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