

Climate change

Intensification and poleward shift of oceanic boundary currents

Change means greater heat and more winter storms for Asia; Gulf Stream is the exception

[28. June 2016] Global warming results in fundamental changes to important ocean currents. As scientists from the Alfred-Wegener-Institute show in a new study, wind-driven subtropical boundary currents in the northern and southern hemisphere are not only going to increase in strength by the end of this century. The Kuroshio Current, the Agulhas Current and other oceanic currents are shifting their paths towards the pole and thus carry higher temperatures and thus the risk of storms to temperate latitudes. For this study, researchers evaluated a wealth of independent observational data and climate simulations. They showed the same pattern for all boundary currents, with the Gulf Stream as the only exception. According to the data, the latter will weaken over the next decades. The study has been published today in the Journal of Geophysical Research professional journal.

Along the eastern coasts of South Africa, Asia, Australasia, and South America, weather and climate will get significantly warmer over the next 100 years and thus presumably also significantly stormier on global average. The reason for this are changes to the western boundary currents that are already beginning to have a significant impact on weather events in these coastal regions.

These surface currents are driven by the wind; with flow speeds of up to nine kilometres per hour, they are amongst the fastest ocean currents in the world. They reach down to a depth of 1000 metres and move warm bodies of water from the tropics to the coastal regions of the temperate latitudes. The best-known western boundary current in Europe is the Gulf Stream. Across the world, however, these also include the Kuroshio Current off the coast of Japan, the Brazil Current off the eastern coast of South America, the Eastern Australia Current as well as the Agulhas Current off the coast of South Africa.

Scientists from the Alfred-Wegener-Institute, Helmholtz Centre for Polar and Marine Research (AWI) have discovered these changes in a major comparative analysis of eleven independent climate data bases. On the one hand, the scientist evaluated oceanographic observational data as well as satellite data on the currents' heat loss between 1958 and 2001. On the other, they considered simulations for past and future climates as well as indicators for the flow speed of the currents, for water temperature and air pressure at the sea surface.

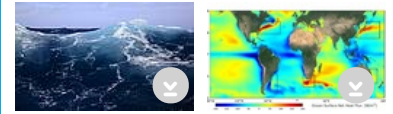
"Our analysis shows that the surface temperature of the boundary currents has increased two to three times faster than in other oceanic regions. In addition, the currents release 20 percent more heat than they did half a century ago, which leads to the conclusion that the temperature of the water has risen, its flow speed has increased and the currents thus transfer more water and also more heat from the tropics towards the pole. The cause of these changes were increasing winds in both hemispheres," explains Hu Yang, AWI climate researcher and author of the study.

The greater the heat transfer from the sea, the higher possibly the probability of storms. "Over the next decades, Japan, China and Korea will need to expect higher air temperatures particularly in winter, because the Kuroshio Current will transport more heat and shift northward with the wind. This heat will change the atmospheric condition in such as way as to make storms more likely in this region. For the Eastern Australian Current, the Brazil Current and the Agulhas Current on the southern hemisphere, our analyses predict a southward shift, because there, too, the winds shift poleward," explains Prof. Gerrit Lohman, climate modeller at the Alfred-Wegener-Institute and co-author of the study.

The Gulf Stream will become weaker




Warmer, stronger, poleward - according to the results, this pattern applies to all western subtropical boundary currents. The only exception is the Gulf Stream. "All of our results predict its long-term weakening. The reason for this is that the Gulf Stream is not only driven by the wind, but is also coupled with the thermohaline circulation. This is also often referred to as a global conveyor belt. Our results indicate that the power of this conveyor belt will weaken in the long term - and in an order of magnitude that more than compensate for the plus of increasing winds. Without the influence of this circulation, the Gulf Stream would follow the same patterns as the other boundary currents," outlines Gerrit Lohmann.




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The Institute

The Alfred Wegener Institute pursues research in the polar regions and the oceans of mid and high latitudes. As one of the 18 centres of the Helmholtz Association it coordinates polar research in Germany and provides ships like the research icebreaker Polarstern and stations for the international scientific community.

The climate scientists also fear far-reaching consequences for the fauna and flora of the coastal regions. "As these currents bring higher temperatures to these temperate latitudes, while advancing further north or south, many species will be forced to move to colder regions. But some of them won't be able to face this challenge," explains Gerrit Lohmann one of the possible consequences of the observed changes.

Original publication

Hu Yang, Gerrit Lohmann, Wei Wei, Mihai Dima, Monica Ionita, Jiping Liu: [Intensification and Poleward Shift of Subtropical Western Boundary Currents in a warming climate](#), Journal of Geophysical Research, DOI: 10.1002/2015JC011513