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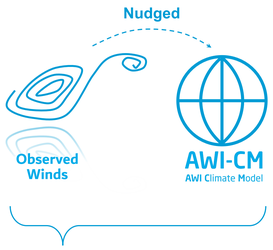
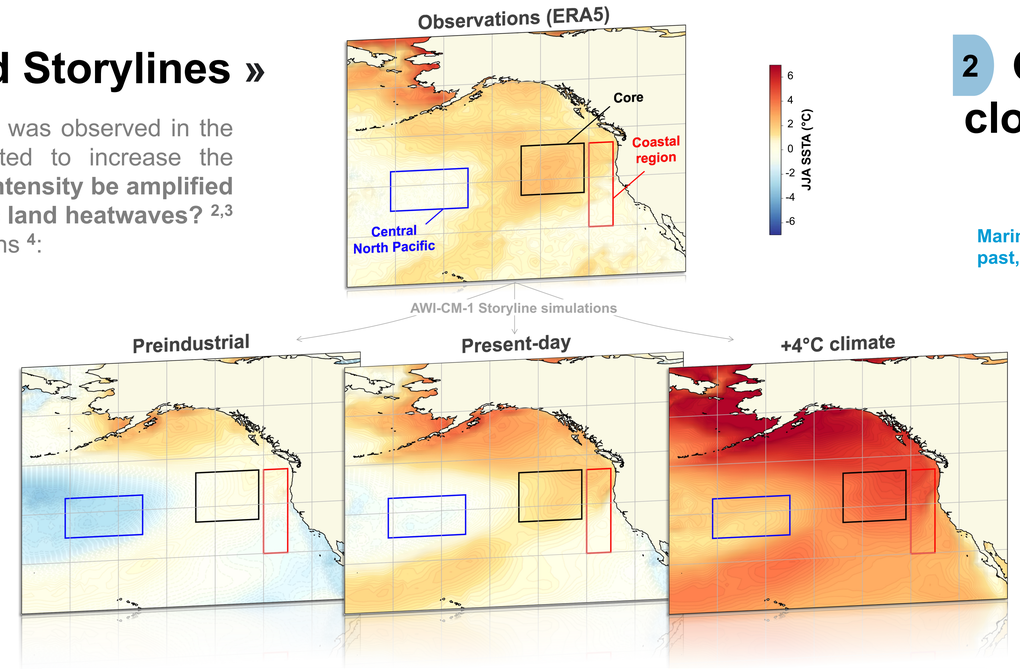
Projected amplification of summer marine heatwave intensity in the Northeast Pacific Ocean in a warming world

1 A novel approach: « Nudged Storylines »

In summer 2019, a **record-breaking marine heatwave** was observed in the Northeast Pacific [1]. While climate change is expected to increase the occurrence of marine heatwaves, **could their growing intensity be amplified or dampened by local feedback processes, similar to land heatwaves?** [2,3] To address this, we use novel nudged storyline simulations [4]:

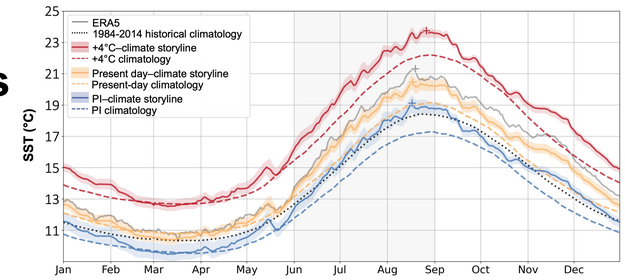


The evolution of **observed (ERA5) large-scale winds** is imposed (i.e., nudged) in a global **coupled climate model** with various climate forcings.



Storylines of the summer 2019 marine heatwave, if it unfolded in past, present, and future climates. Boxes show area-averages

2 Generating close analogues

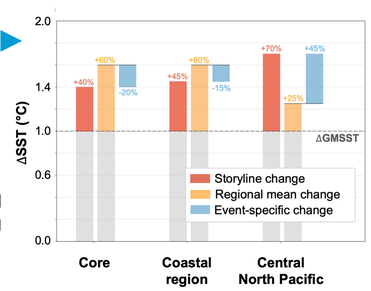


Marine heatwave core SST in past, present, future climates.

Very good spatio-temporal coherence by imposing (nudging) only the observed large-scale winds (Fig. 1, 2). Shows that as for heatwaves over land, the large-scale **atmospheric flow such as the jet stream drives the marine heatwave** observed in 2019.

3 Storyline Attribution…

Area-averaged changes in SST between the preindustrial & present-day climates.

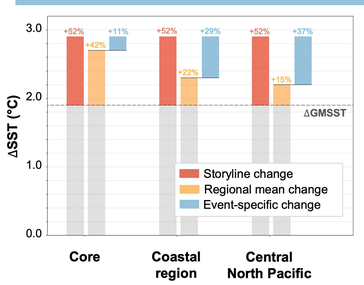


Storyline warming: total marine heatwave warming in storyline simulations

- **1.4°C** of 2019 marine heatwave core temperatures **attributed to thermodynamical aspects of anthropogenic climate change**.
- Essentially due to an **above-average regional mean warming**.
- Event-specific feedback processes dampened marine heatwave warming compared to regional mean warming.

4 … and Projections

In a +4°C world, intensity 2.9°C above present levels:
50% more than the projected 1.9°C global-mean ocean warming

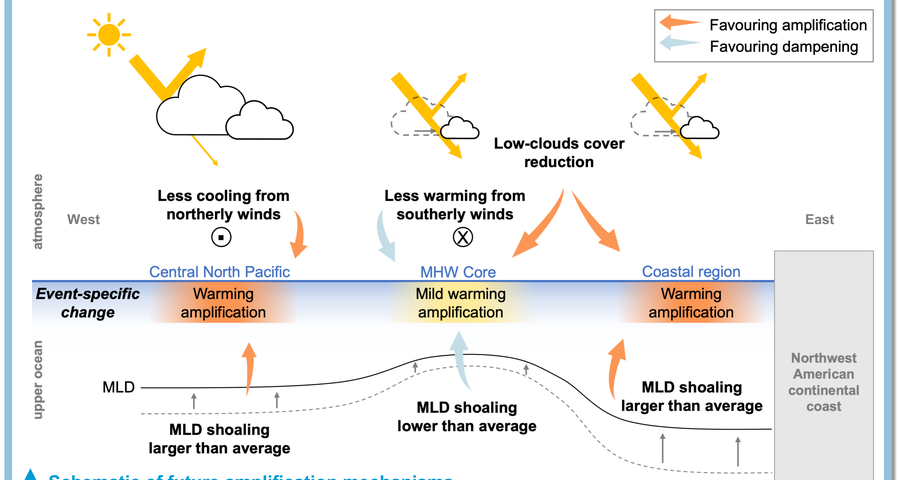


Same for changes between present-day and +4°C warmer climates.

- Also **10 to 40% more than projected regional mean changes** (2.3 to 2.7°C), due to event-specific air-sea feedback processes.
- Feedbacks drive a larger event-specific warming amplification at the periphery than at core: **extend spatially future analogous marine heatwaves**.

Local feedbacks would amplify future similar marine heatwaves even above projected regional mean trends

5 Air-sea feedbacks can amplify future marine heatwave warming



Schematic of future amplification mechanisms.

6 Implications of our findings

Greater stress on marine ecosystems than expected, even more if thermal tolerances are exceeded. Ramifications on **fishery economics** and continental weather.

Effects of **climate change more tangible** with nudged storylines. **Inform future studies** on projected changes in other marine extremes.

More details: Ask us!

Paper submitted to Nature Climate Change

Find us on-site
Poster Attendance: Thu. 27 April, 10:45-12:30

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Glossary
ΔGMSST : Global-Mean SST increase
MLD: Mixed Layer Depth
Storyline warming: Differences between storylines in two climates. Indicates the total marine heatwave warming: regional mean and (event)- specific changes.

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