REQUEST FOR A SPECIAL PROJECT 2013–2015

MEMBER STATE: Germany

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Project Title:

The global impact of explicitly resolving small-scale processes: A model study with the finite element sea-ice ocean model FESOM

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** _ SPDEJUNG	
Starting year: 2012 (Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)		
Would you accept support for 1 year only, if necessary?		NO

Computer resources required for 2013-2015: (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2015.)	**2013**	**2014**	**2015**
High Performance Computing Facility (units)	490000	490000	
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): 23.04.2012

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

It is expected that Special Projects requesting large amounts of computing resources (500,000 SBU or more) should provide a more detailed abstract/project description (3-5 pages) including a scientific plan, a justification of the computer resources requested and the technical characteristics of the code to be used. The Scientific Advisory Committee and the Technical Advisory Committee review the scientific and technical aspects of each Special Project application. The review process takes into account the resources available, the quality of the scientific and technical proposals, the use of ECMWF software and data infrastructure, and their relevance to ECMWF's objectives. - Descriptions of all accepted projects will be published on the ECMWF website.

The World Modelling Summit (WMS), which was held in May 2008 at ECMWF, called for a revolution in climate modeling to advance improvements in accuracy and reliability (Shukla et al. 2009). One of the promising ways forward highlighted at the WMS lies in the use of very high-resolution models which explicitly resolve meso-scale processes without the use of parametrizations. However, with the computer resources available at present it is impossible to run multi-decadal integrations with state-of-the-art climate models (or their sub-components) at such a high resolution. This is because present-day climate models use quasi-regular grids, that is, the same high resolution is used everywhere. It seems reasonable to expect that key-processes in some regions benefit more from increased resolution than those in others. Open ocean convection,for example, is only found in relatively small parts of the world ocean such as the Labrador Sea and Irminger Sea. Therefore it would be desirable to put the resolution where it is actually required. With this in mind, modeling efforts are underway to develop new global model systems which allow regional mesh-refinements in a global setting by employing dynamical cores based on unstructured grids.

At the Alfred-Wegener-Institute for Polar and Marine Research (AWI), a global Finite Element Sea-ice Ocean Model (FESPOM) has been developed (e.g., Danilov et al. 2004, Wang et al. 2008). So far, the focus at AWI (and other institutions developing similar models) has been on idealized cases or regional aspects (e.g., Wang et al. 2010). Little, if anything, is known about the potential of FESOM and other models employing unstructured grids for global, more climate-related applications. The aim of this study is to use FESOM to test the hypothesis that locally resolving important processes explicitly is beneficial for the simulation of the large-scale circulation and its variability. We expect to gain new insight into the role of small-scale processes for global climate and to improve our understanding of the benefit of using models based on unstructured meshes in climate research.

The mesh used in the proposed research is shown in Fig. 1. The highest resolution is put in Denmark Strait (3 km) and other parts of the high-latitude North Atlantic-Arctic region (about 8km). Resolution is also increased close to the coastline in order to ensure that the simulated mean ocean circulation looks reasonable (Wang et al. 2008). In other parts of the globe a relatively coarse resolution of about 130 km is used. The total number of 3D nodes in this configuration amounts to about $10 \cdot 10^6$. The results for the mesh depicted in Fig. 1 will be compared with a control integration in which the same number of 3D nodes is distributed equally across the globe (30km resolution). A comparison between the two experiments, which require the same amount of computing resources, will reveal the benefit that local refinement (stretching factor of about 40) has on the simulated climate and its variability. The experiments will cover the period 1958-2010 using a combination of ERA-40 and ERA-Interim data to force the model.

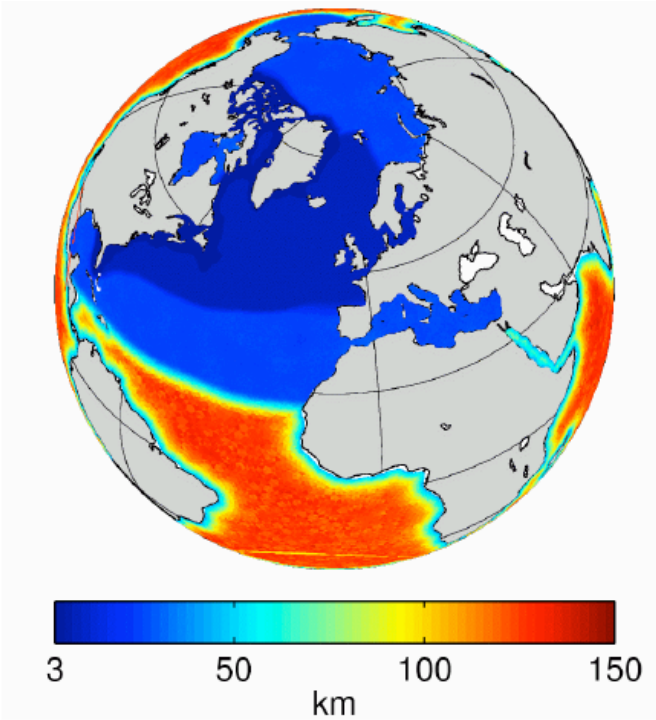

Figure 1: Horizontal resolution (in km) of the FESOM mesh used in the proposed study.

References

Shukla, J., R. Hagedorn, B. Hoskins, J. Kinter, J. Marotzke, M. Miller, T. Palmer and J. Slingo, 2009: Revolution in climate prediction is both necessary and possible: A declaration at the world modelling summit for climate prediction. Bull. Amer. Meteor. Soc., 90, 175-178.

Danilov, S., Kivman, G. and J. Schröter, 2004: A finite element ocean model: Principles and evaluation. Ocean Modelling, 6, 125-150.

Wang, Q., S. Danilov and J. Schröter, 2008: Finite element ocean circulation model based on triangular and prismatic elements with application in studying the effect of topography representation. J. Geophys. Res., 113, 148-227.

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