

New approaches and capabilities: Emergent constraints

Presentations

- Alex Hall: *What have we learnt about emergent constraints?*
- Peter Cox: *Emergent constraints on carbon cycle feedbacks*

Key scientific advances since AR5?

- Proliferation of proposed ECs since AR5 spanning Earth system
- A few have made their way into the confirmed and useful categories
- Deeper understanding of model spread including structural and parameterization uncertainties
- Recognition of the need for mechanistic understanding
- Classes of ECs have been identified: trend to trend, present day variability (temporal or spatial) to sensitivity, mean state to sensitivity (most 'proposed').

Shortcomings, gaps and opportunities?

- Needed Research: What are the advantages/drawbacks/limitations to using ECs for prediction versus model improvement?
- Opportunity: ECs can be used to constrain observations
- Needed Research: Assessment of model interdependence, particularly independence of successive generations of CMIP ensembles
- Needed Research: How should ECs be used to weight models?
- Needed Research: Which proposed constraints can be moved into the confirmed and useful categories?

Long term perspective?

- Problem: How do we combine (synthesize) multiple ECs?
- Need: Better tools to make extracting and analyzing data from the CMIP archive (for example) easier?
- Need: Better incorporation of uncertainty bounds on model values (due to e.g. internal variability) and observations
- Problem: How do we ensure our learning about ECs makes its way into model development?

Framing Identified During this Meeting

- ECs can be used to:
 1. make predictions from currently-available models
 2. Improve the next generation of models
- ECs can be unuseful for several reasons. Articulating these reasons gives us a recipe for deciding which constraints are credible:
 1. correlation may be spurious/unreproducible in independent ensembles
 2. our archived models may obey a constraint not followed by nature
 3. observations may fall outside span of models, requiring extrapolation
 4. uncertainty on obs may span the set of model predictions