MITIGATION

Accounting for air freight

Atmos. Environ. **45,** 7036–7045 (2011)

The reduction targets agreed under the Kyoto Protocol omitted emissions from international air transport because they were too difficult to quantify. Reliable plane fuel data are hard to come by and, as they are commercially sensitive, government agencies are forced to use rough proxies such as fuel sales statistics. However, a group from the University of Otago in New Zealand hopes to change this. They present a method of estimating the carbon output of the aviation sector, country by country.

Oliver Howitt and colleagues first worked out carbon dioxide emission factors for aircraft based on data for the amount of fuel taken onboard individual planes that departed Auckland, New Zealand in 2007. These were 0.82 and 0.69 kg of carbon dioxide per tonne-km for short-haul and long-haul journeys, respectively.

They used these emission factors along with mass and distance travelled of international air freight to estimate the carbon dioxide emissions. In 2007, they report, air freight transported in and out of New Zealand emitted 1.2 Mt of carbon dioxide (compared with 4.3 Mt generated by international air-passenger transport). *AP*

MITIGATION

Gauging unconventional gas

Environ. Res. Lett. **6,** 044008 (2011)

Extracting shale gas trapped in rocks by hydraulic fracturing, or fracking, produces just 11% more greenhouse-gas pollution than drilling for natural gas in wells, according to an analysis by Nathan Hultman, of the University of Maryland, and his colleagues. The finding comes after another study placed the carbon footprint of shale gas alongside that of coal.

The greenhouse-gas content of the differently located gases is the same — both are mainly methane and both extraction processes leak some of this gas. However, drawing up shale gas involves injecting high-pressure fluids to force the gases embedded in rock to diffuse into fractures, which requires slightly more energy and gas leakage. Hultman's group calculated the leakage rates using individual data provided by the US Environmental Protection Agency for more than 400,000 wells, but they acknowledge that methane leakage estimates for shale-gas production are 'uncertain'.

In a life-cycle analysis, the per kilowatt greenhouse-gas impacts of shale gas are 56% of those of coal when both are used in electricity generation for the US grid, the authors calculate. *AP*

ENERGY

Attributing carbon emissions

Proc. Natl Acad. Sci. USA **108,** 18554–18559 (2011)

Carbon dioxide emissions from fossil fuels are usually attributed to the country where the fuel is burnt. However, fuels are often extracted in one country and burnt in a different country, to produce goods that could be consumed in a third country. Failure to recognize this trade leads to an unfair attribution of carbon emissions.

Steven Davis, of the Carnegie Institution of Washington, and colleagues tracked global carbon dioxide emissions along the value chain — through the various stages from consumption back to production and fuel extraction — of 57 categories of goods and services in 112 countries and regions during 2004.

They found that 37% of global emissions were the result of burning imported fuels. They also found that 51% of global emissions were attributable to the extraction of fuels that were then used for goods and services in a different country. In particular, the researchers showed that regulating the fossil fuels extracted in China, the United States, the Middle East, Russia, Canada, Australia, India and Norway would cover 67% of global carbon emissions. *MC*

ECOLOGY

Seaweeds recede

Curr. Biol. **21,** 1828–1832 (2011)

Seaweeds around Australia's coast are shifting their distributions towards the South Pole so quickly that 100–350 species may be lost in the next 60 years, according to an analysis.

The study compares distribution records in Australia's Virtual Herbarium — a publicly accessible online database. It contains more than 20,000 records of seaweeds collected in Australian waters from the 1940s onwards.

A team led by Thomas Wernberg, of the University of Western Australia's Oceans Institute in Crawley, looked separately

CLIMATOLOGY

On blocking

Science **334,** 655–659 (2011)

The climate of the North Atlantic Ocean is heavily influenced by a climate system called the North Atlantic Oscillation (NAO). The NAO in turn was thought to be governed over decadal timescales by changes in the flow of warm water, which normally sweeps north near the Atlantic Ocean's surface and travels south at depth. But now there is a new theory. It suggests that long-term shifts in the Atlantic Ocean climate are actually prompted when the prevailing westerly winds that cross the ocean become blocked — sometimes for just five days — by a large anticyclone over the Atlantic Ocean.

Sirpa Häkkinen of NASA's Goddard Space Flight Center in Greenbelt, Maryland, and colleagues propose that such an atmospheric blockage can cause the high-altitude jet stream to develop large, near-stationary meanders. This reduces the wind-forcing that maintains the subpolar gyre to such an extent that a new pathway is opened up for warm, more saline water from the subtropics to flow north.

Among other evidence to support their idea, they show that winters with more blocking events between Greenland and Europe are also associated with a warmer and saltier subpolar ocean. *AP*

at the Pacific east coast and the Indian Ocean west coast. Both coasts have warm water currents of similar strengths flowing north to south, yet, at 3,500 km apart and facing different oceans, they have distinct algal floras.

The seaweed distribution shifts were similar in magnitude on both coasts. The authors warn that temperate Australia is home to many seaweed-dependent marine organisms. Global warming is therefore likely to be driving the rearrangement of whole marine communities — not merely altering the seaweed composition of Australia's shores. *AP*

CLIMATOLOGY

Feedbacks feeding back

J. Geophys. Res. **116,** D20109 (2011)

Self-reinforcing processes, known as positive feedbacks, amplify climate change, and are responsible for rates of change in the Arctic being among the highest on Earth. Although the major processes involved in these feedbacks are quite well understood, it is not clear how different feedbacks interact.

Yonghua Chen of Columbia University and the Goddard Institute for Space Studies, USA, and co-workers used a climate model to investigate how the amount of thermal radiation emitted towards the surface by the Arctic atmosphere varied with changes in water vapour and cloud properties throughout the seasonal cycle, and how they are projected to increase over the twenty-first century.

The results show that the emitted thermal radiation was most sensitive to water vapour and cloud density in the winter, explaining much of why the largest amplification of surface temperature occurs during this season. The increased levels of water vapour and cloud density expected in coming decades owing to greater greenhouse-gas concentrations will weaken the feedback interaction, suggesting that the current rate of amplified warming in the Arctic, relative to the rest of the Northern Hemisphere, may be reduced in future. *AB*

METEOROLOGY

The drought child

Environ. Res. Lett. **6,** 044007 (2011)

The El Niño/Southern Oscillation (ENSO) is a coupled atmosphere–ocean circulation occurring over the tropical Pacific Ocean, and is one of the main sources of the Earth's climate variability. Its extremes — the El Niño (warm phase) and La Niña (cold phase) — both affect rainfall in many parts of the world.

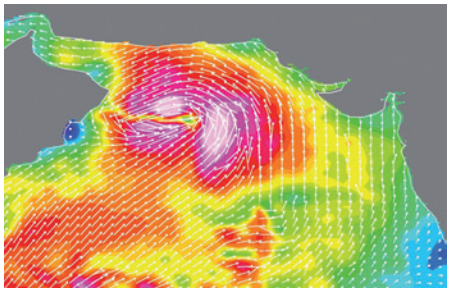
To better understand how ENSO influences droughts, Sergio Vicente-Serrano, of the Pyrenean Institute of Ecology (IPE-CSIC) in Zaragoza, Spain, and co-workers looked globally at the role of the ENSO phases on various drought types associated with hydrological, agricultural and environmental impacts.

The results indicate that the number of regions and months affected, and the total surface area with drought is much higher for El Niño phases than for La Niña phases. In large areas of America and Eastern Europe, ENSO contributes to droughts on short timescales of one to three months at the beginning of the events. In South Africa, Australia and Southeast Asia the effects were more obvious some months later, and at longer timescales. The authors suggest that the large temporal lag between the development of ENSO phenomena and the identification of drought conditions detected in the study may help in forecasting dry conditions in some regions up to one year before their occurrence, potentially improving early warning and adaptation to drought conditions. *AB*

METEOROLOGY

Sooty cyclones

Nature **479,** 94–97 (2011)



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The development of tropical storms in the Arabian Sea — associated with low-pressure cyclonic airflow — is limited by the interaction of winds at different heights, an effect known as vertical wind shear. The region is strongly influenced by monsoonal circulation patterns, which exhibit strong vertical shear and inhibit cyclone development. However, emissions of anthropogenic aerosols (fine particles suspended in the atmosphere) are thought to have weakened this monsoonal circulation. As such, it seemed plausible that the aerosol-driven circulation modification also affects the intensity of Arabian Sea tropical cyclones.

Amato Evan, of the University of Virginia in Charlottesville, USA, and co-workers investigated the intensity of the pre-monsoon tropical cyclones in the Arabian Sea during the period 1979–2010.

Based on a combination of modelling and observational data, they report an increase in pre-monsoon intensity and demonstrate that this is concurrent with a simultaneous upward trend in anthropogenic black carbon and sulphate aerosol emissions. *AB*

BIOGEOGRAPHY

In hot water

Science **334,** 652–655 (2011)

MEGAN SAUNDERS

To speak of a steady poleward advance of species is to oversimplify how organisms are responding to a warming world, argues a team led by Michael Burrows of the Scottish Marine Institute in Oban. A more accurate approach is to map spatial changes in isotherms, and then to consider the challenges that organisms face in maintaining their thermal niches.

Burrows and colleagues did this, and then compared the results with a calculation of the seasonal timing of temperatures over the past 50 years, measured in days per decade. They report that both methods show a patchy velocity of climate change on land and seasonal shifts at sea. For example, spring advanced 30–40% faster in the oceans in both hemispheres than on land between 1960 and 2009.

The authors say that certain marine zones are particularly at risk from climate change, notably those near the poles where species may lose their thermal niches entirely, and places such as the Mediterranean Sea, where the European land mass prohibits creatures from tracking thermal niches. *AP*

Written by Anna Petherick, Monica Contestabile and Alastair Brown.