

REQUEST FOR A SPECIAL PROJECT 2013–2015

MEMBER STATE: Denmark

Principal Investigator¹: Dr. Shuting Yang

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Project Title: **Last Glacial Maximum and Mid-Holocene Climate in EC-Earth**

If this is a continuation of an existing project, please state the computer project account assigned previously.	SP _____	
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.)</small>	2013	
Would you accept support for 1 year only, if necessary?	YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Computer resources required for 2013-2015: <small>(The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2015.)</small>	2013	2014	2015
High Performance Computing Facility (units)	495000	495000	
Data storage capacity (total archive volume) (gigabytes)	5000	5000	

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): *April 30, 2012*

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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Extended abstract

Global climate models of the earth system have been widely used to provide projections of possible climate changes for future scenarios of increasing atmospheric CO₂ concentrations. These models are mostly validated by evaluations of their ability to reproduce the present-day climate. However, the ability to simulate the present-day is not a sufficient test of model capability and the ability to simulate future climate changes. Model inter-comparison studies reveal that models performing equally well for present-day may produce very different responses to likely changes in forcing in the future. Therefore an international effort, the Palaeoclimate Modelling Intercomparison Project (PMIP, <http://pmip.lsce.ipsl.fr/>), has been coordinated to evaluate and benchmark climate models by comparing simulations of past climate against palaeo-observations.

Two key periods in the past have been selected by PMIP as the initial focus for benchmarking climate models: the Last Glacial Maximum (LGM: ca 21,000 years ago; 21 ka) when the expansion of the continental ice sheets was most extensive during the last glacial cycle, and the mid-Holocene (MH: ca 6000 years ago; 6 ka) when the climate was significantly warmer than the present day. Sufficient global-scale observations for these periods are available for model evaluation. The LGM simulation is designed to examine the climate response to the presence of large ice sheets, cold oceans and low greenhouse gas concentrations. The MH simulation is to examine the climate response to a change in the seasonal and latitudinal distribution of incoming solar radiation caused by known changes in orbital forcing. Such climate simulations of the past conditions, can test the performance and reliability of state-of-the-art climate models when the external forcings were large and relatively well known and for which various types of geological evidence indicate what actually happened, thereby assessing the ability of these models to simulate radically different climates. These assessments may help us understand the climate sensitivity and identify the uncertainty in future climate projections.

In recent years the EC-Earth consortium has worked extensively to develop and improve the new climate model, EC-Earth, in corporation with the ECMWF. The EC-Earth model has been evaluated against the present-day climate and is currently applied as one of the CMIP5 models to carry out a large ensemble of historical and future scenario simulations following the CMIP5 protocol. These applications, together with all other CMIP5 simulations, form the basis for the assessment to the future climate change for the next IPCC assessment report (IPCC AR5). In this project, we will further test the EC-Earth model under the palaeo-conditions and evaluate the model performance at 6 ka (LGM) and 21 ka (MH). In particular, EC-Earth simulations at LGM and MH will be carried out following the PMIP experiment protocols for model benchmarking. These simulations will then be evaluated against the palaeo-observations and other climate models in PMIP to assess the EC-Earth performance. The climate feedback with different CO₂ and other greenhouse gas concentrations in these simulations will be compared with scenarios as simulated in the (existing) EC-Earth CMIP5 experiments. The response of the climate system, including the changes of the Arctic circulation, the North Atlantic overturning circulation, monsoons and tropical Pacific ENSO and its teleconnections, etc. will also be investigated.

Some references pertaining the proposed work:

Braconnot, P., B. Otto-Bliesner, S. Harrison, S. Joussaume, J.-Y. Peterchmitt, A. Abe-Ouchi, M. Crucifix, E. Driesschaert, Th. Fichefet, C. D. Hewitt, M. Kageyama, A. Kitoh, A. Laine, M.-F. Loutre, O. Marti, U. Merkel, G. Ramstein, P. Valdes, S. L. Weber, Y. Yu, and Y. Zhao, 2007: Results of PMIP2 coupled simulations of the Mid-

Holocene and Last Glacial Maximum – Part 1: experiments and large-scale features. *Clim. Past*, **3**, 261–277.
www.clim-past.net/3/261/2007/.

- Braconnot, P., B. Otto-Bliesner, S. Harrison, S. Joussaume, J.-Y. Peterchmitt, A. Abe-Ouchi, M. Crucifix, E. Driesschaert, Th. Fichefet, C. D. Hewitt, M. Kageyama, A. Kitoh, M.-F. Loutre, O. Marti, U. Merkel, G. Ramstein, P. Valdes, L. Weber, Y. Yu, and Y. Zhao, 2007: Results of PMIP2 coupled simulations of the Mid-Holocene and Last Glacial Maximum – Part 2: feedbacks with emphasis on the location of the ITCZ and mid- and high latitudes heat budget, *Clim. Past*, **3**, 279–296, <http://www.clim-past.net/3/279/2007/>.
- Hazeleger, W., X. Wang, C. Severijns, S. Stefanescu, R. Bintanja, K. Wysser, T. Semmler, S. Yang, B. van den Hurk, T. van Noije, E. van der Linden and K. van der Wiel, 2011: EC-Earth v2.2: description and validation of a new seamless earth system prediction model, *Clim. Dyn.*, doi:10.1007/s00382-011-1228-5
- Lü Jun-Mei, Seong-Joong Kim, Ayako Abe-Ouchi, Yongqiang Yu, Rumi Ohgaito, 2010: Arctic Oscillation during the Mid-Holocene and Last Glacial Maximum from PMIP2 Coupled Model Simulations. *J. Clim.*, **23**, 3792-3813.
- Otto-Bliesner, B. L., E. C. Bradygabriel Clauzet, R. Tomas, S. Levis, And Z. Kothavala, 2006: Last Glacial Maximum and Holocene Climate in CCSM3. *J. Clim.*, **19**, 2526-2544.
- PMIP: Palaeoclimate Modelling Intercomparison Project, <http://pmip.lsce.ipsl.fr/>.