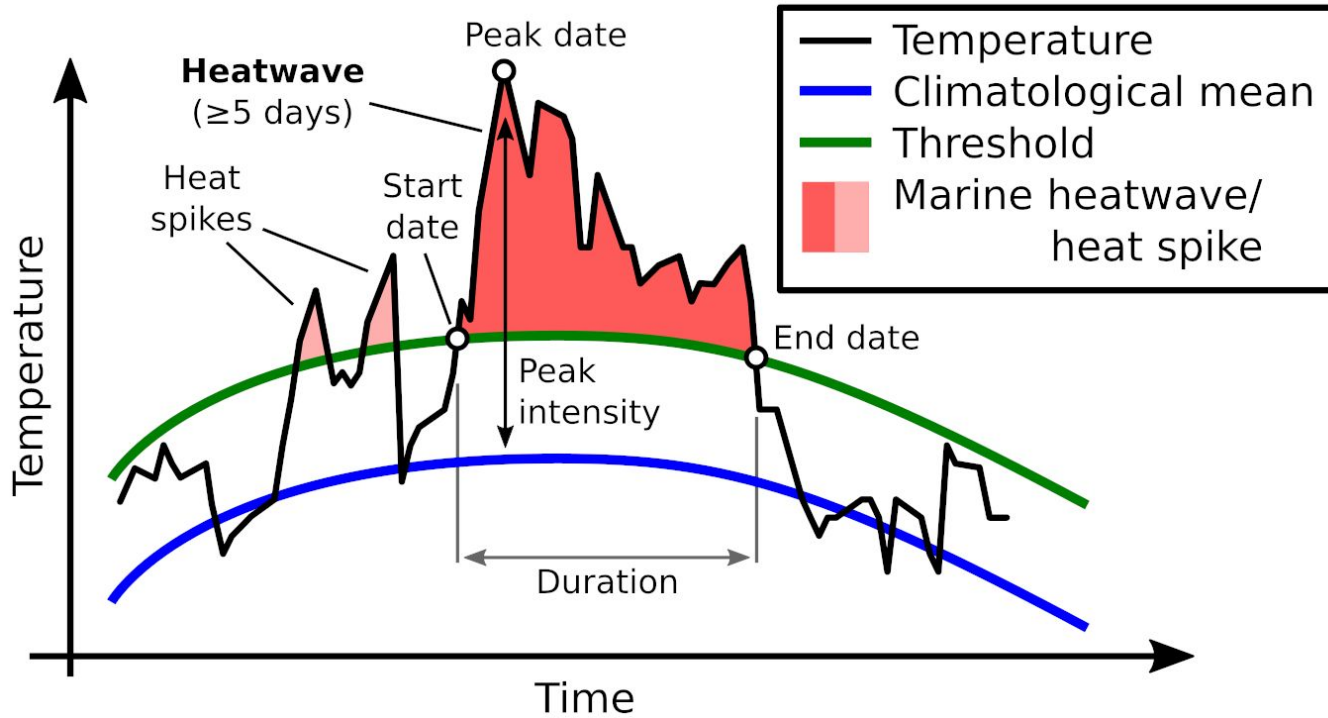


THE DETECTION OF MARINE (AND MARINE COLD-SPELLS) THE TOOLS AND RESOURCES AVAILABLE

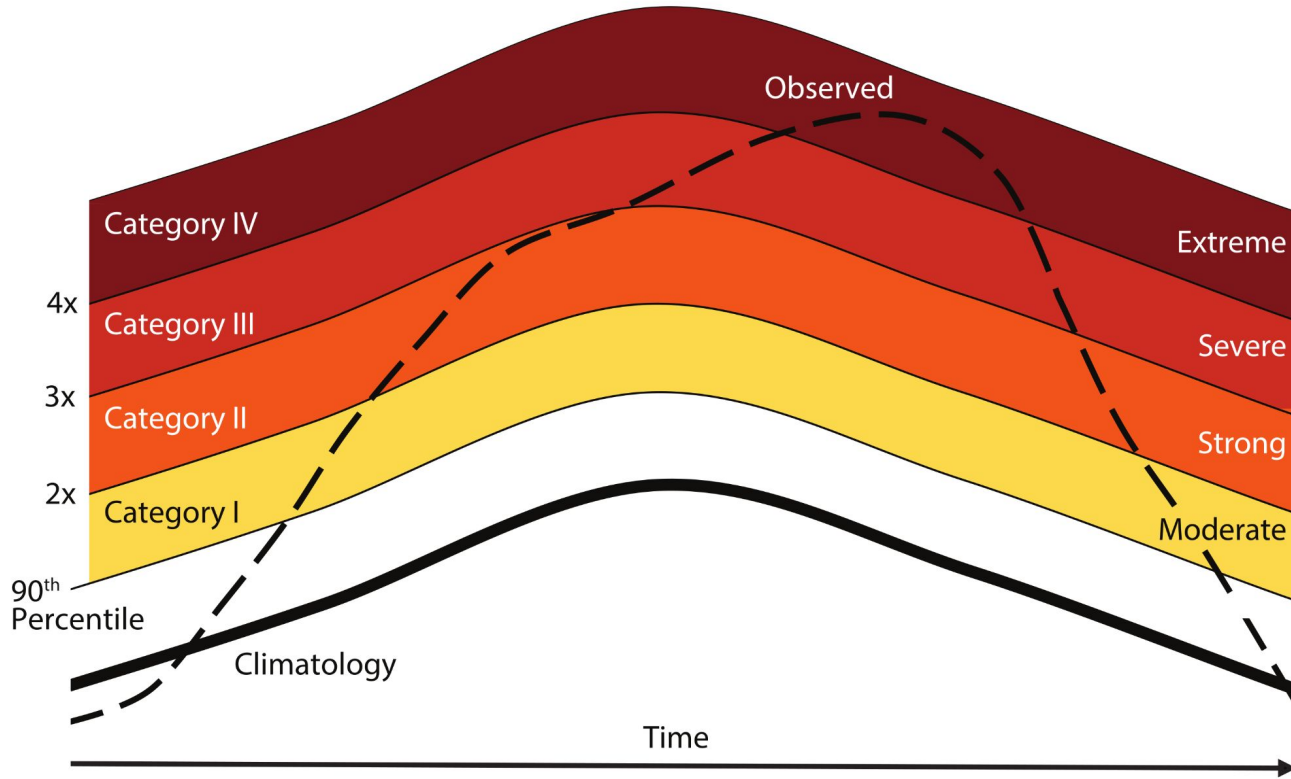
- Definition
 - 'Classic' vs adapted
 - Software - i.e. code
- Data
 - *In situ*
 - Remote
 - Model
- Databases
 - Dataset
 - Summary
 - Interactive
- Detection
 - Non-stationary - i.e. Lagrangian vs Eulerian
 - 4D - i.e. depth + time
- Example

DEFINITION



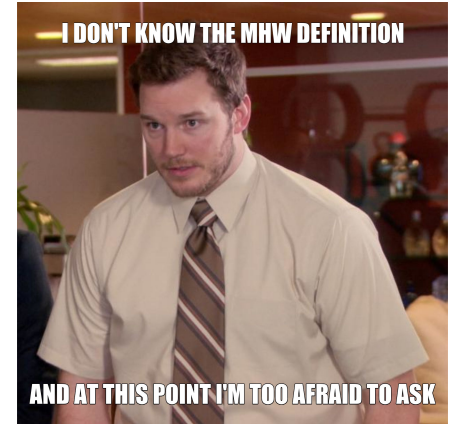
Oliver; MHW International Working group

Hobday et al. (2016) : A hierarchical approach to defining marine heatwaves



Hobday et al. (2018) : Categorizing and naming marine heatwaves

- To trend or not to trend? That is the question.
- Is 5 days is too short?
- Why the 90th percentile?
- Do the categories mean anything?
- Daily data only?
- Can MHWs move?
- Are surface events the same at depth?





- **marineHeatWaves**
 - github.com/ecjoliver/marineHeatWaves
- **heatwaveR**
 - robwschlegel.github.io/heatwaveR
- **m_mhw**
 - github.com/ZijieZhaoMMHW/m_mhw1.0
- **xmhw**
 - xmhw.readthedocs.io/en/latest
- **heatwave3**
 - robwschlegel.github.io/heatwave3

DATA

- Daily time series with 20+ years
- Not more than 20% missing
- Not more than 3 consecutive days missing
- Multiple variables within network
 - Physical and biogeochemical
- Actively supported into future

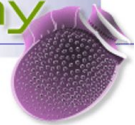
somlit
Service d'Observation en Milieu Littoral



biogeochemical
Argo

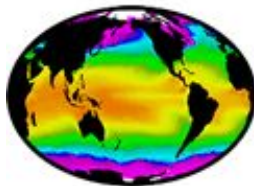
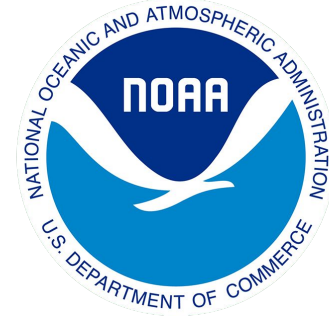
TMEDNet

rephy



- Temporal resolution
 - Return period of 1-2 days
- Spatial resolution + coverage
 - i.e. Level 3 (L3) vs Level 4 (L4)
- Still want 20+ years
- Operational or near-real-time
- Ease of access and data format
- Future support
 - End of life or renewed missions?

dOISST v2.1



GHRSSST
GROUP FOR HIGH RESOLUTION
SEA SURFACE TEMPERATURE



MODIS

Moderate Resolution Imaging Spectroradiometer

- Depth?
- Multiple pathways?
- Ease of access
 - API or code library?
- Spatial AND temporal subsetting?
- How many variables?
 - Downloaded separately?
- Updated regularly?

GLORYS12v1



Copernicus
Marine Service



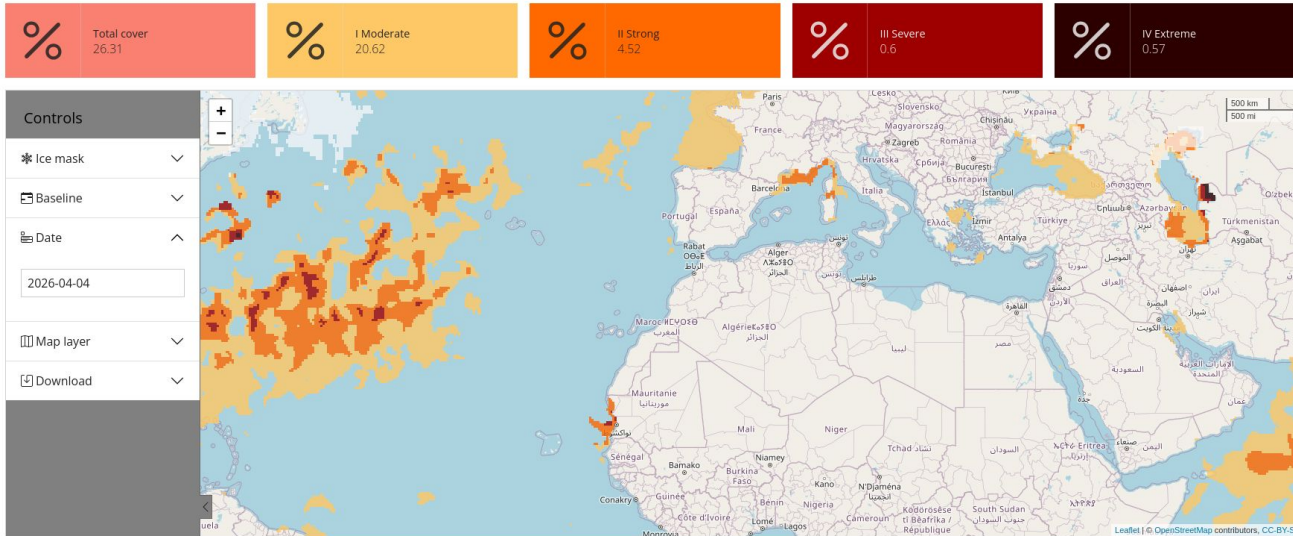
**MERCATOR
OCEAN**
INTERNATIONAL



DATABASES

- MHW-MAD – Global
 - 1982 to 2024
 - $0.05^\circ \times 0.05^\circ$
 - Hayward et al. 2025
 - essd.copernicus.org/preprints/essd-2025-590
- Baltic sea
 - 1983 to 2023
 - $0.02^\circ \times 0.02^\circ$
 - Bashiri et al. 2025
 - nature.com/articles/s41597-025-06251-7

- Point B - CoastHF / LOV
 - obs-vlfr.fr/~gazeau/Temperature_EOL.html#canicules-marines
- MHWMS - icatmar
 - cosmo.icm.csic.es/MMS/index.php
- Coral Reef Watch - NOAA
 - coralreefwatch.noaa.gov
- MHW Bulletins - Mercator

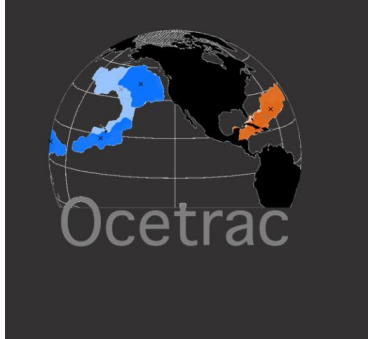


- MHW Tracker - MHW International Working Group
 - www.marineheatwaves.org/tracker.html
- NOAA Marine Heatwaves
 - psl.noaa.gov/marine-heatwaves

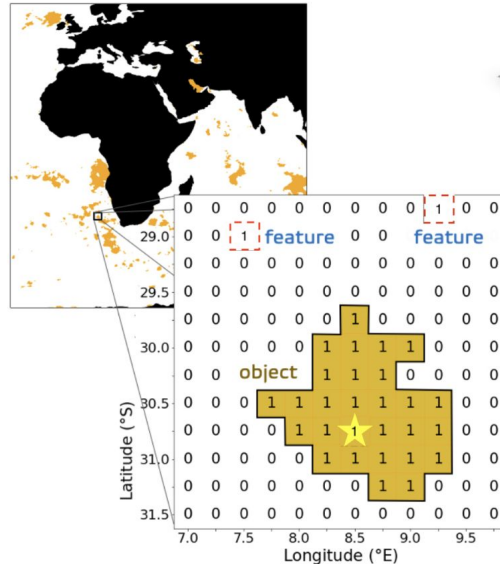
DETECTION

OCETRAC

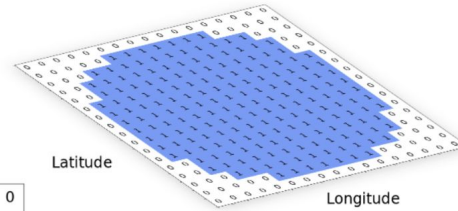
- Spatiotemporal Evolution of Marine Heatwaves Globally
 - Scannell et al. 2024



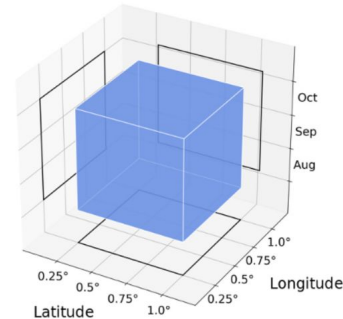
(a) Binary Image



(b) 2D Structuring Element (R=8)

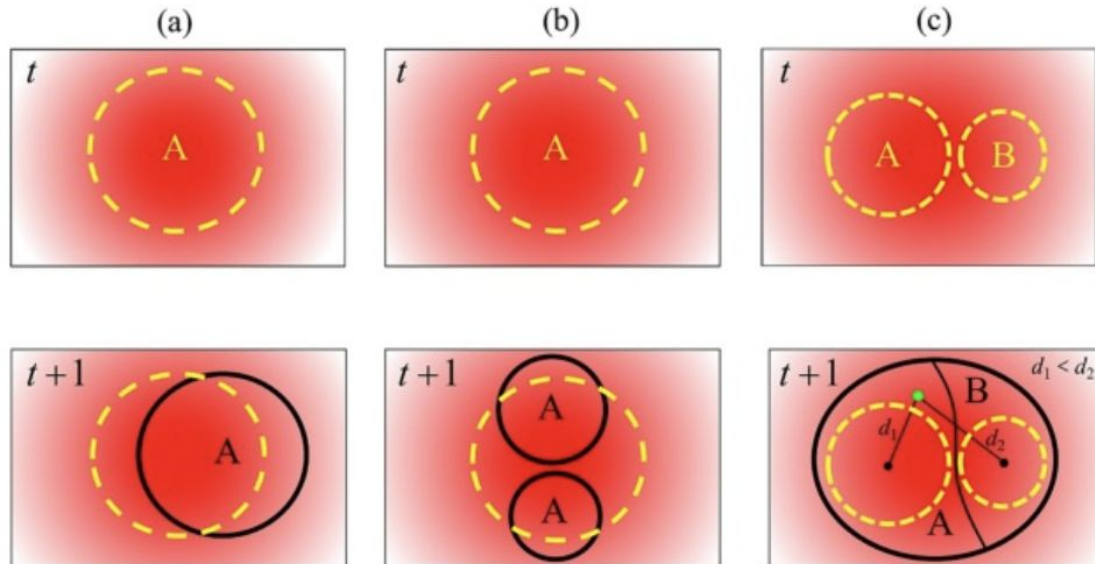


(c) 3D Connectivity Element



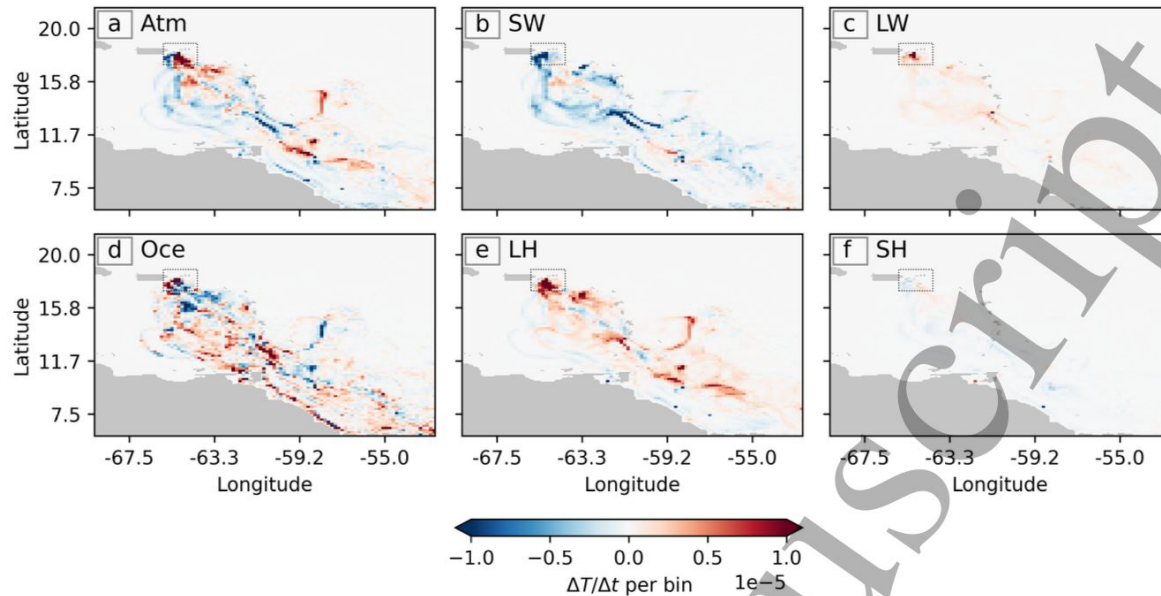
MHWTRACKING

- Characterizing global marine heatwaves under a spatio-temporal framework
 - Sun et al. 2023



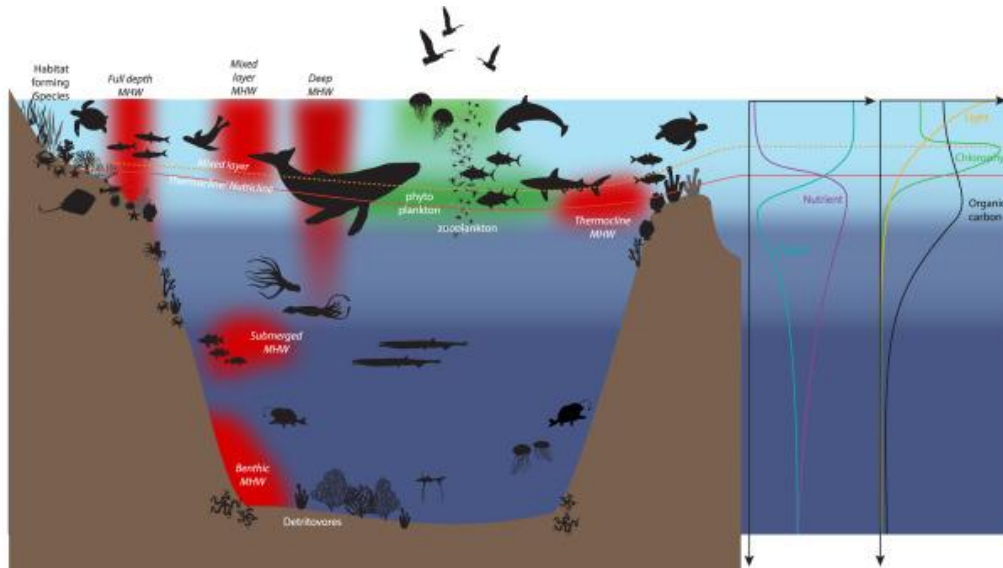
TRACMASS-LMHW

- Lagrangian attribution of marine heatwave drivers
 - Eisbrenner 2025



MHW TYPOLOGY

- Lifting the lid on marine heatwaves
 - Malan et al. 2025



TOOLS SHOULD BE:

- **Usable**
 - Is the methodology/algorithm in a language most researchers use?
- **Portable**
 - Can it be applied to any computing environment?
- **Applicable**
 - Can the results be used '*as is*' for a range of investigations?

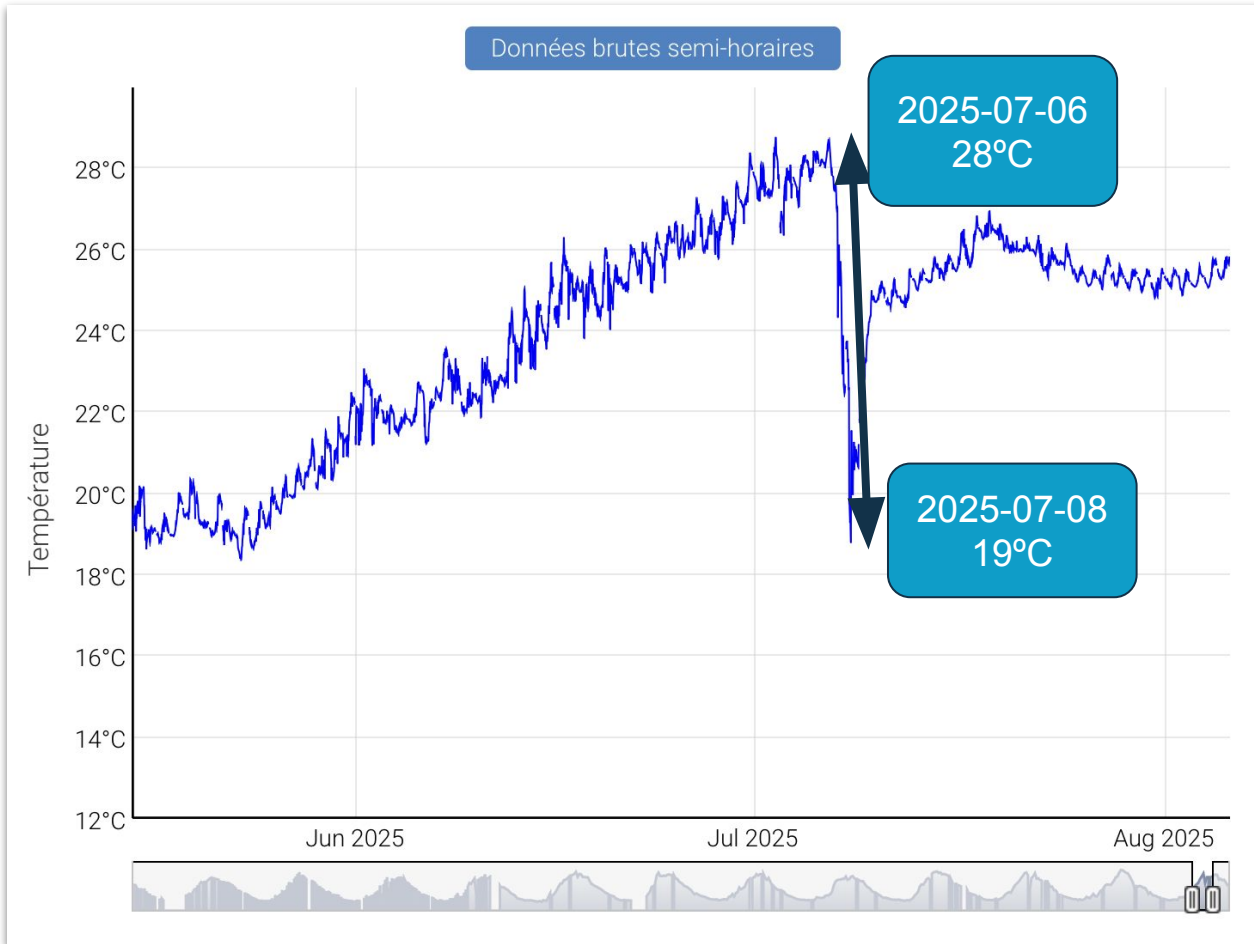
EXAMPLE

POINT B



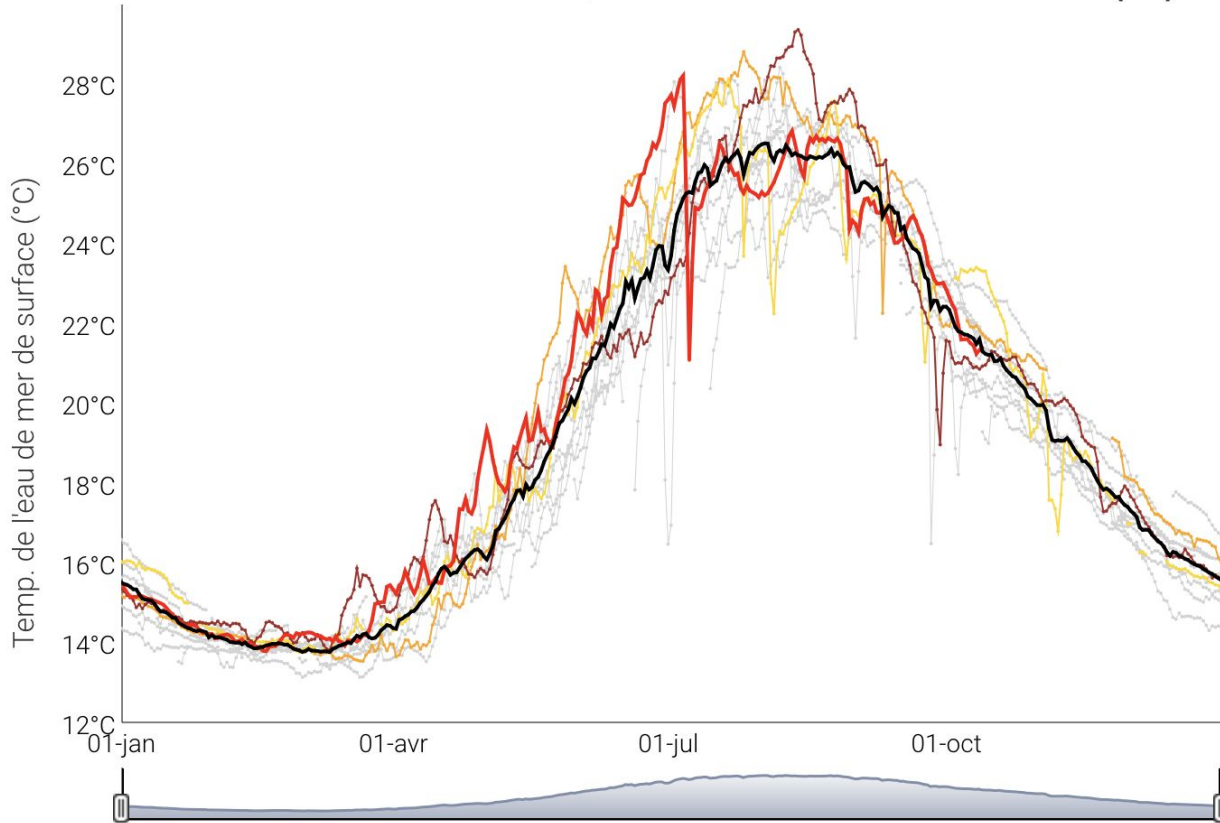
Crédits : Alliouane S.



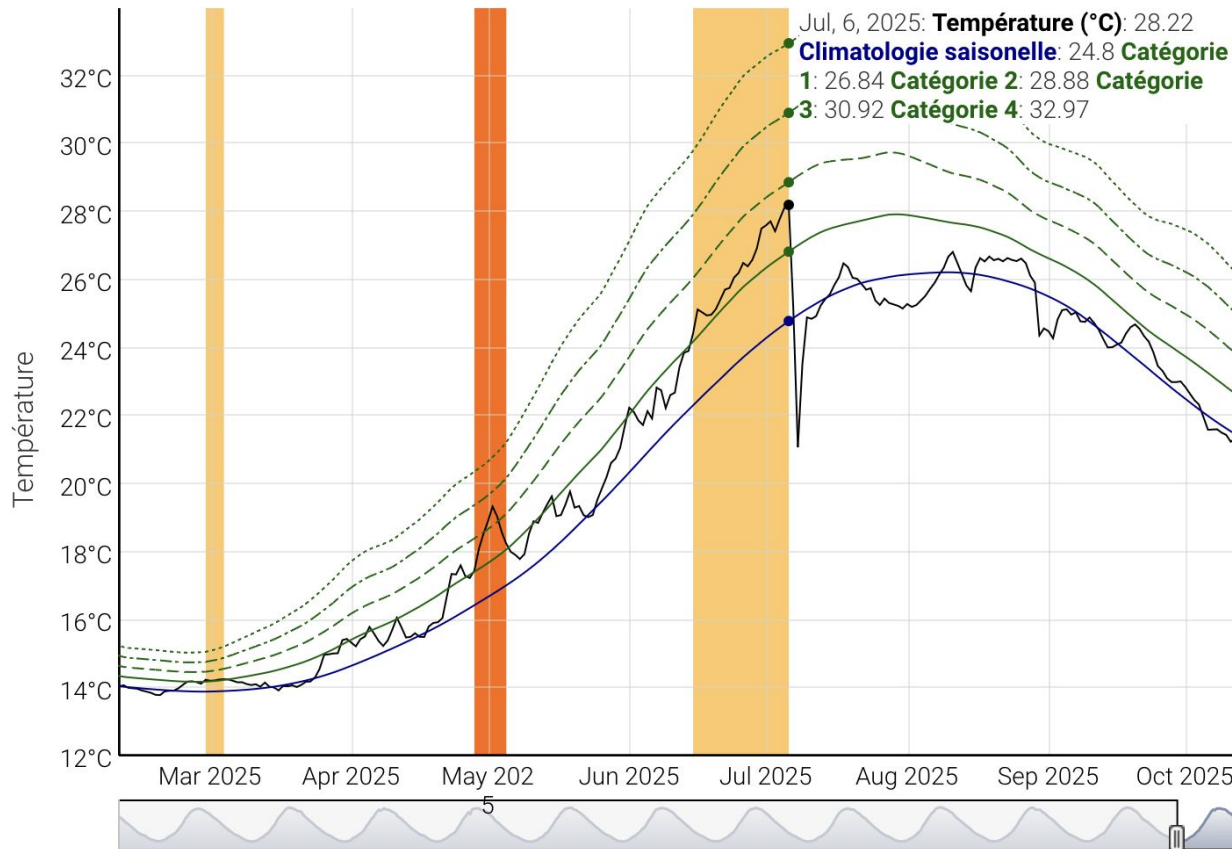


POINT B

Méditerranée Nord-Occidentale, Rade de Villefranche-sur-Mer (06)

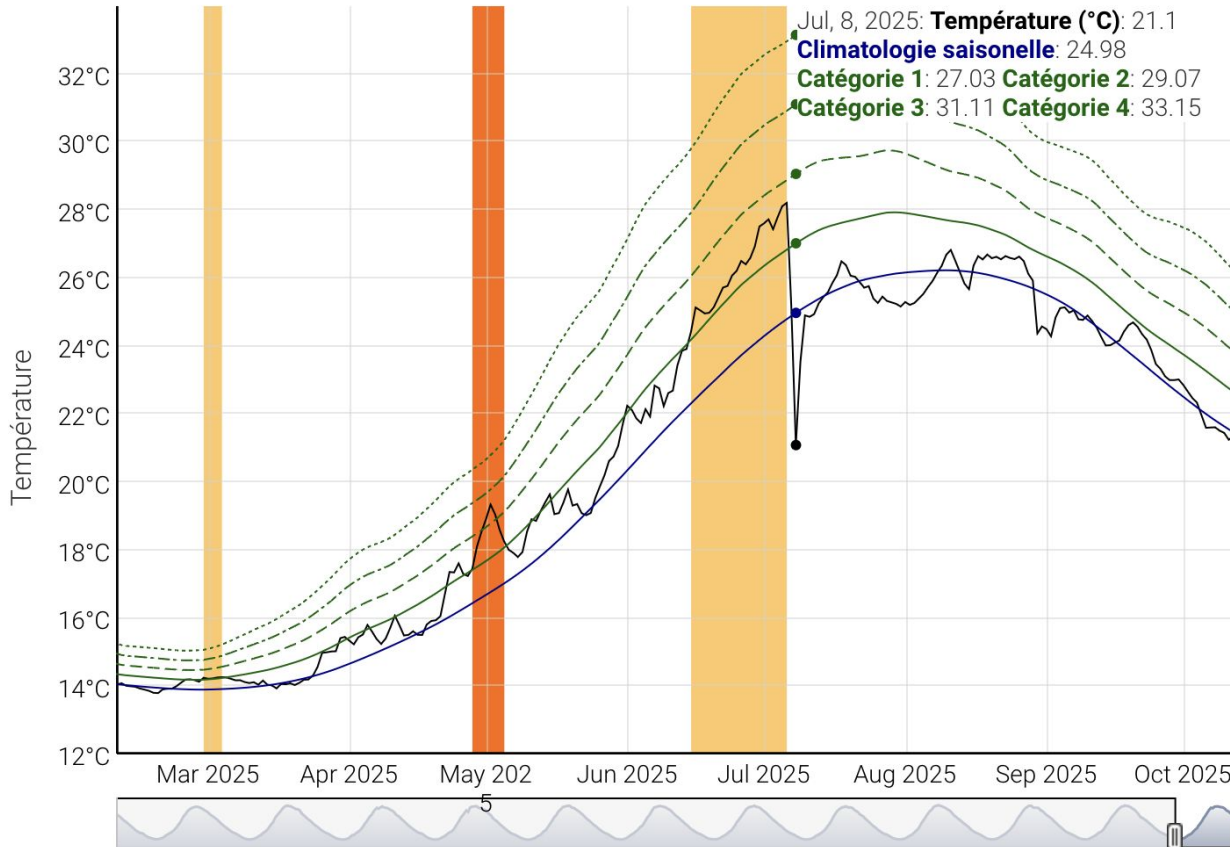


• Période de référence : 2013-09-16 à 2025-10-13



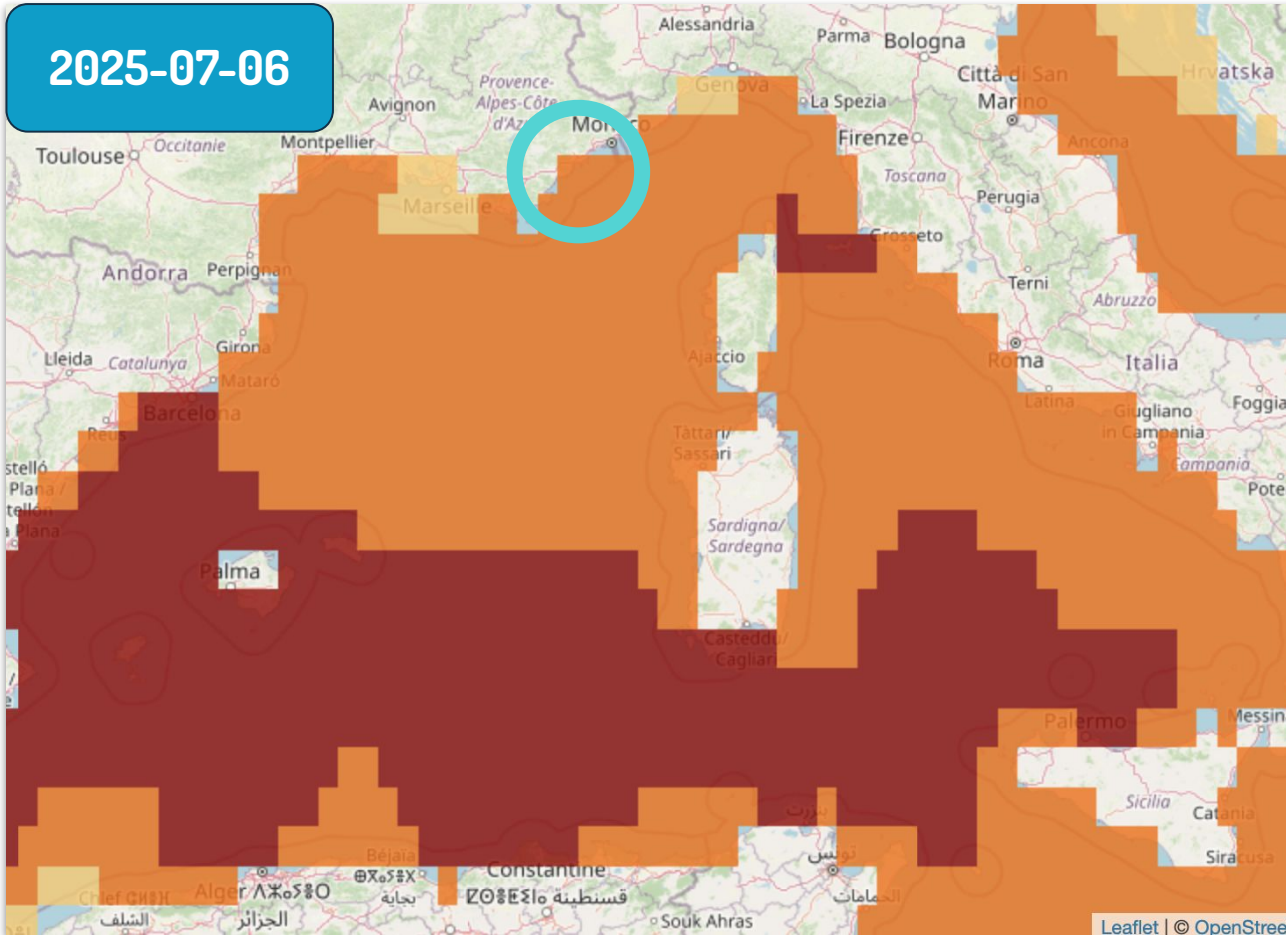
POINT B

• Période de référence : 2013-09-16 à 2025-10-13

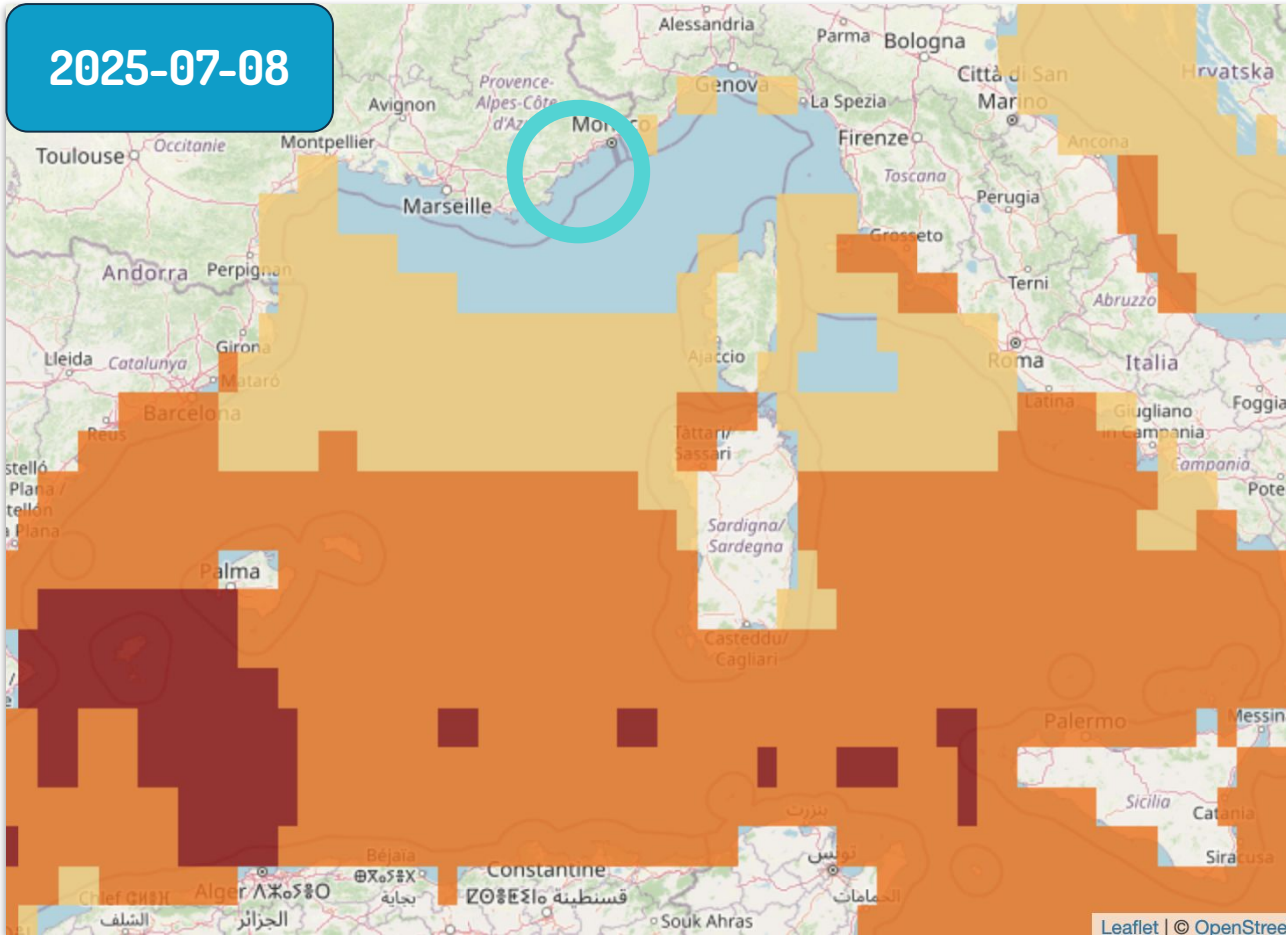


MHW
TRACKER

2025-07-06



2025-07-08



MHW
TRACKER

