UFZ HELMHOLTZ Centre for Environmental Research

Applying ISIMIP3BASD-LE to large-ensemble climate model data for wildfire impact modelling

Andreia F. S. Ribeiro (UFZ), Jakob Wessel (Uni. Exeter), Sabine Undorf (PIK), Maik Billing (PIK), Werner von Bloh (PIK), Kirsten Thonicke (PIK), Jakob Zscheischler (UFZ)

Goal

We bias-adjust and downscale a single-model initial-condition large-ensemble (SMILE) preserving the internal variability to serve as input to the impact model LPJmL-SPITFIRE, allowing for assessing credible climate storylines of extreme wildfires.

Data

SMILE: ACCESS-ESM1-5 (40 members), daily, 1.25 °x 1.875° grid (1979-2014)

Observations: GSWP3-W5E5 (ISIMIP3a), 0.5°x0.5° grid

ECDFs of daily global averages after Bias-Adjustment and Statistical Downscaling (BASD)

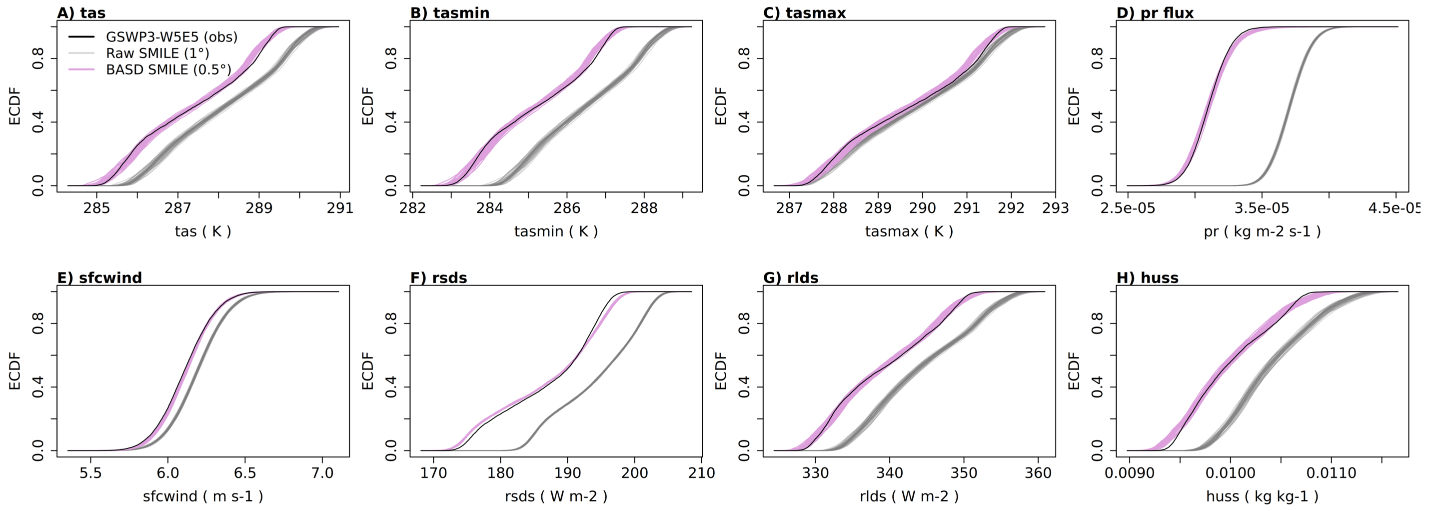


Fig. 1 – ECDFs of tas (average temperature), tasmax (maxmimum temperature), tasmin (minimum temperature), precipitation (pr), surface wind (sfcwind), surface downwelling longwave and shortwave radiation (rlds and rsds), specific humidity (huss); ACCESS-ESM1-5 before (gray) and after bias-adjusted and downscaling with ISIMIP3BASD-LE (purple).

ISIMIP3BASD-LE method

1. Temporal concatenation of ensemble members
2. Bias-adjustment with Quantile Delta Mapping (QDM) at 1°×1° (odd and even years used for training and application)
3. Statistical Downscaling with MBCnSD (multivariate QDM) of bias-adjusted individual ensemble members to 0.5°×0.5°

Is ISIMIP3BASD-LE able to preserve the SMILE ensemble spread?

- Spread metric: standard deviation (SD) with respect to the ensemble mean ($\bar{x}$) size M=40

$$SD = \sqrt{\frac{1}{M-1}\sum_{m=1}^{M}(x_m - \bar{x})^2}$$

- BASD ensemble spread remains largely comparable to the raw ensemble, with small and positive spread ratios.

Ensemble spread of daily global averages

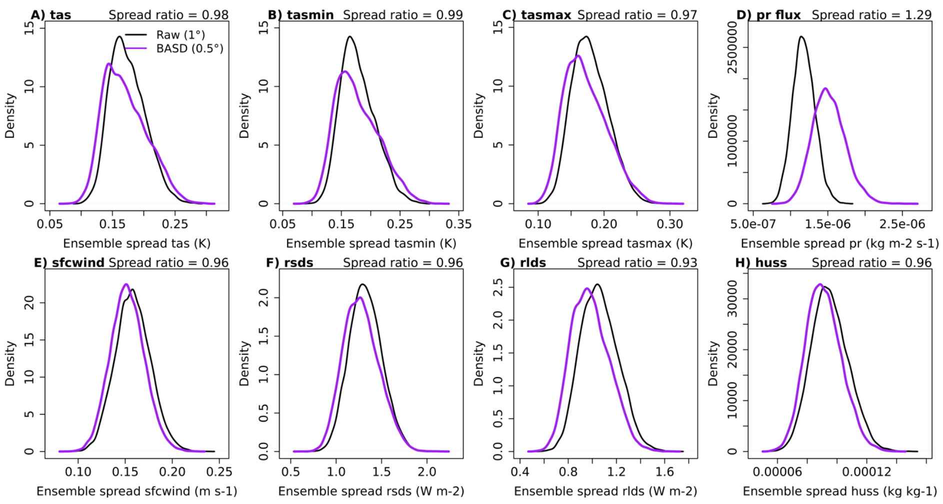


Fig. 2 - Standard deviation (SD) of daily global averages with respect to the ensemble mean ($\bar{x}$) before (black) and after bias-adjusted and downscaling with ISIMIP3BASD-LE (purple).

How ISIMIP3BASD-LE impacts extremes?

We assess global means of

- Annual maximum of tas, tmax, tmin, sfcwind, rsds, rlds (Fig. 2)
- Annual minimum of huss (Fig. 2 H)
- Consecutive dry days (CDD) (Fig. 2 D)

After bias-adjustment and downscaling, the RMSE is reduced in terms of **annual extremes.**

Annual extremes

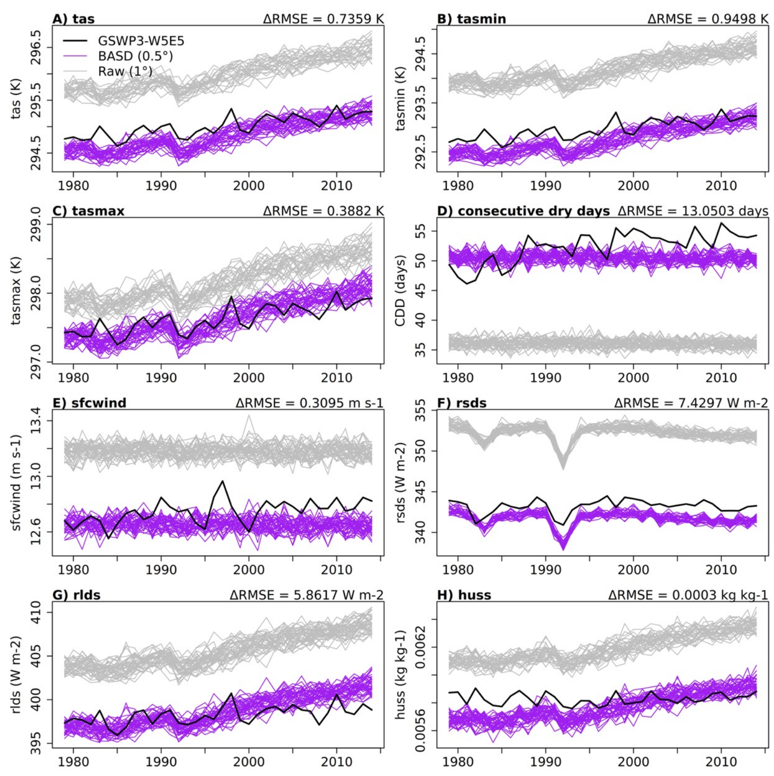
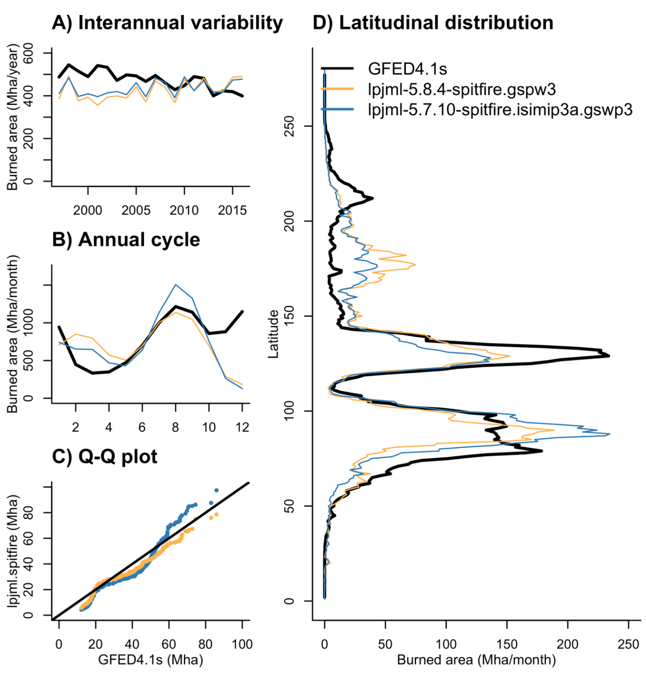


Fig. 3 – Global averages of annual extremes of reference dataset GSWP3-W5E5 (black), ACCESS-ESM1-5 before (gray) and after bias-adjusted and downscaling with ISIMIP3BASD-LE (purple).

Preliminary wildfire simulations with LPJmL-SPITFIRE

Global sums of burned area



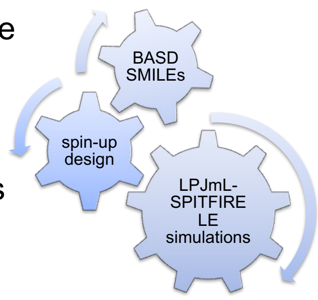
- Input data set: GSWP3-W5E5
- LPJmL-SPITFIRE: version 5.7.10 (ISIMIP3a) and version 5.8.4
- Observation of burned area: GFED4.1s

(A) Declining trend not captured
(B) Fire season peak captured
(C) Extremes captured
(D) Spatial distribution captured

Fig. 4 – LPJmL-SPITFIRE version 5.7.10 (ISIMIP3a) and version 5.8.4 burned area output (forcing: GSWP3-W5E5) , in comparison with remote sensing observations of burned area GFED4.1s (1996-2016).

Take-aways and next steps

- ISIMIP3BASD-LE is able to preserve ensemble spread (Fig. 2) and performs well in terms of correcting annual extremes (Fig. 3)
- Burned area output using reanalysis as input dataset suggests a good performance of LPJmL-SPITFIRE (Fig. 4)



ISIMIP3BASD-LE is made available by
Undorf, S. (2023). ISIMIP3BASD-LE. Zenodo. https://doi.org/10.5281/zenodo.10377116

www.ufz.de

Contact: Andreia F. S. Ribeiro
andreia.ribeiro@ufz.de
https://www.afsribeiro.com/