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Interactions between the Atlantic cold tongue and the West African monsoon

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The Atlantic cold tongue (ACT) is a dominant feature of the eastern Equatorial Atlantic that develops in Boreal Spring and peaks in Boreal summer. The ACT is a key feature of the West African monsoon (WAM), impacting the evolution and intensity of the rainfall in the West African region. The timing of the ACT development influences the onset of both the coastal rains in Boreal Spring and the Sahelian rains in Boreal summer. A key aspect of the onset of the coastal rains is acceleration of low-level cross-equatorial southerly winds, important for establishing the ACT, discouraging convection near the Equator and transporting moisture towards the coast. We argue that the rainfall peak is maintained at the coast, rather than steadily moving inland with the solar insolation, due to persistent warm water in the coastal region together with frictionally induced moisture convergence there. A key aspect of the onset of the Sahelian rains, from this perspective, relates to the continued cooling of the ACT (as well as cooling of coastal water) that discourages rainfall there. We will also show how interannual variability in the ACT impacts the monsoon onset dates in both the coastal region in Spring and in the Sahel in Summer. Motivated by this it is clearly important to understand the mechanisms that determine the nature of the ACT including the extent to which the WAM itself impacts this. We argue that air-sea coupling between the ACT and the WAM occurs in two key phases. From March to mid-June, the ACT mainly results from the intensification of the southeastern trades associated with the St. Helena anticyclone. Steering of surface winds by the basin shape imparts optimal wind stress for generating the maximum upwelling south of the equator. During the second phase (mid-June-August), wind speeds north of the equator increase as a result of the northward progression of the intensifying trades and as a result of significant surface cross-equatorial heat flux gradients produced by the differential cooling between the ACT and the tropical waters circulating in the Gulf of Guinea. Given the importance of the ACT for the monsoon and given the lack of in situ observations there, recommendations will be made for future monitoring and field campaigns in the region, as well as for modeling of this coupled system.