“Longer” time-scale impressions

Gerald A. Meehl

Is it possible to identify a "best" model or set of models (or eliminate "bad" models)?

1. Use the multi-model ensemble of opportunity because it always seems to out-perform any single model
2. Use a single multi-parameter metric to rank models
3. Use multiple separate metrics for specific applications to rank models
4. Use all the models but weight them based on some set of metrics
5. Choose a subset of models based on performance in a specific region of interest, or for a specific process or application

“Longer” time-scale systematic errors in coupled models:

1. **Things we could fix but are constrained by logistical limitations (mainly computer resources):**

   higher ocean resolution: improved Gulf Stream and ACC, eddy heat transport, currents, (and thus SST)

   higher atmospheric resolution: tropical cyclones, reduced long wave systematic errors, Antarctic Peninsula climate, midlatitude cyclones, precipitation extremes

"Longer" time-scale systematic errors in coupled models:

1. **Things we could fix but are constrained by logistical limitations (mainly computer resources):**

   higher ocean resolution: improved Gulf Stream and ACC, eddy heat transport, currents, (and thus SST)

   higher atmospheric resolution: tropical cyclones, reduced long wave systematic errors, Antarctic Peninsula climate, midlatitude cyclones, precipitation extremes

   Requires large dedicated computer resources for coupled climate modeling to allow increases of resolution, as well as resources for storage and manipulation of huge amounts of model data

2. Things we think we know something about; an improved simulation would reduce uncertainty; features identified that can be fixed; have either new model formulations or new observed data that may provide improvements soon:

a. Cloud feedbacks
b. Low level clouds and SW CRF
c. Ocean heat content
d. ENSO period (related to improved mean state)

2. Things we think we know something about; an improved simulation would reduce uncertainty; features identified that can be fixed; have either new model formulations or new observed data that may provide improvements soon:

a. Cloud feedbacks
b. Low level clouds and SW CRF
c. Ocean heat content
d. ENSO period (related to improved mean state)

Must ensure funding is in place to follow through from data collection/analysis to actual model improvements

3. Persistent errors with either limited or incomplete understanding of processes, inconsistent or model-dependent complications, or no clear solution how to fix

a. Seasonal cycle in eastern equatorial Pacific

b. Double ITCZ

c. Over-extensive equatorial Pacific cold tongue

d. MJO

3. **Persistent errors with either limited or incomplete understanding of processes, inconsistent or model-dependent complications, or no clear solution how to fix**

   a. Seasonal cycle in eastern equatorial Pacific

   b. Double ITCZ

   c. Over-extensive equatorial Pacific cold tongue

   d. MJO

Initiate a dedicated program to specifically address these problems: "Improvement of systematic errors in coupled models", with PI funding to work with modeling groups, and workshops

Looming challenge:

Emergence of Earth System Models (ESMs), based on global coupled climate models but including interactive carbon cycle, chemistry, computed aerosols, dynamic vegetation

Development of these models will compete with improvement of existing coupled climate models in terms of human and computational resources

This will involve scientists from different communities (e.g. biogeochemistry, land surface/ecosystem, ocean ecosystem, chemistry), but will also tax developers of current coupled models

Looming challenge:

Emergence of Earth System Models (ESMs), based on global coupled climate models but including interactive carbon cycle, chemistry, computed aerosols, dynamic vegetation

Development of these models will compete with improvement of existing coupled climate models in terms of human and computational resources

This will involve scientists from different communities (e.g. biogeochemistry, land surface/ecosystem, ocean ecosystem, chemistry), but will also tax developers of current coupled models

Systematic errors in existing coupled models will negatively affect coupling to new components, and funding agencies must not lose sight of urgent need to make improvements in existing models