Assessing the spatiotemporal variability of Sea Surface Temperature in Delaware Bay, USA, Using the GHRSST Data Product

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1 Introduction

- The aim of this study is to assess the spatial and temporal variability of Sea Surface Temperature (SST) in Delaware Bay, USA during the period between 2003 and 2020 (fig.1).
- SST is a strong indicator of the interaction between oceans, seas, and the atmosphere that can be employed to understand the variation of the different components in the marine environment.
- Studies of SST variation are essential to understanding the response of the bay's environmental and ecological system to climate variability.

2 Material & Methods

- Two datasets consisting of in-situ daily SSTs from six stations operated by the National Data Buoy Center and a 17-year GHRSST dataset of 0.01° × 0.01° spatial resolution are employed.
- GHRSST data were evaluated against long-term in situ measurements using statistical methods.
- Non-parametric trend analysis and a change point detection method were used to assess the temporal variability of daily and annual mean SST.
- The correlation between SST and climate oscillations (ENSO, NAO, AMO, and WHWP) was examined for different lag times.
- The correlation between SST anomalies and streamflow temperature anomalies was analyzed for different lag times.

3 Comparison of In-situ and GHRSST Data

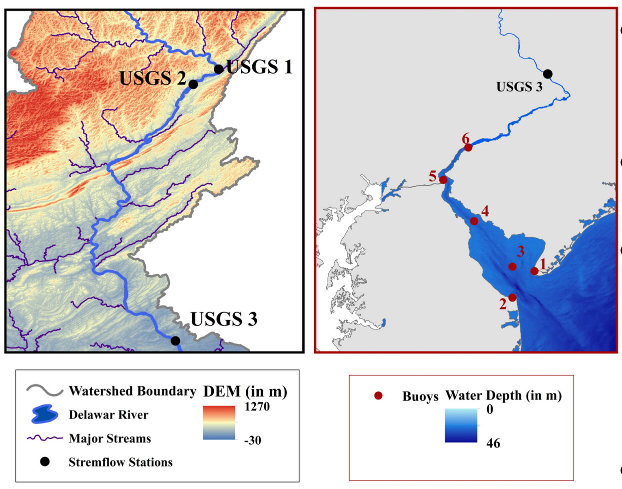

Fig.1 Locations of the buoys in Delaware Bay and streamflow gauging station

- GHRSST and in situ data were found in good agreement with average KGE = 0.97, R = 0.99, and RMSE in the range of 0.33 to 0.63 °C.
- GHRSST data showed higher bias values when compared to buoys located closer to the river mouth.
- The annual mean, minimum, and maximum SST time series derived from GHRSST data and in situ measurements exhibited similar statistical characteristics in terms of arithmetic average, skewness, and standard deviation.
- Both GHRSST and in situ data have shown bimodal behavior, with the summer season being longer than the winter season.

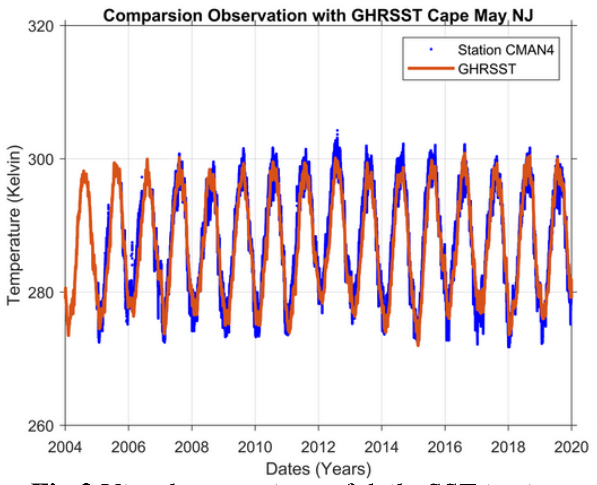

Fig.2 Visual comparison of daily SST in situ measurement and GHRSST data at selected locations

4 SST Variability analysis

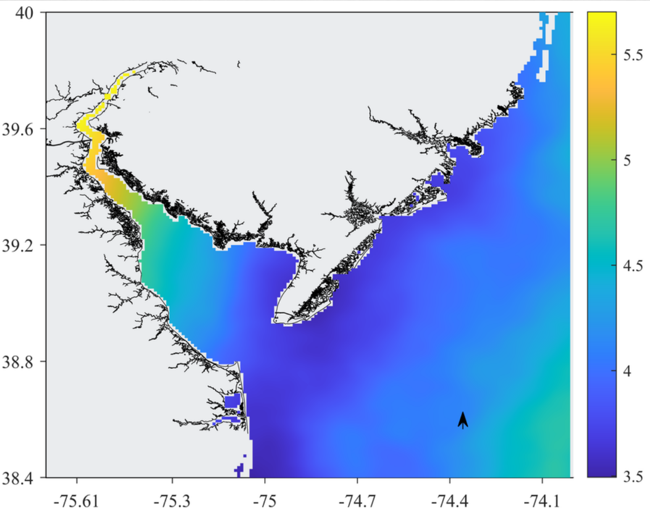

Fig.3 Modified Mann-Kendall test results

- The MMK test results revealed a statistically significant upward trend in the SST daily series with higher Z-values in the upper estuary (fluvial) (fig 3).
- The annual SST increased by 0.14, 0.08, and 0.04°C/year in the upper, middle, and lower (marine) portions of the estuary, respectively.
- The 95th percentile SSTs increased by 0.18, 0.12, and 0.06°C/year in the upper, middle, and lower portions of the estuary, respectively.
- The 5th percentile SSTs increased by 0.1, 0.06, and 0.08°C/year in the upper, middle, and lower portions of the estuary, respectively.
- The results of the Pettitt test revealed significant change points in the SST daily series in 2011, 2015, and 2011 in the upper, middle, and lower portions of the estuary, respectively.

5 Relation of SST Variability to Streamflow Temperature and Climate Indices

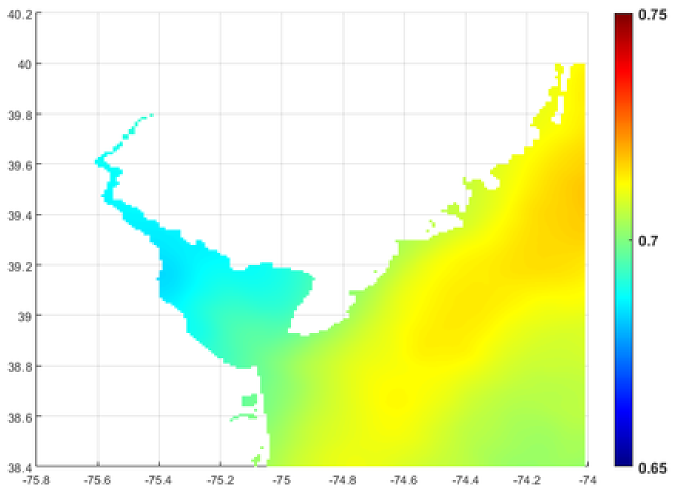

Fig.3 Correlation results between SST and WHWP

- In the fluvial part of the estuary, there is a strong correlation between streamflow temperature anomalies and SST anomalies with R values between 0.62 and 0.74.
- In the middle and lower parts of the estuary, the correlation between streamflow temperature anomalies and SST anomalies decreased with R less than 0.4.
- The strongest correlation between streamflow temperature anomalies and SST anomalies was observed during the winter season when the mixed layer deepened.
- The results of teleconnections with climate indices indicated that the variability in SST patterns was significantly influenced by the Western Hemisphere Warm Pool (WHWP) (fig. 4) and the North Atlantic Oscillation (NAO) indices at lag 0 and lag 1 month, respectively.

6 Conclusion

- In the different parts of the estuary, there is a significant positive trend rate of daily mean, annual mean, 95th percentile, and 5th percentile SSTs. The estuary ecosystem may be adversely affected by the increasing SST slopes.
- The teleconnection patterns associated with SST variability in the study area revealed that the positive ocean-atmosphere feedback in the eastern North Pacific to the Gulf of Mexico and the Caribbean is responsible for the warming and cooling variability in SST.

7 References

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