Earth Systems and Climate Change Hub

National Environmental Science Programme

climate change **science brief**

Marine heatwaves in the Tasman Sea: future projections

As our climate has warmed, the severity, duration and frequency of marine heatwaves – periods of abnormally high temperatures in the ocean – have increased.

The Tasman Sea is a global hotspot for ocean warming, with sea temperatures rising faster than the global average rate. The two most intense marine heatwaves in this region have occurred in recent years (2015/16 and 2017/18), causing widespread impacts to the regional ecology and ocean-dependent industries.

Earth System and Climate Change Hub researchers have investigated the likelihood of marine heatwaves with a similar intensity and duration to these two events occurring in the Tasman Sea in the future.

Impacts of the 2015/16 and 2017/18 marine heatwaves

During the summers of 2015/16 and 2017/18 large areas of the Tasman Sea, off the east coast of Tasmania, experienced sea surface temperatures greater than 2°C above average levels over several months (Figure 1). Both marine heatwaves resulted in a range of ecological impacts. For example, outbreaks of Pacific Oyster Mortality Syndrome (POMS) were most likely triggered by the temperature stress causing widespread mortality of juvenile Pacific oyster stocks and forcing the closure of oyster hatcheries. Poor conditions were also recorded for blacklip abalone during the summer of 2015/16, with approximately 5% mortality, and reduced performance in cultured Atlantic salmon resulted in limited supply to seafood markets.
The region has also experienced increased 'tropicalisation', with the appearance of fish species typically found further north.

Given the severity of these impacts on the region, the Earth Systems and Climate Change (ESCC) Hub set out to investigate how likely it would be for marine heatwaves of these magnitudes to occur again.

Drivers and characteristics of Tasman Sea marine heatwaves

The extreme warmth of the 2015/16 marine heatwave stretched around the east coast of Tasmania several hundred kilometres offshore and to a depth of more than 400m. This event was primarily caused by a strengthening of the East Australian Current, which brought warm tropical waters from the north into the region.

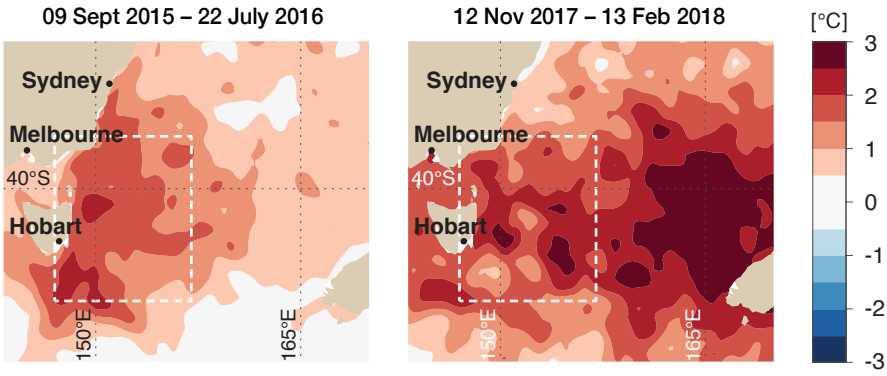


FIGURE 1 **Mean sea surface temperature anomalies during the 2015/16 (left) and 2017/18 (right) Tasman Sea marine heatwaves.** Relative to the 1983-2012 seasonal climatology. The white box indicates the extent of the area analysed.

The Tasman Sea experienced further extreme temperatures during the 2017/18 marine heatwave, reaching up to 3°C above average over a much wider area between Tasmania and New Zealand, but for a shorter duration of three months and to only 30m depth. This event was driven by a persistent blocking atmospheric high-pressure system resulting in surface layer warming from increased solar radiation.

Climate projections of future marine heatwaves

ESCC Hub researchers examined the likelihood of extreme marine heatwaves occurring under two possible future scenarios: a low greenhouse gas emissions scenario (RCP2.6) and a high emissions scenario (RCP8.5).

While for any given scenario there are wide ranges in simulated marine heatwave statistics, analysis of climate projections under the two different emissions scenarios reveal starkly different outlooks.

Currently, marine heatwaves of similar intensity to the 2015/16 and 2017/18 events occur approximately once every 20 years on average.

Under the low emissions scenario, future maximum marine heatwave intensities are not likely to change substantially (Figure 2) and the maximum intensities observed in 2015/16 and 2017/18 are expected to remain rare events, perhaps occurring once every 15 years (on average) by 2100. However, under the high emissions scenario, the observed 2017/18 maximum intensity is likely to become an annual occurrence by around 2060.

ESCC Hub researchers also found that under the high emissions scenario, the ocean off eastern Tasmania is likely to be in a permanent marine heatwave state by 2080 (relative to recent climate conditions, with a 1983-2012 baseline). Under the low emissions scenario, almost 150 annual marine heatwave days are projected to occur by 2050 and could stabilise through to 2100 – a similar number as observed during the 2017/2018 event.

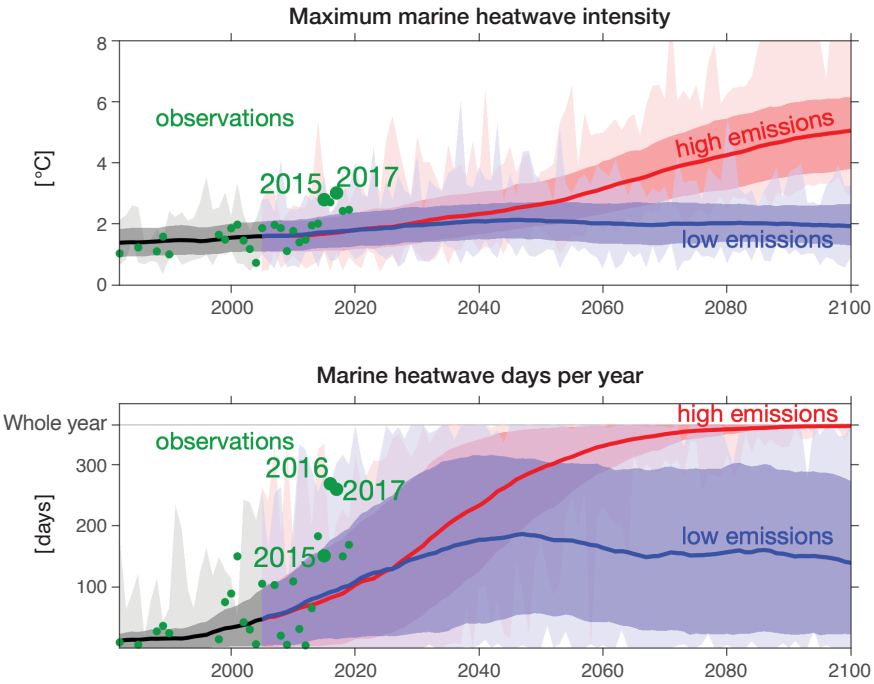
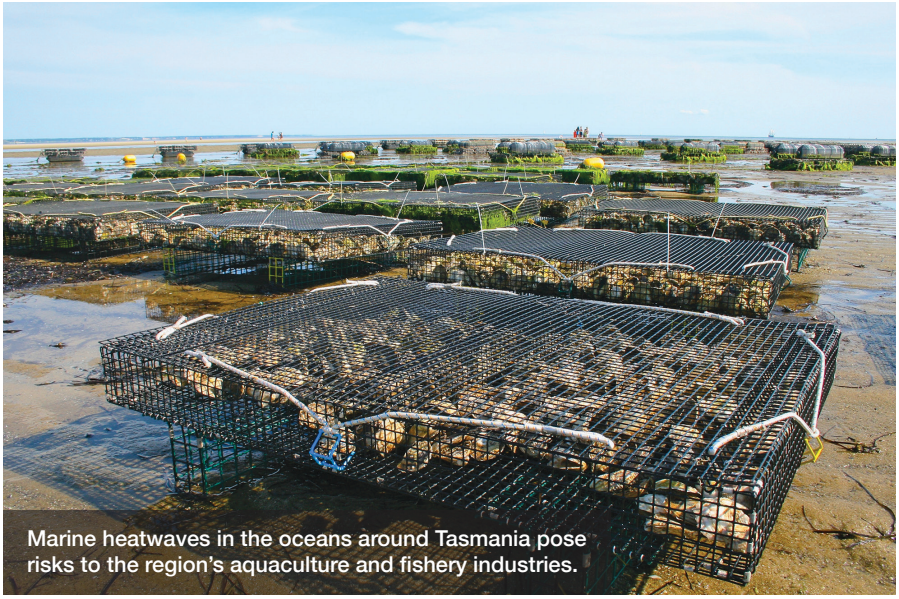


FIGURE 2 **Marine heatwave intensity and duration are projected to increase more under a high emissions scenario compared to a low emissions scenario.** Model projections from 17 CMIP5 models, under low (RCP2.6) and high (RCP8.5) emissions scenarios. Light shading denotes the full model ranges, darker shading the 66% likelihood range, and solid lines the model mean.



Marine heatwaves in the oceans around Tasmania pose risks to the region's aquaculture and fishery industries.

Planning for future marine heatwaves

Changes in the intensity, duration and frequency of future marine heatwaves will have implications for marine ecosystems and ocean-based industries. Tasmanian aquaculture and fishery operators are aware of the threat of increasing sea temperatures and require longer seasonal forecasts and higher resolution spatial information. A better sense of possible future marine heatwave risks under a changing climate will aid business planning and adaptation by these marine industries into the future.

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