Watching the skies

While much of the effort to combat climate change impacts addresses the roles of the cryosphere, forests and Earth's oceans, less is known about the role of clouds. **Prof Dr Pier Siebesma** of the Royal Netherlands Meteorological Institute and the Delft University of Technology discusses his latest project

Could you explain the workings of cloud feedback and the effect climate change has had on it?

As everyone knows, clouds are good reflectors of sunshine. If you look at a satellite image of the Earth you can see that clouds are white and the sea surface is dark. That illustrates the fact that clouds reflect up to 70 per cent of the incoming solar radiation whereas the sea's surface only reflects five per cent – so clouds clearly cool our planet.

The big question is how the global cloud amount will change as a response to global warming: fewer clouds will further enhance global warming while more clouds will dampen this process. Since clouds are so extremely variable in space and time we need to carefully monitor clouds in order to measure the signs and strength of this cloud feedback. At present, observations have not been able to quantify this feedback.

How will EUCLIPSE work to ensure the accuracy of climate change estimates due to cloud-related processes?

The only way to obtain more confidence in this accuracy is through critical evaluations of the cloud processes in the present climate. To this purpose EUCLIPSE will propose a metrics that will allow us to quantitatively determine the skill of the various climate models to represent cloud processes and their effect on the radiative energy balance. The premise here is that climate models that have a better capacity for representing cloud processes in the present climate will be more reliable in their future climate.

Moreover, what are some of the challenges you will need to overcome to generate models that are as reliable as possible?

The road toward improved cloud representation in climate models is a slow bottom-up process with many hurdles. Usually, improved cloud parameterisations are based on isolated case studies that involve detailed observations from atmospheric profiling stations along with simulations with high resolution cloud resolving models that act as an atmospheric laboratory. Once the newly developed cloud parameterisations have passed critical tests for a number of such isolated case studies, a further step is to show that the climate model exhibits an improved capacity on a global scale using satellite observations over a period of several years. This whole process requires close cooperation of different scientific communities. One of the main challenges is to establish a fruitful collaboration between these different modelling and observational communities that are brought together for the first time within the EUCLIPSE project.

Has the project made any key developments or surprising findings since its kick-off in February 2010?

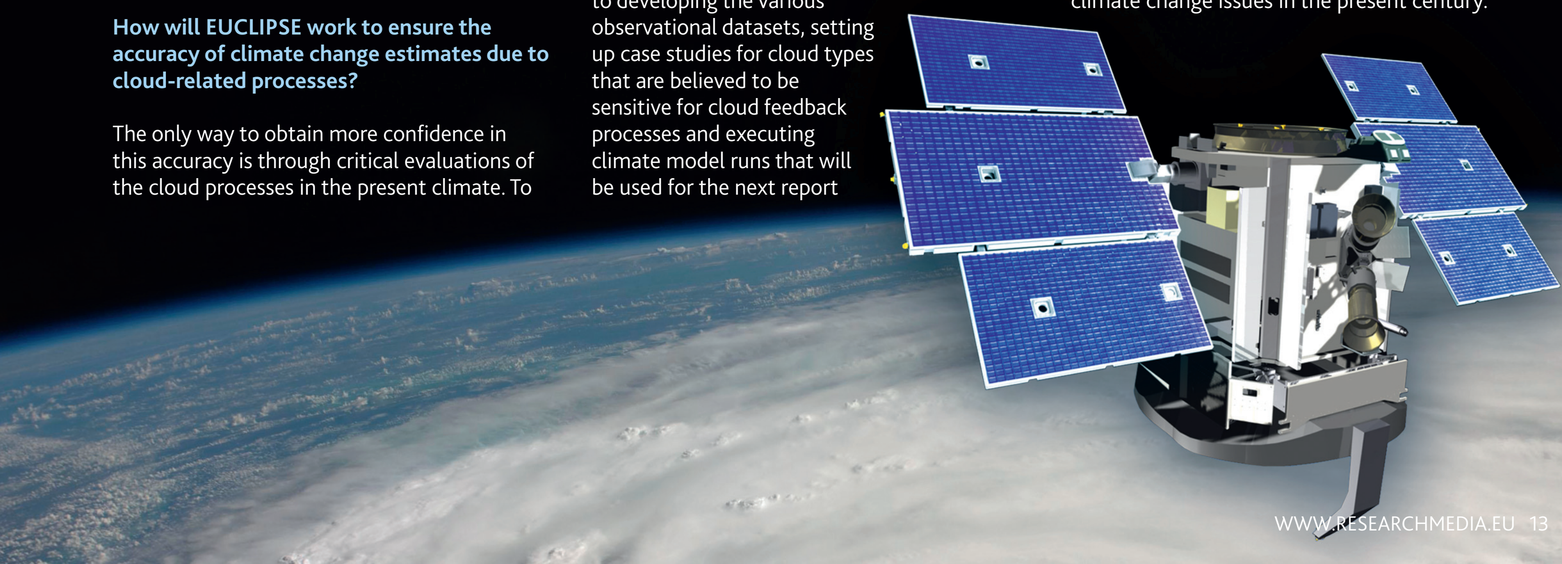
The first year has been mainly dedicated to developing the various observational datasets, setting up case studies for cloud types that are believed to be sensitive for cloud feedback processes and executing climate model runs that will be used for the next report of the Intergovernmental Panel on Climate Change (IPCC). One of the surprising results is that the new cloud climatologies that resulted from the new generation satellites revealed that there are far more mid-level clouds than was originally thought. A realistic representation of these clouds will be just one of the extra challenges of the EUCLIPSE project.

What will be the project's focus in its second year?

The second year will be a crucial one. In this year the future climate model scenario runs for the next IPCC report will be completed and evaluated with the new observational datasets. Furthermore, various case studies for relevant cloud types performed with single column versions of the participating climate models will be evaluated with observations and with cloud-resolving model simulations and should provide guidance for new improved parameterisations.

How does EUCLIPSE contribute to the IPCC? What impact do you believe EUCLIPSE's findings will have on policy makers?

The global climate model centres that participate in EUCLIPSE will directly contribute to IPCC's fifth Assessment Report through the execution and analysis of present day climate runs as well as through future scenario climate runs for the 21st Century. More specifically, in the next IPCC report there will be, for the first time, a separate chapter completely dedicated to the role of clouds in our climate system. The results of EUCLIPSE will provide a major input for this chapter. The IPCC report will provide the main background for policy makers in the area of water management, infrastructure and health where it concerns climate change issues in the present century.



Blue sky **thinking**

While international scientific communities search for new ways to forecast climate change, the **EUCLIPSE** project is looking to the skies for the answer; their findings may change perceptions of the role clouds play in the process

IN RECENT DECADES the issue of climate change has grown considerably in importance. We are now able to see the effects that greenhouse gases, such as carbon dioxide (CO_2), have on our suffering atmosphere. Scientists have developed tools and methods to study the rate at which our climate is rising in temperature and in order to forecast what climate changes are yet to come.

Scientists study climate change using Earth System Models (ESMs). These ESMs follow greenhouse gases within our atmosphere to make predictions on our climate. However, the ESMs currently in scientific use all have disparate interpretations of our climate's future. When given the hypothetical scenario of Earth's CO_2 levels doubling, for instance, ESMs will predict a rise in global surface temperature ranging anywhere between 2-4°C. This gap in accuracy, while not seemingly large, leaves a vast margin for error when attempting to predict something as variable as climate change.

Our climate is a very dynamic system and cloud effects remain the largest source of uncertainty in this area. The number of clouds in the sky and their position in relation to the Earth's surface has a far more profound effect on climate change than originally thought. Acting as strong reflectors of the sun, a low cloud formation has a cooling effect on the Earth without contributing significantly to the greenhouse effect. Very high clouds, meanwhile, have a considerable impact on enhancing the effects of greenhouse gases in the atmosphere while doing little to cool us down.

Clouds are naturally changeable and thus difficult to forecast. Current ESMs do not take cloud cover into account accurately. Until experts are able to gain a thorough understanding of the inner workings of clouds through ESMs they will be unable to make significant advances in climate change studies or prediction. Realising this issue, coordinator at the Royal Netherlands Meteorological Institute, Prof Dr Pier Siebesma set up the EU Cloud Intercomparison Process Study and Evaluation project (EUCLIPSE).

Initiated in February 2010 to support the fifth Assessment Report being prepared by the Intergovernmental Panel on Climate Change (IPCC), EUCLIPSE aims to reduce the uncertainty in the representation of cloud processes and feedback by concentrating its efforts on new generation ESMs. Presently, experts endeavour to predict whether there will be fewer clouds in our atmosphere or more as we move into a warmer climate. To do this, appropriate tools are necessary in order to be able to realistically alter cloud parameters. Before EUCLIPSE, Siebesma outlines, this was not an option: "Even with the most powerful computers, operational climate models operate on computational grids with a resolution of around 100 km. Since cloud fields are typically smaller than this resolution, the implication is that climate models are essentially blind for most cloud processes".

WORKING TOGETHER

The project is made possible via a link between four separate scientific communities: observational, numerical weather prediction, cloud modelling and climate modelling. The project's observational community provides modern measurements from active and passive remote sensing based both on the ground and in space, while the numerical weather prediction community supplies analyses of short-term timescale model biases induced by the cloud processes. The cloud modelling community provides small-scale models as tools for further study of cloud behaviour while the climate modelling community combines the project's overall physical understanding and observational limitations to improve the representation and assessment of cloud processes in ESMs.

SIEBESMA DURING THE FILMING OF A RECENT DOCUMENTARY

The EUCLIPSE project employs modern, novel satellite technologies equipped with active radars and lidars that can study the three-dimensional climatology of clouds. As a result, rather than with conventional satellites that can only look at the surface of clouds, these new generation technologies are able to study clouds from the inside. EUCLIPSE also makes use of advanced atmospheric profiling stations to provide comprehensive data from various locations. It is hoped that this will give rise to the project's hypotheses made through studying cloud-related processes such as turbulence and convection in varying circumstances.

While Siebesma plans on improving the study of climate change, he admits that something this changeable proves difficult to master: "This premise is not without problems; there are recent studies that show that the relationship between the capacity of climate models for present day climate and their behaviour in a future climate is not an obvious one".

MAKING PROGRESS

The EUCLIPSE project is set to run until 2014 and is already deep into its second year. In the first year alone, EUCLIPSE's new generation satellites were able to produce climatologies that suggest there are more mid-level clouds in our atmosphere than first thought. Once the project's different cloud parameterisations begin to show success in a series of isolated case studies, the next step is to forecast the climate models on a global scale and over a number of years to see if it really does present an improved method of representation.

EUCLIPSE is funded by the European Union as an international effort under theme nine ('Environment') of the Seventh Framework Programme. The project emerged from two other international projects: the Cloud Feedback Model Intercomparison Project (CFMIP), which focuses on climate model evaluation while acknowledging cloud feedback processes, and GEWEX Cloud Systems Studies (GCSS), which develops better parameterisations of cloud systems for climate models by improving understanding of the physical processes: "The strength of EUCLIPSE derives from the merging of these two different communities," Siebesma states.

The team uses media in many forms to publicise the project's work. Siebesma has already contributed to a documentary on the subject made for EURONEWS and intends on continuing this publicity throughout the project's four-year span. The team will distribute observational datasets on different climate models to the model development and climate model evaluation communities via web sources and publish relevant scientific information through peer reviewed literature. EUCLIPSE will also run workshops and summer schools, and eventually publish a book detailing their findings on clouds and climate processes.

INTELLIGENCE

EUCLIPSE

EUROPEAN UNION CLOUD INTERCOMPARISON, PROCESS STUDY AND EVALUATION PROJECT

OBJECTIVES

To improve the evaluation, understanding and description of the role of clouds in the Earth's climate with a focus on the cloud feedback in a warming climate.

PARTNERS

Royal Netherlands Meteorological Institute, Netherlands • **Max Planck Institute for Meteorology**, Germany • **Met Office**, UK • **Centre National de la Recherche Scientifique Institute Pierre Simon Laplace**, France • **Academy of Athens**, Greece • **European Centre of Medium Range Weather Forecasts**, UK • **Delft University of Technology**, The Netherlands • **Météo-France**, France • **University of Stockholm**, Sweden • **Eidgenössische Technische Hochschule Zürich**, Switzerland • **University of Warsaw**, Poland • **German High Performance Computing Centre for Climate- and Earth System Research**, Germany

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