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Why we should care about dust – and the crucial role it plays in our climate

Dust doesn't get a lot of attention until it collects in dark corners, or blows up in dramatic storms. However, that is beginning to change. While carbon dioxide is the main driver of climate change, scientists have begun to realise that dust also plays a crucial but highly complex role in controlling global climate – as well as a number of other global scale processes, including ocean productivity, and even soil and water quality.

The role of airborne particles (collectively known as aerosols) in the atmosphere is far from straightforward: one of their most significant impacts is that they contribute directly to the cooling of the earth, as they reflect the sun's rays away from the earth. But they also play a role in heating the earth, by absorbing outgoing radiation from the earth and other objects that emit heat, which then contributes to the warming effect.

Dust also contributes to the nutrient dynamic of the oceans as it may contain iron. When these mineral-bearing particles fall into the ocean, they can act as a fertiliser for the growth of algae or phytoplankton. As algae consume CO_2 and sink to the bottom of the ocean, they take the carbon from the atmosphere with them, and reduce the total amount of harmful carbon in the air. Indirectly, iron-rich dust may therefore cause global cooling.

Dust is also a significant contributor to soil quality, as the minerals it contains are deposited into soils downwind of dust-emission zones, such as the Bodele depression in Chad, or Owens Lake in California.

While scientists have identified the major global point sources around the globe, they do not yet understand what controls the dust-release process, or indeed the dust supply to these source points and regions.

The difficulties of modelling dust

This has become a crucial weakness in creating numerical models, but skilful simulation of the dust cycle depends on realistic representations of the sources of dust. However, these areas are discrete, very remote, and not systematically monitored. Until recently, measurements of African dust have been carried out at locations remote from dust-source regions, such as over the Atlantic, and North America.

One important project that aims to rectify our lack of knowledge about dust is the Dust Observation for Models Programme (DO4), a £1.5-million project funded by the Natural Environment Research Council (NERC) in the UK. Richard Washington, professor of climate science at Oxford and principal investigator of the project, leads it in collaboration with other research institutions, including UCT.

The project has been monitoring dust-emission hotspots in the Makgadikgadi Pans in Botswana, the west coast of Namibia, and the Etosha pans.

"These areas are particularly suitable," explains Dr Frank Eckardt of the Department of Geographical and Environmental Science, who is leading UCT's input into the project, "as they are typical and representative of major dust-source regions and processes worldwide."

UCT's role has mainly been to identify the dust sources – how dust becomes airborne – through the use of a variety of satellite images. Of the £1.5 million, around £800,000 has been spent on the advanced technological equipment needed for the project.

You might think the answer to how dust becomes airborne is obvious: wind. However, explains Eckardt, there are many more complex factors that play a role. "Finer and drier dust particles are more likely to be released. There are also crusts that form a kind of lid, preventing dust from escaping into the atmosphere. And sand grains can act as agitators, facilitating the release of dust."

The team monitors the dust in the atmosphere and potential surface controls such as moisture, roughness, crusts and sand content. "All of these, combined with strong winds, determine how much dust is released into the atmosphere," says Eckardt.

The dust in our clouds

Future projects will build on the research from the Dust Observation Project, tapping into climate questions around low-level clouds.

Low-level cloud covers about 10 percent of the world's oceans and acts as a mirror, reflecting energy into space; its presence or absence, therefore, has important implications for ocean temperature and climate change. Clouds form as a result of condensation, which occurs when moisture adheres to particles in the atmosphere, some of which are dust particles.

One of these projects is CLARIFY (Clouds and Radio-active Impacts), another NERC-funded UK-wide consortium between the UK Meteorological Office and the universities of Oxford, Reading, Leeds and Manchester, and led by Washington.

The fate of aerosols is still poorly understood. CLARIFY, along with ORACLES (discussed below), seeks to study the area over the south-east Atlantic off Namibia, as this region hosts some of the largest aerosol optical depths on the planet. Aerosol optical thickness refers to the degree to which aerosols prevent the transmission of light by absorption or scattering of light.

ORACLES is another project, funded by NASA to the tune of $30 million, which will look at the atmospheric interplay between oceans, cloud and land, monitoring dust-emission hotspots.

This project will also use aeroplanes to sample the clouds, including a plane with the capacity to fly at 100 000 feet (30 480 metres), which is the highest a craft can fly with wings.

Eckardt's role in both the ORACLES and CLARIFY projects will be to use his knowledge to help with flight planning and identifying potential target sites, especially around dust sources.

Story by Carolyn Newton and Natalie Simon.

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