CAREHeat

deteCtion and threAts of maRinE Heat waves

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CAREHeat started in March 2022

https://careheat.org/

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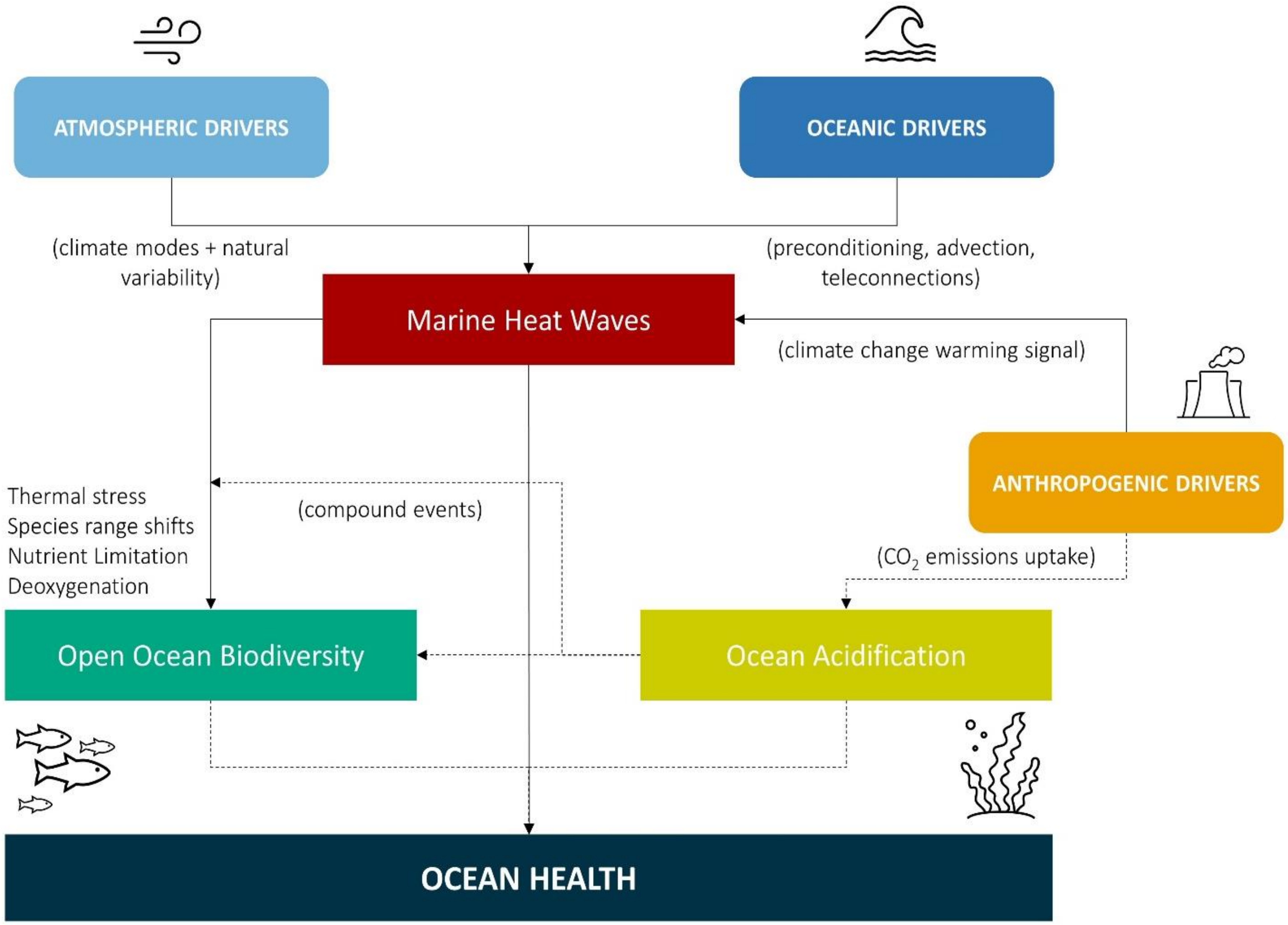
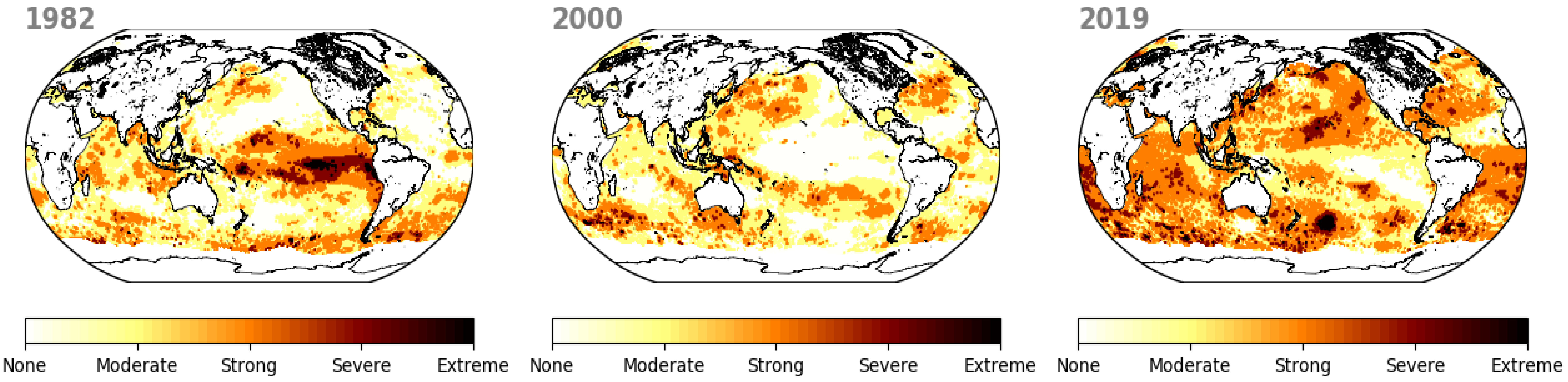
CAREHeat objectives

- IMPROVE current MHW **Detection** and **Characterization** methodology
- BUILD 4D field of Temperature to analyse **MHW vertical propagation**
- COMPILE a **Global Atlas** of MHW at the sea surface
- ADVANCE the understanding of the physical processes involved in **MHW Development**
- ASSESS MHW impact on marine **Ecosystems and Biogeochemistry**
- ASSESS the impact of MHW on **Ecosystem Services**



MHW definition

- **MHW definition:** persistent Extreme Events of anomalously warm SST with respect to “usual” values (e.g. **reference baseline**, typically a **fixed climatology**).



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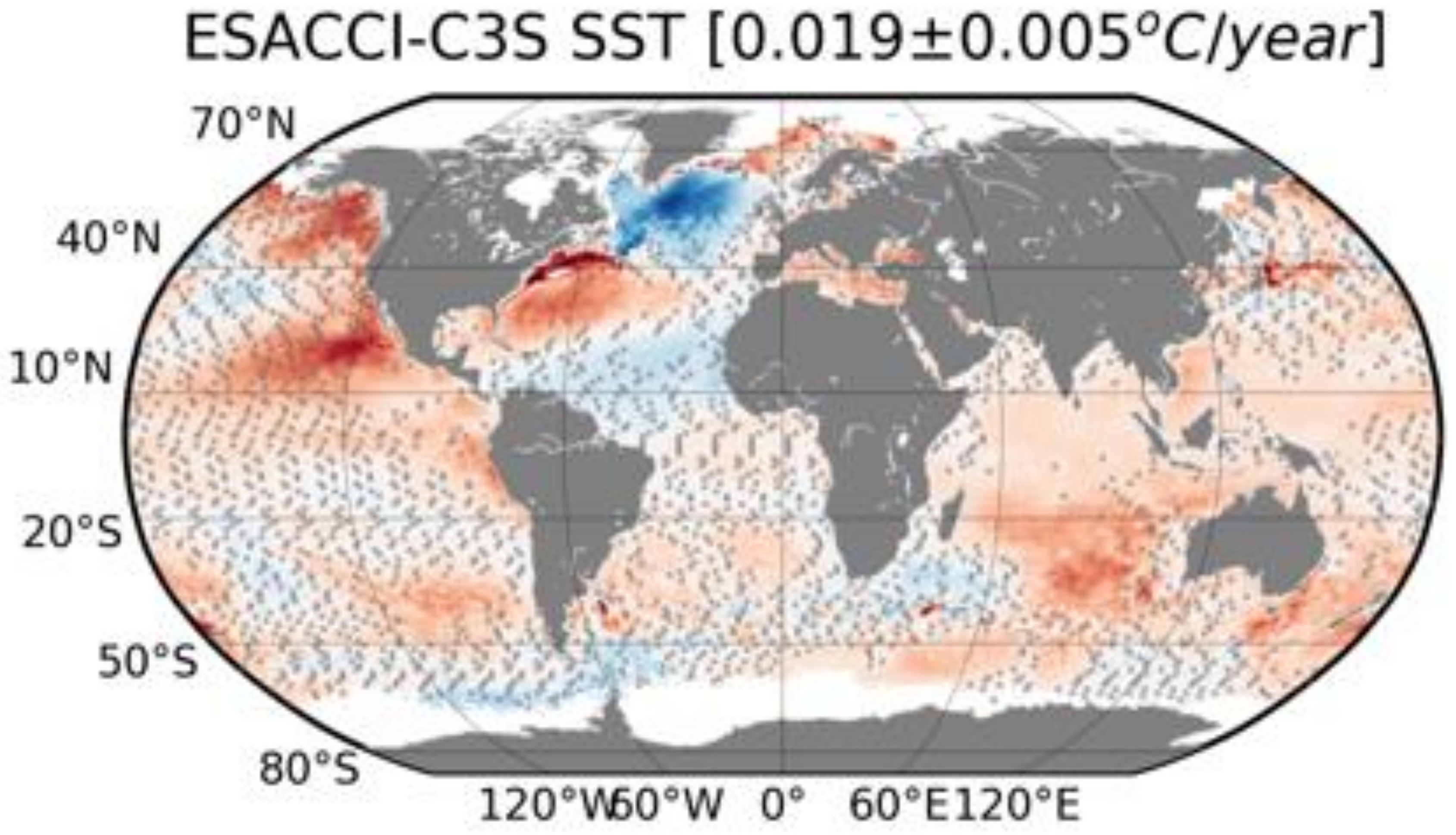
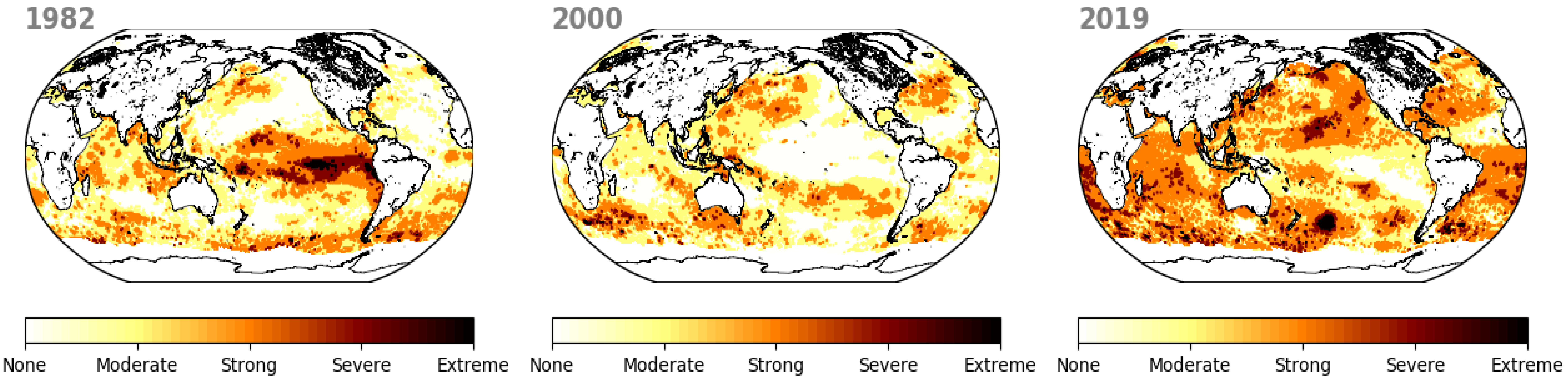
MHW changes over time

- But…**what happens in a non-stationary system?**

- **Definition of "extreme" needs to hold true even when the "usual" is changing!!**





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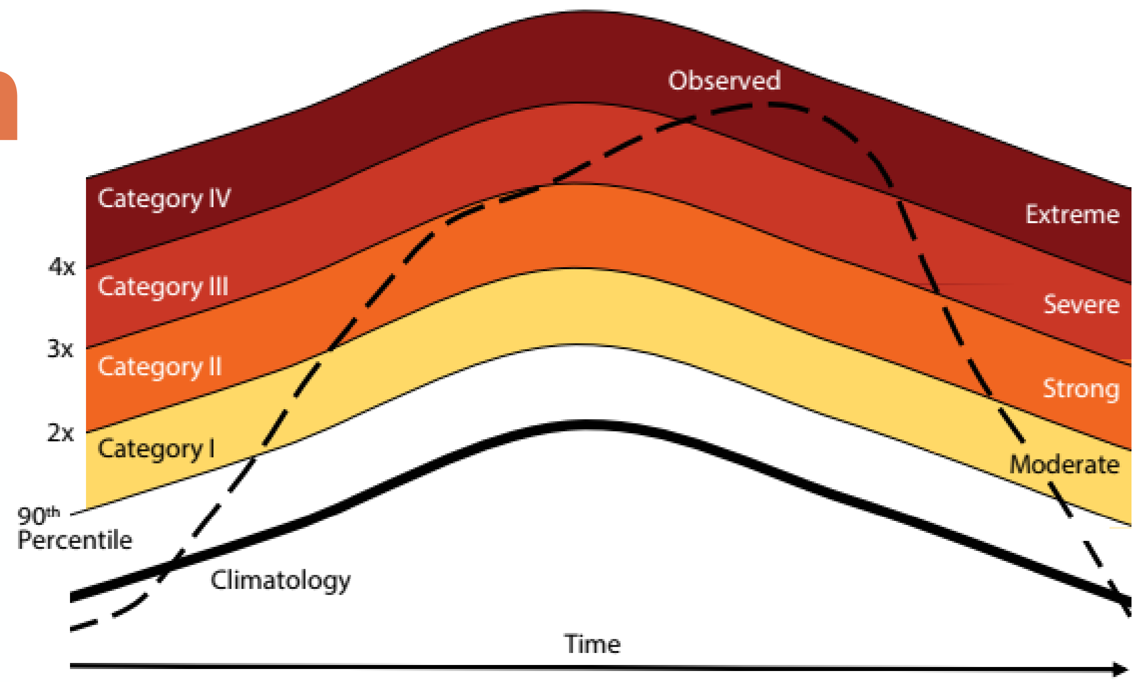
Hobday's MHW definition

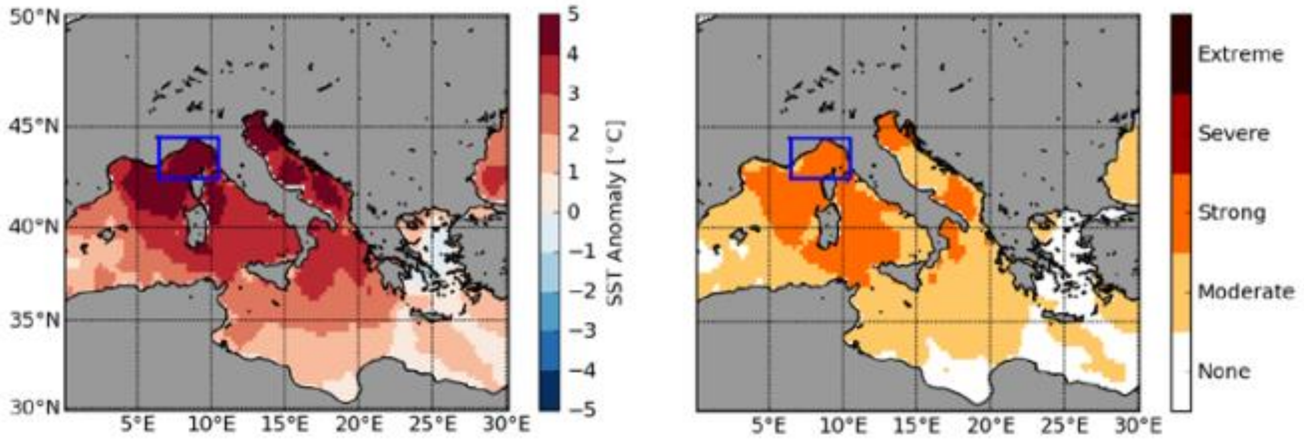
- Get the **daily climatology**, defined on a fixed **30-years baseline** period

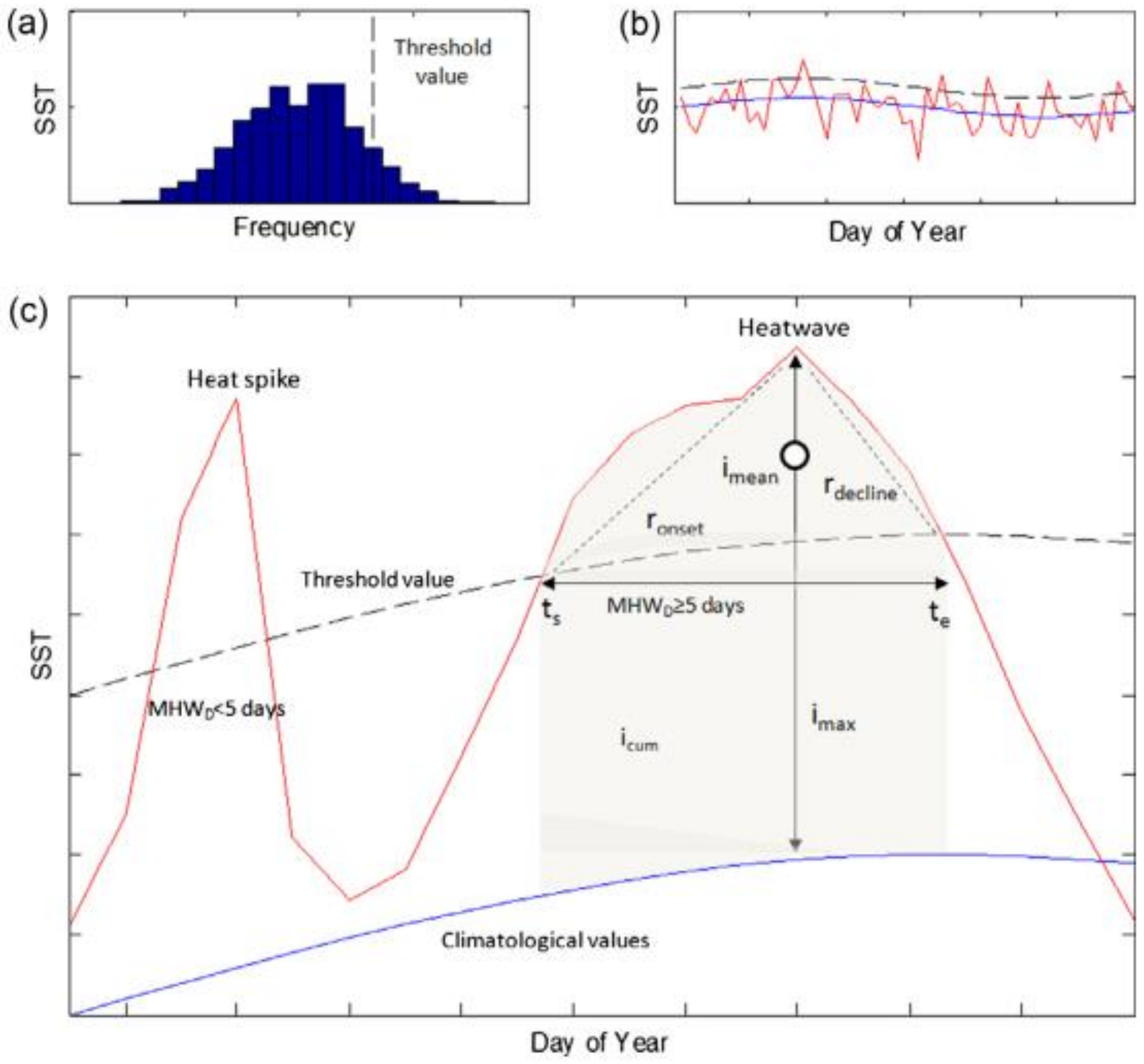
- The SST statistical distribution is **calculated for each DOY**, using all the 30-years data and **smoothed through an** 11-days **moving window approach**

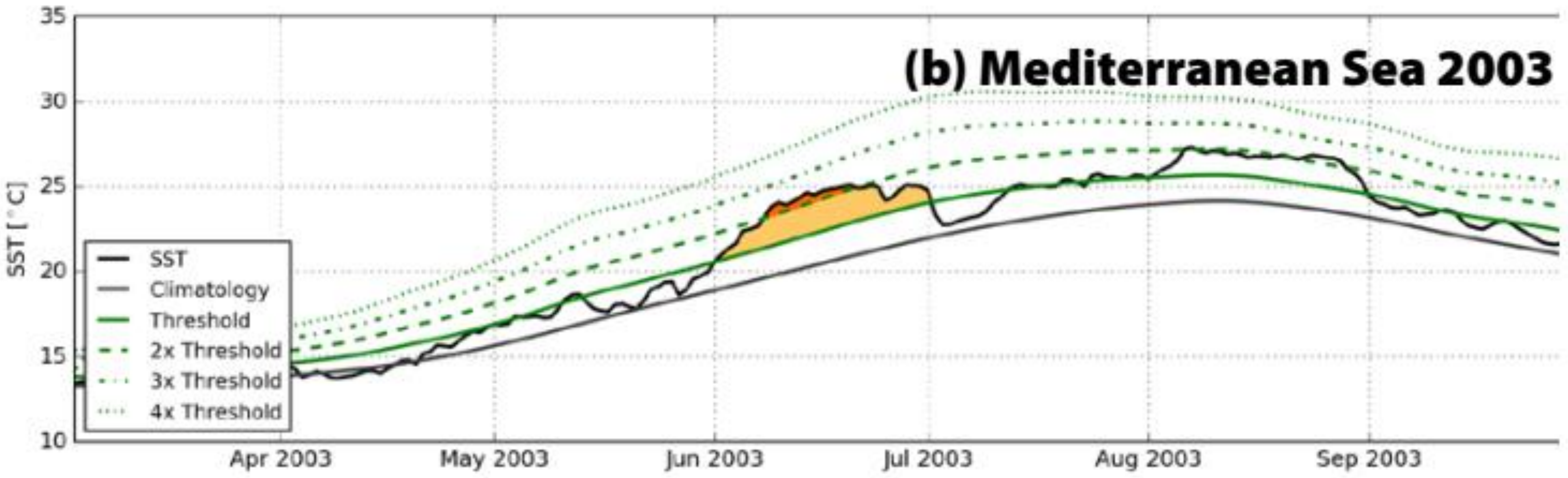
- The **90th percentile is the selected threshold**

- **A MHW event is the identified when the SST anomaly** with respect to the climatology **exceeds the 90th percentile threshold for, at least, 5 days**









Hobday, A. J., Oliver, E. C., Gupta, A. S., Benthuysen, J. A., Burrows, M. T., Donat, M. G., ... & Smale, D. A. (2018). Categorizing and naming marine heatwaves. Oceanography, 31(2), 162-173.

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MHW definition update

- **Disentangle MHWs detection from:**

  1. **What is the contribution of natural climate modes of variability?**

  2. **what is the contribution of the long-term climate trends?**

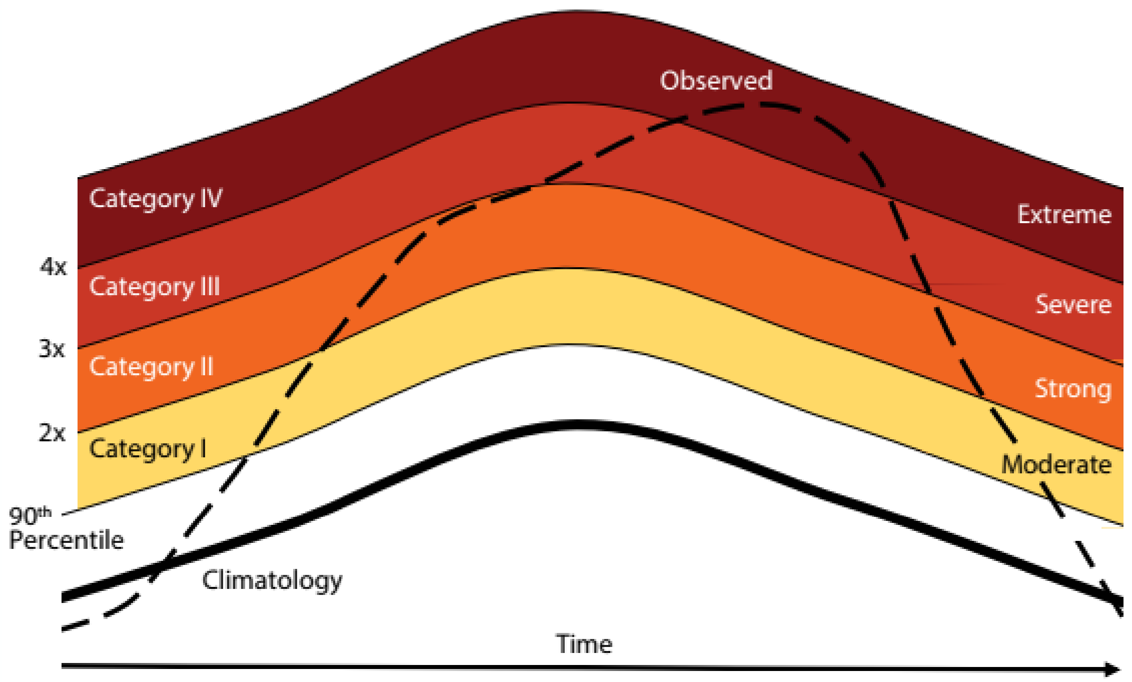
- **METHOD IMPROVEMENT:**

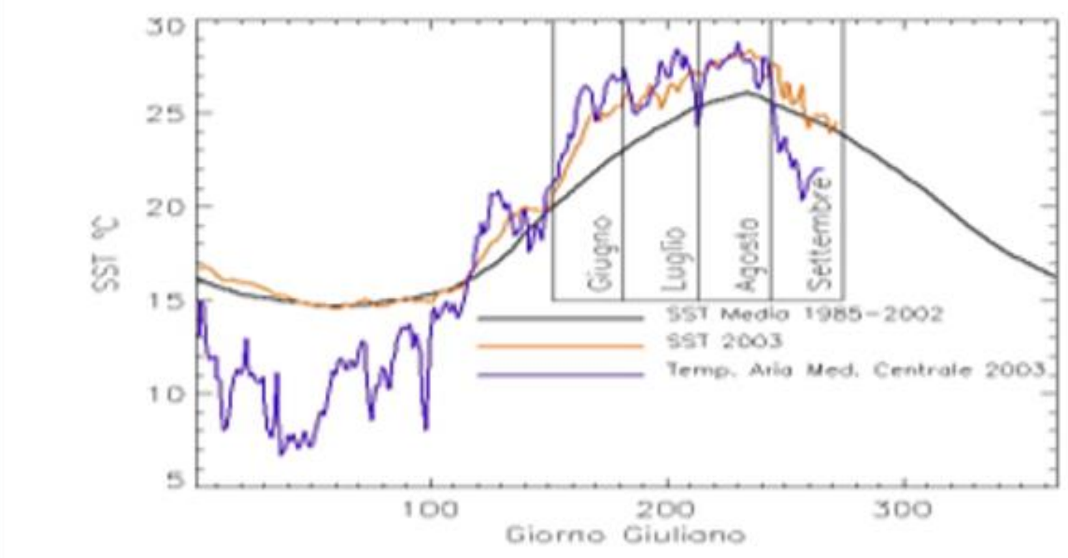
  1. **Impact of SST TRENDS and CLIMATE MODES on the statistical thresholds at regional and global scale**

  2. **Sensitivity of MHW to different climatologies (e.g., fixed versus moving)**

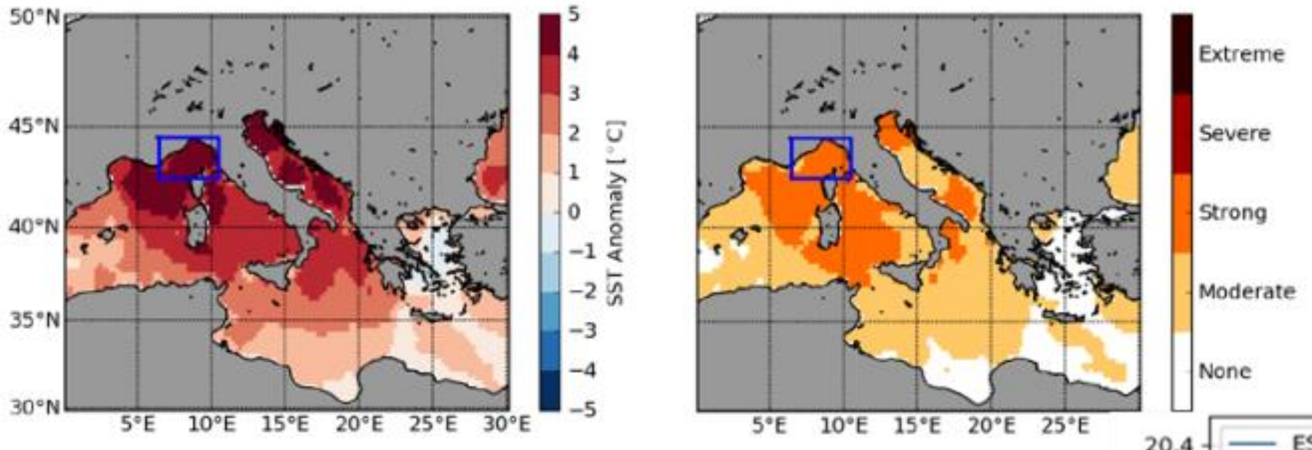
  3. **Effects of DIURNAL WARMING**

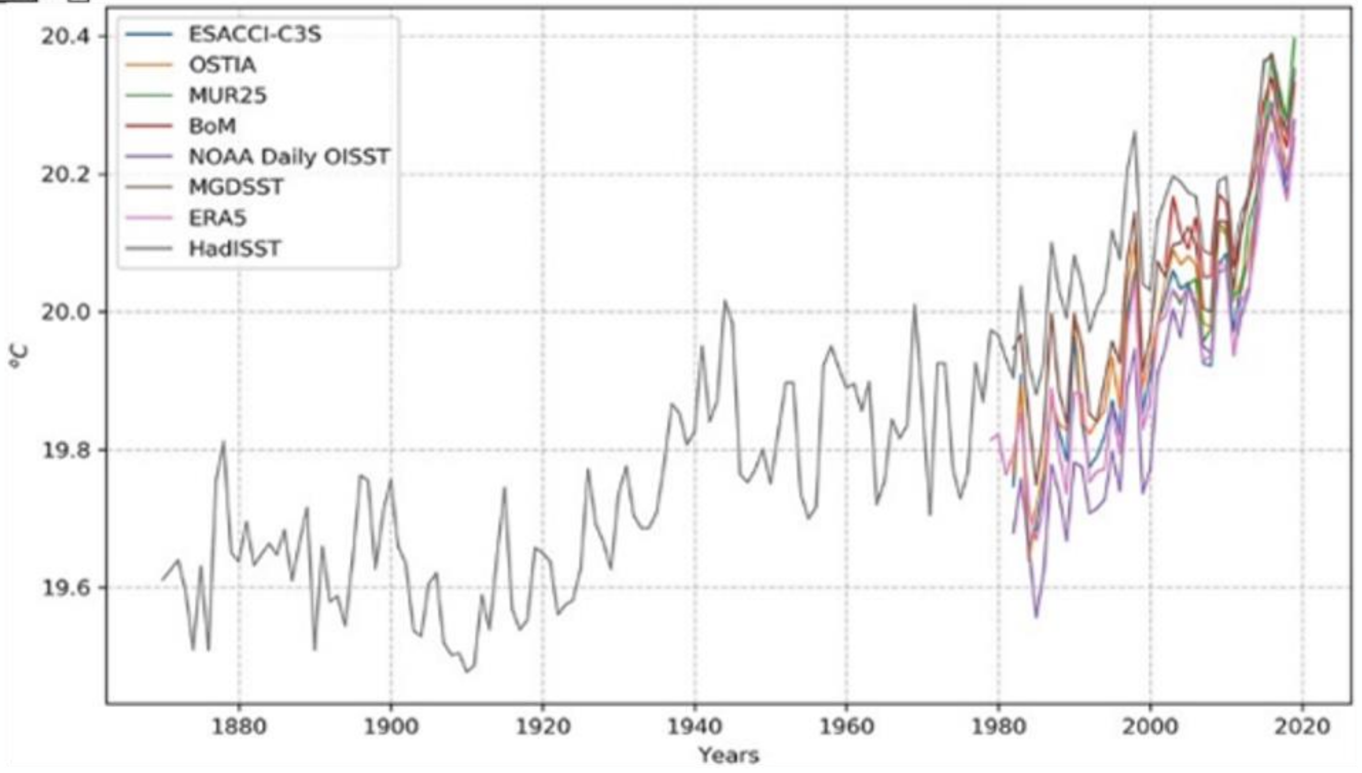
  4. **Disentangle MAIN DRIVERS of MHW**





Marullo & Guarracino (2003)





Yang et al 2021: Global monthly mean SST time series for all the ensemble members for the whole covered period originally obtained in each SST product.

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MHW ATLAS Output

https://zenodo.org/record/7473733

- **OUTPUT and VALIDATION:**
  1. **New MHW time series data:**
     1. **New surface 2D MHW ATLAS**
        - The European Space Agency (ESA) Climate Change Initiative (CCI) SST dataset v2.1 consists of spatially and temporally complete (namely, Level-4) maps of global daily average SST at 20cm nominal depth at 0.05° x 0.05° regular grid covering the period from September 1981 to present (Merchant et al., 2019).
        - The Output will be an update to the already available Global Atlas of MHWs at 1ºx1 º, covering 1982-2021
     2. **New subsurface 4D MHW reconstruction**
  2. **Validation against observed well-know MHW events**

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December 22, 2022 Dataset Open Access

Global Atlas of Marine Heatwaves (MHWs) as detected from ESA CCI SST 1°x1° covering 1982-2021

Leonelli, Francesca Elisa; de Toma, Vincenzo; Pisano, Andrea; Yang, Chunxue; Marullo, Salvatore; Santoleri, Rosalia

Daily records of Marine Heatwaves (MHW) intensities and categories resulting from detection conducted on European Space Agency (ESA) Climate Change Initiative (CCI) Sea Surface Temperature (SST) satellite product, regridded to a 1°x1° regular grid, covering the period 01/01/1982-31/12/2021.

The MHW detection has been carried out via Hobday's method (Hobday et al. 2016), with the following parameters:
At a pixel-wise level a MHW event is detected when the SST value exceeds:
- the 90th percentile threshold over climatology reference for 5 consecutive days at least, where
- the climatology reference has been computed as the daily average over the whole period (1982-2021).

The **mhw** field describes the intensity of anomaly [°C] of MHW events detected. The **cat** field gives information on the category of the events detected (1=moderate, 2=strong, 3=severe, 4=extreme). Definition of categories can be found in Hobday et al. (2018).

The production of the dataset has been sustained with the support of the European Space Agency (ESA) "deteCtion and threAts of maRinE Heat waves" project (CAREHeat; grant number: 4000137121/21/I-DT) and of Copernicus Climate Change Service Quality Assessment of ECV Products (C3S_511; grant number: C3S_511_CNR) project.

References:
Hobday, A. J., Alexander, L. V., Perkins, S. E., Smale, D. A., Straub, S. C., Oliver, E. C., ... & Wernberg, T. (2016). A hierarchical approach to defining marine heatwaves. Progress in Oceanography 141:227–238, https://doi.org/10.1016/j.pocean.2015.12.014.

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Files (15.5 GB)

Name	Size	
GlobalAtlas_MHW_ESACCISST_1deg_1982-2021.nc	15.5 GB	Download

md5:9661df91c6849bf7369dfe0d561d7cba

Publication date: December 22, 2022
DOI: DOI 10.5281/zenodo.7473733
Keyword(s): Marine Heatwaves Extreme Events Sea Surface Temperature

Versions

Version 1.0 Dec 22, 2022
10.5281/zenodo.7473733

Cite all versions? You can cite all versions by using the DOI 10.5281/zenodo.7473732. This DOI represents all versions, and will always resolve to the latest one. Read more.

How to cite: Marullo, S., De Toma, V., di Sarra, A., Iacono, R., Landolfi, A., Leonelli, F., Napolitano, E., Meloni, D., Organelli, E., Pisano, A., Santoleri, R., and Sferlazzo, D.: Has the frequency of Mediterranean Marine Heatwaves really increased in the last decades?, EGU General Assembly 2023, Vienna, Austria, 24–28 Apr 2023, EGU23-4429, https://doi.org/10.5194/egusphere-egu23-4429, 2023.

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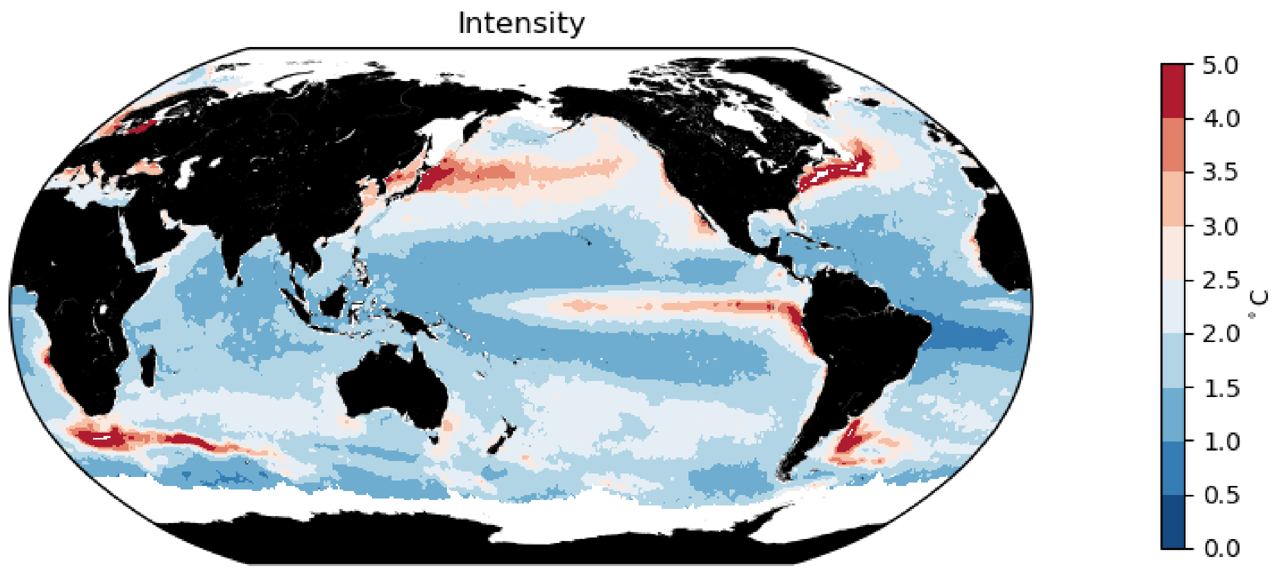
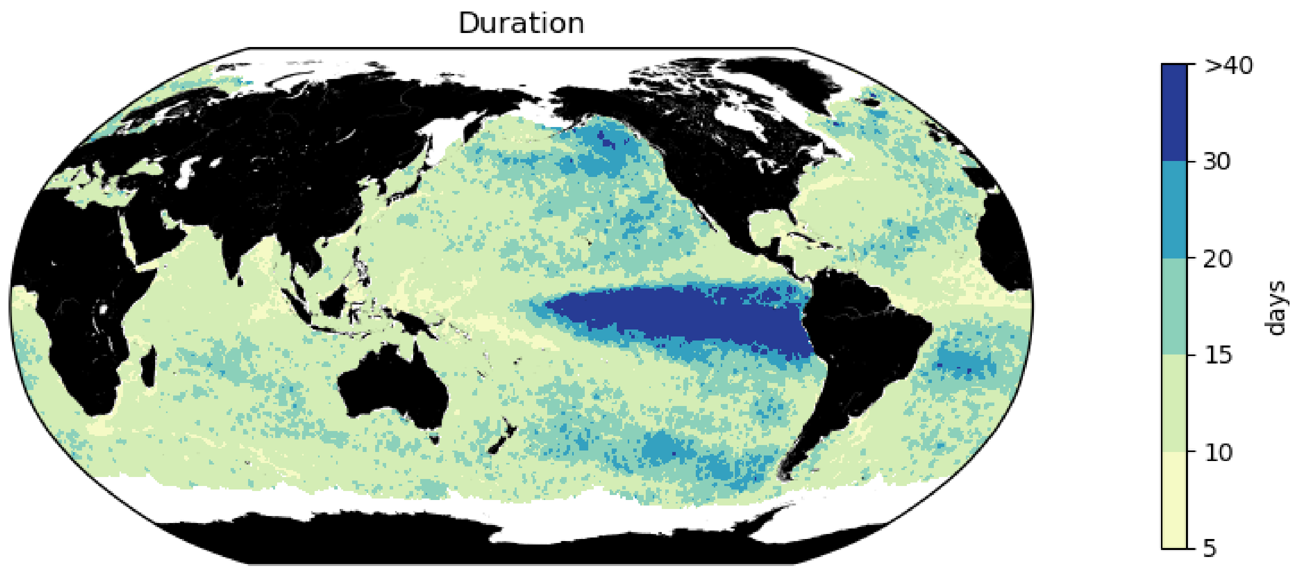
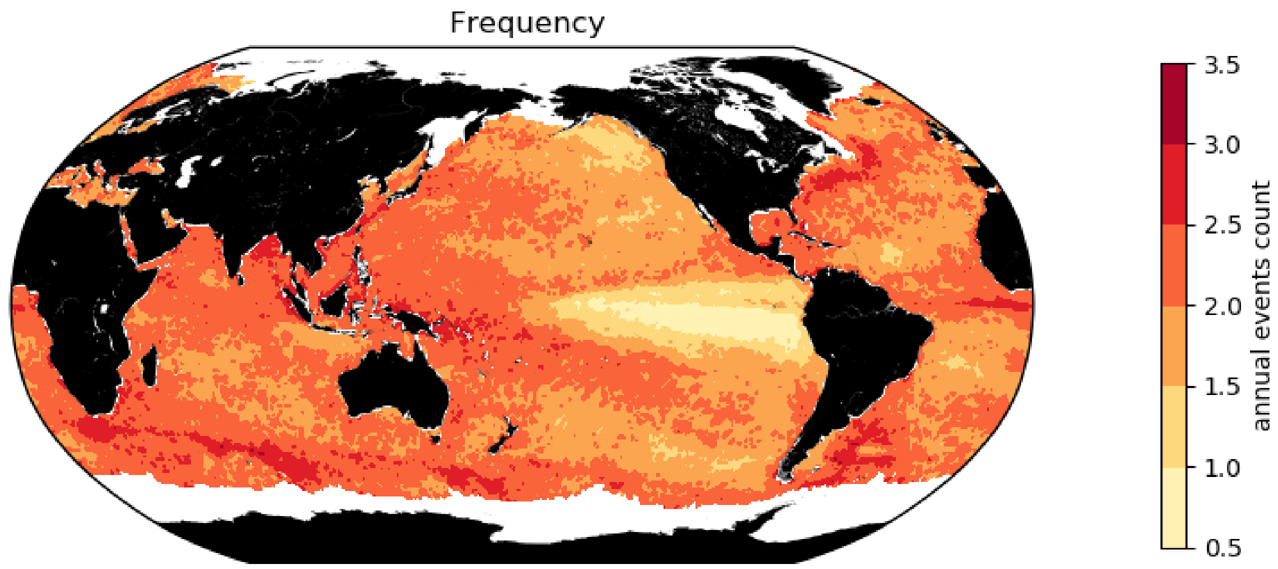
MHW ATLAS Output

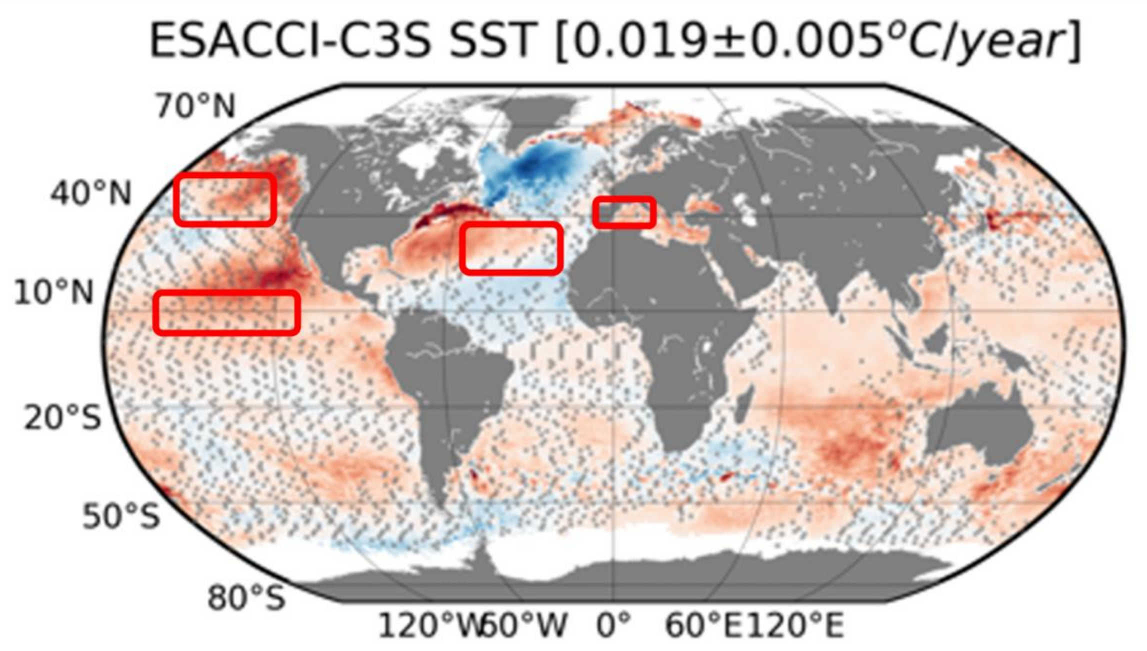
- **ADDED-VALUE:**

1. **Characterize MHW variability, drivers and precursors** that are responsible for MHW occurrence and evolution
2. Assess the **impact of MHW on marine biodiversity and biogeochemistry** along the water column
3. Identify **MHW role in the scope of compound events**
4. Assess **MHW impact on specific user-driven Use Cases**









THE PRODUCTION OF THE NEW ATLAS IS ONGOING !

MHW: the case of the Mediterranean Sea

ORIGINAL RESEARCH article

Front. Mar. Sci., 30 June 2023
Sec. Physical Oceanography
Volume 10 - 2023 | https://doi.org/10.3389/fmars.2023.1193164

Evolution of marine heatwaves in warming seas: the Mediterranean Sea case study

Justino Martínez[1*†], Francesca Elisa Leonelli[2†], Emilio García-Ladona[1], Joaquim Garrabou[1], Diego K. Kersting[3], Nathaniel Bensoussan[4] and Andrea Pisano[2]

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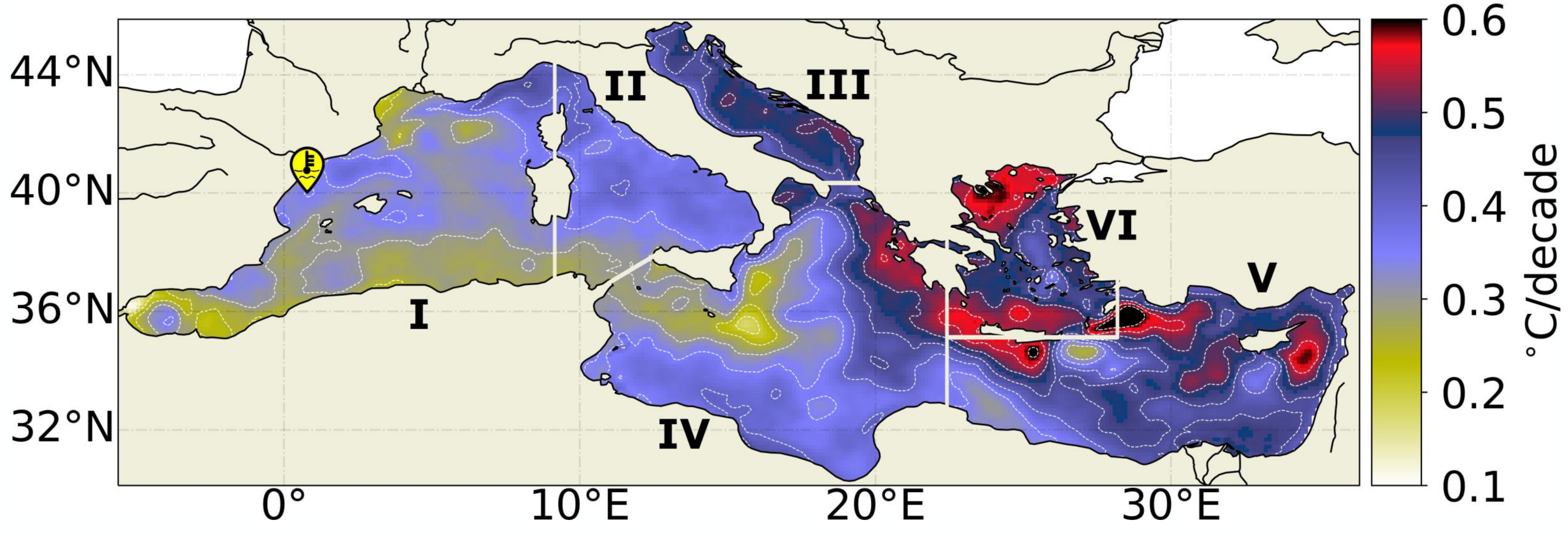

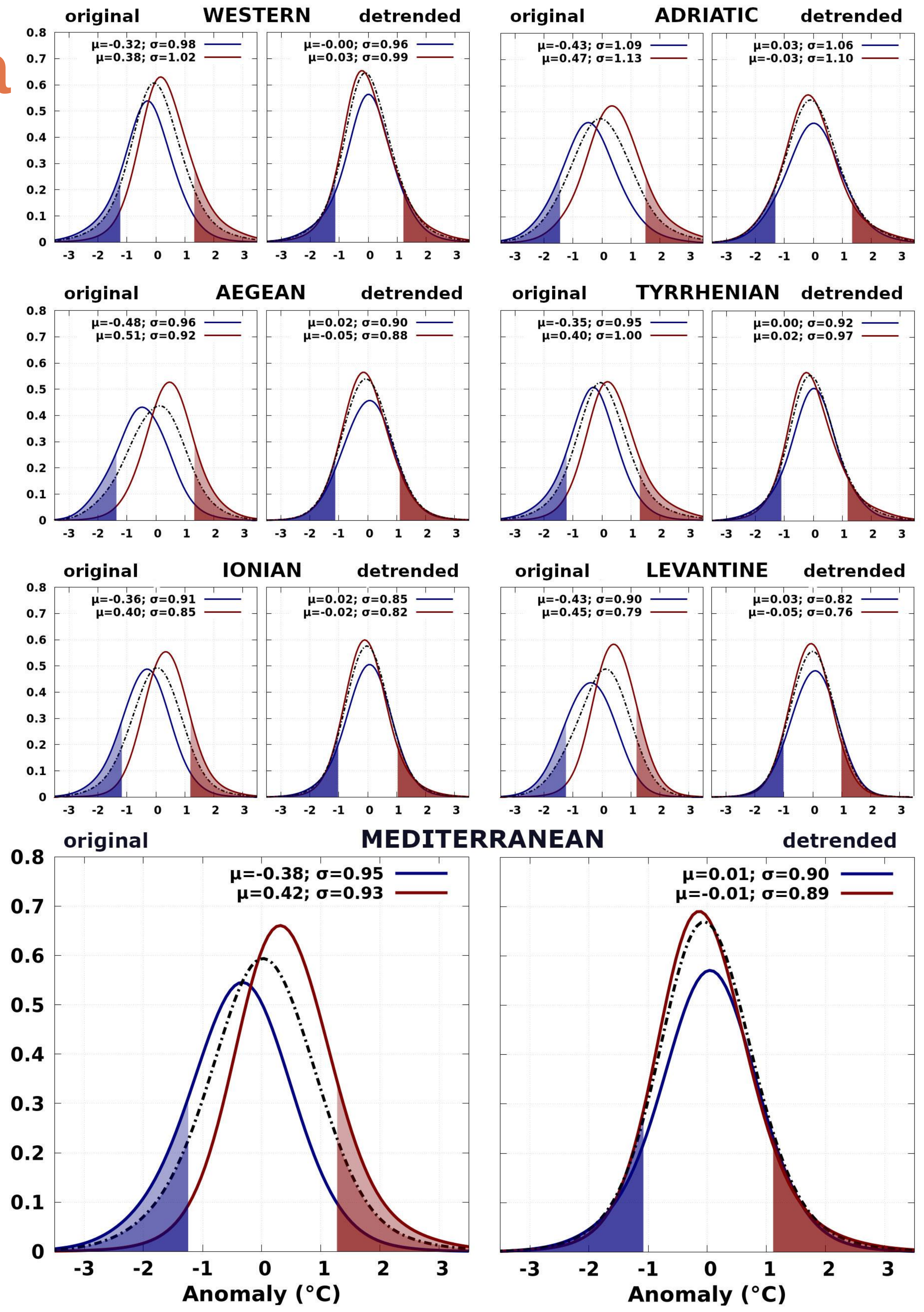

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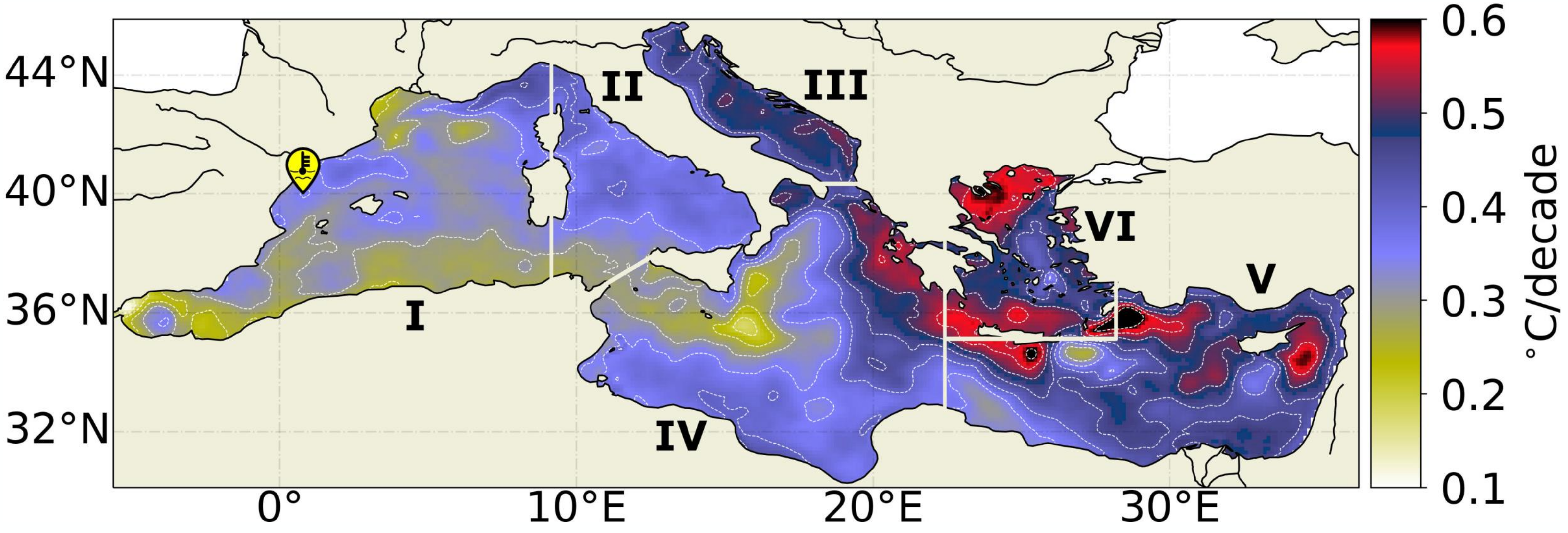
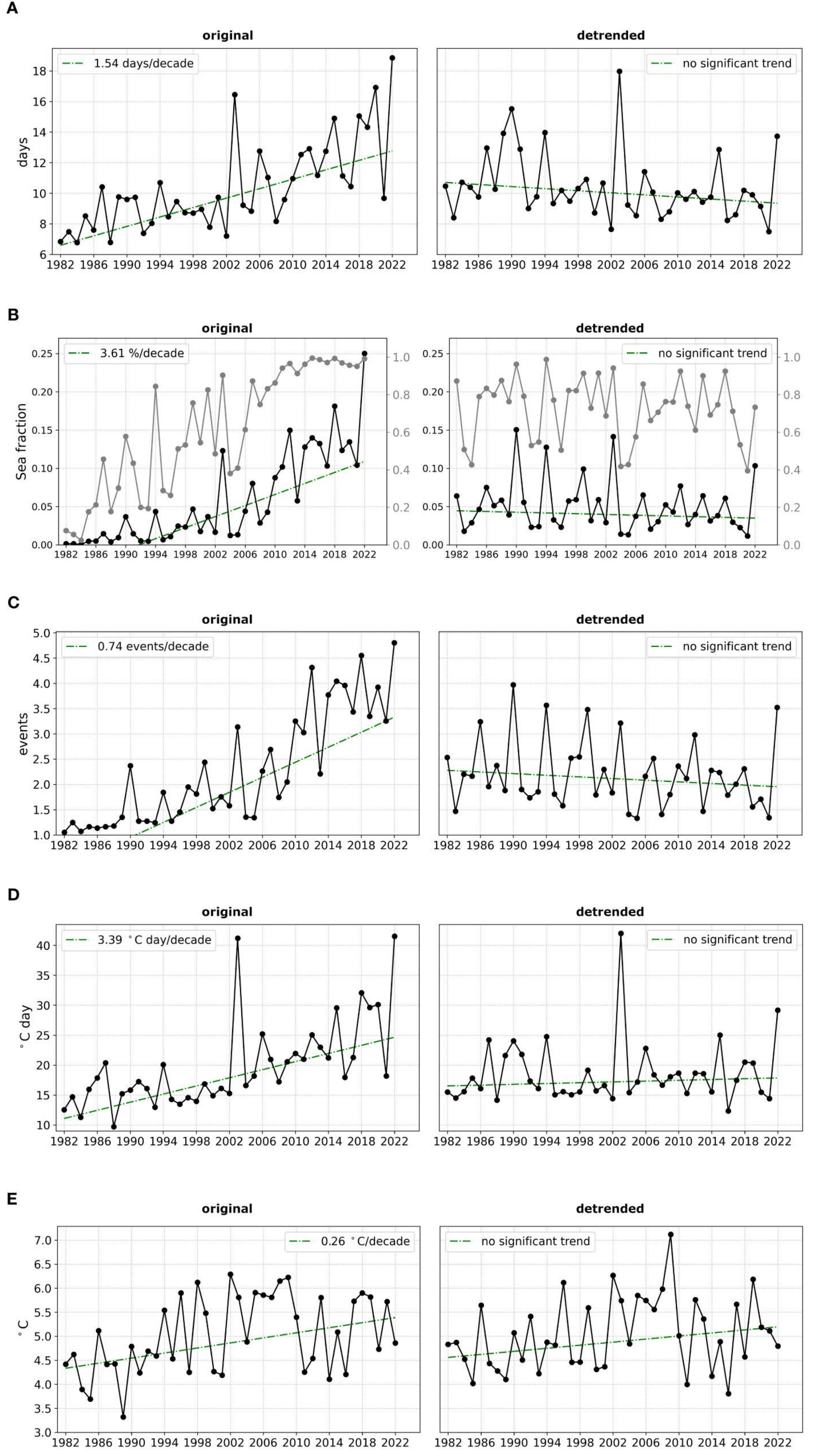
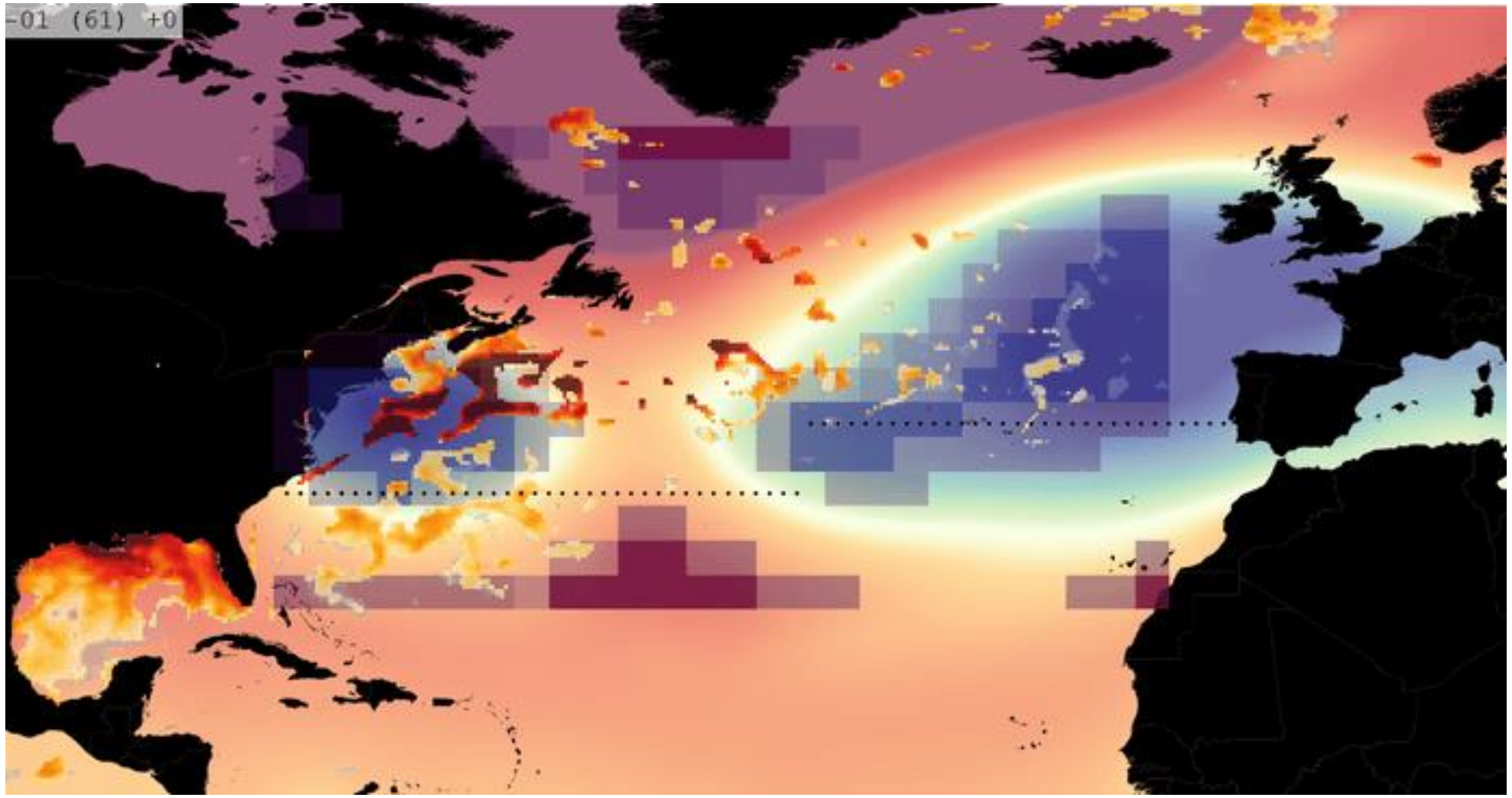
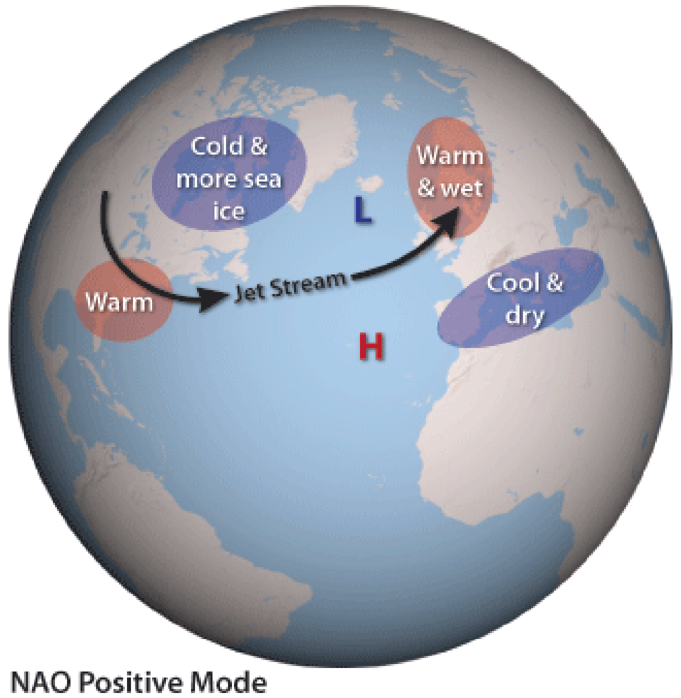


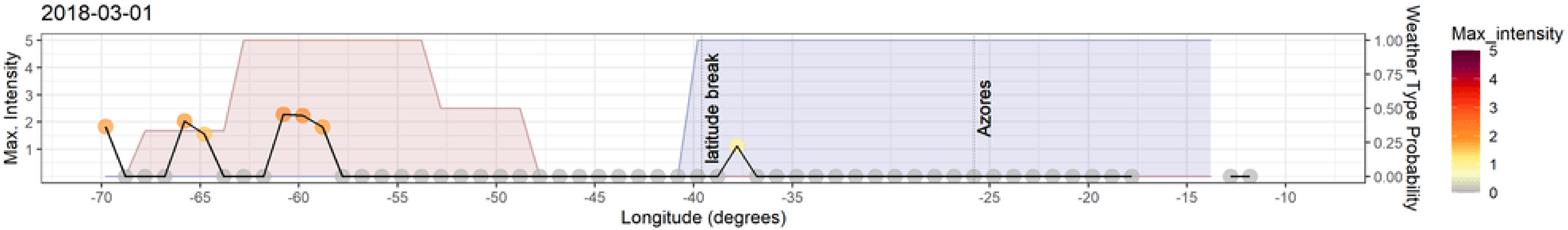


MHW: the case of the North Atlantic





NAO Positive Mode



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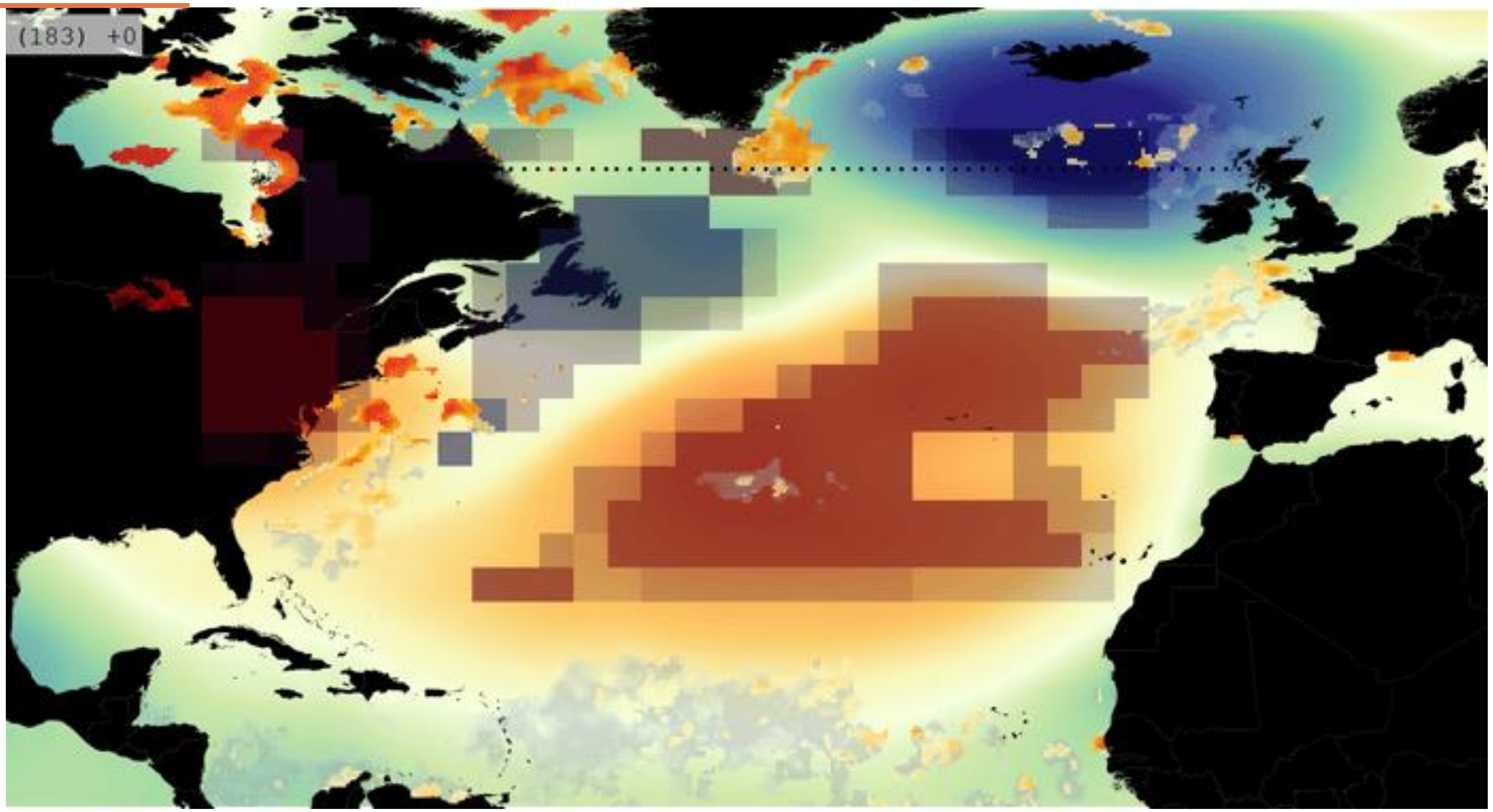
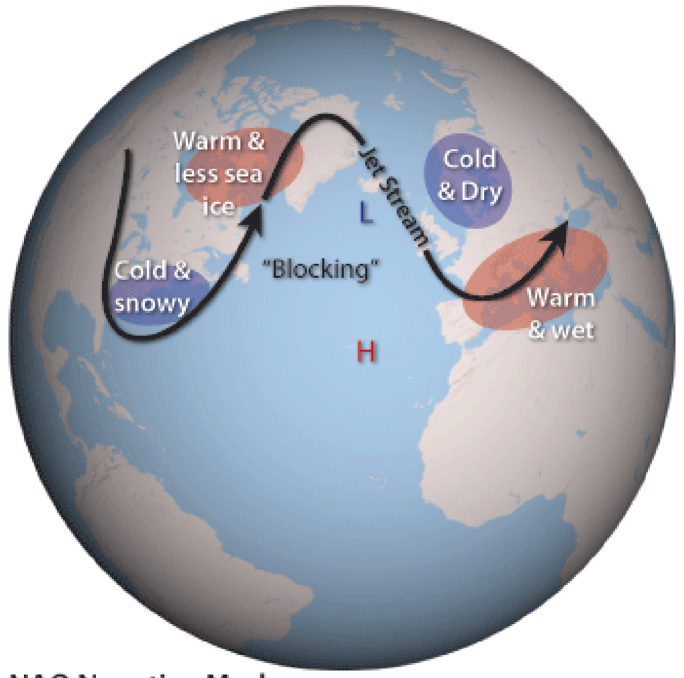
MHW: the case of the North Atlantic





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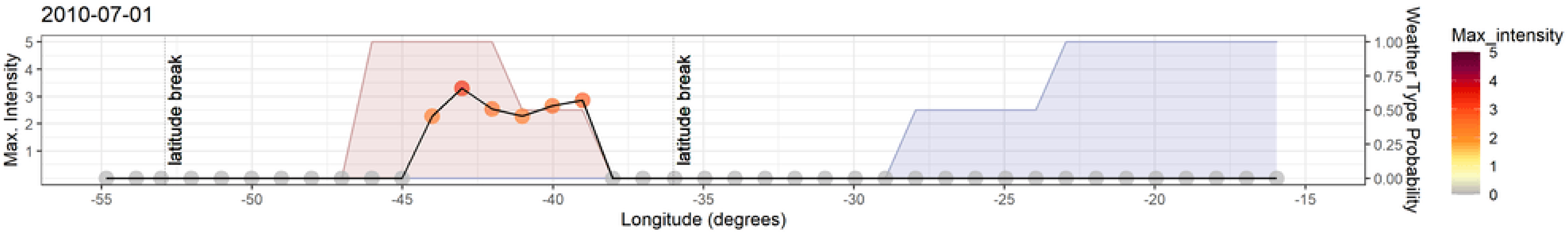

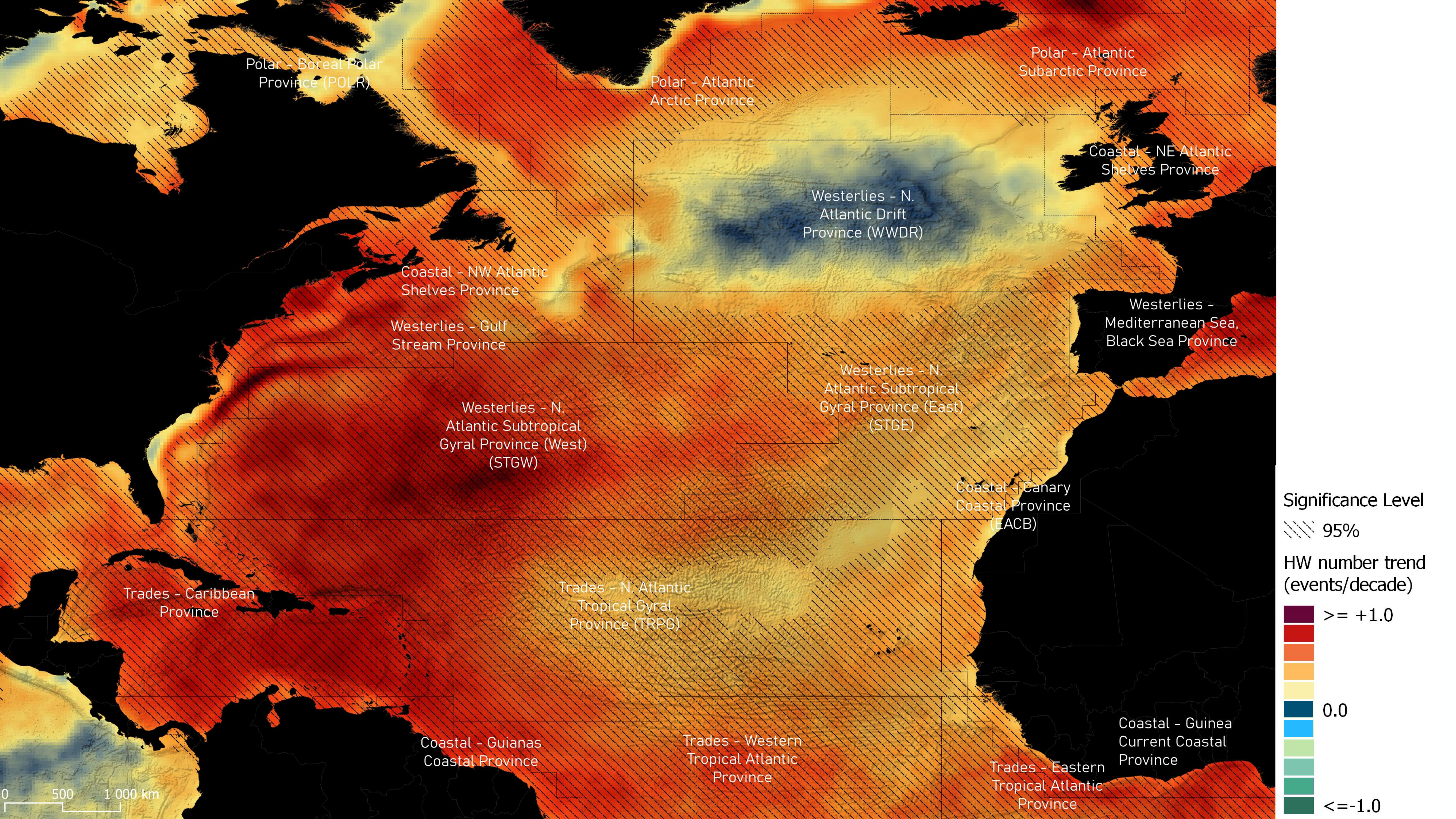

Polar - Boreal Polar Province (POLR)
Polar - Atlantic Arctic Province
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Coastal - NE Atlantic Shelves Province
Westerlies - N. Atlantic Drift Province (WWDR)
Coastal - NW Atlantic Shelves Province
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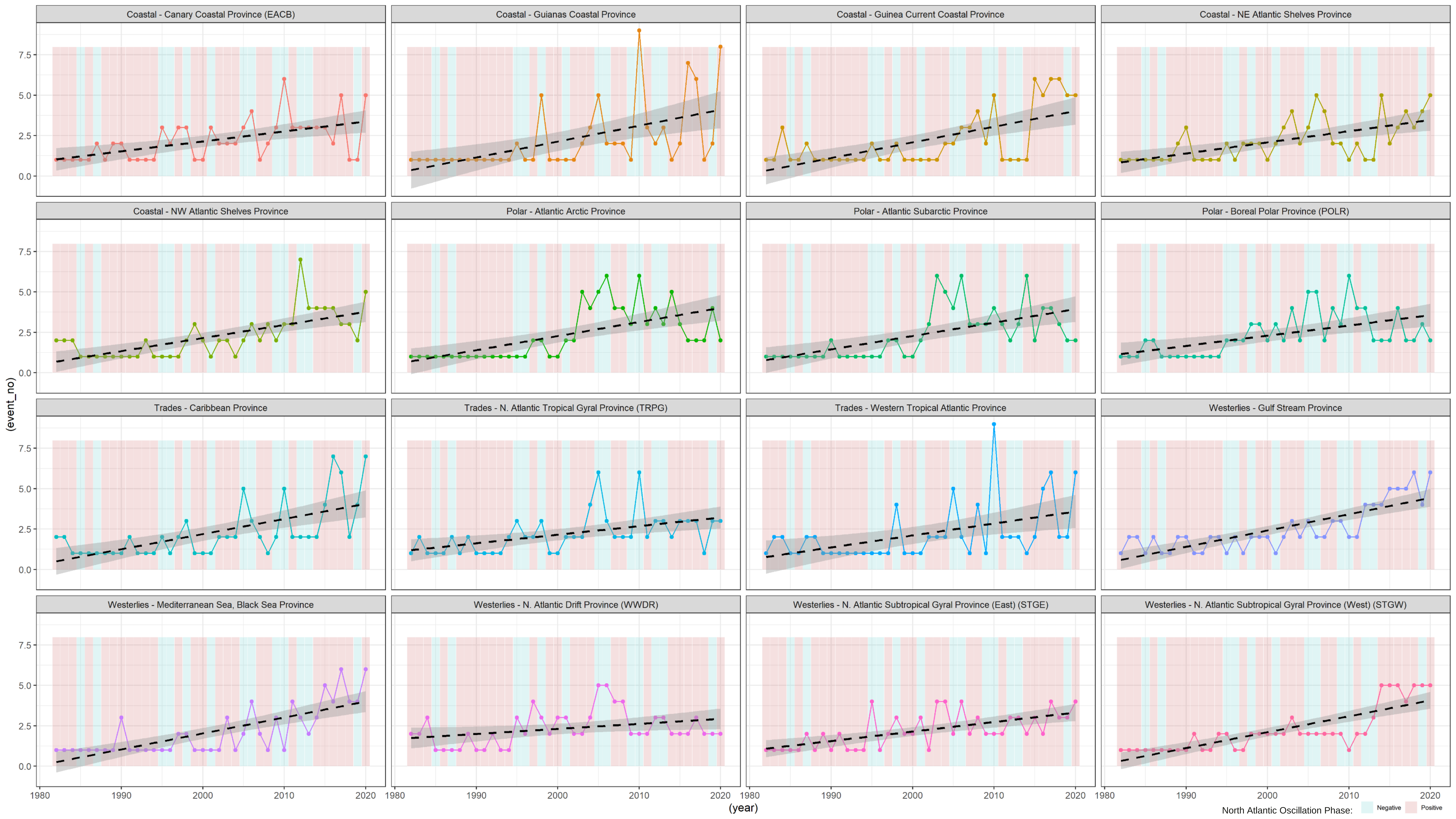
Coastal - Guinea Current Coastal Province
0
500
1 000 km
Significance Level
95%
HW number trend (events/decade)
>= +1.0
0.0
<=-1.0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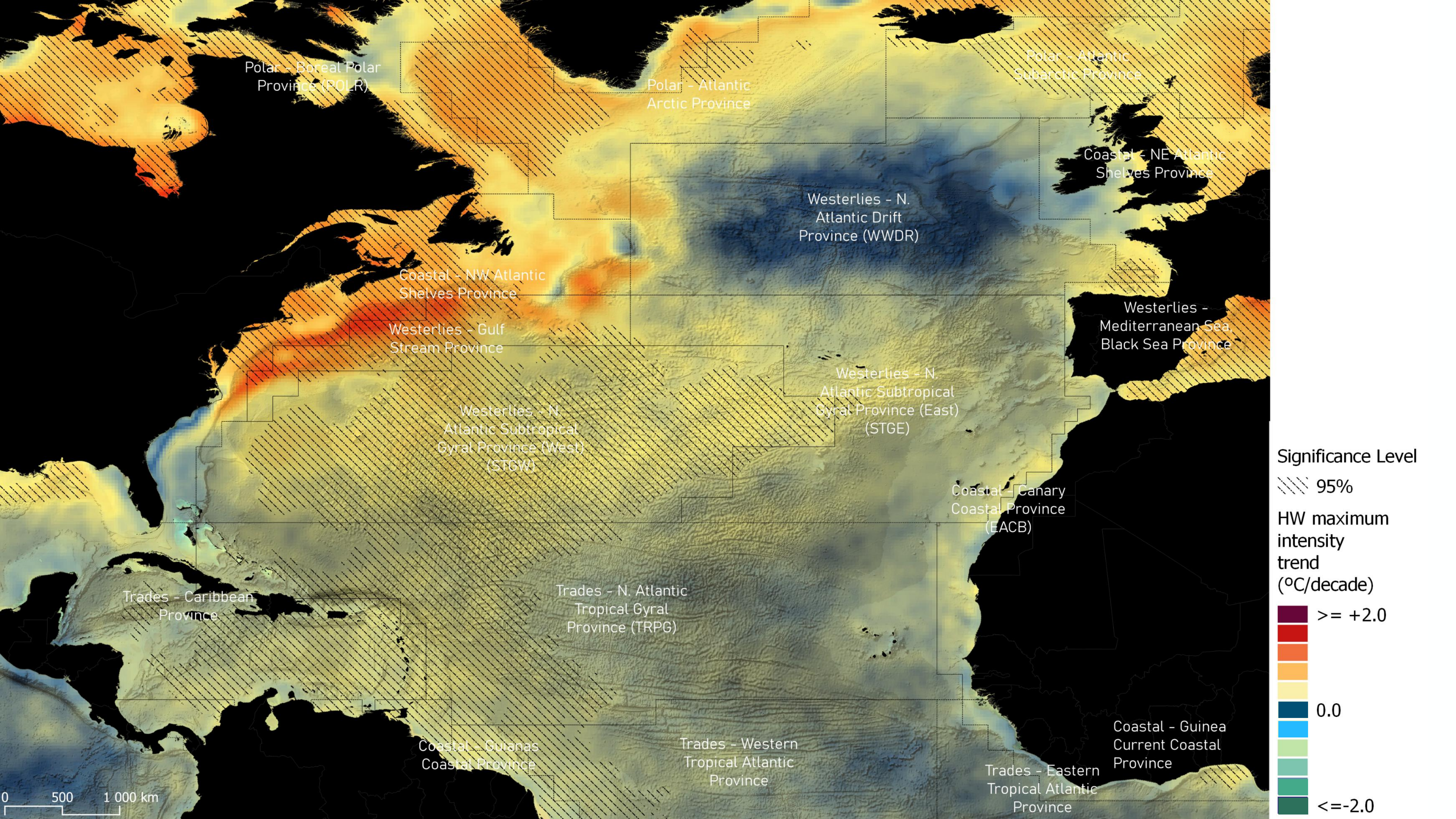
(event_no)
(year)
North Atlantic Oscillation Phase:
Negative
Positive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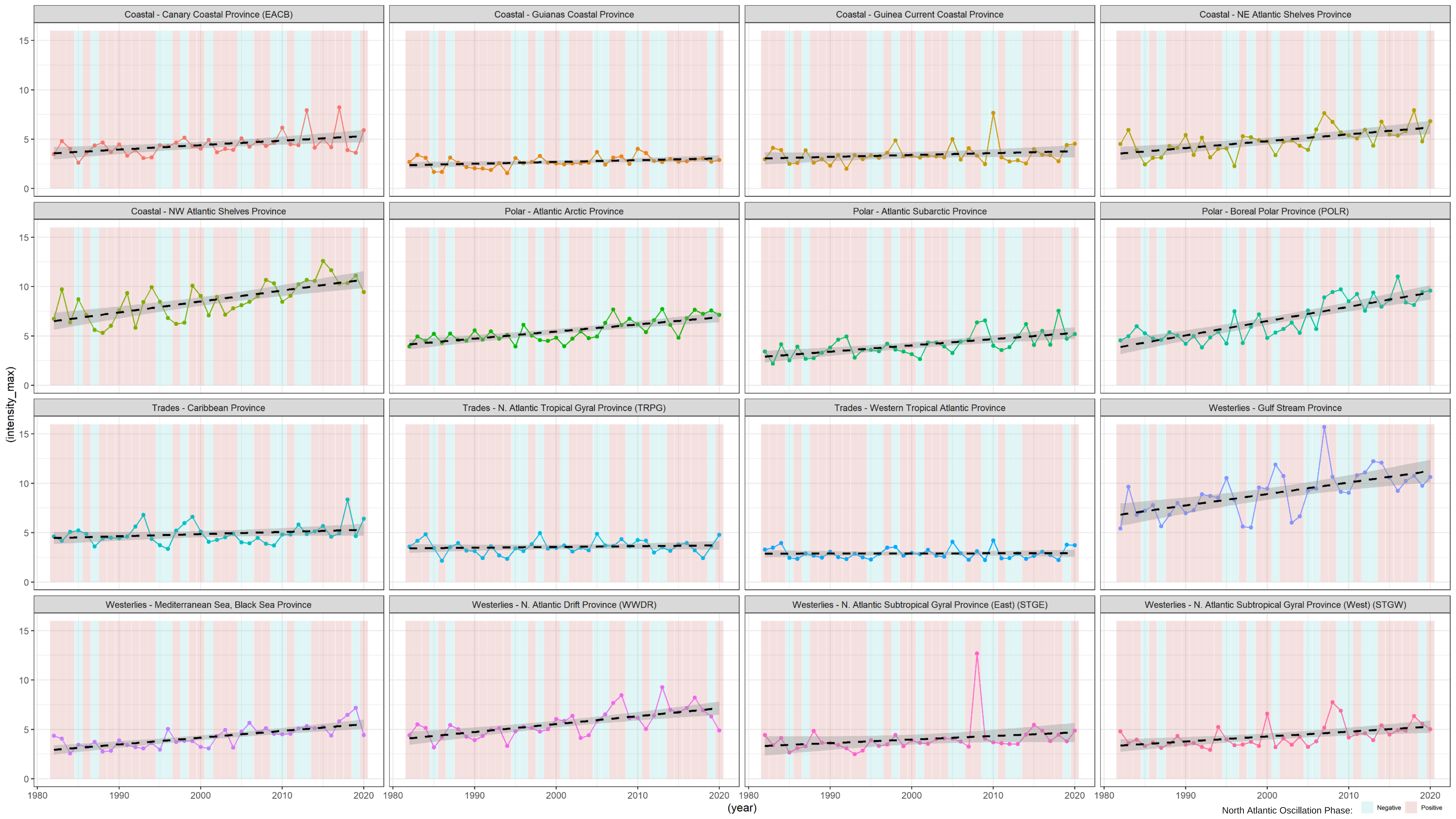

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MHW: Impact Assessment Use Cases

MHW Atlas/MHW-4D

Impact on Ecosystem Services
And Human acitivities

- Frequency/duration/intensity?
- Confounding/mediators factors?

Impact Assessment

WP5100: Fisheries Impact Assessment [CSL]

- SPECIES: skipjack and bigeye, tropical tunas
- LOCATION: South Pacific Subtropical
- DATA & METHODS: This task will use two reanalyses of the population dynamics of Pacific skipjack and bigeye populations, to explore the impact of the most extreme MHW events on tunas for short term and long-term impacts.
- EXPECTED RESULTS: contribute to fish stock estimation/management

WP5200: Aquaculture Impact Assessment [+ATL]

- SPECIES: seabream and kelp
- LOCATION: Subtropical and Subarctic North Atlantic
- DATA & METHODS: This task will use WP3000 outputs and biological data provided by the aquaculture stakeholders to test the biological response to MHW
- EXPECTED RESULTS: contribute to aquaculture optimization/decision-support

WP5300: Marine Protected Area Impact Assessment [ENEA]

- SPECIES: endemic coral, sea urchin and marine bird
- LOCATION: Mediterranean
- DATA & METHODS: MHW atals will be used together with in situ biological data to better understand the biology, physiology and behaviour of target protected species
- EXPECTED RESULTS: contribute to environmental health protection

MHW: Impact Assessment Use Cases

MHW Atlas/MHW-4D

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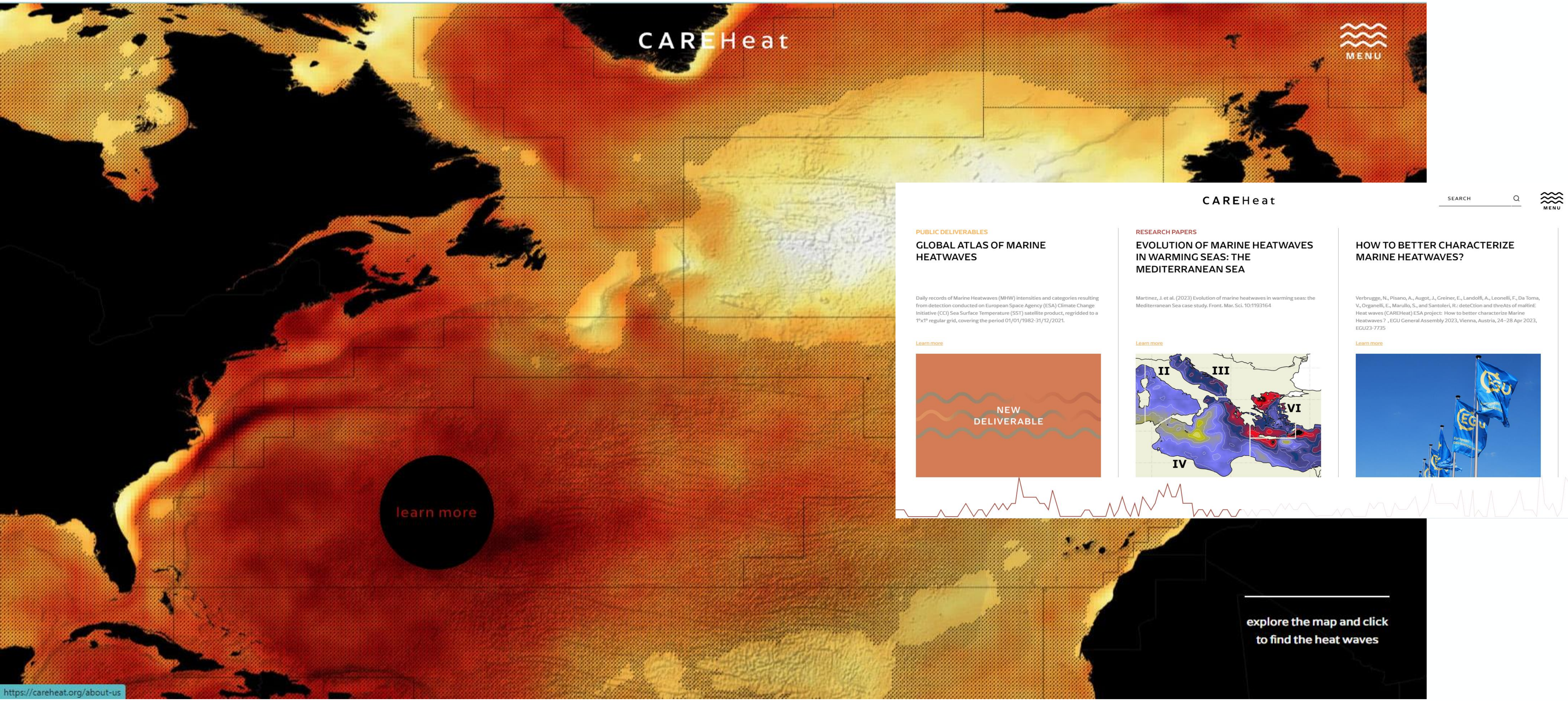

https://careheat.org/
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CAREHeat

deteCtion and threAts of maRinE Heat waves

Thanks for your attention

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