Gulf Stream Sea Surface Temperature Shift

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Abstract

Sea surface temperatures (SST) of the Gulf Stream change enormously on year to year basis. In this study, however, I investigated the trends and temperature shifts over a 20-year period determining if a clear shift is evident in this particular current. I found no significant trends, but I did find several interesting results. I used ArcGIS to gather and analyze data from NOAA’s satellite (AVHRR) and developed an Ordinarily Least Squares regression model comparing a monthly average over 20 years, to determine if the temperature shifts over time were not random. I was able to isolate slopes with significant P-values (P < .05) and determine a trend of those significant values.

Introduction

Gulf Stream shifts have a profound impact on the weather throughout the North Atlantic and surrounding land. The warm water, carried north from the tropics, carries warm air north, severely influencing weather generated in the troposphere. Slight shifts in this massive ocean current have more effect on the weather and climate than previously thought (Blackmon, 1993). As technology improves and satellites and radiometers become more accurate, and real time sea surface temperatures become easier to measure and shifts become more apparent. As one of the most widely studied variables in oceanography, SST accuracy is an improvement for understanding climate change and weather patterns, so it was crucial to obtain reliable, organized data from NOAA’s very high resolution radiometer (Emery, 2001).

Methods

I used ArcGIS 10 to import data from NOAA’s Pathfinder server and when trends did not seem apparent from year to year, I used R-Script to perform an Ordinarily Least Squares regression on 20 monthly averages. This consisted of gathering data from individual pixels from 1986-2006, deriving the slopes of change by graphing them, then computing a best fit line. (see figure C(ii))

I determined which pixels had a 95% probability of not being random (P < .05), creating a refined map of only significant slopes. From here, I isolated what percent of the significant slopes were positive and negative.

Results

Initially, no correlation existed for the slopes of individual pixels over the 20 year period (Figure A), but the regression analysis revealed a trend among the significant slopes. In Figure B, several pockets of significant slopes are evident throughout the North Atlantic. I calculated which areas had positive and negative slopes. Figure D shows the positive and negative slopes of only the significant slopes. The graphs above show the temperatures of individual pixels over a 20 year period taken from areas of high and low slopes. Figure C(ii) shows positive slopes (increasing temperature) and Figure C(i) shows negative slopes (decreasing temperature).

Figure X

The graphs above show the temperatures of individual pixels over a 20 year period taken from areas of high and low slopes. Figure C(ii) shows positive slopes (increasing temperature) and Figure C(i) shows negative slopes (decreasing temperature).

Discussion

The Advanced Very High Resolution Radiometer measures the earth in 5 wide spectral bands and is able to gather Sea Surface temperature around the world. AVHRR uses thermal infrared remote sensing to measure the “skin SST” at a depth of 10 μm (Maurer, 2002). Figure E (below) shows how sea surface temperature represents such a small amount of the ocean temperatures.

Figure E

There has been significant research on documenting the accuracy of the AVHRR due to its sensitivity regarding water vapor and the effect on results. Technology currently exploring ways to improve this problem involve algorithms compensating for the error, but buoys and ships gathering data still remain the most accurate way to compare and confirm temperature trends. (Vasquez, 1998)

The variation in technology over time can be difficult to navigate around, especially when discussing monthly averages. Water vapor from one day can skew a monthly average significantly, thus compromising the integrity of the study. The AVHRR’s improved sensitivity makes the daily SST readings extremely accurate and useful for real time endeavors and weather predictions, but computing trends in such a rapidly changing environment is less accurate. More data and analysis is needed to validate the results in this study because there are many variables unaccounted for.

Conclusion

The results indicate a general increase in Sea Surface Temperature of the waters surrounding the Gulf Stream, especially in Northern areas. In a similar, but more extensive study performed by NOAA which released in April 2013, indicates ocean temperatures off the northeast coast in 2012 were the warmest they’ve been in 150 years, suggesting the changes in the Gulf Stream represent more than simply shifting weather trends (NASA 2013).

References

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In Figure B above, the pockets of turquoise represent a high P-value, meaning a high probability of the information having significant trends. In Figure A (above) positive slopes represent pockets where temperature generally increased over time (shown in orange) while negative slopes represent where temperature generally decreased.