Individual Project Summary 3/13

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Introduction

Despite alternative facts to the contrary, rapid, anthropogenic climate change is not only real, but arguably the most dangerous threat (in the mid- to long-term) facing human societies ("Scientific Consensus on Global Warming | Union of Concerned Scientists" 2017). Given this unprecedented challenge, climate scientists have developed computational models to predict spatio-temporal changes in global climate under a variety of scenarios and assumptions (Hawkins and Sutton 2009). Using these models in any analysis that goes beyond imagining apocalyptic futures, however, comes with considerable caveats. For one, estimates of model uncertainty do not necessarily indicate actual climate uncertainty. The models (in our case CMIP5 models) often share both code modules as well as the biases of their implementors. Thus the models, and their outputs do not represent independent draws from the space of "all possible future climates". Because of this, combining the models in the hopes of developing a "consensus climate" becomes statistically untenable (Knutti 2010). Moreover, crafting policy based on any such consensus will imply a sense of certainty that we cannot reasonably expect (Larose et al. 2005).

The question then becomes: what can we do with these data? The most interesting option we have found so far is described in (Knutti 2010). In this work, the authors attempt to describe a method of constructing a consensus model (a combination of the models) that takes into account their interdependence.

They expand ("flatten") the model outputs (which are multidimensional arrays) into 1D vectors, then concatenate the vectors of six variables together (TS PR RSUT RLUT T RH) so that each model is represented by a single row vector in an general model-matrix. They then perform PCA to limit the model matrix to only orthogonal columns, and finally perform an MDS on the rows of this new matrix.

Because their study includes a set of observational data, collected (and subsequently regrided for comparison to CMIP data) from a variety of sources, that allows them to go another step futher. They define a grid of points over the MDS space then use the distances of the MDS-space distance between observation and model points to try to define a prior over this space. This can then be used to draw independent samples from the MDS space and work backwards to turn that sample into a consensus model. Furthermore, they build a way to describe the overall behavior of that model by defining a new quantity for each model called Climate Sensitivity ("the equilibrium global mean surface temperature response to a doubling of carbon dioxide"). They then interpolate this quantity over MDS space, allowing them to assign any point sampled from there to be immediately assigned a Climate Sensitivity value.

Issues

Current Results

Anticipated Directions

References

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