CASE STUDY

Modelling the global, national and local land surface

JULES is the principal land-surface model in the UK, simulating responses to weather and climate change on local, national and global scales.

CUSTOMER

International, UK and local governments and decision-makers

DELIVERABLE

The UK's main land-environment simulator for climate change and daily weather

OUTCOMES

10% increase in accuracy of specific forecasts

Reduced health risks in cities

Contributions to international climate change policy

> *"The...JULES land model is very good, is essentially **the** land model in the UK, [and] links weather-water-hydrology-climate at many government labs, institutes and universities"*
>
> US National Oceanic and Atmospheric Administration National Weather Service
> Written evidence, Science in the Met Office: House of Commons Science & Technology Committee Report, Session 2010-2011

The challenge

The global land surface absorbs about a quarter of human-made emissions. Understanding how it interacts with the atmosphere is therefore critical to understanding long-term climate change, as well as our day-to-day weather.

This is a complex process, however, requiring consideration of a number of factors including the effects of carbon, groundwater and permafrost.

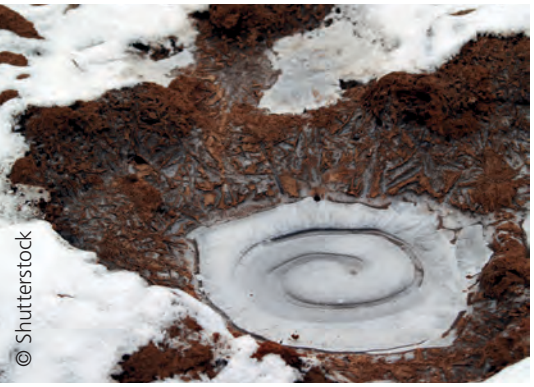
The research

The Joint UK Land Environment Simulator (JULES) models the processes that alter our climate and affect both short- and long-term weather predictions. Run by the Centre for Ecology & Hydrology (CEH), it simulates the intricate interactions between the land and atmosphere at local, regional and global scales.

Through JULES we analyse data on everything from the terrestrial carbon cycle to freshwater cycles and changes in vegetation. Recent developments, such as the inclusion of carbon-rich permafrost regions, will only continue to increase confidence in predictions.

JULES acts as the land-surface component of both the National Environment Research Council's (NERC) Earth System Modelling Strategy, and the Met Office Unified Model (MetUM), which has been at the heart of their weather and climate predictions since 1990. JULES is also available to the UK research community, allowing a broad range of researchers to investigate potential impacts of climate change and contribute to future model development.

> *"JULES is central to the preparation of carbon budgets, since the land is by far the dominant area of uncertainty."*
>
> **Dr Chris Jones**
> Leader of research into vegetation and carbon cycle modelling at the Met Office and author of the carbon cycle chapter of the latest report from the Intergovernmental Panel on Climate Change (IPCC)



Flooded woodland, Wales

	JULES development:
Early 1990s	Vertical fluxes of heat and water
Mid 1990s	Photosynthesis and respiration
Late 1990s	Vegetation model (TRIFFID), runoff and river flow
2000s	Biogeochemistry, UK application
2010s	Nitrogen, improved biogeochemistry, fire, groundwater, dams, etc.

The outcomes

JULES has a wide range of applications, but is used primarily to calculate global and regional carbon, water and energy budgets. Its ability to synthesise the land's carbon absorption is central to ensuring that we stay within two degrees of global warming, and it has improved the accuracy for specific forecasts by 10%, a significant improvement in warning of national weather events.

JULES provides the core land surface component of UK Earth System Modelling initiative, the UK flagship climate model, which will help deliver the UK's contribution to the next Intergovernmental Panel on Climate Change (IPCC) report. Its ability to translate climate impacts into impacts on people, through changes in river flows, water availability, crop yields and food security, is invaluable in this regard.

As an integral component of the Met Office Unified Model (MetUM), JULES is firmly embedded in NERC and Met Office strategy. Through MetUM, JULES research informed the Mayor of London's strategy to manage urban 'heat islands' in London, reducing health risks associated with extreme cooling and heating demands.

In addition, the application of JULES at the global scale allows NERC and the Met Office to become involved in large, international projects. In particular, JULES is increasingly used to address the sustainable development goals.