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	2021
Project Title:	HARMONIE Climate (HCLIM) Regional Downscaling Simulations for Ireland
Computer Project Account:	spiemcgo
Principal Investigator(s):	Jonathan McGovern, Met Éireann John Hanley, Met Éireann
Affiliation:	Met Éireann
Name of ECMWF scientist(s) collaborating to the project (if applicable)	
Start date of the project:	2019
Expected end date:	2021… 2022 * * Project will finish end 2021, see request for special project 2022-2024 for 1-year continuation of project

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)	20 million (+10 million *)	30 million	18 million (+4.5 million *)	17.9 million
Data storage capacity	(Gbytes)	35,000	90,000	45,000	110,000

* additional resources were applied for in 2020 and this year 2021

Summary of project objectives (10 lines max)

The aim of this project is to produce and assess a set of future climate projections for Ireland by downscaling EC-Earth (EC-Earth 3 (Döscher et al, 2021)) CMIP6 global climate model output using HCLIM, a regional climate model based on the HARMONIE NWP modelling system (Bengtsson et al., 2017). HCLIMv38 (Belusic et al. 2020) was used. A two-stage downscaling approach is taken (global –> 12km –> 4km) with three experiments planned:

Experiment 1: HCLIM driven by lateral boundary conditions from ERA5 for the period 1981-2000. This run will be used to validate Experiment 2.

Experiment 2: HCLIM driven by lateral boundary conditions from an EC-Earth CMIP6 ensemble member for the present-day period 1981-2015. This run will be used as a reference for Experiment 3.

Experiment 3: HCLIM driven by lateral boundary conditions from EC-Earth CMIP6 ensemble members for the "future" period 2015-2100, simulated using the ScenarioMIP "Tier 1" Shared Socioeconomic Pathways (SSPs); SSP2–4.5 and SSP5–8.5.

Summary of problems encountered (10 lines max)

The EC-Earth CMIP6 simulations were delayed due to technical problems, which in turn delayed the start of this project. A bug in the latest version of HCLIM when downscaling to 4km using HARMONIE-AROME physics was also discovered during testing and was resolved with the help of the HCLIM partners.

Production runs began in Q4 2020

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

Experiments 1 and 2 have been completed. There are insufficient remaining computational resources to complete all of Experiment 3, namely downscaling both SSP2–4.5 and SSP5–8.5 scenarios. The remainder of the project will instead focus on downscaling the SSP2–4.5 scenario only. A new project proposal for a 1-year continuation of this project with the goal of downscaling the SSP5–8.5 scenario has been submitted for 2022.

The SSP2–4.5 scenario was chosen as it represents the medium part of the range of future forcing pathways (O'Neill et al., 2016). The 12km and 4km downscaling runs of this scenario are on schedule to finish by the end of August 2021. Basic sanity checks of all completed runs have been performed where the downscaled output was compared with the original ERA5 and EC-Earth data. A more in-depth validation is underway and will be included in the end-of-project report.

List of publications/reports from the project with complete references

N/A

Summary of results

Production runs

A two-stage approach was used for the downscaled runs of the planned Experiments 1, 2 and 3. Data was downscaled first to 12 km over a domain covering Ireland and Western Europe with HARMONIE-ALADIN physics and subsequently to 4 km with HARMONIE-AROME physics over a domain covering Ireland and UK. The domains are shown in Fig. 1.

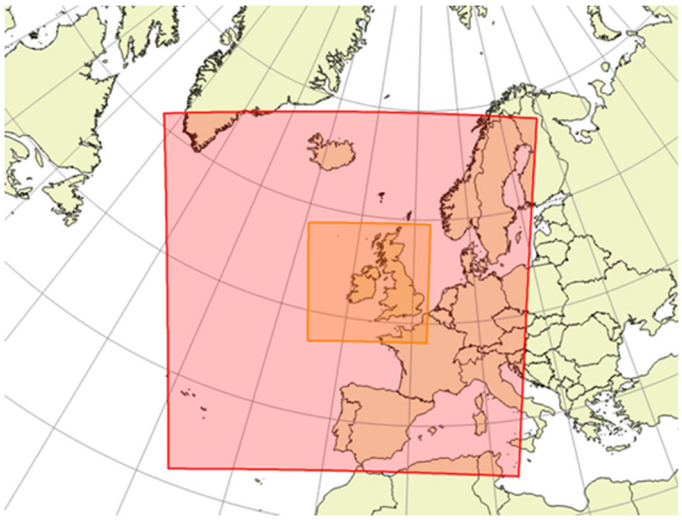

Fig.1 *Domains of the 12 km resolution (red) and 4 km resolution runs (orange)*

Experiments 1 and 2, the ERA5 and historical EC-Earth runs, have been completed. One of the runs of Experiment 3, the SSP2-4.5 ScenarioMIP scenario run, is currently underway; as of the end of June 2021 it has completed to 2080. We have sufficient resources to complete this run by August 2021.

Data preparation

Before downscaling the EC-Earth runs (Experiments 2 and 3), the raw EC-Earth CMIP6 data had to be made compatible with HCLIM, a step required for downscaling CMIP6 EC-Earth runs. Working scripts from HCLIM partners at SHMI were developed for this in 2020 and the latest version of these were modified, adapted and implemented to convert the raw IFS and NEMO EC-Earth grib files. Converted grib files were produced and these could then be used as input for the EC-Earth runs.

Validation

Experiment 1 is used to validate Experiment 2. Validation of runs started in 2021 and is ongoing. Basic sanity validation checks of all runs have been carried out whereby the downscaled HCLIM output was compared with the original ERA5 and EC-Earth data, and further validation tests of the ERA5 and EC-Earth runs are underway.

The spatial distribution of temperature, mean sea level pressure, magnitude of wind speed and precipitation of HCLIM output, at different time steps from January over 1980 to 2001, were compared. Output from the 12 km and 4 km ERA5 HCLIM runs was compared directly to that of the ERA5 dataset, and output from the 12 km and 4 km historical EC-Earth HCLIM run compared to EC-Earth model output. The ERA5 run (Experiment 1) and historical EC-Earth run (Experiment 2) performed well, with

spatial patterns matching well overall. Output from the future EC-Earth SSP2-4.5 HCLIM runs was compared to EC-Earth model output. This run also performed well, with spatial patterns also found to match well overall.

Further in-depth validation tests are currently underway and will be presented in the final report.

Next steps

The SSP2-4.5 run of Experiment 3 will complete this year, and it is intended to carry out the second of the proposed runs of Experiment 3, the high emission future SSP5-8.5 scenario run, next year (see the request for a 1-year continuation of this project (Request for a Special Project 2022–2024)).

References

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