Marine Heatwaves and Marine Cold-spells on the Yucatan Shelf-break Upwelling region and its relationship with Red tide

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This work studies the presence and magnitude of anomalous events at the sea surface temperature (SST) from a climate change perspective in a Non-eastern upwelling system, also, it explore temporal relationship among those anomalies and the Red tide that struck the coastal region in the year 2011

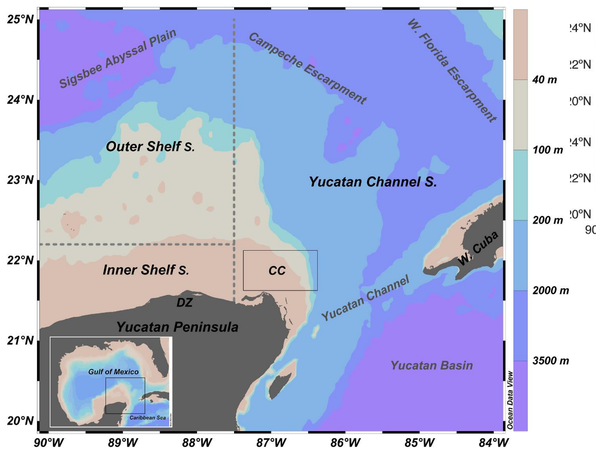

Fig. 1. Study region, Gulf of Mexico and Caribbean Sea. The sub-regions are bounded by a grey dotted line,
The Shelf-break Yucatan Upwelling (around CC) plays the main regulator of the spatial and temporal regulation of the sea temperature

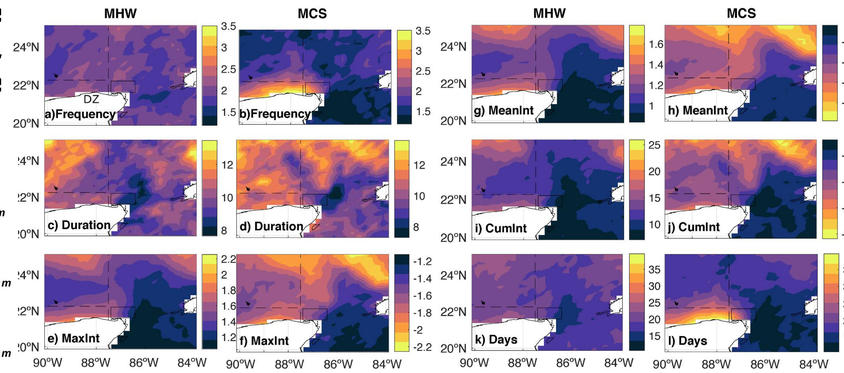

Fig. 2. Mean metrics of the Marine Heatwaves (MHW) and Marine Cold Spell (MCS)

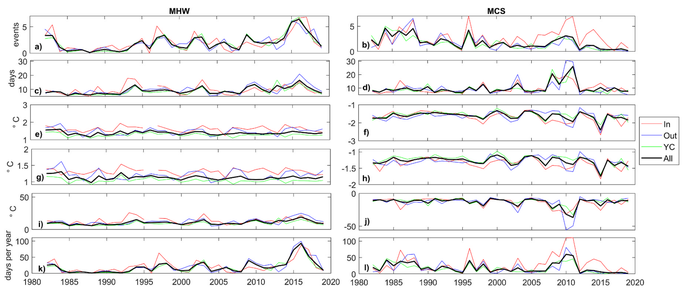

Fig. 3. Annual time-series metrics of MHW and MCS of the sub-regions, inner–shelf (in), outer–shelf (out), Yucatan Channel (YC), and all-region (All) plotted in color lines.

Frequency	Duration
events per year (events)	days per event (days)
MHW/ MCS metric	
Intensity/Cumulative (°C)	Days event accumulated per year (total days)

Concepts and metrics for Marine Heatwaves (MHW) and Marine Cold–Spell (MCS)[a] were applied over the marine region of the Yucatan continental shelf and Yucatan Channel [Fig. 1]. To calculate[b] the MHW/MCS and climatology between 1982 and 2019, a remote historic dataset of SST [NOAA-OI SST, V2-AVHRR] was used (Fig. 2).

Temporal differences of MHW/MCS events were calculated to assess the increase of MHW reported at a global scale in the last 10–20 years (Fig. 3), splitting the resulting metrics of the study period. Furthermore (Fig. 4), a frequency-domain cross-correlation analysis between SST and Chlorophyll-a (MODIS, 2010–2012) was conducted to analyze a temporal relationship among those anomalies and the Red tide that struck the coastal region, in the year 2011 (Fig. 5).

Results.- The MHW mean frequency was 1.5 and 2.3 events/year; 2017 was the year with the most frequent events mean 6.8 events. MCS mean frequency ranged around 1.18 to 3.5 events, mean of 6.9 events was recorded in the year 2011...

The inner–shelf figure as important zone. The MHW/MCS mean duration ranged between 7.6 and 13.4 days, and the intensity was between -2.25 to 2 °C (Fig. 2, 3). A maximum of 100 days of MHW were recorded in the year 2016, while MCS was 110.7 days in 2011.
Hot and cold anomalous days were more frequent with longer duration and occurrence between 2010 and 2017, similar to global events. MHW trend was headed to increase significantly in frequency, duration, intensity and abnormally warmer days. MCS trend was toward a decrease in frequency, except for some coastal localities

Discussion.- Variability of the Yucatan current and upwelling, as well as large-scale synoptic atmospheric events are discussed as possible drivers for MHW/MCS. Significant temporal relationship was proposed among MCS and the Red Tide of 2011 associated to The ENSO.

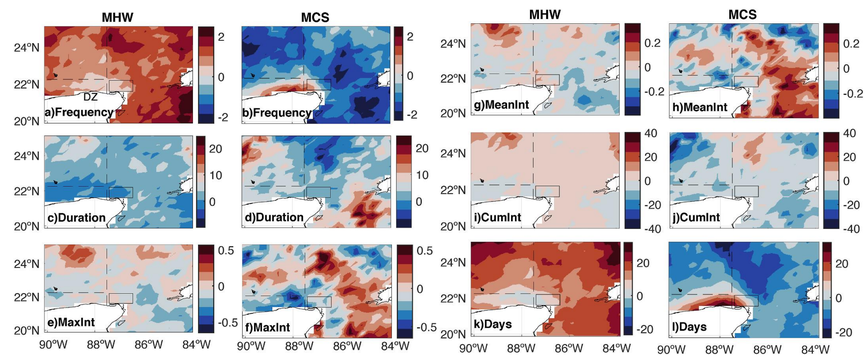

Fig. 4. MHW/MCS metrics difference between the periods 2002–2019 and 1982–2001.

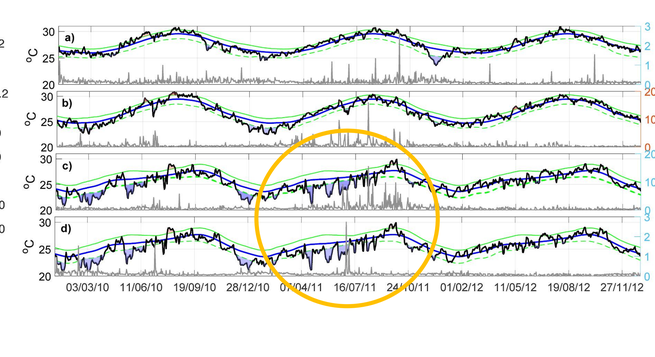

Fig. 5. Eventline MHW and MCS 2010–2012, a) Yucatan channel, b) Cabo Catoche, c) inner–shelf, d) outer–shelf.

Conclusion.- MCS events were of equal or greater relevance than MHW, mainly in the inner–shelf sub-region. Warm and cold anomalous days were more frequent with longer duration and occurrence during 2012-2019.. MHW were more frequent offshore, while MCS did in inshore. The extreme biological event reported in 2011 could be explained by MCS since 2010

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a.- Hobday et al. (2018, 2016) doi.org/ 10.1016/j.pocean.2015.12.014. doi.org/10.5670/oceanog.2018.205; b.- Zhao and Marin (2019) doi.org/10.21105/joss.01124. Red tides Bulletins were generated by CINVESTAV-GEF-SSY. Reyes-Mendoza 2022 doi.org/10.1016/j.csr.2022.104707