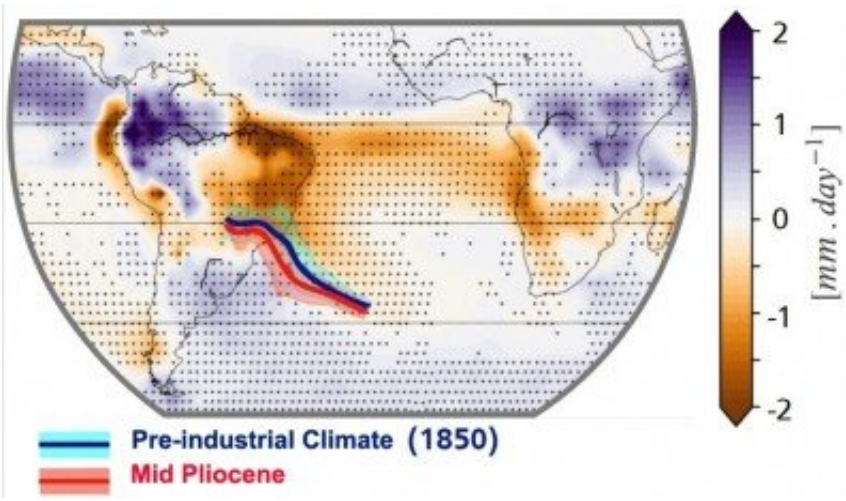
Southern hemisphere could see up to 30% less rain at end of the century

September 21 2020



Analysis is based on climate models for the mid-Pliocene period, which occurred 3 million years ago and shared characteristics with present-day warming. Credit: Gabriel Marques Pontes / USP

Projections based on climate models for the mid-Pliocene Warm Period (about 3 million years ago) suggest that countries in the tropical and subtropical southern hemisphere, including Brazil, may face longer droughts in the future. Annual rainfall may decrease as much as 30% compared with current levels.

One of the main variables considered in this scenario is a rise of 3 °C in the global average temperature, which may happen between 2050 and the end of the century unless the effects of climate change are mitigated.

The mid-Pliocene, before the emergence of Homo sapiens, shares characteristics with modern warming because temperatures were then between 2 °C and 3 °C higher than in the pre-industrial age (around the 1850s). High-latitude sea surface temperatures rose as much as 9 °C in the northern hemisphere and 4 °C in the southern hemisphere. Atmospheric CO_2 levels were similar to today's at about 400 parts per million (ppm).

These considerations are in the article "Drier tropical and subtropical Southern Hemisphere in the mid-Pliocene Warm Period," published in *Scientific Reports*. The lead author is Gabriel Marques Pontes, a Ph.D. candidate at the University of São Paulo's Oceanographic Institute (IO-USP) in Brazil with a scholarship from São Paulo Research Foundation—FAPESP .

The second author is Ilana Wainer, a professor in IO-USP and Pontes's thesis adviser. Other co-authors include Andréa Taschetto of the University of New South Wales (UNSW) in Australia, a former awardee of a scholarship from FAPESP.

According to the authors, their simulations showed that one of the most notable changes in southern hemisphere summer rainfall in the mid-Pliocene compared to pre-industrial conditions occurs in subtropical regions along the subtropical convergence zones (STCZs). Another change, they add, is associated with a northward shift of the inter-tropical convergence zone (ITCZ) due to consistent increased rainfall in the northern hemisphere tropics. The total November-to-March mean rainfall along the STCZs decreases in both models.

"These changes result in drier-than-normal southern hemisphere tropics and subtropics. The evaluation of the mid-Pliocene adds a constraint to possible future warmer scenarios associated with differing rates of warming between hemispheres," the article states.

In an interview, Wainer explained that the mid-Pliocene is the most recent period in Earth's history when global warming was similar to that projected for the rest of this century. "It's possible to put the expected natural variability in this context and distinguish it from the change caused by human activity," she said. "Studying past climate extremes helps elucidate future scenarios and address the associated uncertainties."

For Pontes, this is the first detailed investigation of southern hemisphere rainfall changes in the mid-Pliocene. "Understanding atmospheric circulation and precipitation during past warm climates is useful to add constraints to future change scenarios," he said.

Current impacts

According to a report issued in July by the World Meteorological Organization (WMO), the global average temperature could rise more than 1.5 °C above pre-industrial levels by 2024, much sooner than scientists previously thought. The report warns of a high risk of extreme rainfall variability across the various regions in the next five years, with some facing drought and others flooding.

In March the WMO confirmed that 2019 was the second warmest year on record, with a global average temperature that was 1.1 °C above pre-industrial levels. The warmest ever was 2016, partly owing to a strong El Niño, characterized by unusually warm sea surface temperatures in the Equatorial Pacific.

Since the 1980s each decade has been warmer than the previous one, the WMO noted, adding that retreating ice, record sea levels, increasing ocean heat and acidification and extreme weather combine to have major impacts on the health and well-being of both humans and the environment. The problem affects world socio-economic development,

causing migration and food insecurity in terrestrial and marine ecosystems.

In 2015, 195 countries signed up to greenhouse gas emission reduction targets in the Paris Agreement and promised to limit global warming to between 1.5 °C and 2 °C. These promises have not been kept.

"The United Nations has promoted measures to try to limit warming, but 1.5 °C is already having a significant impact," Pontes said. "The projections point to 3 °C by the end of the century when the consequences could look like the mid-Pliocene simulations performed in the study."

There was practically no external impact on vegetation in the mid-Pliocene, when the Amazon rainforest was much larger, generating more moisture and helping to offset the drier climate in the region, he added. Future droughts will be worse if deforestation and burning continue at the present rate.

Data published by the National Institute for Space Research (INPE) in Brazil shows a 34% increase in deforestation in the Amazon between August 2019 and July 2020 compared with a year earlier. Over 9,200 square kilometers of forest were destroyed in 12 months. Since 2013 deforestation in the Amazon has rebounded to reach high levels in consecutive years, after trending down for a period compared with the 1990s.

Data from INPE also shows a 28% increase in forest fires in the Amazon in July 2020 compared with a year earlier, itself considered the worst since 2010. For Pontes, drier weather and higher temperatures in South America could decrease annual rainfall by as much as 30%, leading to water shortages across the continent.

"The more we can mitigate warming and deforestation, the more we can help reduce the impact of climate change on the population of South America," he said.

The article recommends further research taking changes in plant cover into consideration by analyzing the effects of deforestation and warming together to estimate the possible decrease in rainfall in South America.

More information: Gabriel M. Pontes et al, Drier tropical and subtropical Southern Hemisphere in the mid-Pliocene Warm Period, *Scientific Reports* (2020). DOI: 10.1038/s41598-020-68884-5

Provided by FAPESP