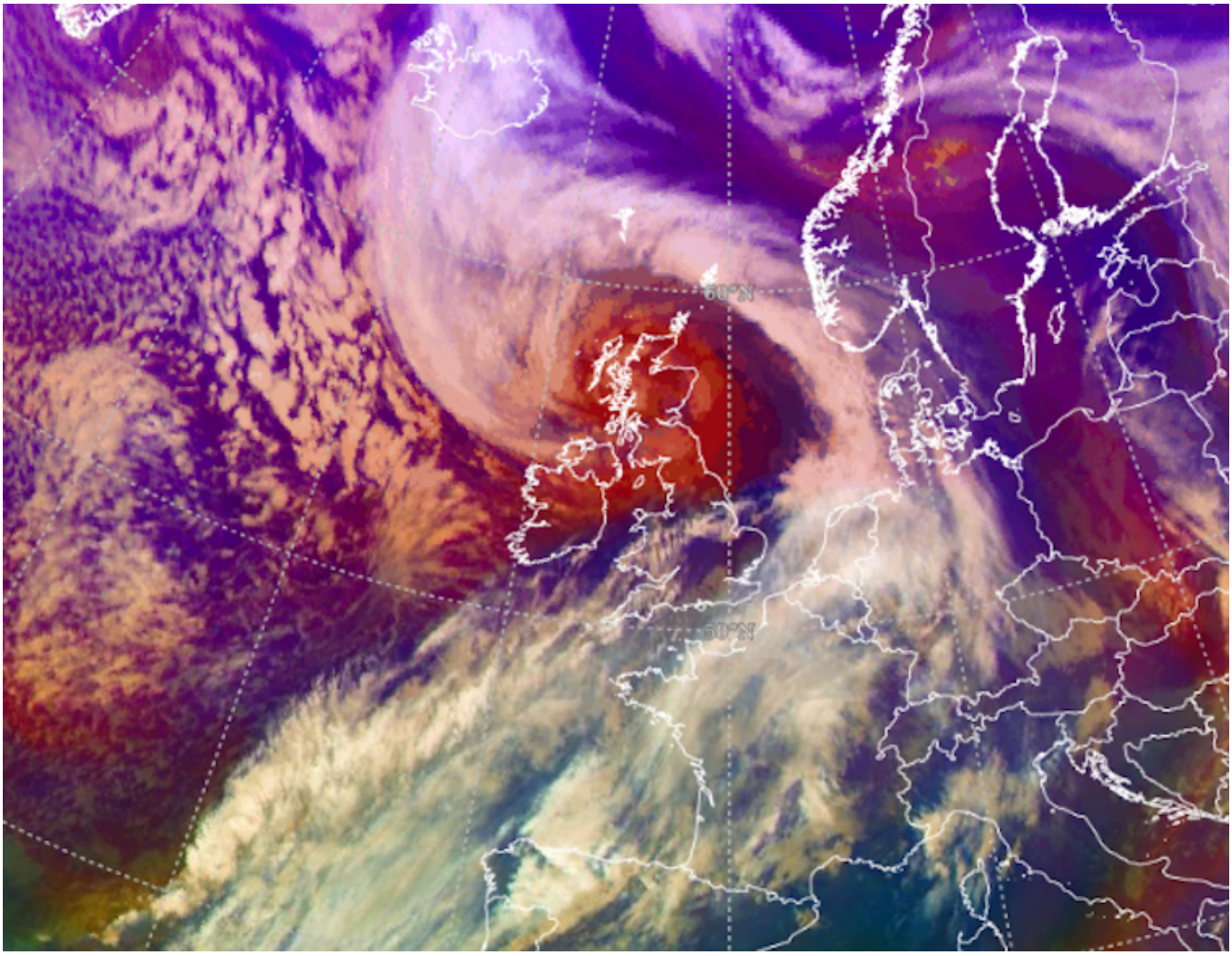
Storm Éowyn – the view from the meteorologists

Why meteorologists are comparing Storm Éowyn to a bomb



A satellite image of the British Isles during Storm Éowyn's descent.

Suzanne Gray, *University of Reading* and Ambrogio Volonté, *University of Reading*

Storm Éowyn has unleashed strong and damaging winds over the British Isles, and particularly over Ireland and Scotland.

Air pressure at the centre of the storm plummeted 50 millibars in the 24 hours leading up to midnight on January 24. That's more than twice what is required in the definition of "explosive cyclogenesis", in other words, the development of a cyclonic (anticlockwise rotating) storm that is both rapid and severe – like a bomb going off. As a result, Éowyn can be termed a "bomb cyclone".

It is not unusual for winter storms in this part of the world to reach bomb cyclone status. However, only very few in recent years have shown a rate of deepening pressure that is comparable to that of Storm Éowyn.

The exceptional intensity of Storm Éowyn was predicted and it has prompted the Met Office and Met Éireann to issue red warnings covering the whole island of Ireland and central and southern Scotland. This tells the public to expect widespread gusts of 80-90mph and up to 100mph in the most exposed locations. A record-breaking gust of 114 mph has this morning been provisionally reported at Mace Head on Ireland's west coast.

Similar intense storms have left widespread damage and tragically claimed lives. Some, such as the infamous Great Storm of 1987, have entered popular culture.

Éowyn's place in history

The maximum gust during the Great Storm was measured as 115mph at Shoreham, on the west Sussex coast. However, the anemometer stopped recording immediately afterwards so the real peak may have been higher.

A scientific paper has cast doubts on the UK national low-level wind gust record (so, excluding mountain summits) of

142mph. This was recorded at Kinnaird Head Lighthouse at Fraserburgh in Aberdeenshire, Scotland on February 13 1989. The researchers documented brief power supply interruptions to the recording anemograph, which could have given a faulty reading.

The record-highest wind gust measured in England sits at 122mph. This was recorded at the Needles, a very exposed site at the edge of the Isle of Wight, during Storm Eunice in February 2022. Two gusts of similar strength were recorded less than two years later (November 2023) in Brittany during Storm Ciarán.

In Ireland, the strongest gust recorded by an inland low-altitude weather station was during ex-Hurricane Debbie in 1961, with 113mph measured at Malin Head, the most northerly point of mainland Ireland. A gust of 97mph was measured in October 2017 at Roche's Point at the entrance to Cork harbour during ex-Hurricane Ophelia.

The measurements we're now seeing during the passage of Storm Éowyn are up there with those recorded during the most infamous storms of recent years and decades.

What makes a storm 'explode'

Like making a cake, there are several key ingredients to cooking up an explosively developing bomb cyclone like Storm Éowyn.

A strong jet stream – the ribbon of winds about six miles up in the atmosphere over the North Atlantic – is one. Winds here are currently exceeding 200 mph – their strength is linked to the strong temperature contrast between the cold plunge of air across the eastern US and the far warmer air over the western North Atlantic.

This strong jet has provided the energy for the storm's

development and is also the cause of its race towards the UK across the North Atlantic. Storm Éowyn came to life off the eastern seaboard of the US during Wednesday January 22 and will have covered over 2,000 miles before it arrives off western Scotland by Friday midday.

The low-pressure centre of Storm Éowyn crossed the jet stream from south to north en route, an ideal track for explosive development.

Éowyn's heavy rainfall as it tracks towards the UK is a result of another key ingredient for explosive storm development: deep clouds within the storm that generate energy when their water condenses. These clouds are fed by strong fluxes of heat and moisture from the warm ocean surface, and scientists have been detecting record-warm surface ocean temperatures in the North Atlantic in recent years.

The role of climate change

When a storm such as Éowyn occurs, people ponder the role of climate change in fuelling its strength. Our experiences of future storms will depend on what tracks these storms typically take and how that influences their intensity. Stormy weather is, of course, not unusual in the autumn and winter over the British Isles and it requires detailed research to attribute the strength of any specific storm to climate change.

To date, the observed trends in storminess have not provided a conclusive link with climate change. The latest assessment report from the Intergovernmental Panel on Climate Change, experts relating to all aspects of climate change who are convened by the United Nations, states that there is "low confidence" in the direction of trends in the number and intensity of extratropical storms (those that form outside of the warm band surrounding Earth's equator) over the last century.

One reason why it is difficult to make this link is that the position and variability of storminess is very dependent on the jet stream, and its position varies a lot from day to day, week to week, and beyond. Large-scale climate patterns such as the El-Niño Southern Oscillation and North Atlantic Oscillation, and sea surface temperatures and the extent of sea ice are also likely to be important factors.

Despite this uncertainty, there are indications that in the future, winter storms may become more frequent and more clustered (such that several storms occur within a few days of each other), which can exacerbate their overall impact. The frequency of storms with extreme winds may also increase. Rainfall is highly likely to increase, as a warmer atmosphere can hold more moisture.

Another thing that could change about intense storms in future is their propensity to develop "sting jets". Sting jets are descending airstreams that can produce particularly destructive surface winds, as in the Great October storm, Storm Eunice and Storm Ciarán. Sting jets are short-lived and occur over very small areas, making them hard to predict and identify.

There is speculation over whether a sting jet has descended during Storm Éowyn. Post-event verification will be needed. While the overall impact on wind speed is uncertain, the small number of studies that have considered sting jets in future cyclones have predicted an increase in their likelihood.

Cyclones that are capable of producing sting jets also typically show more vigorous cloud development, consistent with the hypothesis that the intense storms of the future will be influenced by our hotter and wetter atmosphere.

Don't have time to read about climate change as much as you'd like?

Get a weekly roundup in your inbox instead. Every Wednesday, The Conversation's environment editor writes Imagine, a short email that goes a little deeper into just one climate issue. Join the 40,000+ readers who've subscribed so far.

Suzanne Gray, Professor of Meteorology, *University of Reading* and Ambrogio Volonté, Senior Research Fellow in Meteorology, *University of Reading*