Multi-temporal patterns of Surface Temperature Variability in the South China Sea: a perfect reflection of global ocean-climatic variability cycles?

Anthony Banyouko Ndah (Ph.D.)
Universiti Brunei Darussalam

Abstract

- Met Office Hadley Centre's (HadISST1) Surface temperature data from 1870-2014 has been analysed for the South China Sea (SCS) using a number of complementary statistical techniques
- The aim is to attempt to uncover multiple patterns of variability embedded in the SST Record that go beyond just the seasonal and linear trends.

Introduction

The ocean and climate are intricately connected and operate via multiple coupled oscillatory patterns. However, in reality the current perception and approach to temperature/climate change is largely biased towards the seasonal pattern (Fig. 1) and the long term trend or linear change. This perception is seen here as a major hindrance to understanding ocean-climatic changes as well as long term prediction.

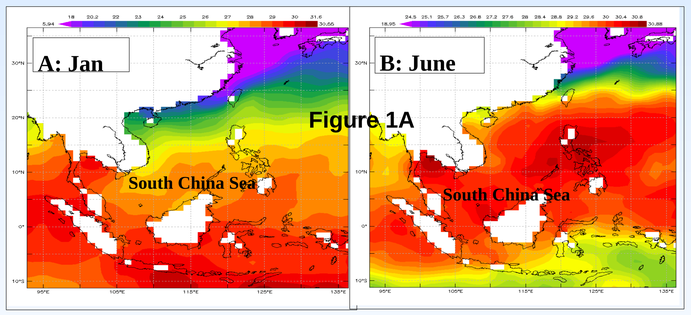


Figure 1A

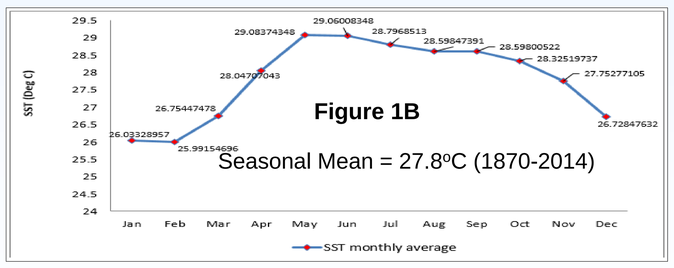


Figure 1B

Seasonal Mean = 27.8ºC (1870-2014)

Methods

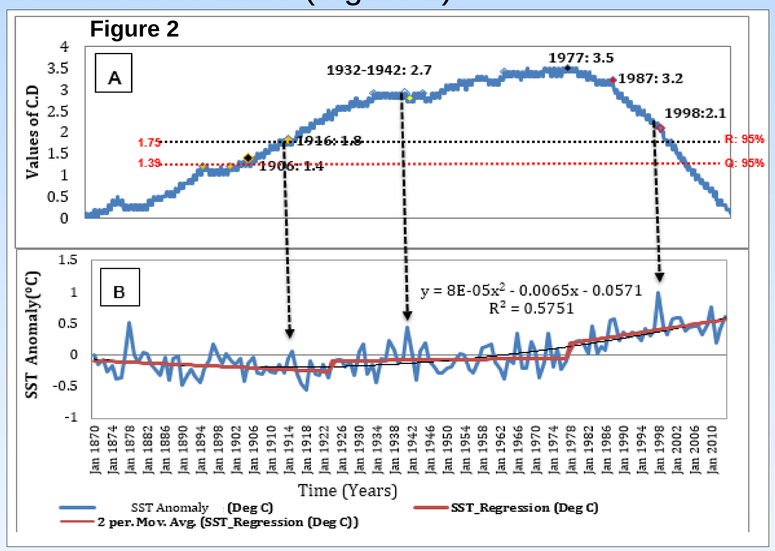
Five complementary methods are used including: Spectral Analysis; Regression; Low Pass Filter; Cumulative Deviations Test and Standard Normal Heterogeneity Test (SNHT)

Results: Patterns of SST Variability

- Seasonal patterns
- Long term trend
- Decadal/Multi-decadal patterns and Hiatus
- Inter-annual Patterns

Results 1: *Long term variability Patterns*

In the long term, there has been a weak positive change of SST. The amount of change (mean) is 0.003ºC. Almost all of the change occurred between 1900-1998. Much of the change however occurred between 1950-1998 (Figure 2)



Graph depicting results of the C.D Test (A) and Step-wise regression analysis (B)

Results 2: *Decadal / Multi-decadal & Hiatus*

- Decadal/multi-decadal patterns characterize the long term trend of SST corresponding with PDO (Fig 3)
- 8 Decadal patterns between 1870 and 1953 are characterized by negative anomalies
- The Multi-decadal trend running from 1954-1998 is the warmest period since 1870
- This period is further characterized by decadal Patterns of varying warming intensities; The warmest decade runs from 1987-1998 (0.42ºC)
- Two major hiatus periods with no obvious change in the trend of SST run from 1953-1976, and 1999-2014

Figure 3: Relationship between SST, PDO and NINO Index in the spectral domain

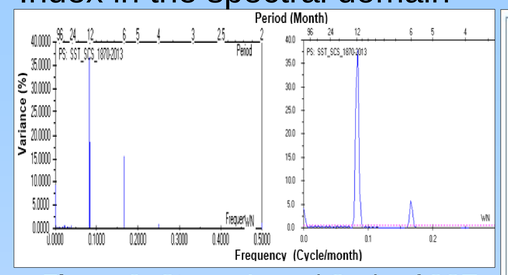


Figure 3: *Strong Annual Cycle of SST and weak semi-annual cycle*

- Spectral Analysis of monthly SST data reveals a strong annual and weaker semi annual cycle at frequencies of 0.08 and 0.17cycles/month respectively (Figure 3)
- Analysis based on the annual running mean of SST in the spectral domain also reveals four low frequency signals at 3.65 years, 46 years, 57.5 years and 76.5 years (Figure 4 A), corresponding with similar cycles of PDO and ENSO (Figure 4 B and C).

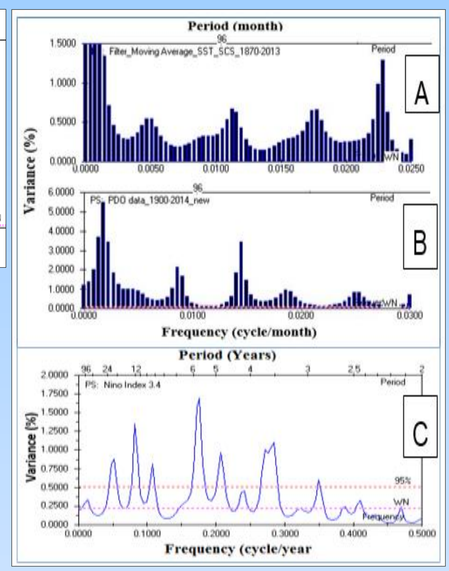
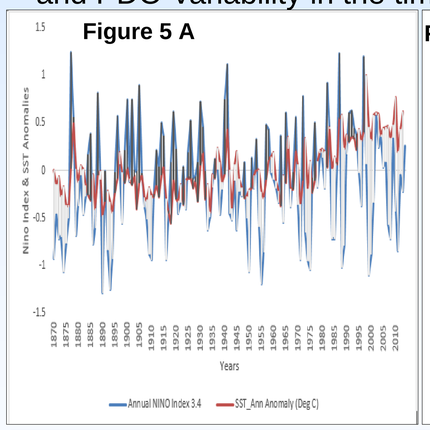
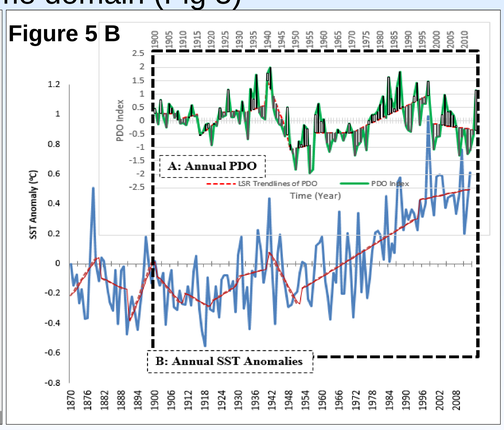


Figure 4: Inter-annual and decadal cycles of SST, PDO and NINO Index

Results 3: *Relationship between SST, PDO and ENSO in the time domain*

- Prominent Inter-annual and Decadal patterns of SST are in the SST are also seen to correspond with patterns El Nino/La Nina and PDO Variability in the time domain (Fig 5)





Conclusion

- SST is the most important indicator of ocean-atmosphere variability and predictability
- However, a good understanding of drivers of multi-temporal variability patterns is a central issue
- Advances in SRS/technology provide an opportunity for improved measurements of SST as well as at greater depth but historical reconstructions remain an invaluable resource