

Water Research Laboratory | School of Civil & Environmental Engineering

Global wave climate trends, what do the Australian buoys tell us?

François Flocard, Mitchell Harley, Ian Coghlan, Ron Cox

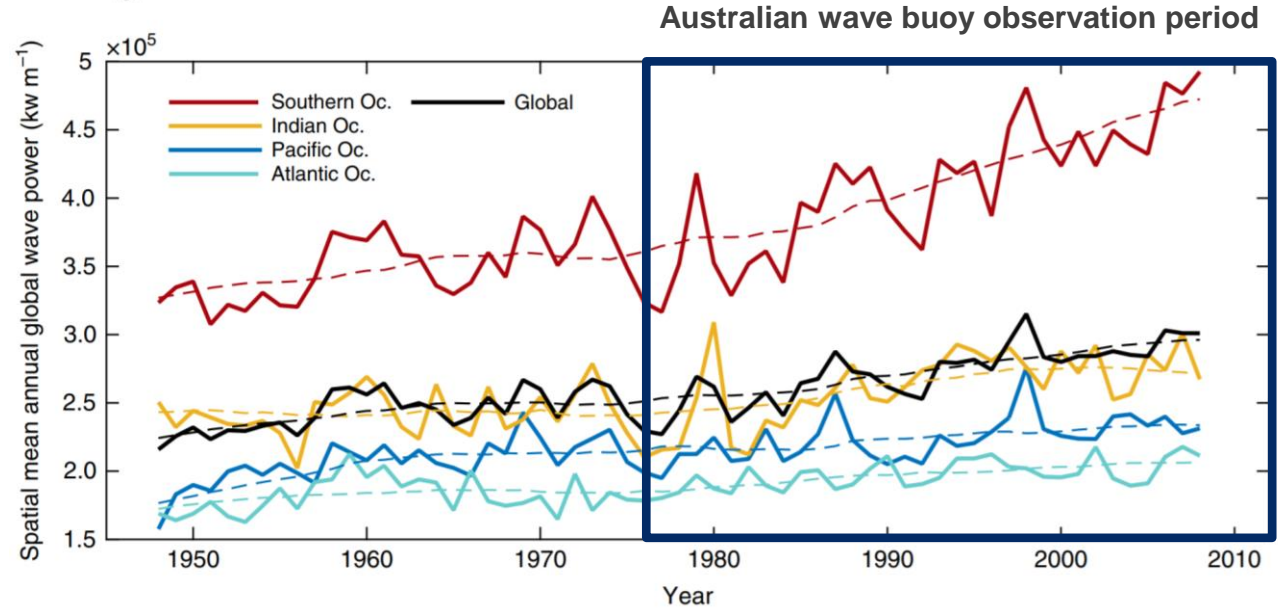
ARTICLE

<https://doi.org/10.1038/s41467-018-08066-0>

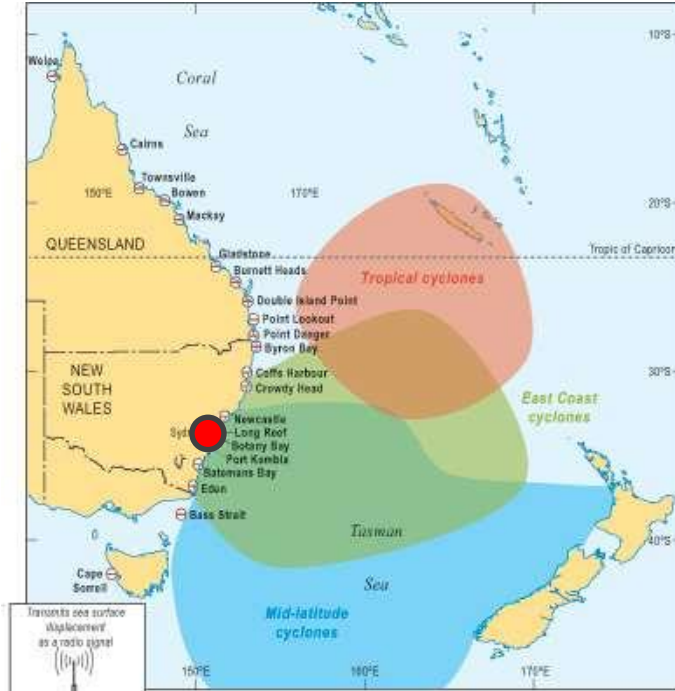
OPEN

A recent increase in global wave power as a consequence of oceanic warming

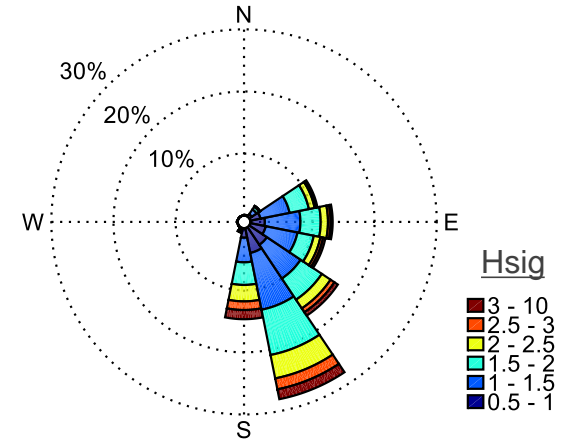
Borja G. Reguero^{1,2}, Iñigo J. Losada¹ & Fernando J. Méndez¹



43 years of beach surveys at Narrabeen Beach, Australia



Sydney wave climate



Mean $H_{sig} = 1.6$ m

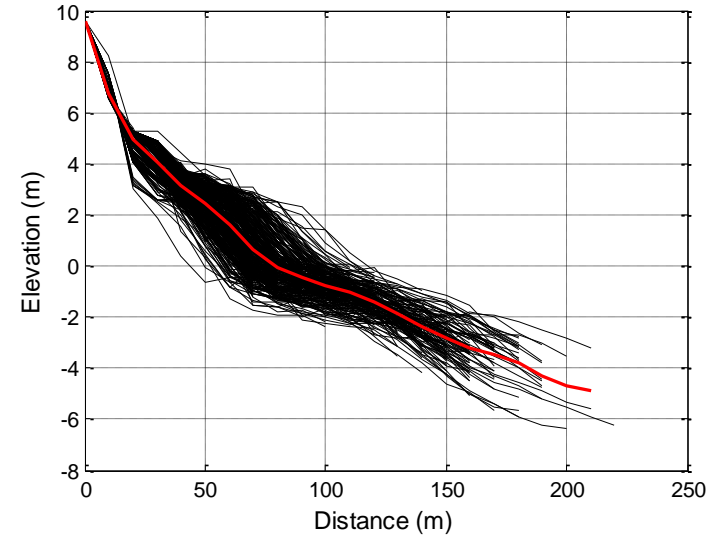
Mean $T_{peak} = 10$ s

Storm threshold: $H_{sig} = 3$ m

43 years of beach surveys at Narrabeen Beach, Australia

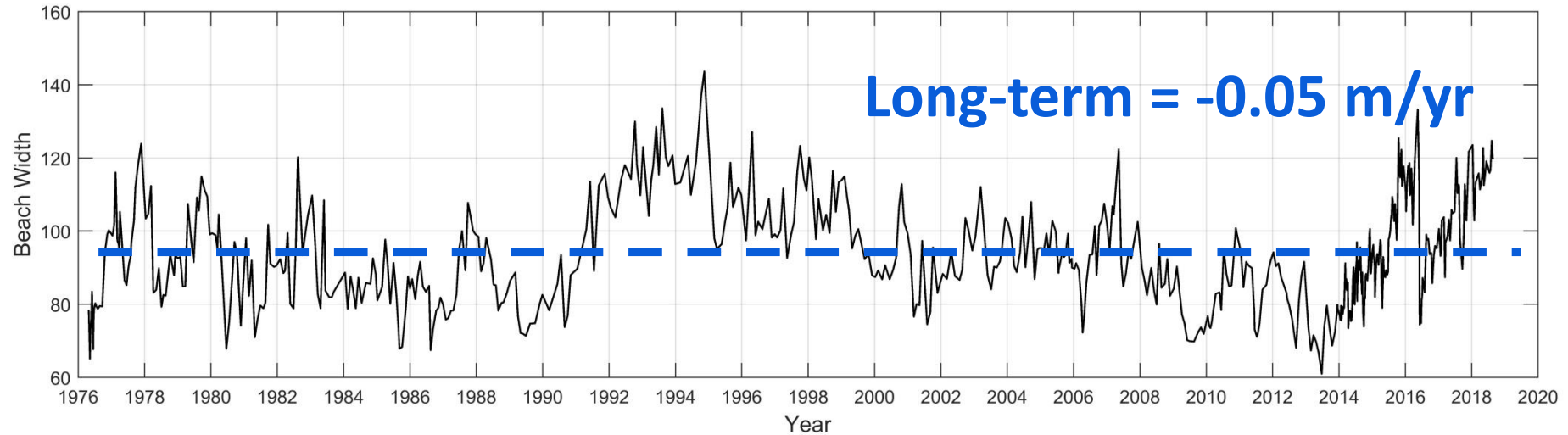


Historical surveying using Emery method

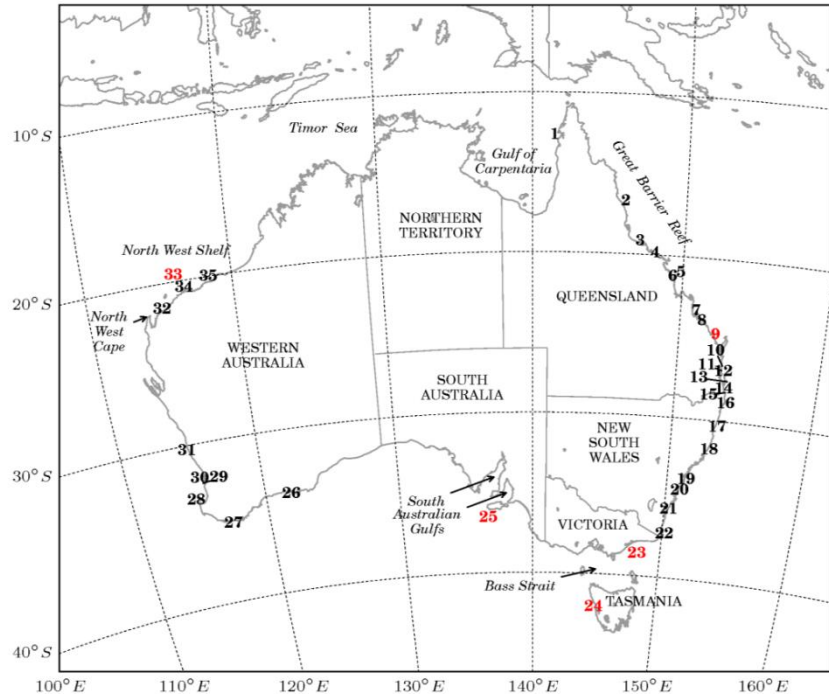


Surveys of five transects down to MSL

43 years of beach surveys at Narrabeen Beach, Australia



The Australian wave observation network



Greenslade et al., (2018)

- **35+** wave buoys across Australia
- **15** buoys with > 25 years of wave measurements
- Generally consistent use of Datawell waverider buoys
- Many available on **Australian Ocean Data Network** data portal (<https://portal.aodn.org.au/>)

Challenges of long-term observational wave data

S. DEAVES

Wave data recording program

Cairns region

For the years 1975 - 1997

2.3 Station configuration

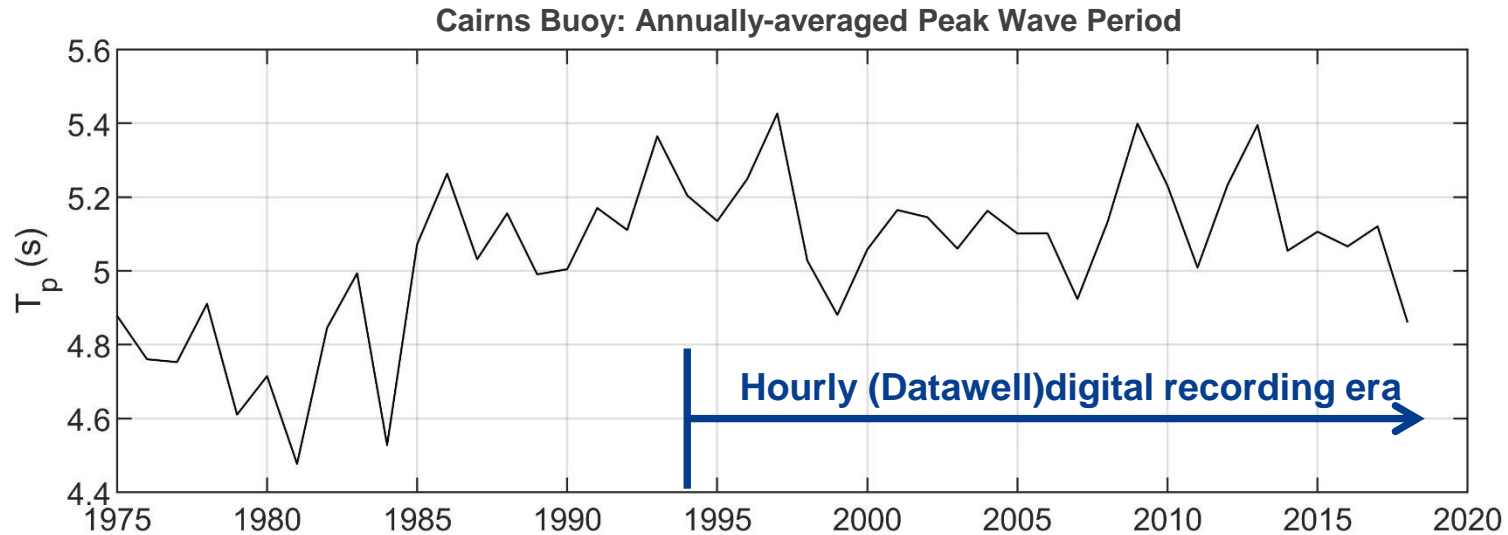
In the original configuration of the Cairns station, for the period 2 May 1975 to 17 March 1981, the installation comprised a waverider 6000 series non-directional buoy and a recording station consisting of a WAREP Mark II waverider receiver coupled to an ANMA analogue recorder. The WAREP receiver controlled the timing of data recording, provided a paper chart of the water level recordings and relayed an analogue signal to the ANMA analogue recorder.

Between 18 March 1981 and 20 January 1994, the recording station was upgraded by replacing the ANMA analogue recorder with a DIMA digitiser/recorder.

The WAREP receiver controlled the timing of data recording and provided a paper chart of the water level signal. Wave data were recorded by the DIMA unit in 20 minute bursts and digitised at 0.5 second intervals (2.0Hz). The data were recorded on digital cassettes and, with the paper charts, transferred to the Brisbane office for processing.

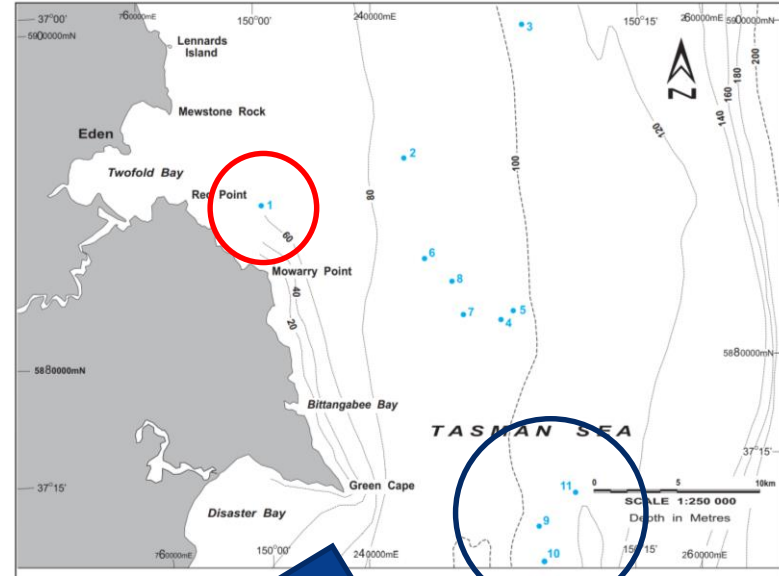
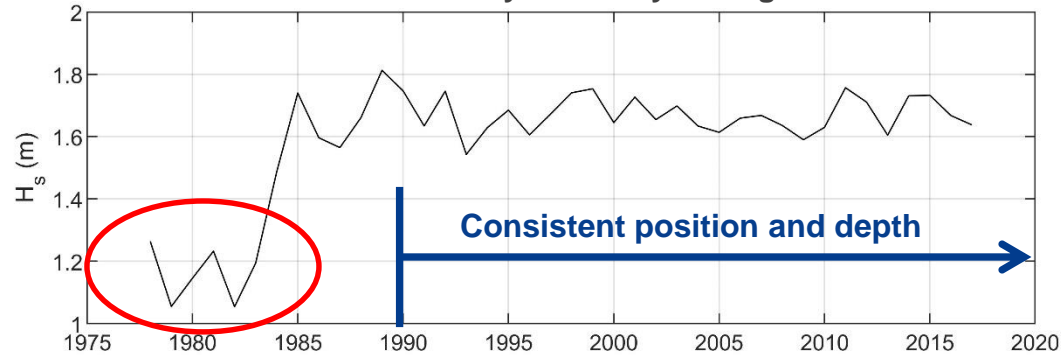
On 21 January 1994, the Cairns wave recording station was further upgraded with a non-directional waverider buoy and the recording system upgraded to a PC-based system utilising the Datawell DIWAR waverider receiver/digitiser. The water level data, digitised at 0.39 second intervals (2.56Hz), is recorded in bursts of 4096 points (approximately 26 minutes) and recorded on the PC hard disk.

Challenges of long-term observational wave data



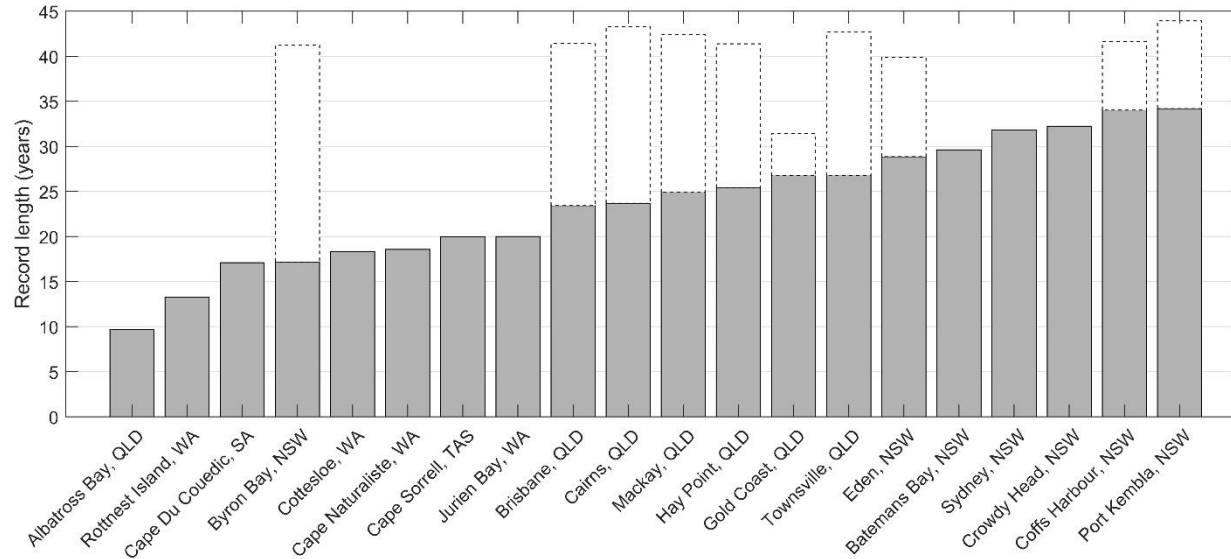
Challenges of long-term observational wave data

Eden Waverider Buoy: Annually-averaged SWH



Eden Buoy Stations (1978-present)

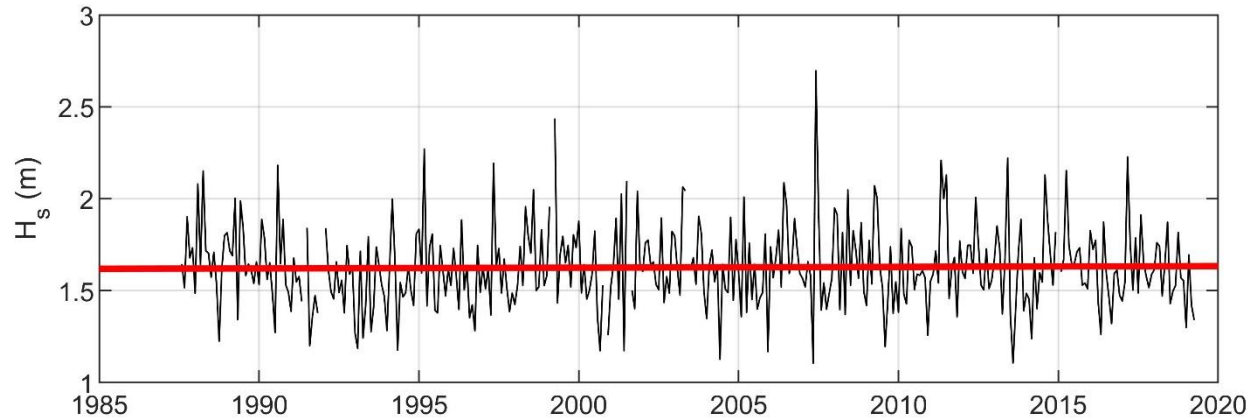
The Australian wave observation network



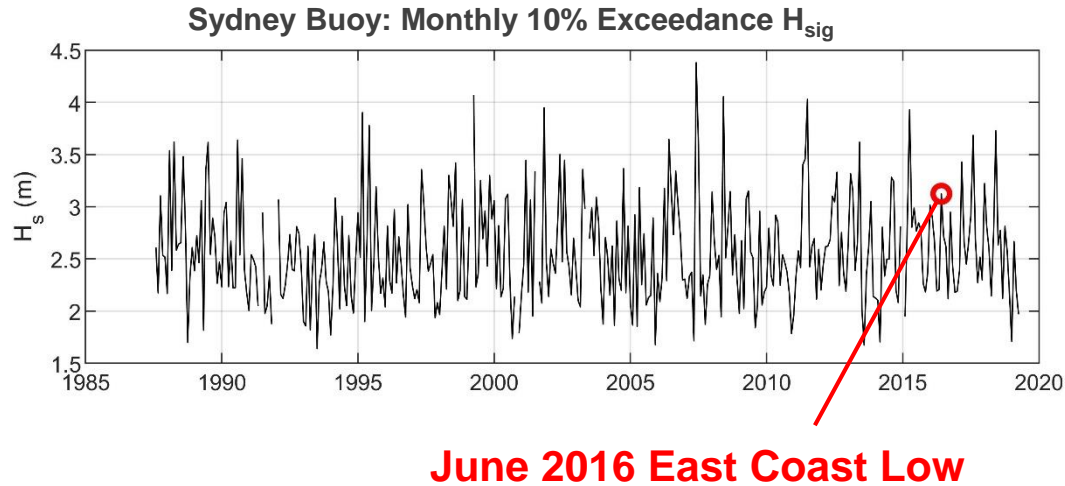
- Focus of this study on **20 buoys** with data record lengths **> 10 years**
- Majority (13 of 20) in eastern states of NSW and QLD

Methodology

- Monthly + annual means calculated in H_{sig} and T_p
- Monthly + annual 10% and 1% exceedance calculated for H_{sig}
- Linear trends defined by Sen's slope
- 95% significance using Seasonal Mann-Kendall Trend Test



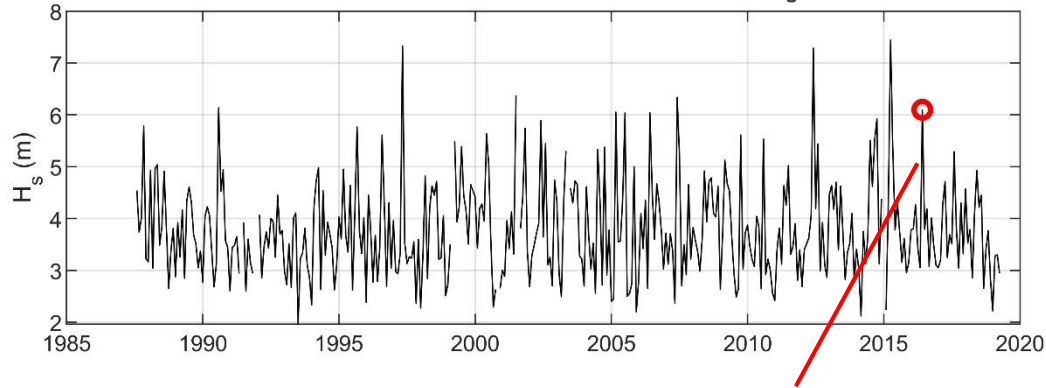
Monthly extreme wave heights and coastal erosion



Largest erosion event in past 40 years

Monthly extreme wave heights and coastal erosion

Sydney Buoy: Monthly 1% Exceedance H_{sig}

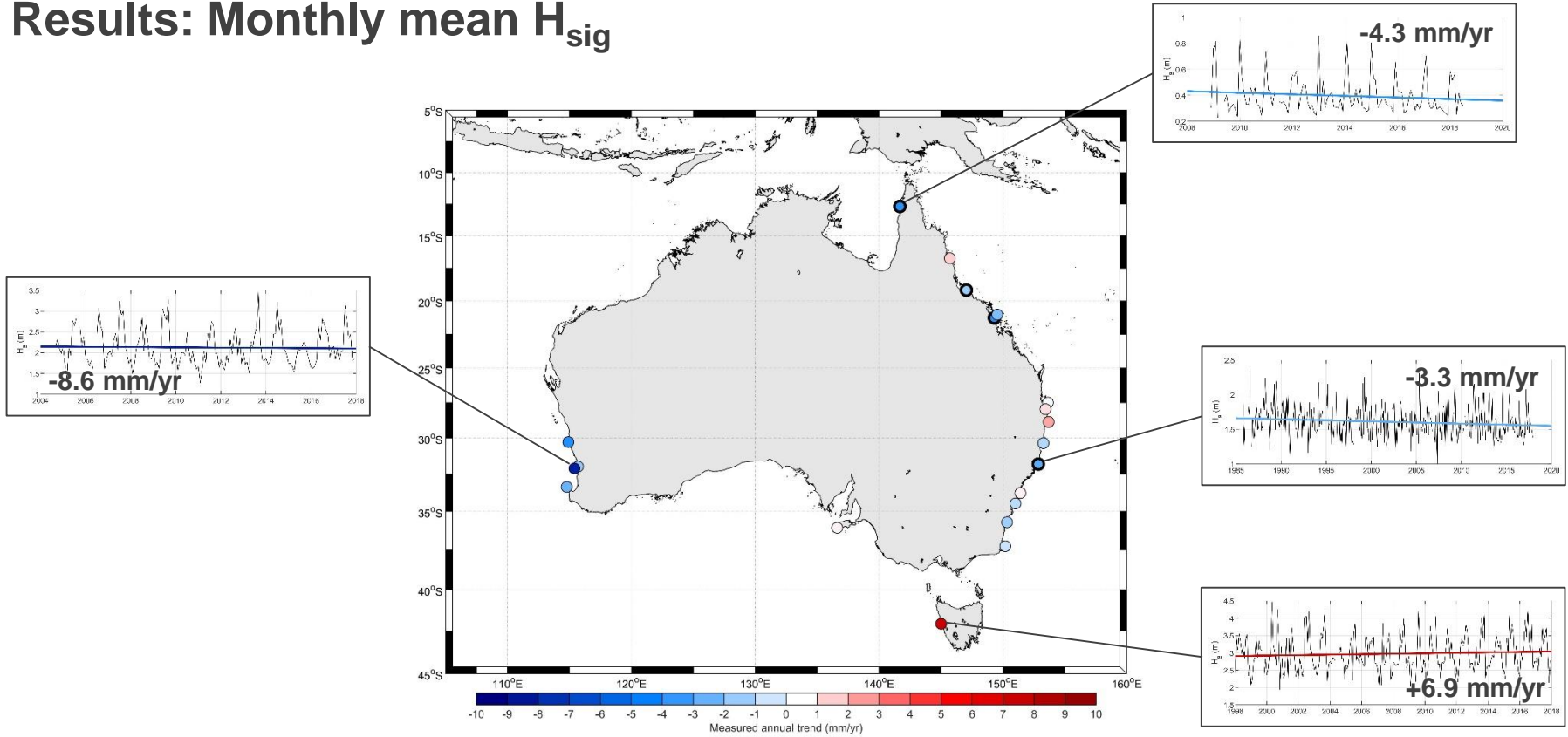


June 2016 East Coast Low

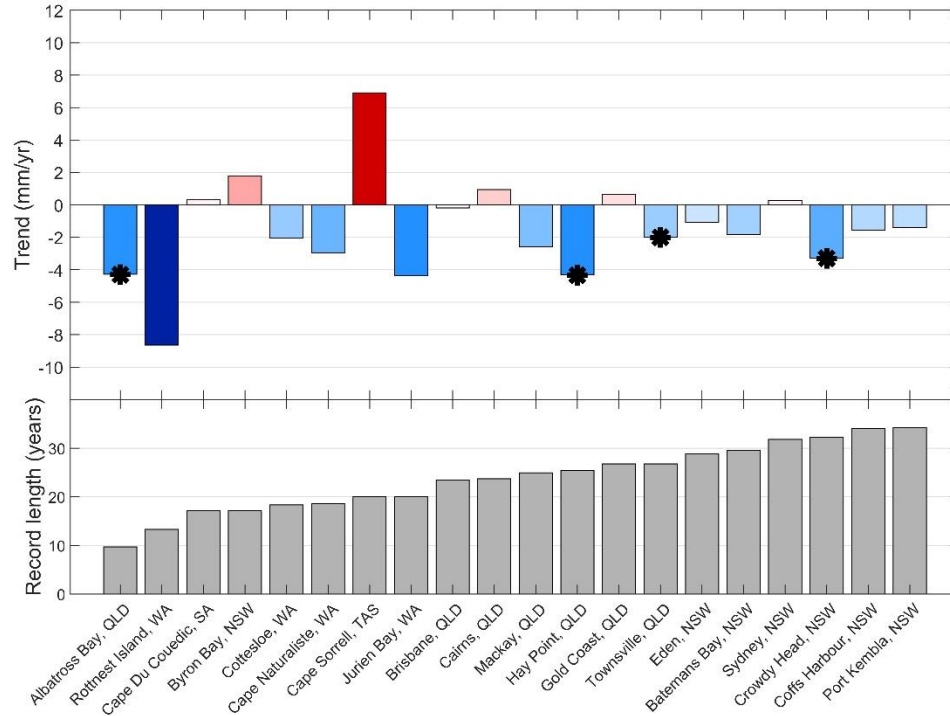


Largest erosion event in past 40 years

Results: Monthly mean H_{sig}

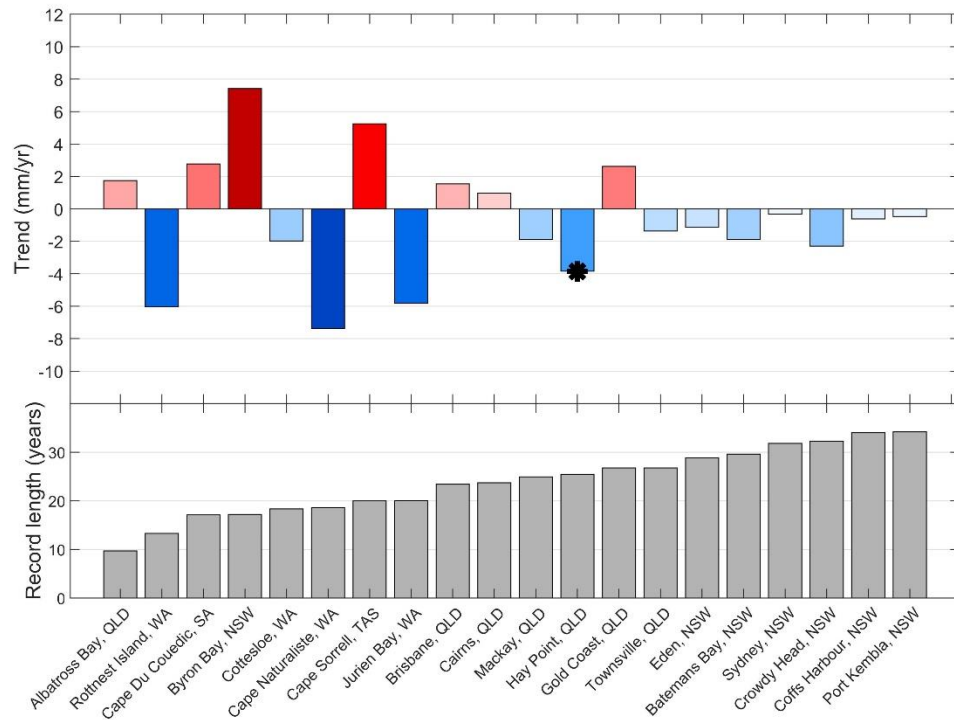


Results: Monthly mean H_{sig}



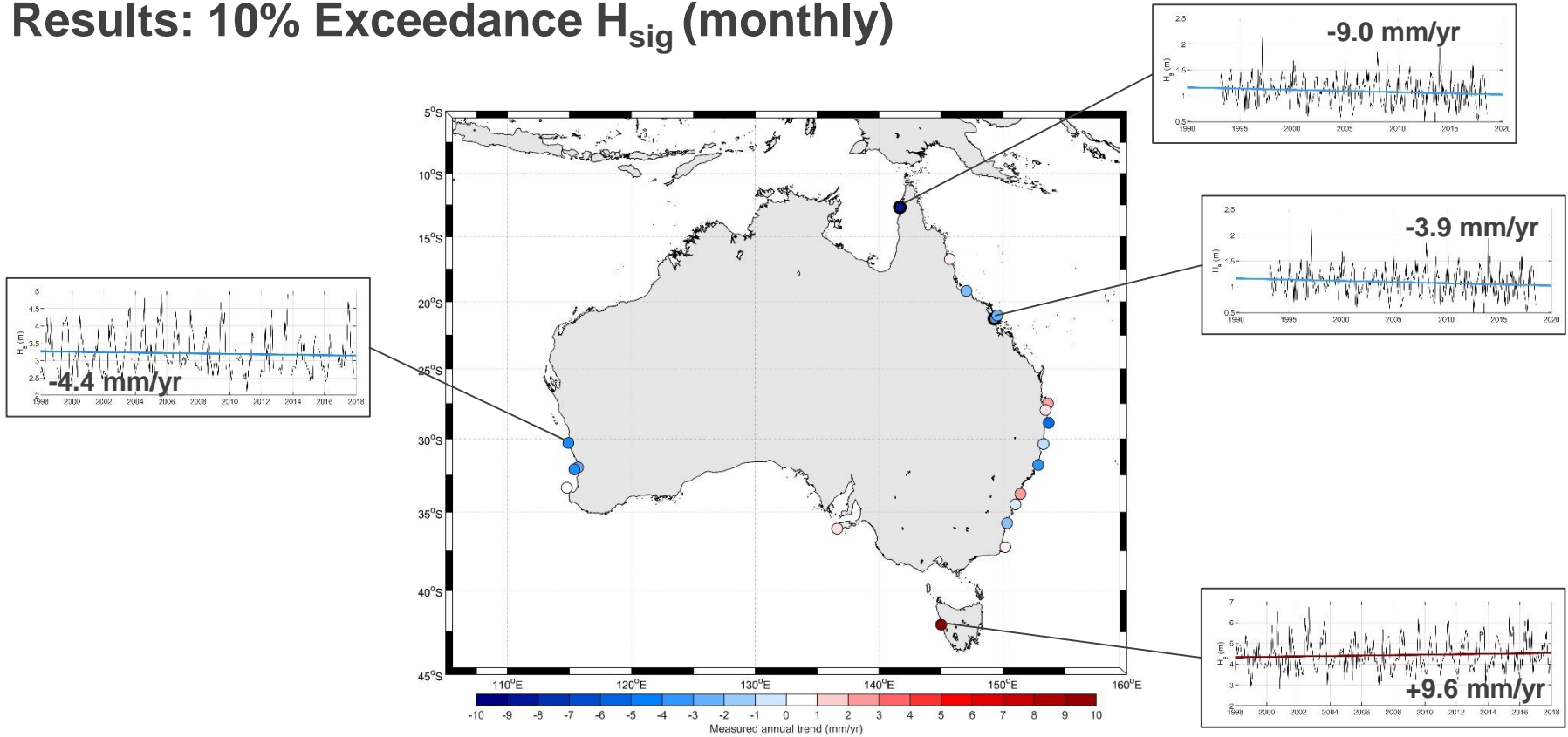
- **70%** of Australian wave buoys indicate **decrease** in H_{sig} over time
- 4 buoys indicate significant decrease up to 4.4 mm/yr:
 - Albatross Bay, QLD
 - Hay Pt., QLD
 - Townsville, QLD
 - Crowdy Head, NSW
- Cape Sorrell non-significant increase (+6.9 mm/yr)

Results: Annual mean H_{sig}

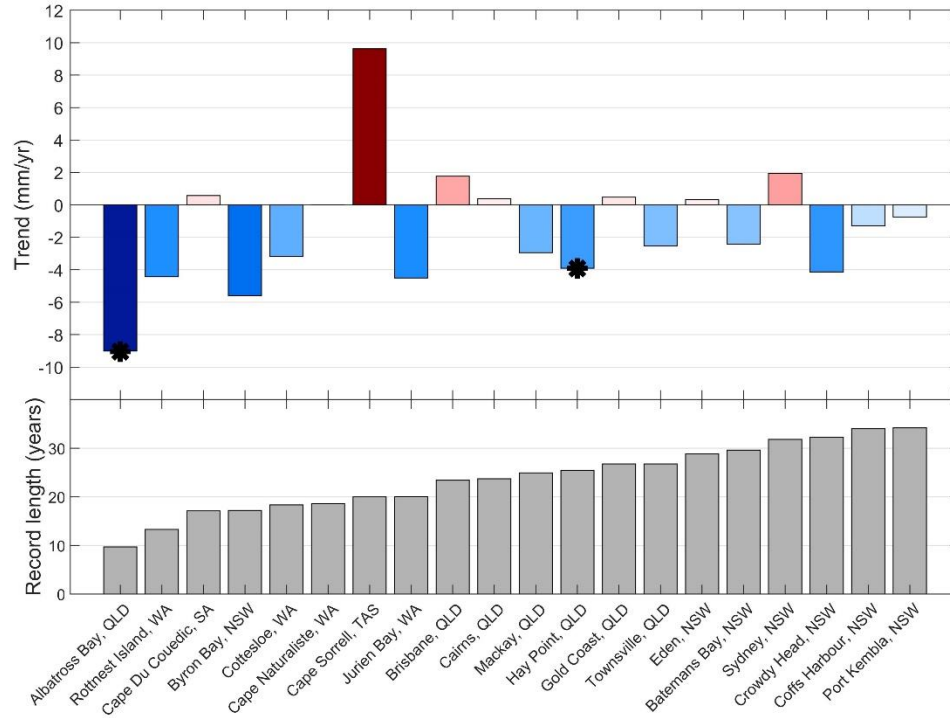


- Annual mean trends largely in agreement with monthly means (65% of wave buoys indicate decrease in H_{sig} over time)
- One buoy significant decrease:
 - Hay Pt., QLD

Results: 10% Exceedance H_{sig} (monthly)

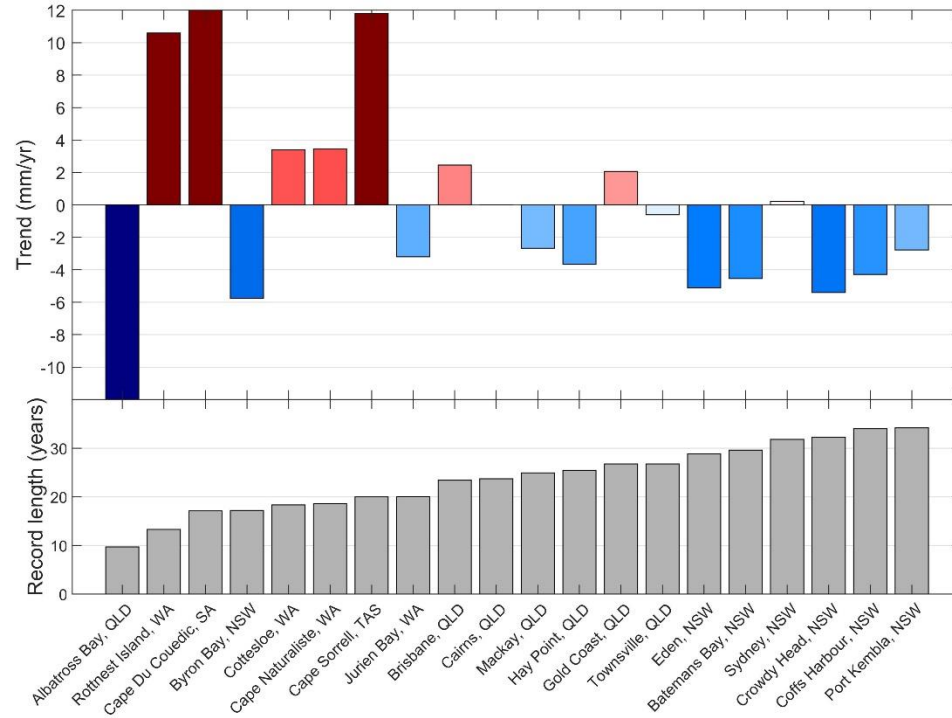


Results: 10% Exceedence H_{sig} (monthly)



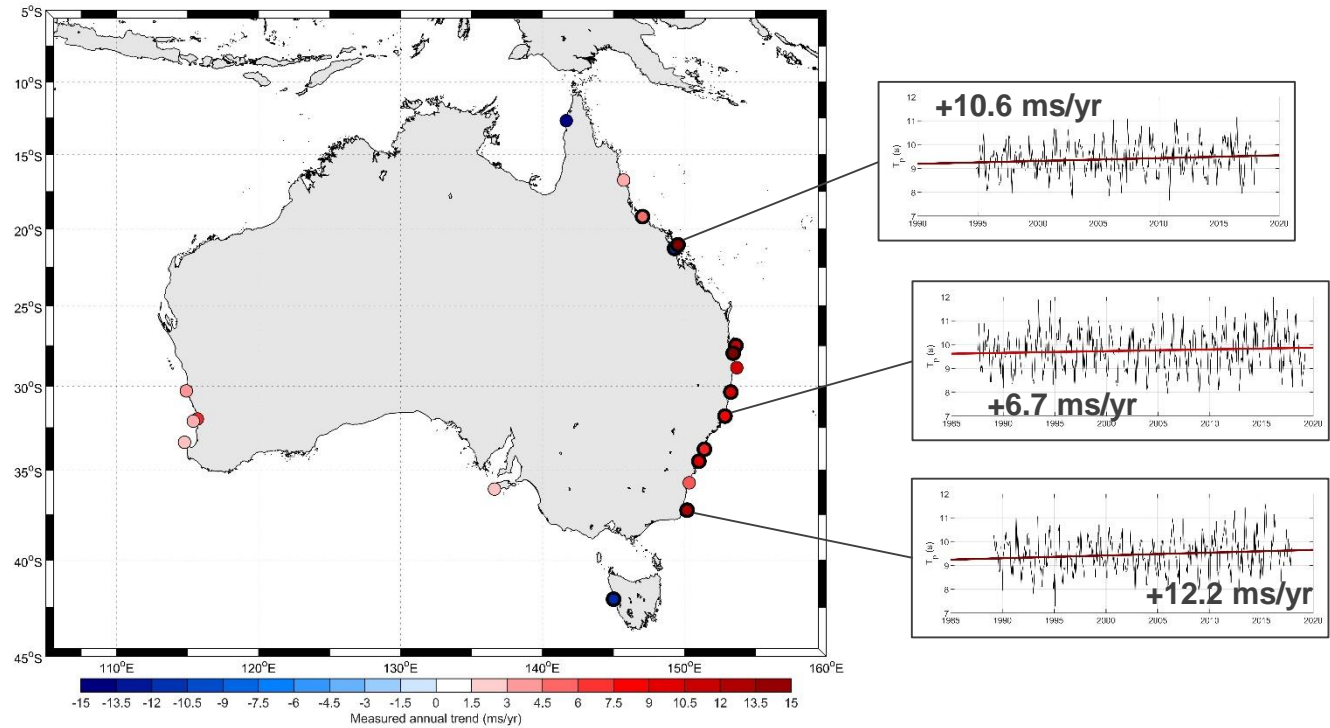
- 60% of Australian wave buoys indicate linear decrease in $H_{10\%}$ over time

Results: 1% Exceedence H_{sig} (monthly)

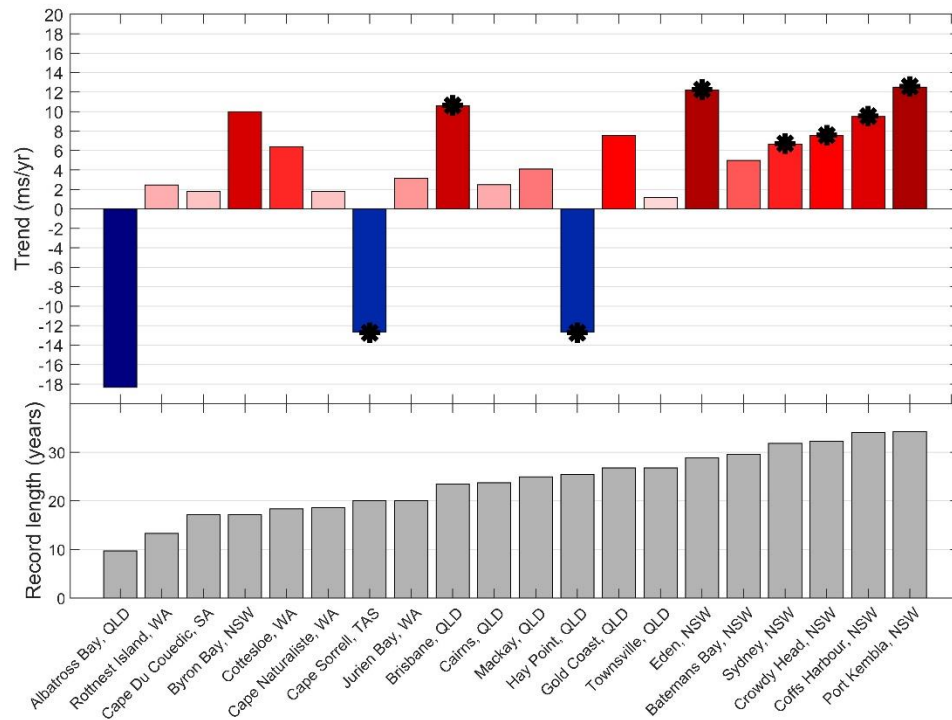


- 60% of Australian wave buoys indicate linear decrease in $H_{10\%}$ over time
- When focusing on $H_{1\%}$, western Australian buoys indicate positive trends (but not statistically significant)

Results: Monthly peak wave period

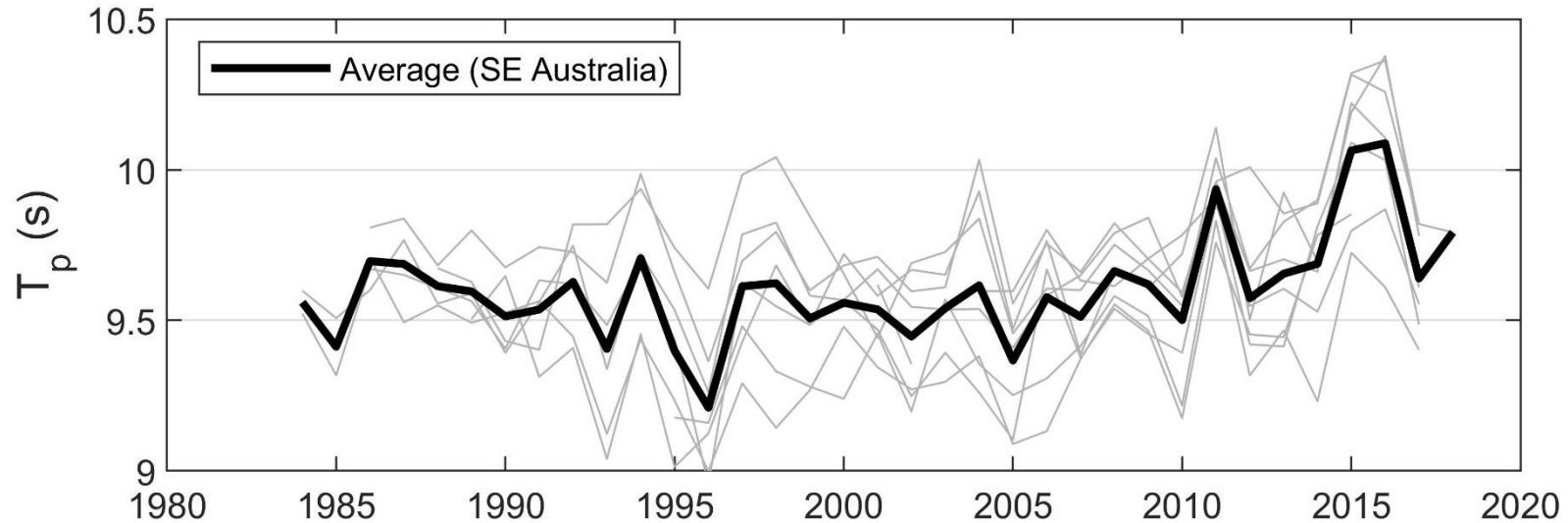


Results: Monthly peak wave period



- Significant trend of increasing wave period in almost all SE Australian wave buoys
- Significant decreasing trend in Hay Pt and Cape Sorrell wave buoys

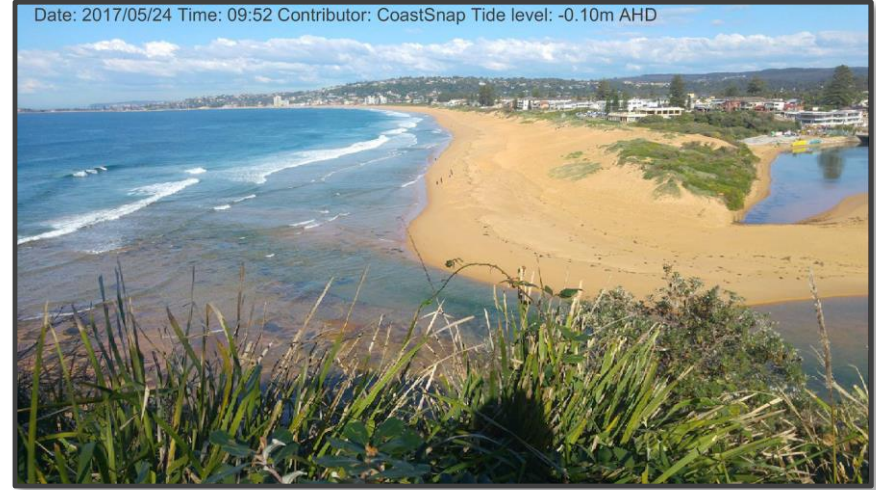
Are we seeing wave periods getting longer in SE Australia?



Are we seeing wave periods getting longer in SE Australia?



CoastSnap citizen science beach monitoring

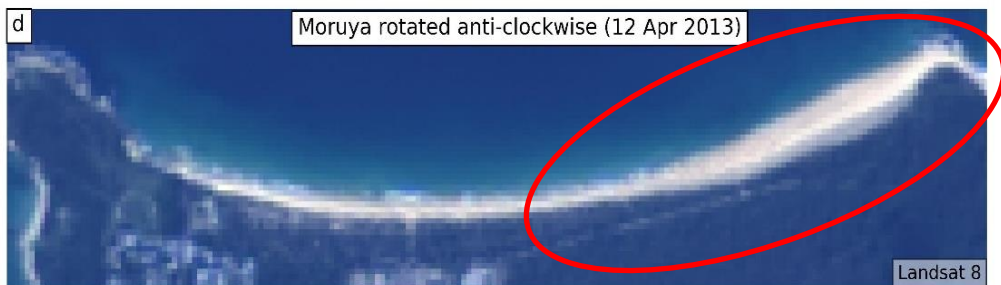
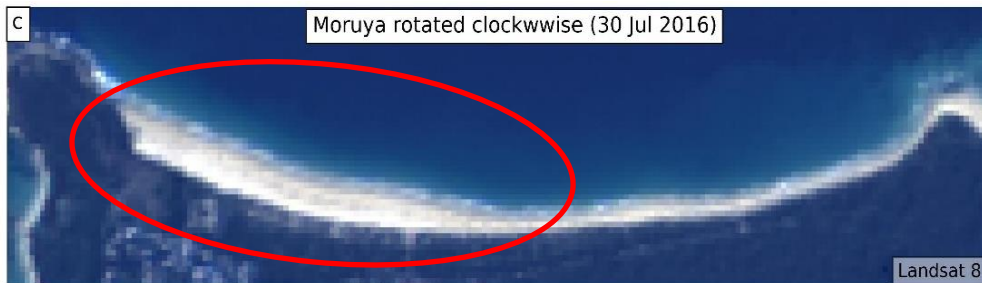


Rotation of embayed beaches towards northern end (clockwise)

A clockwise rotation of embayed beaches in SE Australia since 2014



Kilian Vos



Landsat 8

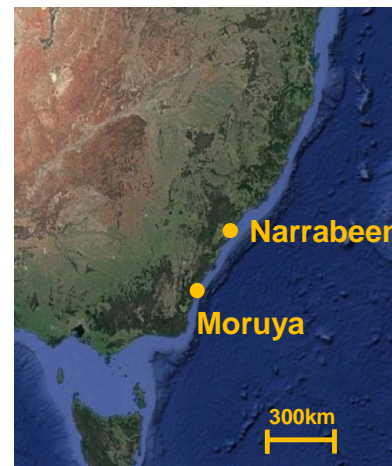
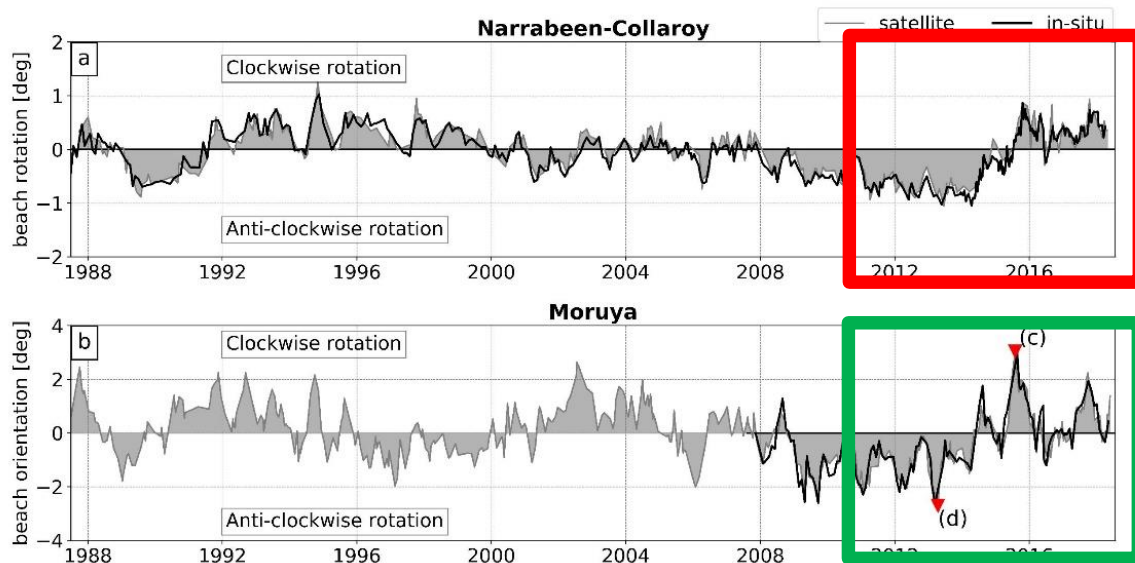
CoastSat: A Google Earth Engine-enabled Python toolkit to extract shorelines from publicly available satellite imagery

Kilian Vos , Kristen D. Splinter, Mitchell D. Harley, Joshua A. Simmons, Ian L. Turner

A consistent clockwise rotation of beaches in SE Australia since 2014



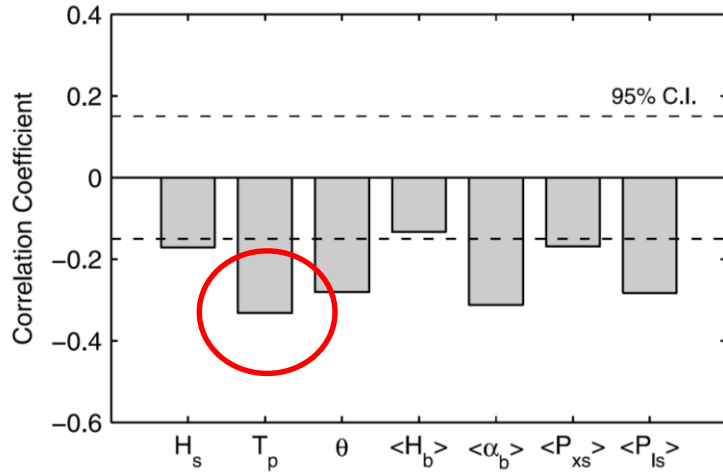
Kilian Vos



CoastSat: A Google Earth Engine-enabled Python toolkit to extract shorelines from publicly available satellite imagery

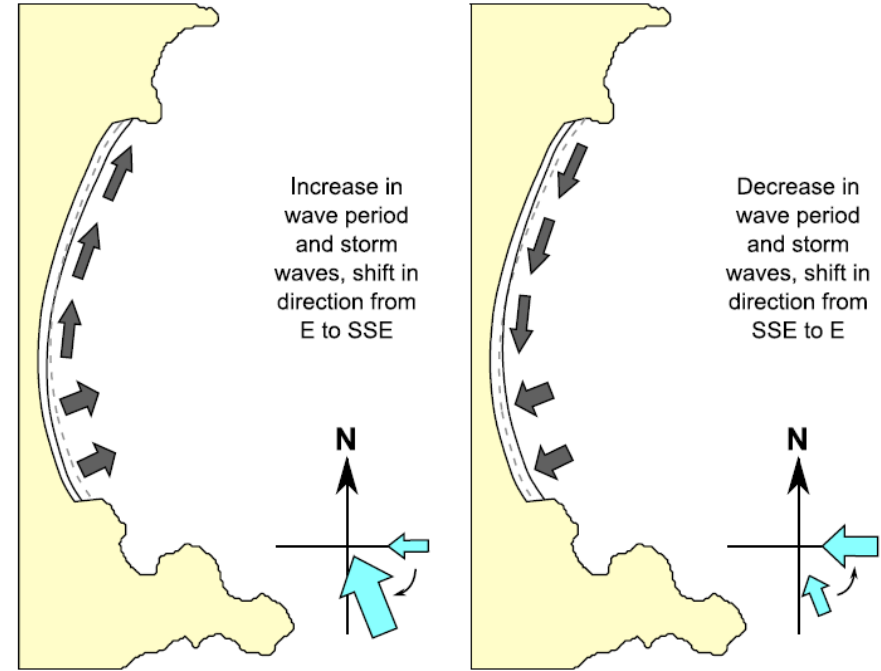
Kilian Vos, Kristen D. Splinter, Mitchell D. Harley, Joshua A. Simmons, Ian L. Turner

A clockwise rotation of embayed beaches in SE Australia since 2014



Wave period a major control of beach rotation on embayed beaches

2nd EOF: 26% of variability



Conclusions and Future Work

- Little evidence to support general increase in waves in Australian coastal waters based on Australian buoy network
- A broad-scale increase in wave periods observed at all SE Australian wave buoys
- Might be related to general clockwise realignment of beaches observed since 2014?
- Future work to look at wave direction shifts and climate controls (ENSO, SAM)