Project: **777**

Project title: **Evaluating the Climate and Air Quality Impacts of Short-Lived Pollutants (ECLIPSE)**

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Allocation period: **1.1.2017 - 31.12.2017**

Project overview

The project "Evaluating the Climate and Air Quality Impacts of Short-Lived Pollutants" (ECLIPSE, http://eclipse.nilu.no), funded by the 7th Framework Programme of the European Commission, analyses the impact of ozone, soot and other short-lived atmospheric pollutants on air quality and climate. For this assessment, simulations with several coupled model systems are preformed. The University of Leipzig contributes simulations with the model system ECHAM6-HAM2/MPIOM.

The highly successful project itself already came to an end. However, there is a lot of on-going research exploiting the simulations and observations (two papers published in 2016, two more submitted). The most important activity is to publish the results from the transient simulations for the future, as well as various related results in.

Range of planned work from the scientific view

The planned work is a contribution to an unfunded follow-up initiative to ECLIPSE that, as we believe, will yield important insights and publications. Anthropogenic aerosols potentially have a significant influence on modulating the regional circulation and precipitation patterns. In this study the role of emission trends on atmospheric circulation and precipitation patterns will be examined using the ECHAM6-HAM2 global aerosol-climate model. Three ensembles of free/nudged fixed SST model simulations of ECHAM6-HAM2 aerosol-climate model will be performed (for 10 years), with control and experiment simulations. In order to identify clear and statistically significant results, rather than transient simulations, we will perform experiments with anthropogenic aerosol emissions fixed at 1960, 1980 and 2010 levels (interactive emissions for dust and sea salt). An additional control simulation will be carried out in which only natural (pre-industrial (PI, 1750)) aerosol emissions are used.

Mathematical and/or computational aspects, Algorithmic/mathe-matical/numerical methods and solution procedures

In the planned studies, we will use the atmospheric general circulation model ECHAM6 (Stevens et al., 2012), coupled to the aerosol module HAM2 (Zhang et al., 2012). This model system solves the Primitive Equations in hydrostatic approximation using a spectral discretisation with parameterisations of the diabatic processes. The aerosol module computes the sources, transport, chemical and microphysical transformation and removal processes of atmospheric aerosols including a simplified chemistry scheme for sulfur and secondary organic aerosols, and including a coupling to a double-moment cloud microphysics scheme in ECHAM6. The model is fully parallelized and vectorized.

Particular suitability to solve the problem with help of HLRE-3

The proposed science necessitates simulations of length and resolution which can only performed with the help of HLRE. We already have ample experience with running the atmospheric general circulation model ECHAM6 with online-coupled aerosol on the new mistral machine, and the codes are parallelised and vectorised. Indeed, the environment of HLRE 3 is ideally suited to perform the necessary simulations as well as to perform data postprocessing and storage.

Performance benefits depending on the number of used CPUs (scalability)

Experience with the ECHAM6 GCM including the online HAM module on mistral have shown that the model scales very well with increasing numbers of CPUs. The project will take care that code modifications do not diminish the numerical efficiency and scalability.

Required computing time and amount of storage space

Our experience shows that the ECHAM6-HAM2 model system requires 25.2 Node-hours for each year of integration on mistral. In terms of output, each integrated year (monthly output and daily diagnostics for selected variables) generates 40 GB for diagnostics.

Model	Number of simulations	Model integration time (years)	Node-h/ year	Total Node time	Disk space / GB
ECHAM6-HAM2 T63L47	12	10.25	25.2	3100	4920
		total		**3100**	**4920**

It is expected that of the new output, about 10% need to be archived temporarily and 1% permanently (for at least 10 years), i.e. 492 GB in /arch and 49 GB in /doku.

Additional value compared to other projects

The purpose of this project – assessment of climate impacts and radiative forcings of short-lived anthropogenic pollutants in the atmosphere – is to our knowledge not the topic of any other DKRZ project. A related project is bm0103, which, however, focuses on the development of the aerosol module for ECHAM6.

References

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Zhang, K., D. O'Donnell, J. Kazil, P. Stier, S. Kinne, U. Lohmann, S. Ferrachat, B. Croft, **J. Quaas**, H. Wan, S. Rast, and J. Feichter, The global aerosol-climate model ECHAM5-HAM, version 2: sensitivity to improvements in process representations, Atmos. Chem. Phys., 12, 8911-8949, doi:10.5194/acp-12-8911-2012, 2012.