, modified mean bias, root mean square error, fractional gross error, and correlation (Jolliffe and Stephenson, 2003). Averaged quality indicators are displayed on the MACC-RAQ webpage for the next 72h forecast period and as time-series at 03:00 UTC and 15:00 UTC for the last week and for the last three month. Figure 2 exhibits exemplary quality indicators taken from the EURAD-IM QC/QA dossier for September to November 2010.

The EURAD-IM AQ service is validated against the MACC User Requirements Document.

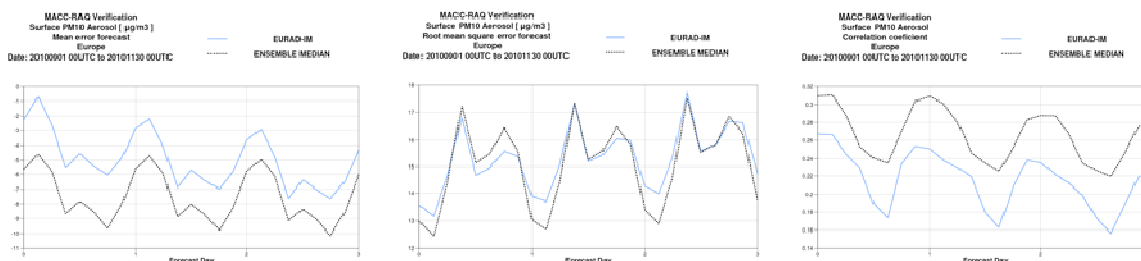


Figure 2: Bias (left), root mean square error (middle), and correlation (right) of near surface PM_{10} concentrations averaged over the time span from September 1 to November 31, 2010. Blue: EURAD-IM forecast, black: MACC-RAQ ensemble forecast.

Quality control

The supervisor monitor scheduler developed at ECMWF is used to control the production of the daily EURAD-IM AQ forecast and AQ analysis. SMS enables users to run a large number of programs in a controlled environment. It provides reasonable tolerance for hardware and software failures, combined with good restart capabilities.

SVN, a revision control system, is used to document changes of the EURAD-IM source code. Changes of the AQ service are reported in the quarterly EURAD-IM QC/QA dossiers. Furthermore, the dossiers provide performance and availability statistics. The performance statistic consists of graphical representations of mean quality indicators (bias, root mean square error, and correlation) for predicted near surface O₃, NO₂, and PM₁₀ concentrations.

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