How to better observe sudden changes in Europe’s climate

A team of scientists has identified certain metrics that can be used to detect abrupt variations in the system of sea currents in the Northern Atlantic Ocean.
Sudden and violent changes in climate, generally known as tipping points, are difficult to predict with the use of existing models. However, it’s crucial to monitor these thresholds (tipping points) where a tiny change can push a system into a completely new state. A case in point is the Atlantic Meridional Overturning Circulation (AMOC), a system of currents in the Atlantic Ocean that brings warm water up to Europe from the tropics and beyond.

The AMOC is characterised by a northward flow of warm, salty water in the upper layers of the Atlantic and a southward flow of colder, denser water in the deep Atlantic. It’s part of a wider network of global ocean circulation patterns that transports heat all around the world. Changes in this circulation – triggered by developments like the ocean warming from increasing greenhouse gases and freshwater from melting glaciers entering the ocean – could have profound impacts on the global climate system. These include cooling of the northern hemisphere, sea level rise in the Atlantic, an overall decrease in precipitation in Europe and North America, and a southward shift in monsoons in South America and Africa.

Although a collapse of the AMOC in the next century is considered unlikely, it’s crucial to identify signals of tipping in time to prepare for its effects. However, what are the metrics that may give early warnings of such abrupt changes? A team of researchers supported by the EU-funded TiPES project has sought answers to this question. Their findings were published in the ‘Journal of Climate’.

Multiple metrics

In a news item on the TiPES project website, study author Dr Laura Jackson comments: “We show, that using metrics based on temperatures and densities in the North Atlantic in addition to continuing to directly monitor the AMOC can improve our detection of AMOC changes and possibly even provide an early warning.”

In the ‘Journal of Climate’ article, Dr Jackson and her colleague Dr Richard Wood note that the metrics used “have been proposed as fingerprints in previous studies.” They state: “We find that the metrics that perform best are the temperature metrics based on large-scale differences, the large-scale meridional density gradient, and the vertical density difference in the Labrador Sea.” The researchers add: “The best metric for monitoring the AMOC depends somewhat on the processes driving the change. Hence the best strategy would be to consider multiple fingerprints to provide early detection of all likely AMOC changes.”

In the study, the researchers conclude that “the best metric may depend on the question being asked.” According to the TiPES news item, Dr Jackson emphasises that “it is difficult from these measurements to tell whether a change in the AMOC is from natural variability that takes place across decades, from a gradual weakening
because of anthropogenic climate change, or from crossing a tipping point.” Therefore, more research is needed. “One step in the right direction will be the evaluation of the available metrics in competing climate models to estimate the robustness of the results from the current work.”

The ongoing TiPES (Tipping Points in the Earth System) project was set up to clarify and analyse the dynamics and thresholds of climate change tipping points and to ensure that climate projections also include them.

**Keywords**

TiPES, tipping point, climate change, AMOC, ocean

**Related projects**

<table>
<thead>
<tr>
<th>TiPES</th>
<th>Tipping Points in the Earth System</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 April 2020</td>
<td></td>
</tr>
</tbody>
</table>

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