

Friday morning

BOG 3 Gaps and Opportunities until
AR6

Shortcomings, gaps, opportunities

BOG 2 OBS

- How to use ensembles of observations in model evaluations → Statisticians
- Encourage obs groups to do better in characterizing obs uncertainty
- One error number is not enough (error budget, decompose into instrument, sampling, processing, etc)
- How do we use the better error estimates for model evaluation?
- Update and check forcing data sets more regularly
- Continue crucial satellite observations used for climate model evaluation (SSM/I sea ice satellite series to be discontinued)
- How to represent biodiversity?

Shortcomings: Gaps and Opportunities

BOG 3 EvalTools

- CMIP-endorsed MIPs provide analysis suites to be integrated into CMIP evaluation tools
- Examples being set now regarding traceability and provenance of models should be expanded to other codes
- There are gaps in observational data and ways in using existing observational data and domain gaps in model evaluation that require enhanced collaboration and funding opportunities across modeling and observational communities to address
- Scientific studies on key evaluation metrics and diagnostics should be reproducible and the algorithms submitted as part of the publication process, adding uptake of these diagnostics into the evaluation suite
- Systematic comparison of results from existing tools
- Community-based process needed to establish a tiered list of critical metrics across Earth system components
- More widespread dissemination of process-oriented diagnostics from the peer reviewed literature into the public domain
- International efforts have started to define process-oriented metrics and frameworks that are beginning to be disseminated in CMIP evaluation (e.g. WMO MJO Task Force, NOAA MAPP Model Diagnostics TF)

Systematic Biases: Shortcomings, Gaps & Opportunities

BOG 5 Systematic Bias

- Terrestrial nitrogen cycle
- Frozen soil impacts on heat and carbon
- Ice sheets beginning to be incorporated in ESMs
- Permafrost
- Aerosol forcing
- Decadal climate variability
- Assessment of ocean mixing for heat & carbon
- Argo, BGC Argo & Deep Argo
- OSSE, state estimation and reanalysis for the ocean
- Transpose CMIP – NWP: Use climate prediction systems
- Agricultural representation in land surface/dyn veg models
- Manipulated experiments for land bgc
- Large ensembles – initial condition & perturbed physics
- Groundwater & aquifers

Shortcomings, gaps and opportunities?

BOG 6 Emergent Constraints

- 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?

Equilibrium Sensitivity (ECS/TCR)

BOG 7

• Interpreting the 20th century record

- Non-constancy of feedbacks and drivers
- Model-data discrepancies in the ocean
 - Warmpool width, ENSO air temperature
 - Southern Ocean Heat uptake
 - Possible links between Δ and cloud responses

• Quantification of feedbacks and forcings

- Radiative forcing quantification
- Middle and high cloud mechanisms

BGC impact on TCRE

- Definition: global mean surface temperature change per 1000 PgC emitted CO₂

- $TCRE = \Delta T / E = \alpha / (1 + \beta + \alpha * \gamma)$

- $\alpha = \Delta T / \Delta CO_2$

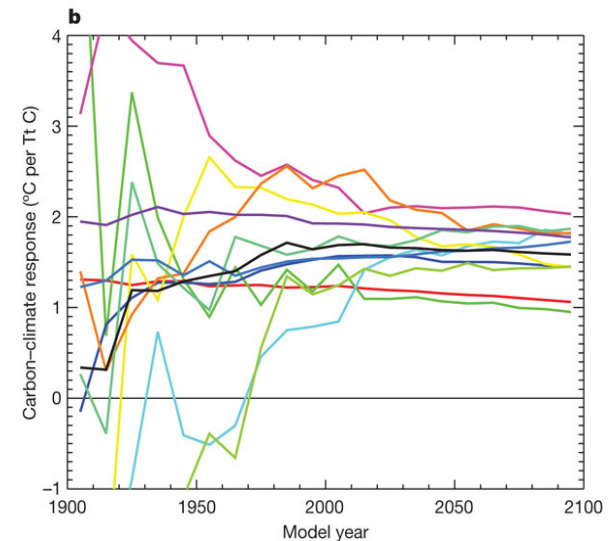
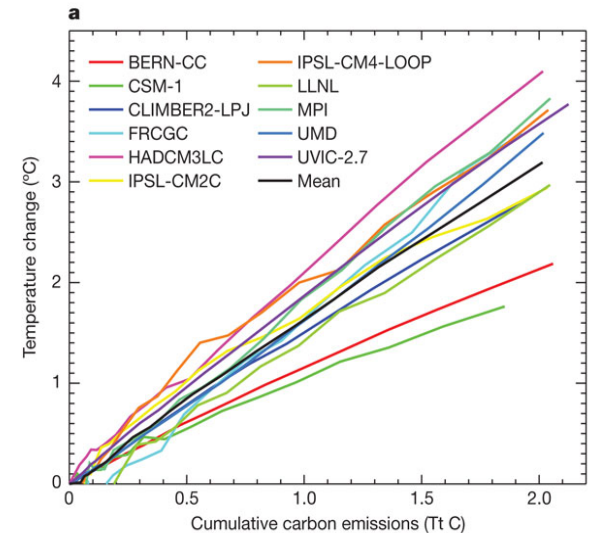
- $\beta = \Delta C / \Delta CO_2$

- $\gamma = \Delta C / \Delta T$

- Understanding limits of TCRE

- 50-50 physical (TCR) and BGC on model spread

- Beta more influential → more focus



Shortcomings, gaps and opportunities?

BOG 8 Weighting

- Shortcomings
- Metrics are not transitive, optimising one generally doesn't provide benefits for others, not possible to optimise all metrics
- The importance of tuning choices in confounding weighting
- The recognition mean state weighting has pitfalls (e.g. tuning, arbitrary model assumptions etc)
- The danger of performance weighting based on the right answer for the wrong reason-ensuring you understand the mechanism
- Currently no concrete recommendations for how to move beyond model democracy

- Gaps
- Identifying the role of structural vs internal variability across MMEs

- Opportunities
- Moving beyond mean state weighting, incorporating temporal variability into weighting schemes
- The combination of weighting schemes and emergent constraint approaches
- Knowledge transfer between the weighting scheme community and the DandA community
- Use long time series records both historical and paleo to understand internal variability
- Recommended weighting schemes for specific purposes

Shortcomings, Gaps, and Opportunities BOG 9 Impacts

- Establishment of a CORDEX-like activity needed (harmonized dynamical downscaling)
- Understanding the variability of tropical rainfall regimes
- Capturing/improving the diurnal cycle
- Co-temporaneous extremes
- Low frequency output of high frequency
 - Hourly: $T < 0^{\circ}\text{C}$, $T < 5^{\circ}\text{C}$, $T > 35^{\circ}\text{C}$, $T > 40^{\circ}\text{C}$, $T > 45^{\circ}\text{C}$; $P = 20\text{-}50\text{ mm}$, $50\text{-}100\text{ mm}$, $>100\text{ mm}$
 - Daily: $P = 1\text{-}5$, $5\text{-}20$, $20\text{-}50$, $50\text{-}100$, $>100\text{ mm/d}$; $T < 0^{\circ}\text{C}$, $T < 5^{\circ}\text{C}$, $T > 35^{\circ}\text{C}$, $T > 40^{\circ}\text{C}$, $T > 45^{\circ}\text{C}$
- Climate informatics (e.g., big data methods, cloud computing, GEE)
- Extractable subsets of model output
- Probabilistic climate change information for impacts
- ESM expert guidance for impacts community on use of ensembles, etc.
- Connecting skillful extreme rep. in impacts models with prioritized metrics from ESMs
- No good guidance on drought indices (crop-specific, incorporation of stomatal closure, etc.)
- Better incorporation of qualitative findings
- Connecting atmosphere & ocean circulation changes to extremes (e.g., blocking)
- Improve understanding of scale relevance from ESMs to impacts; improve tools and techniques to make connections across those scales (including uncertainties)