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The Surprisingly Quiet 2013 Atlantic Basin Hurricane Season

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1. Introduction

The Atlantic basin hurricane season was much less active than anticipated by Atlantic basin seasonal hurricane forecasts issued by Colorado State University (CSU), the National Oceanic and Atmospheric Administration (NOAA), Tropical Storm Risk, and the UK Met Office, among others. For example, NOAA's outlook issued on May 23 called for 13-20 named storms, 7-11 hurricanes and 3-6 major hurricanes, while CSU's outlook issued on June 3 called for 18 named storms, 9 hurricanes and four major hurricanes. While the 2013 Atlantic hurricane season had near-average named storm activity, with 13 named storms forming, only two hurricanes and no major hurricanes formed. This is the fewest hurricanes to occur in a season since 1982. This manuscript attempts to analyze, with the benefit of hindsight, what climate conditions caused this year's hurricane season to be much weaker than anticipated. Section 2 describes the data utilized, while Section 3 examines the climate features present during the 2013 Atlantic hurricane season. Section 4 concludes the manuscript. A much more detailed discussion of the 2013 Atlantic hurricane season can be found with the Tropical Meteorology Project's 2013 verification located online at http://tropical.atmos.colostate.edu.

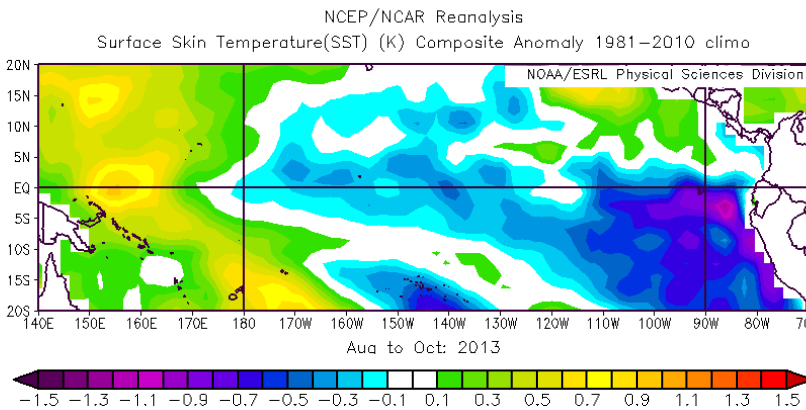

Fig. 1 August-October SST anomalies across the tropical Pacific.

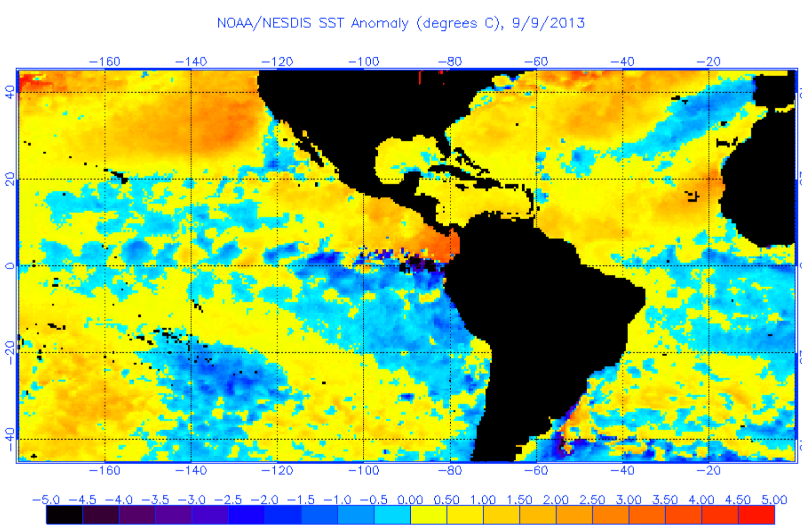

Fig. 2 Western Hemisphere SST anomalies on September 9, 2013.

2. Data

Tropical cyclone statistics were calculated from the operational b-decks created by the National Hurricane Center. Large-scale climate fields were calculated from the NCEP/NCAR Reanalysis (Kistler *et al*. 2001).

3. Climate features present during the 2013 Atlantic hurricane season

El Niño has been documented in many previous studies to have a detrimental impact on Atlantic basin tropical cyclone activity through alterations in vertical wind shear, mid-level moisture, upper-tropospheric temperature and static stability (Tang and Neelin, 2004; Klotzbach, 2011a). Figure 1 displays sea surface temperature (SST)

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anomalies across the central and eastern tropical Pacific averaged over August-October 2013. Anomalies were generally slightly cooler than normal, indicating cool neutral El Niño-Southern Oscillation (ENSO) conditions. Consequently, ENSO is not thought to have played a significant detrimental role in this year's hurricane season.

Another area that shows strong correlations with Atlantic basin hurricane activity is Atlantic basin SSTs. While tropical Atlantic SSTs were warmer than normal, cool anomalies were evident in the subtropical eastern Atlantic. This area has been shown in several studies including Klotzbach (2011b), 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. As a general rule, the farther east that African easterly waves recurve, the less likely they are to intensify into hurricanes. Figure 2 displays SST anomalies across the Western Hemisphere around the peak of the Atlantic hurricane season.

The primary reason why the Atlantic basin storm season was likely so much less active than forecast was due to a combination of copious amounts of dry air and mid-level sinking that occurred.

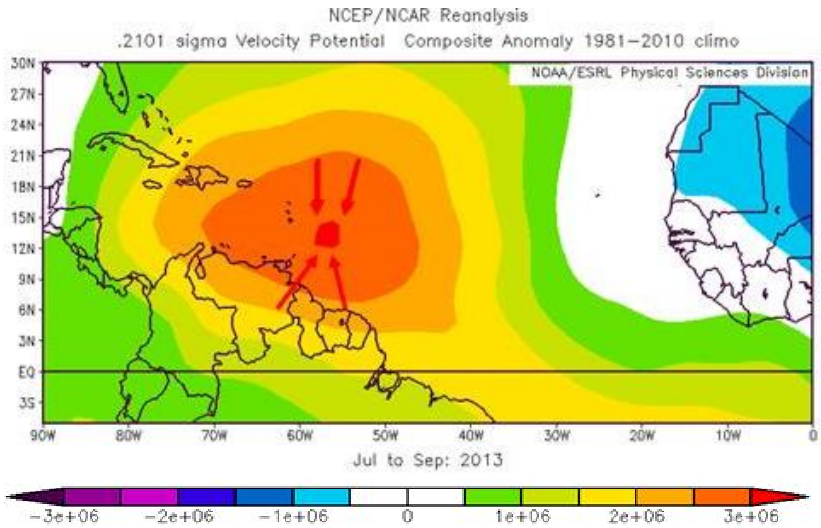

Fig. 3 Upper-level velocity potential anomalies in July-September 2013. Note the positive velocity potential anomalies that occurred during the months, indicating upper-level convergence (as demarked by the red arrows) and sinking motion.

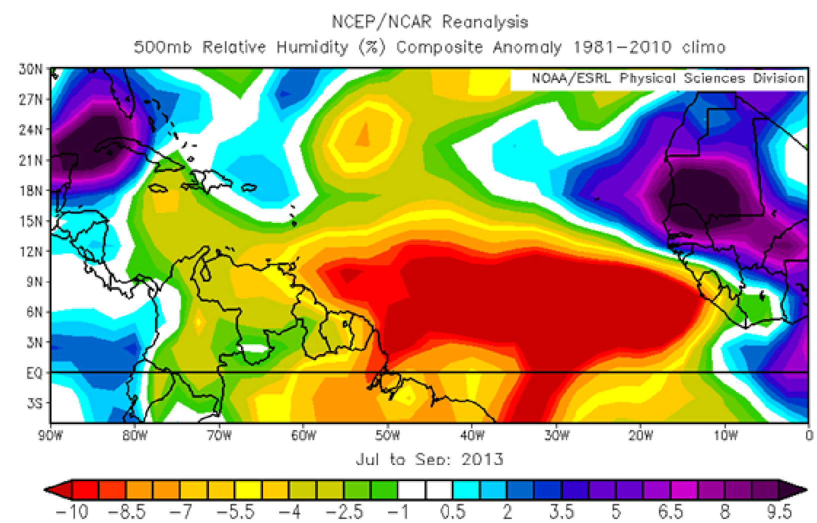

Fig. 4 July-September 2013 500-mb RH anomalies. Note the anomalous dryness across the Atlantic MDR this year.

The mid-level sinking that occurred during July-September 2013 is quite pronounced across the tropical Atlantic, especially when looking at velocity potential anomalies (Figure 3). Positive velocity potential anomalies at upper levels are associated with upper-level convergence and consequently sinking and drying at the middle levels of the atmosphere.

The anomalous dryness that persisted across the tropical Atlantic was also quite pronounced throughout the peak months of MDR formation from July-September. By October, TC formation tends to shift westward towards the Caribbean. NCEP/NCAR Reanalysis moisture values seem reasonable since the late 1970s (*e.g.*, no unusual trends). Table 1 displays relative humidity and specific humidity compared with other years from 1979-2012. A ranking of one indicates the driest during the time period. Note the anomalous dryness that occurred throughout the three-month period. It seems like this dry air was one of the critical reasons why the season was very quiet.

Figure 4 displays anomalous 500-mb relative humidity during the three-month period from July-September 2013. RH was quite low across the MDR, with even drier anomalies noted to the south of MDR.

One of the primary reasons why several of the seasons since 1995 have been very active was due to a pronounced and northward shifted Intertropical Convergence Zone (ITCZ) in the eastern tropical Atlantic (Klotzbach and Gray 2006). A stronger than normal ITCZ is associated with strong cross-equatorial flow which provides increased moisture flux into the tropical Atlantic and provides pre-existing cyclonic vorticity that helps spin up easterly waves. Anomalous meridional flow in July-September 2013 in the eastern tropical Atlantic was strongly out of the north, indicating a suppressed ITCZ and anomalous moisture divergence out of the tropical Atlantic (Figure 5).

Specific Humidity

	300-mb	500-mb	700-mb
July 2013	5	9	16
August 2013	12	2	6
September 2013	2	2	14

Relative Humidity

	300-mb	500-mb	700-mb
July 2013	5	8	11
August 2013	7	14	1
September 2013	2	2	8

Table 1 Specific humidity and relative humidity rankings for July 2013, August 2013 and September 2013 at 300-mb, 500-mb and 700-mb across the MDR (7.5-22.5°N, 20-75°W). Note that a ranking of one implies the driest (or most enhanced downward motion) across the MDR, while a ranking of 35 would imply the wettest (or most enhanced vertical motion) month of the last 35 years across the MDR.

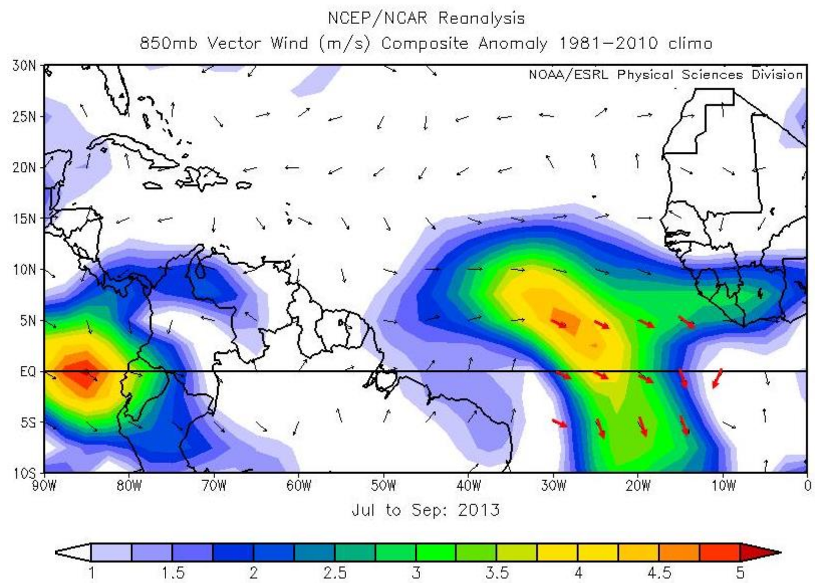

Fig. 5 Anomalous vector wind anomaly from July-September 2013. Note the anomalous northerly flow in the tropical Atlantic which likely was one of the reasons why there was such significant dryness in the tropical Atlantic this year.

4. Summary

This paper briefly discusses the reasons behind the much quieter than expected 2013 Atlantic basin storm season. While ENSO did not appear to play a significant role, it seems like a combination of cooler-than-normal subtropical Atlantic SSTs (and concomitant formation of upper-level lows), anomalously strong upper- and mid-level subsidence, and anomalous upper- and mid-level dryness were the likely culprits that restricted TC formation in the Atlantic in 2013. A much more thorough explanation of the reasons for the 2013 Atlantic hurricane season forecast bust are described in the Tropical Meteorology Project's end-of-season forecast verification located online at http://tropical.atmos.colostate.edu.

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