Trends in Marine Heatwaves (MHW) and Marine Cold Spells (MCS)

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1. Introduction

Global warming is causing extreme climate events to become more frequent and more severe. Marine Heat Waves (MHW) and Marine Cold Spells (MCS) are prolonged, discrete periods of anomalously high/low SSTs with wide ranging impacts. Previous research has found that MHW are increasing in frequency and intensity, but MCS remain less well understood.

Using the Hobday framework (Hobday et al 2018); MHW and MCS events were assigned a category from I (moderate) to IV (extreme). This was used to compare their global intensities and trends in their frequency over the period 1982-2021.

Hobday, Alistair J, Eric C J Oliver, Alex Sen Gupta, Jessica A Benthuysen, Michael T Burrows, Markus G Donat, Neil J Holbrook, et al. 2018. “Categorizing and Naming MARINE HEATWAVES.” Oceanography 31 (2): 162–73. https://www.jstor.org/stable/26542662.

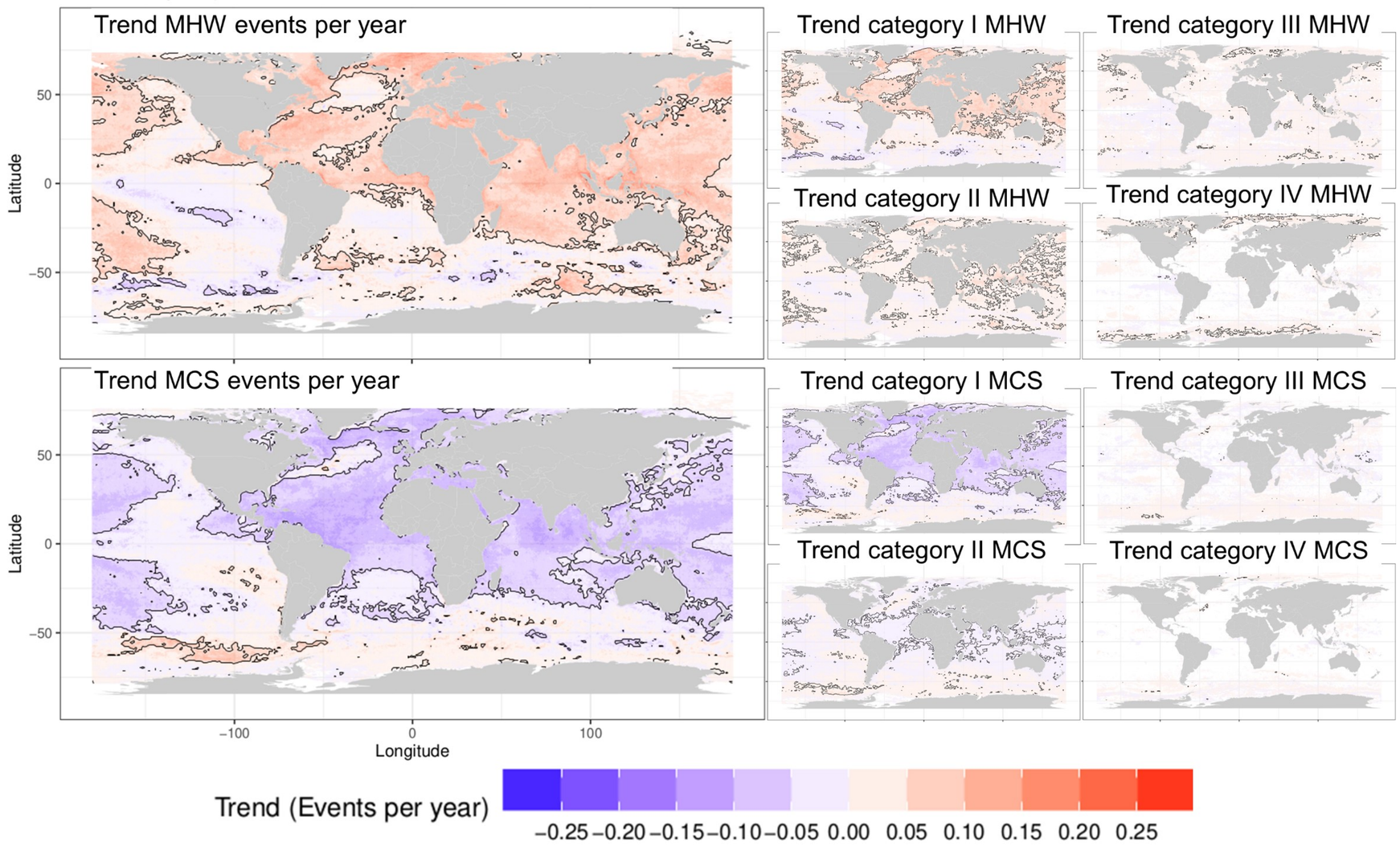

Figure 1: Trends in the number of MHW and MCS per year. The contour bounds the area where the trends exceed the 99% confidence level of a two-tailed t-test compared to a constant rate of occurrence.

2. Trends in frequency

Figure 1 shows linear trends in MHW and MCS calculated using a least squares fit.

MHW in the central Atlantic, Indian, and Western Pacific Oceans are increasing by one event every five to ten years, and this trend is significant to the 99% confidence level in much of the region.

MCS in much of the Atlantic, Indian, and Western Pacific Oceans are decreasing at a rate of up to one event every five years and that these decreases are significant to the 99% confidence interval for most of the region

Most of the changes in both MCS and MHW are due to changes in category I and II events, with category III and V events occurring at a roughly constant rate at most locations.

The Southern Pacific Ocean (in particular east of South America) goes against the general trends, with statistically significant increases in MCS and decreases in MHW, both of around one event every 10-20 years.

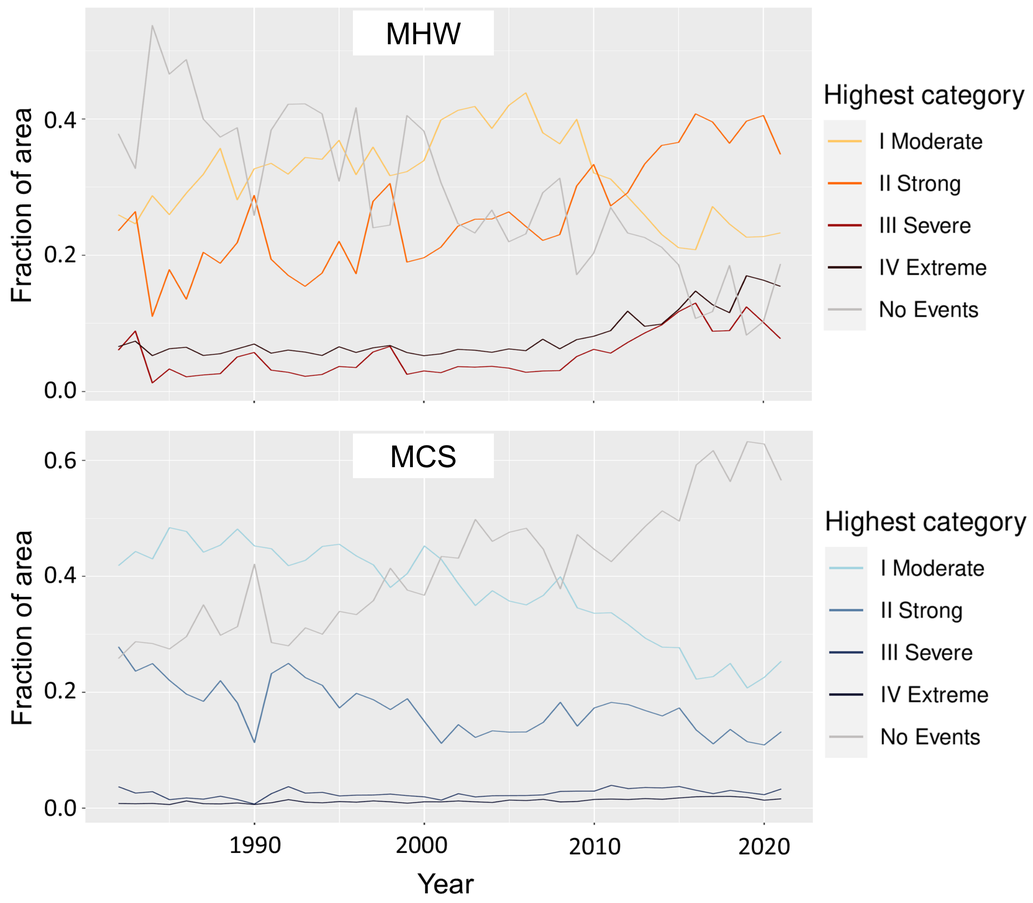

Figure 2: The fraction of area where the highest category event each year was I, II, III, IV, or no events.

3. Trends in coverage

Figure 2 shows that the amount of ocean without any MHW has fallen steadily from 37.8% in 1982 to 18.7% in 2021. The amount of ocean where the highest category was category I initially increased but has decreased sharply in recent years, coinciding with an increase in category II, III, and IV events

The amount of ocean without any MCS has increased from 26% in 1982 to 56.6% in 2021. The amount of ocean where the highest category was I or II has steadily decreased.

The amount of ocean where the highest MCS category detected was III and IV is just 1-3%, and has remained roughly constant throughout the timeseries. This suggests that extreme MCS will continue to be a rare feature of the global oceans, even as the world warms.

Conclusions

We have shown that in much of the ocean, MCS have become less frequent while MHW have become more frequent at a similar rate (around one event every five to ten years). The changes are mostly due to changes in category I and II events.

The number of locations in the ocean where MHW occur each year is increasing and the most intense MHW are becoming more common. In contrast, the number of locations with no MCS is decreasing, and the most intense events are occurring at a constant rate.

The investigation outlined in this poster will be published in the Ocean State Report No. 7 to be released in 2023

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