Comparison of multiple SST products using the Marine Heatwave Tracker

Robert W. Schlegel

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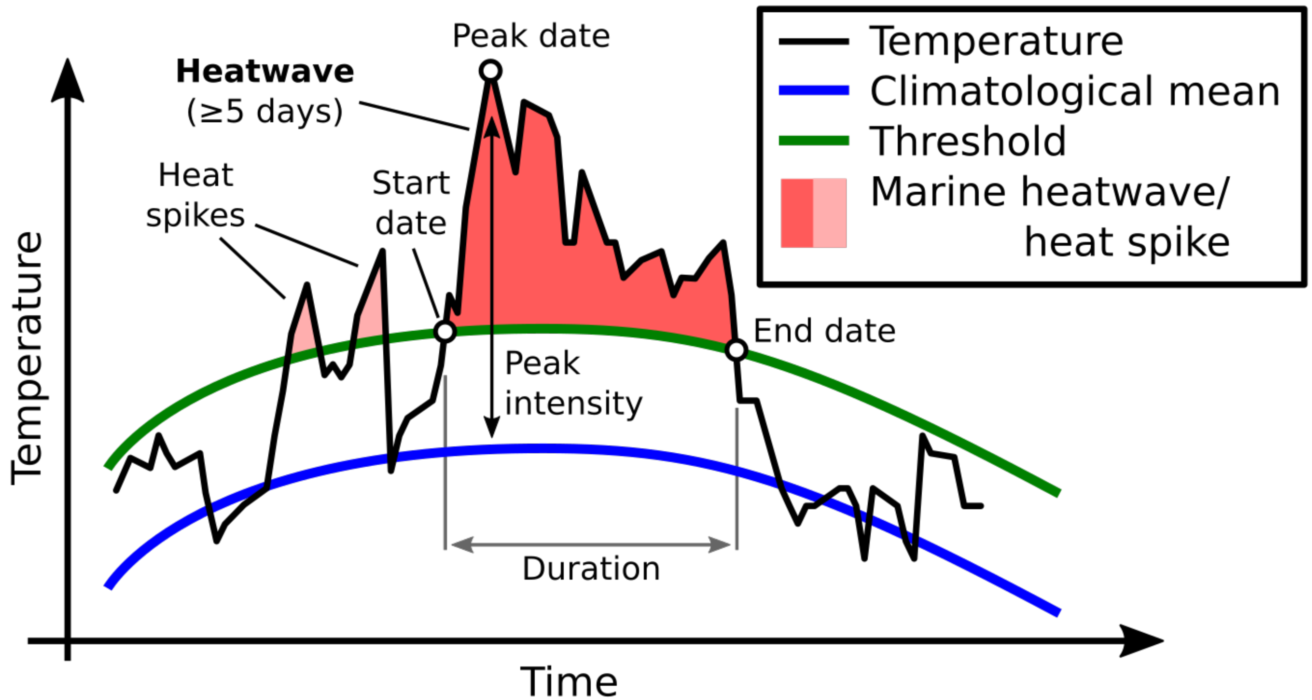
1 Introduction

It is known that differences between SST products exist, and that the differences between some products are much larger than others. These comparisons however are generally based on daily/monthly/annual differences. What I propose to investigate here is the difference in the anomalous temperature events, known as marine heatwaves (MHWs), between SST products. To this end we must first discuss what MHWs are, how they are detected, and methods for quantifying them. We will then look at what is required of an SST product for use in MWH detection before taking an interactive tour through the results. This talk will conclude with insight into the differences observed between SST products and advice on their use.

2 Marine heatwaves (MHWs)

2.1 Definition

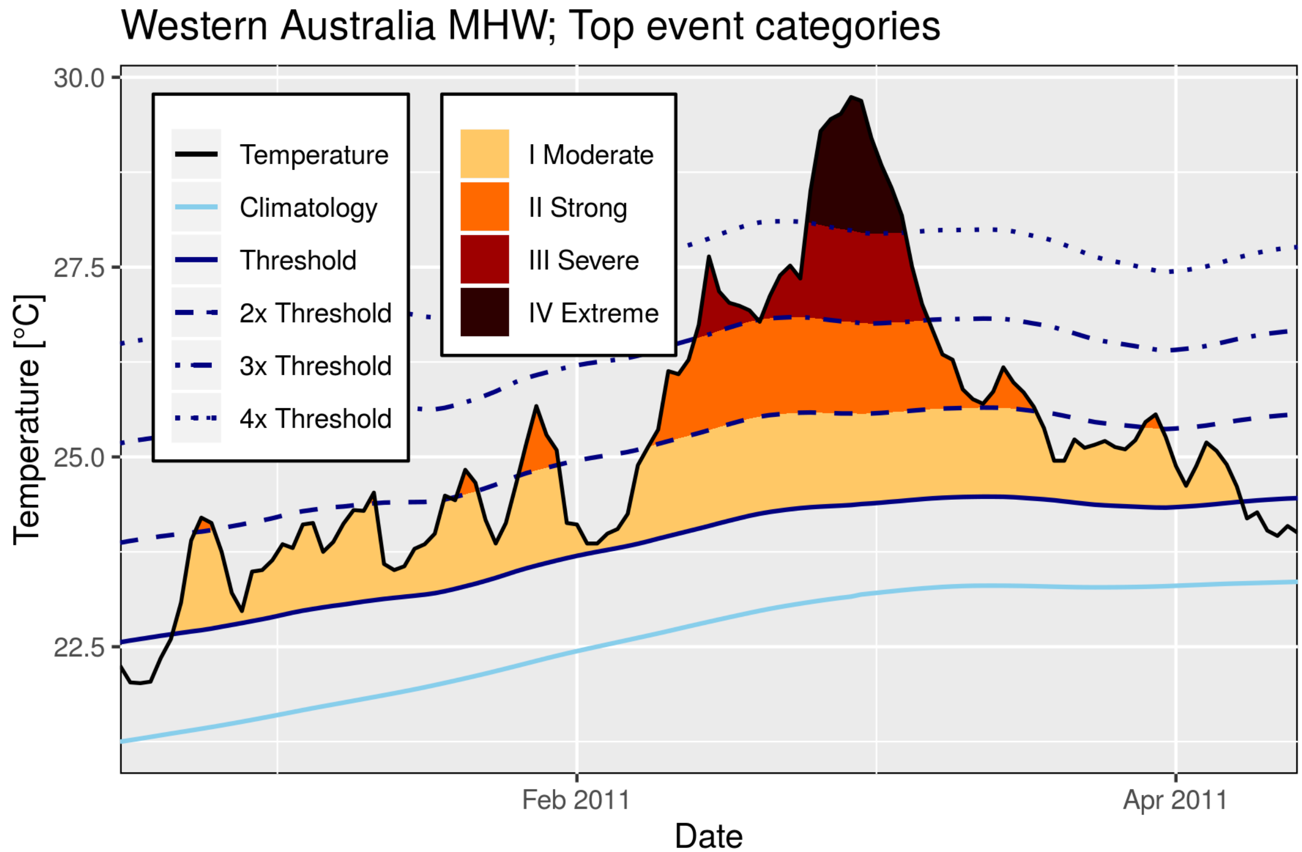
- “A prolonged discrete anomalously warm water event that can be described by its duration, intensity, rate of evolution, and spatial extent.” (Hobday et al., 2016)
- Temperature at a location exceeds the 90th percentile for a given calendar day, for 5+ days, with no more than a 2 day gap



Credit: Eric Oliver

2.2 Categories

- There is also the more qualitative category system (Hobday et al., 2018)
- Compromise between using the 90th or 99th percentile
- Effective science communication



3 SST products

- Criteria for optimal time series use in MHW detection:
  - Daily sampling of study area
  - At least 30 years in length, not less than 20
  - Level 4 gridded gapless
  - Spatial resolution of at least ~25km (1/4 degree)
  - Updated in near-real-time
  - No current best practice on SSTskin vs. SSTsub-skin
  - No current best practice on infra-red vs. microwave vs. reanalysis

3.1 Product info

OISST | CCI | CMC

- NOAA Optimum Interpolation (OI) SST
- 1/4 degree gridded global daily dataset
- AVHRR sensor
    - Gaps interpolated with *in situ* records
- v2.0 from 1981 to 2015
- v2.1 from 2016 to present
- Available in near-real-time
- (Banzon et al., 2016; Reynolds et al., 2007)

4 Methods

- Data prep:
    - All products standardised to same date formats, columns, etc.
    - All products regridded to OISST 1/4 degree grid
- MHW detection:
    - Detection algorithm run for each individual pixel
    - Two climatology periods used
        - 1982-2011 for OISST and CCI comparisons
        - 1992-2018 for OISST, CCI, and CMC comparisons
- MHW summaries:
    - Daily summaries created by adding/averaging global MHW pixels per day
    - Annual summaries made from the daily summaries
    - Maps created of the max category event recorded at each pixel per year

5 Interactive results

- Marine Heatwave Tracker: http://www.marineheatwaves.org/tracker

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6 Conclusion

- Similarities:
  - Agreement between products improves towards the equator
  - Products converge closer to present day
  - CCI becomes more similar to CMC closer to present day
- Differences:
  - Ice cover is so different as to be incomparable
  - CMC becomes more dissimilar from OISST and CCI further into the past
  - OISST MHWs tend to be larger in extent but shorter in duration
- Categories
  - CMC shows the highest average daily count and total days per year
    - OISST is slightly higher for cat. II ‘Strong’ events
  - OISST shows the highest average coverage of the ocean
    - CMC then CCI are much higher for cat. IV ‘Extreme’ events
  - CMC and CCI record more cat. IV ‘Extreme’ events than cat. III ‘Severe’
    - CMC records twice as many cat. IV events than cat. III
- Advice on usage
  - OISST tends to be more conservative, which is good
  - CCI omits areas of high ice coverage, which may be preferable
  - CMC does not appear to have any benefit over OISST or CCI

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7 Acknowledgements

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8 Code availability

https://github.com/robwschlegel/MHWapp

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9 Session info

```
sessionInfo()
```

```
## R version 4.0.0 (2020-04-24)
## Platform: x86_64-pc-linux-gnu (64-bit)
## Running under: Ubuntu 20.04 LTS
##
## Matrix products: default
## BLAS:   /usr/lib/x86_64-linux-gnu/blas/libblas.so.3.9.0
## LAPACK: /usr/lib/x86_64-linux-gnu/lapack/liblapack.so.3.9.0
##
## locale:
##  [1] LC_CTYPE=en_CA.UTF-8       LC_NUMERIC=C
##  [3] LC_TIME=en_CA.UTF-8        LC_COLLATE=en_CA.UTF-8
##  [5] LC_MONETARY=en_CA.UTF-8    LC_MESSAGES=en_CA.UTF-8
##  [7] LC_PAPER=en_CA.UTF-8       LC_NAME=C
##  [9] LC_ADDRESS=C               LC_TELEPHONE=C
## [11] LC_MEASUREMENT=en_CA.UTF-8 LC_IDENTIFICATION=C
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## loaded via a namespace (and not attached):
##  [1] compiler_4.0.0  magrittr_1.5    tools_4.0.0     htmltools_0.4.0
##  [5] yaml_2.2.1      Rcpp_1.0.4.6    stringi_1.4.6   rmarkdown_2.1
##  [9] knitr_1.28      stringr_1.4.0   xfun_0.13       digest_0.6.25
## [13] rlang_0.4.6     evaluate_0.14
```

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