Observations for Climate: The need for an ocean observing system in the Caribbean and Gulf of Mexico for improving seasonal outlook and intensity forecast of hurricanes

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Abstract

Recent studies using both observations and numerical models have shown that the Atlantic Warm Pool (AWP) - a large body of warm water comprised of the Gulf of Mexico, the Caribbean Sea, and the western tropical North Atlantic - reduces the vertical wind shear and increases the convective available potential energy over the main development region for Atlantic hurricanes, and thus facilitates the formation and development of Atlantic TCs. The AWP also plays an important role in the hurricane track. An eastward expansion of the AWP shifts the hurricane genesis location eastward, decreasing the possibility for a hurricane to make landfall. A large AWP also induces barotropic stationary wave patterns that weaken the North Atlantic subtropical high and produce the eastward steering flow anomalies along the eastern seaboard of the United States. Due to these two mechanisms, hurricanes are steered toward the northeast without making landfall in the United States (Figure 1-3).

Similarly, the Tropical Cyclone Heat Potential (TCHP) - the ocean heat content contained between the sea surface and the depth of the 26°C isotherm - has been shown to play an important role in the intensification of Atlantic TCs. In particular, the intensification (weakening) of Atlantic TCs has been linked with (low) values of TCHP contained in warm (cold) ocean eddies (Figure 4). The AWP and TCHP are closely related and both show high spatial and temporal variability associated with oceanic mesoscale features.

However, currently, no operational ocean monitoring with in situ observations (Argo, drifters, XBTs) exists in the Caribbean and Gulf of Mexico, the crucial core AWP region highly linked to landfalling Atlantic hurricanes (Figure 5). Sea surface height observations derived from satellite altimetry and their statistical correlations with large AWP also induce barotropic stationary wave patterns that weaken the North Atlantic subtropical high and produce the eastward steering flow anomalies along the eastern seaboard of the United States. Due to these two mechanisms, hurricanes are steered toward the northeast without making landfall in the United States. As a result, the number of U.S. landfalling major hurricanes is not increased during large AWP years compared to small AWP years.

Steering flow and wind shear

Figure 3. Shown are (a) the TC steering flow anomalies (×10^4 mPa s^-1) and (b) vertical wind shear during June-November for large minus small AWP years. A large AWP induces barotropic stationary wave patterns that weaken the North Atlantic subtropical high and produce the eastward steering flow anomalies along the eastern seaboard of the United States. A large AWP also increases the vertical wind shear over the MDR. The steering flow anomalies are the vertically averaged wind anomalies in 550 hPa to 800 hPa. The vertical wind shear is calculated as the magnitude of the vector difference between winds at 200 hPa and 850 hPa. The box represents the MDR for Atlantic hurricanes.

References