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Understanding Atlantic Meridional Overturning Circulation and linked variations in precipitation and temperature distribution during the warmer climate

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Long-term and abrupt changes in precipitation (P) patterns remain ambiguous in a warmer climate. Modern studies project that a warmer climate will cause intensification of the hydrological cycle. However, paleoclimate evidence from the warm period, i.e., the Medieval Climate Anomaly (MCA; 800-1400 AD), contradicts this because, during MCA, some regions were humid (wet), while others had arid (dry) climates. Here, we investigated the P response to variations in the temperature (T) and Atlantic Meridional Overturning Circulation (AMOC) variation throughout the Northern Hemisphere (NH) using 75 for P, 17 for the AMOC, and 48 records for T from NOAA and PAGES paleoclimate databases.

Our results show a continuous weakening trend in AMOC from the 9^{th} to 13^{th} centuries. The weakened AMOC has probably altered the atmospheric heat and water vapor distribution, and consequently the hydroclimate around the NH. The hydroclimate over the eastern North America and the Western Europe looks more vulnerable to weak AMOC as it shifted from warm-humid to cold-arid climates. Weak AMOC induces motion in Inter-Tropical Convergence Zone (ITCZ) southwards. Our results show signals of an ITCZ shift over equatorial Africa and southern Asia with the warm and humid response. Although warm (cold) climates are not always associated with increased (decreased) P, they may also lead to arid (humid) climates. Overall, we found that when T is higher than their average, the hydrological conditions are arid, but when T is similar or close to the average level, the conditions are humid. However, these hydroclimate responses may vary according to the regionally available water resources. Therefore, an improved understanding of long-term T variability and AMOC trend changes, specifically during warmer periods, could provide relevant insights into the present and future climates.