Marine heatwaves detected in time series as short as **10 years** and **missing 20% data** are comparable to those detected in **complete 30 year** time series.

Detecting marine heatwaves with sub-optimal data

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1 Introduction

The **Hobday et al. (2016)** and **Hobday et al. (2018)** definitions are used here for marine heatwaves (MHWs) and their categories. These events are increasing in duration and intensity around the globe **(Oliver et al. 2018)**. Many coastal, oceanic, and polar regions with ecosystems/species that are vulnerable to these events **(Smale et al. 2019)** do not have optimal sea water temperature time series available for the detection of MHWs.

An optimal time series is defined here as meeting these two primary requirements: 1) 30 years long, 2) no missing data. Any time series shorter than 30 years long or missing any data is therefore sub-optimal. The purpose of this study was to determine how confident we may be in our results when using sub-optimal data.

1.1 Objectives

1. Find the sub-optimal data limits for detecting MHWs
2. Quantify the effects of sub-optimal data on individual MHWs
3. Determine if these effects are consistent around the globe

2 Methods

- Reference time series from the `heatwaveR` package **(Schlegel and Smit 2018)** were re-sampled 100 times and made increasingly sub-optimal by:
  - Removing one year of data; 37 – 10 years
  - Randomly removing 1% of data; 0 – 50%
  - Adding linear trend of 0.01°C/dec.; 0.00 – 0.50°C/dec.
- The effect on an entire time series and one focus MHW (Figure 2.1) were measured
- The sub-optimal treatments were performed on global NOAA OISST product and effects measured

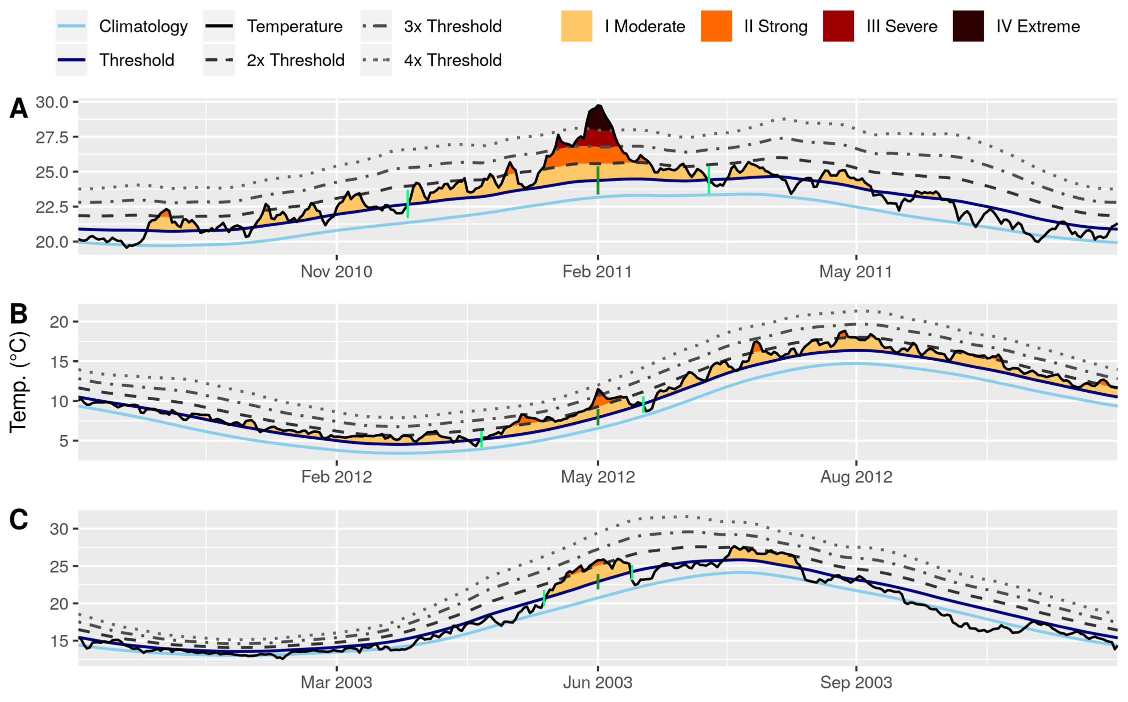

Figure 2.1: Focus MHWs from the three reference time series: A) Western Australia, B) Northwest Atlantic, C) Mediterranean. Start/end dates shown with light-green marks.

3 Results

- MHWs detected with 10 years of data do not differ significantly from those detected with 30 years of data (Figure 3.1)
- 20% missing data or less does not have an appreciable effect on the MHWs in a time series, but this can impact individual MHWs by dividing them up into smaller events 3.2)
- Individual MHWs in 10 year time series around the globe are on average 10% less intense (Figure 3.3) and 28% shorter than the same event in a 30 year time series

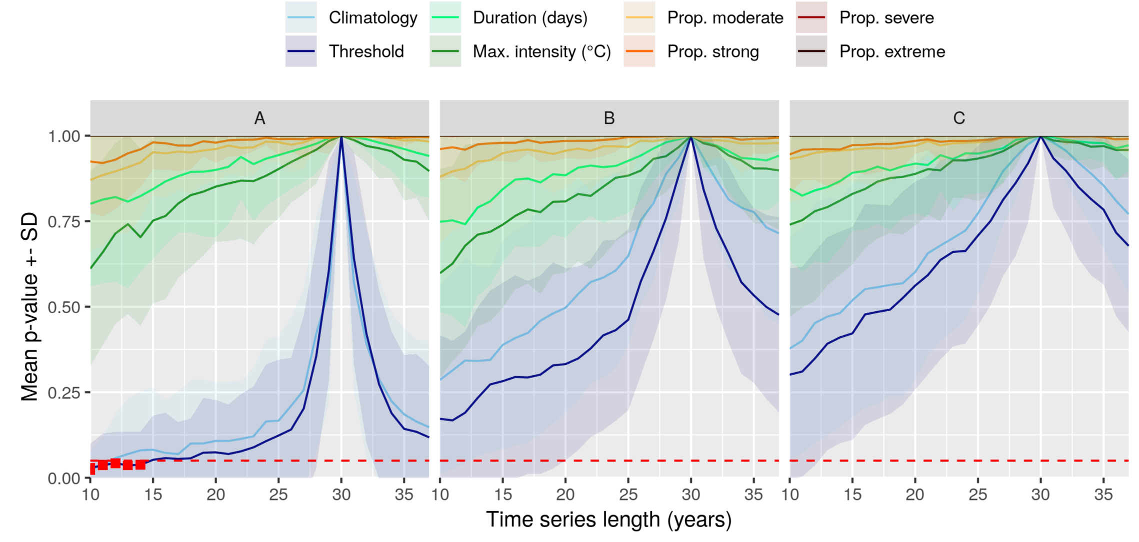

Figure 3.1: The effect of length on the MHWs detected within the 100 re-sampled time series. Note that lengths greater than 30 years also produce different results.

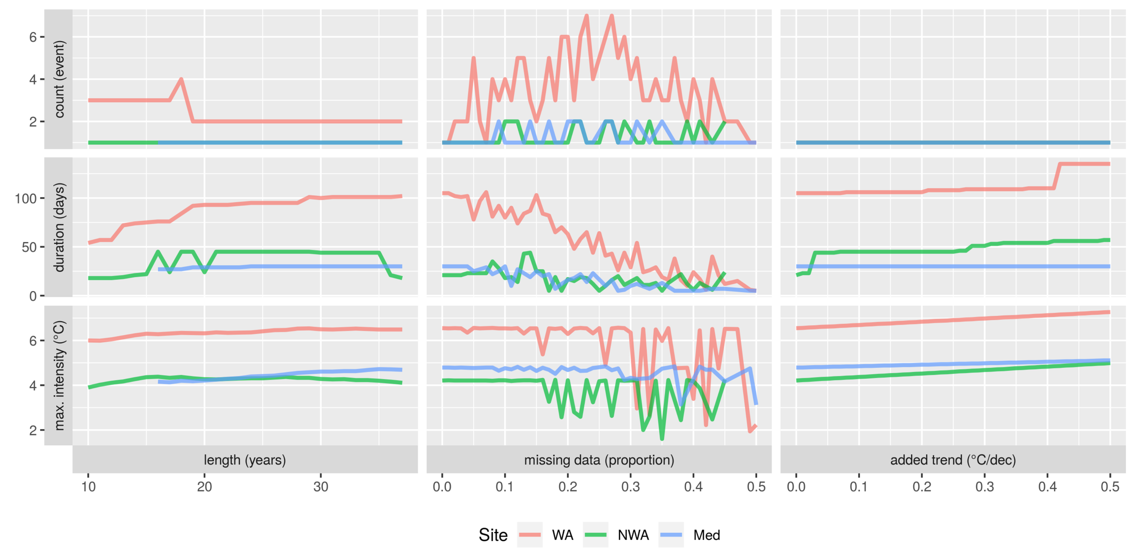

Figure 3.2: The effect on the focus MHWs (Figure 2.1) given the three different sub-optimal data challenges.

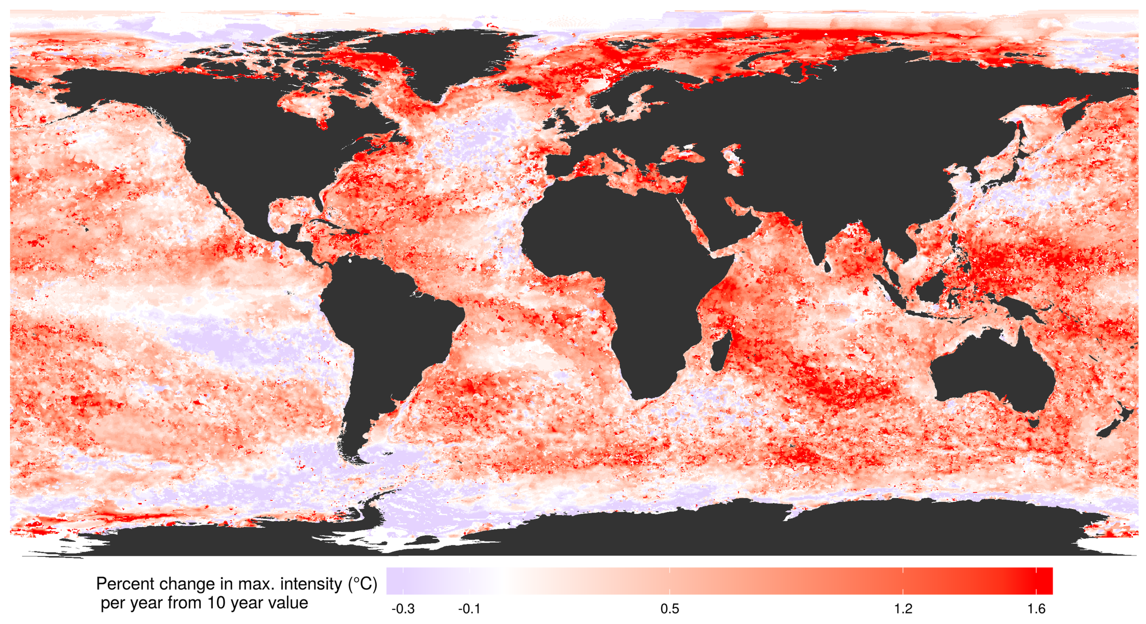

Figure 3.3: Global map showing the trends in increasing or decreasing maximum intensity of MHWs as a time series is lengthened.

4 Conclusions

The MHW detection algorithm provides robust results that are insensitive to sub-optimal data challenges.

Missing data has a greater effect on MHWs than time series length. Linear interpolation is an effective fix for missing data up to 40%.

Time series length has a less predictable effect than missing data.

The shifting up or down of the mean climatology is the primary driver of change in MHWs.

Optimal data should still be used when possible.

References

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