SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year	2017
Project Title:	High Resolution EC-Earth Simulations
Computer Project Account:	spienola
Principal Investigator(s):	Dr Paul Nolan Dr Sarah Gallagher
Affiliation:	Climate Research Department, Met Éireann
Name of ECMWF scientist(s) collaborating to the project (if applicable)	N/A
Start date of the project:	01/01/2016
Expected end date:	31/12/2018

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)	14,000,000	200,000	16,000,000	400,000
Data storage capacity	(Gbytes)	22,000	6,000	22,000	10,000

Summary of project objectives
(10 lines max)

The goal of the research is to simulate the effects of climate change at the global scale. The first component of the research involves tuning and testing the new version (3.2.2) of the EC-Earth Earth System Model (ESM) in preparation for the upcoming Coupled Model Intercomparison Project Phase 6 (CMIP6) contributions. Once the testing phase is complete, we will run a number of EC-Earth production runs which will comprise Ireland's contribution to CMIP6. CMIP6 will provide a framework for coordinated climate change experiments for the next number of years and thus will include simulations for assessment in the expected U.N. Intergovernmental Panel on Climate Change (IPCC) AR6 reports.

Summary of problems encountered (if any)
(20 lines max)

The EC-Earth community have delayed the start of the tuning work due to problems with the newest version of the model. The bugs are nearly completely fixed and the tuning work and running of simulations are due to start in the coming weeks/months. Because of these delays, a minimum number of core hours have been used to date on the ECMWF systems.

Summary of results of the current year

We have successfully implemented and performed scale-test experiments of ECEarth3.2.2 (trunk version) on ECMWF (cca/ccb). The Intel compilers were used with the standard ECEarth compile flags. The scaling results and crash information have been shared with the EC-Earth community so that the bugs can be identified and fixed.

We are currently running longer simulations with the aim to determine the source of the ECEarth remaining bugs. In particular, we are investigating the issue of an under-estimation of the global overturning circulation.

The standard ECEarth setup is somewhat computationally inefficient (on cca/ccb) since a full node (consisting of 36 cores) is utilised for each of the xios and runoff components. This would involve "wasting" up to 70 cores per run. We therefore tested setups whereby the xios and runoff components are shared on the IFS and NEMO nodes. The following strategies were tested:

i.   number of IFS cores = number of Nemo cores. One node each for xios and runoff.
ii. number of IFS cores = 2 x Nemo cores. One node each for xios and runoff.
iii. number of IFS cores = number of Nemo cores. xios and runoff shared (as described at subversion development / 2017 / r4059-aprun-mpmd-forking)
iv. number of IFS cores = 2 x Nemo cores. (xios and runoff shared as above)

Scaling results for a one-month simulation are presented in Figure 1. The scaling results have been shared with the EC-Earth community.
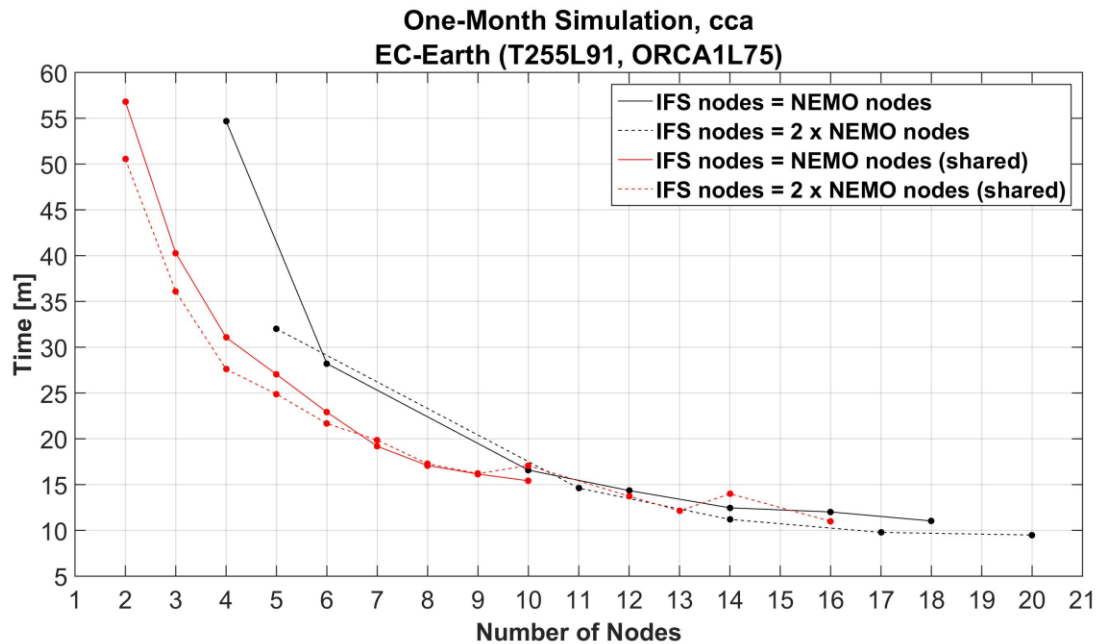
Figure 1. EC-Earth (T255L91, ORCA1L75) scaling results on ECMWF (cca) for a one-month simulation.

We have prepared pre-processing scripts to downscale the CMIP6 ECEarth data, using the WRF3.9 and COSMO-CLM5 RCMs. These simulations will provide high-resolution regional projections for Europe and Ireland.

We are currently implementing an experiment to assess the impacts of Methane on global warming. The experiment will involve running two long-term (200 years) EC-Earth simulations; one with actual and one with 2 x Methane concentrations in the atmosphere.

List of publications/reports from the project with complete references
N/A

Summary of plans for the continuation of the project

The EC-Earth tuning work will complete in the coming weeks. Once the tuning work is complete, the CMIP6 productions runs will commence.

After discussion with the EC-Earth community, Met Éireann/ICHEC are provisionally committed to running the following EC-Earth CMIP6 contributions:
- 5 x T255-ORCA1L75 AOGCM CMIP6 Historical Simulations, 1850-2014
- 5 x T255-ORCA1L75 CMIP6 ScenarioMIP-4 SSP3_70 Simulations 2015-2100
- 2 x T511L91-ORCA025L75 CMIP6 HighResMIP-2 1951-2050 Simulations (200 years).
- To evaluate the impact of increased resolution, the high resolution experiments will be repeated with the standard CMIP6 T255-ORCA1L75 resolution.

The planned simulations, outlined above, are a minimum estimation of our planned CMIP6 contributions.