Characterization of the North Atlantic exceptional warming in May-June 2023

THIBAULT GUINALDO[1], CHRISTOPHE CASSOU[2], AURÉLIEN LINÉ[3], JEAN BAPTISTE SALLÉE[4]

[1] *Centre National de Recherches Météorologiques, Université de Toulouse, Météo-France, CNRS, Lannion, France*

[2] *CECI-CERFACS, Université de Toulouse, CNRS, Toulouse, France /Laboratoire de Météorologie Dynamique, CNRS, Paris, France.*

[3] *Institut de Mécanique des Fluides de Toulouse, Université de Toulouse, CNRS-INP-UPS, Toulouse, France*

[4] *Sorbonne Université, CNRS/IRD/MNHN, Laboratoire d'Océanographie et du Climat Expérimentations et Approches Numériques (LOCEAN), Paris, France*

In the year 2023, we witnessed an exceptional array of climate-related records shattering across the globe, whether in the atmosphere, on continental surfaces, or in the oceans. During this period, the oceans recorded their hottest year since the beginning of satellite monitoring, and the long-lasting record sea surface temperatures (SST) in the North Atlantic contributed significantly to this record year. Notably, 292 daily SST records in the North Atlantic were broken from March 2023 onward. The strongest warming of the surface waters occurred in May-June with an increase of 0.61°C in 25 days, reaching a peak intensity on the 21^{st} of June, exhibiting a distinct horseshoe-shaped pattern across the North Atlantic basin. This pattern, driven by anomalies in turbulent and radiative fluxes, was caused by marine heatwaves occurring in the tropical basin and in the north-eastern basin which experienced its strongest marine heatwaves in the satellite data archives. This study represents the first attempt, to the best of our knowledge, to delineate the characteristics of the extreme temperature event in the North Atlantic region. The analysis primarily focuses on a basin-scale evaluation during the peak intensity in May-June 2023 and the connections to the atmospheric circulation. Additionally, a quantitative analysis offers a two-dimensional perspective on the vertical extent of this event, assessing the potential preconditioning of the waters concerning ocean heat capacity and stratification. Finally, the analysis of ocean surface temperature data from CMIP6 models members is used to assess the probability of a similar event occurring in the current climate, taking into account anthropogenic climate warming. This analysis helps to quantify the contributions of continuous warming induced by greenhouse gases emissions and the inherent variability of the system that enhanced warm waters to reach record-level intensity.