

Interactive comment on “FalRv2.0.0: a generalised impulse-response model for climate uncertainty and future scenario exploration” by Nicholas J. Leach et al.

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We thank both Glen Peters and one anonymous reviewer for their comments and suggestions. We have attempted to address each comment in turn, with point-by-point responses in the separate response documents. In addition to our responses to the specific comments made by the reviewers, we have also updated the manuscript in a number of other places. These changes aim to ensure the text and model is fully up-to-date with the current state of the literature, and make several improvements to the transparency and robustness of the analysis within the manuscript. These additional changes are set out directly below.

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We now use emission data solely from RCMIP throughout, for reasons of consistency and transparency.

We use CMIP6 data from <https://cmip6.science.unimelb.edu.au/> where possible throughout, processed as set out in Nicholls et al., 2021. This includes the CMIP6 tunings.

Updates to the default parameterisation:

We have updated the ozone parameterisation in line with the recent studies from Thornhill et al., 2021, and Skeie et al., 2020. This parameterisation means we no longer distinguish between tropospheric & stratospheric ozone.

The default aerosol parameters are now set to be equal to the central values of the CONSTRAINED ensemble.

The default climate response is set to be equal to the central response of the CONSTRAINED ensemble.

We now include (where data is available) verification runs for the CMIP6 climate response emulation, using the abrupt-2xCO₂ and abrupt-0p5xCO₂ experiments as verification experiments for the tunings (which are computed using the abrupt-4xCO₂ and 1pctCO₂ experiments). However, these data are not available for all models we emulate, so we cannot verify the tuned parameters for each model.

We have updated the constraint methodology used to determine CONSTRAINED parameter sets from the FULL ensemble. Before, we used a simple pass/fail criterion based on the global warming index calculation (GWI, Haustein et al., 2017). While this was very straightforward, it did not make full use of the GWI, which provides an estimate of the distribution of current level and rate of warming; and additionally it sampled from regions of exceptionally low likelihood in level/rate space. In our updated constraint, we set the probability of selecting an individual ensemble member equal to the likelihood of the present-day level & rate of warming as determined by the GWI. This is

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a significantly stricter criterion (only ~8 % of the FULL ensemble is retained).

Within this new constraint methodology, in addition to the sensitivity to prior assumptions on climate response, we also test the sensitivity to the observational dataset used to compute the GWI (particularly relevant with the arrival of HadCRUT5). This demonstrates how future projections can be impacted by the choice of observational dataset used in such a constraining procedure. We believe that this additional test of sensitivity is particularly useful given the several recent papers that use observed warming to constrain future projections.

References:

Nicholls, Z., Lewis, J., Makin, M., Nattala, U., Zhang, G. Z., Mutch, S. J., ... Meinhäuser, M. (2021). Regionally aggregated, stitched and de-drifted CMIP climate data, processed with netCDF-RSCM v2.0.0. *Geoscience Data Journal*, 00, gdj3.113. <https://doi.org/10.1002/gdj3.113>

Thornhill, G. D., Collins, W. J., Kramer, R. J., Olivé, D., Skeie, R. B., O'Connor, F. M., ... Zhang, J. (2021). Effective radiative forcing from emissions of reactive gases and aerosols – a multi-model comparison. *Atmospheric Chemistry and Physics*, 21(2), 853–874. <https://doi.org/10.5194/acp-21-853-2021>

Skeie, R. B., Myhre, G., Hodnebrog, Ø., Cameron-Smith, P. J., Deushi, M., Hegglin, M. I., ... Wu, T. (2020). Historical total ozone radiative forcing derived from CMIP6 simulations. *Npj Climate and Atmospheric Science*, 3(1), 1–10. <https://doi.org/10.1038/s41612-020-00131-0>

Haustein, K., Allen, M. R., Forster, P. M., Otto, F. E. L., Mitchell, D. M., Matthews, H. D., & Frame, D. J. (2017). A real-time Global Warming Index. *Scientific Reports*, 7(1), 15417. <https://doi.org/10.1038/s41598-017-14828-5>

Geoffroy, O., Saint-Martin, D., Olivé, D. J. L. L., Voldoire, A., Bellon, G., Tytéca, S., ... Tytéca, S. (2013). Transient Climate Response in a Two-Layer Energy-Balance

Model. Part I: Analytical Solution and Parameter Calibration Using CMIP5 AOGCM Experiments. *Journal of Climate*, 26(6), 1841–1857. <https://doi.org/10.1175/JCLI-D-12-00195.1>

Cummins, D. P., Stephenson, D. B., & Stott, P. A. (2020). A new energy-balance approach to linear filtering for estimating effective radiative forcing from temperature time series. *Advances in Statistical Climatology, Meteorology and Oceanography*, 6(2), 91–102. <https://doi.org/10.5194/asmo-6-91-2020>

Tsutsui, J. (2020). Diagnosing Transient Response to CO₂ Forcing in Coupled Atmosphere–Ocean Model Experiments Using a Climate Model Emulator. *Geophysical Research Letters*, 47(7). <https://doi.org/10.1029/2019GL085844>

Nicholls, Z., Meinshausen, M., Lewis, J., Gieseke, R., Dommenges, D., Dorheim, K., . . . Xie, Z. (2020). Reduced complexity model intercomparison project phase 1: Protocol, results and initial observations. *Geoscientific Model Development Discussions*, 1–33. <https://doi.org/10.5194/gmd-2019-375>

Nicholls, Z. R. J., Meinshausen, M. A., Lewis, J., Rojas Corradi, M., Dorheim, K., Gasser, T., . . . et al. (2020). Reduced Complexity Model Intercomparison Project Phase 2: Synthesising Earth system knowledge for probabilistic climate projections. *Earth and Space Science Open Archive*, 29. <https://doi.org/10.1002/ESSOAR.10504793.1>

Millar, R. J., Nicholls, Z. R., Friedlingstein, P., & Allen, M. R. (2017). A modified impulse-response representation of the global near-surface air temperature and atmospheric concentration response to carbon dioxide emissions. *Atmospheric Chemistry and Physics*, 17(11), 7213–7228. <https://doi.org/10.5194/acp-17-7213-2017>

Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2020-390>, 2020.

