Future marine heatwaves in the western South Atlantic

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Introduction

Marine heatwaves (MHWs) are periods of anonymously high sea surface temperature (SST).

These events can threaten physical, biological, and human systems (Smale et al., 2019).

60% of MHW in the western South Atlantic are **caused by atmospheric blocking** during austral summer (Rodrigues et al. 2019).

Methodology

CMIP6's models **historical, SSP245 and SSP585** runs for **SST, precipitation, wind at 850hPa and geopotential height at 850hPa.**

CMIP6's models SST and OISST used to evaluate MHWs as Hobday,2016 (Optimum Interpolation Sea Surface Temperature Reynolds et al., 2007).

For the 3 better and least performing models, atmospheric variables were used to characterize **atmospheric blocking** conditions:

1. Anticyclonic circulation
2. Droughts

Results I

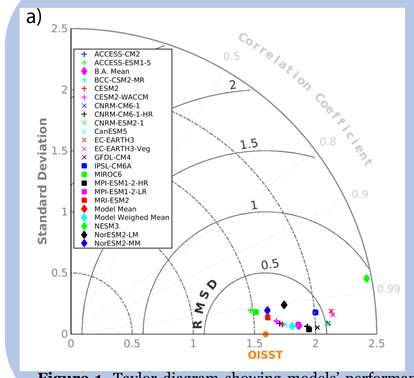

Figure 1. Taylor diagram showing models' performance to estimate annual SST (°C), in the western South Atlantic from 1985 to 2014.

Austral summer SST simulation values for **correlation coefficients > 0.8** and **root-mean square error < 0.6**

Results II

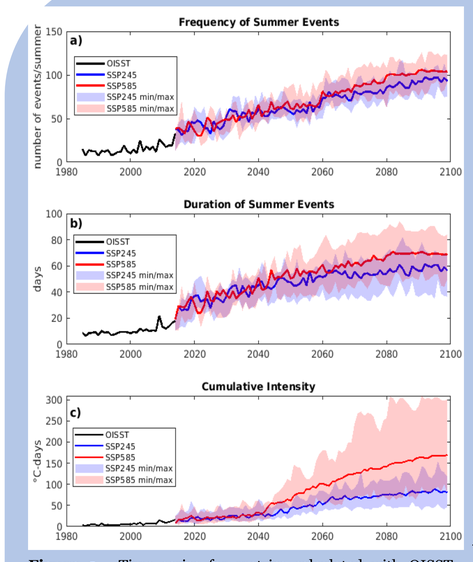

Figure 2 . Time series for metrics calculated with OISST (black), for CMIP6 model mean SSP2-4.5 run (blue), and for SSP5-8.5 (red). Shaded areas are for minimum and maximum intervals.

Modeled MHW **frequency is overestimated**, while **the cumulative intensity is underestimated.**

Pathways show a significant increase in all metrics.

A near to **permanent MHW state is seen** in SSP585.

By the end 2100, there will be **~20 more MHW days per summer**, for the SSP58.5 compared to SSP245.

Results III

Better performing models present the **anticyclonic circulation** encompassing the area encompassed by approximately 20-35°S and 35-60°W.

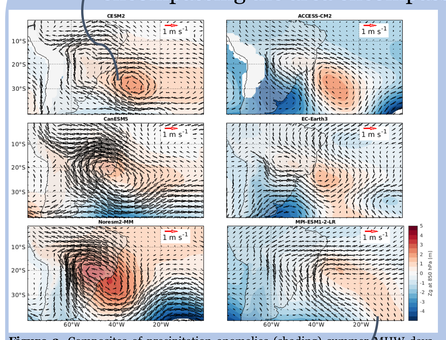

Figure 3. Composites of precipitation anomalies (shading) summer MHW days over the period 1985–2014 for selected models. Contour lines represent the 1985-2014 climatological mean precipitation with 3mm/day intervals.

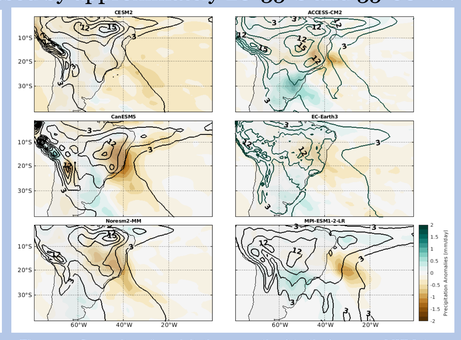

Figure 4. Composites of precipitation anomalies (shading) summer MHW days over the period 1985–2014 for selected models. Contour lines represent the 1985-2014 climatological mean precipitation with 3mm/day intervals.

Better performing models (left panels) **reproduce more accurately the atmospheric blocking** conditions:

1. Anticyclonic circulation
2. Droughts

The **least performing models** show **weaker wind anomalies** and **different placing of the anticyclonic circulation**.

Results IIII

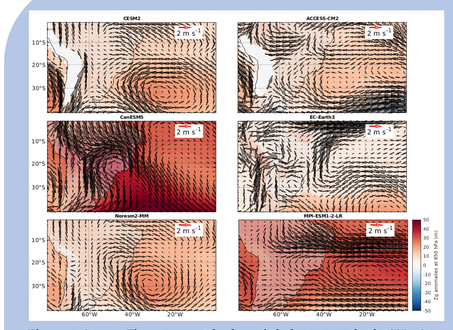

Figure 5. Same as Figure 3, except for the period of 2071-2100 for the SSP5-8.5 scenario.

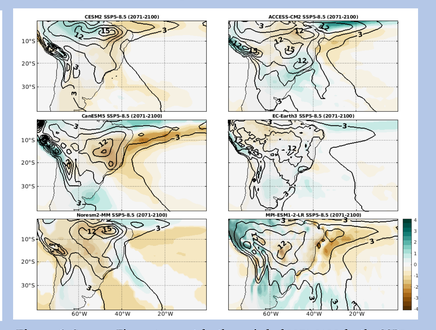

Figure 6. Same as Figure 4, except for the period of 2071-2100 for the SSP5-8.5 scenario.

SSP585 predictions show stronger Atmospheric blocking conditions.

Higher geopotential height and wind anomalies

Stronger droughts (negative precipitation anomalies)

The increase in the MHW metrics is not only due to the long-term warming but also due to an increase and intensification of the atmospheric blocking over this region.

Conclusion

Our analysis shows that the end of the 21st century could reach a nearly permanent state of MHW. Similarly, all atmospheric variables analysed presented intensified anomalies for 2071-2100, leading to the conclusion that atmospheric blocking is also intensifying and, therefore, playing a role in the intensifying MHW metrics.

References

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