RESEARCH CASE STUDY

UK Centre for Ecology & Hydrology

Improving rainfall “blind spots” with advanced X-band radar

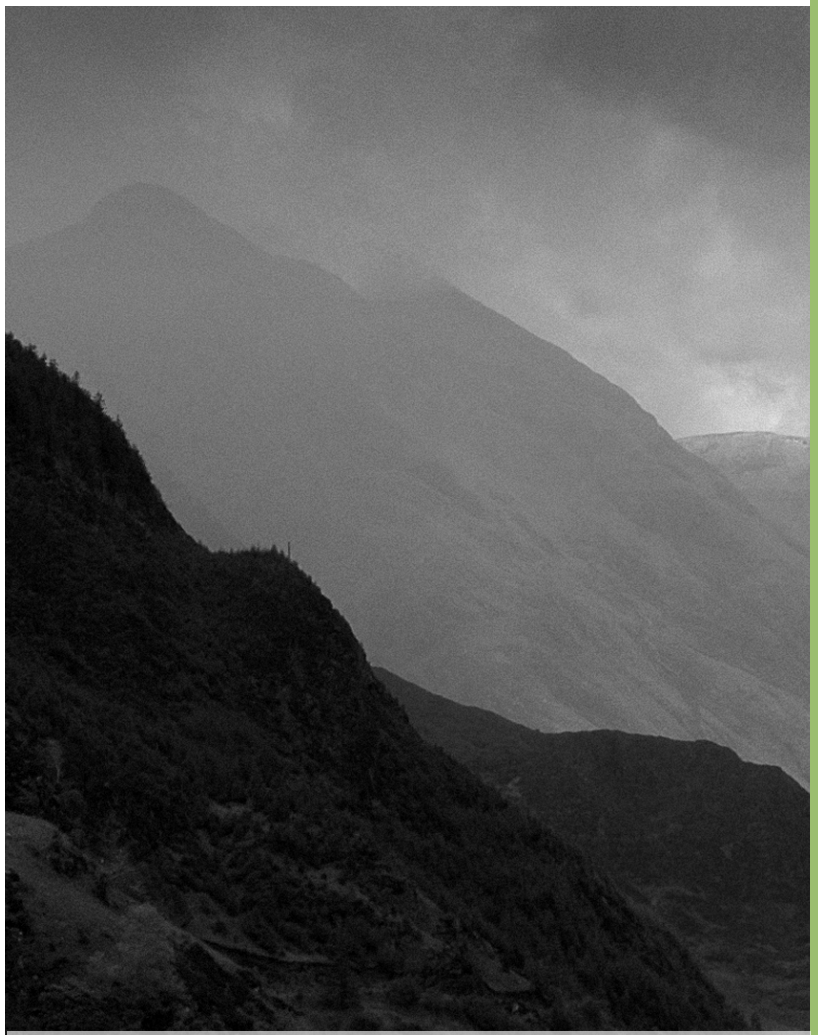
Steven Cole, John Wallbank, Robert Moore (UKCEH)
David Dufton, Ryan Neely III, Lindsay Bennett (NCAS)

Hydro-JULES

Why it matters

In the UK, measuring rainfall – along with other forms of precipitation such as snow and hail – often involves the combined use of weather radars and raingauges. The resulting rainfall data are used in many ways, from the animated maps we see on television weather broadcasts to flood forecasts and warnings. A key aim of the Hydro-JULES programme is to improve these measurements so that we can better understand and model how river flow changes in response to rainfall.

Unfortunately, weather radar coverage and data quality vary across the UK due to a number of factors. Radar beams, which increase in height the further they travel, can overshoot and miss distant storm clouds. Mountains, meanwhile, can block radar beams entirely. As a result, there are known “blind spots” across the country – like Inverness and Carlisle – where radar quality is lower than desired. These blind spots impact our ability to forecast and mitigate floods. This was the case with Storm Desmond in December 2015, which brought record-breaking amounts of rainfall to Cumbria.

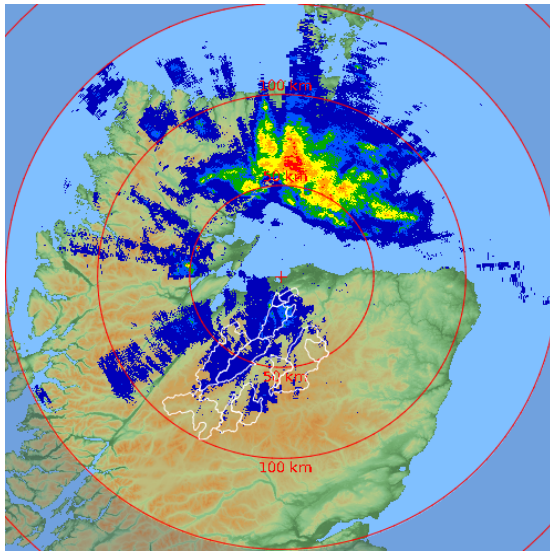


Mountains can block weather radar coverage, limiting our ability to forecast rainfall events.

Hydro-JULES, is a research programme funded by the UK’s Natural Environment Research Council (NERC), in order to advance our ability to predict the future availability of water resources and the risk of water related disasters under a changing climate.

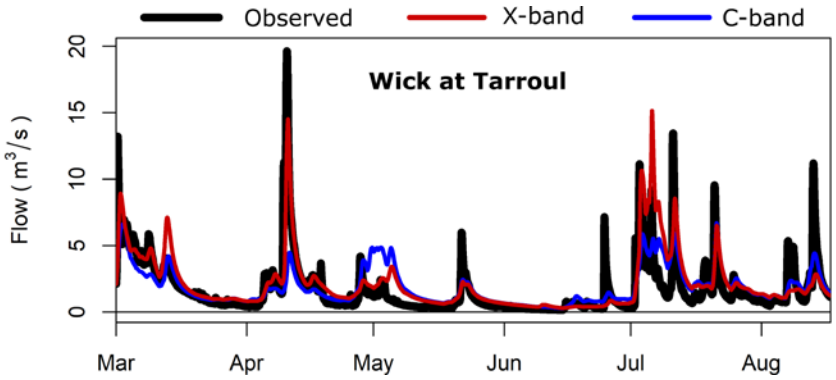
The Hydro-JULES programme is building a three-dimensional, open source, community model of the terrestrial water cycle to support and enable collaborative work across the research and academic communities in hydrology and land-surface science. This five-year programme is delivered by the UK Centre for Ecology & Hydrology (UKCEH) in partnership with the British Geological Survey (BGS) and National Centre for Atmospheric Science (NCAS).

w: hydro-jules.org
t: @HydroJules



X-band radar rainfall image over Scottish Highlands, 07:58 am 9 April 2016

Improved flood flow simulations for River Wick (northern Scotland) using X-band (red) in C-band (blue) "blind-spots", when compared to river observations (black)



What we did

To address this problem, radar specialists at the National Centre for Atmospheric Science (NCAS) have teamed up with hydrological modelling experts at UKCEH, with support from the Scottish Environment Protection Agency, Environment Agency and Met Office. As part of Hydro-JULES, we are investigating new ways to improve precipitation measurements and assess the benefits for modelling floods.

One potential way to fill in the blind spots is to use a type of radar known as an X-band weather radar. Compared to the large, stationary C-band radars currently used in the national network, X-band radars are cheaper and smaller, albeit with a shorter sensing footprint of around 100 kilometres. They can also be moved around the country to areas where they are most needed and can send radar beams over mountainous areas at relatively low elevation. These advantages should allow X-band radars to provide better measurements of ground-level precipitation over areas affected by blind spots.

To test this idea, in 2016 an X-band research radar operated by NCAS was relocated to the Scottish Highlands near Inverness. Analysis using raingauge data confirmed the X-band radar gave more accurate precipitation measurements for a majority of the region than C-band radar. When UKCEH compared river levels with flood simulations, those produced using the X-band's radar data were found to be more accurate. This hydrological analysis brought fresh insights into catchment-scale rainfall and is stimulating further improvements in radar methods.

Following these promising findings in Scotland, attention has now turned to a similar X-band radar experiment in Cumbria that has provided researchers with almost two years of data to investigate. The use of X-band radars alongside C-band radars may provide an answer to the UK's precipitation measurement blind spots – and thus more accurate and reliable flood forecasts.

UK Centre for Ecology & Hydrology
National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL
BGS British Geological Survey
UKRI Natural Environment Research Council