Observing Marine Heatwaves in the Chesapeake Bay with Satellite Sea Surface Temperature

Photo credit:
Max Shein via Upsplash

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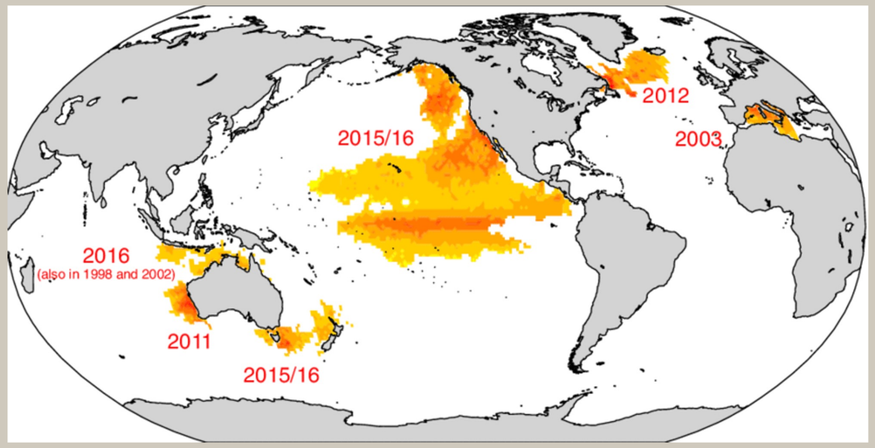
Marine heatwaves have impacts globally, including the Chesapeake Bay



Frölicher & Laufkötter (2018) Nature

Oliver, et al. (2019) Front. Mar. Sci.

Globally

INCREASE IN FREQUENCY

and a significant increase in intensity over the period from 1925-2016.

2x

A trend projected to continue through the 21st century.

Ecological impacts of marine heatwaves include:

- ↓ diminished growth rate
- ↓ reduced reproductive output
- ↑↓ altered population structure

Chesapeake Bay - 2005 Event

DECREASE IN SEAGRASS

Z. marina loss during the 2005 marine heatwave

>50%

3

COMMERCIAL FISH SPECIES

Populations declined as an indirect result of decrease in seagrass meadows

Smith, et al. (2023) Annu. Rev. Mar. Sci.

What is a marine heatwave?

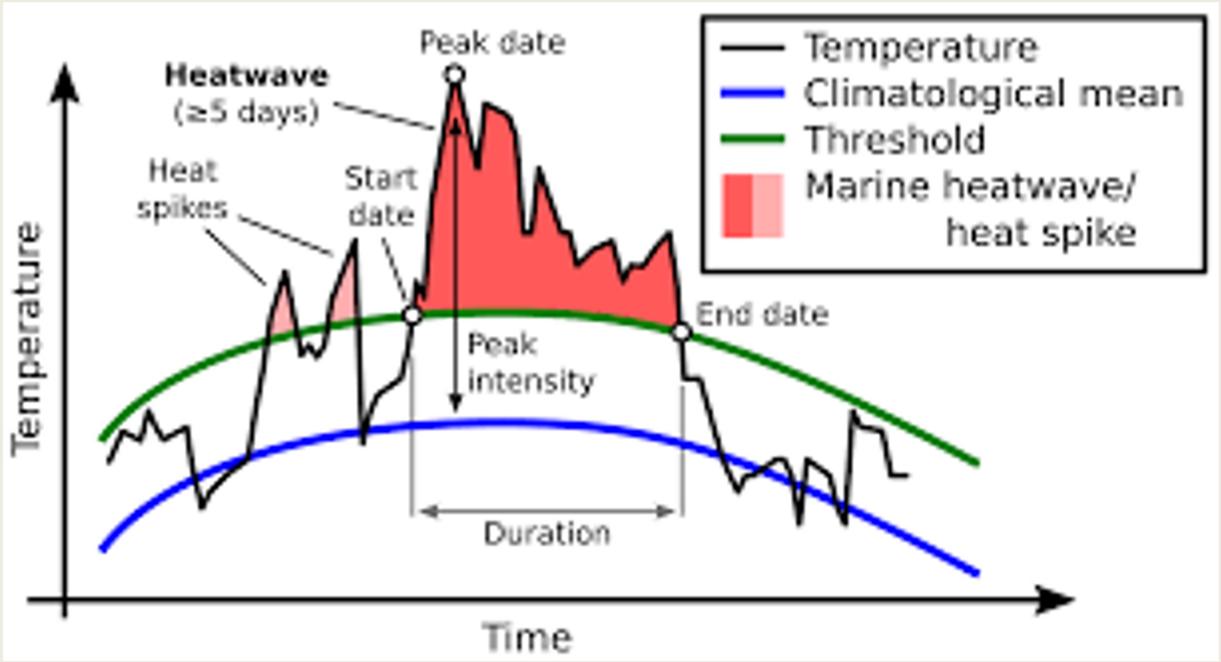
Marine heatwave = very hot water

How hot is "hot"?

90th percentile value, defined from a baseline climatology

How long is a "wave"?

At least 5 consecutive days



Hobday, et al. (2016) Progress in Oceanography

http://www.marineheatwaves.org/

Can we use satellite data to look at marine heatwaves in the Chesapeake Bay?

NASA MUR SST

- 1km spatial resolution
- Time window: 2002 - present
- Gap-filled

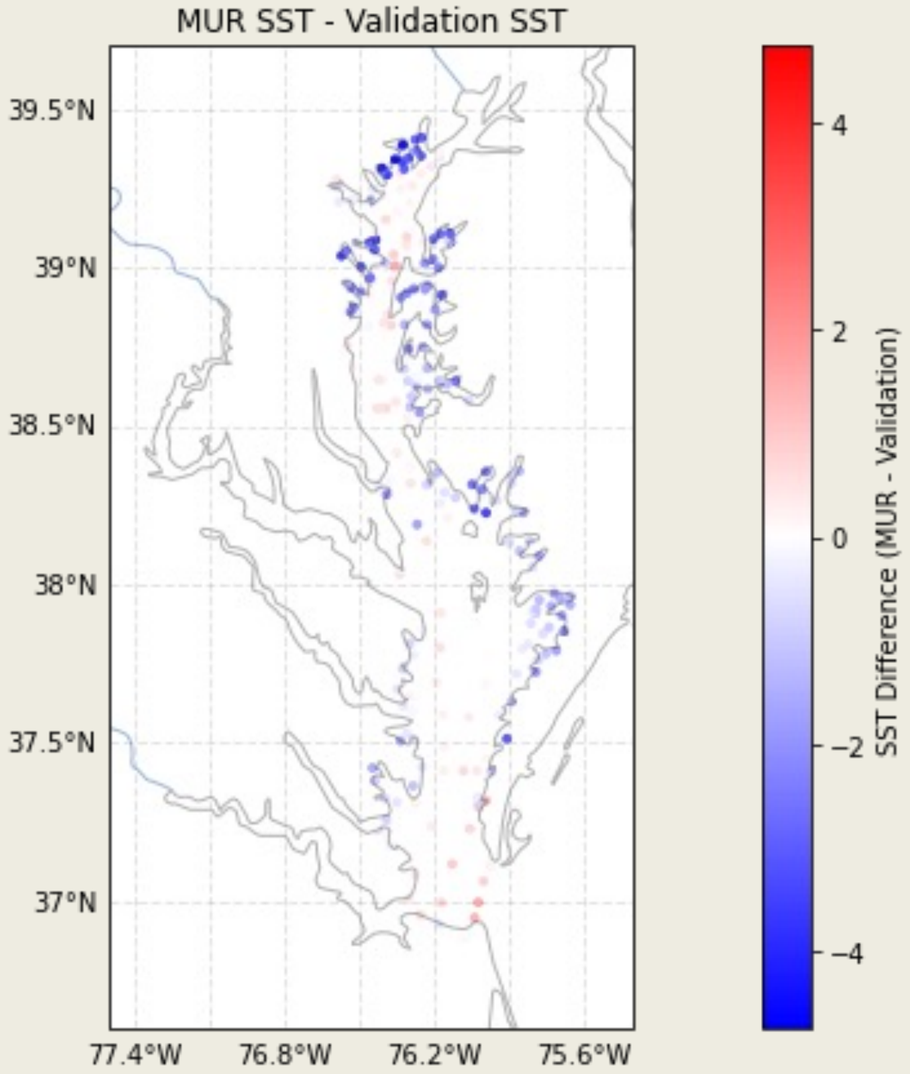
NOAA Geo-polar Blended SST

- 5km spatial resolution
- Time window: 2002 - present
- Gap-filled

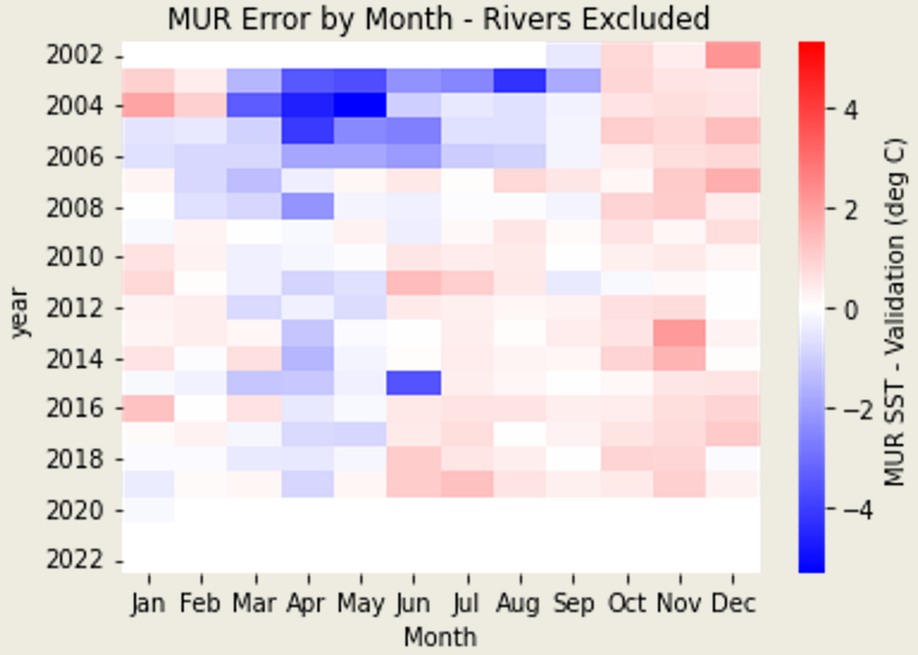
MUR SST shows a long term time bias

Validation data comes from the Chesapeake Bay Monitoring Program

Chesapeake Bay Program
Science. Restoration. Partnership.



Satellite	RMSE	Slope	R^2
MUR	2.06	0.969	0.935



Types of bias to consider:

- mean bias
- long term time bias
- seasonal bias
- spatial bias

Geopolar SST performs better than MUR

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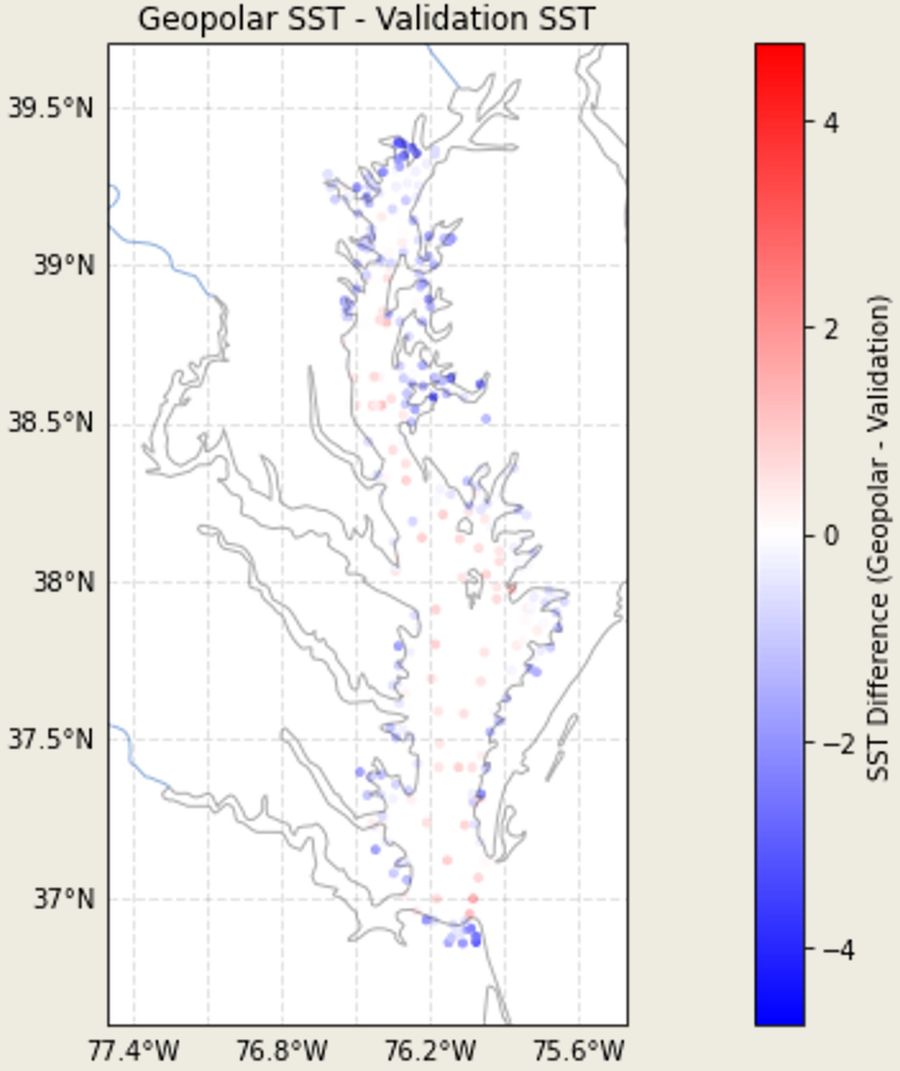
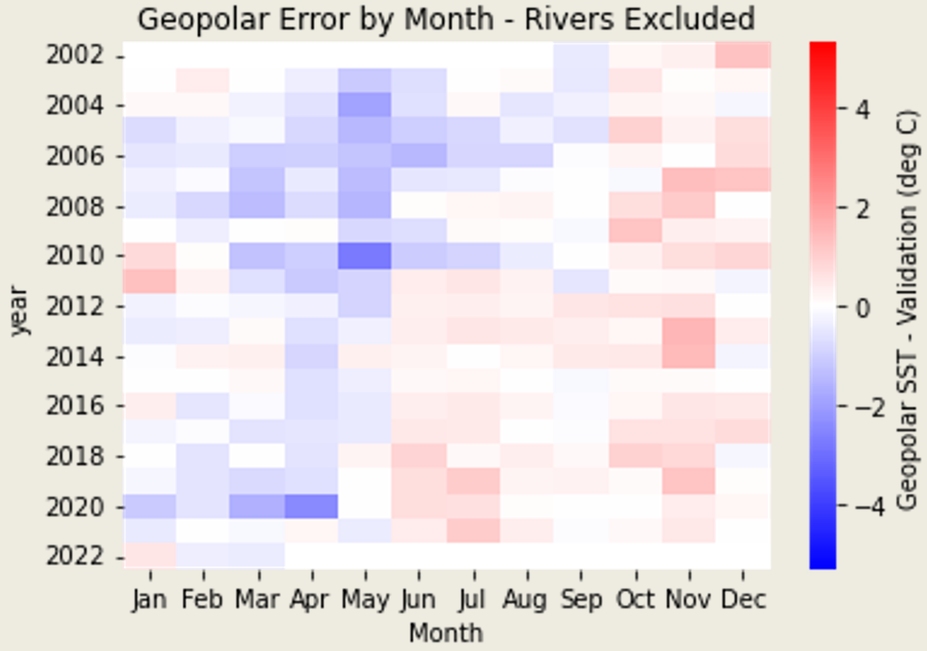


Satellite	RMSE	Slope	R^2
Geopolar	1.64	0.974	0.958



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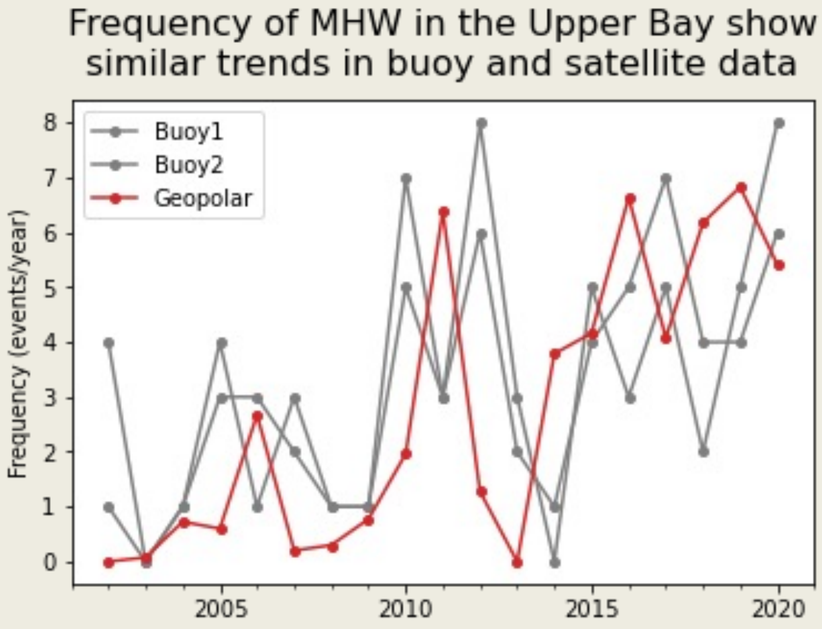
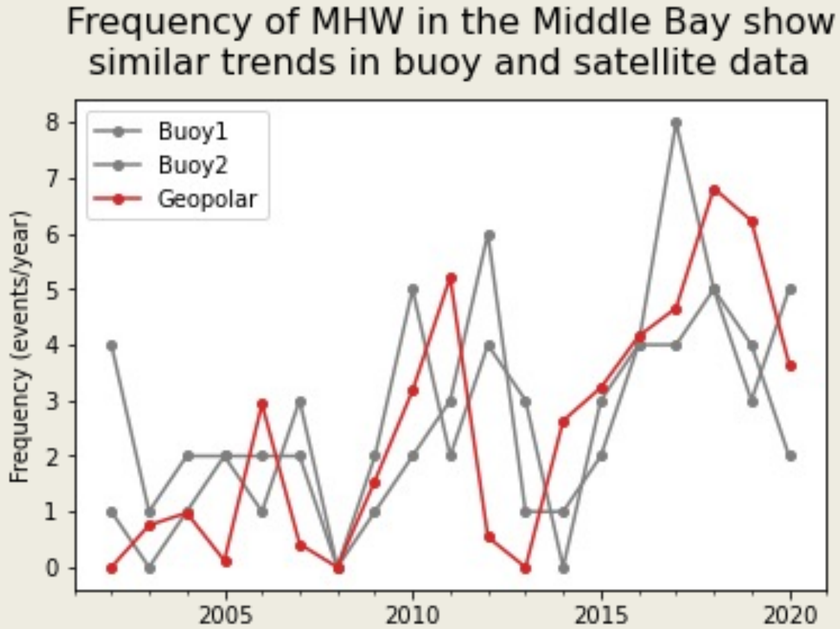
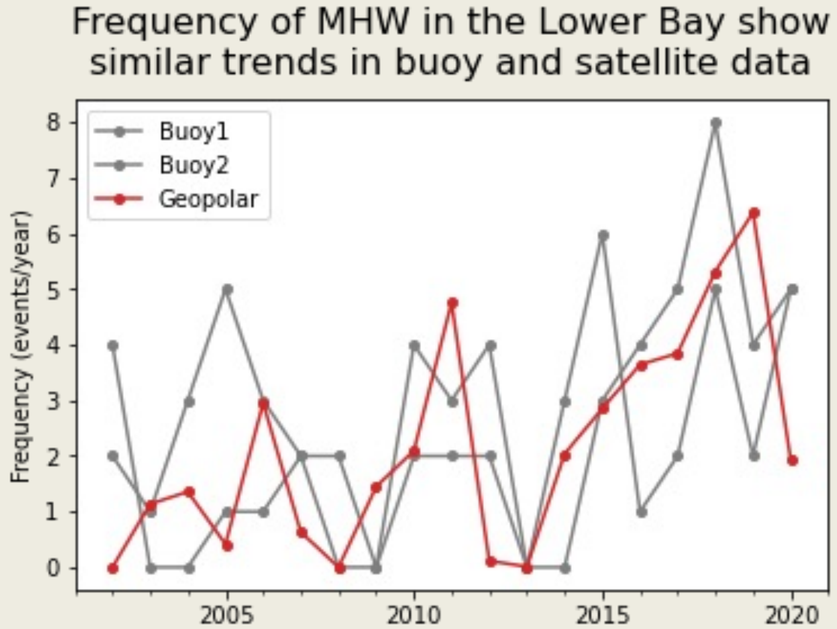
MUR SST

Geopolar Blended SST

Satellite SST analysis agrees with existing work using buoys

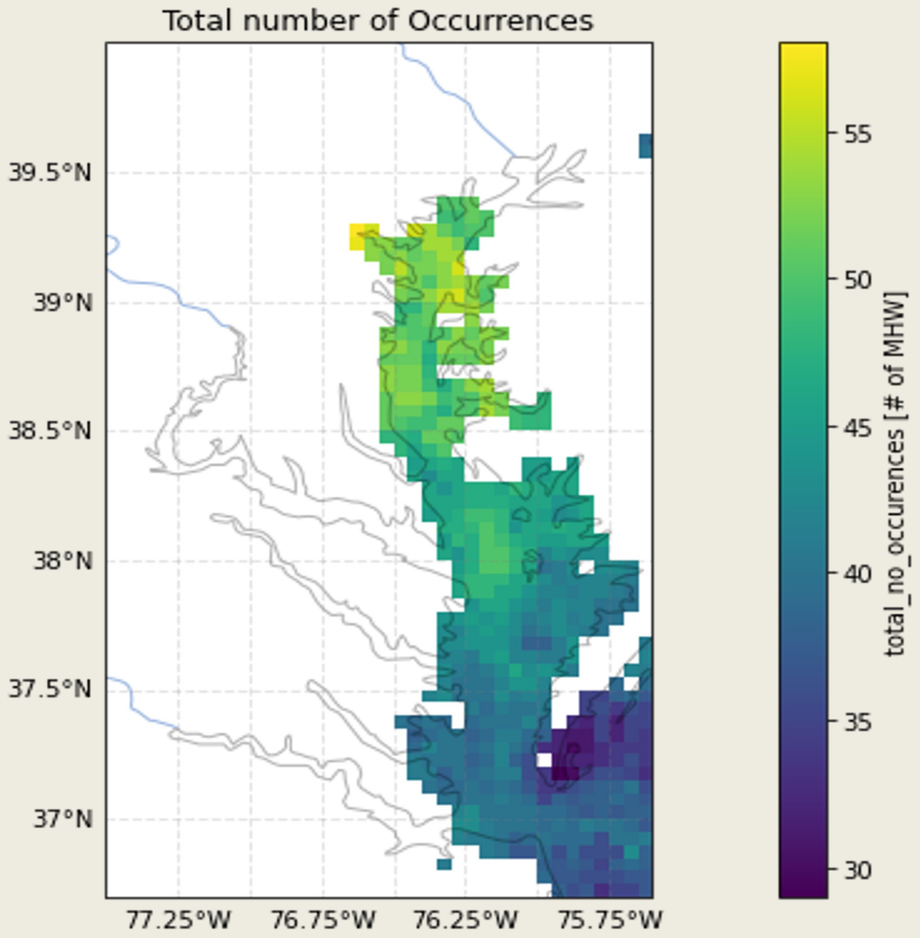


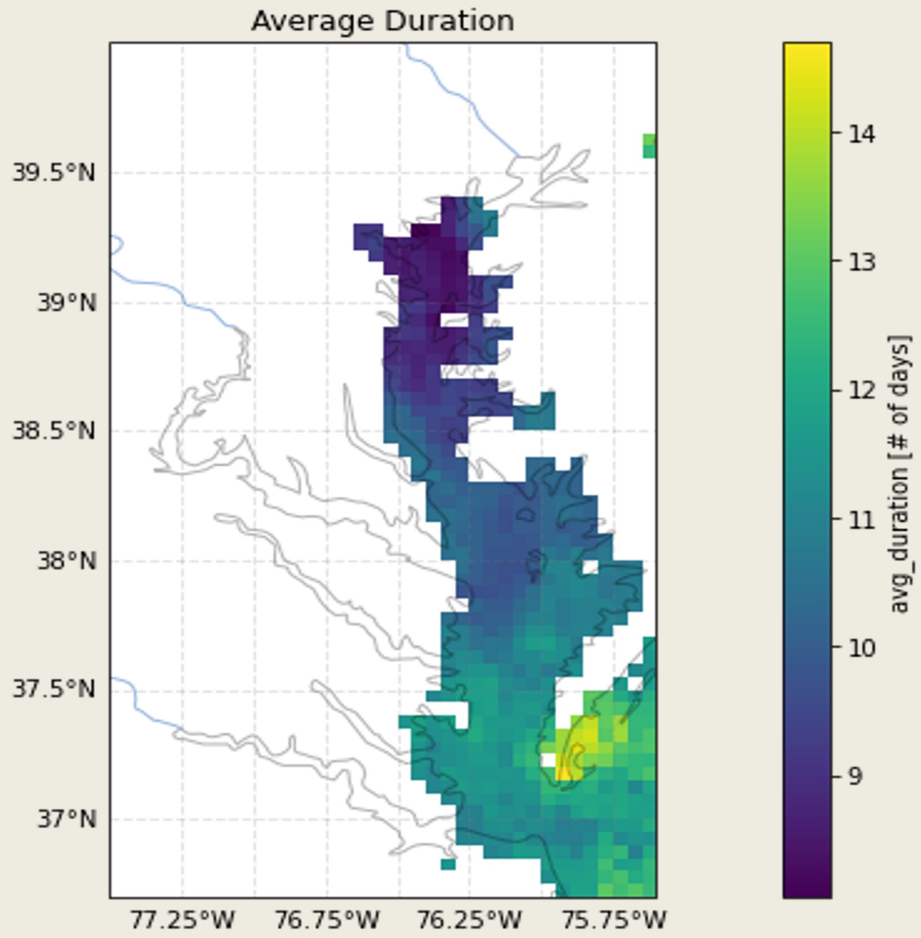




Comparing results to: Mazinni & Pianca (2022) Frontiers in Marine Science

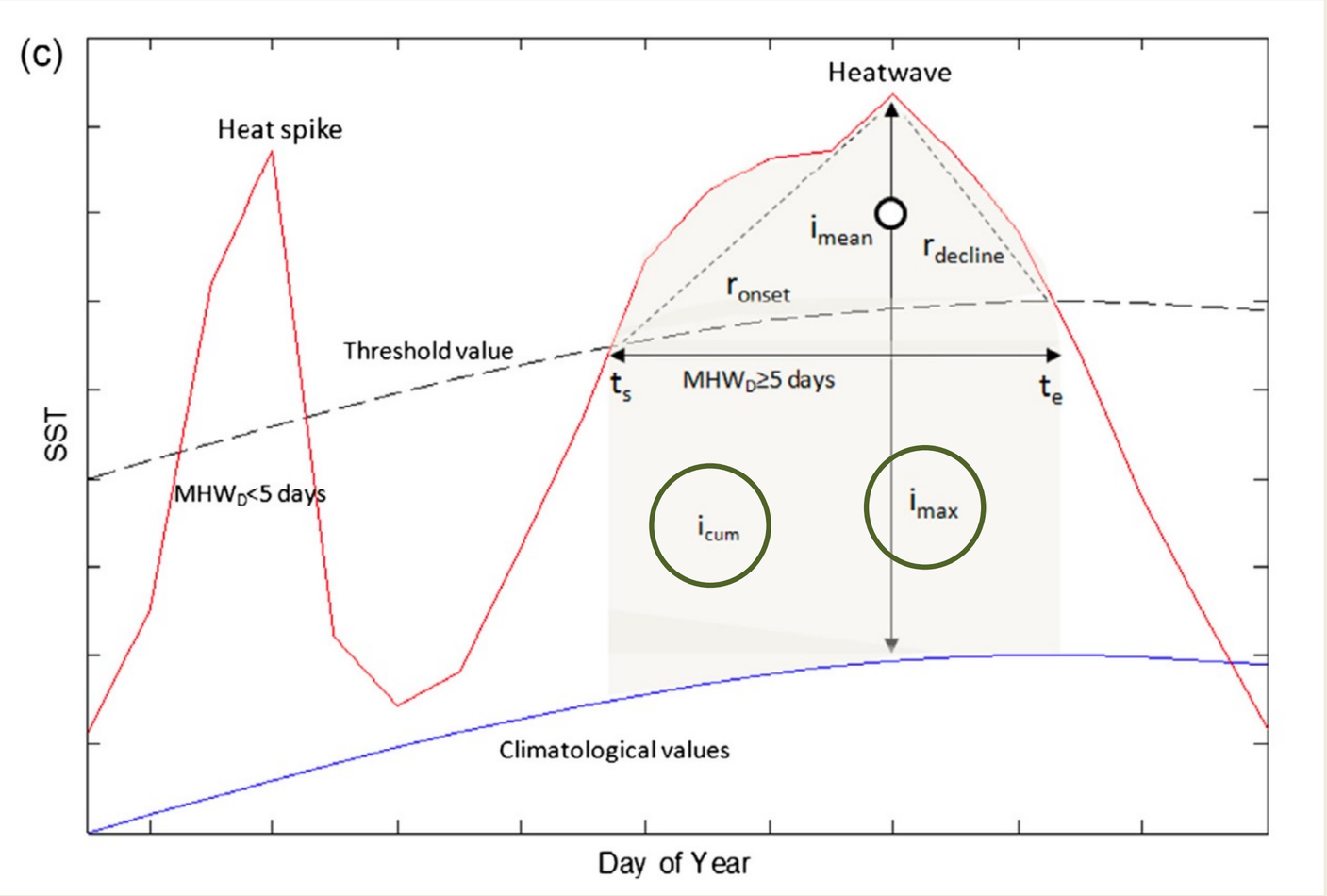
Marine heatwave characteristics maps





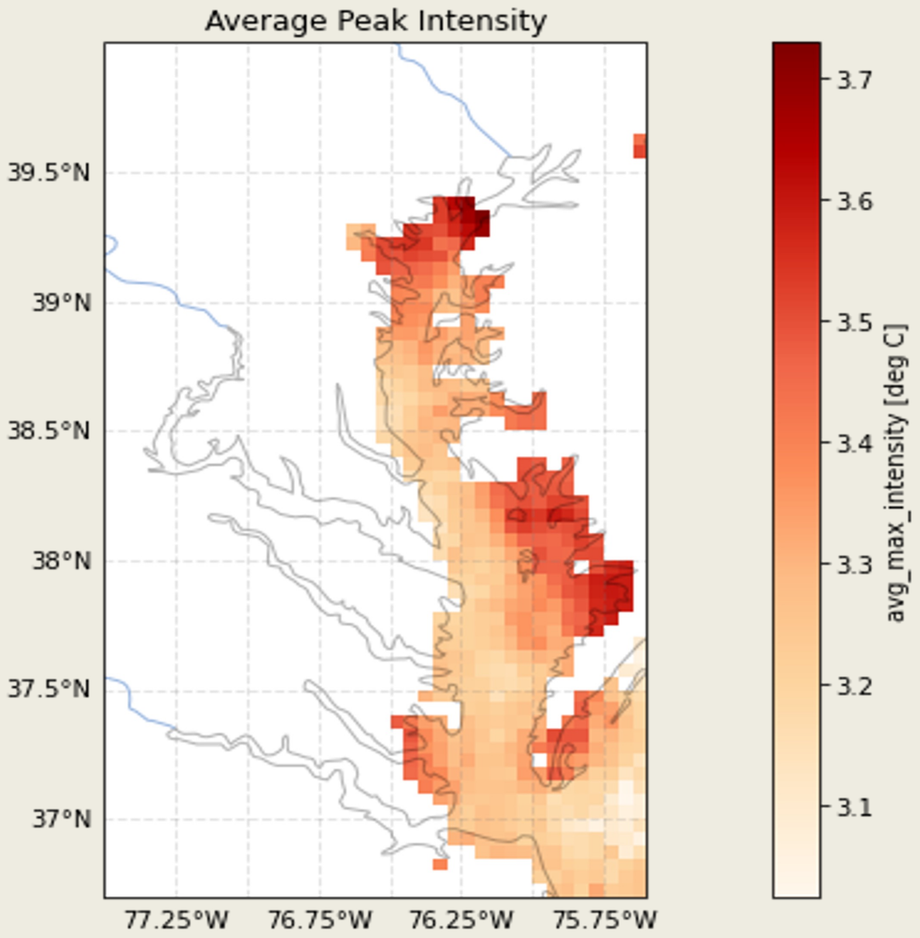
Duration and number of occurrences show an inverse relationship

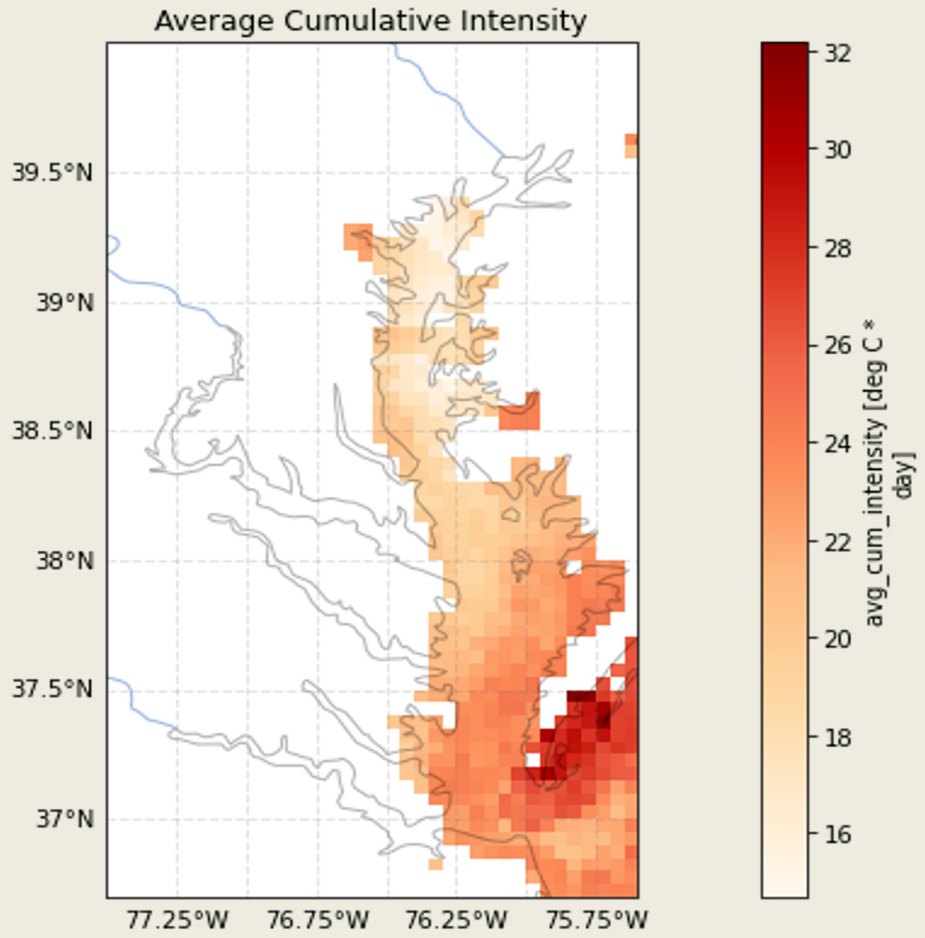
Marine heatwave characteristics



Hobday, et al. (2016) Progress in Oceanography

Marine heatwave characteristics maps





The structure of cumulative intensity is dominated by marine heatwave duration, not peak intensity

Conclusions

01 NOAA Geopolar Sea Surface Temperature (SST) can be used to investigate marine heatwaves in the main stem of the Chesapeake Bay

02 Maps of marine heatwave characteristics show different marine heatwave patterns in different parts of the bay

- A Duration and number of events are inversely related
- B Cumulative intensity structure is dominated by duration, not intensity