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Geoscientific Model Development Discussions

Interactive comment on "Atmospheric River Tracking Method Intercomparison Project (ARTMIP): Project Goals and Experimental Design" *by* Christine A. Shields et al.

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Response to GMDD Interactive comment from Referee #1

Questions to answer in overview:

Q: I think the attempt to compare and synthesize different methods and metrics for the identification of ARs is indeed a very valuable and important effort. I wondered if and how systematic model related properties are treated for the evaluation, e.g which role plays horizontal and vertical, temporal resolution for the results and the applicability of the metrics? Is it possible to add a global (or at least northern hemispheric) view for

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the test period?

A: Thank you for your review and noting the importance of ARTMIP. During the course of Tier 1, ARTMIP participants will be disentangling these great questions.

We will absolutely include a global view in a Tier 1 overview paper, which we are actively working on now. However, for this GMDD paper (and the results from the 1-month test we conducted last Fall), the purpose is twofold: 1) document the experimental design for the community and outline the goals for the project, and 2) act as a proof-of-concept that such an intercomparison will work and produce interesting results. Given that we are actively working with the full algorithm catalogues (i.e, the 1980-2017 MERRA-2 period), we feel that we can better use our resources and serve the community by presenting the full results in our science overview paper, rather than add an additional plot with a global view to this experimental design paper. The figures we present here are intended to show the flavor of the types of analysis we are doing but are not necessarily meant to be final "results". We expect some of these metrics may change after looking at the full Tier 1 data, especially so given that have a larger pool of catalogues for Tier 1 is available compared to those analyzed for the proof-of-concept. We will certainly add a comment to the paper to make clear that we intend to present global metrics in future research. We can also include a global snapshot of MERRA-2 IVT data with sample ARs labelled in the supplementary material to illustrate example events across the globe.

In terms of temporal resolution, we begin to address the issue in the supplemental text (Figures S1 and S2) where we show the difference between MERRA-2 3 hourly derived data versus 1-hourly data. As for horizontal resolution, all algorithms are applied to the same MERRA-2 data (~50km) for Tier 1, and 25km data for Tier 2-climate change. Note that other Tier 2 plans include intercomparing different reanalysis products at different resolutions.

General points:

Q: Though the comparison of methods is essential and required to judge results of larger model simulations I missed the link to observations. How do the algorithms do compare with observations of atmospheric water vapor columns e.g. from satellite observations? Wouldn't it be useful to define criteria (or refine the definition of) ARs on the basis of satellite observations to allow to estimate the capability of algorithms and methods to identify the structures?

A: We have actually spent a great deal of time thinking about how we might perform a verification of sorts, but it turns out to be much easier said than done. The AMS Glossary of Meteorology recently adopted a definition for atmospheric rivers, a definition vetted by numerous subject matter experts and commented on during town hall meetings at major conferences. This definition is very broad, and while some generic numbers are provided via schematics, no exact criteria for identifying or tracking an AR are described. The upshot is that while there is broad consensus among the community regarding very general characteristics of ARs, there is no agreement regarding the variables, magnitudes, or precise geometries that should be used to identify them. So, while we could, for example, assess which methods most closely track satellite observed IWV features > 2000 km long and < 500 km wide (one definition, among many), we would already be self-selecting our preferred algorithm. This is true across a host of definitions. In light of this, we have chosen to focus our project on quantifying the uncertainty that arises as a result of these various algorithms and making this data available, at which point other researchers can feel free to pursue additional analyses.

Q: Is it planned to give recommendations of methods to be used to identify ARs?

A: We will need to wait for the results, but we have some ideas about the form some of these recommendations might take. For example, certain algorithms might produce outliers in terms of AR climatology over certain regions. We may have reason to trust some algorithms more than others over certain regions, or to trust some algorithms more than others in anticipating the effects of a changing climate on ARs. We will need time to work out these details. What we do not want to do is rank algorithms.

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Recommendations will be based on identifying algorithm(s) that are most appropriate for specific science questions.

Q: How will region specific methods (i.e. only applicable to the Western U.S.) implemented for global analyses?

A: All ARTMIP participants are running their algorithms for the North American west coast, the European west coast, and globally, or in whichever of those regions their algorithm is capable of running. We also have several algorithms being applied to Polar regions. We expect that algorithms developed specifically for a given region will be in closer agreement with each other than those developed for other regions and then applied there, but we don't yet have those results. To compare all algorithms (i.e. global with regional) we need to look at the common denominator. For example, we have looked at landfalling ARs on the US West Coast because all catalogues include this area. However, this does not preclude sub-setting algorithms for other areas. Note that European landfalling ARs is a subset of the total number of algorithms in ARTMIP. Metrics applicable to global-only algorithms can also be analyzed in isolation. We also note that Tier 1 catalogues will be made available to the community after the completion of this phase and hope that members of the community will take advantage of the catalogues.

Technical Comments:

Q:Why are captions placed above the Figures?

A:Agreed, we will move captions to below the figure.

Q: Fig.5a) and Fig.5b) (also Fig.6): Please label the color bar with units in both cases. Caption Fig.5b): Clarify text: "Same as Fig.5a) ..."

A: We will incorporate these suggestions into the revised manuscript.

Q: Please mention in the caption that the number of cases is different in Fig.5a) and Fig.5b) (also 6) due to the regional constraint of the respective definitions.

A: We will note this explicitly in the figure captions.

Q: p.23, l.23: Why do not all algorithms participate in the 1-month test case?

A:The reason all algorithms are not represented in the 1-month test is simply that we had a schedule, and not all participants' data was available at that time (we have also added new participants for Tier 1 and Tier 2 since the posting of this GMDD paper).

Q:Table 1: instead of using symbols (+,ËĘ) for footnotes I suggest to use capital letters, which facilitates reading. Similarly explanations of *ZN and AR_coeff: Which methods refer to these quantities and what is the meaning of AR_coeff? Why is it 0.3 and is this a general number?

A: We will change the symbols to letters. To avoid confusion with A1, A2, etc. and the notation for the algorithms, we will use lower case lettering "a", "b", and "c." AR_coeff refers to an empirically-derived coefficient used to define atmospheric rivers in the foundational paper of Zhu and Newell (1998). More work and a deeper exploration of this value was also done by Newman et al (2012). Methods that use (or are based on) the Zhu and Newell method of AR identification are noted by footnotes and are: the Gorodetskaya et al. and Shields and Kiehl methods. The Zhu and Newell paper is already cited in the references, but we will add the Newman paper for those interested in more detail.

Zhu, Y., and R. E. Newell (1998), A proposed algorithm for moisture fluxes from atmospheric rivers, Mon. Weather Rev., 126(3), 725–735, doi:10.1175/1520-0493(1998)126<0725:APAFMF>2.0.CO;2.

Newman, M., G. N. Kiladis, K. M. Weickmann, F. M. Ralph, and P. D. Sardeshmukh (2012), Relative contributions of synoptic and low-frequency eddies to time-mean atmospheric moisture transport, including the role of atmospheric rivers, J. Clim., 25, 7341–7361.

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