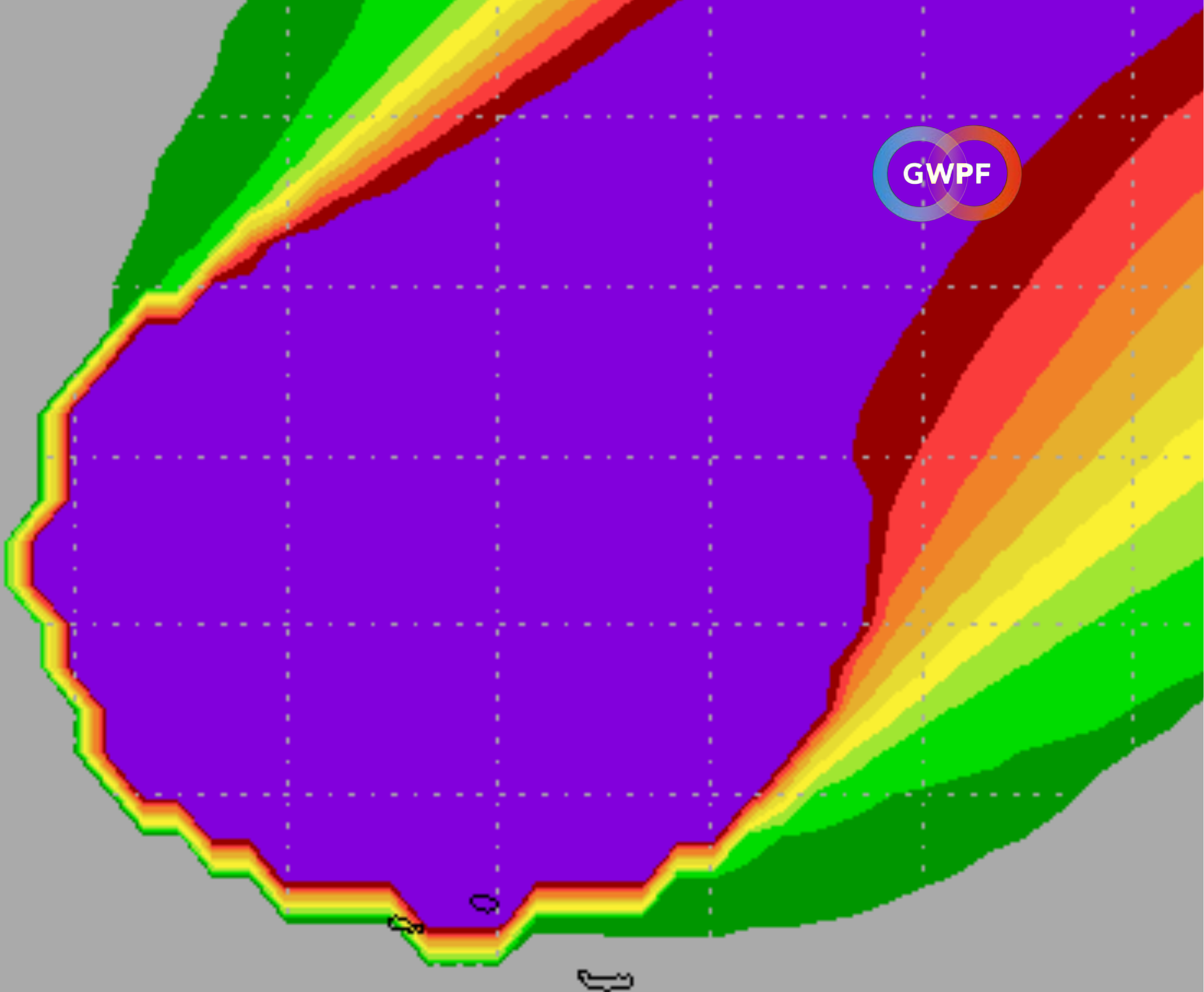

What caused HURRICANE LORENZO?

Ray Bates

The Global Warming Policy Foundation

GWPF Note 19

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About the author

Professor J. Ray Bates is Adjunct Professor of Meteorology in the Meteorology and Climate Centre at University College Dublin. He was formerly Professor of Meteorology at the Niels Bohr Institute, University of Copenhagen, and a Senior Scientist at NASA's Goddard Space Flight Centre. In his early career he was Head of Research at the Irish Meteorological Service. He obtained a bachelor's degree in physics at University College Dublin and a PhD in meteorology at MIT. His PhD supervisor at MIT was Jule G. Charney, chairman of the committee that wrote the 1979 'Charney Report' on the effects of carbon dioxide on climate.

Professor Bates has been the recipient of a number of awards for his scientific work, including the 2009 Vilhelm Bjerknes Medal of the European Geosciences Union. He is a former President of the Irish Meteorological Society. He has served as an Expert Reviewer of the IPCC's Third and Fifth Assessment Reports. He is a member of the Royal Irish Academy and the Academia Europaea and a Fellow of the American Meteorological Society and the Royal Meteorological Society.

1 Introduction

Hurricane Lorenzo affected the west coast of Ireland on 3 October 2019, although by the time it reached our shores, it had weakened to become an extratropical storm. It originated as an African easterly wave (a westward-moving weather disturbance), moving into the Atlantic from the coast of West Africa at about 11°N on 22 September. During the following days it followed a west-by-northwest track, strengthening as it went. By 29 September it was positioned near (25°N, 45°W), and had attained Hurricane Category 5 strength, with a central pressure of 925 hPa. Normally, African easterly waves follow a track much further to the south and those that become hurricanes do so much farther to the west, in the region of the Caribbean. It is rare for Atlantic hurricanes to reach Category 5 status, and the position at which this happened in the case of Lorenzo was the farthest east it had happened since satellite observations began in the mid-1960s. Lorenzo then curved northwards towards the Azores and continued in a northeasterly direction, losing strength as it moved over colder waters towards Ireland.

The unusual track and strength of Hurricane Lorenzo have been portrayed in some media reports as being due to increased sea surface temperatures (SSTs) in the Atlantic associated with climate change. In this note, the evidence relating to this attribution will be examined.

2 Lorenzo's development and track

Lorenzo became a named storm on 23 September. Figure 1 shows its characteristics at midnight GMT on 24 September, as identified by the wind pattern at the 700 hPa level.* This wind pattern, steering the storm in an unusual west-by-northwest direction and contributing to spinning it up through its strong horizontal wind shear, was crucial for Lorenzo's early development. Up to this stage, the SSTs in the region of the Atlantic over which the storm had passed were near to or slightly below the 1988–2017 climatological average for the dates in question (Figure 2).

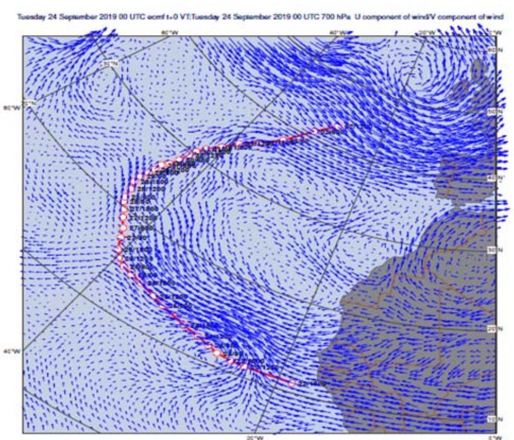


Figure 1: Lorenzo's early development

Wind patterns at 700 hPa, 00 UTC on Tuesday 24 September 2019. The storm track is superimposed, with its position marked every 6 hours. Source: European Centre for Medium-Range Weather Forecasts (ECMWF).

* This is a characteristic steering level, marking the level below which approximately 30% of the mass of the atmosphere lies.

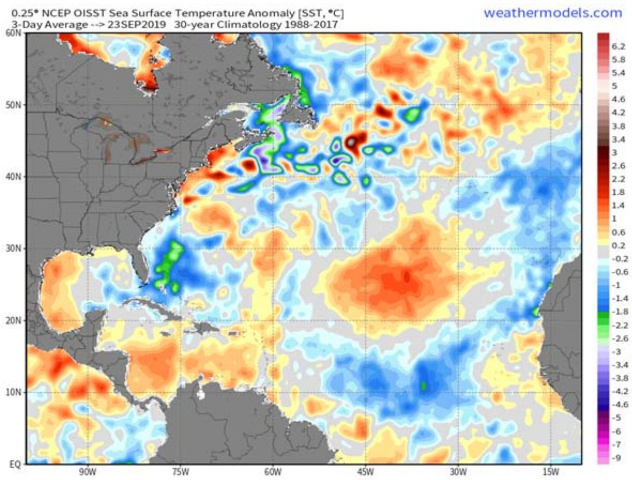


Figure 2: Ocean temperatures at the time

Three-day average (21–23 September 2019) SST anomalies in the region of Lorenzo's track, relative to the mean SSTs for these dates for the 30-year period 1988–2017.

After crossing latitude 20°N, Lorenzo encountered an area of anomalously warm SSTs, which allowed it to deepen rapidly as a result of a large increase in evaporation and the associated latent heat release. While still within this warm pool,[†] it attained its lowest surface pressure of 925 hPa, on 29 September. SSTs in the vicinity were warmer than normal by up to 1.5°C. Vertical wind shear in the storm was also much lower than normal, while mid-level moisture was higher than normal. Both of these factors contributed to its reaching Category 5 intensity. The wind pattern around this maximum stage of development is shown in Figure 3.

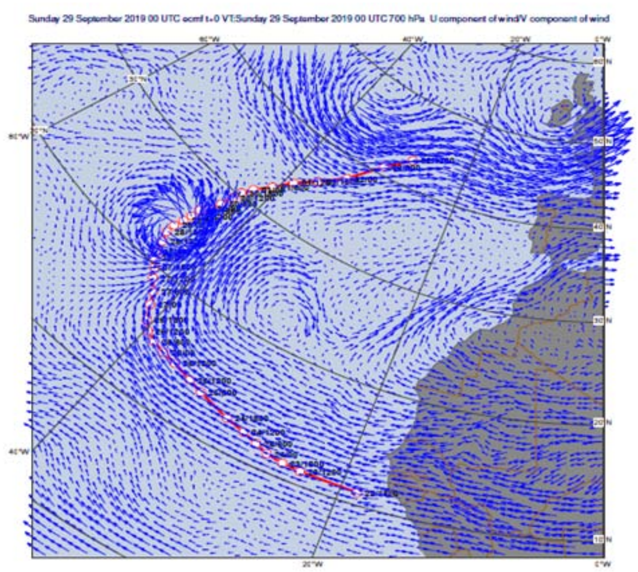


Figure 3: Lorenzo at its peak.

700 hPa winds at 00 UTC on Sunday 29 September. Source: ECMWF.

† At 25°N, 45°W.

Subsequent to the stage shown in Figure 3, Lorenzo began gradually to lose strength, but it was still a dangerous hurricane when it passed the Azores, with a central pressure of 960 hPa on 2 October (Figure 4). At this point, with forecast models predicting a northeasterly track from there, Met Éireann wisely issued status-orange wind warnings for our western seaboard.

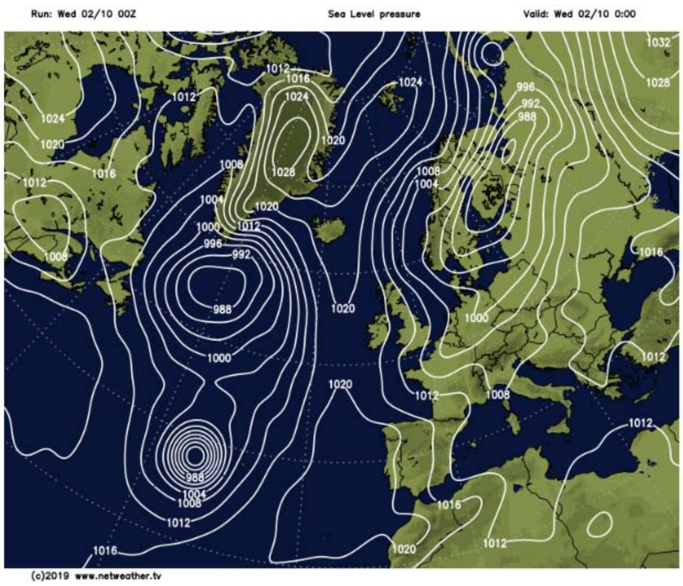


Figure 4: Lorenzo passes the Azores.
Surface pressure chart for the North Atlantic at 00 UTC on Wednesday 2 October.

Fortunately, the hurricane decreased in strength as it moved over colder waters and it was no longer identified as a tropical cyclone after midday on 2 October. Its configuration at midnight on 4 October is shown in Figure 5. It is notable that, by that time, the 700 hPa winds in the tropical Atlantic had reverted to a normal easterly trade wind pattern.

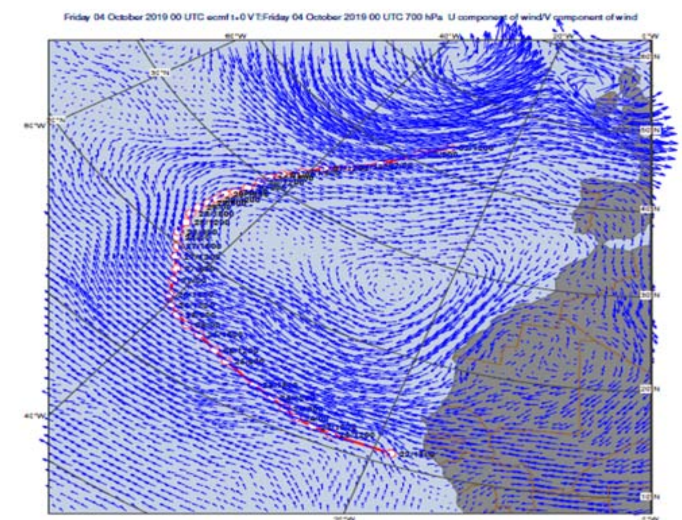


Figure 5: Lorenzo, now an extratropical storm, approaches Ireland
Winds at 700 hPa, 00 UTC on Friday 4 October. Source: ECMWF.

3 Was Lorenzo due to Atlantic warming?

The warm SST pool in the mid-Atlantic was clearly an important factor in Lorenzo's development to hurricane strength. But was this warm pool due to climate change? It is most unlikely. As seen in Figure 2, it was very localised, and was surrounded by seas that were at or below normal temperatures. This observation is corroborated by Figure 6, which shows a chart of average SST anomalies for the week 22–28 September, evaluated using a different base period. This shows that, apart from the warm pool and an area of warm SSTs stretching northeastwards from it, North Atlantic SSTs overall were near normal.

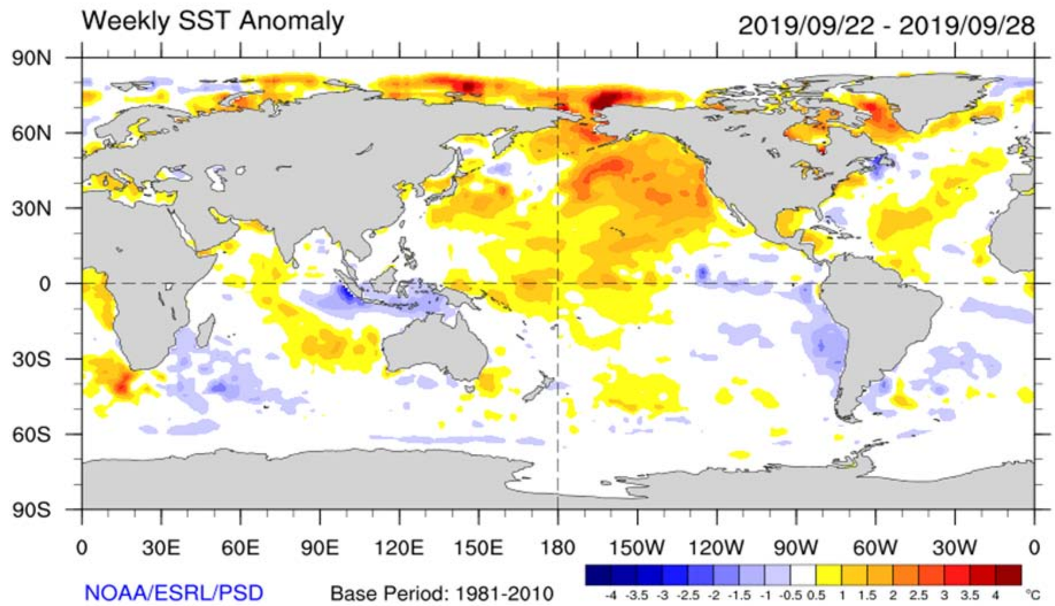


Figure 6: North Atlantic SSTs were mostly normal.
Mean SST anomalies for the week 22-28 September (relative to the base period 1981-2010).
Source: http://www.esrl.noaa.gov/psd/map/clim/sst.shtml.

The late September pattern of warm SST anomalies near the mid-Atlantic was also of a transient nature. This can be seen by comparing Figure 7a (for 30 September) with Figure 7b (for 27 June). It can be seen that large areas of the North Atlantic that were anomalously warm in September were anomalously cool in June. This changing pattern of SST anomalies, varying in the range +1.5°C to −1.5°C or more on monthly time scales, is due to natural variability. In contrast, the SST warming due to greenhouse gas increase is slowly evolving and is smaller than the above range; Figure 8 shows a graph of global average SST anomalies for the period 1850–2018. It can easily be shown using the underlying raw data[‡] that the most recent 30-year average SST on this graph is warmer than the 30-year average centred at the middle of the last century by only a third of a degree Celsius.[§]

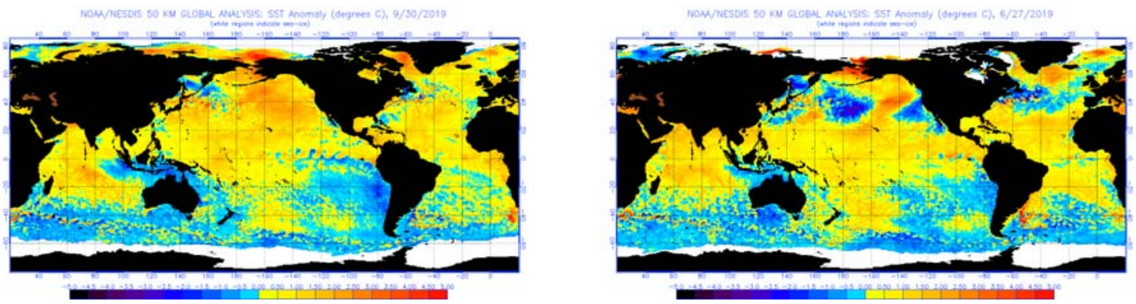
Finally, the 700 hPa wind pattern that steered the growing storm Lorenzo from the coast of Africa in a west-by-northwesterly direction towards the warm SST pool near the mid-Atlantic, contributing to spinning it up through horizontal wind shear as it went, was quite anomalous. The normal trade wind pattern in that area steers African easterly waves towards

‡ They are available at the same website as that cited for the figure.

§ More precisely, the raw data show that $SST_{\text{Jan 1989–Dec 2018}}$ average – $SST_{\text{Jan 1936–Dec 1965}}$ average = 0.3325°C.

the Caribbean, where some of them develop into hurricanes at a location much further to the west than did Lorenzo.

In conclusion, the evidence indicates that Lorenzo's unusual track and intensity were due to anomalous wind and SST patterns associated with natural variability rather than to greenhouse gas-induced Atlantic warming.



(a) 30 September 2019 (b) 27 June 2019

Figure 7: The warm pool was transient.
Source: https://www.ospo.noaa.gov/Products/ocean/sst/anomaly/.

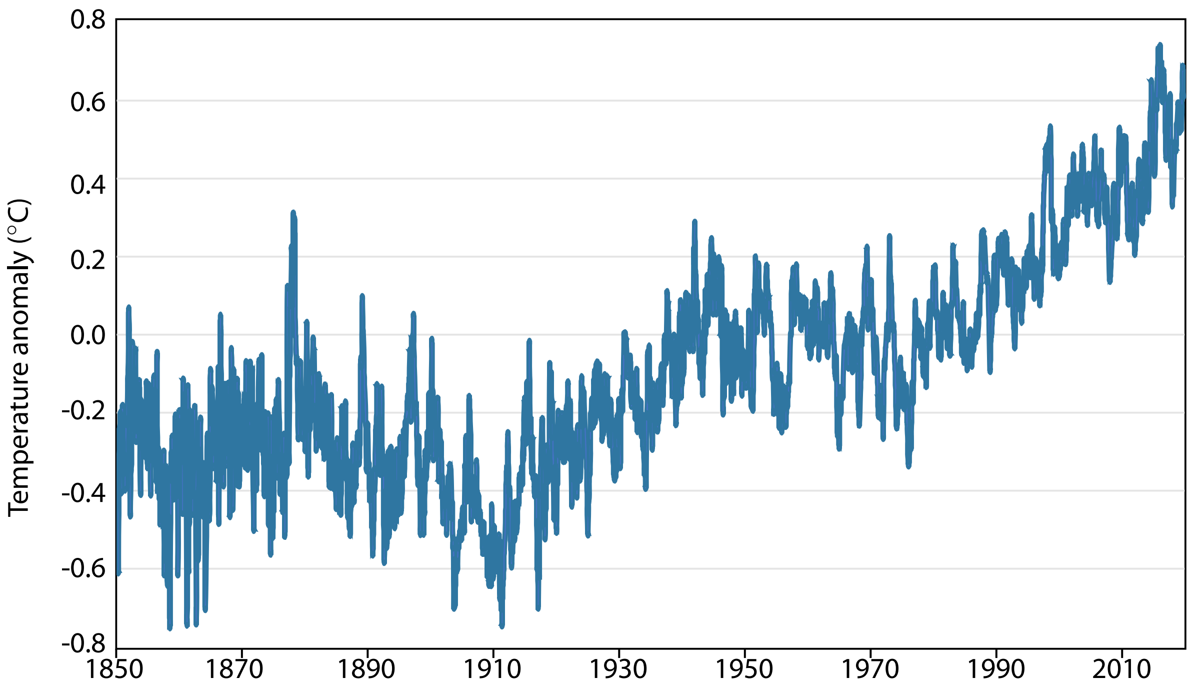


Figure 8: Monthly mean global SSTs (HadSST3) from 1850 to 2018.
Source: https://climexp.knmi.nl.

About the Global Warming Policy Foundation

The Global Warming Policy Foundation is an all-party and non-party think tank and a registered educational charity which, while openminded on the contested science of global warming, is deeply concerned about the costs and other implications of many of the policies currently being advocated.

Our main focus is to analyse global warming policies and their economic and other implications. Our aim is to provide the most robust and reliable economic analysis and advice. Above all we seek to inform the media, politicians and the public, in a newsworthy way, on the subject in general and on the misinformation to which they are all too frequently being subjected at the present time.

The key to the success of the GWPF is the trust and credibility that we have earned in the eyes of a growing number of policy makers, journalists and the interested public. The GWPF is funded overwhelmingly by voluntary donations from a number of private individuals and charitable trusts. In order to make clear its complete independence, it does not accept gifts from either energy companies or anyone with a significant interest in an energy company.

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