Scientist Takes Comprehensive Look at Human Impacts on Ocean Chemistry

June 17 2010

Scott C. Doney was co-chief scientist on an expedition in the South Atlantic on the NOAA ship Ronald H. Brown. He led a team trying to quantify the ocean uptake of anthropogenic CO2. (Photo by John Bullister, NOAA/PMEL)

(PhysOrg.com) -- Numerous studies are documenting the growing effects of climate change, carbon dioxide, pollution and other human-related phenomena on the world's oceans. But most of those have studied single, isolated sources of pollution and other influences.

Now, a marine geochemist at the Woods Hole Oceanographic Institution

(WHOI) has published a report in the latest issue of the journal *Science* that evaluates the total impact of such factors on the ocean and considers what the future might hold.

"What we do on land—agriculture, fossil fuel combustion and pollution—can have a profound impact on the chemistry of the sea," says Scott C. Doney, a senior scientist at WHOI and author of the Science report. "A whole range of these factors have been studied in isolation but have not been put in a single venue."

Doney's paper represents a meticulous compilation of the work of others as well as his own research in this area, which includes ocean acidification, climate change, and the global carbon cycle.

He concludes that climate change, rising atmospheric carbon dioxide, excess nutrient inputs, and the many forms of pollution are "altering fundamentally the…ocean, often on a global scale and, in some cases, at rates greatly exceeding those in the historical and recent geological record."

The research documents several major trends, which include a shift in the acid-based chemistry of seawater, reduced subsurface oxygen, both in coastal waters and the open ocean, rising coastal nitrogen levels, and a widespread increase in mercury and other pollutants.

"Human impacts are not isolated to coastal waters," Doney says. They "are seen around the globe."

Moreover, he says, "many of these changes in climate and ocean chemistry can compound each other, making the problem considerably worse for marine life." For example, warming and nutrient runoff both can trigger a decline in oxygen levels off the coast, according to Doney. And acidification, he says, may exacerbate coral bleaching.

Among Doney's findings:

• Global ocean pH and chemical saturation states are changing at an "unprecedented" rate, 30 to 100 times faster than temporal changes in the recent geological past, "and the perturbations will last many centuries to millennia."

• "Ocean acidification will likely reduce shell and skeleton growth by many marine calcifying species, including corals and mollusks."

• "Ocean acidification may also reduce the tolerance of some species to thermal stress…Polar ecosystems may be particularly susceptible…"

• Fertilizer runoff and nitrogen from fossil fuels are increasing the severity and duration of coastal hypoxia, or decreased oxygen.

Doney was part of an international consortium of scientists that reported recently that carbon dioxide emissions from fossil fuels have increased by almost a third over the last decade, rendering the Earth's future uncertain unless "CO2 emissions [are] drastically reduced."

They attributed the rise to increasing production and trade of manufactured products, particularly from emerging economies, the gradual shift from oil to coal, and the planet's waning capacity to absorb CO2.

Doney led a team that developed ocean-model simulations for estimating the historical variations in air-sea CO2 fluxes. "Over the last decade, CO2 emissions have continued to climb despite efforts to control emissions," Doney said. "Preliminary evidence suggests that the land and ocean may be becoming less effective at removing CO2 from the atmosphere, which could accelerate future climate change."

In his Science paper, Doney calls for “a deeper understanding of human impacts on ocean biogeochemistry…Although some progress has been made on a nascent ocean observing system for CO2, the marine environment remains woefully undersampled for most compounds. The oceanographic community needs to develop a coordinated observational plan…”

More detailed studies are needed, in particular, to look at the responses of cells and organisms to biochemical intruders to their undersea environment. “Lastly, Doney says, “targeted research is needed on the impacts on marine resources and fisheries, potential adaptation strategies, and the consequences for human and social economic systems.”

Provided by Woods Hole Oceanographic Institution