Detection of Recent Regional Sea Surface Temperature Warming in the Intra-Americas Region, 1982-2012

Equisha Glenn
ESES Graduate Initiative
NOAA CREST
Earth Systems Science/
Environmental Engineering Dept., CCNY

Jorge E. Gonzalez, PhD
Mechanical Engineering Dept., CCNY
NOAA-CREST

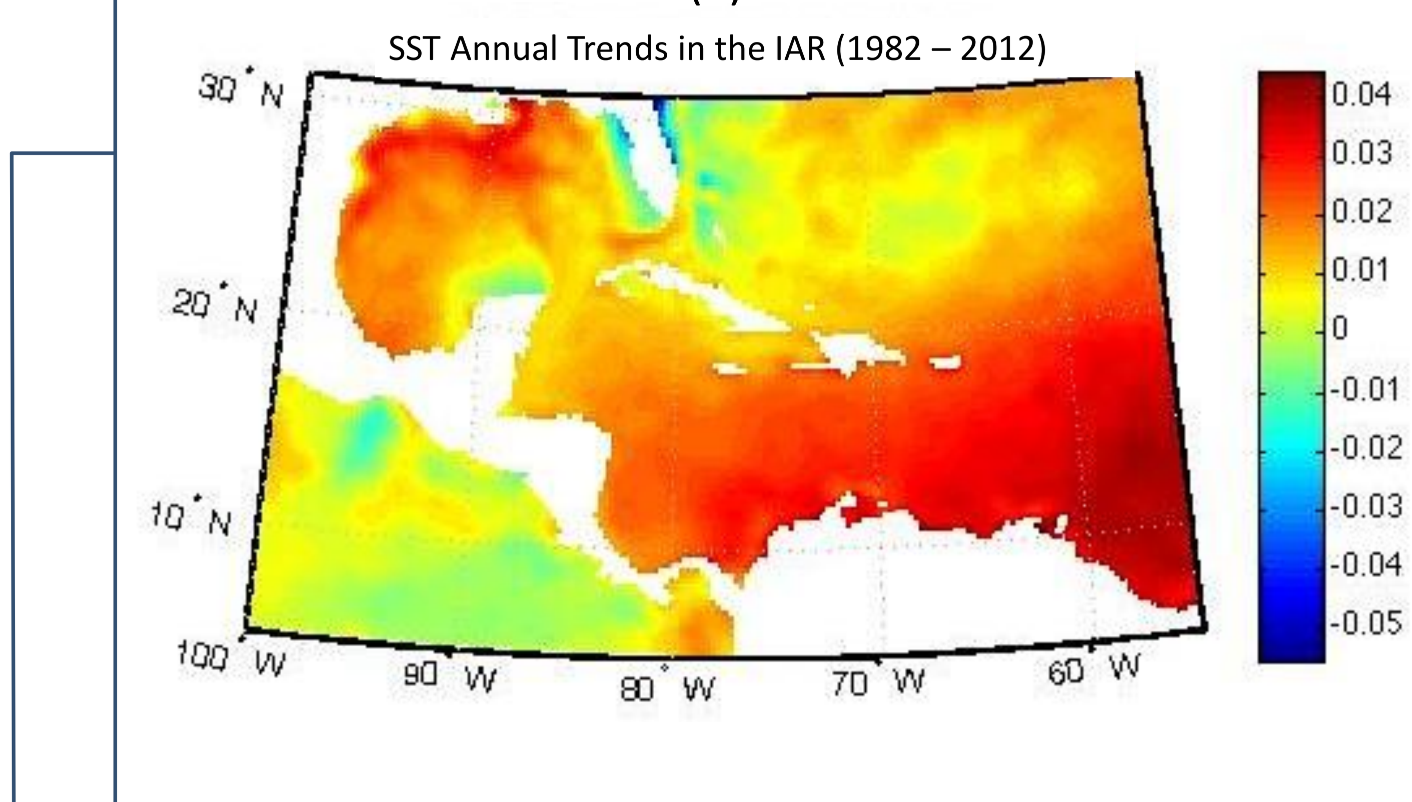
Daniel Comarazamy, PhD
NOAA/NESDIS/STAR/SOCD
University of Maryland, College Park

Tom Smith, PhD
NOAA/STAR/SCSB and CICS/ESSIC
University of Maryland, College Park

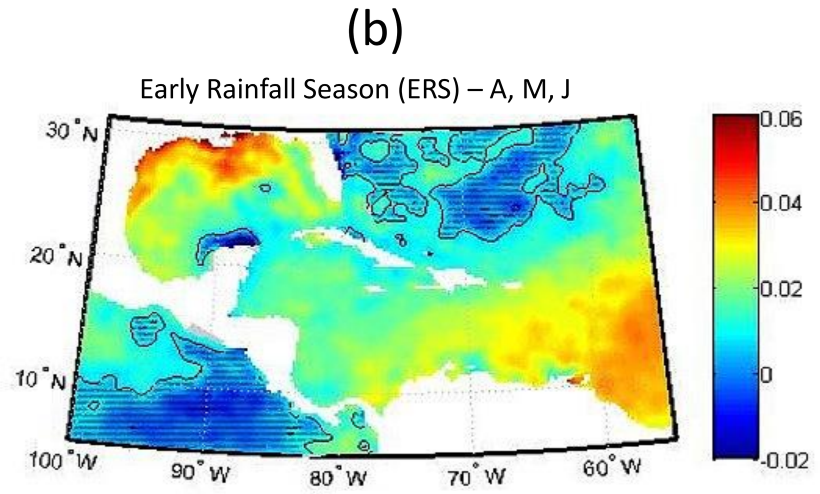
Abstract

We report a recent sea surface temperature (SST) warming trend occurring in the Intra-Americas Region (IAR) over the 1982 – 2012 period. The IAR, defined as the geographical region that includes the Caribbean, Mexico, Central America and parts of North and South America, is a distinctive region of dynamic climatological phenomena that is particularly sensitive to climate changes.[1] Using an optimum interpolated SST (OISST), 0.25° resolution data product of the National Oceanic and Atmospheric Administration (NOAA), a 30-year climatological analysis was generated to observe annual, monthly, and seasonal trends.[2] Results show that SSTs are increasing annually for the region at a rate of approximately 0.015°C year^{-1}. For the two Caribbean rainy seasons, the Early Rainfall Season (ERS) and the Late Rainfall Season (LRS), estimated trends at 0.0161°C year^{-1} and 0.0209°C year^{-1} were observed, with high statistical significance.[3] Sub-regional gridded analysis revealed that warming is greatest in the Gulf of Mexico and North of South America during the ERS and LRS, also with high statistical significance. Additionally, LRS averages for 1998-2012 reflect an increase in magnitude and intensity of the Atlantic Warm Pool (AWP) since the 1983-1997 period reflected in the AWP Area Index. The AWP Area Index, the region with temperatures above the threshold of 28.5°C, shows a clear expansion of close to twice its size over this 1998 – 2012 period. Extreme increases/decreases in time series show potential correlation with El Niño and the Southern Oscillation (ENSO) while in the El Niño (positive) phase.

(a)



(b)



(c)

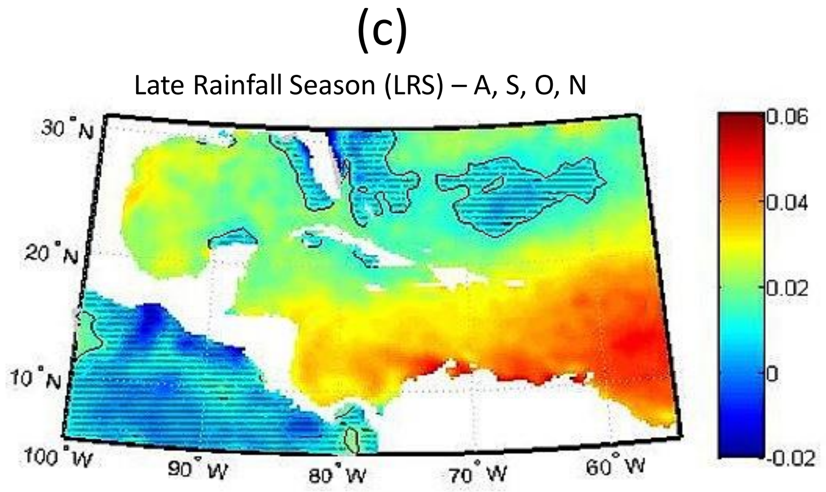


Figure 1. a) Per grid SST slopes (trends) per year with all seasons included, b) per grid SST slopes (trends) per year for the Early Rainfall Season (ERS), c) per grid SST slopes (trends) per year for the Late Rainfall Season (LRS) for the 1982-2012 period. The color bar represents °C year^{-1} and hatch lines indicate values that were not determined to be significant.

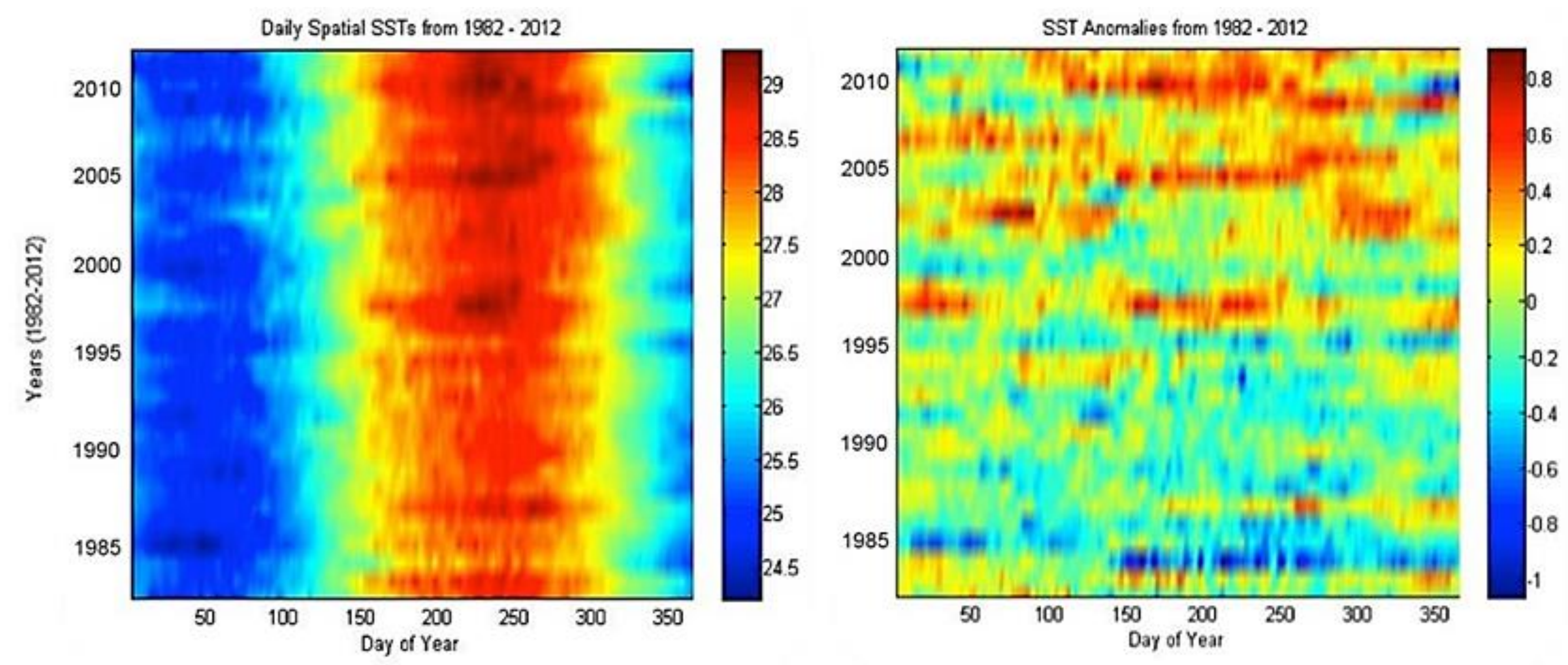


Figure 2. Results of the spatial SST analysis for daily SSTs (left) and the daily SSTs anomalies (right). The x-axis represents Julian days and the y-axis represents the years 1982-2012. The colorbar is SSTs in degrees Celsius. The daily anomalies were produced by using the daily climatology for the period (1982-2012).

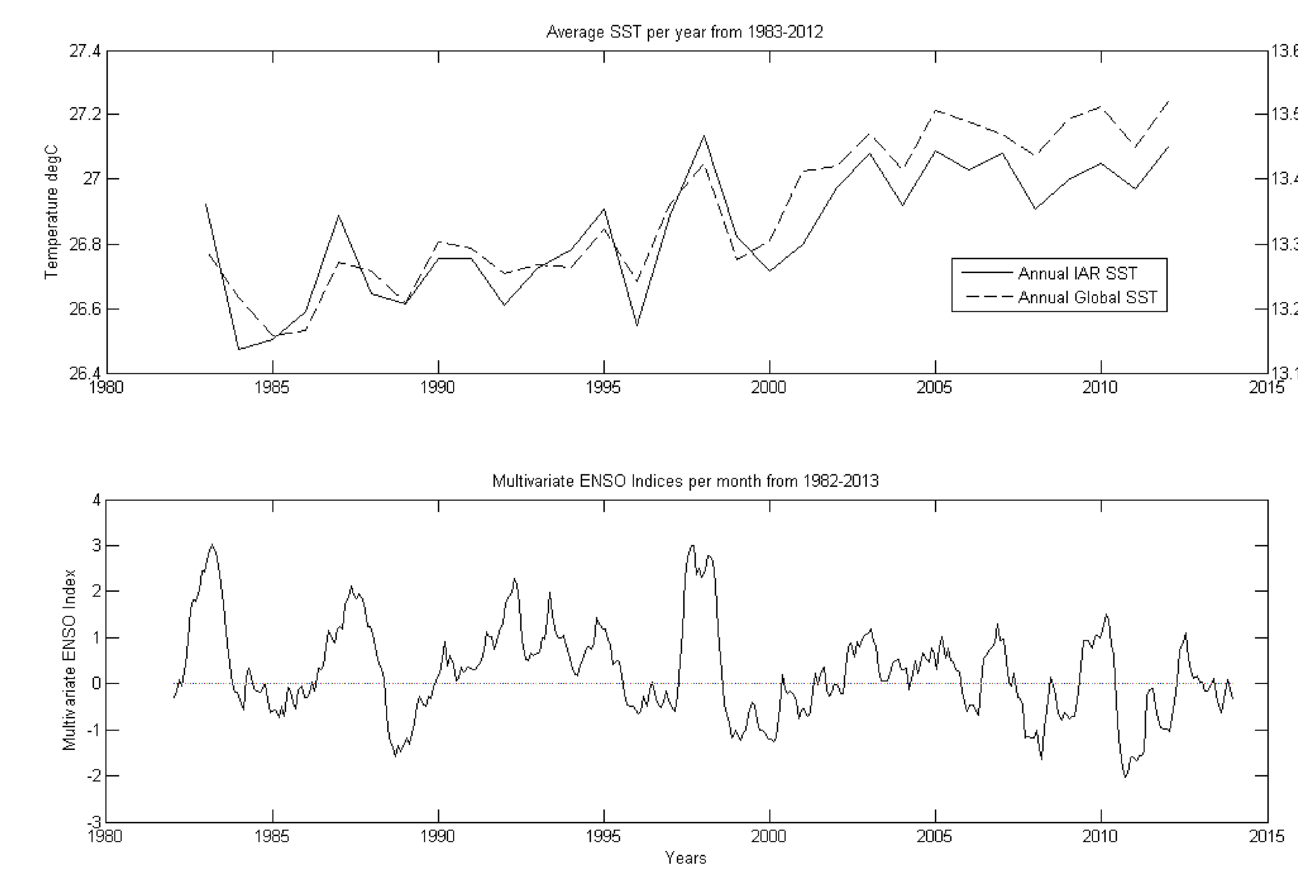


Figure 3. Annual SST trend analysis results for the years 1982-2012 for the Intra-Americas Region: (top) global annual average SSTs, Intra-Americas Region regional annual SSTs and (bottom) monthly Multivariate ENSO Index. For the top figure, SSTs for the IAR are on the left y-axis and global SSTs are represented by the values on the right y-axis.

Methodology

The SST analysis for this study was conducted on both a regional (spatial-average) basis and a per-grid basis using NOAA's Optimum interpolate sea surface temperature product (OISST). The regional analysis includes the estimation of annual, monthly (not shown), and seasonal trends (slopes) and the per-grid analysis includes estimations of annual and seasonal trends. The linear statistical significance (p-value) of each of these trends was calculated. Trend values were determined to be statistically significant if the calculated p-value was less than 0.025. The degree of change (slope) and the significance (p-value) were determined using a linear regression analysis and a two-tailed t-test, respectively. For this study, the February 29th leap year days were excluded (a total of 8 leap year days).

Hypothesis

The SSTA-driven Atlantic Warm Pool (AWP), The Caribbean Low Level Jet (CLLJ) and other regional and global phenomena, such as ENSO, play a key role in controlling and modulating local climate changes that are affecting specific sensitive ecosystems.

Data Description

Product	Source	Mode of Retrieval	Availability	Resolution	Time Range
OISST (Optimum Interpolation SST)	NOAA NCDC (National Climatic Data Center)	○ Buoy Data ○ Ship Data ○ Advanced Very High Resolution Radiometer (AVHRR) Satellite Data ○ Sea Ice Data	Daily	0.25°	1982-2012

Results

IAR is a significant region of various climate activity and variability:

- SSTs and air temperatures show **statistically significant regional and local warming** trends within the IAR – annually and per season.
- OISST data can be used to detect the Atlantic Warm Pool (AWP) variability and intensity (Fig. 4); AWP has significantly increased in size over the 1982-2012 period.
- Cross-correlations analysis shows significant correlations between warming Caribbean SSTs and precipitation in areas experiencing the greatest warming.

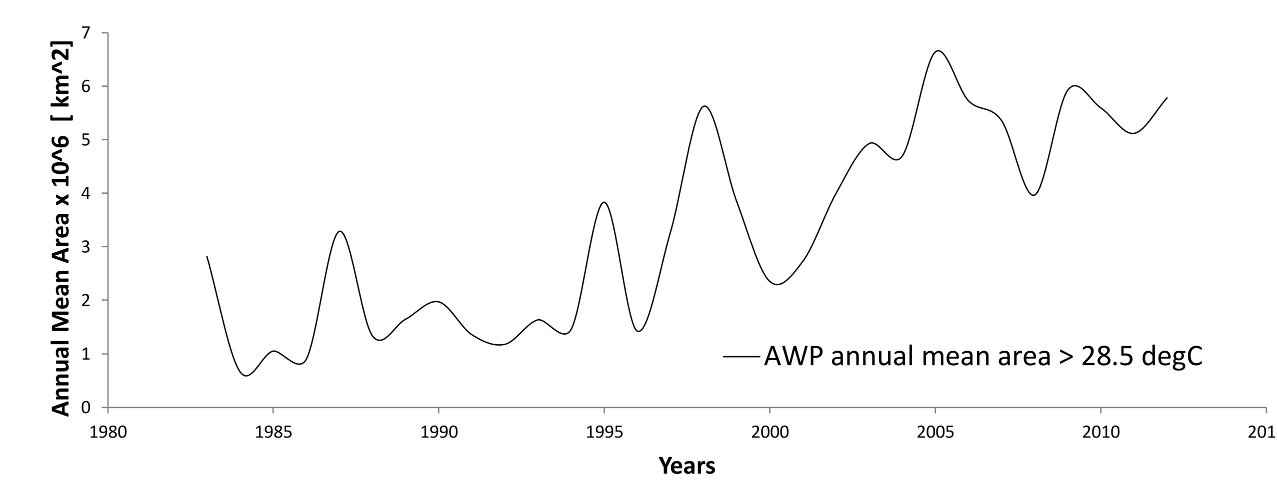


Figure 4. Atlantic Warm Pool Area Index time series for the Intra-Americas Region (Lat: 5N – 30N, Lon: 100W – 55W).

Future Work

- Precipitation analysis for the same time period 1982-2012
- Upper atmosphere analysis using NCEP large gridded datasets to detect possible changes in the Caribbean Low-Level Jet (CLLJ)

References

1) Intergovernmental Panel on Climate Change (2007), Climate Change 2007: Synthesis Report. Working Group I, II and III contributions to the Fourth Assessment Report. http://www.ipcc.ch.
2) Reynolds, R. W., T. M. Smith, C. Liu, D. B. Chelton, K. S. Casey and M. G. Schlax, (2007), Daily high-resolution blended analyses for sea surface temperature. *J. Climate*, **20**, 5473-5496.
3) Glenn, E., D. Comarazamy, J. E. González, and T. Smith (2015), Detection of recent regional sea surface temperature warming in the Caribbean and surrounding region, Geophys. Res. Lett., 42, doi:10.1002/2015GL065002.

Acknowledgements

This research and poster was made possible by the National Oceanic and Atmospheric Administration (NOAA), Office of Education Partnership Program award NA11SEC4810004 and by the US Department of Education – Earth Science and Environmental Sustainability (ESES) Graduate Initiative, award P031M105066. Its contents are solely the responsibility of the award recipient and do not necessarily represent the official views of the U.S. Department of Commerce, NOAA or the US. Department of Education.