https://news.mongabay.com/2024/07/climate-surprises-amazonia-and-the-lessons-of-brazils-catastrophic-flood-in-rio-grande-do-sul-commentary/

Climate surprises: Amazonia and the lessons of Brazil's catastrophic flood in Rio Grande do Sul (commentary)

by **Philip M. Fearnside** & **Rosimeire Araújo Silva** on 4 July 2024

- *Brazil's catastrophic flood in the state of Rio Grande do Sul is helping to raise public awareness of climate change but has had no visible effect on the Brazilian government's actions and plans on greenhouse gas emissions. The flood provides an example of "climate surprises," which are expected to increase further in frequency and severity with projected global warming.*

- *Amazonia has already been the victim of a series of such surprises, and these threaten the Amazon forest with collapse and the consequent pushing of global warming beyond a point of no return.*

- *Except for the Ministry of the Environment and Climate Change, the rest of Brazil's presidential administration is on the wrong side of the issue,*

> *expanding fossil fuel extraction and promoting deforestation in various ways. An immediate turnaround is needed.*

- *This is a commentary and does not necessarily reflect the views of Mongabay.*

"Surprises" is a term introduced to the literature in climate science by Stephen Schneider (1945-2010) to represent unexpected climatic events, usually reflecting processes that are not yet included in climate models (see [here](#) and [here](#)). These surprises are to be expected because the real-world climate is much more complex than the models, and because the real climate includes chaotic nonlinear processes. Surprises will become more frequent with ongoing global warming, and elements of the catastrophic 2024 flooding in Rio Grande do Sul appear to be an example. Extreme precipitation events in Brazil have increased dramatically in recent years, and they are [expected increase](#) much more under projected global warming. Recent indications of disproportional changes include record breaking Amazonian droughts, such as that in 2023 (see [here](#) and [here](#)), in central and southeastern Brazil as in 2014 and 2021(see [here](#) and [here](#)) and the 2014 [Madeira River flood](#).

The flood disaster in Rio Grande do Sul

In April and May 2024, 90% of Brazil's state of Rio Grande do Sul [was flooded](#), including the capital city of Porto Alegre (Figure 1), displacing 581,638 people, with 169 confirmed deaths and many others missing. Several climatic factors converged to cause such an unprecedented event. The event occurred in an El Niño year, which normally results in greater than average rainfall in southern Brazil, the most famous case being the floods in Blumenau, in the state of Santa Catarina that neighbors Rio Grande do Sul, during the 1982 El Niño. However, in April and May 2024 the 2023-2024 El Niño was well past its peak, which was in September-October 2023. Nevertheless, this El Niño increased the probability of a 10-day extreme rainfall event by a factor of 2 to 3, and increased its intensity 4-8%, as calculated by a [recent study](#) led by the Grantham Institute at Imperial College London.

Parque de diversões foi tomado pela água em Canoas (RS) (Foto: Nelson Almeida/AFP)

Figure 1. Flood in Porto Alegre, capital of Brazil's state of Rio Grande do Sul (Source: G1).

El Niño, a natural climate phenomenon caused by above-average sea-surface temperatures in the tropical Pacific Ocean that, since 2007, have been recognized by the Intergovernmental Panel on Climate Change (IPCC) as increasing due to anthropogenic global warming (IPCC, p. 779). Severe El Niños have increased in frequency and intensity, and unprecedented "super-El Niños" are projected to result from continued global warming.

Another factor contributing to the event was a large area of hot air that remained in place over the states of São Paulo and Minas Gerais (Figure 2). This forced the winds known as "flying rivers" that carry water vapor from the Amazon to southern and southeastern Brazil to pass to the south, with all of the water vapor that would normally be spread from Minas Gerais to Rio Grande do Sul passing over Rio Grande do Sul. Back calculation of wind patterns indicates this redirection of the winds (Figure 3). However, this was not the first time that a hot air mass has formed over São Paulo and Minas Gerais, and during other such events, as in 2021, catastrophic flooding did not occur in Rio Grande do Sul. In addition, April and May are not at the peak of water-vapor transport from Amazonia, which is from December to February.

Figure 2. Record temperatures in the city of São Paulo as with a stationary mass of hot air over the states of São Paulo and Minas Gerais (Source: *O Antagonista*)

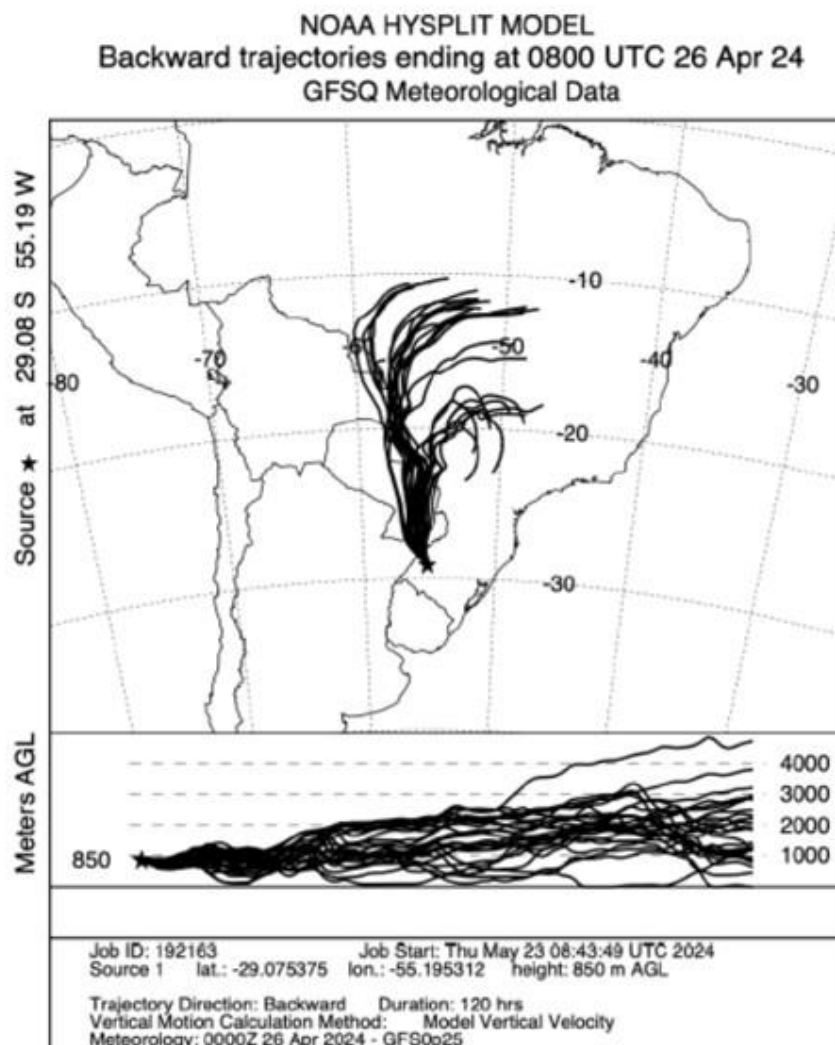Figure 3 Five day backward trajectories of wind ending in Rio Grande do Sul on the 26 April 2024 (Source: Grantham report; data: NOAA-ARL).

Another factor influencing the disaster was formation of a high-pressure area in the South Atlantic (Figure 4), which served to block the passage of the moisture-carrying winds that would have otherwise passed over Rio Grande do Sul and continued over the Atlantic. However, the high-pressure cell over the South Atlantic the South Atlantic is an essentially permanent feature, and its positioning near southern Brazil is not uncommon (see here, here and here).
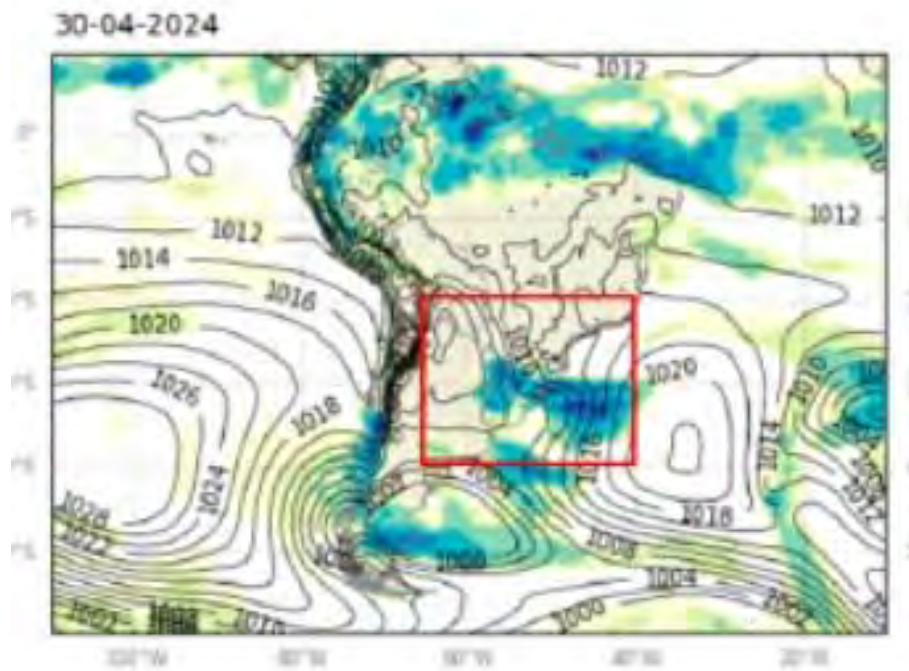

Figure 4. Mean daily pressure at sea level (isoheights) and precipitation (blue) on 30 April 2024 (Source: Grantham report; data: Copernicus)

For water vapor to condense to form rain, cold air is normally needed. This cooling may have been provided by a patch of cold water in the South Atlantic off the coast of Argentina (Figure 5). This contrasts with other years, such as 2021, when a mass of hot air also formed over São Paulo and Minas Gerais but the same area of ocean was anomalously warm.
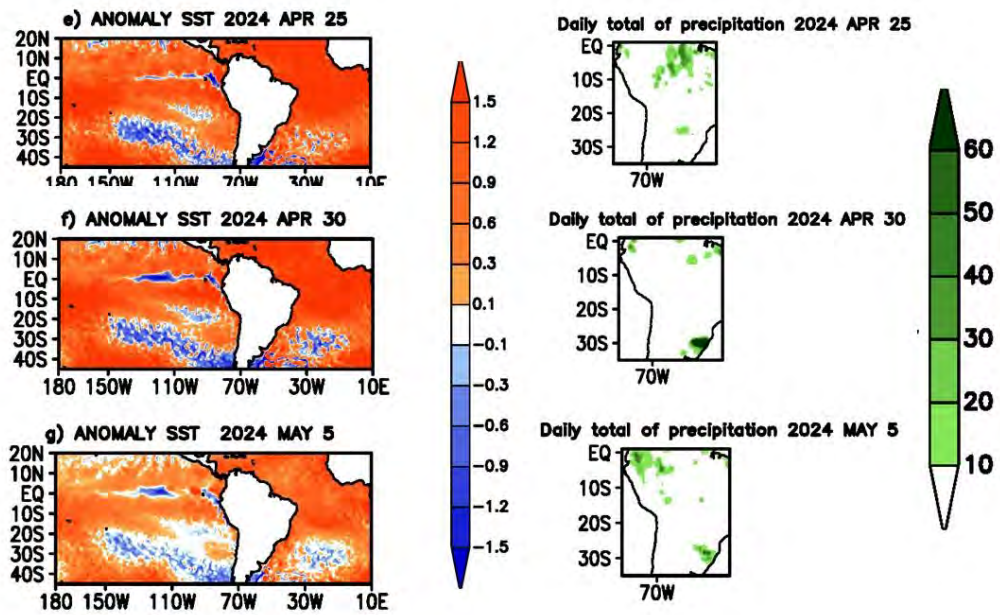
Figure 5. Sea surface temperature anomalies (left) and precipitation (right) from 25 April to 5 May 2024. The 10-day rain event in Rio Grande do Sul lasted from 26 April to 5 May (Source: NOAA-PSL).

The "climatic surprise" in Rio Grande do Sul was likely influenced by another phenomenon (and this one is indeed unprecedented): the anomalous behavior of the South Atlantic anticyclone. This system, a large circle of winds that move in a counterclockwise direction, underwent a radical change beginning in 2023 (Figure 6). The South Atlantic anticyclone index remained at a practically constant level over the 43-year period from 1979 to 2022, after which it has oscillated radically. This anticyclone circles around the South Atlantic high-pressure cell.
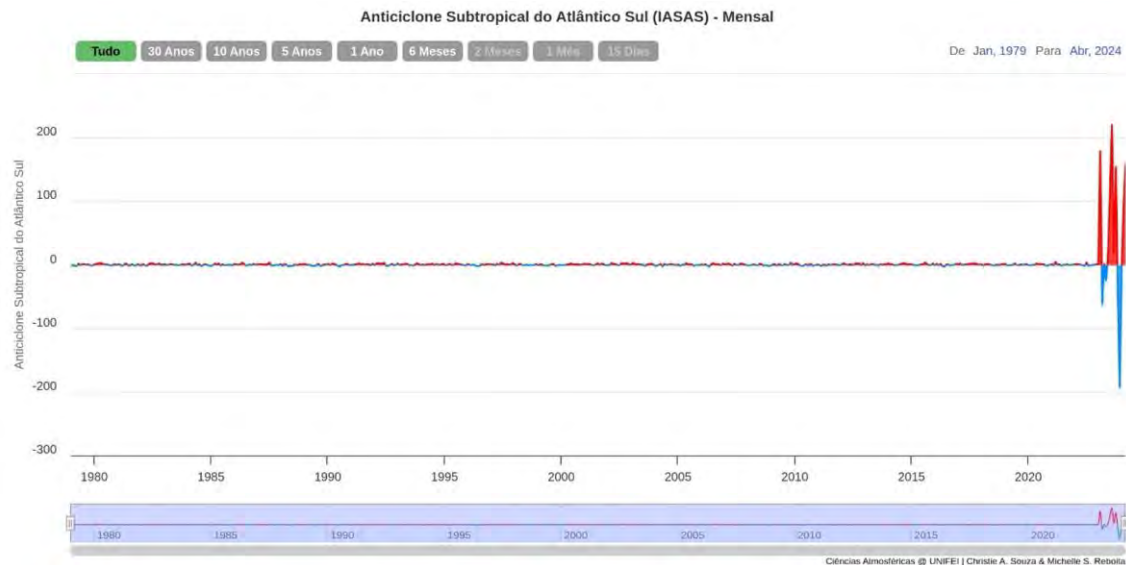
Figure 6. Monthly values of the South Atlantic Anticyclone index since 1979 (Source: UNIFEI).

Lessons of the climatic surprise

In the aftermath of the flood disaster much attention has been focused on the failure to prepare for such events and the errors in responding to it. More fundamental, however, is the need to confront the underlying cause: anthropogenic global warming. The Grantham Institute study calculated that the current 1.3°C of anthropogenic global warming more than doubled the likelihood of the Rio Grande do Sul event and increased its severity by 6-9%, and that if global mean temperature continues to increase to the 2°C mark, the likelihood of such an event would further increase by a factor of 1.3-2.7 its intensity would increase by another 4%.

The United Nations Framework Convention on Climate Change (UNFCCC) global stocktake, released at COP28 in December 2023 determined that global anthropogenic greenhouse gas emissions must decrease by 73% by 2030 and by 84% by 2050 to avoid the major increased risk of global warming crossing a tipping point beyond which it escapes from human control if global mean temperature passes the 1.5°C mark above the pre-industrial mean that was agreed as the maximum limit under the Paris Agreement. Achieving this requires immediate massive changes throughout the world. No country can postpone cutting its emissions using the excuse that the rest of the world must act first. Brazil should not only cut its emissions, it should also assume a position of global leadership in this effort. This requires

setting an example both by curbing Amazon deforestation and forest degradation and by proceeding to eliminate fossil fuels.

While the need for immediate action to reduce Brazil's emissions is the primary lesson to be taken from the climatic surprise in Rio Grande do Sul, this has not affected the Brazilian government's actions. With the important exception of the Ministry of the Environment and Climate Change, which has waged a heroic battle against deforestation, the rest of the current presidential administration is on the wrong side of the issue. The Minster of Mines and Energy is intent on expanding gas and oil fields both offshore and in the Amazon forest, and the minister has said that Brazil will continue to extract and sell petroleum until the country reaches the economic level of a "developed country". President Luiz Inácio Lula da Silva has said essentially the same thing: with respect to the risk-laden proposal he endorses to drill for oil in the Amazon River estuary, he said "… we will not throw out any opportunity to make this country grow". Since Brazil will always need to grow and to strive for a higher economic level, these positions mean expanding fossil fuel extraction indefinitely.

Despite the great environmental improvement with regard to Amazon deforestation following the change of presidential administrations in January 2023, Brazil's actions in the area of fossil fuels have consistently followed this infinite expansion path. At the Amazon summit in August 2023 Brazil refused to accept Colombia's proposal to renounce oil drilling plans in the Amazon forest, which include the plans for the vast "Solimões sedimentary area," Brazil joined OPEC+, ironically while the COP28 climate conference was in session, in January 2024 Brazil held the "end of the world" auction of drilling rights, including numerous sites in the Amazon forest, and another massive auction is planned for 2025. Unfortunately, this is not compatible with containing global warming: the International Energy Agency (IEA), which is by no means an environmentalist group, has taken the position that the world must reach net zero carbon emissions by 2050 and that there should be no new oil and gas fields opened anywhere in the world, extraction being progressively decreased in the existing fields until net zero is achieved.

BR-319 as seen from satellite. © Microsoft Zoom.

Other sectors of the government continue to promote projects that drive deforestation, and consequently greenhouse-gas emissions. The Ministry of Transportation is moving quickly to rebuild the disastrous BR-319 (Manaus-Porto Velho) highway that, together with planned side roads, would open vast areas of Amazon forest to deforesters from Brazil's notorious "arc of deforestation". The Ministry of Agriculture continues to subsidize cattle and soy in Amazonia, which are major drivers of deforestation. The National Institute for Colonization and Agrarian Reform (INCRA) continues with programs to legalize illegal land invasions and the claims of "land grabbers" in undesignated public lands, and the president has even stated the intention of creating a "shelf" of land to distribute in these "undesignated" areas. These measures are putting in place processes that will drive deforestation for decades to come. The notion that governance, including repressing deforestation through inspections and fines, will contain these pressures is a myth that serves to justify the most dangerous of projects, such as the reconstruction of Highway BR-319. The seriousness of controlling global warming has clearly not penetrated the most influential parts of the Brazilian government. The disaster in Rio Grande do Sul is helping to raise public awareness but has not changed Brazil's policies.

An earlier version of this text was published in Portuguese by Amazônia Real.

Header image: Flooding in Porto Alegre in Rio Grande do Sul, Brazil's southernmost state, on April 27, 2024. NASA Earth Observatory image by Wanmei Liang, using MODIS data from NASA EOSDIS LANCE and GIBS/Worldview and Landsat data from the U.S. Geological Survey.