



Spotlight: Marine heatwaves

Version V1
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Background

Marine heatwaves (MHWs) are periods of abnormally high sea surface temperatures that last for days to months, disrupting marine ecosystems and coastal communities. They can cause mass mortality of fish, corals, and other species, alter ocean and atmospheric circulation, and threaten food security by impacting fisheries and aquaculture. Climate change is causing MHWs to become more frequent, intense, and widespread across the world's oceans. Understanding their causes is essential for predicting impacts and developing strategies to protect ecosystems and societies.

The Challenge

Marine heatwaves result from complex interactions between the ocean and atmosphere, making it difficult to pinpoint the exact drivers behind their onset and duration. Their variability across regions and timescales also complicates efforts to predict and model their impacts reliably. Moreover, the resistance of species and ecosystems to extreme heat varies hugely, rendering it difficult to precisely define MHWs. More efforts are needed to understand MHWs, and to predict their occurrence and impacts more accurately.

ObsSea4Clim activities

In ObsSea4Clim work on MHWs, we cover several European national waters and regional seas, each providing unique challenges and considerations to MHW observation. Our key activities include:

- Identifying the sensitivity of MHW statistics and trends to the MHW definition chosen in the target regions. Deeper analysis of the uncertainty within and between satellite data has begun, indicating important differences in MHW characteristics and trends depending on uncertainty within and between different products, such as ESA CCI, OISST, and OSTIA. The use of multi-product ensembles highlights an abundance of satellite-derived SST data, and is recommended going forward.
- Promoting a flexible MHW indicator framework, in which the context of the impacts and case studies are key.
- Creation of a multi-definition dataset of historical MHWs, to support the flexible indicator definition, test the robustness of results, and to provide stakeholders a user-relevant dataset.
- Quantifying the coverage and utility of in situ data for MHW monitoring; so far in situ data has proven less useful for long-term MHW studies, due to their short or intermittent temporal coverage restricted to coastal areas and the surface.



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- Investigating ocean–atmosphere linkages underpinning the connections between global warming, ocean warming, large-scale atmospheric circulation, and the occurrence of MHWs, with a specific focus on the North Atlantic region and the aim of determining which EOVs and ECVs are most critical for effectively monitoring and addressing MHWs.
- Leveraging high-resolution regional reanalyses to better understand the vertical characteristics of MHWs and their extension to key target depths and the sea floor.
- Exploring MHWs in a diverse range of environments and exploring drivers in each, including the ice-covered Arctic Ocean undergoing Atlantification, the complex coastal zones of the Baltic and Mediterranean Sea, and the wide open-ocean of the North Atlantic susceptible to basin-scale climate variability.

Resources

1. Presentation on **monitoring and forecasting MHWs** delivered by Ronan McAdam (CMCC) at the Indian Institute of Tropical Metrology (IITM) in Pune, India, in February 2025.
Zenodo: <https://zenodo.org/records/15583376>
2. Presentation on **unravelling the challenges of marine heatwaves in the Mediterranean Sea** delivered by Giulia Bonino (CMCC) at a CMCC webinar in September 2024.
Zenodo: <https://zenodo.org/records/15584053>;
Recording: [CMCC website](#)
3. Presentation on **marine heatwaves in the Baltic Sea** delivered by Veera Haapaniemi (FMI) at the ObsSea4Clim BioEcoOcean Clustering Event, March 2025.
Zenodo: <https://zenodo.org/records/15282851>
4. Presentation on **assessing the frequency and the intensity of marine heatwaves in the Barents Sea** delivered by Ajith Joseph Kochuparampil (NERCI) at the ObsSea4Clim BioEcoOcean Clustering Event, March 2025.
Zenodo: <https://zenodo.org/records/15279654>
5. Presentation on **exploring the interplay between marine heatwaves and atmospheric circulation in the North Atlantic** using observation data and climate indicators delivered by Fabíola Silva (+ATL) at the ObsSea4Clim Annual Meeting, March 2025.
Zenodo: <https://zenodo.org/records/15076937>; YouTube: <https://youtu.be/jJk4U66avv0>
6. **Codes for analysis** used in a paper by Giulia Bonino (CMCC), Ronan McAdam (CMCC), et al.: Mediterranean Summer Marine Heatwaves Triggered By Weaker Winds Under Subtropical Ridges.
Zenodo: <https://zenodo.org/records/15690822>



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7. Poster on **tracking marine heatwaves in the Balearic Sea**: temperature trends and the role of detection methods, presented by Blanca Fernández-Álvarez (IMEDEA-CSIC) at the European Geosciences Union (EGU) General Assembly 2025.
Zenodo: <https://zenodo.org/records/15533690>
8. Poster on **marine heatwaves in the Mediterranean Sea: a comparative analysis of CMIP and MedCORDEX model outputs**, presented by Francesco De Rovere (CMCC) at the European Geosciences Union (EGU) General Assembly 2025.
Zenodo: <https://zenodo.org/records/15526909>
9. Poster on **marine heatwaves on the Patagonian Shelf**, presented by Vincent Combes (IMEDEA-CSIC) at the European Geosciences Union (EGU) General Assembly 2025.
Zenodo: <https://zenodo.org/records/15534991>
10. Report on **identification of extreme indicators** for Task 3.2 "Marine extremes in Europe and the Arctic area" (Milestone MS5).
Zenodo: <https://zenodo.org/records/14623263>

Latest Publications

1. Darmaraki, S., Denaxa, D., Theodorou, I., Livanou, E., Rigatou, D., Raitzos E., D., Stavrakidis-Zachou, O., Dimarchopoulou, D., Bonino, G., Mcadam, R., Organelli, E., Pitsouni, A., & Parasyris, A. (2024). Marine Heatwaves in the Mediterranean Sea: A Literature Review. *Mediterranean Marine Science*, 25(3), 586–620.
<https://zenodo.org/records/14381921>
2. Bonino, G., McAdam, R., Athanasiadis, P. et al. (2025). Mediterranean summer marine heatwaves triggered by weaker winds under subtropical ridges. *Nature Geoscience*.
<https://zenodo.org/records/17017084>
3. Kohlman et al., (2025). Surface and subsurface biogeochemical impacts of the 2019 Northeast Pacific marine heatwave. *Geophysical Research Letters*, 52(16).
<https://zenodo.org/records/17017263>



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