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Special Section:
Atmospheric Rivers: Intersection of Weather and Climate

Key Points:

- Uncertainty associated with atmospheric river (AR) definition dominates model uncertainty for projections of Pacific and Atlantic landfalling ARs
- Most AR detection algorithms show an increase in AR frequency in future simulations
- AR statistics in CMIP 5-and-6 models compare remarkably well with reanalysis

Supporting Information:

Supporting Information may be found in the online version of this article.

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Increases in Future AR Count and Size: Overview of the ARTMIP Tier 2 CMIP5/6 Experiment

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Abstract The Atmospheric River (AR) Tracking Method Intercomparison Project (ARTMIP) is a community effort to systematically assess how the uncertainties from AR detectors (ARDTs) impact our scientific understanding of ARs. This study describes the ARTMIP Tier 2 experimental design and initial results using the Coupled Model Intercomparison Project (CMIP) Phases 5 and 6 multi-model ensembles. We show that AR statistics from a given ARDT in CMIP5/6 historical simulations compare remarkably well with the MERRA-2 reanalysis. In CMIP5/6 future simulations, most ARDTs project a global increase in AR frequency, counts, and sizes, especially along the western coastlines of the Pacific and Atlantic oceans. We find that the choice of ARDT is the dominant contributor to the uncertainty in projected AR frequency when compared with model choice. These results imply that new projects investigating future changes in ARs should explicitly consider ARDT uncertainty as a core part of the experimental design.

Plain Language Summary Atmospheric rivers (ARs) are a type of weather pattern known to be important for moving water from the warm, moist tropics to the cool, dry polar regions; when they reach midlatitudes in the winter time, they are commonly associated with heavy precipitation. Recent studies that assess the impacts of global climate change on ARs tend to agree that there will be more ARs in a warmer climate, and that ARs will tend to be more extreme. However, it has been increasingly recognized by the AR research community that these results may depend on the method used to identify ARs and the choice of climate model. This study reports results from a controlled experiment, involving an international research community, that aims to show how different AR identification methods and climate models might impact our scientific understanding of ARs in the future. Results show that there will likely be more ARs in the future, and that ARs will generally have a larger spatial footprint. This experiment also shows that uncertainty in these results are large, with the uncertainty from AR identification methods outweighing that of climate models. Future efforts to better understand the physics of ARs may help us reduce this uncertainty.