SPECIAL PROJECT PROGRESS REPORT

Reporting year   2016

Project Title: High Resolution EC-Earth Simulations

Computer Project Account:

Principal Investigator(s):   Dr Paul Nolan
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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
Data storage capacity	(Gbytes)			22,000	6,000

Summary of project objectives

The first component of the proposed research will involve tuning and testing the new version (3.2) 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, Met Éireann will commit to running a number of CMIP6 EC-Earth production runs on the ECMWF ccb system. 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)

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 preliminary scale-test experiments of ECEarth3.2beta (beta version) on ECMWF (cca). The Intel compilers were used with the standard ECEarth compile flags. The scaling results and 'traceback' crash information have been shared with the EC-Earth community so that model bugs are identified and fixed.

We encountered some problems when running the coupled version (configuration "ifs nemo lim3 rnfmapper xios:detached oasis"). These errors were mostly of the form "20 LUDCMP Singular Matrix". A typical traceback message showed:
Calling traceback from intel_trbk()

Image	PC	Routine	Line	Source
ifsmaster-ecconf	0000000003A14C38	Unknown	Unknown	Unknown
ifsmaster-ecconf	000000000374841D	intel_trbk_	10	gentrbk.F90
ifsmaster-ecconf	000000000371A939	sdl_mod_mp_sdl_tr	66	sdl_mod.F90
ifsmaster-ecconf	00000000036F5AD8	mpl_abort_mod_mp_	35	mpl_abort_mod.F90
ifsmaster-ecconf	000000000371CAEC	abor1_	31	abor1.F90
ifsmaster-ecconf	0000000002BE045F	ludcmp_	64	ludcmp.F90
ifsmaster-ecconf	0000000002A70D02	cloudsc_	2554	cloudsc.F90
ifsmaster-ecconf	00000000298474D	callpar_	3442	callpar.F90
ifsmaster-ecconf	00000000025B0927	ec_phys_	787	ec_phys.F90
ifsmaster-ecconf	0000000001786BD6	ec_phys_drv_	402	ec_phys_drv.F90
ifsmaster-ecconf	0000000001756B50	gp_model_	553	gp_model.F90
ifsmaster-ecconf	0000000000A65757	scan2m_	548	scan2m.F90
ifsmaster-ecconf	0000000000A62C0B	scan2h_	107	scan2h.F90
ifsmaster-ecconf	00000000004510FA	stepo_	361	stepo.F90
ifsmaster-ecconf	0000000000411CE4	cnt4_	1087	cnt4.F90
ifsmaster-ecconf	0000000000411CE4	cnt3_	324	cnt3.F90
ifsmaster-ecconf	00000000004104F4	cnt2_	76	cnt2.F90
ifsmaster-ecconf	0000000000410321	cnt1_	116	cnt1.F90
ifsmaster-ecconf	00000000040FDED	cnt0_	154	cnt0.F90
ifsmaster-ecconf	00000000040F4E3	MAIN__	33	master.F90

It was noted that as the number of MPI processes were increased (>= 320), these problems became less common. Although not practical, we found that relaxing the compile flags reduced the number

of crashes (e.g. removing "-fp-model precise" and "-fpe0"). These errors are due to bugs in the EC-Earth model and are not related to the ECMWF system.

A number of 30-day simulations were run to scale test the model. Scaling results for a one-month simulation are presented in Figure 1(a) (IFS processes = NEMO processes) and Figure 1(b) (IFS processes = 2 x NEMO processes). In each case, one core was used for both xios and rnfmapper. A one-year coupled simulation successfully completed without any problems. Longer simulations are currently being tested. The scaling results demonstrate that the simulations of the proposed project can be run within the project lifetime. Furthermore, the analysis establishes the optimal number of CPUs to request per run, while striking a balance between run-time and use of computational resources.
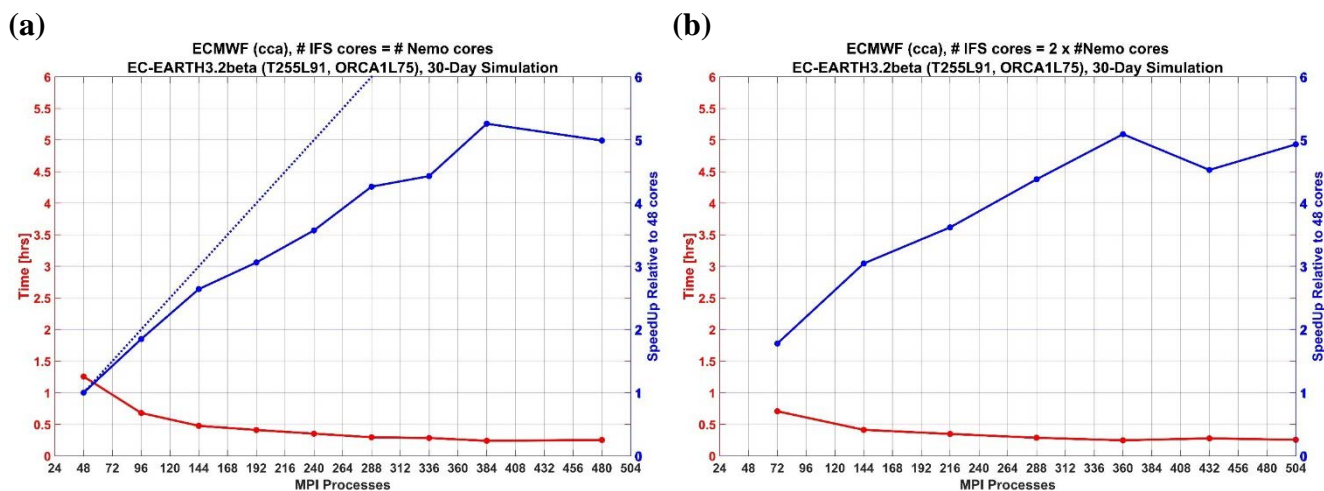
(a) **(b)**

Figure 1. EC-Earth (IFS T255L91,ORCA1L75) timings (red line) and speedup (blue line) for a one-month simulation on ECMWF cca. The dashed blue line represents the ideal speedup. (a) The ratio of IFS cores to NEMO cores is 1:1, (b) the ratio of IFS cores to NEMO cores is 2:1. Here the speedup is relative to 48 cores of (a)

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 commence in the coming weeks. We will mostly focus on this work from July to ~Oct 2016. Once the tuning work is complete, the CMIP6 productions runs will commence.

After discussion with the EC-Earth community, EPA/Met Éireann 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.