radiation, organic matter both scatters and absorbs radiation. The absorptive component of organic matter is brown carbon, and is currently ignored in most climate models. Its exclusion results in organic matter being considered as a cooling agent, ignoring the potential warming component.

Chul Chung, from the Gwangju Institute of Science and Technology, and co-workers, investigated the radiative forcing of carbon aerosols using observations from both satellite- and ground-based work, for the period 2001–2009.

Brown carbon is found to contribute ~20% to carbon aerosol absorption globally, meaning organic matter has a net effect of radiative forcing that is close to zero. They find a larger radiative forcing from carbon aerosols than has been previously reported, due to the inclusion of brown carbon, which is at least comparable to that caused by methane. Carbon aerosols are shown to have a net warming effect, even in regions where previously scattering by organic matter was thought to negate the warming by black carbon. *BW*

MARINE BIOGEOCHEMISTRY

Algae to atmosphere

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The structure of marine ecosystems, and associated biogeochemical cycles, will be affected by climate change and increased human activity. Marine phytoplankton produce a wide range of trace gases, and it has been suggested these gases play a role in controlling atmospheric chemistry. Bromocarbons — produced by diatoms — are released to the atmosphere as inorganic bromine, which interacts with ozone and dimethyl sulphide, and has a role in cloud formation. Climate-induced changes in phytoplankton composition could lead to altered gas release to the atmosphere.

Claire Hughes, from the University of East Anglia, and colleagues, measured biogenic bromocarbons and biological parameters in coastal waters and the atmosphere of the western Antarctic Peninsula. The sampling encompassed all seasons over a number of years.

Samples from diatom blooms showed significantly higher bromocarbon concentrations than non-bloom waters, with the sea-to-air flux of biogenic bromine increasing by a factor of 3-4. This suggests that non-bloom conditions could decrease the atmospheric bromine level, and therefore feedback on atmospheric composition and chemistry. *BW*

ECONOMICS

Responsibilities shared

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Allocating the carbon emissions that are associated with products exchanged in the international market to the producers or consumers of the goods is critical for global climate policy.

María-Ángeles Cadarso of the Universidad de Castilla-La Mancha, Spain, and colleagues outline the idea of 'shared responsibility' between both buyers and sellers as a way of allocating emissions from internationally traded goods according to the value added by countries to each step of the global product chain. They apply their model to the Spanish economy, divided into 46 sectors, during the period 2000–2005. They first allocated the emissions from imported goods only to Spain and found that the country's total emissions increase by 40.8% in 2005. Using the shared-allocation model, Spain's total emissions were found to increase by only 34.4% in 2005.

The researchers conclude that using a shared-allocation approach would help to discriminate which economic policies are more useful for climate change mitigation. *MC*

REGIME CHANGE

Savannah Shift

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Climate change will affect all ecosystems, and when they reach tipping points, regime shifts may occur. Vegetation areas may shift to alternative states. The savannah complex — which encompasses the vast grassland, savannah and forest ecosystems of tropical and subtropical regions — is known to undergo regime shifts and the large areas involved means that future shifts will be of global importance.

Steven Higgins, of Goethe University Frankfurt, and Simon Scheiter, of the Senckenberg Nature Research Society, use a dynamic global vegetation model to predict the effect of increasing atmospheric carbon dioxide concentrations on vegetation states in the savannah complex. They observed vegetation shifts between the years 1850 and 2100. Each regime moved to a higher vegetative state, for example deserts to grasslands, and grasslands to savannahs. As modelled future precipitation is uncertain, they assumed rainfall remains as it is today, so future work will need to investigate whether this would alter projections. They conclude that atmospheric carbon dioxide has been, and will continue to be, a key factor shaping vegetation landscape, with local changes occurring more rapidly than global changes. *BW*

Written by Alastair Brown, Monica Contestabile and Bronwyn Wake.