REQUEST FOR A SPECIAL PROJECT 2014–2016

MEMBER STATE: ……Denmark……..…

Principal Investigator[1]: ……Jens Hesselbjerg Christensen……..……

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Other researchers: ……Martin Stendel, Peter Langen……..……

……..……

Project Title: ……Permafrost in a changing climate: Formulating the proper ……

…… lower boundary condition in EC-Earth ……..……

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** _____	
Starting year: (Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)	2014	
Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for 2014-2016: (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2016.)	**2014**	**2015**	**2016**
High Performance Computing Facility (units)	450,000		
Data storage capacity (total archive volume) (gigabytes)	500		

*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):

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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: … Jens Hesselbjerg Christensen ……

Project Title: Permafrost in a changing climate: Formulating the proper lower boundary condition in EC-Earth

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.

A fundamental choice is made in the formulation of most if not all comprehensive coupled climate models: The lower boundary underlying land surfaces is characterized by a zero flux formulation. This requirement makes a lot of sense from many points of view, including the fact that this will avoid spurious or unaccountable sources and sinks of energy and moisture to the system that the model is established to model. In particular this is a very sensible approach in climate change simulations, where the role of atmospheric drivers is under inspection. However, it is also clear that such an approach have some limitation, in particular if the lower boundary is not far enough below the surface as the annual temperature signal does penetrate rather deep into the ground, depending on the actual location. This challenges the interpretation of the typical delta-change approach in studying climate change impacts on climate properties that is not directly handled by the model itself. This is particular the case over the major Ice Sheets, where simple soil schemes are not representing these realistically and therefore using climate model output to drive an of line Ice Sheet model is partially flawed by using input from a too simplistic formulation of the processes used in the climate model itself. This has led to a new generation of models, where the Ice Sheets are being treated consistently within the climate models as an integral part of the entire climate system (e.g. now available in EC-Earth).

In cold regions, underlain by permafrost something similar applies. The lowest model level in the soils is located less than 5 meters below the surface and thus the atmosphere. This is clearly not deep enough to reflect the penetration of transient temperature signals into the deeper layers (Nicolsky et al. 2007; Christensen et al. 2008). Little has been done to investigate this in any details and nothing is available in the scientific literature in support of firm conclusion about the role of the lower boundary in climate change experiments. In this project, we plan a set of simple tests. We will compare a standard coupled EC-Earth climate change experiment as it was submitted to CMIP5 with an experiment (historical and future scenario amounting to app. 250 simulation years), where we simply replace the lower zero flux boundary condition with another formulation in which we relax the deepest temperature to its climatology in regions where present day conditions are identified to be underlain by permafrost.. We expect to see a delay in the warming in Arctic regions, but we are not able to judge a priory how big this signal will be. The implications in a broader context – but beyond this special project – would be to work on a new formulation of the soil scheme to enable a better handling of the temperature signal in particular for cold climates.

References:

Christensen, J.H., M. Stendel, P. Kuhry, V. Romanovsky, and J. Walsh, 2008: Does Permafrost Deserve Attention in Comprehensive Climate Models, Editor(s): D.L. Kane and K.M. Hinkel Collection: Proceedings of the Ninth International Conference on Permafrost, June 29-July 3, Fairbanks, Alaska, 2008 Bibliography: Vol. 1, pp. 247-250.

Nicolsky, D.J, V.E. Romanovsky, V.A. Alexeev and D.M Lawrence, 2007: Improved modeling of permafrost dynamics in a GCM land-surface scheme. Geophys. Res. Lett., 34: L08501, doi: 10.1029/2007GL029525.