QUESTIONS TO GUIDE PRESENATIONS AND REVIEW OF CLIMATE RESEARCH AND MODELING (CRM) PROGRAM

Underpinning the many science and programmatic questions below is the fundamental question: Is the strategy being followed by CRM to address climate research and modeling issues an effective one? If not, what changes in strategy should be made?

Overview

1. What have been the major accomplishments of NOAA's climate research and modeling efforts over the past 5 years?
2. How is the research leading to scientific advancements and improved deliverables? How have the results been used? Do NOAA's operational climate prediction systems make effective use of research? How is research and operational progress measured?
3. What are the current key challenges in NOAA's climate research and modeling program? Where are the gaps?
4. Are NOAA's strategies, prioritization and investments in climate research and modeling consistent with the critical scientific questions and needs? Where is NOAA best poised to address the needs and gaps?
5. How can NOAA enhance its role in addressing the principal research issues on climate variations and change facing the nation and the world? What is the unique role of NOAA's efforts in climate research and modeling? What are the synergistic research linkages with other Federal agencies and other partners?

Panel 1: Understanding Climate Processes

Overarching Questions:
Are research findings effectively transferred from this capability into modeling and analyses information, in turn resulting in high-quality products? Are the research findings generating other information needs? Are these ready to serve the emerging climate services? What aspects should be emphasized to generate products for climate services? Who are NOAA's key partners for collaborations on research and deliverables?

Panel 1a

Atmospheric Composition and Climate - aerosols, (direct/indirect effects), water vapor, stratospheric and tropospheric ozone issues

1. What have been NOAA's contributions to the major advances in understanding of processes related to stratospheric and tropospheric ozone and non-CO2 greenhouse gases and their influences on climate? What aspects should be emphasized to improve climate prediction/projection?

2. What studies should NOAA conduct to understand, predict, and provide policy options during the recovery of the stratospheric ozone layer? How can the quantification of the stratospheric effects on climate be improved (and vice-versa) and is the present scope appropriate?
3. How should the gaps in the understanding of aerosols and their effects on climate be addressed by NOAA (including aerosol-cloud interactions)? How can knowledge of aerosol forcing on climate be advanced and the effects more reliably quantified through NOAA's research?

Clouds, Aerosols, and Convection

4. What have been NOAA's major advances in understanding processes related to aerosols, clouds, and convection over the past 5 years? What are the major gaps and how can NOAA optimally focus resources to address short- and long-term issues?
5. What aspects of convection need to be emphasized by NOAA to improve its climate models? What should be emphasized to result in improved NOAA climate predictions and projections, both globally and regionally?

Climate and Air Quality

6. What should be NOAA's highest priorities for advancing an understanding of the effects of air quality on climate and vice versa (ozone, aerosols)?

Panel 1b

Ocean processes and Carbon Cycle

7. Where are the major gaps in current understanding of the climate-relevant physical processes in the oceans including sea-ice and land-ice, and how should these be addressed by NOAA? What is needed to better model and understand the ocean's role in climate variations, change, and predictability?
8. What other process studies, such as the ocean-atmosphere or land-atmosphere interface, should NOAA emphasize to improve its modeling of the carbon-climate interactions, including better quantification of carbon uptake by oceans and biosphere?
9. What investments are required by NOAA to improve the understanding and modeling of the fluxes of carbon among the land, ocean, and atmosphere?

Panel 2: Reanalysis and Data Assimilation

Reanalysis and reforecasting

1. How should NOAA's development of a fully coupled ocean-atmosphere reanalysis/analysis system be accelerated, with due attention to the component systems (atmosphere, oceans, land, ice, biosphere)?

Reanalysis of the 20th Century

2. How is NOAA research contributing to advancements in the understanding of the 20th century climate? To what extent has this led to increased knowledge of detection and attribution of climate variations and change, including extremes?

Data Assimilation development - ocean model and future plans

3. What additional steps by NOAA toward an Integrated Earth System Analysis beyond coupling the ocean and atmosphere are possible in the near term?

Carbon Tracker

4. How are the goals enabling the addressing of key scientific aspects of the carbon problem? What are the critical needs, and what steps should NOAA undertake?

Panel 3: Earth System Modeling, Predictions, and Projections

Computing resources; Modeling strategies; Assessments

1. What should be NOAA's overarching priorities for Climate Modeling, Predictions, and Projections? How should NOAA address the gaps in basic science, measurements, process modeling, computational resources and reliable quantification of climate variations/change on all space and time scales of interest?
2. How are NOAA's computer needs for climate modeling being addressed? Does NOAA make effective use of its computing resources and modeling expertise currently available across the nation?
3. To what extent have these accomplishments resulted in improvements to NOAA operational products or other applications (e.g., IPCC AR4, WMO/UNEP O3 assessment, CCSP SAPs, NCEP seasonal forecasts)?

Model Development Activities

4. What improvements in numerical methods are being explored to make computer codes more efficient? Is NOAA making effective use of these advances?

5. What are the requirements for an Earth system model to address key scientific questions and to be relevant for applications, and how should these requirements be prioritized by NOAA?
6. How are the strengths and weaknesses of the component models having a bearing on NOAA's Climate and Earth System Models? How robust are the simulations?

GFDL and NCEP strategy and challenges

7. Has NOAA made productive and reliable trade-offs among model complexity, model resolution, and ensembles of runs being considered in addressing different issues and applications?
8. Has NOAA made effective use or done appropriate research on regional climate models versus increasing resolution of global models?
9. What are the strengths and weaknesses of the two model approach for unifying NOAA modeling from seasonal to centennial time scales?

Operational Climate Monitoring and Prediction Products and Services, and the Climate Test Bed

10. What steps are needed by NOAA to improve intraseasonal and seasonal predictions? Are new strategies needed in light of a changing climate?
11. Are operational monitoring and prediction products and services developing properly on ISI timescales?
12. Albeit in its early stages, is the Climate Test Bed proving to be an effective mechanism for accelerating the transition of research into operations?
13. How effectively has this capability transferred its needs on process studies compared to that in Panel 1?
14. Should NOAA make CFS available for use by the greater community (e.g. document, help desk, transportable, etc.)? Would it help to improve and understand the model and its products?
15. Is NOAA's approach to a National Strategy on Multi-Model Ensembles appropriate?
16. Is there an appropriate balance between CFS as a national model and development of CFS as a member of a MME prediction system, given the available resources?

Panel 4: Integration Between and Across Programs

Integration within CRM

1. Are the three CRM capabilities effectively working together to synthesize and deliver information needed by decision and policy makers, including regional attributions and manifestations of extreme events, abrupt change, and drought?

2. How does research and modeling at NOAA cooperative institutes and other multi-year institutional grantees (ARCs, RISAs, IRI) align with related activities within NOAA and support the other Climate Goal programs?

Integration Between the Climate Programs

3. To what extent have the accomplishments of the CRM program impacted activities in the other Climate Goal programs: Climate Observations and Monitoring, and Climate Service Development (and their precursors) and vice versa?
4. How does research and modeling supported by the CPO competitive grants program and at NOAA cooperative institutes align with climate research and modeling within NOAA? Do NOAA operational climate models (CFS, CM) make effective use of this research?
5. How has NOAA's CRM Program coordinated with other NOAA programs in focusing research, developing priorities and addressing mutual needs?
6. How has NOAA utilized *in situ* and satellite observations in its research? Should this be further enhanced within the CRM?

Integration with National Agencies on Climate

7. How are NOAA's partnerships with other Federal agencies, and other national and international partners faring? Are these successful?
8. How can this coordination be improved and co-dependency established for mutual benefits and for jointly advancing the science and deliverables?

NOAA's Role in Assessments

9. How has NOAA science contributed to the major results from the recent assessments?
10. How can the outcomes from these assessments, particularly the statements on the unresolved issues and uncertainties, be used by NOAA to steer prioritization of future research?

Panel 5: Decadal Variability and Predictability

Decadal Climate Variability and Predictability

1. Does NOAA/CRM have an effective strategy to increase our understanding and make use of decadal climate variability and its broader impacts?
2. Does NOAA/CRM have an effective strategy for understanding and utilizing decadal-scale climate predictability that include the effects of both natural variability and forced climate change?

Abrupt Change

3. Does NOAA have an effective/timely approach to use improved understanding of cryospheric processes that contribute to sea level rise be incorporated into its climate models?
4. What are the potential sources of abrupt change in the climate system that NOAA should focus on?
5. How is NOAA/CRM addressing the topic of abrupt climate change in terms of increased understanding and the development of prediction systems?

Atlantic Meridional Overturning Circulation – AMOC

6. Are NOAA's priorities within the AMOC implementation plan consistent with its strengths?

Climate and Extremes

7. How is NOAA's climate modeling research advancing the scientific knowledge on changes in weather and climate extremes? How can this be improved?