

Atlantic Hurricane Seasons: Active (2005) vs. Quiescent (2006)

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ABSTRACT

Recent Atlantic hurricane activity has raised several questions. For example, why was the 2005 season so early and active and are there similarities with the past, and contrary to many expectations, why was the first half of the 2006 season quiescent? We show that parallels exist between 2005 and previously active years. In 2006, a reversal of the large-scale ocean-atmosphere conditions from those in 2005 contributed to a quieter season. On longer time-scales SST, sea level pressure and zonal winds exhibit multidecadal variability; weaker easterlies during the positive phase of the Atlantic Multidecadal Oscillation (AMO) result (via ocean-atmosphere interactions) in warmer water and generally increased hurricane activity. However, individually active or quiescent years may occur independent of both the AMO phase and the secular warming trend.

Early 2005 hurricane season

- Number of storms by end of July: 4 tropical storms + 3 hurricanes (cat 1, cat 4, cat 5)
- Large scale ocean-atmosphere fields in the Atlantic in early 2005 were favorable for early-season hurricane formation (Fig. 1)
- Pressure patterns in June 2005 were similar to those more commonly found in September during active years (Fig. 2)
- These Pressure patterns led to weak easterly trade winds
- Weak easterly trade winds resulted in less latent heat loss from the ocean (positive anomaly)
- Less latent heat loss from the ocean produced a positive SST anomaly

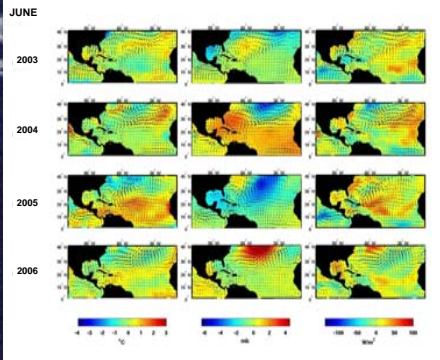


Figure 1: SST (left), SLP (middle), Latent Heat flux (right) and wind anomalies in June 2003, 2004, 2005, and 2006

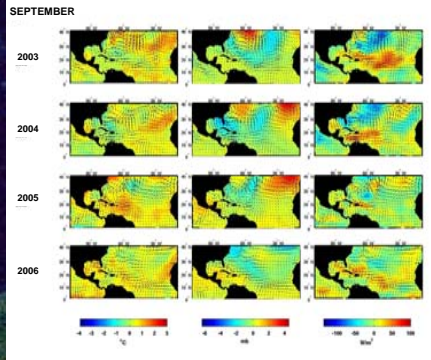


Figure 2: SST (left), SLP (middle), Latent Heat flux (right) and wind anomalies in September 2003, 2004, 2005, and 2006

Early 2006 hurricane season

- Number of storms by end of July: 3 tropical storms
- Large scale ocean-atmosphere fields in the Atlantic in early 2006 were opposite to early 2005 (Fig. 1)
- The Bermuda/Azores High was stronger and, therefore, easterly trade winds were stronger
- Strong easterly trade winds resulted in greater latent heat loss from the ocean (negative anomaly)
- Increased latent heat loss from the ocean produced a negative SST anomaly
- The early 2006 hurricane season was quiet for reasons other than El Niño

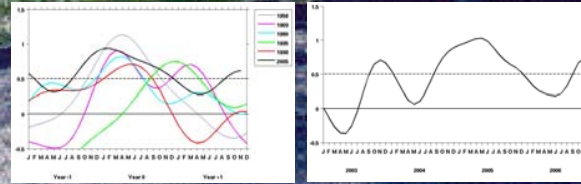


Figure 3: Low-pass filtered SST anomaly averaged over 10°-20°N, 30°-55°W. (Left) Year 0 are years with frequent storms, as indicated in the legend. (Right) SST anomaly from 2003 to 2006.

Annual cycle of SST anomaly & the hurricane season (Fig. 3)

- SST anomalies are generally positive and begin increasing in the summer of the year preceding (year -1) an active season
- Largest SST anomalies generally occur in early spring of the active year (year 0)
- Peak SST anomalies are greater than 0.5°C
- The 2004 and 2005 hurricane seasons were connected by an increasing SST anomaly that exceeded 0.5°C from early autumn 2004 to winter 2005
- SST anomalies were positive and began increasing in summer 2006...

Interannual variability of zonal wind anomaly (Fig. 4)

- When zonal wind anomalies exceed 0.5 m/s (i.e. weaker easterlies) there is an active hurricane season
- Anomalous zonal wind conditions in 2004 and 2005 were not unprecedented
- On multidecadal time scales, changes in the zonal winds correspond to the AMO
- Easterly trade winds are generally stronger (weaker) during the negative (positive) phase of the AMO, which corresponds to generally less (more) hurricane activity
- Early signs indicate weaker easterlies in 2007...

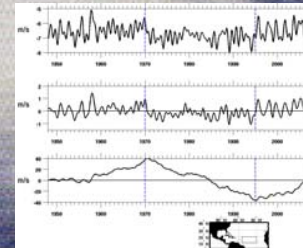


Figure 4: Zonal wind in a tropical Atlantic box (10°-20°N, 30°-55°W) : (a) average, (b) anomaly and (c) integrated anomaly.

Interannual variability of SST anomaly (Fig. 5)

- When SST anomalies exceed 0.5°C there is an active hurricane season
- Anomalous SST conditions in 2004 and 2005 were not unprecedented
- On multidecadal time scales, SST is cooler (warmer) during the negative (positive) phase of the AMO, which corresponds stronger (weaker) easterlies and generally less (more) hurricane activity

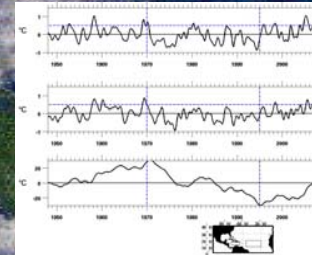


Figure 5: Detrended SST anomaly averaged over the (a) tropical Atlantic (10°-20°N, 30°-55°W) and (b) Caribbean (13.5°-17.5°N, 65°-80°W). (c) Integrated tropical Atlantic SST anomaly.

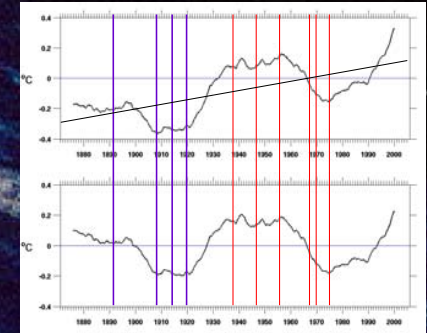


Figure 6: Atlantic Multidecadal Oscillation (AMO; top) and detrended AMO (bottom). Red lines indicate years with active seasons. Purple lines indicate years with catastrophic storms.

Atlantic Multidecadal Oscillation, secular temperature warming trend & hurricane activity (Fig. 6)

- Warming trend shows 0.4°C increase in Atlantic Temperatures in 130 years
- Individual active seasons occur regardless of AMO phase
- Individual strong storms occur regardless of secular temperature warming trend

Conclusions

- Lower latent heat loss from the tropical Atlantic and Caribbean in late spring and early summer 2005 than in preceding years, due to anomalously weak trade winds associated with weaker SLP, resulted in anomalously high SSTs
- These factors contributed to earlier and more intense hurricanes in 2005
- Conditions in the Atlantic & Caribbean in 2004 and 2005 were not unprecedented
- The 2004 and early 2005 active hurricane seasons were connected by a prolonged warm SST anomaly
- Large-scale oceanic and atmospheric fields in the Atlantic in 2006 were opposite to those in spring and early summer 2005
- This indicated a quieter 2006 hurricane season as early as March 2006
- The early 2006 hurricane season was quiet for reasons other than El Niño
- On multidecadal timescales, easterly trade winds are stronger (weaker) during the negative (positive) phase of the AMO when the SST is cooler (warmer) and the hurricane activity is generally lower (greater)
- Individual active seasons and strong storms occur regardless of the AMO or the secular long-term warming trend

Acknowledgements

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