

Specific comments:

Section 5.1: The higher error in MAP for both PREMU and the linear regression seems to occur in Australia and West Africa (or more across the Sahel) which surround arid areas. It may also be that these areas have low relative changes in precipitation and hence prediction with principal components based on gridded Tair becomes more tough. This could be easily checked by the significance in their coefficient values obtained for Equation 2.

Editorial comments:

R4.2

“Thus, Lower complexity models (LCMs) are designed as the common approaches to improve computational efficiency in climate change research **by focussing** on the most impact relevant variables”

R4.4

The emulators developed by Beusch and Mckinnon are a bit different, consider restructuring to e.g.

“Joint temperature and precipitation emulation by considering anthropogenic GHG forcing and large-scale modes of Sea Surface Temperature (SST) variability has proven possible (Mckinon and Deser 2018; Mckinon and Deser 2021). More recently, a spatially resolved emulator (MESMER) solely requiring GMT e.g. by coupling to the emission-driven LCM (MAGICC), to then generate annual temperature fields, has been developed (Beusch et al. 2021)”

R4.5

“Precipitation has high spatio-temporal variability and is affected by atmospheric dynamics **and** inter-annual modes of variability (Li et al., 2021; Tsanis and Tapoglou, 2019), making **representation of it** with traditional LCM approaches difficult. Thus, only two LCMs (IMOGEN and OSCAR) have tried to emulate precipitation, **but with poor skill** (Zelazowski et al., 2018; Gasser et al., 2017). IMOGEN emulates the gridded precipitation based on the regression relationship (by month and location) between gridded precipitation and global land average temperature (Zelazowski et al., 2018). OSCAR constructs the emulator by establishing a relationship between global average precipitation and global average temperature and radiative forcing, **from which a pattern-scaling method is used to deduce the gridded precipitation** (Gasser et al., 2017). Nevertheless, the gridded precipitation estimated by the simple linear method is not **fully** reliable **in either** IMOGEN **or** OSCAR; the gridded precipitation predicted by IMOGEN **only** explains less than 20% of variance of seasonal precipitation in most regions (Zelazowski et al., 2018) and OSCAR cannot capture ...

L204: Refer to O'Neill (<https://doi.org/10.5194/gmd-9-3461-2016>) when referencing SSP 5-8.5, consider also rephrasing :

due to it representing the most extreme changes in Tair amongst SSPs.

L209 and L318: Set out in ~~the~~ Table

L214: Do you have examples of the “limited area application”, it is not too important but a reference here may help give an idea about what improvements your study’s approach brings.

L215: and hence ~~why~~... has a k dependency.

L312: ~~and~~ where

L315: Do you mean?:

we constructed 315 the regression relationship between GLAP and the 10 individual principal components ~~individually~~ ~~separately~~.

Section 3.2.2 seems to be more of a “Generating emulations using PREMU” than “Validation”. Section 3.3 seems to capture validation quite well so maybe consider renaming?

L320-L323: Based on the principal component coefficients extracted using these calibration datasets, we then estimated the $T_{e,m}^{PCA}(y, t)$ using Equation 1, for 1951- 2016 using Tair from GSWP3 and for 2015-2100 using Tair from each ESM independently under the other three SSPs ~~weighted by ... Eq. 1~~.

L403: The percentage error at each grid **point**

L459: A key requirement of **PREMU** is that it...

L485: West Africa

L486: which **is** discussed

L591: considering restructuring the sentence “..., that are account for in ESM simulations,...” seems to be floating without any subject.

L607: the SSP5-8.5 scenario and SSP1-2.6 scenario. Though with a different order of PCA coefficients (Fig. S19-S20), this suggests...

L623: . There are some studies that predict ~~that the variability of precipitation will increase in a warmer world~~ an increased variability in precipitation under a warmer world (Zhang et al., 2021; Song et al., 2018),

L635: Throughout this study, we used ~~Here, we used throughout~~ the three-month average temperature...

L650: This may **be** due to...

