The Atlantic Ocean's fingerprint on the climate of the Middle East

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The Atlantic Ocean acts as a key pacemaker for Middle East surface air temperature (ME-SAT) multidecadal variability in summer. This is the important result of a study published on *NPJ Climate and Atmospheric*

Science unveiling and demonstrating the existence of a North Atlantic-Middle East teleconnection, that is, a remote influence of the Atlantic multidecadal variability on the decadal variability of Middle East summer temperatures. This Atlantic-ME summer connection involves ocean-atmosphere interactions through multiple ocean basins, with an influence from the Indian Ocean and the Arabian Sea.

The study, led by Muhammad Azhar Ehsan currently at ICTP and co-authored by Dario Nicolì, Alessio Bellucci and Paolo Ruggieri, CMCC scientists at the Climate Simulation and Prediction Division, examined the impact of North Atlantic sea surface temperature (SST) variations, one of the main drivers for Northern Hemisphere climate, on summer ME-SAT.

The SST variability was analyzed through an important indicator, termed AMV—Atlantic Multidecadal Variability or AMO—Atlantic Multidecadal Oscillation to remind of its apparent oscillatory behavior; the instrumental records show that AMO/AMV is associated with a low frequency fluctuation of basin-wide anomalously warm and cold phases, with a typical 40-80-year time scale.

The phenomenon is not only interesting from an academic point of view, but also for its impacts on the climate across a large area: on the regional and local scale, it drives the climate of North America and western Europe, Mediterranean surface temperatures, influences the global monsoon, the current high levels of Atlantic hurricane activity, controls Sahel rainfall, and impacts Eurasian climate and the South Asian summer monsoon.

"This study," explains Alessio Bellucci, "identified this teleconnection between North Atlantic and Middle East and shed light on its causal nexus. Correlation analysis indicates a significant in-phase relationship between the summer ME-SAT and AMV observations, and the ME-SAT

decadal variability can be largely explained by the AMV signal."

Understanding the nature and drivers of this multiscale climate variability is a fundamental step in developing robust climate predictions and risk assessments over the ME. Surface air temperature over the ME shows a statistically significant positive trend (0.28 °C/decade) with accelerated warming from the 1980s, which is projected to continue into the future. The study shows that the strong recent warming trend over the Middle East could persist as long as the North Atlantic remains anomalously warm.

In order to investigate the relationship between Atlantic multidecadal variability and ME temperatures, researchers used observational evidence and numerical simulations. The CMCC provided in particular a suite of idealized numerical simulations that contributed to understand the causal network linking the basin-wide north Atlantic SST fluctuations and the summer ME-SAT multidecadal variability.

"Due to the identified teleconnection," adds Bellucci, "summer air temperatures over the Arabian Peninsula are potentially highly predictable on multiyear time scale and this has a high societal relevance, because during the next decade, "Hajj," the largest annual pilgrimage in the Holy city of Makkah gathering several million of Muslims in the Arabian Peninsula, will occur during boreal summer (in 2020, it will occur from 28 July to 2 Aug). Therefore, knowing the physical mechanism of the SAT variability during summer could inform government agencies in adopting timely appropriate mitigation and adaption strategies that may provide ease and comfort to Pilgrims."

How these results can be correlated to global warming? The AMV oscillatory-like alternation of warm and cold phases modulates the current temperature trend, amplifying or mitigating the global warming signal. "Well, if we were able to predict the trend of this signal in the

North Atlantic, we could be able to predict if this signal will exacerbate or not the trend of increasing temperatures due to climate change. It will be crucial to understand whether and when a turning point of this signal will occur. The recent pattern of summer Middle East climate may be expected to continue as long as the present warm phase of AMV persists; in the future, temperatures in this region could increase or decrease, according to the evolution in the next decades of this signal in the North Atlantic. Understanding the nature and drivers of the AMV phase transitions and its impact on the regional scale climatic changes is a very active research area, and will be further explored in future research."

More information: Muhammad Azhar Ehsan, et al. (2020). Atlantic Ocean Influence on Middle East Summer Surface Air Temperature, *NPJ Climate and Atmospheric Science*, DOI: 10.1038/s41612-020-0109-1

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