Combination of atmospheric and oceanic processes induced long-lasting marine heatwave in the Southeast Pacific Ocean

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Summary

Marine heatwaves (MHWs) are discrete warm-water anomalies events occurring in both coastal and open ocean, having major impacts on ecosystems, fisheries and aquaculture. They are generally caused by a combination of oceanic and atmospheric conditions that favours the increase of the sea surface temperature (SST) and/or reduce the heat transfer from the ocean to the atmosphere. Here we investigated through satellite data the formation of a MHW offshore the Chilean Patagonia in the Southeast Pacific Ocean. This MHW lasted from May to October 2016 and was identifiable through the presence of unusually low heat transfer from the ocean to the atmosphere.

Objectives

- Understand **which processes** led to MHWs formation
- Determine **how the processes conditioned the ocean** to form a MHW/optimal conditions for MHW development

Oceanic and atmospheric conditions

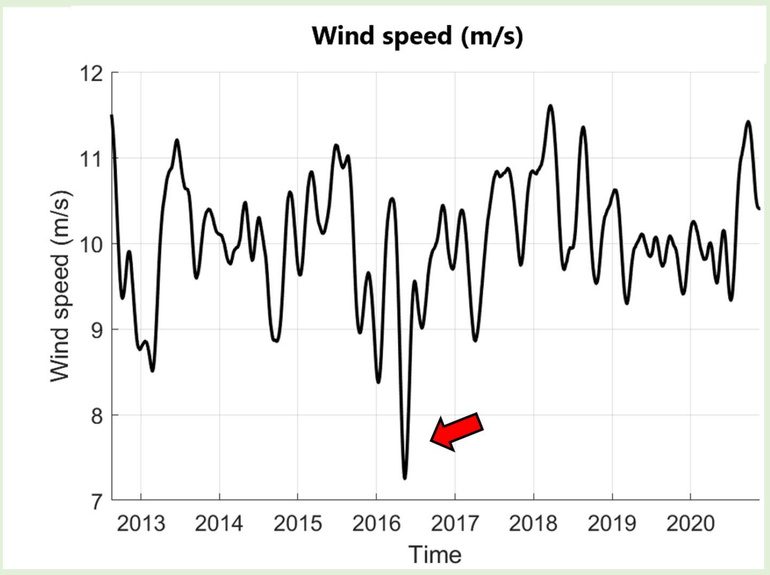

Fig. 1. Wind speed spatially averaged offshore Patagonia.

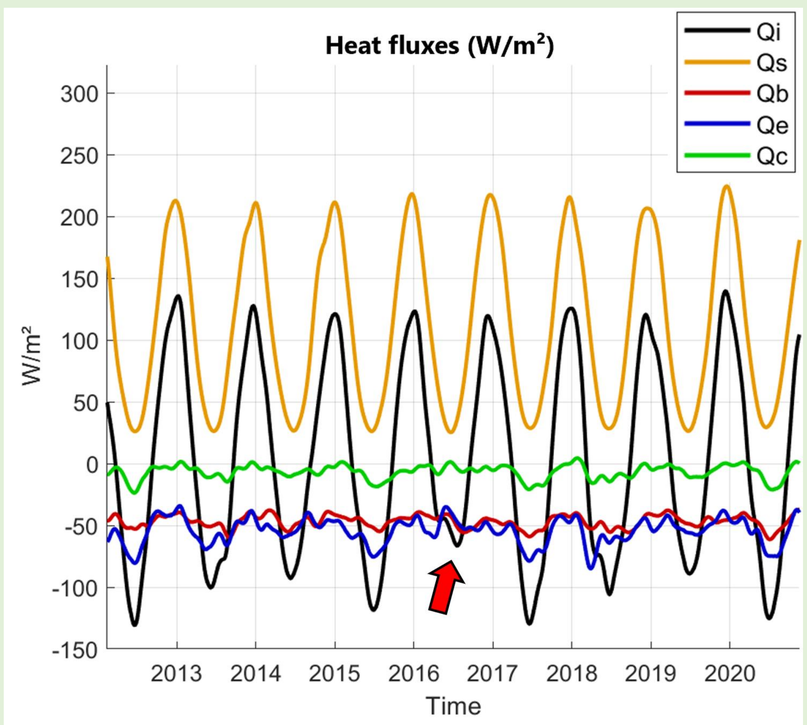

Fig. 2. Heat fluxes spatially averaged offshore Patagonia. Qi: total heat fluxes; Qs: solar heat; Qb: thermic radiation; Qe: latent heat; Qc: sensible heat. Positive (negative) fluxes indicate a heat gain (loss) for the ocean.

Method

Our MHWs detection was based on the method described by Hobday et al. in 2016 using the scripts provided by Schlegel and Smit (2018).

- SST from 1982 to 2020 was used to calculate the baseline daily climatology
- The 90th percentile was used as a threshold: MHW exists if the SST exceeds the threshold during at least 5 days

MHWs are classified in 4 categories which are calculated as multiples of the difference between the threshold and the climatology

Category I is a weak MHW whereas Category IV is an extreme MHW event (see Hobday et al., 2018)

Data

- Detection of the MHWs: identify the periods of warm SST anomalies relatively to a long-term climatology using NASA's optimal interpolation SST (OISSTv2) dataset (spatial resolution: 0,25° ; temporal resolution: 1 day)
- Heat fluxes and winds: ERA5 datasets from the ECMWF (spatial resolution: 0,25° ; temporal resolution: 1 hour)

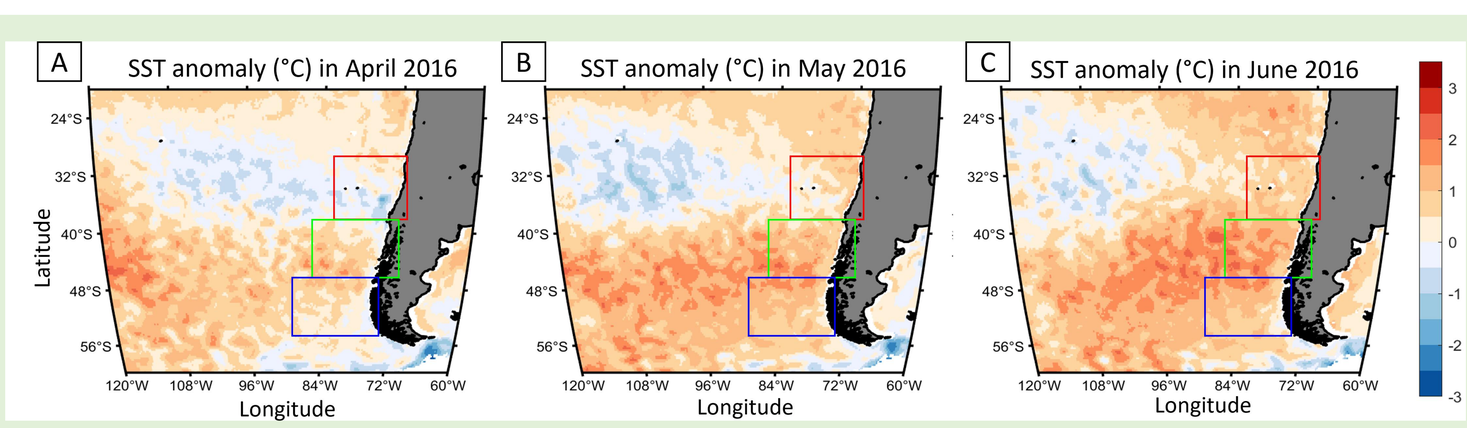

Fig. 3. Sea surface temperature (SST) anomaly (°C). The coloured boxes indicate central Chile (red), North Patagonia (green) and South Patagonia (blue).

- Advection of a warm water patch from the extratropical South Pacific to Patagonian coasts during austral fall and winter
- Winds unusually low during late fall/early winter 2016 associated with persisting high pressure system over Patagonia
- Lower winds have induced a reduction of the heat transfer from the ocean to the atmosphere:
  - → Latent heat transfer was reduced by 1/3 in late fall
  - → Sensible heat transfer was close to zero W/m² in late fall and 2 times lower than usual during winter
  - → The total heat transferred from the ocean to the atmosphere was reduced by 2 in late fall and reduced by 1/4 in winter

Development of the MHW

- **Advection of warm waters** during austral fall 2016 → favourable oceanic conditions for MHWs development
- **Reduced winds** strongly **diminishing the heat transfer** from the ocean to the atmosphere → the **ocean did not cool as much as usual during fall and winter**

Formation of the longest MHW ever recorded offshore Patagonia over the period 1982-2020:

1. The MHW started in North Patagonia in May 2016 when the winds and the heat transfer were the lowest
2. Expand to South Patagonia in June 2016
3. Short heat spikes recorded in central Chile but the MHW episodes remained moderate
4. During winter 2016 the heat transfer from the ocean to the atmosphere progressively go back to normal values but the advection of warm waters continued → the MHW persist up to early spring
5. The MHW brutally disappeared in October 2016
6. According to Hobday et al.'s (2018) MHWs classification, this MHW was a Category II MHW event

Conclusions

Oceanic and atmospheric conditions were reunited to allow the **formation of a 5-months long MHW offshore south Chilean coast**. The **advection of warm waters** was **combined with lower winds** which has in turn **reduced the oceanic heat loss**, favouring the environmental conditions for MHW development.

References

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For further details: Pujol, C., Alvera-Azcárate, A., Pérez-Santos, I., Barth, A. Submitted to *Frontiers in Marine Science,* (2021).