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Persistent atmospheric and oceanic anomalies in the North Atlantic from summer 2009 to summer 2010

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In this work, the authors analyze the air-sea interaction processes associated with the persistent atmospheric and oceanic anomalies in the North Atlantic during summer 2009-summer 2010 with record breaking positive sea surface temperature (SST) anomaly (SSTA) in the hurricane Main Development Region (MDR) in the spring and summer of 2010. Contributions to the anomalies from El Niño/Southern Oscillation (ENSO), the North Atlantic Oscillation (NAO), and long-term trend are identified. The warming in the tropical North Atlantic during summer 2009-summer 2010 represented a typical response to ENSO, preconditioned and amplified by the influence of a strong and persistent negative phase of the NAO. The long-term trends enhanced the warming in the high and low latitudes and weakened the cooling in the middle latitudes. The persistent negative phase of the NAO was associated with active thermodynamic air-sea interaction in the North Atlantic basin. Surface wind anomalies associated with the NAO altered the ocean surface heat flux and changed the SSTA, which was likely further enhanced by the positive wind speed-evaporation-SST feedback. The total heat flux was dominated by the latent and sensible heat fluxes, while the short-wave radiation contributed to the tropical SSTA to a lesser degree. Sensitivity experiments with an atmospheric general circulation model forced by observed SST in the Atlantic Ocean alone suggested that the Atlantic SSTA, which was partly forced by the NAO, had some positive contribution to the persistence of the negative phase of the NAO. Therefore, the persistent NAO condition is partly an outcome of the global climate anomalies and the ocean-atmosphere feedback within the Atlantic basin. The combination of the ENSO, NAO, and long-term trend resulted in the record-breaking positive SSTA in the MDR in the boreal spring and summer of 2010. Based on the statistical relationship, the SSTA pattern in the North Atlantic was reasonably well predicted by using preceding ENSO and NAO as predictors.