

REQUEST FOR A SPECIAL PROJECT 2010–2012

MEMBER STATE: Germany

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Project Title: Monitoring Atmospheric Composition and Climate (MACC)

If this is a continuation of an existing project, please state the computer project account assigned previously.	SP DEFRIU	
Starting year: <small>(Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project. For projects started before 2009, please state 2009 as the start year.)</small>	2009	
Would you accept support for 1 year only, if necessary?	YES <input type="checkbox"/>	NO <input checked="" type="checkbox"/>

Computer resources required for 2010-2012: <small>(The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2012.)</small>	2010	2011	2012
High Performance Computing Facility (units)	2,200,000	2,200,000	--
Data storage capacity (total archive volume) (gigabytes)	15,000	15,000	--

An electronic copy of this form **must be sent** via e-mail to: special_projects@ecmwf.int

Electronic copy of the form sent on (please specify date): 30.4.2009

Continue overleaf

¹ The Principal Investigator will act as contact person for this Special Project and, in particular, will be asked to register the project, provide an annual progress report of the project's activities, etc.

Principal Investigator: Hendrik Elbern

Project Title: Monitoring Atmospheric Composition and Climate (MACC),
subprojects R-EDA and R-ENS

Extended abstract

This request for a special project follows the encouragement of the coordinator of MACC to develop and implement regional air quality modelling and data assimilation at ECMWF compute facilities.

The work to be accomplished is described in the proposal of MACC subprojects R-EDA, R-EVA, and R-ENS.

MACC sub-project R-EDA will develop and deliver improved data assimilation methods to assure optimal exploitation of observations. The ability to provide analysed chemical fields along with locally and temporally resolved error estimates is a key objective, making use of a multi-model ensemble approach. The tasks scheduled in MACC subproject R-EDA include

- Provide observation forward operators and its adjoint operators for various types of routine observations and retrievals, and related error covariances.
- Multi-model forecasts will be taken as basis information for the design of forecast background error covariance matrices, aiming to optimize the design toward anisotropic and inhomogeneous influence radii.
- Application of data assimilation validation procedures, resting on Chi-square tests, A-F, and A-O will be installed and applied.
- Perform an operationalization which includes the technical preparation for service in subprojects R-ENS and R-EVA.
- Study the capabilities of the 4d-var assimilation technique to improve the quality of air quality forecasts. For this purpose it is intended to run the already installed forecasting system with 4d-var support. The continued inversion of the model against emissions should provide emission factors which are able to improve forecast quality even in a free model run. By reason of the otherwise tremendous requirement of computing time this task must be accomplished with 45 km horizontal model resolution. To run the EURAD-IM model in 4d-var mode during a 24 hours assimilation interval by 12 iterations would require about 1200 SBU's per day, which will result in an amount of about 400 kSBU's per year.

MACC sub-projects R-ENS and R-EVA primarily focus on delivering a pre-operational European-scale regional air quality service. This activity largely builds itself upon the methods developed within the GEMS and PROMOTE European projects. The tasks scheduled in MACC subprojects R-ENS and R-EVA include

- Continued development of the forecast and assimilation systems.

- Provide daily 3d-var air quality analyses with 15 km resolution over Europe for the day before, using the system developed and tested within subproject R-EDA. For this purpose near real time in-situ measurements of O₃, NO₂, NO, SO₂, CO, and PM₁₀ as well as satellite derived NO₂ columns from OMI, GOME-2, and SCIAMACHY will be assimilated using the 3d-var method. This task will need about 1,300 SBU's per day. This would result in an amount of about 500 kSBU's per year.
- Provide daily pre-operational 72h forecast over Europe, based on the forecast system developed within GEMS subproject RAQ2. This continental scale near real-time air quality forecast, based upon the forcings provided by the IFS, has been set up using the continental-to-local chemical data assimilation system EURAD-IM with 15 km resolution. The system is able to operate in real-time. 72h forecasts of the concentrations of ozone, nitrogen oxides, CO, SO₂, and the particulate matter constituents PM_{2.5}, PM₁₀, SO₄²⁻, NO₃⁻, NH₄⁺, secondary organics, sea salt, mineral dust and primary particles of anthropogenic origin are regularly delivered. Predicted concentrations of O₃, NO₂, SO₂, and PM₁₀ contribute to a multi-model ensemble forecast. Initial values from the 3d-var analysis of the previous day are used. Computing resources of 300 SBU's per day for the meteorological driver MM5 running on 64 CPU's using the OMP interface, and about 3000 SBU's per day for the chemistry transport model running on 121 CPU's using MPI are needed. To run the forecasting system in this configuration would require an amount of about 1,200 kSBU's during a year.
- Define and study multi-model ensemble methods and products for future operational implementation.
- Validation of the EURAD-IM air quality forecast and other simulations for R-ENS against surface in-situ measurements.