

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 2020.....

Project Title: HARMONIE Climate (HCLIM) Regional Downscaling Simulations for Ireland.....

Computer Project Account:spiemcgo.....

Principal Investigator(s): Jonathan McGovern,
Met Eireann

Paul Nolan,
Irish Centre for High End Computing (ICHEC)
and Met Eireann

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Affiliation:Met Eirean,
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Name of ECMWF scientist(s) collaborating to the project
(if applicable)

Start date of the project:2019.....

Expected end date:2021.....

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)	22M	65000	20M	*6000
Data storage capacity	(Gbytes)	15,000	0	35,000	*0

*Expect to use this in second half 2020, and allocation in 2021, as runs will begin

Summary of project objectives (10 lines max)

This project aims to assess the future projections of Ireland and Europe by downscaling CMIP6 EC-Earth global climate data, using the climate mode of HARMONIE model (Bengtsson et al., 2017), HCLIM. Downscaling for Ireland has been carried out with the previous CMIP5 global data. These HCLIM simulations will serve to update the previous CMIP5 Ireland projections. A number of simulations – present and 21st Century – will be carried out.

Summary of problems encountered (10 lines max)

There were issues regarding making CMIP6 EC-Earth data compatible with HCLIM (see summary of results).

With the EC-Earth3 CMIP6 simulations commencing later than previously expected, the timeline for this project has been shifted. I have been involved and focussing in the second half of 2019 on this (validation, monitoring, runs, cmorisation...). Five historical and 20 ScenarioMIP simulations were carried out. The historical simulations were validated against CRU observational and ECMWF ERA5 reanalysis datasets. At the end of 2019, an additional bug was discovered in the tool used to cmorise the raw EC-Earth model data – to get it compatible with CMIP6 conventions for availability on the EGFS node. A script was implemented, and once this was fixed early 2020, the EC-Earth data were re-cmorised in spring 2020.

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

There has been delay to the timeline to the project, though we intend to carry out the downscaling runs over the second half of this year and finish runs in 2021. Up to the end of 2019 I have been focussing on EC-Earth, and so far in 2020 preparing the global CMIP6 data for downscaling with HCLIM. I have used some of my account SBUs to date (June) to make EC-Earth data compatible with HCLIM, and carry out 1 day HCLIM test runs. Most of the SBU usage started in June, when the latest script was available to convert EC-Earth to CMIP6 data (see summary of results). Since June I have begun to do further 1 day HCLIM run tests.

We do intend to use the remaining account SBU's and into 2021 for the downscaling, and thus ask for the proposed resources in 2021.

	2021	2022
HPCF allocation [SBU]	18000000	-
Data allocation [GB]	45000	-

Experiments 1 and 2 will be performed in the second half of 2020, and envisaged that experiment 3 complete in 2021.

List of publications/reports from the project with complete references

N/A

Summary of results

The goal of this project is to carry out downscaling of CMIP6 (Eyring et al., 2016) data using HCLIM.

EC-Earth work for CMIP6

This project consists of three experiments including the downscaling of EC-Earth CMIP6 Historical (1850-2015) (Experiment 2) and ScenarioMIP future (Experiment 3) simulations (2015-2100). I was involved in and focussed in 2019 on the EC-Earth3 work for CMIP6 (validation, monitoring, runs, cmorisation of these Historical and ScenarioMIP run), and then got Historical and ScenarioMIP CMIP6 data compatible with HCLIM in 2020.

CMIP6 compatibility for HCLIM downscaling

A necessary step that is need prior to these runs being carried out is to make CMIP6 data compatible with HCLIM, since the original raw EC-Earth IFS grib files are not readable by Harmonie/HCLIM.

CMIP6 compatibility for HCLIM. After the EC-Earth work in 2019, I focussed on getting HCLIM ready for CMIP6 in 2020, so that it can now be used in the second half of 2020 and 2021 to downscale CMIP6 data.

At the end of 2019 I got the script to make the previous EC-Earth CMIP5 data compatible with HCLIM working, and since the start of 2020, have been preparing HCLIM for CMIP6. I have processed the EC-Earth CMIP6 data and made it compatible

with HCLIM, ensured this new data can be downscaled with HCLIM, and kept up to date with the latest updates of HCLIM for CMIP6.

Model levels of EC-Earth CMIP6 data, and generally for CORDEX have been saved from about 1950. EC-Earth data with model level saved was made compatible with HCLIM. To get the EC-Earth data compatible with HCLIM, boundary conditions orography and land sea mask for CMIP6 were read.

To get the CMIP6 data compatible with HCLIM, the script to get CMIP5 data compatible with HCLIM was used initially. This was modified to adjust parameters and name files specific for CMIP6. This script had to be modified to deal with an issue with velocities in CMIP6. More recently in June 2020, a new modified script was issued for CMIP6. EC-Earth data files compatible with HCLIM, were successfully produced for CMIP6 with this latest script in June 2020. To make the EC-Earth data compatible the script needs and reads in the input EC-Earth file from the month before the start of a given run is needed (December 1999 file needed for a run starting in 2000, for example).

Parameters from EC-Earth atmospheric IFS output (temperature, precipitation, wind) which is the focus and ocean NEMO output (sea ice concentration, sea surface temperature, ice temperature) were made compatible with HCLIM. The output files produced with the scripts are 6 hourly files, with 20 variables.

The scripts were tested by converting 1 year of data from a certain year with model levels saved. Files from 2010 from Historical (1850-2015) runs and 2020 from ScenarioMIP (2015-2100) were chosen. Files from December 2009 were used to process data from 2010, December 2019 files was used to process data from 2020.

Once files were produced, 1-day test runs were carried out to ensure HCLIM could read these new HCLIM-EC-Earth input files.

HCLIM for CMIP6

HCLIM38 (Belušić et al., 2020) will be used to downscale the data. I have kept up to date with HCLIM38h1 developments for CMIP6. In May 2020, there was a further update in HCLIM for CMIP6, regarding options for choosing which greenhouse gases used. I have done 1-day tests with the new version of HCLIM for CMIP6.

Downscaling

Temperature, precipitation and wind were downscaled for Ireland with the previous CMIP5 (O'Sullivan 2015; Nolan, 2017). These projections will be updated with the now available CMIP6 data.

With Historical and ScenarioMIP CMIP6 EC-Earth data now available, and HCLIM now working successfully with converted CMIP6 EC-Earth data, the project is at the stage to progress with runs (Experiments), which we intend to carry out over the summer, and start of next year. Experiments 1 and 2 will be performed in the second half of 2020, and envisaged that experiment 3 start and complete in 2021.

We thus ask for the proposed resources in 2021.

	2021	2022
HPCF allocation [SBU]	18000000	-
Data allocation [GB]	45000	-

References

Belušić, D. et al., 2020, HCLIM38: A flexible regional climate model applicable for different climate zones from coarse to convection permitting scales, *Geosci. Model Dev.*, 13, **1311–1333**

Eyring, V., Bony, S., Meehl, G. A., Senior, C. A., Stevens, B., Stouffer, R. J., and Taylor, K. E.: Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) experimental design and organization, *Geosci. Model Dev.*, 9, **1937-1958**, <https://doi.org/10.5194/gmd-9-1937-2016>, 2016.

Nolan, P., O'Sullivan, J., & McGrath, R. (2017). Impacts of climate change on mid-twenty-first-century rainfall in Ireland: a high-resolution regional climate model ensemble approach. *International Journal of Climatology*

O'Sullivan, J., Sweeney, C., Nolan, P. and Gleeson, E., 2015. A high-resolution, multi-model analysis of Irish temperatures for the mid-21st century. *International Journal of Climatology*. doi: 10.1002/joc.4419