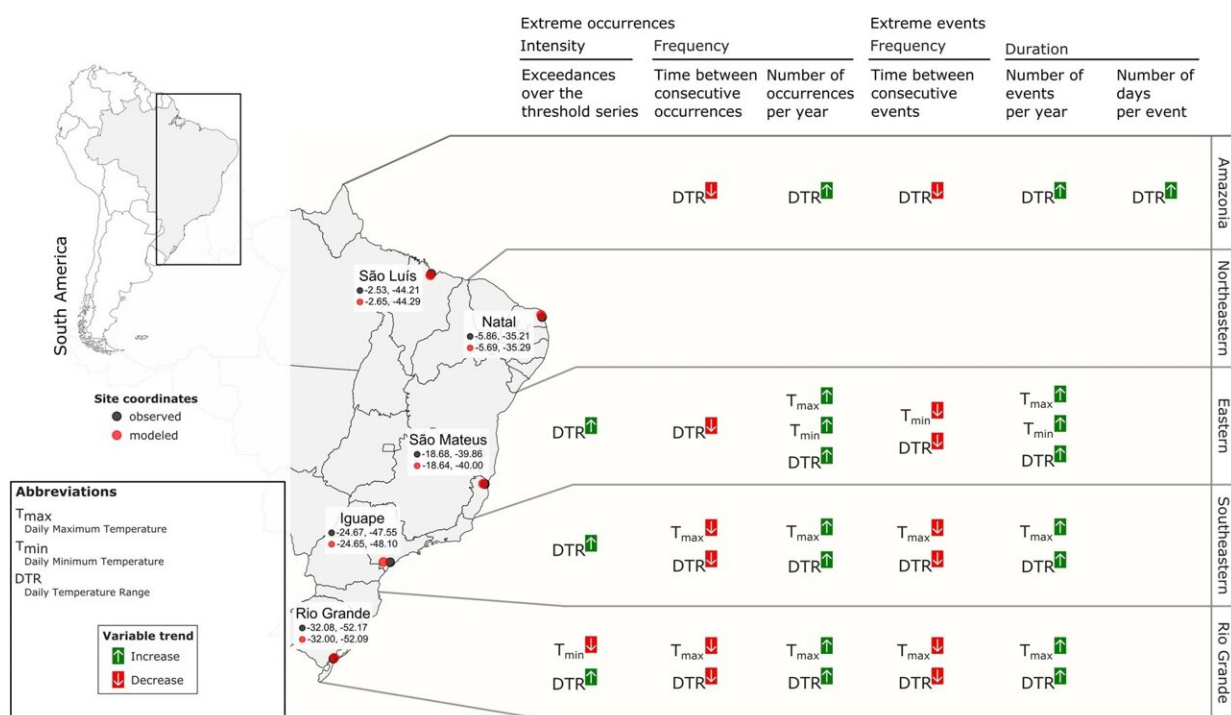


Brazilian coast is warmer and is having more frequent extreme temperature events, study shows

July 18 2023, by Luciana Constantino



Overall statically significant results from trend analysis to all 5 MEOW in the last 40 years. The results are presented to the following response variables: Daily maximum temperatures (T_{max}); Daily minimum temperatures (T_{min}); and Daily temperature range (DTR), with their respective extreme indexes that indicate intensity (Exceedances over the threshold series), frequency (both Time elapsed between consecutive extreme occurrences and events, as well as the Number of extremes per year), and duration (Number of days per extreme event). Credit: *Scientific Reports* (2023). DOI: 10.1038/s41598-023-32722-1

The Brazilian coast, especially in the South and Southeast regions, is already suffering from the impact of climate change, with increasingly extreme surface air temperatures and more frequent swings from heat to cold and back. This is one of the results of a study described in an article published in *Scientific Reports*.

On the coast of Espírito Santo, Rio Grande do Sul and São Paulo states, the frequency of temperature extremes and heatwaves (several consecutive days with very high temperatures) has increased in the last 40 years, rising 188%, 100% and 84% in these three states respectively.

In Espírito Santo, the highs ranged from 28.6 °C in July 1987 to 37.2 °C in March 2013, and the lows from 11.2 °C in June 1993 to 20.7 °C in January 2016. Highs in excess of 35 °C were recorded eight times in the state until 1999 and 19 times in the last decade. On the coast of Rio Grande do Sul, the researchers found that [daytime temperatures](#) are warming in the sense that the lows are becoming less extreme.

The study was conducted by researchers at the Federal University of São Paulo's Institute of Marine Sciences (IMAR-UNIFESP). They analyzed temperature extremes of varying intensity and frequency along the Brazilian coast. According to their conclusion, "the dataset and method used here seem to be a reliable approach for studies of climate extremes, with clear indicators of intensity, frequency, and duration." The method can "easily be applied" to other regions of the planet, they add.

"The findings show that the Southeast and South are already experiencing temperatures that could affect both biodiversity and the economy. The coast of Espírito Santo was the most affected out of the five regions analyzed because it was the only one where the frequency of both extreme cold events and heatwaves increased," said Fábio Henrique Carretero Sanches.

Biodiversity is affected, as [extreme temperatures](#) trigger physiological alterations and changes in the behavior of many species, as well as rising mortality rates among terrestrial and aquatic animals.

For Ronaldo Christofolletti, a researcher at IMAR-UNIFESP and last author of the article, the results of the study are also relevant to [public health](#) because various respiratory diseases are associated with temperature swings. "Extremes of heat and cold affect society in several ways, from thermal discomfort to forest fires, diseases and deaths among animals, plants and humans, especially the elderly and people in situations of vulnerability," said Christofolletti.

According to a [report](#) by the UN Children's Fund (UNICEF), 559 million children are frequently exposed to heatwaves around the world. If the global average temperature rises 1.7 °C compared with the pre-industrial era, the number will reach 1.6 billion by 2050, the report predicts.

Moreover, at least 15,000 people died in Europe last year owing to heatwaves, according to the World Health Organization (WHO). Spain and Germany were the worst-hit countries. The summer of 2022 (June-August) was the hottest on record. High temperatures led to the worst European drought since the Middle Ages.

"The changes in patterns of extreme weather on the coast are an important warning sign of Brazil's overall climate vulnerability. Our study confirmed that the climate emergency isn't futurology but part of a reality we have to deal with by combating its causes with concrete actions to mitigate its impacts and effective public policies for adaptation," said Ana Toni, national secretary for climate change at the Brazilian Ministry of the Environment and Climate Change, through her press office.

According to a [report](#) issued in March by the Intergovernmental Panel on Climate Change (IPCC), human activities have unequivocally increased emissions of greenhouse gases to record levels and global temperatures are likely to reach 1.5 °C above pre-industrial levels before 2030. This warming causes global changes, including a rise in sea levels and extreme weather, resulting in generalized damage to life, subsistence and natural systems.

40 years of hourly data

The researchers analyzed hourly surface air temperatures recorded every day for 40 years in five [coastal areas](#)—São Luís (Maranhão), Natal (Rio Grande do Norte), São Mateus (Espírito Santo), Iguape (São Paulo) and Rio Grande (Rio Grande do Sul).

They used mathematical models to define extreme temperatures for each area and each month of the year, taking regional and seasonal differences into account, and plotted seasonal and daily patterns with impacts measured in terms of "occurrences" (days on which an extreme occurred) or "events" (consecutive days of an extreme, characterizing a wave). No changes in patterns of [temperature extremes](#) were found for São Luís and Natal (both in Northeast Brazil) throughout the year.

They also analyzed two other factors: extreme temperature ranges ($T_{\min} - T_{\max}$) on specific days, and sharp changes in temperature (comparing T_{\min} or T_{\max} on consecutive days). Natal was the only area with no daily variations in temperature range, while in São Luís these were increasingly frequent, and the number of consecutive days with wider temperature ranges rose during the period.

In the Southeast and South, temperature variations were even greater, with the frequency and intensity of daily temperature ranges increased in São Mateus, Iguape and Rio Grande. Iguape had the most variation in

daily highs, with T_{\max} varying from 29.5 °C in July 2000 to 40.4 °C in January 2016, and daily lows, with T_{\min} varying between 1.0 °C in July 1990 and 17.9 °C in February 2018.

"Climate change studies require historical data and continuous monitoring data. To understand the current pattern of extreme events and project future scenarios that contribute to coastal resilience plans, we must urgently increase the number of weather stations on the Brazilian coast," Sanches said.

The researchers created a table of median extreme T_{\max} and T_{\min} values to serve as a reference for each of the five regions analyzed. The values have regional influence for the cities concerned and may vary in the years ahead.

More information: Fábio H. C. Sanches et al, The increase in intensity and frequency of surface air temperature extremes throughout the western South Atlantic coast, *Scientific Reports* (2023). [DOI: 10.1038/s41598-023-32722-1](https://doi.org/10.1038/s41598-023-32722-1)

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