

Bimodality in simulated precipitation frequency distributions and its relationship with convective parameterizations

Science Question

Bimodality in precipitation frequency distributions is often evident in atmospheric models, but rarely in observations. To enable systematic assessment of the bimodality, we define a new metric that is straightforward and well-interpretable.

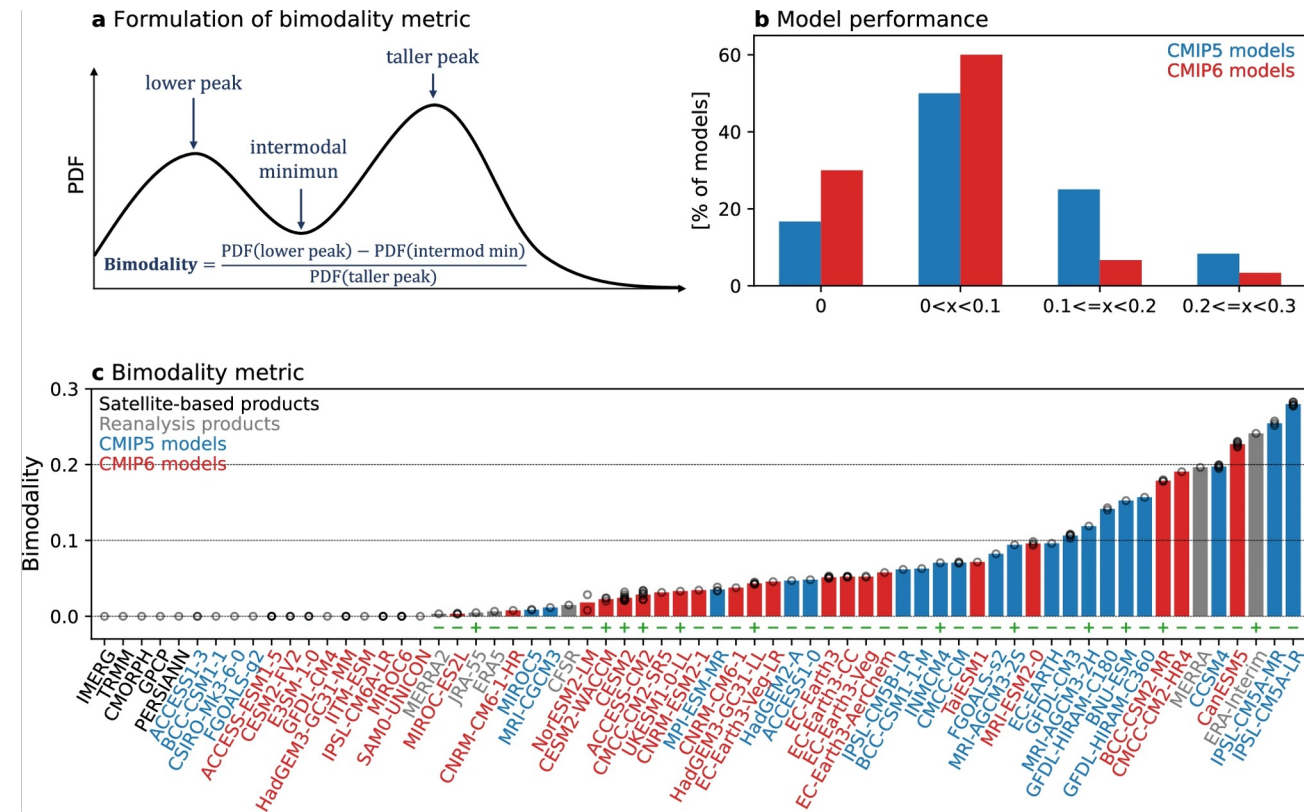
Key Accomplishments

This study i) proposes a metric to objectively quantify the bimodality in precipitation distributions, ii) evaluates model simulations contributed to the Coupled Model Intercomparison Project (CMIP) phase 5 (CMIP5), phase 6 (CMIP6), and the Dynamics of the Atmospheric general circulation Modeled On Non-hydrostatic Domains (DYAMOND) project by comparing them to satellite-based and reanalysis precipitation products, and iii) investigates possible origins of bimodal precipitation distributions.

Impact

Our results reveal that about 83% (20 out of 24) of CMIP5 and 70% (21 out of 30) of CMIP6 models used in this study exhibit bimodal distributions. The few DYAMOND models that use a deep convective parameterization also show bimodal distributions, while most DYAMOND models do not. Predictably, the bimodality originates from the separation of precipitation process between resolved grid-scale and parameterized subgrid-scale. However, in a larger number of models bimodality arises from the parameterized subgrid-scale convective precipitation alone. The metric is implemented to the PCMDI Metrics Package for future usages.

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a Schematic for the formulation of bimodality metric, **b** Probability distribution of model performance, **c** Bar graph of bimodality metric for satellite-based observations (black), reanalysis products (gray), CMIP5 (blue), and CMIP6 (red) models. Circle marks over each bar represent individual ensemble members. Plus or minus marks under each bar respectively indicate that the maximum peak is on a lighter or heavier rain rate.