OCEAN SCIENCE

The acid test

JOHN DORE

Proc. Natl Acad. Sci. USA **106,** 12235–12240 (2009)

It's well recognized that absorption of atmospheric CO_2 is making the ocean more acidic, but there are few long-term data sets that document this trend.

Now research by John Dore of Montana State University and colleagues shows a significant increase in the acidity of surface waters over nearly 20 years at Station ALOHA in the central North Pacific Ocean. The group found that since 1988 surface pH at ALOHA has been falling by 0.0019 ± 0.0002 each year, a value in line with that expected from increasing atmospheric CO_2 entering the ocean. However, they also found that seasonal peaks in biological productivity and temperature — as well as year-to-year fluctuations in ocean mixing — affect the surface pH. Below the mixed layer — that portion of the ocean influenced strongly by the atmosphere — pH has decreased more rapidly, most markedly at a depth of 250 metres. This may be due to the invasion of acidic waters from the north or to the transport of CO_2 from surface waters as organisms die, sink to these depths and degrade.

The team concludes that sparse or short-term records could miss the long-term trends in ocean acidification caused by rising atmospheric CO_2 concentrations.

Alicia Newton

ATMOSPHERIC SCIENCE

Clear view

PUNCHSTOCK

Geophys. Res. Lett. **36,** L15808 (2009)

Climate-cooling aerosols reach the upper atmosphere as a result of human activity, such as coal burning, as well as from volcanic eruptions that eject large quantities of sulphur dioxide. Discerning the source of these particles can be difficult, but a recent break in volcanic activity makes clear just how rapidly atmospheric concentrations of anthropogenic aerosols are increasing.

A team led by David Hofmann of the US National Oceanic and Atmospheric Administration's Earth System Research Laboratory in Boulder, Colorado, tracked upper-atmosphere aerosol levels since 1991 — when the last major volcanic eruption took place — using lidar measurements made at the Mauna Loa Observatory in Hawaii and at the Boulder research station. They found strong seasonal trends in aerosol concentrations, with a wintertime peak, which they attribute to alternating wind regimes in the tropics. Overlaying this seasonal cycle was a four- to seven-per-cent increase in aerosols between 2000 and 2009.

The most likely source of the rise is a steep increase in coal burning, mainly in China, where sulphur emissions have climbed 5.2 per cent per year since 2002. As China's coal use is expected to grow 3.2 per cent per year in the next two decades, atmospheric aerosol levels are unlikely to decline any time soon.

Anna Armstrong

CRYOSPHERE

Seabed seepage

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Geophys. Res. Lett. **36,** L15608 (2009)

Large quantities of methane — a potent greenhouse gas — lie frozen beneath northern oceans in a form known as hydrates, leading to concern that they could be destabilized as waters warm. Now scientists have found plumes of the gas bubbling up from the Arctic seabed near Norway's Svalbard archipelago.

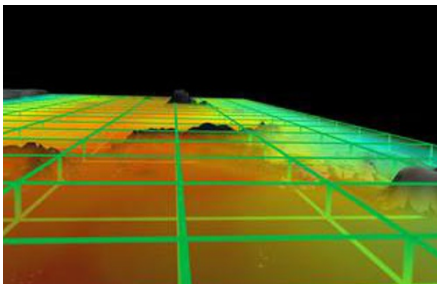
In autumn 2008, Graham Westbrook of the University of Birmingham and colleagues discovered more than 250 gaseous plumes, mostly of methane, emanating from the sea floor off West Spitsbergen at depths of 150–400 metres. Some of the plumes came within 50 metres of the sea surface. Temperature records show the West Spitsbergen current has warmed 1 °C in this area over the last three decades, and the researchers say that as a consequence, hydrates are now dissolving in areas where they formerly remained safely frozen. While methane hydrates were stable to a depth of 360 metres just 30 years ago, they are now stable only below around 400 metres.

As warming of the shallow Arctic seabed continues, tens of millions of tonnes of methane could be released each year. Some of this gas will enter the atmosphere, but most will dissolve in the ocean, contributing to acidification and lowering oxygen levels.

Anna Barnett

CLIMATE PREDICTION

Estimating uncertainty



NASA

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Large uncertainties plague predictions of temperature change at a regional scale. Predicting climate change with greater certainty is of enormous academic and economic interest, as it can inform adaptation and investment decisions.

Ed Hawkins and Rowan Sutton of the UK National Centre for Atmospheric

Science in Reading identified the main sources of uncertainty in predicting temperature change across the globe at scales of 2,000 kilometres — the first study to analyze this issue at the regional level. Using data from 15 global climate models and for three emissions scenarios, Hawkins and Sutton found two important sources of uncertainty: first, diversity between models in how they represent the climate, and second, natural variability inherent in the climate system. They also found uncertainty in the extent to which humans will continue to affect the climate, but this was less significant than other sources at small spatial scales and over one to two decades.

The authors say that much work is needed to reduce these sources of uncertainty and that investments made now could improve predictions in the coming decades by 10–20 per cent for the United Kingdom and Europe, and by up to 20 per cent for the rest of the world.

Olive Heffernan

BIODIVERSITY AND ECOLOGY

Crossing the line

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The tree-line marks the frontier, usually at a certain latitude or elevation, where cold temperatures restrict tree growth. Scientists have speculated that climate change could cause tree-lines to advance, but new research reveals that their response to warming is more complex than predicted.

Melanie Harsch of Lincoln University, New Zealand, and colleagues used data from 166 forested sites across the globe, together with temperature data from nearby climate stations, to look at whether tree-line advance during the twentieth century was linked to local warming. While tree-lines advanced in 87 of the sites studied, they receded at two of the sites and remained stable in the rest. The researchers found that the tendency to advance was highly dependent upon the type of tree-line. Diffuse tree-lines — where the density of trees decreases gradually — were the most responsive to warming, with 80 per cent advancing since 1900. In contrast, only 22 per cent of abrupt tree lines and those dominated by crooked trees advanced over the same time period.

Seasonal temperatures also strongly influenced the response, with abrupt and crooked tree-lines likely to advance when warming occurred during winter and diffuse treelines more commonly affected when warming occurred during summer.

Anna Armstrong

CLIMATE IMPACTS

Expanding sands

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Geophys. Res. Lett.
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The world's subtropical deserts could expand up to 34 per cent by the end of the century, according to a new study. More moderate estimates suggest at most a 10-per-cent increase in desert area by 2100.

Ning Zeng and Jinho Yoon of the University of Maryland used an advanced model of world vegetation to simulate the continued expansion of deserts. Unlike more traditional models, theirs was specifically tuned to capture changes in albedo — the reflectivity of the land surface — triggered by desertification. Factoring albedo into their simulations increased desert expansion by three-fold, Zeng and Yoon found. They suggest that a decline in moisture at the desert edge increases the reflection of light from the land surface, which reduces the amount of heat absorbed. This in turn leads to large-scale changes in air circulation that further reduce precipitation at the desert's margins. The Sahara, Gobi, Kalahari and Great Sandy deserts are at greatest risk of expansion, conclude the authors.

They urge the Intergovernmental Panel on Climate Change to include feedbacks, such as those from albedo, in future modelling efforts to provide a more robust estimate of future desertification.

Alicia Newton