Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2020-55-RC2, 2020


Geoscientific Model Development Discussions
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# *Interactive comment on* "Detection of Atmospheric Rivers with Inline Uncertainty Quantification: TECA-BARD v1.0" *by* Travis A. O'Brien et al.

**Anonymous Referee #2**

Received and published: 13 May 2020

Summary of remarks:

The key point of this manuscript is that TECA-BARD v1.0 can be used to quantify uncertainty associated with parameter selection in atmospheric river detection models. To this end, the manuscript accomplishes its objective. I do have some questions regarding the number of experts' opinions used in the creation of TECA-BARD v1.0 and whether it is also feasible to use the output from other AR tracking algorithms to inform the posterior. Regardless, I think this manuscript is novel in its method for quantifying uncertainty associated with atmospheric river tracking algorithms, and deserves to be published once the following comments are addressed.



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Discussion paper

Major remarks:

1. The authors' basis for the paper is that the best dataset on which to base an atmospheric river tracking algorithm would include the outlines or counts from multiple domain experts. The authors also state that there is no quantitative definition of atmospheric rivers, and that only recently was a qualitative definition created. In response to these issues, the authors use eight expert opinions on the counts of atmospheric rivers to constrain the posterior of their Bayesian model.

However, there could also be issues with a collection of subjective opinions from domain experts being used, without background into how each expert views the quantitative and/or qualitative definition of an atmospheric river. It would be useful for this reason to have many more than 8 experts (an admittedly challenging prospect). Otherwise, there is potential for the dataset to be biased towards one type of atmospheric river definition through sampling bias of expert opinions.

2. Another possible Bayesian model for atmospheric river detection could instead use the various algorithms presented within ARTMIP to constrain the posterior. These algorithms required the combined efforts of more scientists than were used to provide the atmospheric river counts for the current study. It would therefore be helpful for the authors to address this alternative, and to discuss the implications of using a collection of experts' opinions rather than a collection of previously generated algorithms.

3. The large uncertainty that remains within TECA-BARD v1.0 even with the usage of 1,024 unique AR detectors further suggests that including more experts and/or MCMC chains per expert would help converge on a more statistically robust atmospheric river detection method. The qualitative conclusion regarding the uncertainty of the sign of correlation between ENSO phase and atmospheric river frequency is valid regardless of the remaining uncertainty within TECA-BARD v1.0. However, if TECA-BARD is to be used for more quantitative assessments of relationships between atmospheric rivers and climate modes (ENSO, PDO, etc.), it would be useful to constrain the uncertainty

of the model even further.

Minor remarks:

1. It would be useful to cite and discuss recent efforts to collect domain-expert defined outlines of atmospheric rivers, as discussed in Prabhat et al. (2020); https://www.geosci-model-dev-discuss.net/gmd-2020-72/

2. Typo on line 20, page 13: Change “Figures 9” to “Figure 9”

3. Could the parameter space of Figure 10 be filled by using a greater number of samples from each expert? It may be illustrative to fill more of this parameter space, although I understand issues with computational limitations.

4. The posterior PDFs for the combined EGID model shown in Figure 4 exhibit multi-modality. Do you think this multi-modality is caused by the limited number of experts used to constrain the posterior, or is there some other cause? Either way, it would be useful to discuss this within the manuscript.

5. I recommend increasing the size of Figure 5 so it is easier to read in the final manuscript. Also, it could be useful to reference the various phrases used in the flowchart within the manuscript itself.

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