

REQUEST FOR A SPECIAL PROJECT 2010–2012

MEMBER STATE: Germany

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Project Title: Investigation of systematic tendency changes and their influences to the general circulation simulated with climate models

If this is a continuation of an existing project, please state the computer project account assigned previously.	SPDEIFMB	
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 checked="" type="checkbox"/>	NO <input 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)	20000	20000	20000
Data storage capacity (total archive volume) (gigabytes)	2000	2000	3000

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):
27/April/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.

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Prof. Dr. Ulrich Cubasch, Dr. Ingo Kirchner

Project Title:

Investigation of systematic tendency changes and their influences to the general circulation simulated with climate models

Extended abstract

1. Quantification of systematic errors in climate models

Atmospheric general circulation models (GCMs) are most comprehensive tools used for the simulation of the general circulation. They are very complex but not perfect. Therefore systematic errors of such models must be detected, analysed and removed to improve simulations of the past and present Earth climate as well as predictions of future climate changes.

2. Combination of model-results/observations/reanalysis

The combination of model results with reanalysis data (e.g. ERA40) will help to study the error causes. Based on the reanalysis data periods and regions with the largest systematic errors will be detected using the so called analysis increments (analysis minus 6 hour forecast). Especially for these specified periods the climate model will be used to recalculate the observations for specific periods (e.g. extreme weather situations). From these experiments a diagnosis of tendencies and systematic differences between the increments and the model tendencies will be produced. Ensembles of experiments with the low resolution climate model COSMOS will be performed as follows:

First the climate model will run in assimilation mode for few month until the beginning of the specified period. Near the beginning of the specified period the assimilation will be switched off and the climate model will do a forecast. For each case a series of forecast-start-points will be chosen and an ensemble of forecasts will be performed. The detailed analysis of the tendency errors (using a technique as developed and applied in the EU projects POTENTIALS and DETECT) should be used to trace back to the causes of the errors and compare them with the findings of the increment analysis.

3. Influence of different factors (ozone, solar activity, greenhouse gases, aerosols)

The detection of the model uncertainties are important for the estimation of the error bars e.g. on the simulated anthropogenic climate change. The sensitivity of the model due to ozone changes, solar activity, greenhouse gases and aerosols will be studied using the above prescribed ensemble simulations. In addition model experiments with modified forcing factors like ozone, solar constant, greenhouse gases and aerosols will be performed and the changes in the tendency calculations will be compared with the undisturbed simulation results. The simulation results should be prepared for educational purpose and will be part of the modelling courses.

4. Interconnection between stratosphere and troposphere

As a specific topic the analysis will be concentrated on the tropopause region. The tropopause region is characterised by strong vertical gradients. Especially a coarse resolution in climate and weather forecast models in this region can have a large impact to model errors because of the sensitivity of vertical transport processes related to the tropopause height. Initial changes of ozone or aerosols near the tropopause are coupled over the radiation to convective processes. The adjustment process involves complex interactions between Gravity and Rossby waves, which will be studied.

5. Educational aspects

The framework for the model experiments is under development and is part of a seminar together with students. Our project will use the outcome of the PRISM project and should build the bridge between education and Earth System Modelling. The simulations will be documented and discussed together with the students, the results will be published in the FU e-learning platform BlackBoard.

In this project the work will be organized in the following work packages:

- Ozone changes near tropopause and systematic tendency changes (see e.g. Kirchner/Peters, 2003)
- Aerosol and tendency changes: Volcanic aerosols near the tropopause are changing the local radiation forcing. (see e.g. Andersen et al., 2001)
- Wave activity and external forcing: Gravity waves causes increased vertical movements of air with increased high. As result local changes of the temperature in the order of few Kelvin are possible (see e.g. Gabriel et al., 2007).
- Clouds and systematic changes of circulation (see e.g. Kirchner/Peters, 2003): Small changes of the stability near the tropopause are enforced by the clouds. A stronger labilisation in the tropopause region due to a vertical movement of the zone with gradient changes will force higher clouds, more convective activity with strong consequences to the circulation. Such modifications can be caused by small ozone disturbances ending up in a changed radiation balance.

As starting point cloud specific parameter will be studied, because of the systematic tendency errors can have large effects on the clouds. This investigation will include the reanalysis data (ERA40 and ERAINTERIM) and compare them with statistics given by high resolution cloud data, based on satellite observations archived at the IfM (Institut für Meteorologie). The model experiments will be performed as described using the COSMOS model version. The usage of a regional climate model (CLM) will be tested. The resources will be used to get parts of the reanalysis data from the MARS archive. The computing facility are needed for the preparation of model simulations, pre- and postproduction of the simulations. In addition the simulations will be continued with increased intensity in the following years. In addition statistical techniques will be implemented and used as part of the ensemble simulations.

References:

Andersen, U.J., E.Kaas and P.Alpert (2001): Using analysis increments to estimate atmospheric heating rates following volcanic eruptions. GRL, Vol. 28, No. 6, 991-994

DETECT (Detection of changing radiative forcing over the recent decades), EU Project EVK2-CT-1999-00048 (2000-2003)

Gabriel, A., D.Peters, I.Kirchner and H.-F.Graf (2007): Effect of zonally asymmetric ozone on stratosphere temperature and planetary wave propagation. GRL, Vol. 34, L06807, doi: 10.1029/2006GL028998.

Kirchner, I. and D. Peters (2003): Modelling the wintertime response to upper tropospheric and lower stratospheric ozone anomalies over the North Atlantic and Europe. Annales Geophysicae 21, 2107-2118

POTENTIALS (Project on tendency evaluation using new techniques to improve atmospheric long-term simulations), EU project ENV4-CT97-0497 (1998-2000)