The Oceans and Climate

Challenges:

1) Fundamental understanding of ocean circulation and its role in climate, and of sea level rise.
2) Understanding the role of chemical cycles in the bio-sphere in regulating and responding to climate and ocean circulation
3) Understanding cross-scale linkages within the Earth system
4) Ability to identify potential for abrupt change or "tipping points" (e.g., release of methane, biomass distribution, ecosystem regime shifts).
5) Sufficient understanding of Earth system to allow separation of natural and anthropogenic effects on climate, and ocean climate effects on humans.

A cross-cutting issue:

6) Conversion of research results to information that will effectively

- *inform/educate the public*
- *enable resource managers and policy/decision makers*
- *enhance national defense and economic security*

Research Needs:

1) Enable a consistent picture of the ocean's role in climate through analysis of paleo and instrumental data.
2) Improve understanding of key regional (e.g., polar, tropical, coastal) processes (e.g., ocean circulation, air-sea interaction, convection, water mass formation) on climate variability and change.
3) Improve understanding of ocean mixing and turbulence parameterizations.
4) Improve understanding of ocean physical, biogeochemical, and air-sea flux processes. Relationship between these. Application to fisheries, ecosystems, and total productivity.
5) Identify and monitor 3-D ocean circulation and quantities in key regions that can potentially indicate future abrupt climate changes.

Infrastructure and Technology Needs:

1) Global ocean model resolution to sufficient resolution to be useful for physical & biogeochemical processes (~ 1 km scale).
2) Develop an earth systems model linked to the research program (based on community standards).
3) Data assimilation system to link the observations to products for research, forecast, and decision support.
4) Capability to develop climate data records for physical, biological, and biogeochemical data sets.
5) Acquisition of observations necessary to reconstruct past states of the ocean, including the development and refinement of climate proxies.
6) Permanent observing system composed of satellites, in situ sensors, autonomous platforms, ships, drifters, etc. that can continuously evolve to accommodate technological advances and increased knowledge.
7) Industry/academic/government partnerships throughout the entire sensor development, validation and acceptance process.
8) Operate the full observation system by industry/academic/govt partnerships
9) Establish a national technician accreditation program.
10) Mechanisms for sustaining dialogue between resource and decision managers to guide regional efforts and facilitate the application of regional results for social benefit.

Outcomes:

1. **Energy Security**. Improved understanding of the role of carbon cycle in an evolving climate to enable exploration of alternative energy sources for mitigation.

2. **National Security**. Climate predictions and projections of sufficient accuracy & regional specificity to enable strategic and tactical mitigation and adaptation decisions.

3. **Environmental Security**. Skillful climate predictions on seasonal to decadal scales to enable risk reduction with regard to extreme events, effective resource and ecosystem management, and to ensure health and safety

4. **Ocean Literacy.** Increase public appreciation of the oceans' central role in their lives and well-being.