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A multivariate approach to combine general circulation models using graph cuts

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General circulation models (GCMs) are of extreme importance to making future climate projections. Those are used extensively by policymakers to manage responses to anthropogenic global warming and climate change.

To extract a robust global signal and evaluate uncertainties, individual models are often assembled in Multi-Model Ensembles (MMEs). Various approaches to combine individual models have been developed, such as the Multi-Model Mean (MMM) or its weighted variants.

Recently, Thao et al. (2022) proposed a model comparison approach based on graph cuts. Graph cut optimization was developed in the field of computer vision to efficiently approximate a solution for low-level computer vision tasks such as image segmentation (Boykov et al., 2001). Applied to MMEs, it allows selecting for each gridpoint the best-performing model and produces a patchwork of models that maximizes performances while avoiding spatial discontinuities. Thus, it considers the local performance of individual models in contrast with approaches such as MMM or similar methods that use global weights.

Here we propose a new multivariate combination approach of MMEs based on graph cuts. Compared to the existing univariate method, our approach ensures that the relationships between variables, that are present in GCMs, are locally preserved while providing coherent spatial fields. Moreover, we measure the local performance of models using the Hellinger distance between multi-decadal distributions. This allows a combination of models that is not only indicative of the average behavior (e.g. mean temperature or mean precipitation) but of the entire multivariate distribution, including more extreme values that have a high societal and environmental impact.

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