



Major Atlantic ocean current system might be approaching critical threshold

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[摘要] A major Atlantic ocean current -- the Atlantic Meridional Overturning Circulation, or AMOC -- may have been losing stability in the course of the last century, according to new research. A potential collapse of...

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The major Atlantic ocean current, to which also the Gulf stream belongs, may have been losing stability in the course of the last century. This is shown in a new study published in Nature Climate Change. The Atlantic Meridional Overturning Circulation, or AMOC, transports warm water masses from the tropics northward at the ocean surface and cold water southward at the ocean bottom, which is most relevant for the relatively mild temperatures in Europe. Further, it influences weather systems worldwide. A potential collapse of this ocean current system could therefore have severe consequences.

"The Atlantic Meridional Overturning really is one of our planet's key circulation systems," says the author of the study, Niklas Boers from the Potsdam Institute for Climate Impact Research, Freie Universität Berlin and Exeter University. "We already know from some computer simulations and from data from Earth's past, so-called paleoclimate proxy records, that the AMOC can exhibit -- in addition to the currently attained strong mode -- an alternative, substantially weaker mode of operation. This bi-stability implies that abrupt transitions between the two circulation modes are in principle possible."

Loss of dynamical stability could ultimately lead to collapse

It has been shown previously that the AMOC is currently at its weakest in more than a 1000 years. However, so far it has remained an open question whether the observed weakening corresponds to a change in the mean circulation state, or whether it is associated with an actual loss of dynamical stability. "The difference is crucial," says Niklas Boers, "because the loss of dynamical stability would imply that the AMOC has approached its critical threshold, beyond which a substantial and in practice likely irreversible transition to the weak mode could occur."

Long-term observational data of the strength of the AMOC does unfortunately not exist, but the AMOC leaves so-called fingerprints in sea-surface temperature and salinity patterns of the Atlantic ocean. "A detailed analysis of these fingerprints in eight independent indices now suggests that the AMOC weakening during the last century is indeed likely to be associated with a loss of stability," says Boers. "The findings support the assessment that the AMOC decline is not just a fluctuation or a linear response to increasing temperatures but likely means the approaching of a critical threshold beyond which the circulation system could collapse."

In addition to global warming, freshwater inflow is a factor -- which is also linked to climate change

A number of factors are likely important for the phenomenon -- factors that add to the direct effect that the warming of the Atlantic ocean has on its circulation. These include freshwater inflow from the melting of the Greenland ice sheet, melting sea-ice, increasing precipitation and river run-off. Freshwater is lighter than saltwater and reduces the tendency of the water to sink from the surface to greater depths, which is one of the drivers of the overturning.

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"I wouldn't have expected that the excessive amounts of freshwater added in the course of the last century would already produce such a response in the overturning circulation," says Boers. "We urgently need to reconcile our models with the presented observational evidence to assess how far from or how close to its critical threshold the AMOC really is." While the respective relevance of the different factors has to be further investigated, they're all linked to human-caused climate change.

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