New forecasting models could help prevent heat-related deaths

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Credit: João Jesus from Pexels

For parts of southern Europe, extreme heatwaves are now the rule, not the exception. New accurate and reliable weather prediction models could help regions better 'anticipate, prepare for, respond to and recover

from' these increasingly extreme weather events.

To paraphrase a popular song from the early 2000s, 'it's getting hot in here' – especially in southern Europe. This summer saw the mercury hit a scorching 48.8 degrees Celsius in Sicily—possibly the hottest temperature ever recorded in Europe.

This isn't just a fluke; temperatures have been steadily on the rise for years, the result of increasing—and largely unchecked—climate change.

"As average temperatures warm, extreme temperatures will also become warmer, leading to more frequent and warmer heatwaves," said Rachel White, an assistant professor at the University of British Columbia. "This is particularly concerning in regions that already experience high temperatures, such as southern Europe."

Of all the natural disasters occurring in recent decades, heatwaves have caused the greatest loss of human life. And, as temperatures continue to increase, more lives will be put at risk.

The key to saving lives is the use of accurate and reliable weather prediction models that go well beyond today's standard weekly forecasts.

One such model is sub-seasonal to seasonal (S2S) forecasting.

You can't predict the future, but…

Falling between weather forecast models, which predict the weather over the next week or so, and climate models, which predict the average weather, or climate, over many years, S2S forecast serve as extended weather forecasts.

To work, S2S models use the observed state of the atmosphere at the

time the prediction starts and, based on this, simulate how the climate system will likely evolve over the next four to eight weeks. To account for the climate's natural variability, the model produces a group of different simulations based on slightly varied conditions.

S2S models typically run for up to a few months. So, for example, we might use forecasts run from the beginning of June to predict the weather for the rest of the summer.

Because of its ability to 'see into the future," S2S forecasting has the potential to accurately predict extreme weather events several weeks in advance—enough time for the impacted areas to react.

Building more robust S2S models

However, despite this potential, S2S systems are a developing technology and remain in their infancy.

"Although promising, S2S forecast models are not sophisticated enough to forecast extreme heatwaves or to play a role in early warning systems," said Marie Drouard, a researcher at the Complutense University of Madrid.

Drouard, along with David Barriopedro, a researcher at the Spanish National Research Council, both of whom are part of the ISSUL project, are working to advance the sophistication—and usefulness—of S2S models. To do so, they are turning to the power of machine learning.

The benefit of using machine learning is that it allows one to analyze and make sense of huge amounts of data quickly and efficiently—which could prove to be extremely useful when it comes to predicting extreme weather events like heatwaves.

"We expect that, with the help of machine learning, S2S models will become sophisticated enough so that climatologists will someday use them to accurately predict heatwave frequency and intensity," said Barriopedro.

The researchers plan to test their machine-learning enhanced S2S model across southern Europe, including in Greece, Italy, the Balkans and the Iberian Peninsula.

Putting the wave in heatwave

Prior research suggests that human-induced global warming causes the large-scale movement of air, known as atmospheric circulation patterns, that lead to more frequent heatwaves. "This means climate change could have something of a one-two punch on heatwaves, causing not only all temperatures to be warmer, but also causing more frequent heatwaves due to changes in the atmospheric circulation patterns," explained White.

As part of the PROTECT project, White, along with Donate, have demonstrated how many extreme temperature events are associated with atmospheric circulation patterns called Rossby waves. These waves are known for both their strength and their habit of getting 'stuck' over, for example, Southern Europe for many days or even weeks and causing the extreme and dangerous heatwaves like what was seen in the summer of 2021.

"Our research has opened the door to potentially using S2S forecasts to predict not just the surface temperatures of heatwaves, but also the atmospheric circulation conditions that cause them," said White. "This approach may be able to help improve S2S models' ability to forecast the likelihood of heatwaves over a particular region for a coming season."

Research to the rescue

Although extreme heatwaves are always dangerous, due to population density, they pose a particular threat to urban areas.

"Urban areas must become more resilient to climate change and especially extreme heatwaves," said Beniamino Russo, R&D project manager at the SUEZ Group and scientific lead of the RESCCUE project.

Russo is helping create new solutions that cities can use to better anticipate, prepare for, respond to and recover from extreme weather events. These solutions, such as the "Framework for cities resilience assessment" or the "Tool and Database for the Selection of Adaptation Strategies" would allow city and emergency planners to predict and plan for moderate to heavy rain events, such as those that struck Germany, Belgium and the Netherlands in the summer of 2021.

Researchers are now in the early stages of testing the system's applicability to extreme heatwaves, with tests taking place in Badalona, a municipality to the immediate northeast of Barcelona.

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