

Scientific and High-Performance Computing Internship Proposal
Implementation of an ocean-atmosphere coupled model using the XIOS software

A) The company and the work team

The Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique (CERFACS) works on solving scientific problems using modelling, digital simulation and high-performance computing. It brings together physicists, mathematicians, numerical analysts and computer scientists who design and develop innovative methods and software solutions to meet the needs of the aeronautics, space, climate, energy and environment sectors.

More specifically, the 'Climate Modelling and Global Change' team, in which the trainee will be working, plays a leading role in the French climate community, which appreciates its technical and scientific achievements, such as the OASIS3-MCT code coupler and several simulations of the coupled ocean-atmosphere system aimed at studying the climate, its variability and its evolution.

B) Background

The OASIS3-MCT coupler is currently used by more than 70 groups in France and around the world to couple codes modelling the components of the Earth system and thus produce climate models. In particular, OASIS3-MCT is used by the two French climate modelling groups, CNRM-CERFACS and IPSL, to assemble the CNRM-CM and IPSL-CM climate models. These models also use the XIOS input-output (IO) server developed at LSCE/CEA to write their results to disks. XIOS is used not only within a large community in France (IPSL, CNRM, IFREMER, IGE, MERCATOR) but also in Europe via the NEMO ocean model consortium. OASIS3-MCT and XIOS both offer communication functions (data exchange between model components or between the model and the disks) and data transformation functions (to switch from the grid of one component to that of the other or to carry out pre-processing before writing to disk). The latest version of the server, XIOS-3.0, has already been used to create a prototype coupled model in which coupling exchanges are managed by XIOS. The TRACCS PEPR¹ will fund climate modelling activities in France for 51 m€ over the next 8 years. In this context, CERFACS and CEA/LSCE plan to work together to merge these tools in order to be able to manage all the data movements (associated with component coupling or input-output) of our climate models via a single library, taking advantage of a single programming interface.

C) Internship topic

Currently, "toy" coupled models coded in Fortran (like our climate models) are available to test the functionalities of the OASIS3-MCT coupler. These toy models reproduce full-scale coupling exchanges, in terms of algorithms, grids and coupling field size, but do not model any physical or dynamic climate phenomena. It is therefore proposed here to upgrade one existing toy coupled models by replacing OASIS3-MCT with XIOS. The first objective is to assess the feasibility of using XIOS as a coupler. A comparison with the basic coupled toy model using OASIS3-MCT will be carried out in order to identify the functions that XIOS would lack to ensure optimal coupling in our climate models. A comparative performance

¹ Programmes et équipements prioritaires de recherche

study will also be carried out in order to evaluate the efficiency of XIOS for coupling high-resolution, highly-parallelized models running on high-performance computing platforms.

The work will be carried out in a UNIX environment on the Cerfacs "Kraken" LENOVO cluster and on the Atos Bull Sequena "Belenos" supercomputer at Météo-France. Knowledge of Fortran and C++ is recommended. The trainee will work alone on this project and will be supervised by Sophie Valcke, research engineer at Cerfacs, and Yann Meurdesoif, HPC engineer at CEA/LSCE.

Level: Master 2 or 3rd year of engineering school

Salary: An allowance of €650/month is offered.

Duration: 5 months

Application deadline: 01 March 2024

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