Summary & General comments:

The MESMER-M-TP v0.1.0 module is designed to emulate spatially explicit monthly mean precipitation fields using monthly mean temperature fields as predictors. It offers runtime efficiency, which facilitates the efficient exploration of the precipitation forecast and its uncertainty under different scenario or parameters. Despite for some misses in extreme events, the emulator can effectively generate spatially coherent statistics of temperature and precipitation time series in general.

Overall, I enjoyed reading this paper very much. I appreciate that the emulator is carefully designed with physical knowledge and intuition. I also value the simplicity of the emulator, making it easy to understand and interpret. In terms of writing, the methodology is described in detail, the results are well-presented with sufficient explanation of the calculations. The significance and the implications are also discussed. Although I think the paper is already in a good shape, I do have a few minor comments below that I hope can further improve its quality and readiness.

Specific comments:

L6: MESMER(-M): I suggest put the full name here

L94: row-vector: isn't it a column vector?

L103: the local precipitation… -> I suggest "the emulated local precipitation"

A general comments for notations and equations: Please make sure all the notations are used and defined in a consistent way.

e.g.,

(1) Equations (3)-(6):

I assume

$E\left[P_{s,m}|\mathbf{X}_{s,m}\right] = E\left[P_{s,m}|X_{s,m}^{T}\right] = \mu_{s,m}$

$V\left[P_{s,m}|\mathbf{X}_{s,m}\right] = var_{s,m}$

$k_{s,m} = \Phi_{s,m}$

I suggest avoiding the use of multiple notations for the same variables, which might cause confusion.

Also, is the dispersion $k_{s,m} = \Phi_{s,m}$ a constant for different {s,m}? Please clarify.

(2) Equation (8):

Is $f_{s,m}\left(X_{s,m}^{T}\right) = E\left[P_{s,m}|\mathbf{X}_{s,m}\right]$? Please clarify as the form of $f_{s,m}$ is not defined elsewhere in other equations. Also, $X_{s,m}^{T}$->$\mathbf{X}_{s,m}$ to be consistent.

(3) Figures 7&8: $Pr_{s,m}$ -> $P_{s,m}$ to be consistent with the Equations

(4) L154: the first principal component $PCA_{s,m}^{1}$ -> should be $PCA_{s,m}^{0}$?

(5) Equation (7): last column PCA_{m,s,y_0}^{p-1} -> PCA_{s,m,y_0}^{p-1}

L170-175: I suggest describing the methodology in more detail, perhaps including a few equations for clarity.

L213: How sensitive are the results to the number of closest grid points n ? Does using PCA to define the predictor make the results less sensitive to the choice of n?

L218-219: I suggest including an equation to show the actual form of the prediction model, including the interaction terms used in this study.

L243-249: My understanding is that, given the temperature field around a grid point, the emulator predicts a probability distribution of precipitation at the point rather than a single predicted value. Is that correct? If so,

(1) Do you actually draw random samples from the pdf to characterize the distribution? If so, how many samples are drawn?
(2) How do you verify the EMU results (which is a distribution) against ESM (which is a single value)?
(3) What exactly does the quantile refer to in Figure 2? I assume for the ESM, the quantiles are calculated from the ensemble members (so sample size = # of ensemble member), but what about the EMU results (what are the samples size for the quantiles)?

L296: Fig.3 and B1 -> should be B2?

A general suggestion for the figures: it might be helpful to add subtitle like (a),(b),(c) for subplots in some figures. This can make the figure captions easier to describe and the references to the figure in the text clearer.

Figure 2 - L4: Orange/Blue lines represent precipitation estimates of a single ESM/EMU ensemble member -> should be “dashed” lines to distinguish with the solid lines

L300-302: This is an assumption in the modeling framework, is that correct? If so, I suggest change “suggests” -> “assumes”

L314-316: It is not immediately clear to me why this suggests that the model struggles to disentangle the trend and variability?