Climate Models: Discussion

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Climate Models: Verification/Validation

1. Next big movement: starting to use models more like weather forecasting models by using large initial condition ensembles. Why: The non-linearities and resulting chaotic behaviors are being realized as important for regional climate behavior given the role of the ocean temperatures for driving seasonal climate. How do we do this well?
2. What are obvious uncertainties that we are not accounting for when making projections based on climate models? Do we know how to account for these?
3. Downscaling models: crucial for local impacts but can we trust them? Statistical downscaling?
4. How can paleoclimate reconstructions be useful for validating or calibrating climate models?

Handling Complexity and Feedbacks

1. How do we handle complexity in a consistent way from simple energy balance models up through to full Earth System Models (e.g. CMIP6).
2. Challenging when comparing models with subtle differences in feedbacks such as including carbon-cycle or air-pollution feedbacks into different aspects of the full 3D climate models.
3. The differences between simple, intermediate, and high complexity models are probably more easy to distinguish but when a single new feedback or process is changed, the differences are no longer clear until very large ensembles are used to understand the responses.
4. How do we think about temporal, spatial scales?

Climate Models for Projections?

1. How can we combine information from multiple models? Is Bayesian model averaging worth considering or is it fundamentally flawed for use with climate models?
2. In light of all the uncertainties (some accounted for and some not accounted for), and ad-hoc tuning of the models etc. how can we justify using climate models for projections?

Emulation-Calibration

1. Emulation and calibration of climate models
   - time series data
   - spatial data, multivariate spatial
   - non-Gaussian
   - high-dimensional
2. Discrepancy: perhaps the single biggest challenge for most of these problems.
3. Discrepancy/uncertainty quantification: Particularly challenging when observations have complicated error structures, biases etc. (which is the case most of the time!)