

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: HARMONIE Climate (HCLIM) Regional Downscaling Simulations for Ireland

Computer Project Account: spiemcgo

Principal Investigator(s): 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: 2023 *

* Project is scheduled to finish end 2022. See request for special project 2023-2025 for 1-year continuation of the project to 2023.

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)	18 million (+4.5 million *)	22.5 million	25 million	20 million
Data storage capacity	(Gbytes)	35,000	90,000	45,000	110,000

* additional resources were applied for in 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 CMIP6 climate data using HCLIM (Belusic et al. 2020), a regional climate model based on the HARMONIE NWP modelling system (Bengtsson et al., 2017). 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 an EC-Earth CMIP6 ensemble member for the “future” period 2015-2100, simulated using two 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. Experiments 1 and 2 were completed in early 2021. The SSP2–4.5 part of Experiment 3 was completed in Q4 2021, while the SSP5–8.5 run is underway and is on track to be completed in Q3 2022.

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

The future scenario runs in Experiment 3 will form part of a downscaled CMIP6 ensemble for Ireland comprising of output from EC-Earth CMIP6 simulations downscaled using the WRF, COSMO-CLM, COAWST and HCLIM regional climate models. This ensemble will serve as a crucial input to Met Éireann’s TRANSLATE project, a 2-year project to standardise national climate projections for Ireland: <https://www.met.ie/science/translate>.

TRANSLATE requires downscaled simulations for all four main SSP scenarios. Therefore, EC-Earth CMIP6 SSP1–2.6 and SSP3-7.0 scenarios remain to be downscaled using HCLIM after the planned SSP2–4.5 and SSP5–8.5 scenarios in Experiment 3 have been completed. Met Éireann has sufficient computational resources to complete downscaling of the SSP1–2.6 scenario. A new project proposal for a 1-year continuation of this project with the goal of downsampling the SSP3–7.0 scenario has been submitted for 2022.

List of publications/reports from the project with complete references

N/A

Summary of results

Production runs

A two-stage approach was used to downscale. EC-Earth 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.

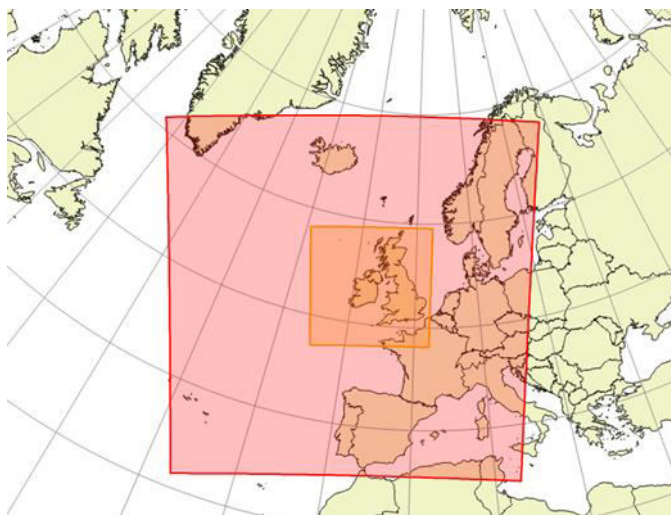


Fig.1 Domains of the 12 km resolution (red) and 4 km resolution runs (orange)

Experiments 1 and 2 have been completed, as well as run SSP2-4.5 of Experiment 3. The remaining Experiment 3 run, SSP2-4.5, is currently underway. As of the end of June 2022 it has completed to 2080 and is expected to be completed by August 2022.

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 has started 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 June 2022

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 and SSP5-8.5 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 SSP5-8.5 run of Experiment 3 will be completed later this year. We intended on carrying out an additional future scenario downscaling run of the SSP3-7.0 scenario next year (see the request for a 1-year continuation of this project).

References

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