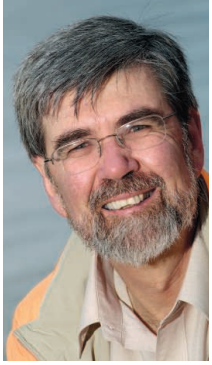

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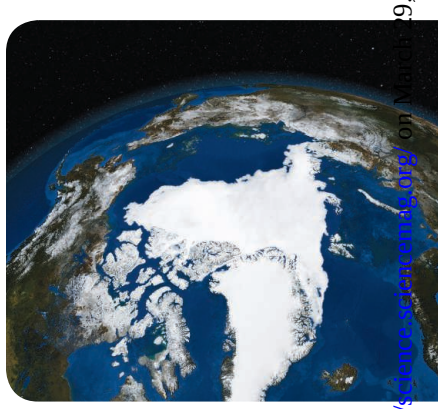
The Changing Oceans

THE EVOLVING DISASTER OF THE GULF OF MEXICO OIL SPILL REMINDS US THAT OUR WELFARE depends on a healthy marine ecosystem and that the oceans are vulnerable to human activities. The oceans sustain a vast wealth of biological diversity, deliver critical ecosystem services, supply valuable natural resources, and are a central component of the climate system. It is therefore critical that the current ocean-observing system be extended to cover a wider range of ocean properties.

The oceans slow the rate of climate change by absorbing over a quarter of the carbon dioxide released by the burning of fossil fuels and by storing over 90% of the excess heat accumulating in the climate system. These two changes, together with nutrient input into the oceans from fertilizer use and other pollution, are affecting the marine ecosystem by increasing the acidity of the oceans, decreasing subsurface oxygen concentrations, and increasing coastal nutrient loads. At the same time, ocean changes affect the terrestrial environment, being the primary source of the water vapor that drives global rainfall patterns. Changes in ocean temperatures and currents and in the oceans' interaction with the atmosphere are already altering the frequency, intensity, and distribution of storms, droughts, floods, heat waves, and cold spells. And by 2100, rising sea levels from ocean thermal expansion and increasing ocean mass (from melting glaciers, ice caps, and the Greenland and Antarctic ice sheets) will expose an additional tens of millions of people annually to the risk of coastal flooding.



The result of these relationships between the ocean, atmosphere, and land is that the world will experience climate and ocean changes that continue for centuries. In addition, continuing greenhouse gas emissions are increasing the risk of crossing critical thresholds, with poorly understood consequences. If society is to reduce the risk of major ice-sheet contributions to sea-level rise and of profound changes in marine ecosystems, a sustained reduction of greenhouse gas emissions is an urgent priority. However, society has thus far failed to heed the clear warnings about continuing greenhouse gas emissions, making the need to adapt to climate and ocean changes unavoidable. This adaptation will become increasingly challenging for many people around the world, particularly the poor, those living in vulnerable coastal communities, those subject to substantial changes in rainfall, and those with few resources or options. Environmental refugees will become a major social challenge.

Adaptation will require a much improved understanding of the oceans, underpinned by long-term sustained measurements. Satellite observations and automated in situ upper-ocean temperature and salinity observations have improved dramatically in recent years. However, the records are short and both spatially and temporally incomplete. Needed, but rare to nonexistent, are long time series—including data from the deep oceans; under-ice measurements; and geochemical, biological, and ecosystem parameters. The ocean-climate communities throughout the world have benefited tremendously from the formulation of a single coordinated ocean-observing plan. Realistic options for completing this plan, for filling in the gaps, and for extension to a wider range of ocean properties, including ecosystem parameters, are required. There also is a need for greater engagement by marine scientists in addressing climate and ocean variability and change, including their impacts on ecosystems, biodiversity, and fisheries, as well as for improved communication of the importance and urgency of their findings.

Finally, it is essential to sustain global-scale ocean-observing systems and to compile available data into quality-controlled, easily accessible databases. At present, almost all ocean observations are supported by short-term research funding that is subject to changes in research priorities. Long-term funding for sustained observations is absolutely critical. An important step would be mandating and funding existing or new national institutions with responsibility to collect the critical environmental observations, backed by an international legal framework to ensure the free, timely, and open sharing of ocean information for all.

– John A. Church

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CREDITS: (TOP) BRUCE MILLER; (RIGHT) NASA/GODDARD SPACE FLIGHT CENTER SCIENTIFIC VISUALIZATION STUDIO

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