At last, climate science may be able to predict tropical Atlantic weather better

February 22 2021, by Hyacinth C. Nnamchi

Credit: CC0 Public Domain

El Niño Southern Oscillation or ENSO, an anomalous warming of the surface waters in the tropical Pacific Ocean, is famous for producing months-long unusual weather patterns across the globe.

A similar, albeit lesser known circulation pattern, the Atlantic El Niño, dominates a wide swath of the Atlantic Ocean. The Atlantic El Niño phenomenon is analogous to the cycles that create Pacific ENSO. But unlike its Pacific counterpart, which has proven invaluable for seasonal climate predictions, the Atlantic El Niño is nearly impossible to predict.

The broad shifts in weather regimes known as ENSO occur when a massive swath of warm water forms off the coast of South America and extends into the central Pacific. The warmth of the water changes the flow of air in the Pacific. This in turn alters the weather patterns in countries bordering the Pacific and beyond as air movements around the globe adjust to the conditions in the Pacific. Because the movement of warm and cold waters occurs rather slowly across the vast stretch of the Pacific, climate scientists are able to predict the arrival of ENSO and accompanying weird weather conditions up to nine months in advance.

This allows the affected countries to prepare for the heavy rainfall and floods in eastern Africa and drought in southern Africa that an ENSO brings them at irregular intervals of 2-7 years.

In many ways, the Atlantic El Niño is like the Pacific-based ENSO. It follows a closely similar pattern of alterations in ocean and the overlying air movements. It occurs when warmer-than-normal waters form in the equatorial Atlantic region bordering the Guinea Coast of Africa, and extending towards the northern parts of South America. This has been linked to heavy rainfall and floods in coastal West Africa from Sierra Leone to southern Nigeria, and droughts in the semi-arid Sahel.

But climate scientists have struggled to understand what causes the Atlantic El Niño to emerge. I recently led a study that offers new insights, raising hope for improved climate predictions and better preparation.

The big puzzle

The air and ocean waters are essentially interwoven. Waters in the ocean move because winds blow on them. The air moves faster than the ocean waters below it. The water responds more slowly. This way, the ocean water forms a distinct pattern of movements, which redistributes heat slowly over a period of several months. Scientists are able use climate models to track the water movements, and predict El Niño events.

Because the El Niño patterns in the Atlantic and Pacific Oceans are considered to be similar, one would expect them to be similarly predictable. This is not so. The Pacific pattern is relatively easy to predict while the Atlantic one is almost completely unpredictable.

And there are additional important differences: the Atlantic events are of smaller magnitude and shorter duration. The reasons for these differences have puzzled climate scientists for decades.

A different kind of El Niño

The key question is how essential the movements of warm and cold waters are for the emergence of the Atlantic El Niño events.

In our study we investigated the seasonal development of the Atlantic warm events, using data from various sources, including in situ observations, reanalysis (in which observations have been blended using climate models), and satellite products.

We identified the movement of the Intertropical Convergence Zone, a band of low air pressure and heavy rainfall stretching across the tropical Atlantic, as the reason why the Atlantic Niño is short-lived. It is only when this zone is very close to or over the equator that the interaction between air and ocean movement is strong enough to cause large climatic impacts. The Intertropical Convergence Zone provides the right conditions in the air to favor the movements of warm and cold waters in the ocean. But the fluctuations in sea surface temperature in the Atlantic are not strong enough to keep the Intertropical Convergence Zone at the equator, as in the case in the Pacific ENSO.

Computer climate simulations show that air, rather than ocean water, movements are key to the Atlantic warm events. One set of simulations was conventional, trying to incorporate the detailed air and water movements. The second set reduced the complexity by modeling the ocean simply as a slab of motionless water with a thickness of only 50 meters.

This model was formulated in such a way that the ocean could absorb heat, emit heat, and evaporate moisture into the air, but the movements of warm and cold water within the ocean itself were ignored. The atmosphere alone accounts for 63% of the Atlantic El Niño events in these simulations.

This implies the movements of water in the ocean, as observed in the Pacific, are of lesser importance in the Atlantic. The Atlantic is "naturally" less predictable.

This is why our new findings, which established a strong connection to the Intertropical Convergence Zone, are important. The zone needs to be represented more realistically in the climate models and this will make them more accurate and reliable.

Going forward

The African and South American countries bordering the equatorial Atlantic strongly depend upon the ocean for societal development, fisheries, and tourism. They are strongly affected by vagaries in weather systems. Accurate climate predictions are essential.

Our findings suggest that accurate predictions, for up to three months, are possible in this region. When realized, this will aid planning adaptation to the severe weather conditions that normally come with Atlantic events.

However, the equatorial Atlantic is a region of key uncertainties in the climate system: climate models exhibit large errors. And for many parameters, there are large gaps in observations that need to be closed. Closing the observational gaps is a key step in reducing the climate model errors, and improving seasonal climate predictions.

Provided by The Conversation

Citation: At last, climate science may be able to predict tropical Atlantic weather better (2021, February 22) retrieved 17 April 2024 from https://phys.org/news/2021-02-climate-science-tropical-atlantic-weather.html