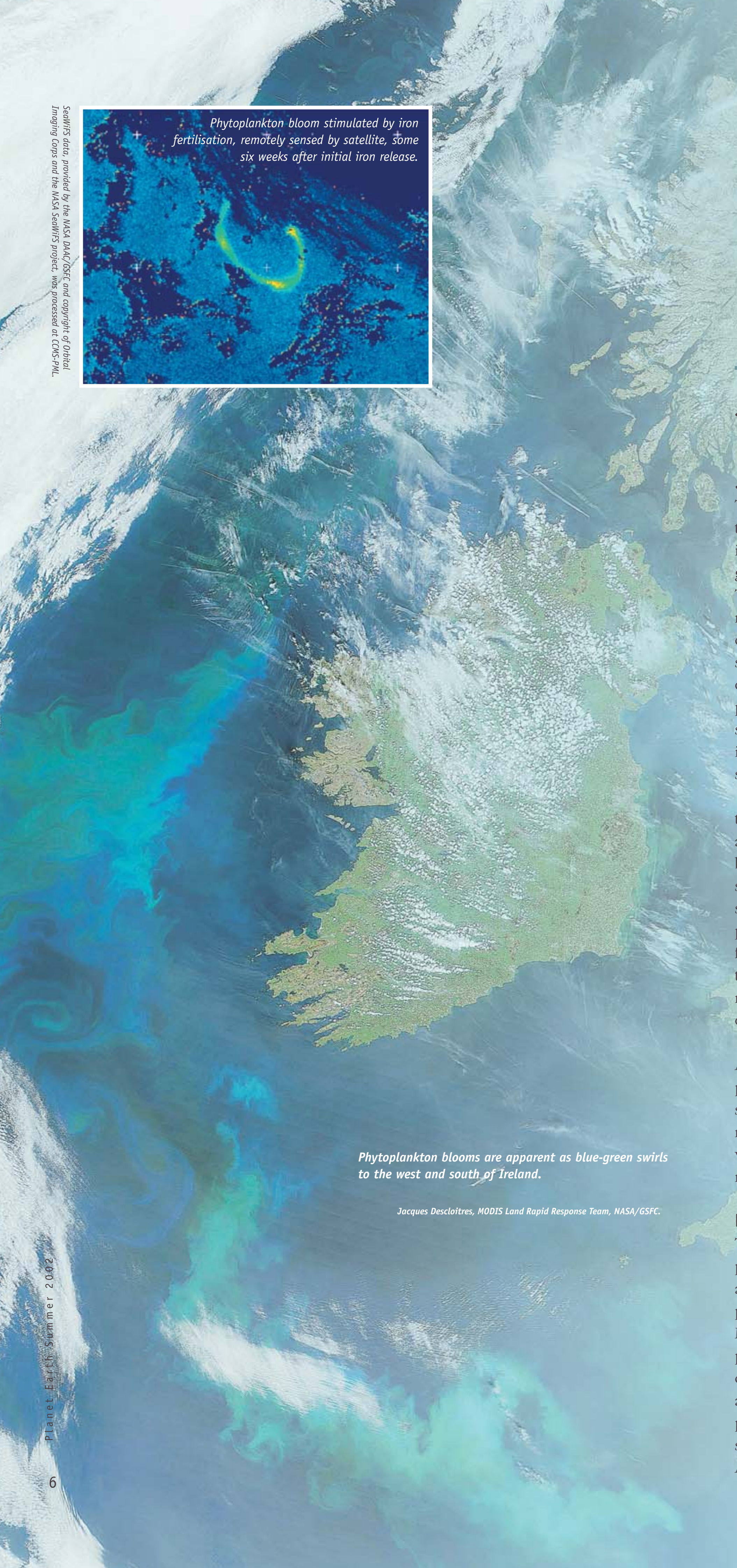


Phytoplankton blooms are apparent as blue-green swirls to the west and south of Ireland.

Jacques Descloitres, MODIS Land Rapid Response Team, NASA/GSFC.

Phytoplankton bloom stimulated by iron fertilisation, remotely sensed by satellite, some six weeks after initial iron release.

SeaWiFS data, provided by the NASA DAAC/GSFC and copyright of Orbital Imaging Corps and the NASA SeaWiFS project, was processed at CCMS-PML.

A dirty planet is a happy planet

Everyone is trying to find ways to lock up the greenhouse gas carbon dioxide. One answer, my friend, could be blowing in the wind, writes Andy Ridgwell.

Dust, something of a nuisance in your home perhaps, but it may be vital to the health of the planet. The wind can pick up anything smaller than the width of a human hair that isn't firmly glued down and carry it great distances through the atmosphere. This dust is mostly fragments of rock minerals and other soil constituents, but can include anything of suitable size, such as pollen grains. Billions of tons of dust are blown away each year, particularly from arid regions (with dry soils and sparse ground cover) where incredible clouds of dust can be clearly seen from space.

Suspended in the air, dust affects the optical properties of the atmosphere. The red sun and sky of a beautiful sunset are caused by dust scattering away the blue light from the sun's rays, allowing red light to predominate. Climate modellers have found that dust can actually affect the temperature at the Earth's surface by modifying incoming sunlight and outgoing infrared light.

Where does all this dust go? Although the wind can carry smaller particles half way around the Earth, sooner or later they might hit (and maybe stick to) a solid surface or be washed out of the sky by falling raindrops.

Manna from Heaven

The chemical composition of a dust particle reflects the soil it came from, and soil contains nutrients. This means plant nutrients are falling out of the sky. Manna from Heaven! Nutrients such as phosphate falling from the atmosphere can be critical in maintaining the health and productivity of ecosystems with poor, infertile soils. Recent research suggests that dust carried across the Atlantic from the Sahara and Sahel deserts feeds the soil in parts of Amazonia, and that dust from the central Asian deserts feeds the Hawaiian Islands' soil.

Ironing the oceans

My own particular interest, however, is in what happens when dust falls onto the oceans. Dust contains iron, an essential nutrient for microscopic marine plants (phytoplankton) – the grass of the ocean. Phytoplankton use carbon dioxide from the atmosphere and when they die, they sink to the bottom of the ocean, taking the carbon dioxide they've used to make their bodies with them. In places, it appears that there isn't enough iron for the phytoplankton.

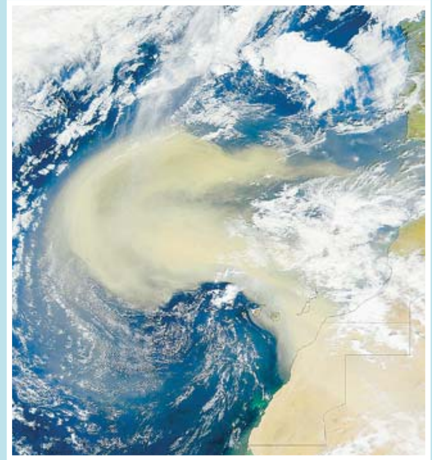
Several international collaborative experiments, including NERC-funded scientists from the University of East Anglia, 'fertilised' parts of the Equatorial Pacific and Southern Ocean with iron to find out how an extra supply of iron would affect phytoplankton. Indeed, it often stimulated so striking an increase in phytoplankton numbers that the ocean visibly changed colour! All this suggests that any change in dust supply alters marine productivity, and with it, the removal of carbon dioxide from the atmosphere. This has powerful implications on how the Earth's climate system may operate.

About 15,000 years ago, the huge ice sheets which had covered much of the northern hemisphere for 70,000 years, rapidly retreated, leaving the UK with the mild wet climate that we enjoy (!) today. One compelling theory as to why this happened is that increased carbon dioxide in the atmosphere warmed the Earth and triggered the collapse of the ice sheets. What drove carbon dioxide levels up? Ice cores drilled deep in the Antarctic ice cap show a decline in dust immediately before the rise in carbon dioxide, suggesting that a reduced iron supply (to the Southern Ocean) may have been important. Results from my computer model of the ocean carbon cycle support this hypothesis. It is amazing to think that rock fragments, too small to see with the naked eye, may have helped bring about the end of a global deep freeze.

Robbing Peter to pay Paul

What about future climate? The supply of wind-blown iron to the ocean depends on a suitable source of dust. How much dust there is depends on how the land is used – is the soil ploughed, is it left bare in winter? The Kyoto Protocol encourages countries to remove (sequester) carbon dioxide from the atmosphere and store it in vegetation and soils. Many ways of achieving this, such as changing agricultural practices and planting new forests, will help protect the soil from wind erosion and restrict the supply of dust to the ocean. With the aid of my computer model, I calculated that even a small decrease in iron supply reduces the ocean's ability to 'soak up' fossil fuel carbon dioxide emitted to the atmosphere. To me, terrestrial carbon sequestration might be 'robbing Peter to pay Paul' – by deliberately engineering more carbon dioxide uptake on land, we might damage the ocean carbon sink.

By following the cycle of dust from start to finish, we are finding that dust closely links together many parts of the Earth system; coupling the land surface and ecosystems of widely separated continents, linking the fate of ancient ice sheets with microscopic marine plants, and producing an adverse reaction in the ocean to improved farming practices on the land. Understanding a complex and interlinked system such as the Earth's climate requires a truly interdisciplinary approach. The joined-up thinking known as Earth system science is the only way that we can hope to discover all the consequences of human intervention in the climate system, and before they become too much of a … surprise.



Norman Kuring, SeaWiFS Project

A massive sandstorm blowing off the north-west African desert blanketing the eastern Atlantic ocean.

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A paper describing the possible dust-driven 'side effect' of carbon sequestration on land appears in a recent issue (vol 29 part 6) of Geophysical Research Letters. 10.1029/2001GL014304, 2002.

A library of 'SeaWiFs' satellite images can be found at: http://seawifs.gsfc.nasa.gov/SEAWIFS/IMAGES/IMAGES.html