Potsdam Institute for Climate Impact Research
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Selection of GCMs for ISIMIP -

Best(?) practice under constraints

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Step 0: The usual situation

We are in a hurry between the availability of the next generation of CMIP simulations and the next IPCC Report….

We cannot wait for the entire CMIP ensemble if we want to keep a chance to provide CMIPX based impact simulations for the next IPCC ARX

Step 1: Data availability

Variable	Specifier	Resolution
Near-Surface Relative Humidity	**hurs**	0.5° grid, daily
Precipitation (including snowfall)	**pr**	0.5° grid, daily
Snowfall	**prsn**	0.5° grid, daily
Surface Air Pressure or sea level pressure (psl)	**ps or psl**	0.5° grid, daily
Surface Downwelling Longwave Radiation	**rlds**	0.5° grid, daily
Surface Downwelling Shortwave Radiation	**rsds**	0.5° grid, daily
Near-Surface Wind Speed or zonal wind components	**sfcwind or uas and vas**	0.5° grid, daily
Near-Surface Air Temperature	**tas**	0.5° grid, daily
Daily Maximum Near-Surface Air Temperature	**tasmax**	0.5° grid, daily
Daily Minimum Near-Surface Air Temperature	**tasmin**	0.5° grid, daily

Set of models that:

- provide **all required atmospheric variables in daily resolution**
- for selected ScenarioMIP scenarios
- at least 500 years of picontrol

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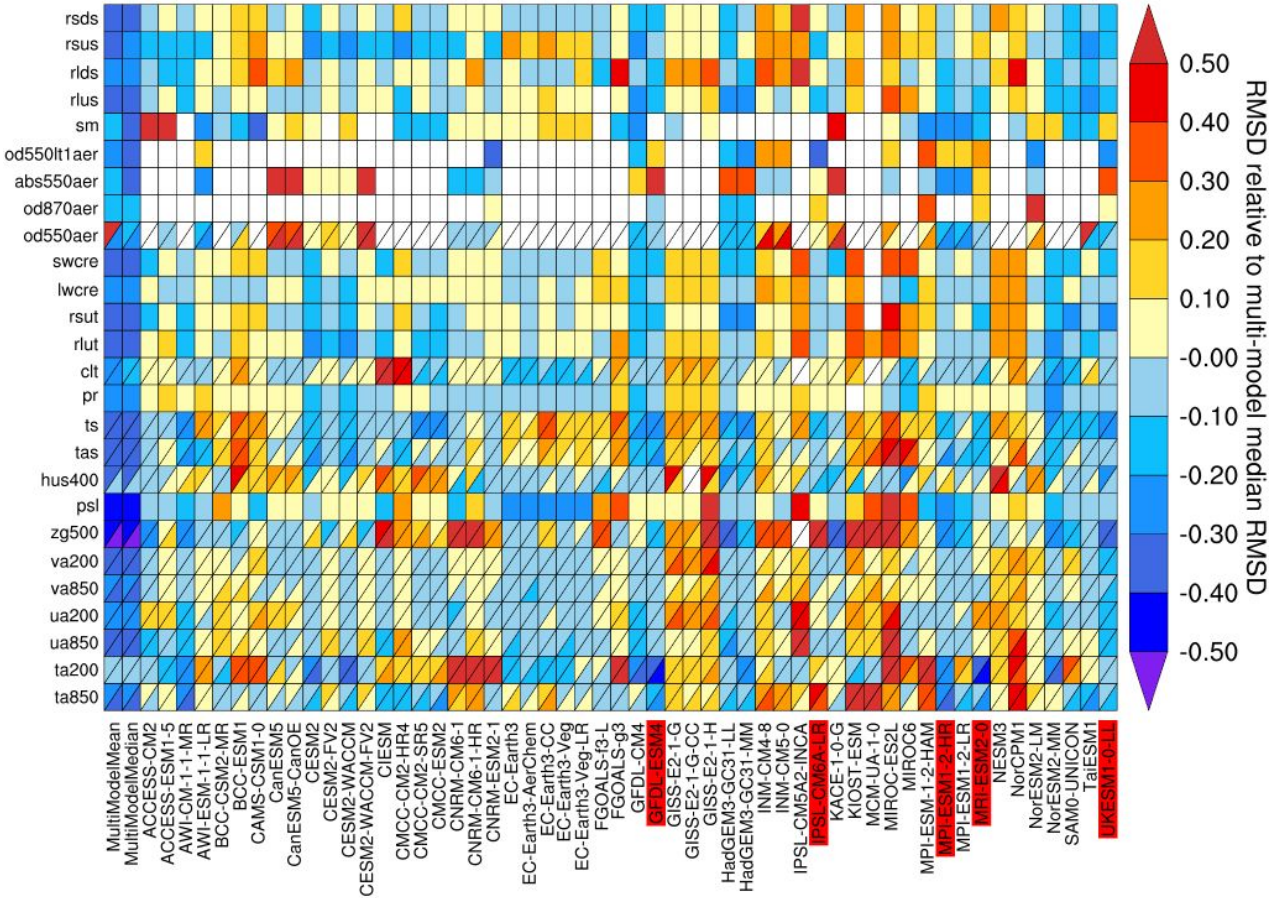
Step 1.1: check for further data

- We also check for all the required oceanic forcings (fisheries and marine ecosystems sector)
  - Less than 5 models to begin with
  - ⟶ not a selection criteria

- Input data needed for the tropical cyclone modelling

Step 2: Performance in the historical period



Evaluation based on ESMValTool v2.0

From 17 GCMs reproducing the observational data well only four(!) provided the required daily data at the time of model selection (GFDL-ESM4, MPI-ESM1-2-HR, MRI-ESM2-0, UKESM1-0-LL)

→ Data availability as a severe constraint

- We want at least 5 models
  - PSL-CM6A-LR provides our data needs and has an at least average performance in the historical period

From these models

- GFDL-ESM4 does not provide all data needed for the ISIMIP tropical cyclone modelling.
- GFDL-ESM4 provides the most comprehensive oceanic bio-geochemical forcings
- Other models cover less and partly other oceanic variables.

Step 3: Structural independence, representation of feedbacks

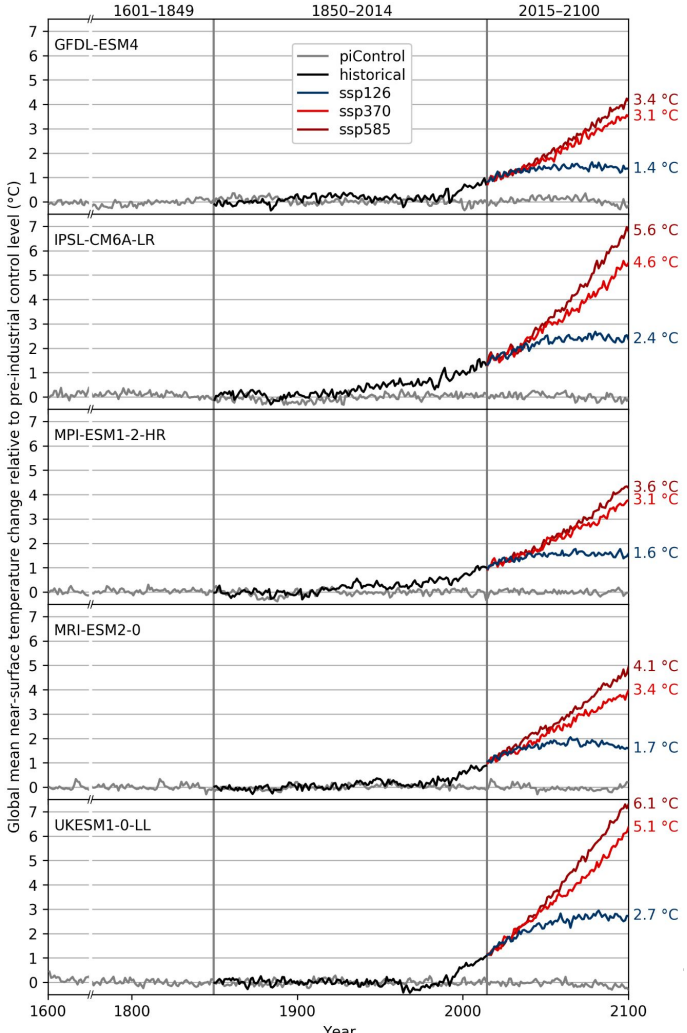
- GCMs are structurally independent in terms of their ocean and atmosphere model components.
- Coupled climate and carbon cycle
- For some: fully interactive chemistry and aerosol components.
- Prognostic couplings between processes and model domains to maximise the coverage of simulated feedbacks.

Step 4: Equilibrium Climate Sensitivity (ECS)

- The five GCMs represent both the mean and the range of the full CMIP6 multi-model ensemble ECS well.

- ISIMIP3b GCMs ESC mean matches CMIP6 multi model mean of 3.7°C.
  - Three models with below-average ECS: GFDL-ESM4, MPI-ESM1-2-HR, MRI-ESM2-0.
  - Two models with above-average ECS: IPSL-CM6A-LR, UKESM1-0-LL

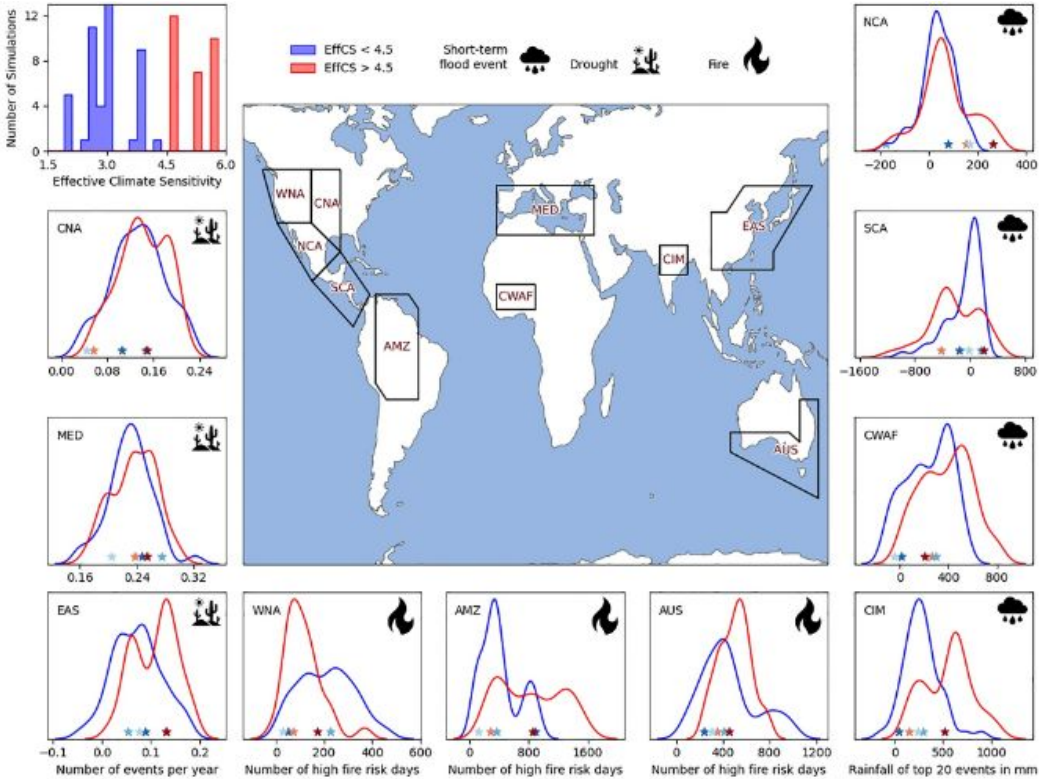
- The transient climate response (TCR) of 2.0°C is also precisely met.



Equilibrium Climate Sensitivity (ECS) as criterion for model selection?

Regional impacts poorly constrained by climate sensitivity

Swaminathan, R.**, Schewe, J.**, Walton, J., Zimmermann, K., Jones, C., Betts, R. A., Burton, C., Jones, C. D., Mengel, M., Reyer, C. P. O., Turner, A. G., & Weigel, K.



- ECS says little about regional impacts, which is what we want to study.
- Strongly recommend NOT to disregard models just based on their ECS
- We try to represent the full range of ESC of CMIP models

0. We should get started

1. Data availability (atmospheric, ocean, tropical cyclone)

2. Performance in the historical period

3. Structural independence & representation of feedbacks

4. Equilibrium climate sensitivity