COASTAL MARINE HEATWAVE ANALYSIS: DISTRIBUTION, CHARACTERISTICS AND CLIMATE CHANGE IMPACT

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I. Introduction

- Marine Heat Waves (MHWs) are a growing threat to marine ecosystems and fishery industries as oceans warm due to Climate Change.
- MHW research mainly focuses on regional events. Global understanding of MHW behaviour and mechanisms remains limited.
- One global study by Oliver et. Al (2018) addressed it using the NOAA OISST, highlighting the recent increase of MHW exposure during the last 35 years, which was attributed to a change in the mean SST (Oliver et al., 2019)
- However, such global analysis can mask MHW behaviour in coastal areas, where the richest marine ecosystems are located. In addition, results are only based on one satellite SST product.

II. Questions to address

- **What are MHW characteristics and trends in coastal areas?**
- **How does Climate Change influence MHWs in coastal areas?**
- **How does it compare to offshore MHWs?**
- **Is MHW's representation consistent throughout SST datasets?**

III. Data & Methods

PRODUCT	TIME COVERAGE & RESOLUTION	SPATIAL RESOLUTION (°)	DEPTH
NOAA Optimum Interpolation SST v.2 (OISST)	01/09/1981 - present daily	0.25x0.25	0.1m
Merged satellite and in-situ data Global Daily SST (MGD)	01/01/1982 - present daily	0.25x0.25	foundation
Canadian Meteorological Center 0.2 degree analysis (CMC)	01/09/1991 - 17/03/2017 daily	0.2x0.2	foundation
ESA SST Climate Change Initiative record v2.1 (CCI)	01/09/1981 - 31/12/2016 daily	0.05x0.05	0.2m

- **Coastal pixels** from each dataset starting in **01/01/1992 to 31/12/2016**
- **Closest** CMC and CCI coastal pixels to the 0.25x0.25 grid
- **Sea-ice** contaminated pixels **excluded** from analysis
- **Offshore** pixels chosen **80km** away from coastal pixels **normal** to the coastline

MHW definition: Hobday et al., (2016)

- Threshold is the **90th** percentile based on an **11 day-window** climatology
- **Detrended** timeseries used to derive **climatologies** (1992-2016)

IV. Results

A. Mean State

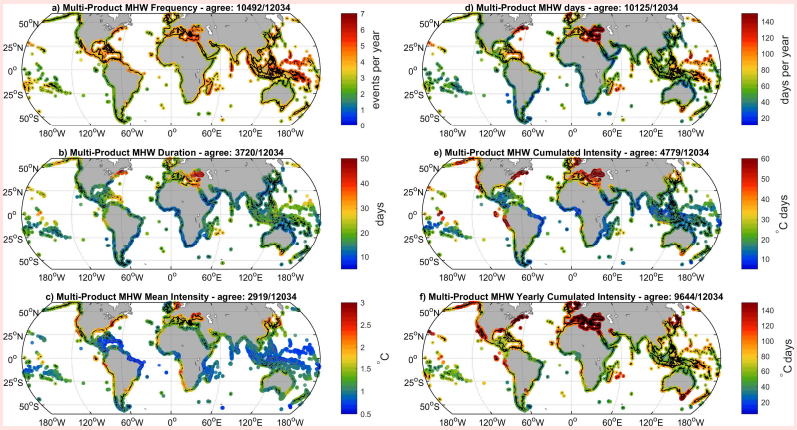

Figure 1: Multi-product average of a) mean MHW frequency, b) mean MHW duration, c) mean MHW mean intensity, d) mean MHW days, e) mean MHW cumulated intensity and f) mean MHW yearly cumulated intensity over 1992-2016. Locations where all products agree are marked in black.

B. Long-term changes

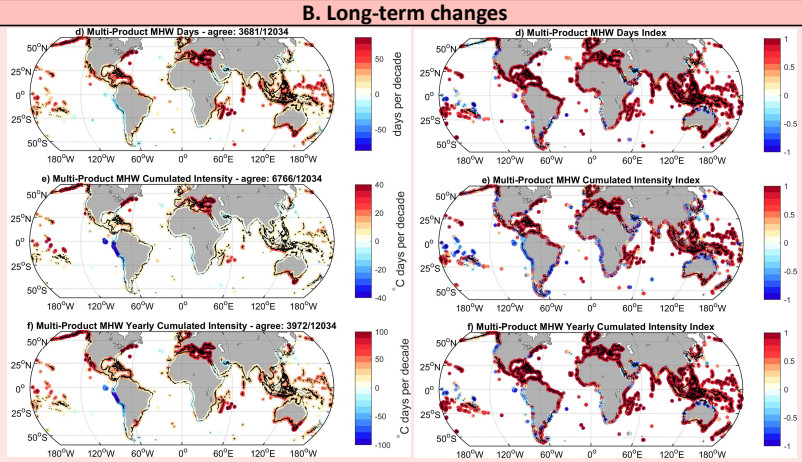

Figure 2: Multi-product linear trends of d) annual MHW days e) mean MHW cumulated intensity and f) mean MHW yearly cumulated intensity over 1992-2016. Significant trends were marked with black dots.

Figure 3: Multi-product linear trends Index of d) annual MHW days e) mean MHW cumulated intensity and f) mean MHW yearly cumulated intensity over 1992-2016. The Index compares both the long-term SST changes and the internal variability component of the trends. Positive (negative) values indicate that observed trend is mostly driven by long-term SST changes (internal variability). Black dots indicate locations where at least one trend component is significant...

C. Onshore-Offshore comparison

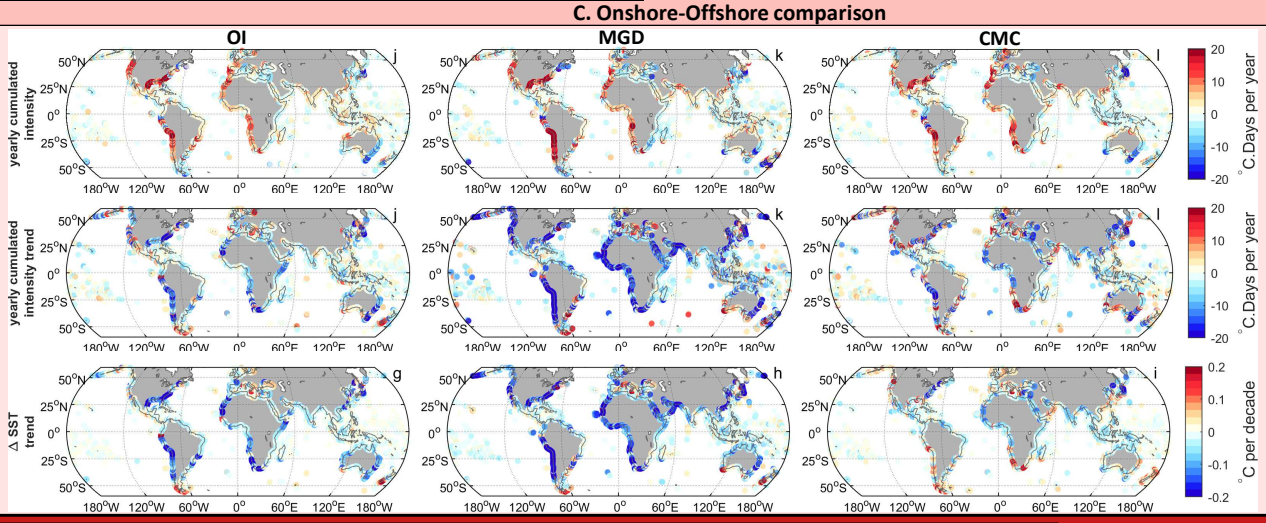

Figure 4: Onshore coastal pixel difference with corresponding offshore pixel of average yearly cumulated intensity average (a-c) and linear trends (d-f) and SST linear trends derived from the OISST (left), MGD (middle) and CMC (right) products. Offshore pixels were retrieved for each product separately being at least 80km away from its corresponding pixel in a normal direction to the coast. MHW algorithms were then applied to offshore pixels following the same methodology as onshore pixels. Offshore pixels associated with several coastal pixels were only paired with the closest coastal pixel.

V. Summary

- **Increases** in most MHW metrics, with higher increases in **MHW hotspots**
- MHW trends mostly **driven** by changes in **long-term SST**
- **Lack of agreement** between products
- **Higher** MHW intensity near-shore than offshore **at eastern boundary** current system
- MHW metric increases **dampened** onshore compared to offshore, likely due to dampened increase in mean SST

References

- Hobday et al., 2016. A hierarchical approach to defining marine heatwaves. Prog. Oceanogr. 141, 227–238.
- Oliver, E.C.J et al., 2018. Longer and more frequent marine heatwaves over the past century. Nat. Commun. 9.
- Oliver, E.C.J., 2019. Mean warming not variability drives marine heatwave trends. Clim. Dyn.