



PROGRAMME OF THE EUROPEAN UNION



### Marine heatwaves

Dr Hayley Evers-King

Marine Applications Expert – EUMETSAT

EUMETrain Event Week on Heatwaves and Droughts – 31/05/2023









#### What are marine heatwaves?

# What are the impacts of marine heatwaves?

Some case studies

How can we observe marine heatwaves?

- As on land a period of abnormally high ocean temperatures, relative to regional, seasonal average.
- Coupled process
- Typically occurring:
  - Over thousands to millions of square kilometres
  - For weeks to months
  - Can also occur over ocean depths
- Getting worse:
  - IPCC AR6: "More frequent, more, intense, longer since 1980's...and since 2006 very likely due to anthropogenic climate change"
  - IPCC SR on ocean and cryosphere: 'virtually certain" that ocean absorbed >90% of excess heat, rate of warming has doubled, as has frequency of MHWs.

# What is a marine heatwave?

- Can be classified using thresholds vs long term average (see toolkit later!)
  - Also vary for more extreme events or impacts on specific organisms.
- Caused by:
  - Changes in ocean heat transport
    - Boundary currents, thermocline variability
  - Persistent, large-scale, atmospheric systems.
  - Atmosphere-ocean teleconnection
    - Kelvin waves, climate oscillations
  - See <u>Holbrook et al., 2019</u> and <u>Sen Gupta et al., 2020</u>
- Affected by anthropogenic climate change



<u>Hobday et al., 2018</u> ← Essential reading!

## What are the impacts of marine heatwaves?

- Impact on air-sea flux of CO<sub>2</sub>
- Tropical cyclone formation
- Coral bleaching
- Mammal and sea bird mortality
- Harmful Algal Blooms
- Spatiotemporal shifts in habitats (affecting fisheries).

Note – also some benefits for some creatures – depends on interplay between heatwave and thermal limits per species



opernicus

THE EUROPEAN UNION

#### copernicus.eumetsat.int

IMPLEMENTED BY FEUMETSAT

### Global occurrence of marine heatwaves through time



PROGRAMME OF

THE EUROPEAN UNION

- 91% of coral affected.
- Happened during La Nina (typically cooler).





## Case study: Mediterranean Sea 2022

copernicus.eumetsat.int

- Major marine heatwave 5°C warmer than average.
- Contributing to established trend connecting regional MHWs with mass mortality events.
- Concern about long-term impacts on fisheries and aquaculture

- <u>Summary article from CMEMS</u>
- Recent paper: <u>Guinaldo et al.</u>, <u>2023</u>



#### Ocean surface temperatures are at record highs

Average daily sea surface temperature



#### Rising temperatures in the world's oceans

Average sea surface temperature in 2011-2020 (degrees C), compared to 1951-1980



Source: ECMWF ERA5

ВВС

### How can we observe marine heatwaves?

- Satellites can measure global sea surface temperatures
  - Daily, NRT products available within 3 hours.
  - Multiple satellite missions have contributed to a more than 40 year record of data.
  - Generally you want to use a 'climate quality' data set for long-term trend analysis. NRT/iCDR have to be used for current events so reduced certainty.
  - Data from <u>Copernicus Marine Service</u> and <u>EUMETSAT OSI SAF</u>.
- Reanalysis and models can be used great effect to understand forcing.
- Open source toolkits are available to calculate heatwave occurrence from data sets.

# Visit Slido.com and use the code #MHW\_2023



#### • Example:

- Case study: <u>https://www.eumetsat.int/marine-heatwave-intensification-threatens-coral-reef-health</u>
- Code: <u>https://gitlab.eumetsat.int/eumetlab/oceans/ocean-</u> <u>training/applications/ocean-case-studies/-</u> /blob/main/Case\_studies/UN\_Ocean\_Decade/Challenge02\_ecosystems \_and\_biodiversity/Marine\_heatwaves\_intensification\_threatens\_coral\_re ef\_health.ipynb
  - Code can be run directly on the WEkEO Jupyterlab or after suitable set up (see README)



#### **Thank you!** Questions are welcome.

EUM/0PS-C0PER/TEM/15/813104, v2B, 29 March 2022



13