



Horizon 2020 Societal challenge
5: Climate action, environment,
resource efficiency and raw materials

CONSTRAIN
Constraining uncertainty of multi-decadal climate projections
GA number 820829
H2020-LC-CLA-2018-2

Deliverable number (relative in WP)	D4.11
Deliverable name:	Full documentation of the improved emulators in the form of a technical report or a model presentation publication for FAIR and OSCAR
WP / WP number: 4	
Delivery due date:	Project month 42 (31/12/2022)
Actual date of submission:	31/12/2022
Dissemination level:	Confidential
Lead beneficiary:	CNRS, UNIVLEEDS
Responsible scientist/administrator: Lawrence Jackson (UNIVLEEDS)	
Contributor(s):	Thomas Gasser (IIASA) Lawrence Jackson (UNIVLEEDS) ...
Internal reviewer:	Piers Forster

1.Changes with respect to the DoA

Deferred the delivery date from M36 (30 June 2022) this was to allow more time for development work and recruitment, ensuring scientific quality

2.Dissemination and uptake

Published academic papers and code for use by the wider academic community and decision makers. Results shared within the project.

3. Short Summary of results (< 250 words)

Climate patterns for impact (FaIR)

As described for deliverable D4.10, our results show that spatial patterns of SST in climate model projections are weaker than in observational datasets for the historical period. The methods tested for characterising SST patterns and modelling their impact on radiation fluxes at the top of atmosphere had weak predictive skill in out-of-sample tests. We have produced the following outputs for this deliverable and deliverable D4.10:

- A technical note summarising our results emulating the pattern effect.
- A paper published in Geophysical Research Letters on the limitations of emulator projections.
- A paper in review on pattern scaling errors in regional climate model emulations.

OSCAR

The contribution of OSCAR to the IPCC 6th assessment report and to the reduced complexity model intercomparison project (RCMIP) allowed a thorough diagnosis of the model, which culminated in an evaluation paper that compares the behaviour of OSCAR against that of complex models for close to 100 experiments from CMIP5 and CMIP6.

As a number of shortcomings and development leads were identified, a reduced-form version of OSCAR was further created (dubbed Pathfinder). Its main role was to explore advanced Bayesian calibration techniques using AR6 and CMIP6 data, with the goal of applying the same technique to the fully fledged model. This led to a comprehensive model description paper.

4. Evidence of accomplishment

- Technical note summarising the predictive skill achieved emulating the impact of SST patterns on out-of-sample projections for future global mean temperatures.
- Publication highlighting limitations in out-of-sample projections produced by climate model emulators such as FaIR:
Jackson, L. S., Maycock, A. C., Andrews, T., Fredriksen, H.-B., Smith, C. J., & Forster, P. M. (2022). Errors in simple climate model emulations of past and future global temperature change. *Geophysical Research Letters*, 49, e2022GL098808.
<https://doi.org/10.1029/2022GL098808>
- Manuscript in review highlighting pattern scaling errors in regional climate model emulation:
Wells, C. D., Jackson, L. S., Maycock, A. C., and Forster, P. M.: Understanding pattern scaling errors across a range of emissions pathways, *EGUsphere* [preprint], <https://doi.org/10.5194/egusphere-2022-914>, 2022.
- Manuscript in review with the journal GMD providing validation and show casing the performance and behaviour of OSCAR v3.1:
Quilcaile et al. CMIP6 simulations with the compact Earth system model OSCAR v3.1. <https://gmd.copernicus.org/preprints/gmd-2021-412/>
- Model description paper (accepted) for the Pathfinder model:
Bossy, T., Gasser, T., and Ciais, P.: Pathfinder v1.0: a Bayesian-inferred simple carbon-climate model to explore climate change scenarios, *EGUsphere* [preprint], <https://doi.org/10.5194/egusphere-2022-802>, 2022.
- In addition, both OSCAR and Pathfinder come with an evolving manual:
<https://github.com/tgasser/OSCAR/blob/master/MANUAL.md>
<https://github.com/tgasser/Pathfinder/blob/master/MANUAL.md>