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Variability of the Atlantic Warm Pool and its impact on climate and hurricane activity

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The Atlantic Warm Pool (AWP) is a large body of warm water comprised of the Intra-Americas Sea and the western tropical North Atlantic. AWP variability occurs on seasonal, interannual, multidecadal, and secular (global warming) timescales. Observations and atmospheric general circulation model runs show that the AWP significantly affects the climate of the Western Hemisphere. The climate response to the AWP's heating extends beyond the AWP region to other regions, such as the eastern North Pacific and North American monsoon region. Both the sea level pressure (SLP) and precipitation display a significant response of low (high) SLP and increased (decreased) rainfall to a large (small) AWP, in areas with two centers located in the western tropical North Atlantic and in the eastern North Pacific. In response to the SLP changes, the easterly Caribbean low-level jet is weakened (strengthened), as is its westward moisture transport. A large (small) AWP weakens (strengthens) the southerly Great Plains low-level jet, which results in reduced (enhanced) northward moisture transport from the Gulf of Mexico to the United States east of the Rocky Mountains and thus decreases (increases) the summer rainfall over the central United States. This suggests that a prolonged large AWP condition for multi-years may cause drought in North America. The AWP has an inter-hemispheric influence on the southeast Pacific. The warm pool alternates with northern South America as the seasonal heating source for the Hadley circulation in the Western Hemisphere. During the boreal summer, a strong regional Hadley circulation emanates from the AWP, forks into the subtropical southeast Pacific and thus maintains the subsidence over southeast Pacific. Large (small) warm pools strengthen (weaken) the summertime regional Hadley circulation that emanates from the region of the warm pool into the southeast Pacific. This indicates that improving the AWP simulation may be important to reducing the coupled model biases in the southeast Pacific. Large (small) AWPs also reduce (enhance) vertical wind shear in the Atlantic hurricane main development region and increase (decrease) the moist static instability of the troposphere, both of which favor (disfavor) the intensification of tropical storms into major hurricanes. On multidecadal timescale, the AWP largely follows the Atlantic multidecadal oscillation (AMO) signal. Since the climate response to the North Atlantic SST anomalies is primarily forced at low latitudes, this implies that the canonical relationships of the AMO with North America rainfall and hurricane activity may operate through the mechanisms of the AWP-induced atmospheric changes.