Key Points from Today’s Sessions

- Purpose-driven Practicable Predictability
- Theoretical Limits on Earth System Predictability
- Exploring Predictability through New Methodologies and Technologies

Purpose-driven Practicable Predictability

- Earth system prediction offers major benefits for improving risk assessment and management in multiple sectors; It requires the understanding of, and interaction with, stakeholders
  - We saw several specific examples of this value today
  - Addresses systemic, integrated risks in a way that builds resilience
- Advancing seamless earth system predictability from minutes to centuries to meet societal needs is more optimally done through a value cycle approach
  - Information generation is critical; but not sufficient
  - Process the information in increasing layers of customization
  - Cycle stakeholder interaction learnings back into information pipeline
- Ensuring co-design between users and researchers to set research priorities and ensure advances are useful, usable, and beneficial
  - Including social, behavioral scientists
  - Need for sustained interaction with users
  - Importance of considering equity issues and capacity building
- Working in partnership: internationally, across disciplines – agencies – organizations – research communities, through private-public engagement, engaging early career scientists
  - Draw from existing prototypes, and long-standing efforts and lessons
  - GARP for the 21st century?

Theoretical Limits on Earth System Predictability

- The signal-to-noise ratio determines an upper bound on potential predictability
- Noise in most ensemble forecasting systems is underestimated, which leads to an overestimation of predictability
    - Can address this problem by implementing stochastic parameterizations
    - Apparent in sea ice predictions → missing processes? unresolved processes?
- Model errors lead to incorrect estimation of forecast signals (e.g., coupling dynamics between tropics and extratropics are a source of predictability, but not accurately captured in models).
- Should we rethink how we do numerical weather prediction → use machine learning to step the atmospheric state forward in a stable way?
- Theoretical potential to predict biogeochemical variables in ocean and land systems
    - But lack of observations from which to initialize/assess predictions
- Unrealized predictive potential in some societally relevant systems, e.g. coasts, ocean ecosystems, land water/hydrology
- Need to develop and sustain workforce focused on predictability research and applications

Exploring Predictability through New Methodologies and Technologies

- Identifying situations that are more predictable than others can help better understand predictability of the earth system → ID forecasts of opportunity and focus on those
- ML methods are well-designed to discover and explore these opportunities
- Neural networks are no longer black boxes – tools exist to help visualize their decisions.
- Need earth scientists working with machine learning experts to develop and apply methods tailored to the specific science questions
  - Workforce development implications
- Improve understanding of predictability by capitalizing on the availability of data and combining this with ML and DA tools
- Most Earth system models are not set up to maximize observations, e.g. many opportunities to bring new land observations into models
- In some cases, need to take the leap to recode and take advantage of new tools. More generally, time to adapt new ways of thinking, modeling and computing.

Next up!

- Optimizing Observations to Explore Predictability
- A Holistic Earth Modeling Framework
- A New Research Framework for Practicable Earth System Predictability

Thank you,
See you tomorrow!

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