

INTERNATIONAL

Scientists study jet stream pattern driving heatwaves around the world

Five ‘omega’ waves in air current prompt surging temperatures in US, Europe and Asia

LESLIE HOOK

The deadly heatwaves that have fuelled blazes and caused transport disruptions in Europe, the US and China this month have one thing in common: a peculiar shape in the jet stream dubbed “wave-number 5”.

Scientists are racing to understand whether the band of fast-moving air that controls weather in the mid-latitudes is changing in a way that makes heatwaves more frequent and persistent.

“The jet stream is the leading driver of our weather,” said Paul Williams, professor of atmospheric science at the University of Reading. “The jet stream is like a conveyor belt, delivering storms to us one after the other.”

It can also generate heatwaves when it forms into a U-bend shape, called an “omega block” because it resembles the shape of the Greek letter omega.

At the moment, a global pattern of five big waves is circling the world, leading to simultaneous heatwaves across continents. This pattern, known as wavenumber 5, can persist for weeks, causing hot areas to stay hot for a long time.

In China, more than 900mn people are experiencing heatwaves and more than 70 weather stations have broken records this month. In the US, Texas and Oklahoma are experiencing record-high daily temperatures and more than 20 states have issued heat warnings. The UK also recorded its highest ever temperature this week — 40.3C — while France and Spain have been battling wildfires after an extreme heatwave that has lasted for weeks and set temperature records.

“As often happens in the atmosphere, it is connected: if we see an extreme event in one place, it can be connected to extreme events in another,” said Stephen Belcher, chief scientist at the UK Met Office. “The Met Office forecasters are looking very, very closely at this wavenumber 5 pattern to see how long it persists.”

Belcher said three factors contributed to the heatwave over Europe: the wavenumber 5 pattern in the jet stream; the increase in global average temperatures; and the dry soils, particularly around the Mediterranean, resulting from prolonged hot weather.

Dim Coumou, a climate scientist at VU Amsterdam, said there were two important patterns in the jet stream in summer — with five waves, or with seven waves — that tended to remain in the same place when they formed.

“If such wave patterns become stagnant and persist over longer periods, then we typically see simultaneous heatwaves,” he said.

A growing body of research is trying to answer the question of how exactly the jet stream is being changed by global warming and what this means for future weather patterns. Temperatures have



The Northern Atlantic Jet Stream

A current of strong wind flowing from west to east high in the atmosphere, one of four such bands that circle the Earth. It is a few hundred kilometres wide and several kilometres deep. Located at 8-12km altitude and around 60 degrees latitude, but can meander large distances north and south

North of the stream Colder, wetter weather dominates

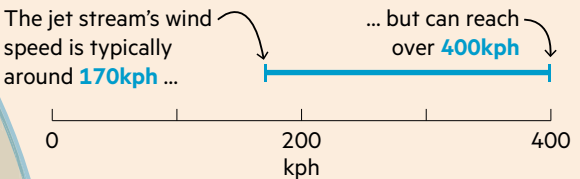
South of the stream Warmer, drier weather prevails

Blocks Near-stationary areas of high pressure that distort the normal west-east flow

Graphic: Ian Bott Sources: NOAA; NWS; Met Office; ESA; FT research

How the Polar Jet forms

- 1 As the air near the equator is much warmer than in the polar region, the temperature difference between those areas leads to a difference in pressure, creating wind. The current of wind is strongest in winter, when this temperature difference is greatest
- 2 The rotation of the Earth deflects the current east (also known as the Coriolis effect) forming the jet stream
- 3 The jet stream carries weather and storms with it across the Atlantic, controlling weather patterns across Europe



Making a splash: swimmers cool down in a water park pool in Huaian, Jiangsu province, China, this month

STR/AFP via Getty Images

already risen by about 1.1C since pre-industrial times due to human activity. The jet stream itself appears to be changing its behaviour over the long term and slowing down in summer, which can make the “omega block” pattern more likely.

Jennifer Francis, an atmospheric scientist at Woodwell Climate Research Center, said the rapid warming of the Arctic region appeared to be the cause of this slowdown.

“There is a general decrease in the winds in summer,” she said. “The reason there is a jet stream at all is because it is cold to the north and warm to the south, and that temperature difference creates

[the condition for the jet stream].” Because the Arctic is warming much faster than the rest of the planet, there is less temperature difference between those air masses now.

Some of the jet stream behaviour is still unexplained. “Over the Atlantic, the jet has shifted south in summer,” said Tim Woollings, author of *Jet Stream* and professor of atmospheric physics at Oxford. “Whereas we were expecting it to shift north in response to climate change.”

The heatwave that the UK recently experienced was “just a little taster” of what the rest of Europe experienced, Woollings said. “The real event is

‘If we see an extreme event in one place, it can be connected to extreme events in another’

over Spain and France,” he added.

The UK experienced two days of extremely high temperatures on Monday and Tuesday before the weather cooled off; Spain and France have seen elevated temperatures for weeks.

As global average temperatures increase, climate models show that heatwaves will get hotter. But it could be years before researchers know precisely how global warming is influencing these patterns of the jet stream.

“We need a very long record of observation,” said Williams. “It might be decades, or even a century, before we convincingly detect any changes.”

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‘Strategic failure’

UK spy chief claims Putin military push ‘about to run out of steam’

DEMETRI SEVASTOPULO — WASHINGTON
BEN HALL — LONDON

MI6 chief Richard Moore said Russia was “about to run out of steam” in Ukraine, giving the Ukrainian military a chance to strike back in the conflict he described as a “strategic failure” for President Vladimir Putin.

Speaking at the Aspen Security Forum in his first overseas speech as head of the UK Secret Intelligence Service, Moore said Russia would face trouble supplying troops and other logistical challenges in the coming weeks.

“The Russians will increasingly find it difficult to supply manpower and material over the next few weeks. They will have to pause in some way and that will give the Ukrainians opportunities to strike back,” Moore said.

The British intelligence chief said that while the conflict was “obviously not over”, Russia was making only very marginal progress in its campaign.

“The Russian forces have made some incremental progress over recent weeks and months, but it’s tiny amounts. We’re talking about a small number of miles of advance,” Moore said. “When they take a town, there’s nothing left of it . . . it is obliterated, and so I think they’re about to run out of steam.”

Moore said it was critical that Ukraine demonstrated its ability to retaliate against Russia, saying it would help ensure continuing high morale and send a strong message to Europe.

“It will be an important reminder to the rest of Europe that this is a winnable campaign by the Ukrainians because we are about to go into a pretty tough winter,” he said. “I don’t want to sound like a character from *Game of Thrones* but winter is coming and clearly, in that atmosphere with the sort of pressure on gas suppliers and all the rest, we’re in for a tough time.”

Russian forces seized the whole of Luhansk province in eastern Ukraine at the beginning of July. After a brief operational pause, they are advancing from the north, east and south-east on the key cities of Sloviansk and Kramatorsk. These are crucial to Ukraine’s defence of Donetsk province and the rest of the Donbas region, which Putin has vowed to “liberate”.

The Russian advance is slow and grinding, relying on intense artillery fire to flatten Ukrainian positions. In recent weeks, Ukraine has acquired multiple launch rocket systems known as Himars from the US to target Russian ammunition depots and slow Moscow’s artillery machine. Satellite data from Nasa has shown the Russian bombardment of the front line has been less intensive, suggesting the Himars may be having the desired effect.

Moore said it was also critical for the west to “tough it out on Ukraine” and keep going through the winter because of the lessons China could draw from the conflict as it weighs its options for Taiwan, over which it claims sovereignty.

Conflict. Agriculture

Ukraine’s farmers fight for survival

Harvest begins but sector has suffered war damage, rising costs and loss of export routes

DEREK BROWER
KYSHCHENTSI, UKRAINE

Combine harvesters cruise through golden crops of barley in the fields of Kyshchentsi, 200km south of Ukraine capital Kyiv, leaving clouds of dust in their wake. Wheat, rapeseed and vegetables will follow as farmers gather the last winter-planted crops.

Ukraine’s harvest has begun despite a deepening crisis in one of the world’s great breadbaskets. Russia’s invasion and blockade of the Black Sea have ravaged the country’s agricultural sector, as war damage to infrastructure, soaring fuel and fertiliser costs and a loss of export routes leave farmers starved of revenues and with stark choices.

“If they can’t sell their crops they will just run out of money,” said Kornelis Huizinga, a Dutch farmer who moved to Ukraine more than 20 years ago and farms 15,000 hectares of land in Kyshchentsi in the central Cherkasy region. “They won’t have money to buy fuel or pay salaries.”

Ukraine exported 54mn tonnes of grain from a record harvest of 106mn during the 2021-22 marketing year that began last July, according to the Ukrain-

ian Grain Association. But the 2022-23 harvest could come in almost 40 per cent lower. The UGA warns exports could plunge to just 18mn tonnes without a swift reopening of the Black Sea route, hurting a range of countries from north Africa to south Asia that depend on Ukraine’s products.

Bohdan Chomiak, a former farmer who is on the board of GN Terminal, a grain facility in Odesa port, said Ukraine’s agricultural sector “has gone into zero mode”. Credit lines would dry up and many farms would go bust unless the blockade was ended soon. “This will be a bad year.”

The financial loss from the blockade is running at \$170mn a day, the UGA calculates, pushing many grain shippers and traders to the brink of bankruptcy.

“We use working capital and people would like their capital back and we can’t do anything,” said Chomiak. “We’re pretty close to collapsing.”

Many farmers are in even deeper financial distress as low domestic demand and prices are compounded by rising fuel and fertiliser costs.

“The only thing that saved and now supports small commodity producers is credit lines,” said Mykhailo Lazarenko, who runs a farm with 6,000 hectares of grain crops and livestock close to the city of Podilsk, 200km north of Odesa.

Russian troops have captured as much as a quarter of Ukraine’s 33mn hectares of arable land since the inva-

sion began in February. Farmers have been killed in fields laced with unexploded munitions. The physical losses — stolen tractors, looted grain and crop-lands ravaged by artillery or fire — amount to more than \$4bn, according to the Kyiv School of Economics’ Center for Food and Land Use Research.

Yet some farmers continue to reap. Vast grain fields and one of the world’s most abundant sunflower crops are ripening from the southern Mykolayiv region — site of fierce fighting in recent weeks — to the relative peace of the Zhytomyr region west of Kyiv.

But the blockade of Black Sea ports means farmers could soon run out of places to store their grain and oilseeds. Corn prices had halved in three months, said Lazarenko, while wheat that fetched \$300 a tonne before the war was

selling from the field for less than \$100, said Huizinga.

Farmers can use alternative export routes, including trucking grain through congested land crossings into Poland. Danube river terminals near the Romanian border have also provided an outlet. But transporting grain south to river ports such as Izmail can cost at least \$85 a tonne, more than four times the price of transporting it to Odesa before the war, Huizinga said.

The UGA said the increased need to stockpile grains could fill Ukraine’s estimated 60mn tonnes of ventilated storage by autumn. With some farmers forced to leave grain outside, Chomiak said about 15 per cent of crops harvested this year could be spoiled.

Turkey expects to broker a deal today with Russia and Ukraine for a resumption of grain exports. But even if the blockade is lifted soon, officials in Kyiv and marine insurers will need to be confident that ships will be ensured safe passage. And clearing the mounting backlog of stored grain will last long into 2023, analysts said.

In Kyshchentsi, Huizinga said Ukraine’s harvest next year could be significantly diminished as farmers assess whether they can afford to plant crops. “The guys who have cash reserves can last till next harvest,” the farmer said. “[But] some farmers say they won’t even be planting this autumn.”

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Black Sea

Kyiv and Moscow officials strike grain export accord

LAURA PITEI — ISTANBUL
GUY CHAZAN — BERLIN
DAVID SHEPPARD AND HARRY DEMPSEY
LONDON

Russian and Ukrainian negotiators will meet in Istanbul today after agreeing a deal to export millions of tonnes of stranded grain from the Black Sea, Turkey has announced, paving the way for the end of a months-long Russian blockade of Ukraine’s Black Sea ports.

Unless derailed at the last minute, the deal will allow an estimated 22mn tonnes of wheat, corn and other grains to be collected by cargo ships from the Ukrainian coast and transported across the world, averting fears of a global food crisis.

The signing will be attended by Turkey’s President Recep Tayyip Erdoğan and UN secretary-general António Guterres, who helped negotiate the deal. Ibrahim Kalin, a spokesman and adviser to Erdoğan, said the signing would be “critical for global grain security.”

Turkey’s announcement came as Russia resumed gas supplies through a critical pipeline to Europe.

But German officials warned of further potential interruptions, accusing Moscow of using its energy exports to “blackmail” Europe.

Nord Stream 1, which runs under the Baltic Sea between Russia and Germany,

had been shut down for repairs for 10 days and many in Berlin and Brussels had feared it would not come back online after the outage.

But Robert Habeck, economy minister, said it was too early to be confident about Europe’s energy security. “Russia as an energy supplier has become unreliable,” he said yesterday. “It is using its great power . . . to blackmail Europe and Germany.”

The uncertainty over gas supplies through NS1 had come to symbolise the breakdown in relations between Russia and the west after Moscow’s invasion of Ukraine, which prompted the EU, US and UK to impose swingeing sanctions on President Vladimir Putin’s regime.

Even before NS1 was closed for maintenance, Russia reduced the flow of gas through the pipeline by 60 per cent, citing technical issues. Germany at the time accused it of “weaponising” its energy exports to Europe to sow panic in the markets and drive up prices.

Though governments in Europe will be relieved the flow of gas has resumed, Habeck said the pipeline was still only operating at 40 per cent capacity — about the levels before the maintenance work began. “Just because 40 per cent of flows have now resumed, we should not lull ourselves into a false sense of security that [supply] will be stable from now on,” said Habeck.