SIDEBAR 4.1: THE 2013 ATLANTIC HURRICANE SEASON: BLIP OR FLIP?—C. T. FOGARTY AND P. KLOTZBACH

The 2013 Atlantic hurricane season threw a few "curve balls" for forecasters and was the "wild pitch" that triggered lengthy discussions among weather and climate scientists. What was predicted to be a very active season with at least seven hurricanes (about one-third of those projected to be major hurricanes) turned out to produce only two Category 1 hurricanes and just 20% of the predicted ACE. It was the quietest Atlantic hurricane season since 1994 in terms of major hurricanes (none), since 1983 in terms of ACE, and since 1968 for lowest peak intensity of the season's strongest storm.

Signals that convinced long-range forecasters to anticipate a very active season included anomalously-warm SSTs in the MDR, the absence of El Niño conditions, below-normal sea level pressures in the tropical Atlantic, and persistence of the positive phase of the AMO (Schlesinger and Ramankutty 1994) early in 2013, among other predictors. During neutral or negative phases of ENSO, upper-level wind shear in the tropical Atlantic is generally relatively weak. Neutral ENSO conditions were correctly predicted to be present by most forecast models during the 2013 hurricane season. The expectation that neutral ENSO conditions and a positive phase of the AMO would continue was key to the prediction of at least three major hurricanes—a relationship described by Klotzbach and Gray (2008).

The big question coming out of the season was "why so little activity when most standard pre-season predictors indicated favorable storm formation conditions?" The primary clue was found over the eastern tropical Atlantic and within the MDR where the peak of the season was characterized by enhanced subsidence. Additionally, SSTs evolved in an unusual manner with little warming in the MDR during the spring and first half of summer when surface water should be warming. While tropical Atlantic SSTs were warmer than normal, cool anomalies were evident in the subtropical eastern Atlantic during the early part of the hurricane season (Fig. SB4.1b). This area has been shown in several studies including Klotzbach (2011), to be a critical area for Atlantic hurricane activity. Cold anomalies in this region tend to generate stronger-than-normal baroclinicity, thereby contributing to cold upper-level lows, which enhance African easterly wave recurvature in the eastern part of the basin.

A similar pattern evolved in the higher latitudes of the North Atlantic. This evolution signalled what would be a short-term reversal of the longer-term positive phase of the AMO since the mid-1990s. These observations, however, raise more questions. Were the enhanced subsidence in the MDR and the "flat-lined" SST (see Fig. SB4.2) related? It certainly appears that way, given that the trade winds strengthened during that period which in turn arrested the usual warming of surface waters necessary to promote convective cloud formation. Dry air from the Saharan region was also advected into the MDR

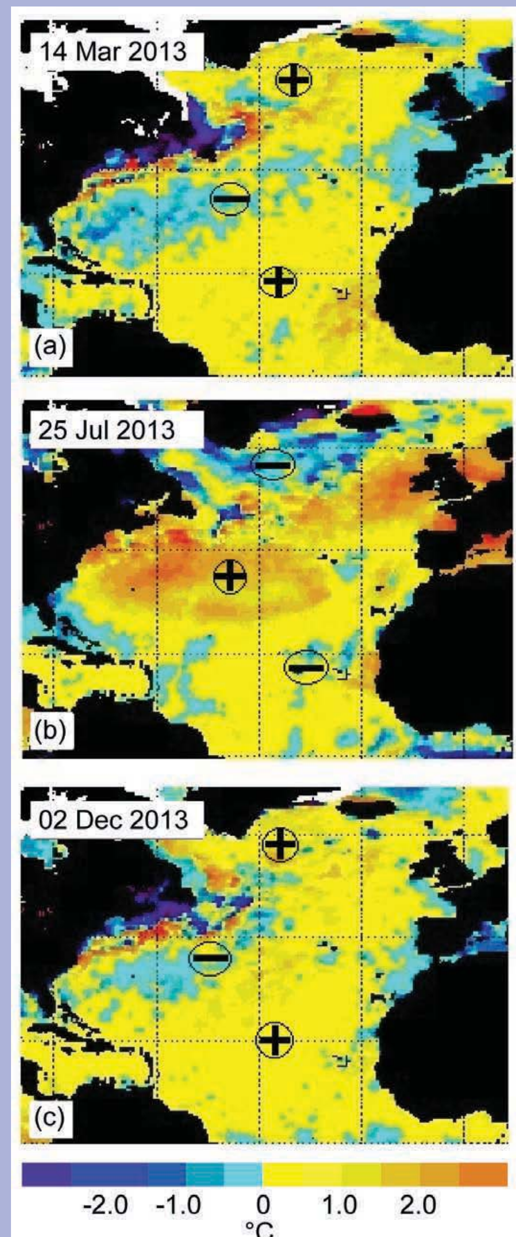

Fig. SB4.1. NOAA/NESDIS 50-km mean weekly SST anomaly (°C) for (a) 14 Mar, (b) 25 Jul, and (c) 02 Dec 2013.

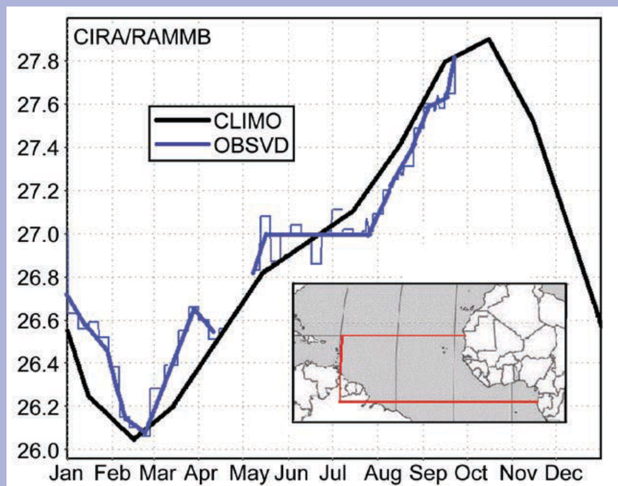

Fig. SB4.2. CIRA/RAMMB area-averaged SST throughout the MDR during 2013. Climatological values shown in black and observed shown in blue. Note the anomaly reversal from May to Jul.

by the enhanced trade winds. Another source of dry air (and wind shear) appeared to be from numerous cyclonic eddies diving southward during a commensurate reversal of the North Atlantic Oscillation (NAO) from negative to positive. Enhanced subsidence implies weaker easterly waves in the eastern Atlantic and a reduced likelihood of TC formation. Although convection was plentiful over the western part of the basin, above-normal vertical wind shear squelched the development of many storms that attempted to form there. Mid-tropospheric subsidence was also detected over the MDR (see http://typhoon.atmos.colostate.edu/).

From August to October the SST anomaly and AMO states returned to their early spring pattern almost as quickly as they deviated early in the year (the similarity between SST anomaly structures in Fig. SB4.1a and c is quite remarkable); however, it appears there was a lagged storm-suppressing impact that affected the MDR during the midst of the season. This intraseasonal change is a reminder that sometimes predictability may be limited to a shorter timeframe, and in the future sudden changes to the AMO cycle (or perhaps even the NAO) may serve as a shorter-term predictor within the season.

Two important questions remain: (1) Does potential exist to anticipate these sudden changes in the AMO? (2) Could the behavior in 2013 simply be a harbinger of a "flip" in the phase of the AMO from the current positive state to a negative one? The last time such a quiet season occurred was in 1994, at the end of the previous long-term negative phase of the AMO. There can be occasional "blips" in the phase or magnitude of the oscillation as seen in Fig. SB4.3. In 1968 there was a sharp drop in storm activity corresponding to a "dip" in the AMO index during that generally active era; however, the following year was extremely active. Data covering the past ~150 years of hurricane activity in the North Atlantic indicate that a period of ~60 years can be expected between peaks of hurricane activity, so the current active phase is more likely than not to persist for at least a few more years.

In summary, while many of the large-scale conditions typically associated with active TC seasons in the Atlantic were present (e.g., anomalously warm tropical Atlantic, absence of El Niño conditions, anomalously low tropical Atlantic sea level pressures), very dry midlevel air combined with midlevel subsidence and stable lapse rates to significantly suppress the 2013 Atlantic hurricane season. These unfavorable conditions were likely generated by a significant weakening of the strength of the AMO/Atlantic thermohaline circulation during the late spring and into the early summer. This very dry midlevel air is well-illustrated in figure 27 from last year's TC forecast verification report that shows the relative humidity anomalies at 600 hPa; that report is available at http://hurricane.atmos.colostate.edu/Forecasts/2013/nov2013/nov2013.pdf.

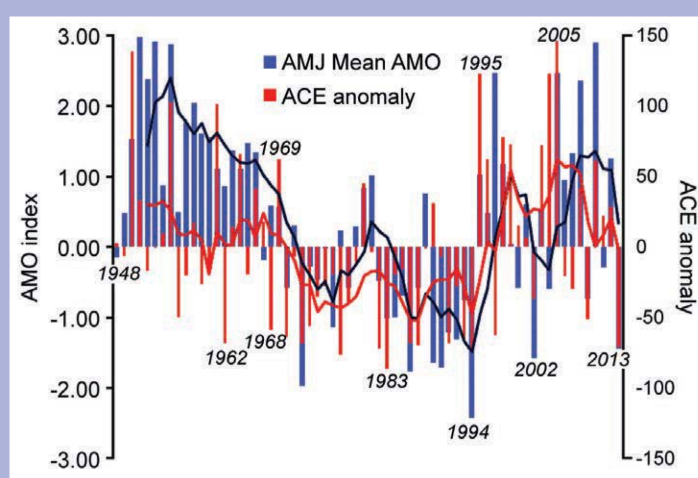

Fig. SB4.3. Apr–Jun (AMJ) mean of the AMO and season-total ACE anomaly from 1948 to 2013. Five-year running mean indicated with bold lines.