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A proposal for an integrated ocean network for long-term climate and seafloor studies

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Ocean studies have been conducted for decades to explore important processes in the oceans leading to discoveries including plate tectonics, the causes of major ocean currents and the important role of mesoscale processes in oceanography. These studies have largely been made using short-term experiments with ships and buoys. In the past twenty years, satellites have played a growing role in ocean studies and a synoptic view of ocean processes have provided powerful tools for seafloor mapping, understanding the rate and spatial variability of sea level rise, monitoring ocean current variability, storm creation and growth, and ice shelf and ice sheet evolution.

The important role of temporary observations, however, are now being eclipsed by the need for much longer-term observations to understand better long-term seafloor deformation and climate variability and change. Because important long-term phenomena are generally characterized by low rates and small changes, separating the relevant measurements from diurnal, annual and interannual "noise" has become increasingly important. While short-term observations associated with the waning scientific activity in process discovery could be conducted with sensors with short ocean lifetimes and limited temporal accuracy, this is no longer the case. Generally, emergent phenomena, climate, and geodetic changes require highly accurate timing for correlation or coherence studies of multiscale observations over long times. In terms of both data and modeling, quantitative estimates of errors are critical if the small, secular changes are to be observed. In addition, temporal or spatial gaps mitigate against the measurements of change and sensor drift is unacceptable. In the case of climate, barotropic phenomena generally propagate quickly to other parts of Earth, but baroclinic changes will move very slowly across the globe (weeks to years). For this reason, a well-studied coastal zone will reveal little about regional change without measurements of related phenomena globally. Multiscale observations extending to the entire Earth are essential.

Unfortunately, oceanographic measurements are and will remain sparse relative to the spatial and temporal properties being measured; the synthesis of observations and models will become increasingly critical.
We propose that national ocean programs, often focused on the coastal or littoral zones, must be carefully combined with global multiscalar observations in the deep ocean as well. To accomplish this goal, open data must be shared in near-real-time among nations and new approaches to timing and sensor accuracy must be adopted. The US NSF Ocean Observatories Initiative (OOI) can potentially serve as a partner in international collaborations in data sharing in near-real-time, providing the observations needed for future climate modeling to predict change in the 20-50 year time scale with confidence. The greatest challenge we all face is that climate system time scales extend well beyond existing instrument-based measurements (e.g. sea level from satellite altimetry, ocean heat content from in-situ observations, or gravimetric changes associated with disappearing ice sheets on Greenland and Antarctica).