LATE REQUEST FOR A SPECIAL PROJECT 2013–2015

MEMBER STATE: Italy

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Project Title:

Performance analysis of the OpenMP+MPI version of the NEMO oceanic model

Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for 2013-2015: (The project duration is limited to a maximum of 3 years, agreed at the beginning of the project. For late requests the project will start in the current year.)	**2013**	**2014**	**2015**
High Performance Computing Facility (units)	100k		
Data storage capacity (total archive volume) (gigabytes)	100		

*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):

10 dec 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.

At present NEMO ocean model is parallelized using the Message Passing Interface (MPI) alone. This version performs well on core counts of up to a few thousand. However, the number of cores on CPUs and consequently, supercomputer nodes, continues to increase. Therefore, hybrid or mixed-mode parallelization is an attractive option for improving application scaling on large core counts. In this approach, maybe just one or two MPI processes are placed on each compute node. These processes are themselves parallelized using OpenMP to make effective use of the multiple cores on the node.
Several OpenMP approaches have been implemented. The simplest one is to parallelize the outermost loop of all the 3 level nested loops used in the code. The second approach is based on the tiling. The sub-domain assigned to each MPI process is divided into tiles. The operations over the tiles are distributed among the OpenMP threads. The dimension and shape of the tiles are key factors for better exploiting the cache hierarchy and hence strongly influence the overall performances. The last approach is based on flattening the nested loops in one "big" loop on all of the matrix elements and hence distributing the operation among the OpenMP threads. The proposed approaches have been applied in the tracer advection with MUSCL scheme (traadv_muscl) kernels and evaluated on an IBM power6 HPC cluster at CMCC, Italy, on HECToR Cray XE6 and on an iDataPlex based on Westmere processors.
The main goal of this project is to evaluate the computational performance of these hybrid parallel approaches on a Power7 based parallel architecture to identify bottlenecks and to estimate the real benefit for the climate community that uses the NEMO model for their simulations.