Historical View of Model Performance, and the Role of Models in Understanding the Climate System

Presentations

- Jerry Meehl: *Historial perspective on model evaluation*
- Isla Simpson: *Modes of variability*

Historical View of **Model Evaluation**, and the Role of Models in Understanding the Climate System

Key recent scientific advances (since AR5)

- Objective evaluation of **internal variability** through availability of large ensembles
- **Shorter time-scale** evaluation, including modes of variability
- Analysis of control runs, especially relating to decadal variability
- Feedback indicator evaluation (e.g. narrowing of uncertainty surrounding **cloud feedback** through emergent constraints)
- Deeper understanding of **model interdependency**
- Enhanced applications of **model hierarchies**, especially **energy balance models**
- Deeper understanding of aerosol indirect effects and narrowing of associated uncertainty.
- Consensus on saving variables needed to characterize biogeochemical cycle functioning
- Improved evaluation and of observational uncertainty (e.g. sea level rise)

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Shortcomings, opportunities, and gaps (short term)

- Systematic model evaluation (enable **quantification of improvement** between generations in a **consistent** way; ESMVal and PMP are addressing this)
- Connecting MIPs in a timely manner– e.g., RFMIP + CFMIP
- Include climate forcings and feedbacks in ESMVal + PMP.
- How to **entrain the impacts community earlier** in the WG1 model evaluation process? The impacts community generally needs rigorous evaluation of precipitation and temperature on a regional and seasonal scale. Dynamical variables may be less interesting. Statistics of shorter time scales are OK.
- How to evaluate **new model components**, viz. **coupled ice sheet models**?
- How to evaluate different **classes of models** (differences in resolution, model complexity is unprecedented)?
- Exploit improvements in observations (including better uncertainty characterization and new variables, especially biogeochemical)
- Take into account new understanding **of limitations in the linear forcing/feedback paradigm**
- **Develop best practices** for **model weighting** and **emergent constraints**

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Long-term perspective

- Shift from documenting model errors to understanding the model behavior and fit-for-purpose
- Need for more and better observations, especially relating to land and ocean biogeochemical cycling.
- Better documentation of model development and tuning practices, but no obvious solutions
- More strategic balancing of computational resources, given needs to characterize natural variability, increase resolution, increase complexity, and characterize parametric and structural uncertainty.
- Improved evaluation of low-probability, high impact events, e.g. tipping points and extreme events, especially joint probabilities of extremes.
- Better use of paleoclimate data to evaluate models.