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St Andrews Network for Climate, Energy, Environment and Sustainability

The Sustainability Series

Bringing clouds into focus

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September 2021

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(Article written by Martin Ince)

Measuring the clouds might seem like the definition of an impossible task. But without accurate knowledge of how clouds behave, our models of the present and future climate will be imprecise.

That is the logic behind CIRCULATES, a multi-institutional collaboration designed to improve the way that clouds are captured by the global circulation models (GCMs) that feed predictions of climate change.

Anna Mackie, a postdoctoral Research Fellow in climate science, says that the University of St Andrews is one of a group of universities and research institutes involved in CIRCULATES. From 2020 to 2024, the University has a budget of £343,000 from the UK's Natural Environment Research Council for its share of the project.

Mackie explains that today's GCMs often work with a horizontal scale of 100 kilometres. She says, "The limitations of computing power hold back the amount of detail you can simulate. The more data points you have, the more computationally expensive the model is to run. So it is very expensive to run a model with high resolution over a long time period."

But as Mackie points out, most clouds are nowhere near 100 kilometres in size. St Andrews' role in CIRCULATES is to examine models with a resolution of three kilometres. These models can actually simulate clouds, allowing us to understand how cloud behaviour in a warming climate might be different at a higher resolution. "Today's GCMs contain assumptions about what is happening on a small scale," she says. "We want to improve our understanding of how model behaviour changes at high resolution. This could reduce the uncertainty of models at all scales."

She adds, "There are many global climate models developed by groups around the world. Sometimes, their projections diverge significantly." One key difference between them is how clouds respond to global warming. So, characterising cloud feedbacks on a smaller scale could reduce uncertainty and help these models to converge.

Clouds from both sides

The wider CIRCULATES project is both observational and computational, and the modelling studies will be complemented by high-resolution satellite data. The aim is to understand cloud processes on the finest scale at which data is available. Mackie says, "A cloud is a difficult thing to model. It is not just about cloud cover. The types of cloud and their height in the atmosphere are also important. So, there are quite a few variables to take into account when you model a cloud." Broadly speaking, clouds reflect sunlight and therefore cool the Earth. But they also warm the Earth by trapping surface heat. The balance between these competing effects depends on the type of cloud. Clouds are also highly variable in both space and time, which means they are a significant source of uncertainty in climate projections.

The CIRCULATES project is at an early stage, so the exact directions of the different observational and computational strands have yet to be developed. However, the overarching aim is to better understand how clouds and circulation interact in a warming climate. The outcomes of CIRCULATES, including the St Andrews contribution, will hopefully inform climate policy by reducing the uncertainty inherent in GCMs. Mackie stresses that this work is made easier by the academic setting of the University's School of Earth and Environmental Sciences: "There is a huge amount of expertise here. There is always someone to talk to about the project, perhaps from a field very different from my own."

While the Earth's surface is cooler than it would be without clouds, the big question is whether future changes in clouds will heat the Earth or cool it. How might the balance change between clouds reflecting heat into space and trapping heat from the surface? Mackie is cautious. "It depends on the cloud changes. A small change in cloud properties or cover can have a big effect on this balance between heating and cooling."

Find out more
Researcher profile: www.st-andrews.ac.uk/earth-sciences/people/arm33

Publisher: St Andrews Network for Climate, Energy, Environment and Sustainability, University of St Andrews.

Editors: Sarah Bennison and Laura Pels Ferra.

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The St Andrews Network for Climate, Energy, Environment and Sustainability (STACEES) is an interdisciplinary research-focused initiative launched in April 2021 at The University of St Andrews.

The Sustainability Series comprises 15 professionally written, accessible articles commissioned by STACEES to showcase the breadth of the world-leading sustainability-focused research at the University.

Designed and produced by University of St Andrews Print & Design Unit, September 2021.
The University of St Andrews is a charity registered in Scotland. No: SC013532.