Marine heat waves:
The added value of a high resolution, coupled atmosphere-ocean regional climate model

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Marine heat waves (MHW's) exert a substantial impact on human life and ecosystems in the ocean. To mitigate future changes in MHW's it is detrimental to increase our mechanistic understanding, and this must be investigated on a local scale to understand the smaller scale driving processes of the heat waves. Here we compare a 12 km grid spacing coupled ocean-atmosphere modelling system (COAWST), which includes the atmospheric model WRF and the ocean model ROMS with three NorESM2 model simulations; a reanalysis driven ocean only NorESM2M version with 1° ocean, the NorESM2-MM which is part of the CMIP6 ensemble and the NorESM2-MH with a higher ocean grid spacing (0.25°). Atmosphere resolution is 1° in both coupled NorESM simulations.

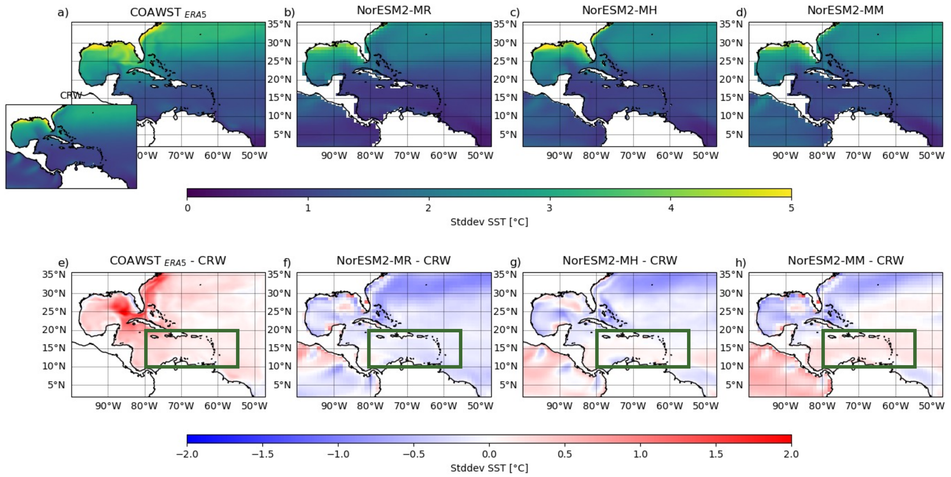


Figure 1: A comparison of the standard deviation in sst in the regional model ROMS, three NorESM2 simulations and the coralreef watch dataset (CRW). During our investigation period the Caribbean Sea have episodes of devastating heat waves, we investigate the green box further (10N-20N, 80W-55W).

Methods:

MHW's are detected following the methodology of Hobday et al. (2018), We base our heat wave calculations on smoothed daily sst's, using a centered 11-day window. The climatology 90. percentile is a 30-day smoothed percentile.
The simulations are analysed over a 20 year window from 1995-2014.

Figure 3: Climatological mixed layer depths (MLD) in the different models and in the SODA dataset. The models have different ways of calculating MLD and is by so not directly comparable. However, it is worth noticing that the interannual variability in NorESM models generally are higher, whereas COAWST has a lower interannual variability.

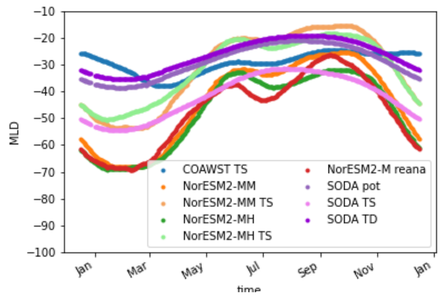


Figure 4: Comparing latent heat during SON days of increasing and decreasing heatwaves shows that when COAWST sea surface temperature is decreasing a large component is the latent heat release t the atmosphere.

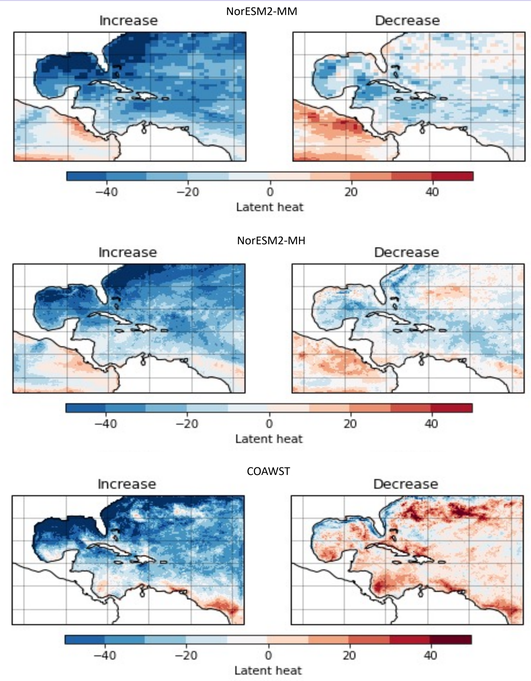
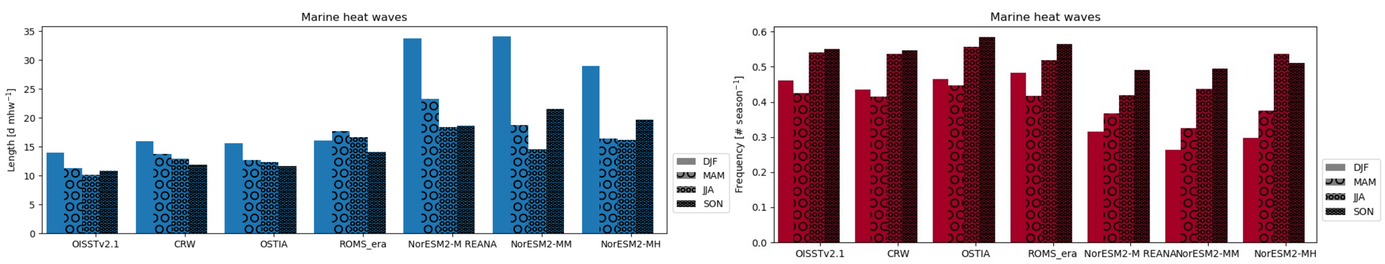


Figure 2: MHW lengths and frequencies in 3 observational datasets (OISSTv2.1, Coralreef watch (CRW) and OSTIA), our regional downscaling ROMS_era, the NorESM2M ocean only, NorESM2-MM and NorESM2-MH. All global NorESM2 models have too few, but too long heatwaves detected, winter season is the main biased season.



Conclusions:

MHW's are too long in NorESM models due to the deepening of mixed layer during autumn & winter, implying a larger total heat capacity. This leads to less decrease in sea surface temperature, hence continuation of heatwaves during winter season. Longer heatwaves leads to lower frequencies of heatwaves. The COAWST model has shallower mixed layer depth, which leads to a larger heat surface heat flux and faster cooling of the mixed layer. The temporal distribution of MHWs is better represented in COAWST.

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References:
Hobday, A. et al. (2018). Categorizing and Naming Marine Heatwaves. *Oceanography*, *31*(2), 162–173. DOI:10.5670/oceanog.2018.205

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