OCEAN SCIENCE

## Southern Ocean saturated

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*Science* **316**, 1735–1738 (2007)

Around half of all human-produced $CO_2$ is removed from the atmosphere by the oceans, slowing global warming. Now, a study shows that the Southern Ocean, one of the largest carbon sinks, is absorbing less $CO_2$ than expected relative to atmospheric levels of the greenhouse gas.

Corinne Le Quéré at the Max Planck Institute of Biochemistry in Martinsried, Germany and co-workers estimated changes in the Southern Ocean's carbon sink from data taken between 1981 and 2004 at 11 stations in the Southern Ocean and 40 stations worldwide. They calculated the $CO_2$ flux between the ocean and the atmosphere and estimated the Southern Ocean sink to absorb, on average, between 0.1 and 0.6 gigatonnes of carbon per year. Since 1981, however, the rate of $CO_2$ uptake slowed by almost 0.2 gigatonnes per year relative to the rate expected given atmospheric $CO_2$ changes over the same period.

The impaired ability of the Southern Ocean to absorb $CO_2$ is attributed to increased windiness. This could be a result of atmospheric changes induced by global warming or ozone depletion in the upper atmosphere. Strong winds are predicted to increase this century, suggesting that stabilization of atmospheric $CO_2$ could be more difficult than expected.

Samia Mantoura

ANTHROPOGENIC CHANGE

## $CO_2$ rising fast

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*Proc. Natl Acad. Sci.* USA **104**, 10288–10293 (2007)

Worldwide emissions of man-made carbon dioxide are rising faster than even the worst case predictions made by scientists. The increase in $CO_2$ levels, which averaged 1.1% per year from 1990 to 1999, leaped to over 3% per year from 2000 to 2004, according to a new study by Michael Raupach of the Commonwealth Scientific and Industrial Research Organisation, Australia, and international colleagues.

The researchers divided the world into nine regions and analysed population trends, economic factors and energy-related data for each region. They found that developed nations, representing 20% of the world's population, accounted for 59% of global human $CO_2$ emissions in 2004. Developing nations, including those with rapidly expanding economies, were responsible for just 41% of total emissions in 2004, but contributed 73% of emissions growth that year.

Even the most fossil fuel-intensive scenarios developed by the Intergovernmental Panel on Climate Change underestimated the rapid increase in $CO_2$ levels since 2000. Raupach and colleagues attribute the observed trends to the increasing energy intensity of economic activity and the carbon intensity of energy sources. The study shows that no region is decarbonizing its energy supply and that $CO_2$ emissions are accelerating worldwide, with China in the lead.

Harvey Leifert

EXTREME EVENTS

## Cyclonic swirling

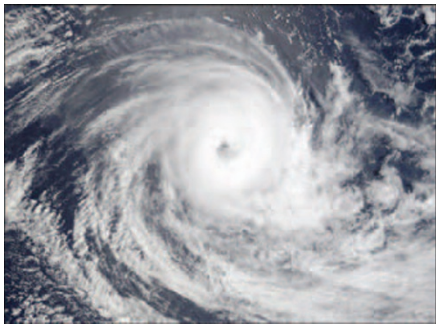
*Nature* **447**, 577–580 (2007)

Ocean mixing plays a crucial role in global climate because it is linked to the ocean's capacity to store and transport heat from the tropics to cooler regions. Tropical cyclones are thought to be important drivers of ocean mixing and heat transport, but until now their relative importance has been uncertain.

Ryan Shriver and Matthew Huber of Purdue University in Indiana now present substantive evidence that tropical cyclones have a significant role in mixing the ocean's uppermost layers. Using more data and longer sampling periods than previous studies, the researchers compared ocean temperatures before and after the passing of tropical cyclones to estimate the effect of these events on vertical mixing. Shriver and Purdue say that up to 15% of peak ocean heat transport can be linked to vertical mixing driven by tropical cyclones. Their estimate that cyclones account for 0.26 petawatts per year of ocean heat transport is significantly smaller than earlier calculations.

More surprisingly, the results show that cyclone-induced heat transport increases substantially with higher sea surface temperatures, suggesting that climate change could alter ocean circulation and heat transport. Climate models could be improved by including the effect of sea surface temperature on cyclone-driven ocean mixing.

Samia Mantoura



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REGIONAL CLIMATE

## Amazonian methane bursts

*Geophys. Res. Lett.* **34**, L10809 (2007)

The eastern Amazon River basin is emitting more methane than climate models take into account. An air sample analysis has now confirmed satellite data showing that the Amazon basin produces large amounts of the potent greenhouse gas. This suggests that scientists have underestimated the tropics as a methane source.

John B. Miller of the US National Oceanic and Atmospheric Administration and colleagues analysed samples taken by aircraft at a range of altitudes over two areas in eastern Amazonia from 2000 to 2003. They found that the region emits an average of 27 mg of methane per square metre per day.

The Amazon contributes on average 34 parts per billion of methane to the air flowing over Brazil from the Atlantic, and can contribute bursts as high as 200 parts per billion.

The researchers say more tropics methane measurements are needed to better understand global trends. Human methane sources are on the rise, but this has been offset by an unusual decrease in methane emissions from wetlands. If wetland emissions recover or other natural sources increase, global atmospheric methane levels could rise above what is already a dramatic increase over pre-industrial levels.

**Eric Smalley**

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## CLIMATE IMPACTS

# Fish fry

*Proc. Natl Acad. Sci. USA* **104,** 9715–9719 (2007)
Entire populations of North American rainbow trout are at risk of extinction as water temperatures rise with climate change, causing multimillion dollar impacts on commercial and recreational freshwater fisheries, a new study finds.

Peter Biro of the University of Technology, Sydney, Australia, and colleagues studied experimentally created trout populations in British Columbia, Canada, during two consecutive years, with eight and nine replicate populations, respectively. In 1998, lake temperatures were several degrees warmer than optimal for trout growth (21–22 °C), whereas 1999 temperatures were near optimal (17.5 °C). Only half as many young trout — about 4% in total — survived 1998, as compared with 1999.

Young trout forage near the shoreline to avoid predators, while seeking to attain sufficient growth to survive winter. Their metabolism increases as the water warms, however, requiring them to eat more to achieve the same weight. But the more they swim in search of food, the more susceptible they are to predation by adult trout, the researchers found. The study is the first to analyse climate impacts on the survival of geographically isolated fish populations, and identify the physiological and behavioural mechanisms responsible.

**Harvey Leifert**

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## CRYOSPHERE

# Sheet stability

*Geology* **35,** 551–554 (2007)
The East Antarctic Ice Sheet has changed relatively little in volume since the Last Glacial Maximum and has been stable for thousands of years, according to a new study.

Andrew Mackintosh at the Victoria University of Wellington and colleagues dated rock exposure ages and positions across the Framnes Mountains in East Antarctica to calculate the extent and timing of ice sheet retreat since the Last Glacial Maximum. The mountain range, which runs north to south perpendicular to the ice sheet margin, extends more than 400 m above the present-day ice sheet surface and contains rocks that were deposited sequentially as the ice retreated. From their analyses, the researchers found that the coastal ice sheet has thinned, at most, by 200 to 350 m in the past 13,000 years and has remained essentially unchanged for the past 7,000 years.

Retreat of the ice sheet during this period was driven largely by rising sea levels rather than by changes in temperature or precipitation, say the researchers. The study suggests that a dramatic rise in sea level caused by melting of the West Antarctic Ice Sheet or in Greenland could pose a future risk to the world's largest ice sheet.

**Eric Smalley**

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