Sargassum Accumulation in the Caribbean Sea in Response to Anomalous Oceanographic and Meteorological Forcing in the North Atlantic Ocean

Acumulacion de *Sargazo* en el Mar Caribe en Respuesta a Anomalias 0ceanograficas y Meteorologicas sobre el Atlantico Norte

Accumulation de *Sargasse* en Mer des Caraibes en Reponse a des Anomalies de Forcages Oceanographique et Meteorologique dans L'Atlantique Nord

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EXTENDED ABSTRACT

During 2011, and again in 2014 - 2015, a number of Caribbean islands experienced the most severe accumulations of Sargassum seaweed ever recorded for the region. The unprecedented accumulation of Sargassum during 2011, 2014, and 2015 on the beaches of the Caribbean Sea also impacted equatorial West Africa and equatorial Brazil. The resulting socioeconomic impacts of the *Sargassum* accumulation spurred interest in the likelihood of similar events in the future, and in the prediction of such events for future planning and mitigation strategies. Several diverse hypotheses were put forward by the scientific community as to the source of the *Sargassum*, and why it seemed to be blooming in areas where it had never been observed before such as in the western tropical Atlantic.

Using NCEP/NCAR reanalysis fields of winds and surface currents, along with surface drifter data from NOAA's Global Drifter Center, we find that unusual conditions related to a historic minimum in the North Atlantic Oscillation (NAO) during 2009 - 2010 and again in 2013 caused dramatic but temporary changes in the large-scale patterns of winds and currents over the entire North Atlantic. The negative NAO caused the westerlies to move farther south and the Trade Winds to weaken compared to the situation during a positive NAO. A negative NAO also leads to very cold temperatures along the US east coast. The NAO index reached its lowest value on record since 1895 during late 2010. It showed particularly low values in December 2009, December 2010, and March 2013.

Our analysis suggests that the *Sargassum* came from the only known source of *Sargassum* in the Atlantic Ocean, the Sargasso Sea, after being blown into the eastern North Atlantic by anomalous westerly winds caused by the extreme negative phase of the North Atlantic Oscillation (NAO). The *Sargassum* then drifted south and west with the prevailing seasonal Trade Winds and currents.

This provided a mechanism for large rafts of *Sargassum* seaweed and other marine debris to enter the divergent tropical Atlantic circulation where the ambient winds and currents allowed it to freely impact the coasts of equatorial Brazil and Africa and enter the Caribbean (as observed). However, the *Sargassum* accumulations in the equatorial Atlantic should ultimately be self-limiting due to the divergent nature of the large-scale winds and currents in the tropical North Atlantic.

In the future we intend to do a more in-depth, quantitative analysis of the NCEP reanalysis and the drifter data sets to examine all of the possible dynamical pathways for *Sargassum* to have reached the areas experiencing the coastal accumulations during 2011 and 2014 - 2015. We plan to compare these results with new satellite ocean color-based observations of floating *Sargassum* mats that are being developed for prediction of *Sargassum* inundations. And finally, we hope to be able to provide an alternative method for advance prediction of similar events, based on real-time observations of large-scale North Atlantic wind and current anomalies.

KEYWORDS: *Sargassum*, Caribbean, North Atlantic Oscillation, winds, currents