

Exploring the Interplay Between Marine Heatwaves and Atmospheric Circulation in the North Atlantic Using Observation Data and Climate Indicators.

ObsSea4Clim Annual Meeting/12-03-2025

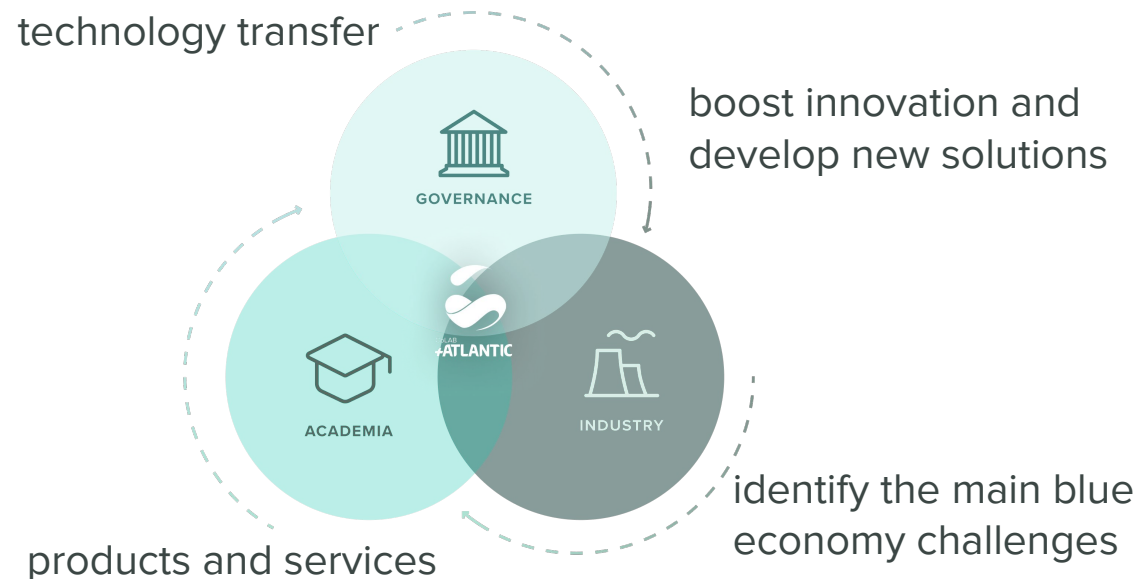
Fabíola Silva on behalf of the +ATLANTIC team



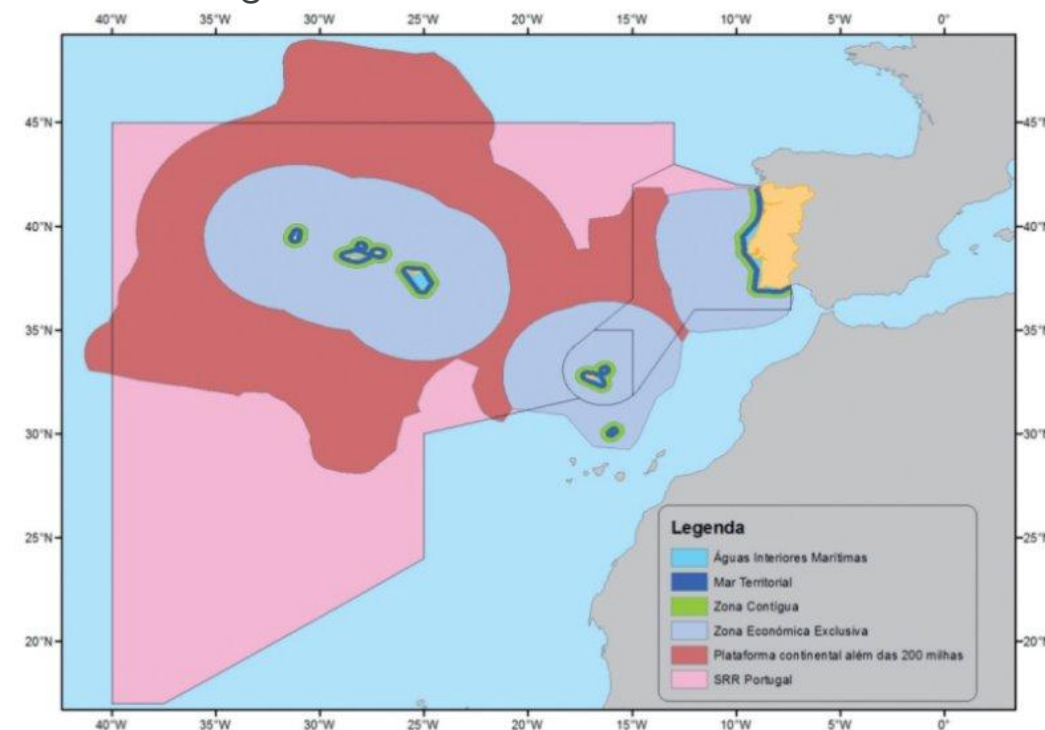
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Decoding Marine Heatwaves: Our Commitment



Portuguese Economic Maritime Area

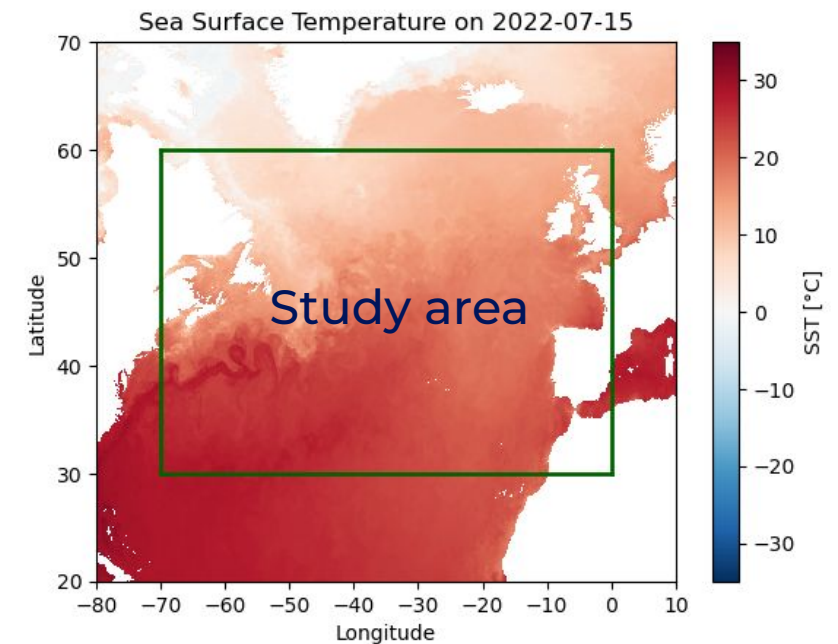


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key scientific questions

1. What historical data reveal about changes in MHW frequency, intensity, and duration over recent decades?
2. How do large-scale climate modes, such as the North Atlantic Oscillation (NAO), influence the occurrence and characteristics of MHWs?
3. What are the primary oceanic and atmospheric drivers of MHWs in the North Atlantic?



Data & Methodology

Dataset	Variable	Temporal coverage	Temporal resolution	Horizontal resolution
ESA CCI (ESA CCI: SST Level 4, version 3.0)	SST	1982-2022	Daily	0.05°x0.05°
ERA5 (https://cds.climate.copernicus.eu/reanalysis-era5)	Mean sea level pressure Geopotential Height 2-m air temperature Latent heat flux Sensible heat flux Longwave radiation Shortwave radiation 10-m wind u,v components	1982-2022	12 UTC	0.25°x0.25°
Hurrell North Atlantic Oscillation (NAO) Index (PC-based) (north-atlantic-oscillation-nao-index)	Annual and monthly NAO	1982 - 2022	Annual/ monthly	-

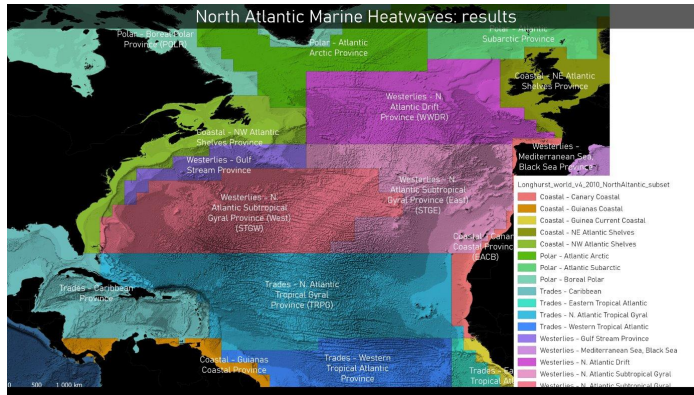
- Climatology period: 1982 – 2022
- Method: Hobday et al. (2016)



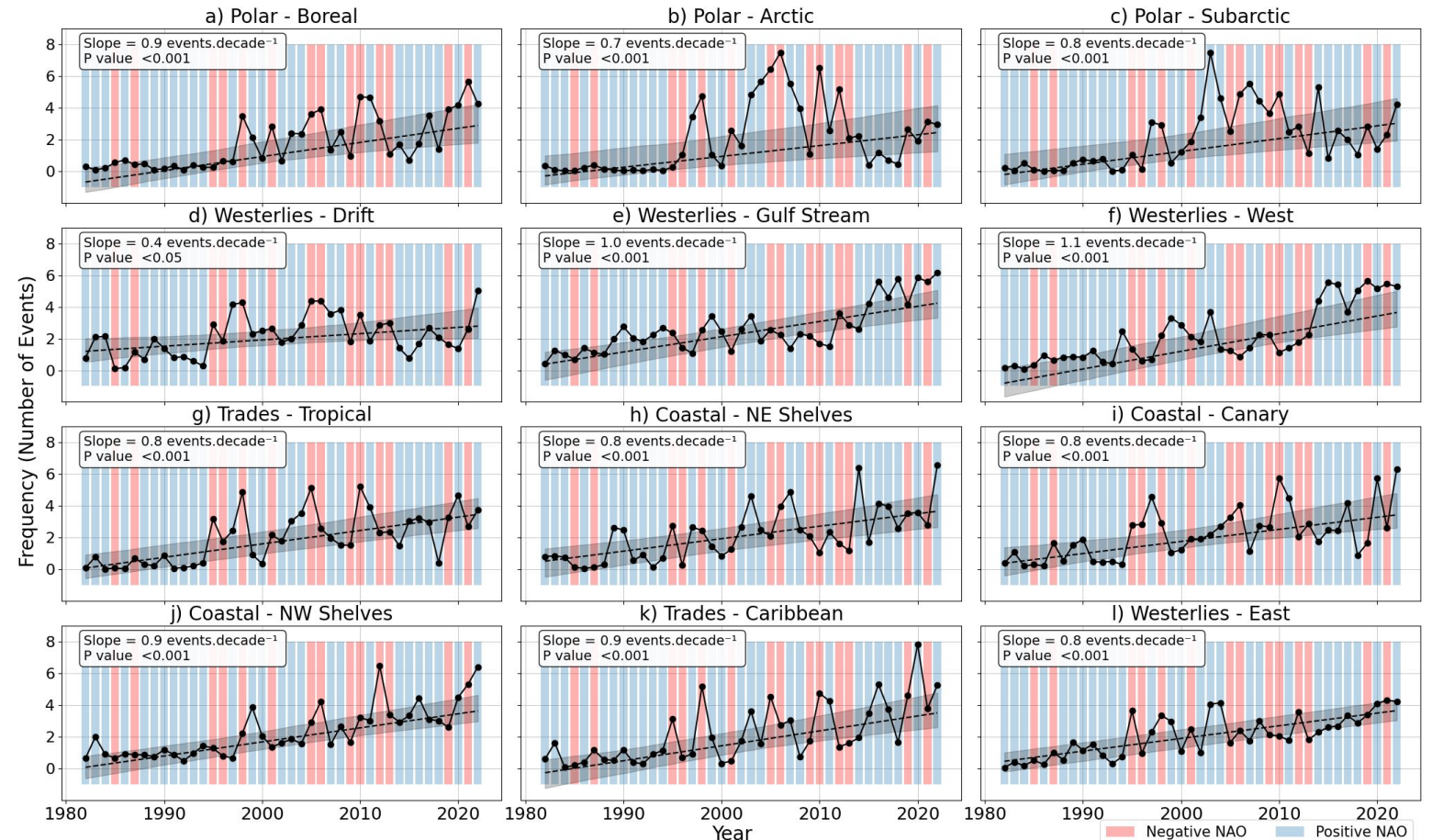
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MHW trends in the North Atlantic – Frequency



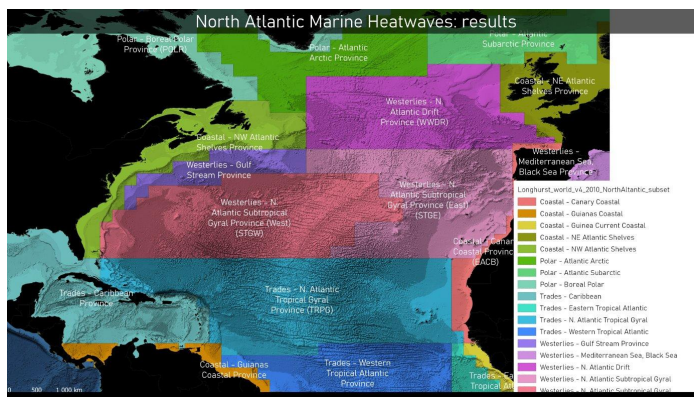
Beatriz' master's thesis (unpublished yet)



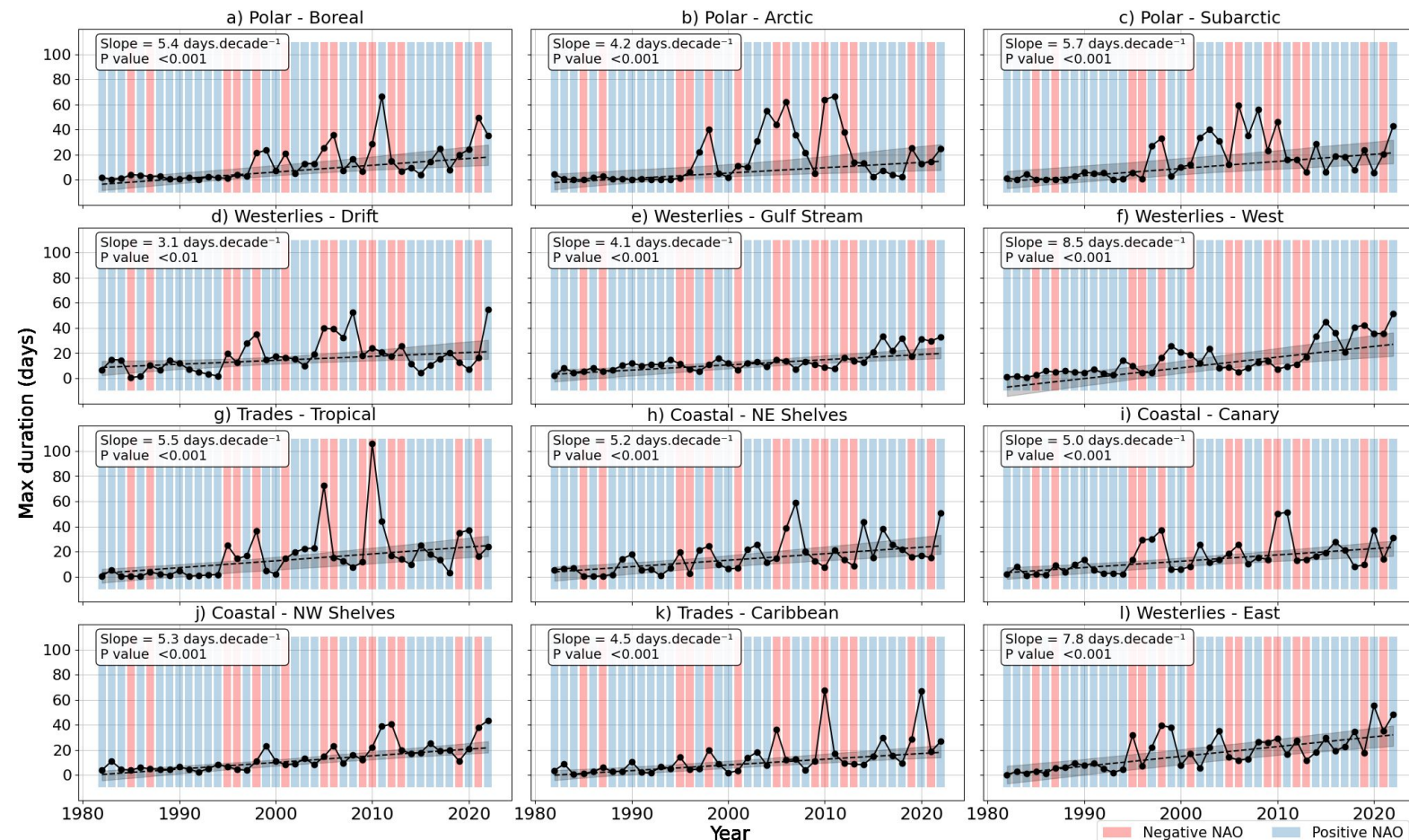
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MHW trends in the North Atlantic – Duration



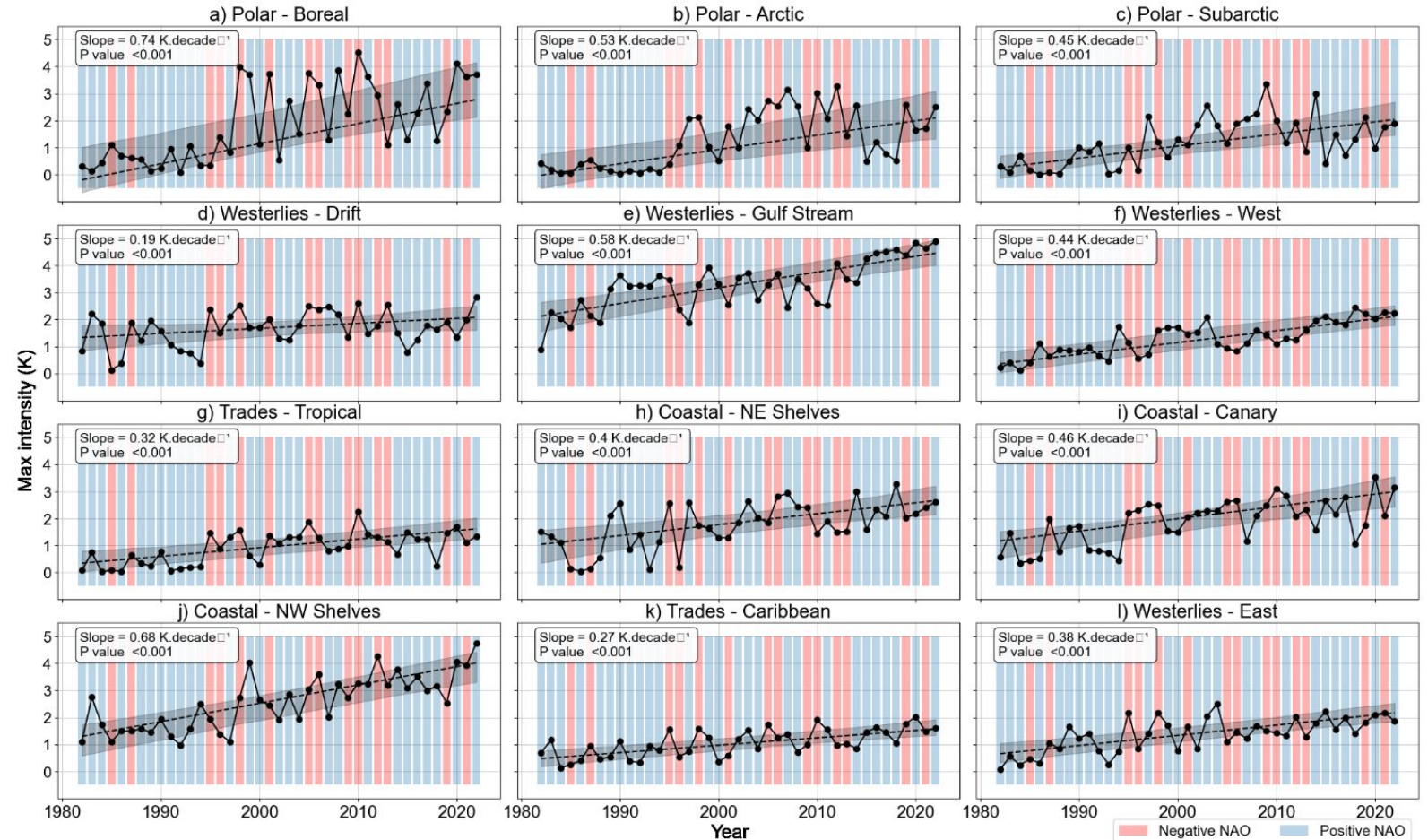
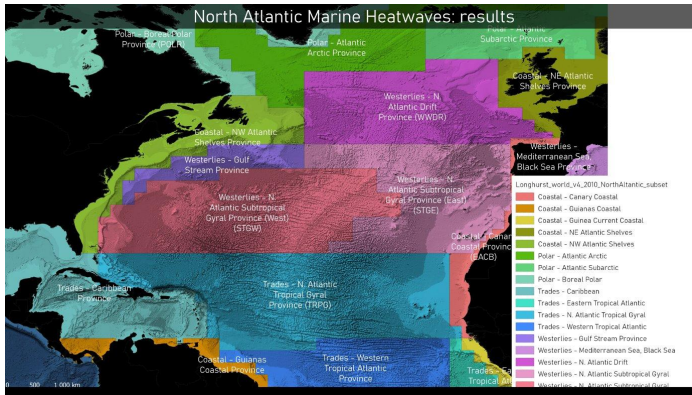
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MHW trends in the North Atlantic – Intensity



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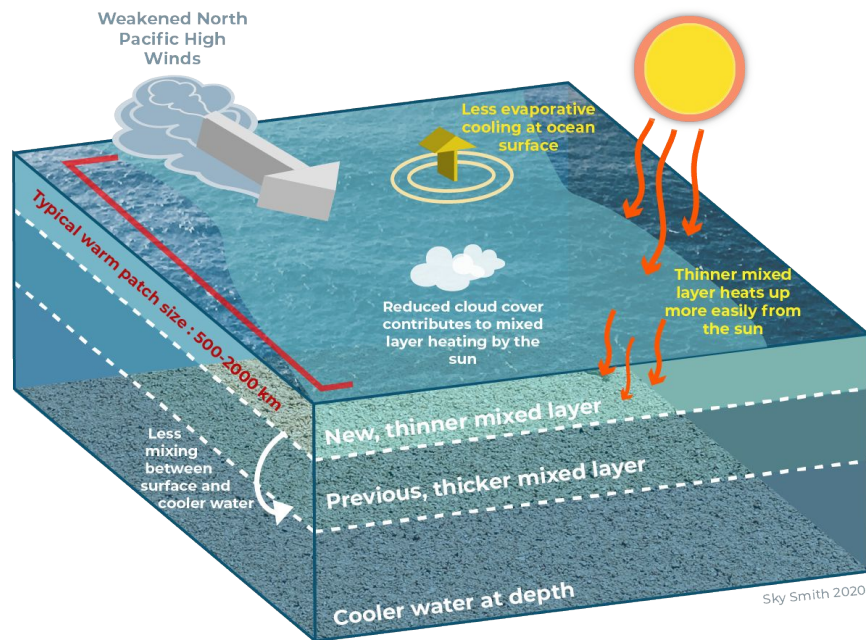


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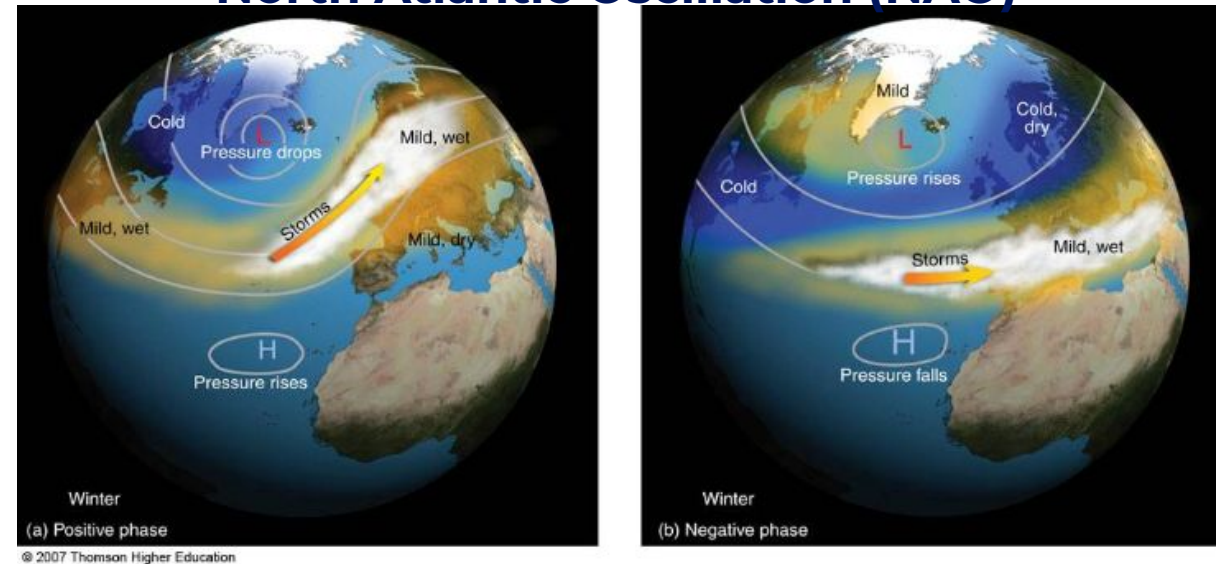
MHWs in the North Atlantic

Essential Ocean Variables



Essential Climate Variables

North Atlantic Oscillation (NAO)



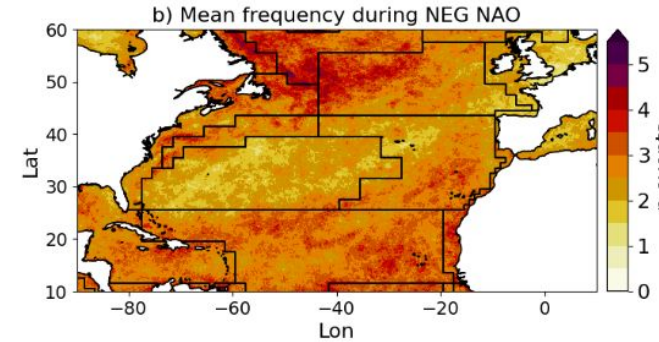
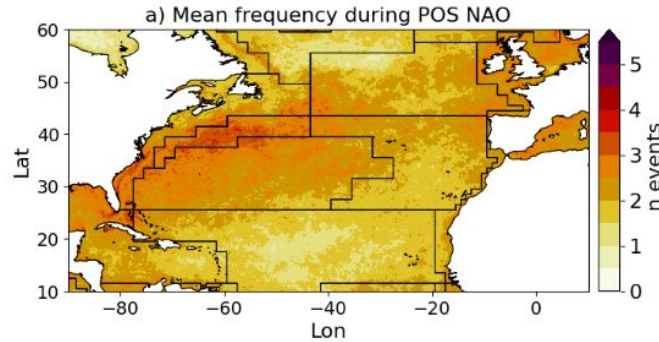
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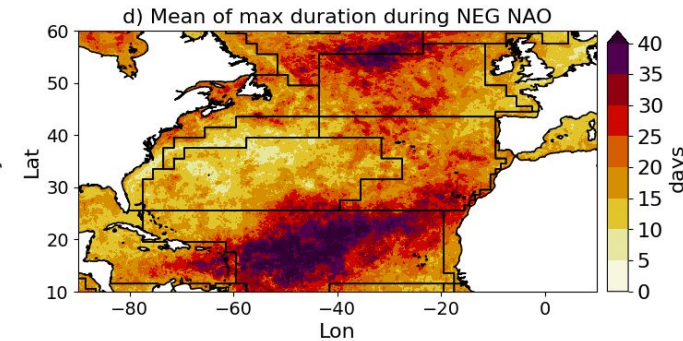
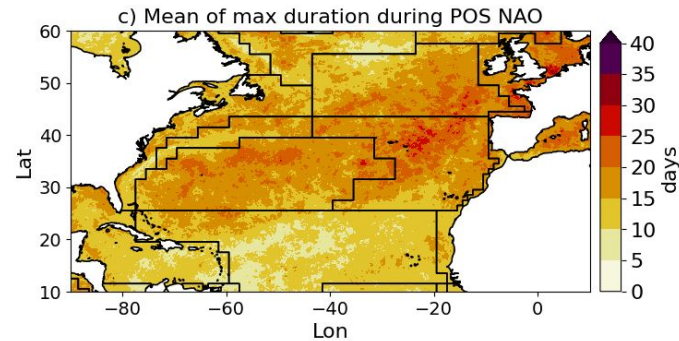
The North Atlantic Oscillation's Influence

-NAO

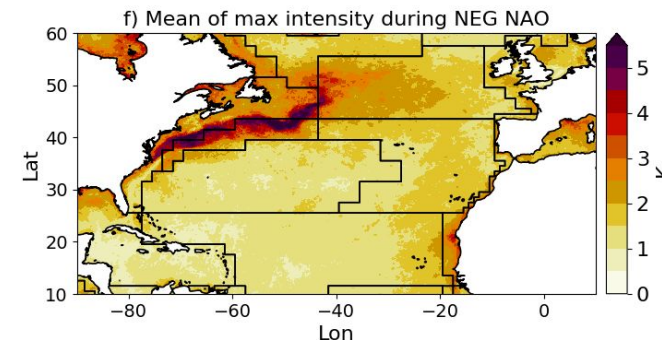
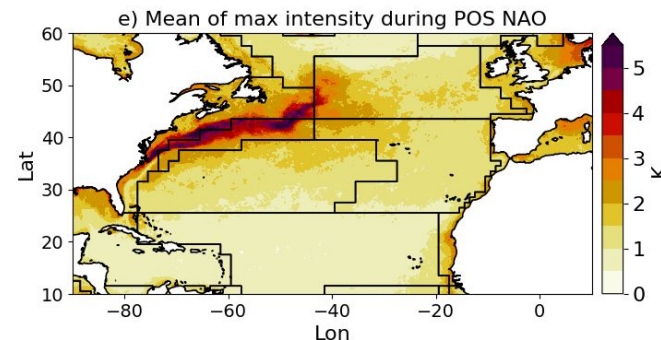
Frequency



Duration



Intensity



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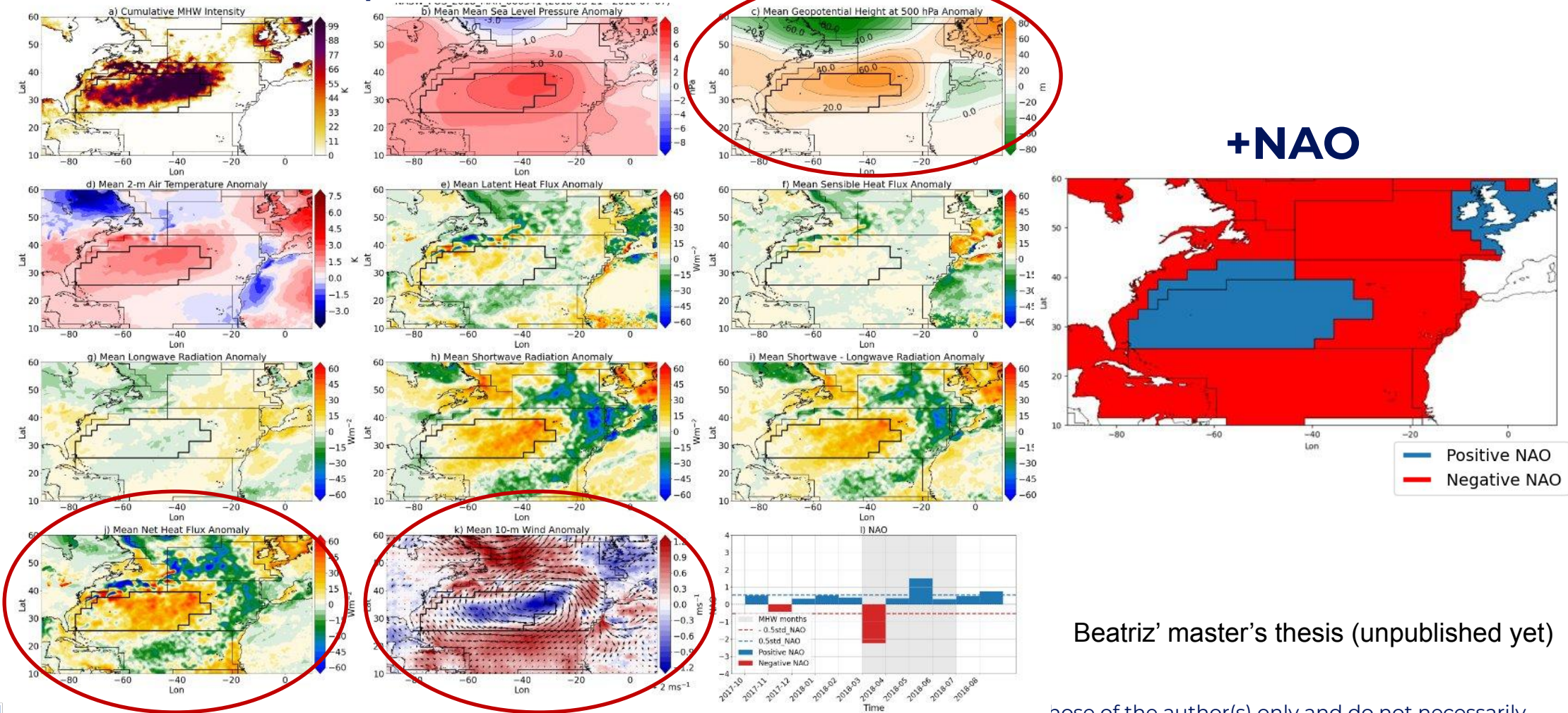
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Climate Modes and Atmospheric Circulation

MHW period: 21/03/2018 – 07/07/2018



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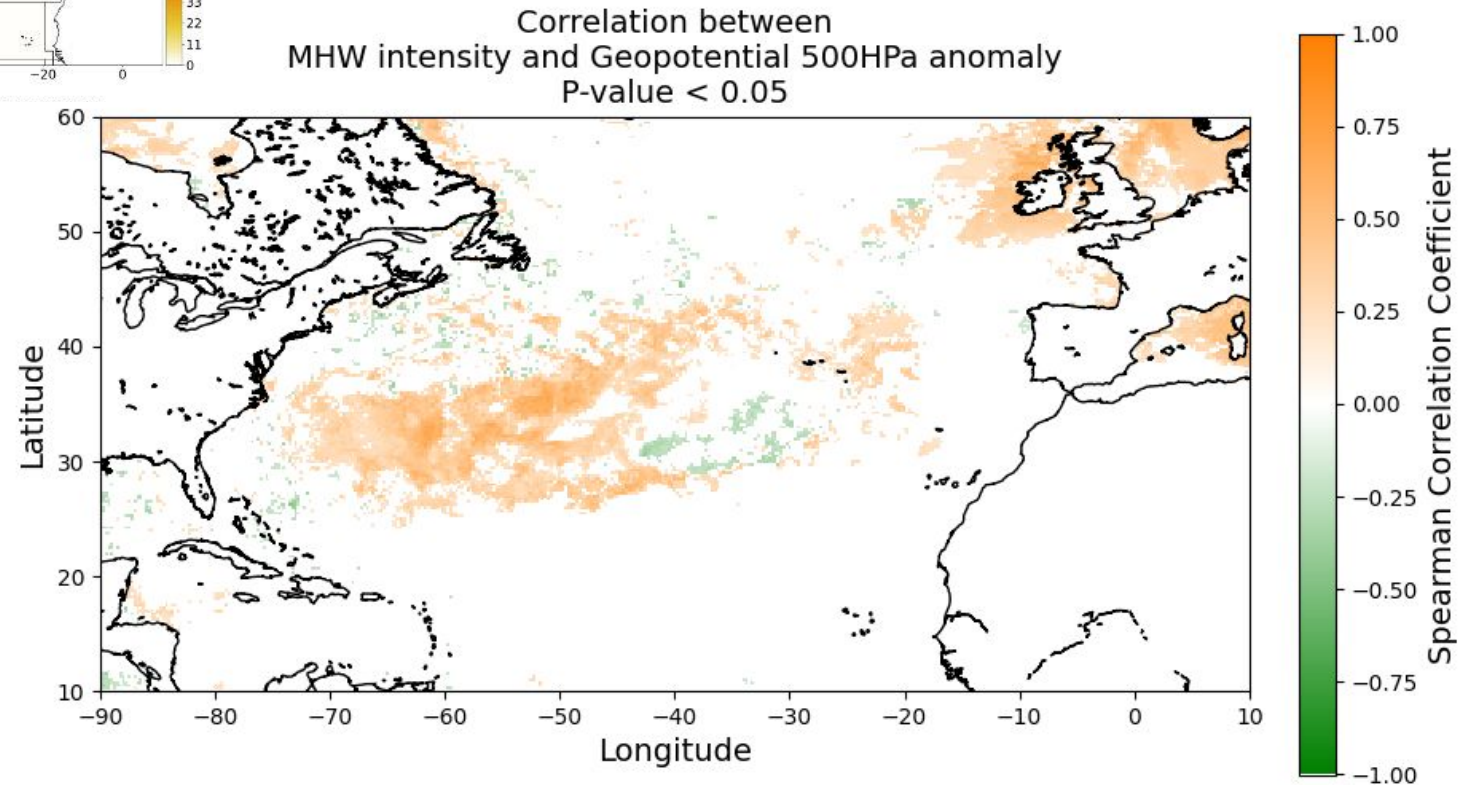
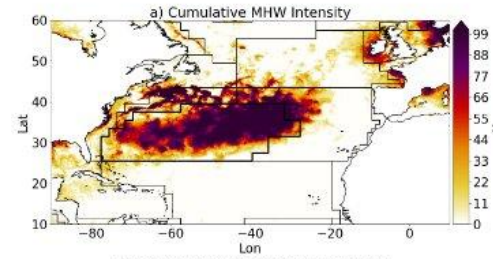
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Statistical Analysis

Spearman Rank Correlation

MHW period: 21/03/2018 – 07/07/2018

**MHW intensity and
geopotential at 500hPa
anomaly
lagged in 5 days**



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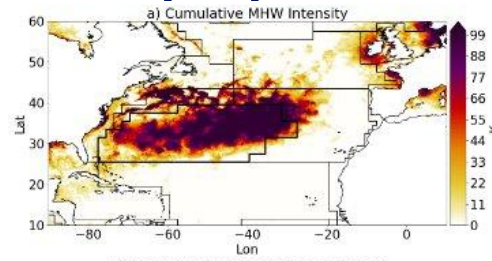
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Statistical Analysis

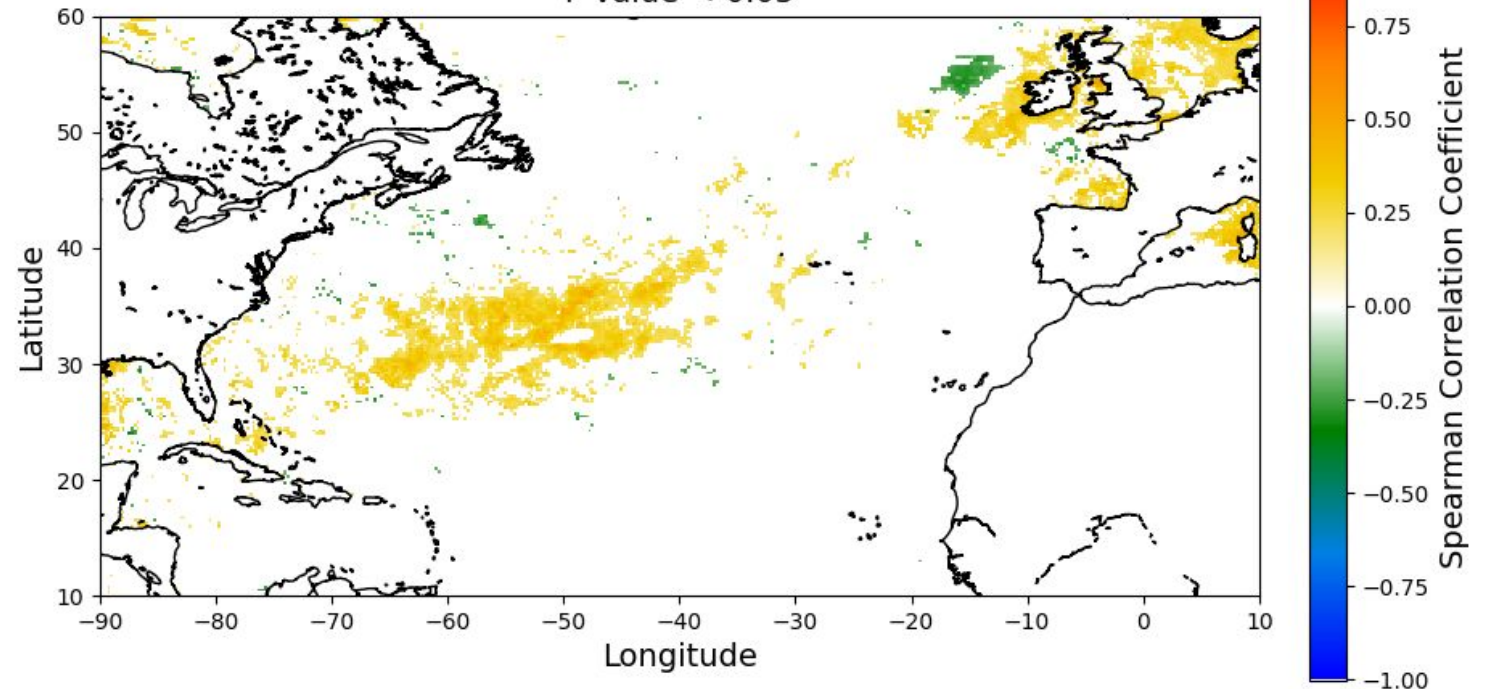
Spearman Rank Correlation

MHW period: 21/03/2018 – 07/07/2018

**MHW intensity and
Net heat flux anomaly
lagged in 5 days**



Correlation between
MHW intensity and Net solar radiation anomaly
P-value < 0.05



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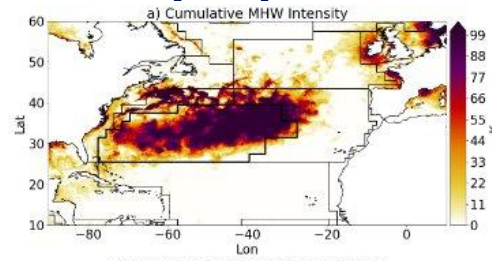
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Statistical Analysis

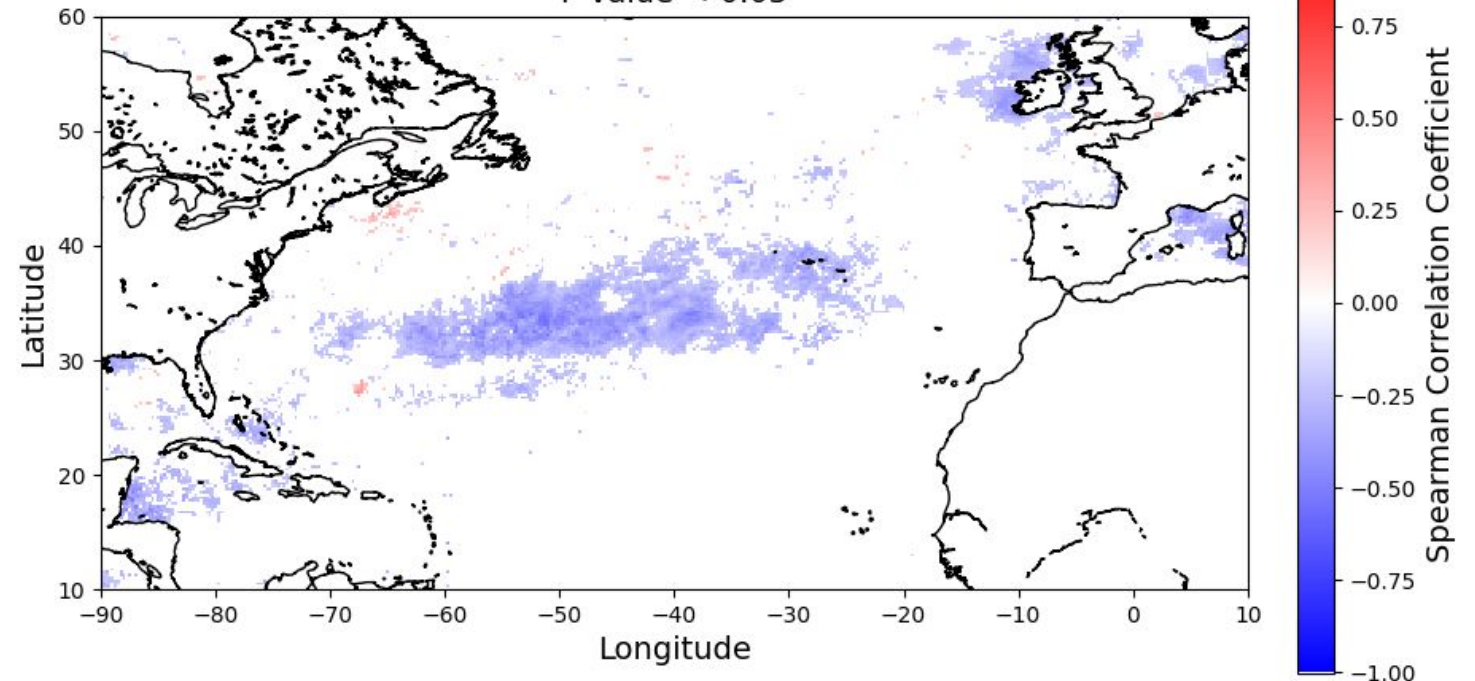
Spearman Rank Correlation

MHW period: 21/03/2018 – 07/07/2018

MHW intensity and
Wind speed anomaly
lagged in 5 days



Correlation between
MHW intensity and Wind speed anomaly
P-value < 0.05

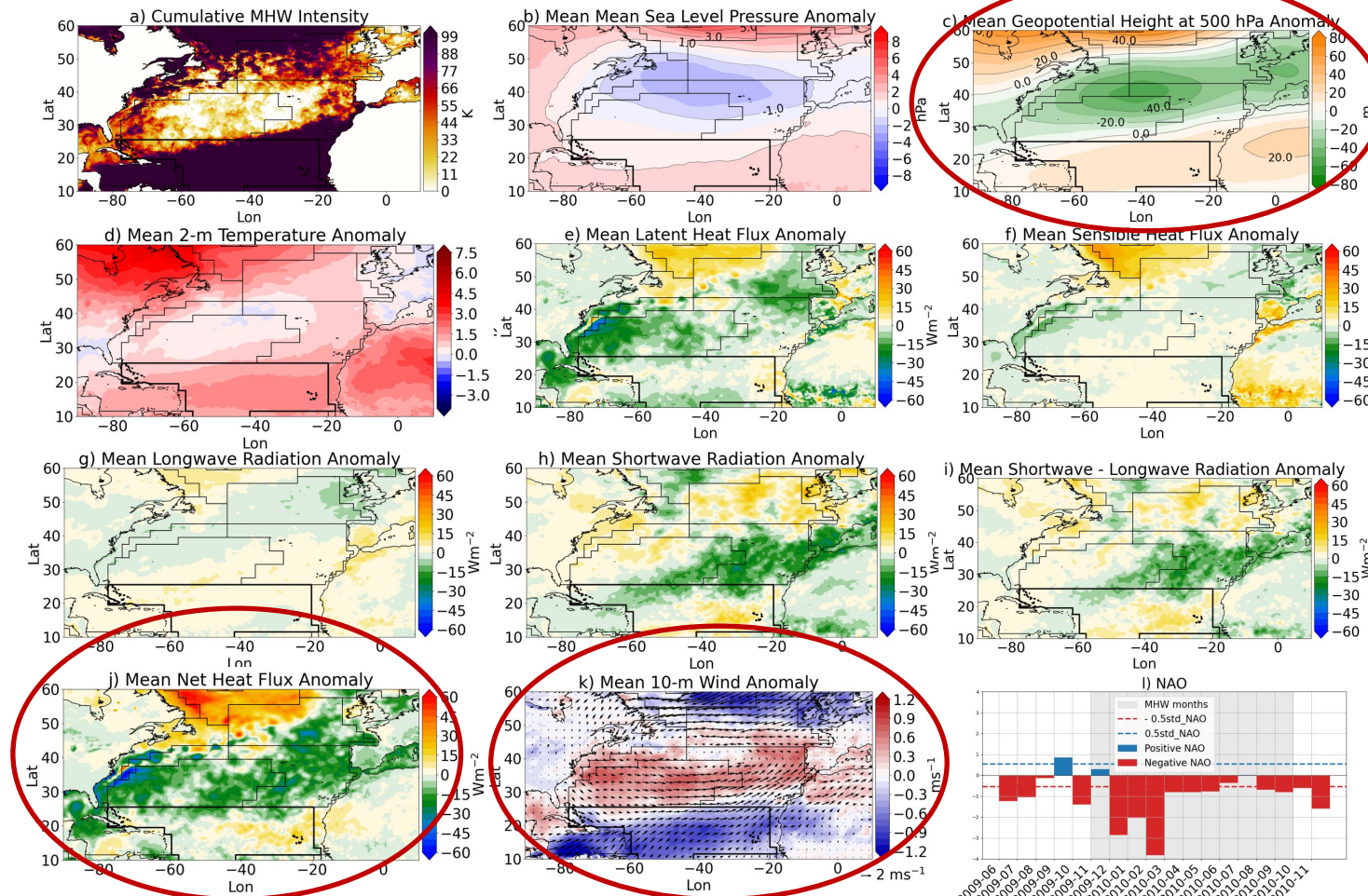


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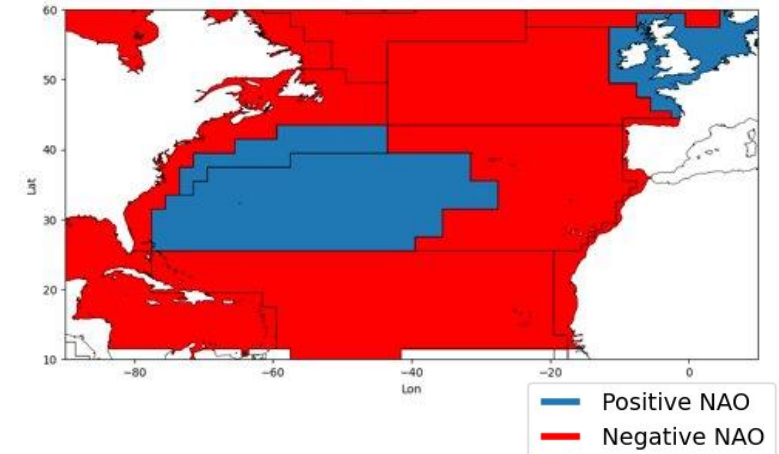
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Climate Modes and Atmospheric Circulation

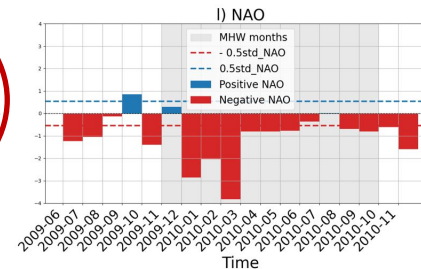
MHW period: 19/11/2009 - 16/10/2010



-NAO



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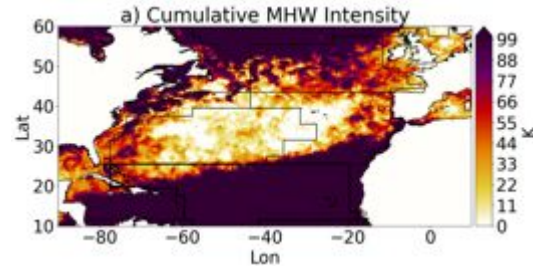
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Statistical Analysis

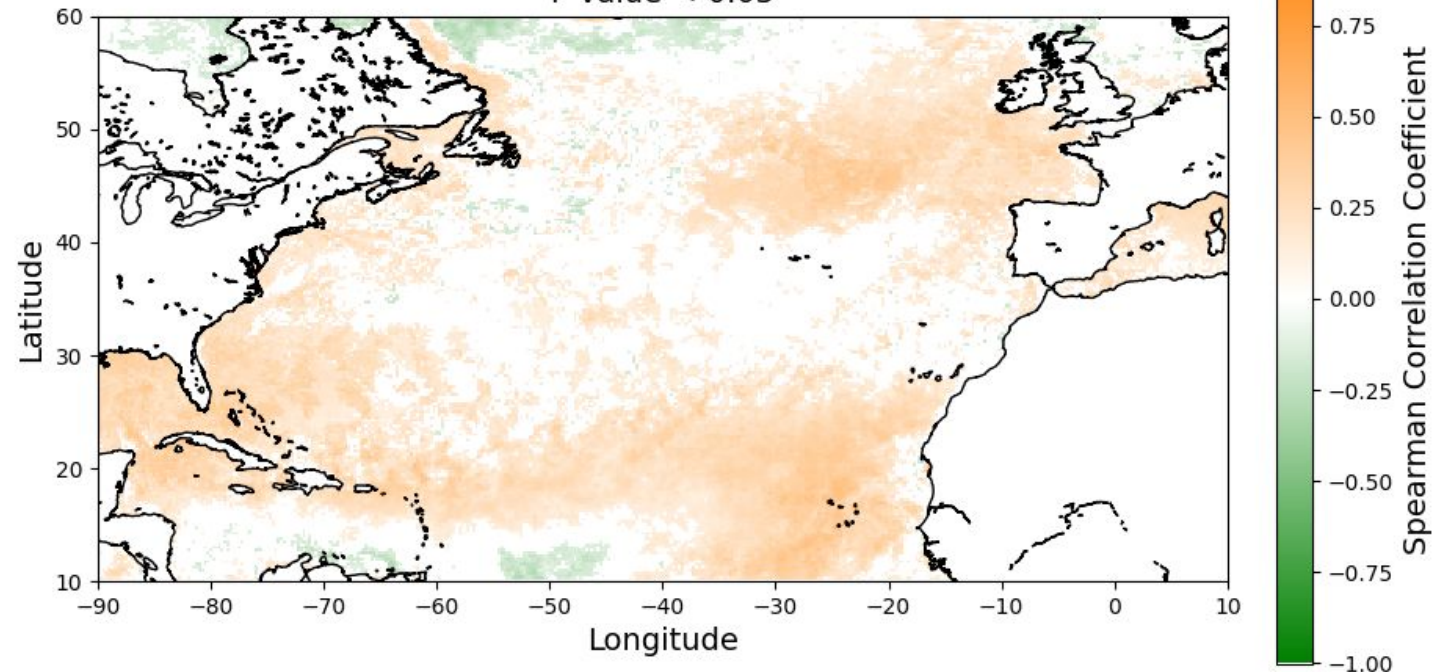
Spearman Rank Correlation

MHW period: 19/11/2009 – 16/10/2010

**MHW intensity and
geopotential at 500hPa
anomaly
lagged in 5 days**



Correlation between
MHW intensity and Geopotential 500hPa anomaly
P-value < 0.05



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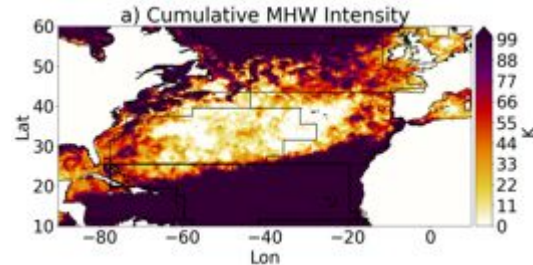
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Statistical Analysis

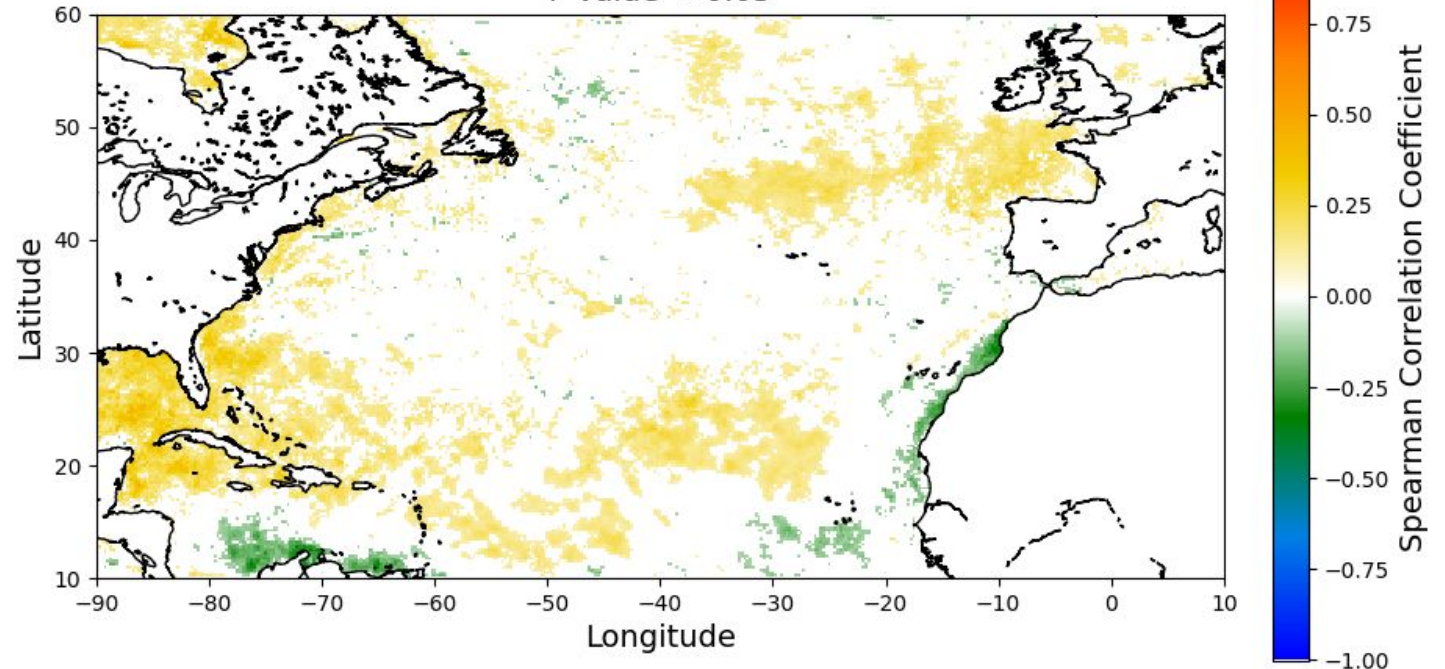
Spearman Rank Correlation

MHW period: 19/11/2009 – 16/10/2010

MHW intensity and Net heat flux anomaly lagged in 5 days



Correlation between
MHW intensity and Net solar radiation anomaly
P-value < 0.05



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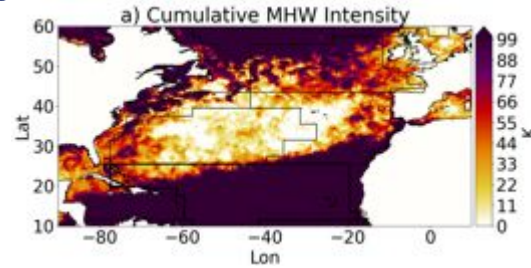
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Statistical Analysis

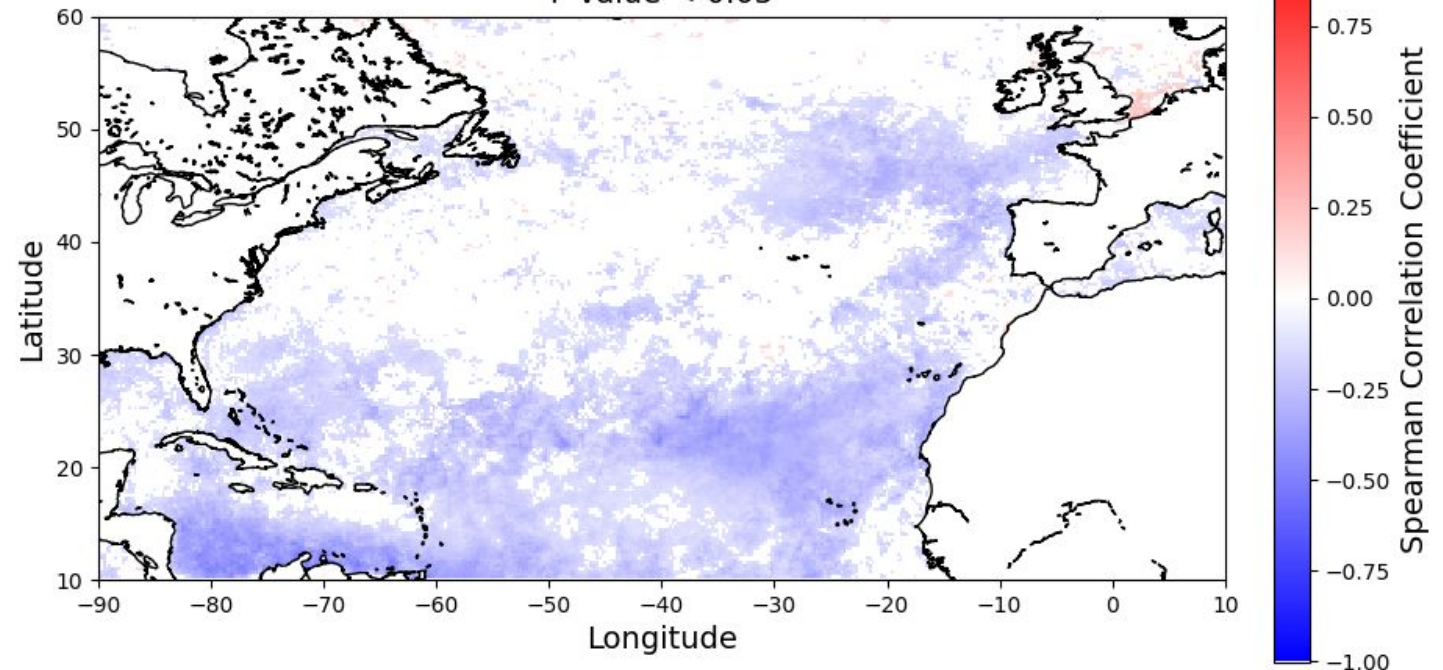
Spearman Rank Correlation

MHW period: 19/11/2009 – 16/10/2010

**MHW intensity and
10-m Wind speed anomaly
lagged in 5 days**



Correlation between
MHW intensity and Wind speed anomaly
P-value < 0.05

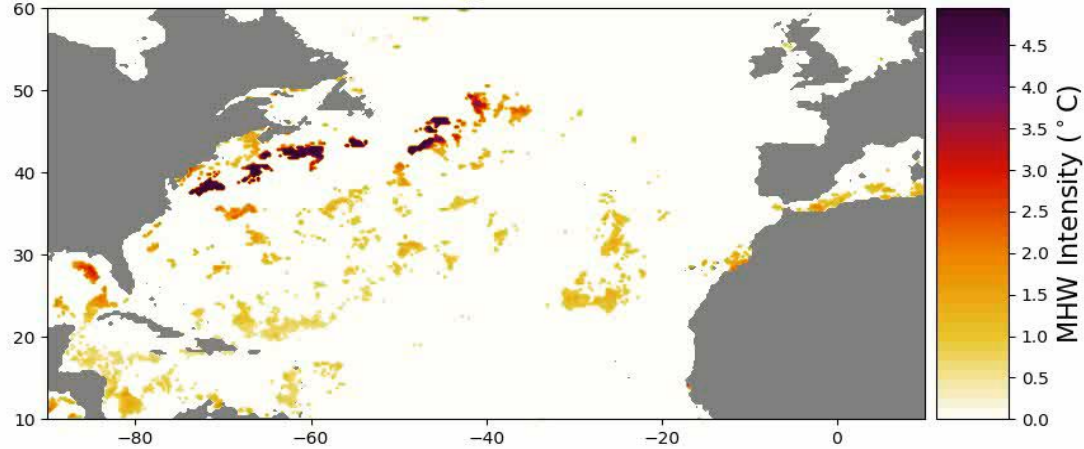


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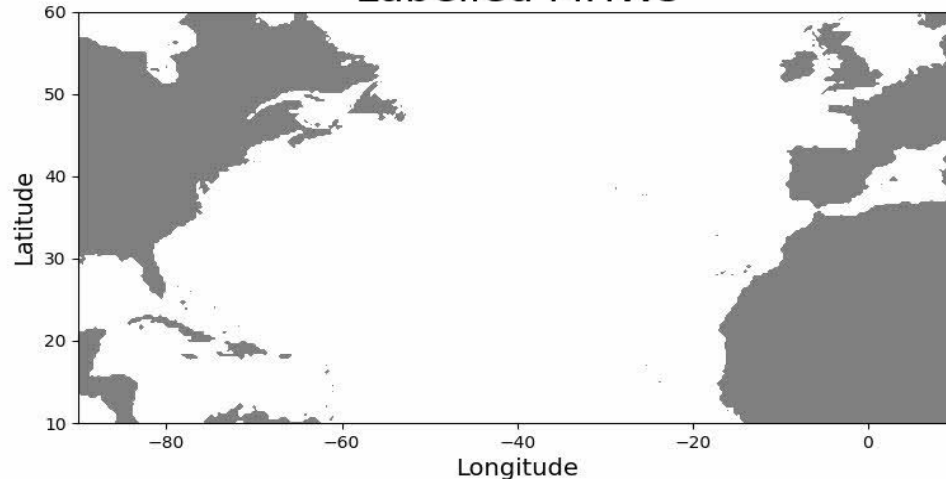
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Clustering MHW in the North Atlantic

MHW Intensity on: 2016-04-23



Labelled MHWs



- Minimum area filters
- Multiple marine heatwaves
- Marine ecosystems impacts
- Socio-economic impacts



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Key questions for further investigation/clarification

1. What are the primary oceanic and atmospheric drivers of MHWs in the North Atlantic?
2. How do large-scale climate modes, such as the NAO and ENSO, influence the occurrence and characteristics of MHWs?
3. Are the atmospheric patterns common to all or most of MHWs?
4. How do air-sea heat flux anomalies (net, latent, and sensible heat exchanges) modulate the intensity and persistence of MHWs, particularly in mid-latitude regions?
5. What is the value of Essential Ocean Variables (EOVs) and Essential Climate Variables (ECVs) in advancing the understanding of MHW dynamics?
6. How can the findings from this study support climate adaptation and marine resource management?



“There is a lot to be done!”

Thank you!



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Sofia Aguiar

Graphic Design and Communication

Sorala Romão

Oceanography and Science Communication

Tiago Garcia

- Actively involved in WP3 and WP4
- Involved in WP6
- Supporting the project



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