Earth System
Dynamics
Discussions

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Interactive comment on "Climate Change Projections of Terrestrial Primary Productivity over the Hindu Kush Himalayan Forests" *by* Halima Usman et al.

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We are grateful to reviewer for their corrections and comments. Kindly find the response to the comments below.

1) Major comments: 1. The climate model data is downscaled and bias corrected to a half-degree resolution using the CRU TS3.0 data. However, observations for the region are very sparse with considerable uncertainty in precipitation and other important fields. The interpolation of data to higher resolution elevation data is also potentially important and a possible advantage of this study. What confidence do you have in

the application of the bias correction approach to a region of complex topography and sparse observations? How does the baseline CRU data compare to other observational estimates?

Reply: Bias-correction is necessary because non-negligible biases in climate models can lead to unrealistic baseline ecosystem properties when fed through a vegetation model such as the LPJ-GUESS model used here. We agree that a high-resolution regional climate dataset, tied to ample observations, would provide improved confidence in the result. Furthermore, in applying a global model set-up, we are making an assessment of how well the HKH region is represented in the types of model simulations most commonly available for this region.

2) Climate uncertainty – the HKH is a region of high uncertainty in future climate response. For instance, there is uncertainty in the sign of change in western disturbances and monsoon affecting the HKH region. How do the available GCMs sample this uncertainty? It would be useful to see how representative these models are.

Reply: In the revised manuscript we will include plots of the temperature and precipitation anomalies for the region from a wider range of CMIP5 GCMs, situating the chosen GCMs here within that ensemble.

3) 3. Detailed assessment of the components and drivers of changes in nbp and its components is generally missing. Analysis of the main results is generally thin.

Reply: Components of NBP are shown below. Will be discussed in the manuscript. In LPJ-GUESS, the main components and drivers of changes consist of NBP consist of soil heterotrophic respiration, wildfire emission and vegetation NPP (Veg+Est). The time series have been changed to 1851-1880, 1986-2015 and 2071-2100 (RCP2.6 and RCP8.5). The attachments include spatial maps of average flux of soil (figure 1), fire (figure 2), NPP (figure 3) and NBP (figure 4) of HKH region respectively. The future RCP8.5 show a higher soil flux with mean value of 0.51 kg C m-2. Furthermore most of the flux values are the concentrated in the western part of HKH with an average

value of 0.68 kg C m-2 in RCP8.5. LPJ-GUESS simulations, show a negative NPP indicating decomposition or respiration is overpowered carbon absorption; more carbon was released to the atmosphere than the plants took in. Furthermore in the revised manuscript, additional graphs on the basis of these figures (spatial and temporal) will be added relating to drivers of NBP of HKH region according to high and low elevation and land use cover.

4) Minor comments: Figure 1: White appears both within the HKH region and the rest of the region. What does it represent?

Reply: White area within the HKH boundary represents area of barren, urban and water.

5) Spinup – can you confirm nbp is zero over the region at the end of the spin-up period? Are the PFT fractions prescribed or dynamically spun-up?

Reply: The relative prevalence of the different PFTs varies dynamically in response to the climate (temperature, precipitation, incoming shortwave radiation) and [CO2] forcing and the evolution (Ahlstrom). NBP averaged over the period 1851-1880 is 0.0034 kg C m-2 yr-1, 0.0058 kg C m-2 yr-1 and 0.001 kg C m-2 yr-1 models in simulations forced by IPSL-CM5A-MR, MPI-ESM-LR and CCSM4, respectively. This is well within expectations for a lack of trend. PFT fractions are dynamically spun-up on natural areas and prescribed on agricultural areas. We will add this information in the revised manuscript.

6) Figure 2: What period is covered here?

Reply: The period covered for GEOCARBON dataset is 2000 and for LPJ-GUESS is 1990-2015. However the LPJ-GUESS year for this figure will be changed to 1986-2015.

7) 3.1 Can you explain why there are differences in the historical BC period?

Reply: Vegetation carbon is different in the historical period when forced by different GCMs this is because the GCMs simulate slightly different climate variability for this

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period. The bias correction used alters means, but not variability.

8)3.2 What confidence do you have in the MODIS data set?

Reply: The MODIS dataset is a well-established independent method to estimate NPP and GPP at these scales. We use it as an independent comparison for our results and do not suggest that it is a truth.

9) 3.1/3.2 A key landclass of concern is EBF. It's not clear whether you are prescribing the vegetation cover or simulating interactively. Are there are insights here? It would be useful to have some assessment of the PFTcover if it is dynamic particularly in regard to the application of the land-use data.

Reply: In all simulations, PFT cover was prescribed as grassland on pasture and agricultural grid-cell fractions, as specified by Hurtt et al. (2011). On all other areas the PFT cover was allowed to vary dynamically, as simulated by LPJ-GUESS. The land cover classification of MOD12Q1, was used in order to assess how variables (such as Veg, primary productivity) changed in different time periods. Land cover classification was not prescribed or simulated. Furthermore in the revised manuscript, an additional figure of LPJ-GUESS capturing the PFT distribution in the MODIS data will be added.

10) 3.3 You suggest land-use change fLuc is the cause of the decline in nbp but I miss any analysis of the nbp components that would justify this basis. It would be very useful to plot and analyse time series of the components. You mention crops and pasture but not how they are harvested and grazed. There is also no assessment of soil carbon and respiration which is a component of nbp.

Reply: Carbon fluxes due to crop and pasture harvest and grazing were not considered in these simulations, but are an important consideration for future work.

11) 3.3 Units are surely incorrect: 'The total VegC (averaged for all models) was estimated to be 7400 kg C m-2 by 1950'

Reply: The values and units will be updated.

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Interactive comment

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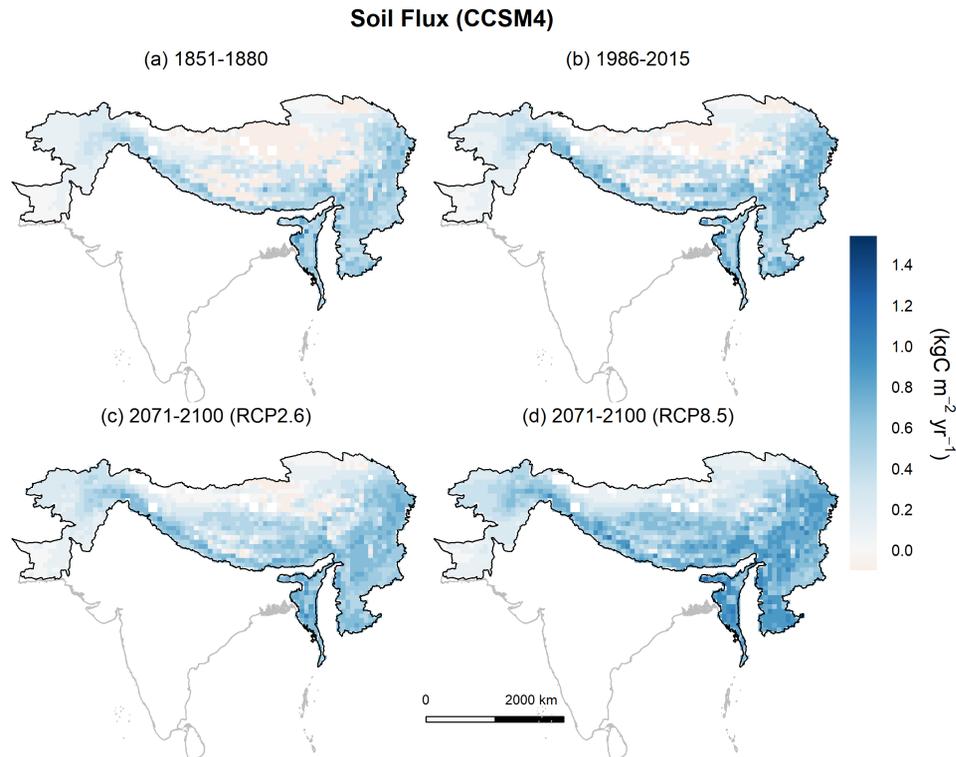[Discussion paper](#)

Soil Flux (CCSM4)

Fig. 1. LPJ-GUESS simulated distribution by CCSM4 of Soil Flux in HKH region under a) past period (1851-1880) b) present period (1986-2015) and future scenario under c) RCP2.6 scenario and d) RCP8.5.
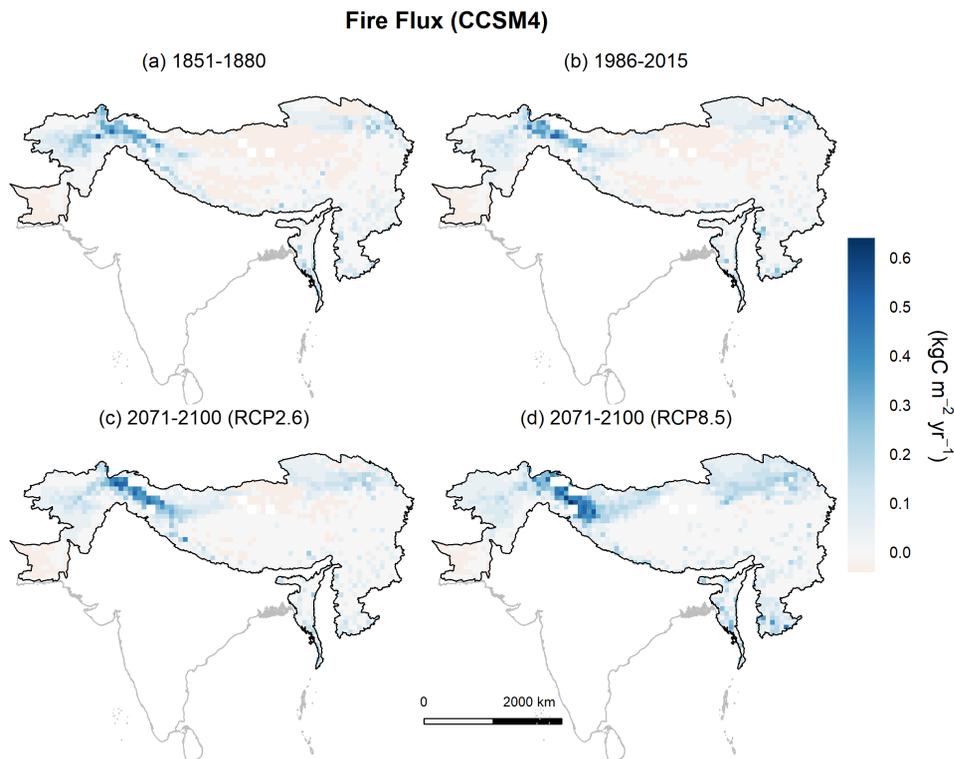
Fire Flux (CCSM4)

Fig. 2. LPJ-GUESS simulated distribution by CCSM4 of Fire Flux in HKH region under a) past period (1851-1880) b) present period (1986-2015) and future scenario under c) RCP2.6 scenario and d) RCP8.5.
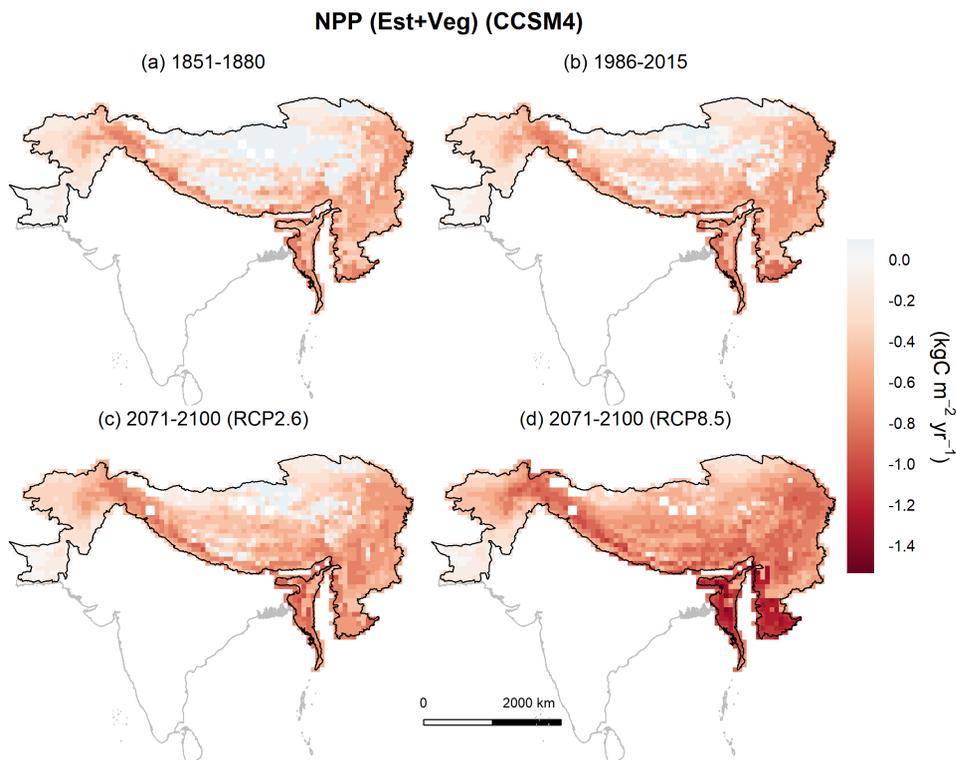
NPP (Est+Veg) (CCSM4)

(a) 1851-1880 (b) 1986-2015

(c) 2071-2100 (RCP2.6) (d) 2071-2100 (RCP8.5)

Fig. 3. LPJ-GUESS simulated distribution by CCSM4 of NPP in HKH region under a) past period (1851-1880) b) present period (1986-2015) and future scenario under c) RCP2.6 scenario and d) RCP8.5.
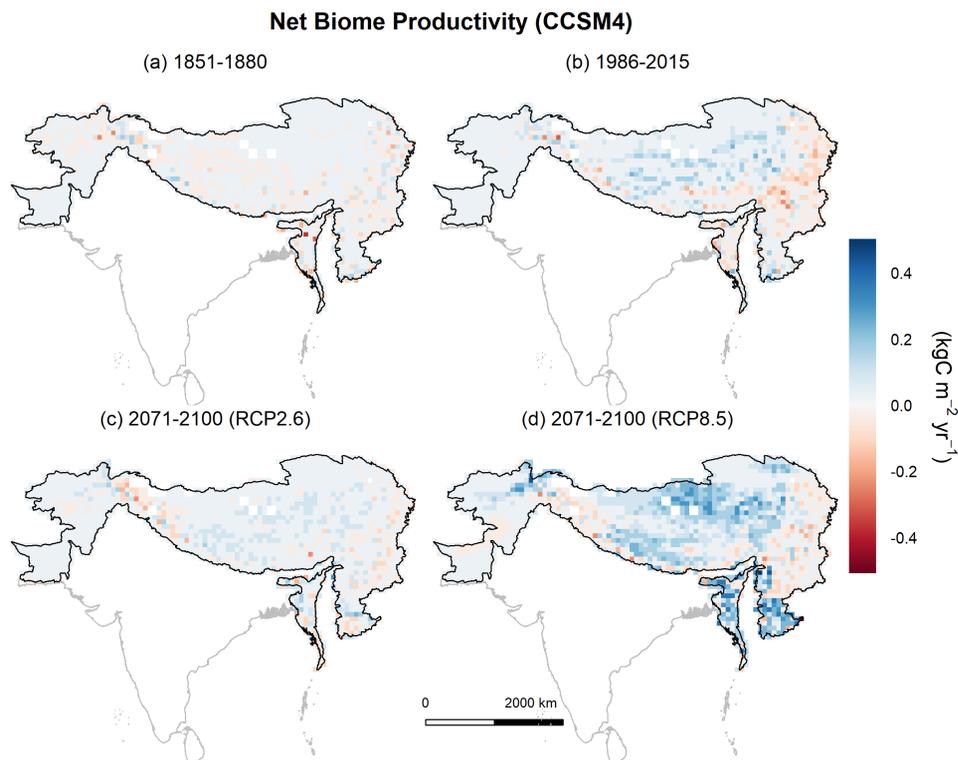
Net Biome Productivity (CCSM4)

Fig. 4. LPJ-GUESS simulated distribution by CCSM4 on NBP in HKH region under a) past pe-riod (1851-1880) b) present period (1986-2015) and future scenario under c) RCP2.6 scenario and d) RCP8.5.