SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year	2022
Project Title:	EC-EARTH4: developing a next-generation European Earth System model based on ECMWF modelling systems
Computer Project Account:	SPNLTUNE
Principal Investigator(s):	Shuting Yang
Affiliation:	Danish Meteorological Institute
Name of ECMWF scientist(s) collaborating to the project (if applicable)	…… ……
Start date of the project:	01/01/2022
Expected end date:	31/12/2024

Computer resources allocated/used for the current year and the previous one

(if applicable)

Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)			100000000	0
Data storage capacity	(Gbytes)			90000	0

This template is available at:
http://www.ecmwf.int/en/computing/access-computing-facilities/forms

Summary of project objectives (10 lines max)

The project aims at supporting the development of configurations of the next generation of the EC-Earth global Earth-system model: EC-Earth4, based on OpenIFS and NEMO4. In particular the project will allow model experiments to be used in the tuning process, including AMIP runs aimed at determining model sensitivity to parameter changes, validation and testing of the model following the integration of new component cycles, experiments aimed at testing new parameterizations and new configurations and long coupled equilibrium experiments at intermediate resolution to assess model biases and to tune ocean parameters. Experiments with different model resolutions and different component configurations are planned. The activity will include the implementation of a continuous testing, tuning and software validation framework.

Summary of problems encountered (10 lines max)

Due to a longer than expected development cycle, the release of a GCM version of EC-Earth4, suitable for tuning and a first evaluation of biases is now planned only for end of summer 2022, slightly delaying the planned schedule for tuning and diagnostics experiments in SPNLTUNE. Since model tests so far were performed on external resources and on ECMWFs Atos BullSequana XH2000 (ATOS), with AMIP sensitivity experiments planned only later this year, the allocated resources have not yet been used.

Summary of plans for the continuation of the project (10 lines max)

The release of the EC-Earth4-GCM configuration (including a coupled and an AMIP configuration, CMIP6 forcing, simplified interactive aerosols and some tuning capabilities) is planned for the end of summer 2022. This version will be tested in SPNLTUNE by performing coupled runs (50y) under present-day conditions to identify the first major biases. We plan to use this version to perform in 2022 a first series of AMIP model runs (up to 20 years/run, 10 atmospheric parameters, at least 5 different parameter values, different model resolutions) aimed at determining model sensitivity to parameter changes to be used for tuning. Further we plan to implement a continuous testing procedure, including model diagnostics, allowing us to perform standardized experiments aimed at rapid tuning, with the goal of maintaining at all times a reasonably tuned version of the model in the main branch.

List of publications/reports from the project with complete references

None so far.

Summary of results

If submitted **during the first project year**, please summarise the results achieved during the period from the project start to June of the current year. A few paragraphs might be sufficient. If submitted **during the second project year**, this summary should be more detailed and cover the period from the project start. The length, at most 8 pages, should reflect the complexity of the project. Alternatively, it could be replaced by a short summary plus an existing scientific report on the project attached to this document. If submitted **during the third project year**, please summarise the results achieved during the period from July of the previous year to June of the current year. A few paragraphs might be sufficient.

The first months of this year were dedicated to developing a first technically working configuration of the model, the first version 4.0 was released on 04 Feb 2022 and is available at https://dev.ec-earth.org/projects/ec-earth-4/repository/show/ecearth4/tags/4.0. Since then the following EC-Earth

components have been updated in the trunk version: OpenIFS 43r3v2, NEMO 4.2, XIOS 2.5+ (trunk), OASIS3-MCT 5.0. Implementation of CMIP6 forcings is underway and a modal aerosol scheme with either strongly simplified chemistry or coupled to more comprehensive chemistry is being developed within the OpenIFS/AC project. Coupling of LPJ-GUESS to simulate dynamic vegetation in AMIP and GCM configurations has started. The implementation of an easy way to modify model tuning parameters from the runtime environment is under development.

It was decided to start proper model tuning waiting for the release of the EC-Earth4-GCM configuration at the end of this summer, a workable version of EC-Earth 4 for GCM and AMIP configurations, capable of running a limited set of CMIP6 experiment configurations.

In the meantime model tuning activities have been focused on the development of a new suite of software tools needed for model monitoring, diagnostics and tuning, which will be integrated in a complete model diagnostics workflow later this year. In particular the tools developed include a new online diagnostics tool , an updated version of a monitoring tool fully integrated in the model "ScriptEngine" scripting environment (https://scriptengine-tasks-ecearth.readthedocs.io/en/latest) and a new python-based lightweight parallelized tool for evaluation of basic properties of the model such as global mean, pattern correlation and climate model performance indices (ECmean4, https://github.com/oloapinivad/ECmean4).

Model development included porting of the model to ECMWF ATOS identifying the needed runtime environment and adapting the model script engine configuration. The model has now been tested and runs both in AMIP and coupled mode on ATOS with success, at both Tco95 and Tco199 atmospheric resolutions.