Marine Heat Waves in the Mediterranean Sea: an assessment from the surface to the subsurface to meet national needs

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Surface MHWs in the Mediterranean Sea

Recent works providing a comprehensive characterization of surface MHWs

Publication	Project	Data used	Period of study	Climatology period	(Sub)-regions	Metrics used	Method.
Dayan et al. (2022)	Eurosea WP2/OSR6	SST satellite + model	1993-2019	1993-2014	Whole Med 4 bio-regions	Frequency, duration, max. intensity, severity	Hobday et al. (2016)
Juza et al. (2022)*	Eurosea WP6	SST satellite	1982-2020	1982-2015	Whole Med 28 sub-regions	Frequency, duration, mean & max. intensity	
Darmaraki et al. (2019)	-	SST satellite + model	1982–2017	1982-2012	Whole Med	Frequency, duration, intensity, severity, max. spatial coverage	
Dayan et al. (in prog.)	Eurosea WP2/6/7	SST + subsurf. T satellite + model	1987-2019	1987-2016	Whole Med 18 EEZs	Frequency, duration, max. intensity	

Large variety due to data availability, strategy, stakeholders, relevancy etc.

* Associated web-based application for the Mediterranean Sea https://apps.socib.es/subregmed-marine-heatwaves/

A general definition for a global identification of MHWs

Definition:

An anomalously **warm event** to be a MHW if it **lasts for five or more days**, with **temperatures warmer than the 90th percentile** (Hobday et al., 2016), based on a baseline period.

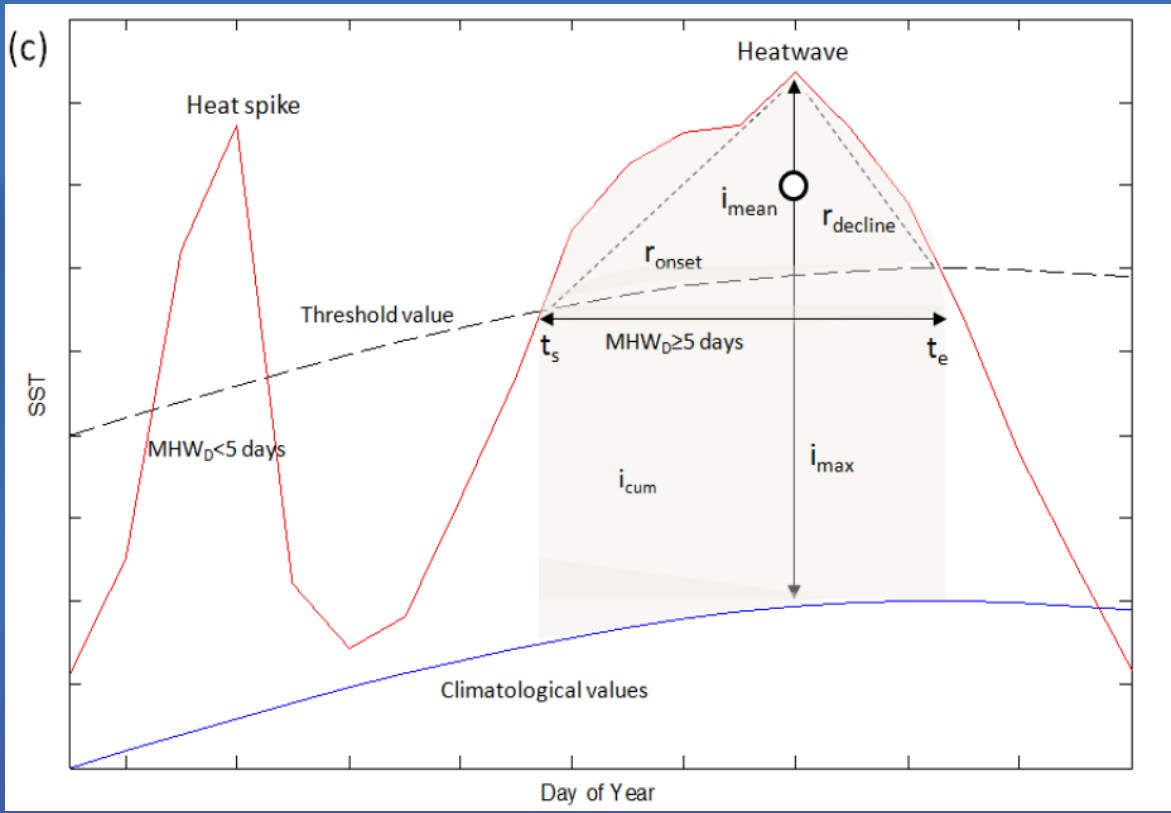


Figure 1 from Hobday et al. (2016).

Method and data

Using the method described by (Hobday et al, 2016), specifically using the algorithm made freely available at https://github.com/ecjoliver/marineHeatWaves

Study period: **1987-2019** (corresponds to temporal coverage of the GLOBAL reanalysis)
Climatology period: **1987-2016**
Percentile target: **90th**
Climatology and percentiles smoothed with **31-day window**

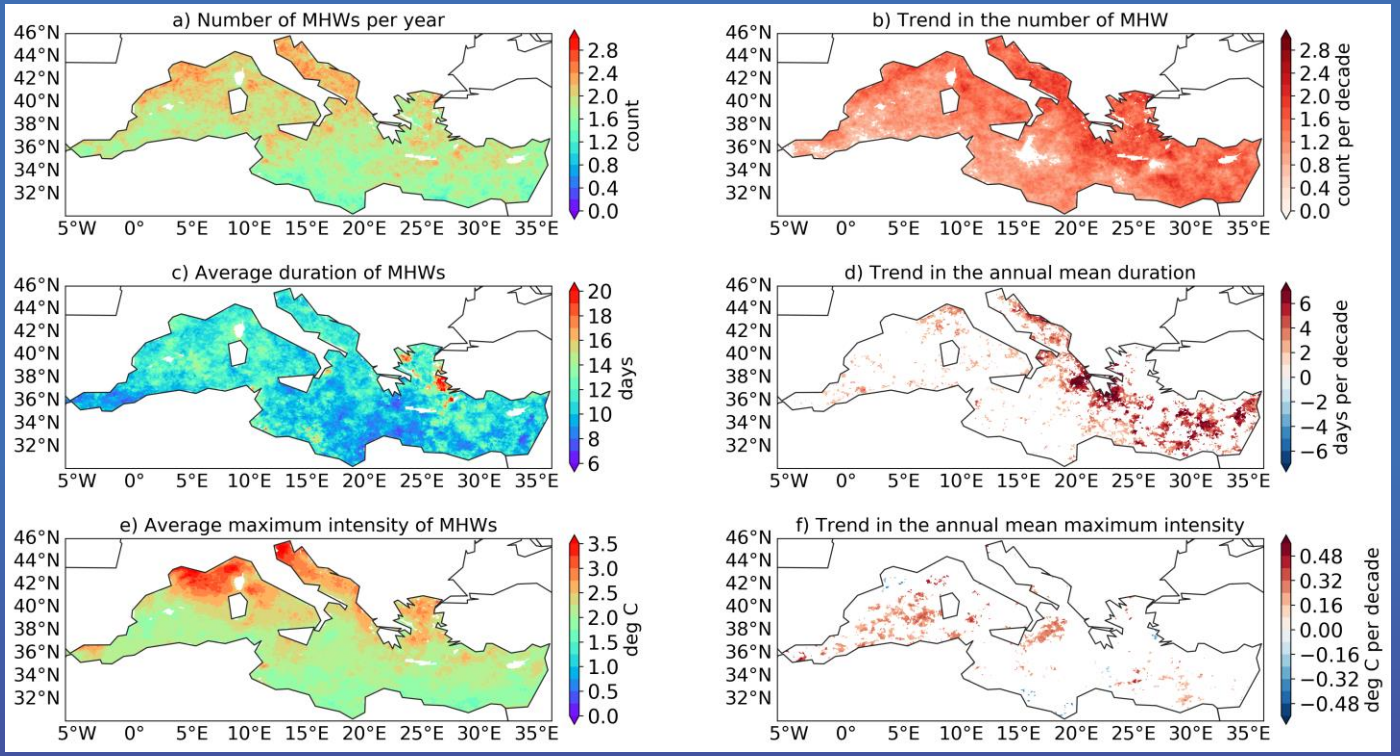
Data:
- *SST_MED_SST_L4_REP_OBSERVATIONS_010_021 (REP, 1/20°,* satellite observations*).*
- *MEDSEA_MULTIYEAR_PHY_006_004* (MED Reanalysis, 1/24º, 141 depth levels, satellite SLA and in-situ TS profiles assimilated, ERA5 forcing)

Variables:
Vertical Temperature (from 0 up to 100 m)

MHW Characteristics:
Frequency, Duration, Intensity Maximum

Surface MHWs in the Mediterranean Sea

Trend/mean of surface MHW characteristics



Period of study:
1987-2019

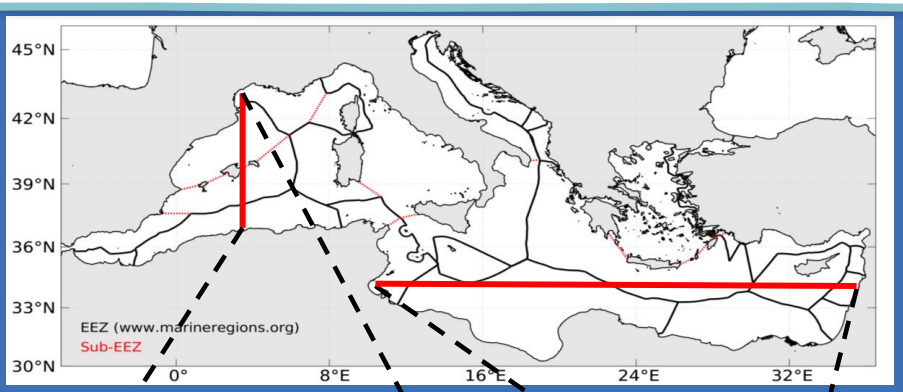
Climatology period:
1987-2016

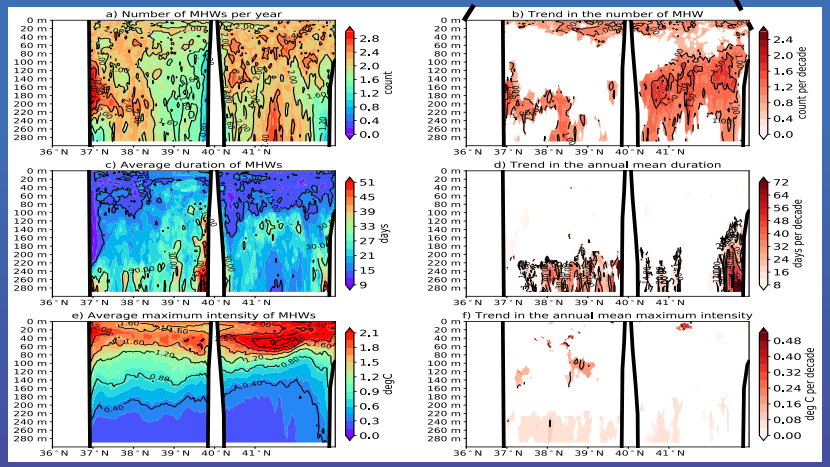
Data:
satellite observations (REP; 1/20° resolution grid; freely available and distributed by the Copernicus Marine Service).

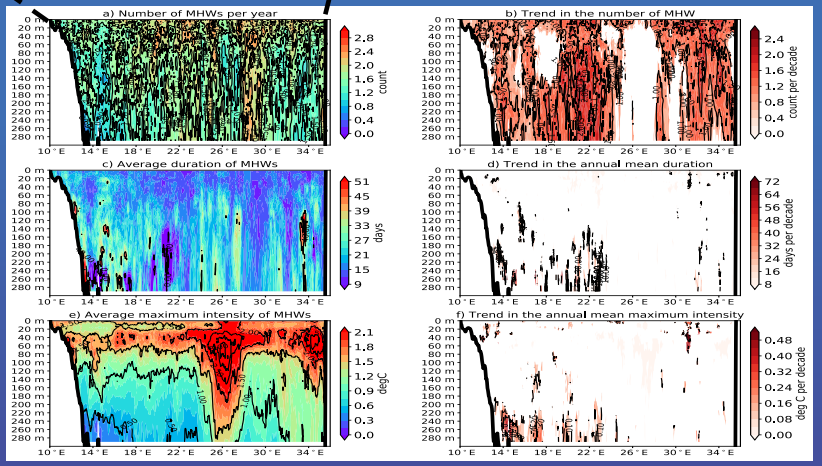
- Strong spatial variability (e.g., north-south, west-east, dynamical regimes)
- Substantial increase of MHW characteristics in most of sub-regions
- Strong and diverse environmental, social and economic impacts.

Subsurface MHWs in the Mediterranean

Trend/mean characteristics of MHWs in subsurface







Period of study:
1987-2019

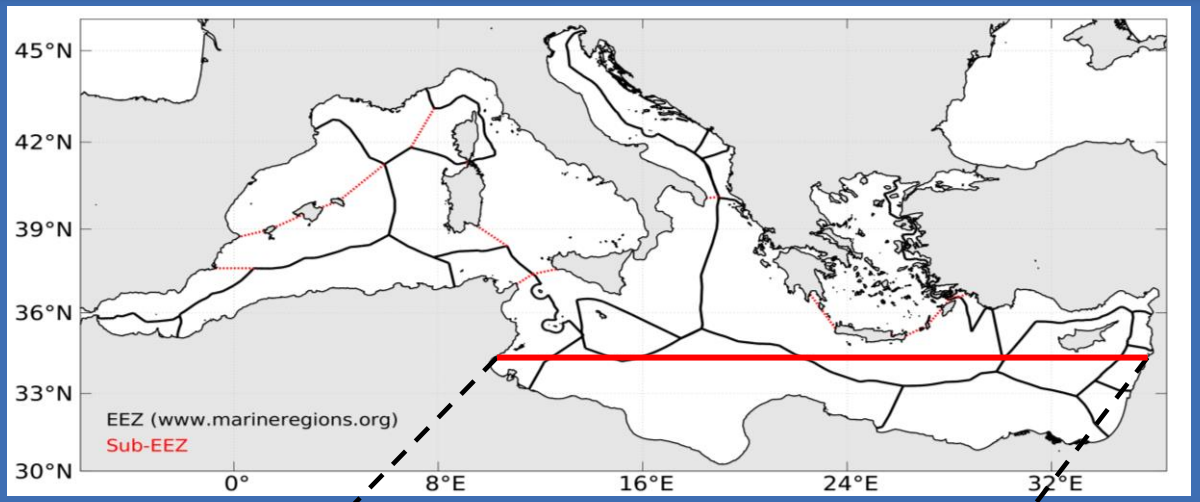
Climatology period: 1987-2016

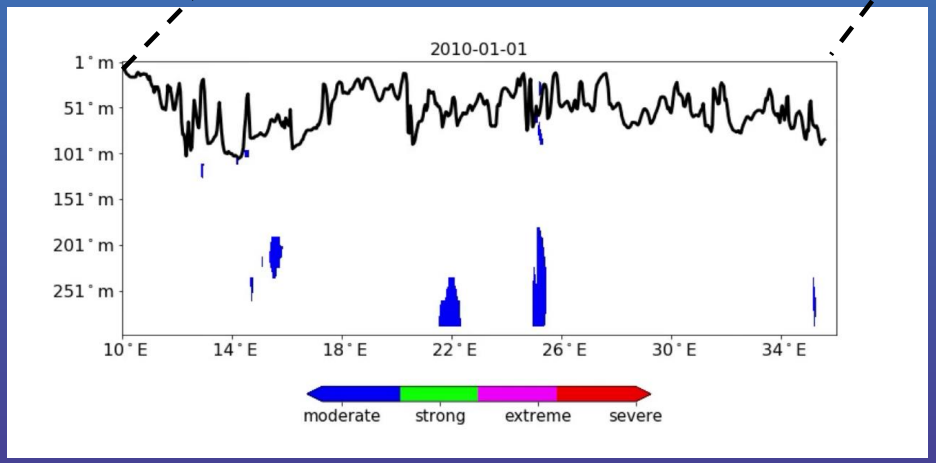
Data:
Reanalysis (MED; 1/24° resolution grid; freely available and distributed by the Copernicus Marine Service).

- Detection of MHWs up to several hundred meters
- Strong signature in the upper 50m (high biological activity, main economic activities)

Subsurface MHWs in the Mediterranean

Daily evolution of MHWs & mixed layer depth over 2010-2019





Period of study:
2010-2019

Climatology period: 1987-2016

Data:
Reanalysis (MED; 1/24° resolution grid; freely available and distributed by the Copernicus Marine Service).

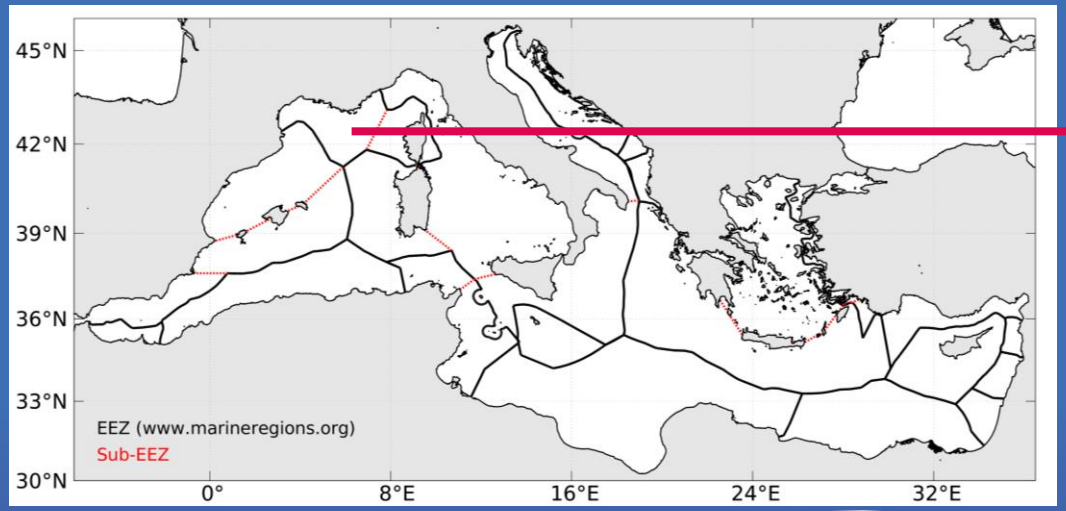
Period of study:
1987-2019

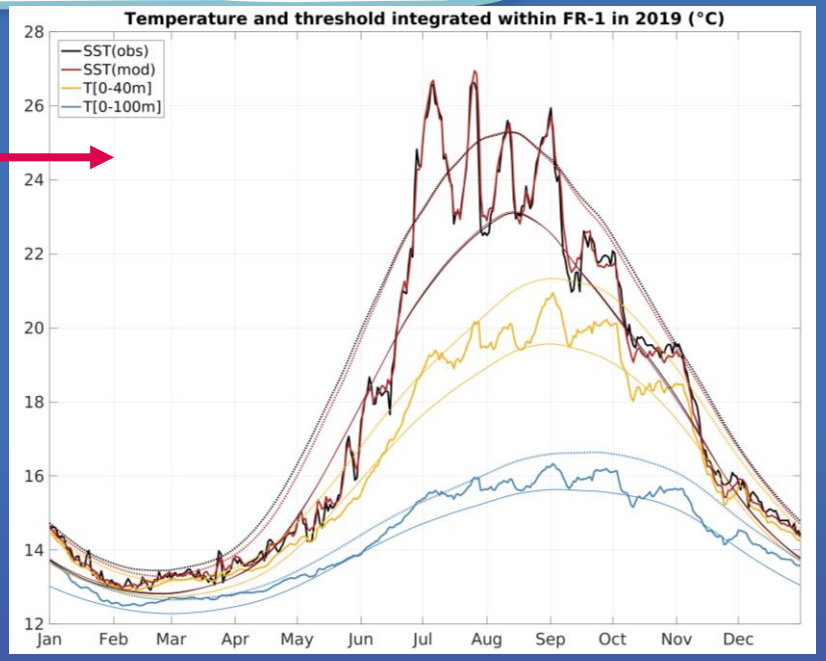
Climatology period:
1987-2016

Stakeholder-oriented information

Integrated information in Exclusive Economic Zones

EEZ = *where special rights are held by a sovereign country*



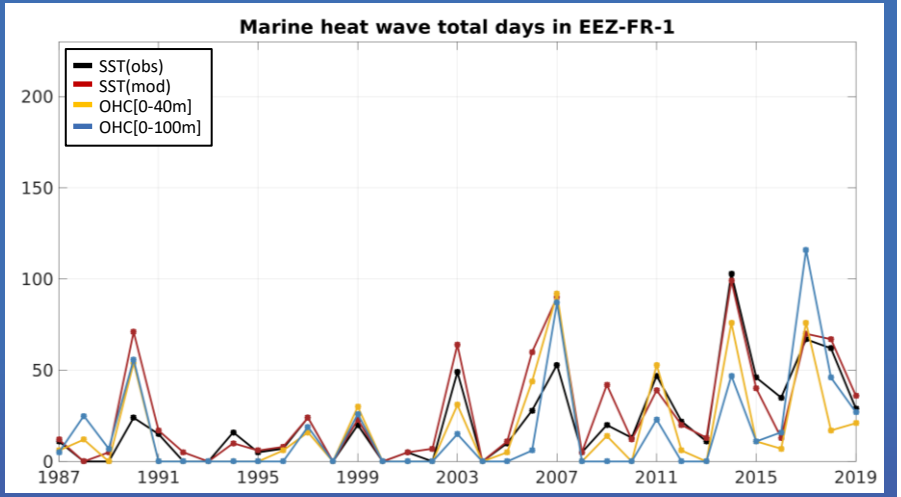


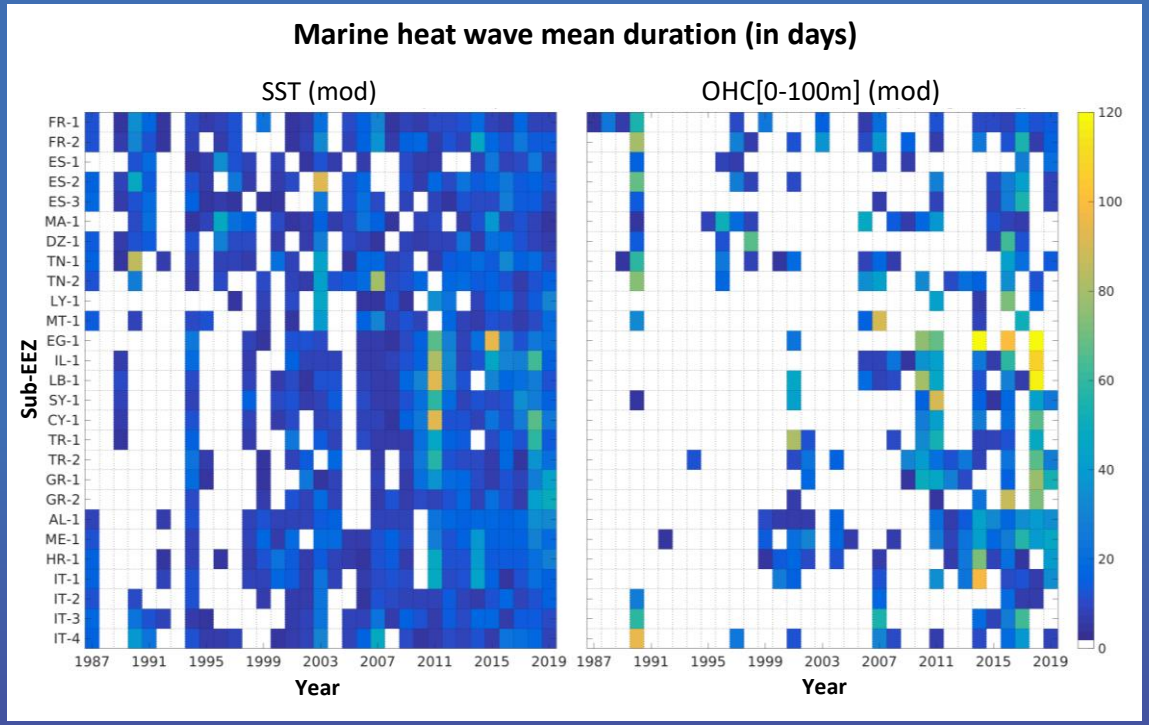
- EEZ integrated information to establish mitigation & adaptation strategies at local/national scales.
- Capture the attention of the national authorities and governments.
- Provides an overview of sub-regional conditions, from which one can “zoom in” to specific stakeholders.

- Good agreement obs/model surface MHWs
- Propagation in depth of some events

Stakeholder-oriented information

Integrated information in Exclusive Economic Zones





➢ Strong temporal & spatial variability in subsurface response at sub-EEZ scale

Conclusions

Methodology

- Consensus on methodology.
- Diversity of metrics / baseline periods.

MHWs at surface

- Substantial increase of MHW characteristics.
- Strong seasonal and spatial variabilities.

MHWs in subsurface

- Strong signature in the upper 50m.
- Detection of MHWs up to several hundred meters.
- Seasonal variations of subsurface MHWs.
- Role of dynamical (depth propagation through deep convection, downwelling…).

Impacts and actions

- Environmental, social and economic impacts.
- EEZ integrated information ➔ creation of a more direct narrative to capture the attention of the national authorities and governments.
- Species-specific versus statistics-based indicators ?