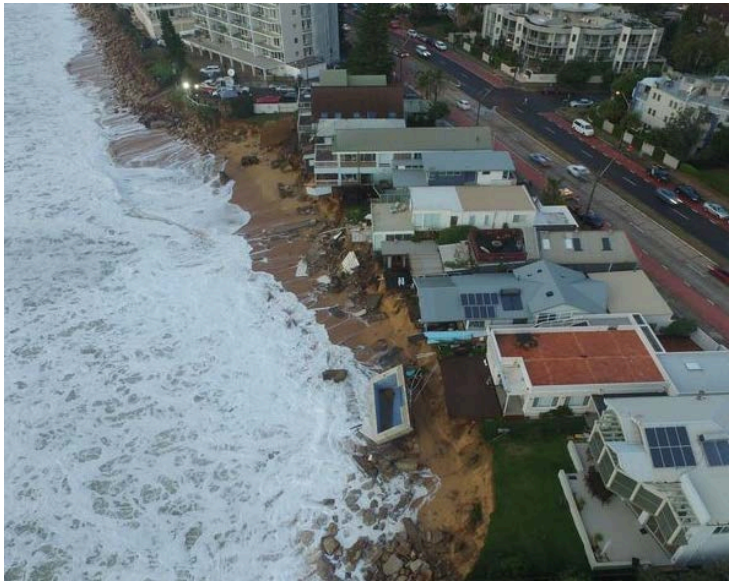
A retrospective of a number of high-impact coastal storm events in the southern hemisphere

Ron K. Hoeke, Alec Stephenson, Kathleen McInnes, Mark Hemer, Robert Davy, Julian O'Grady



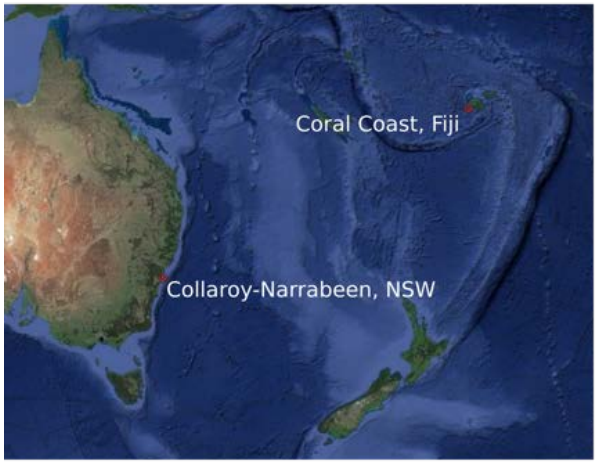
Sydney's northern beaches: June 2016

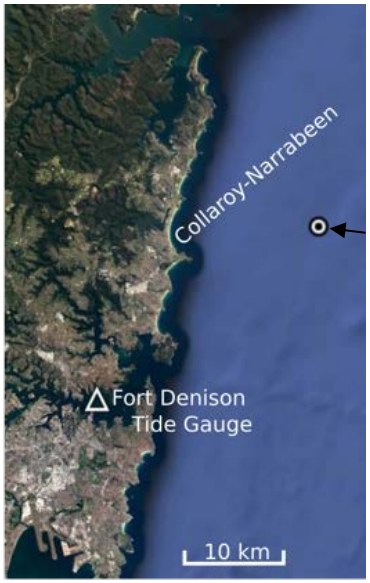
Fiji's Coral Coast: May 2011

Retrospective: methods

Analysis data:

- hourly tide gauge observations
- hourly wind-wave hindcast





Hindcast extraction point

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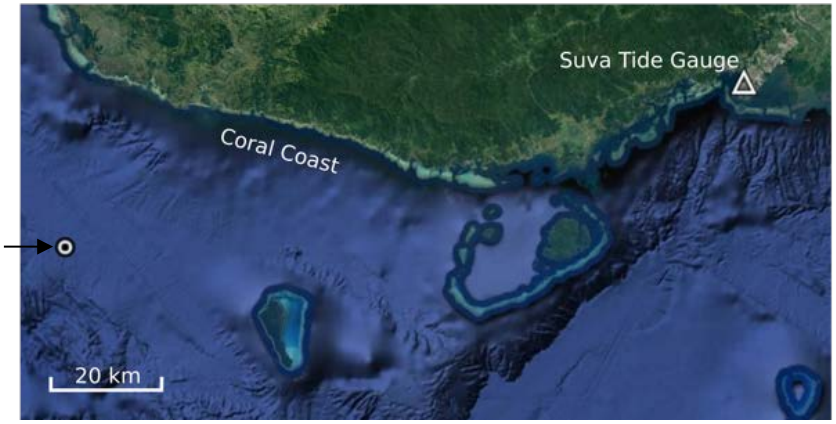
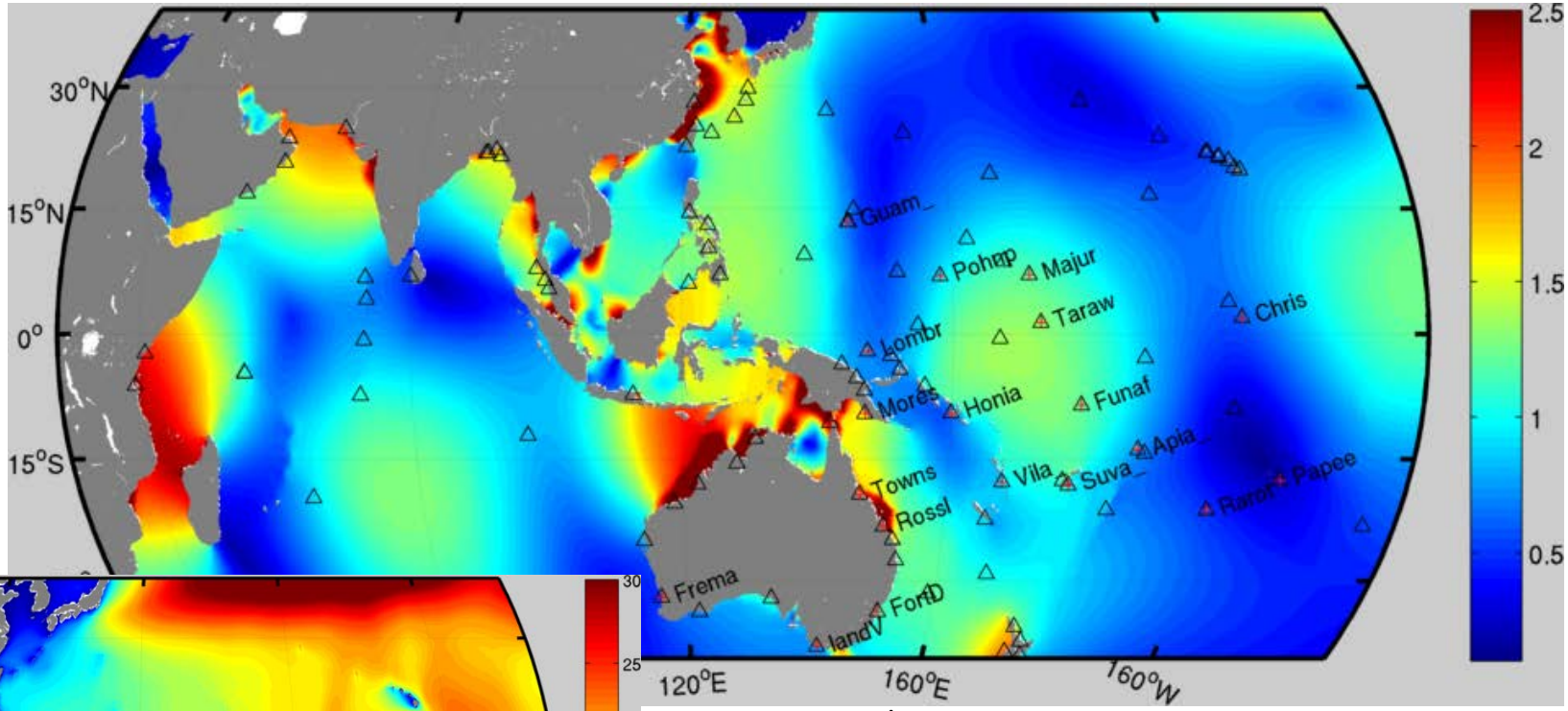
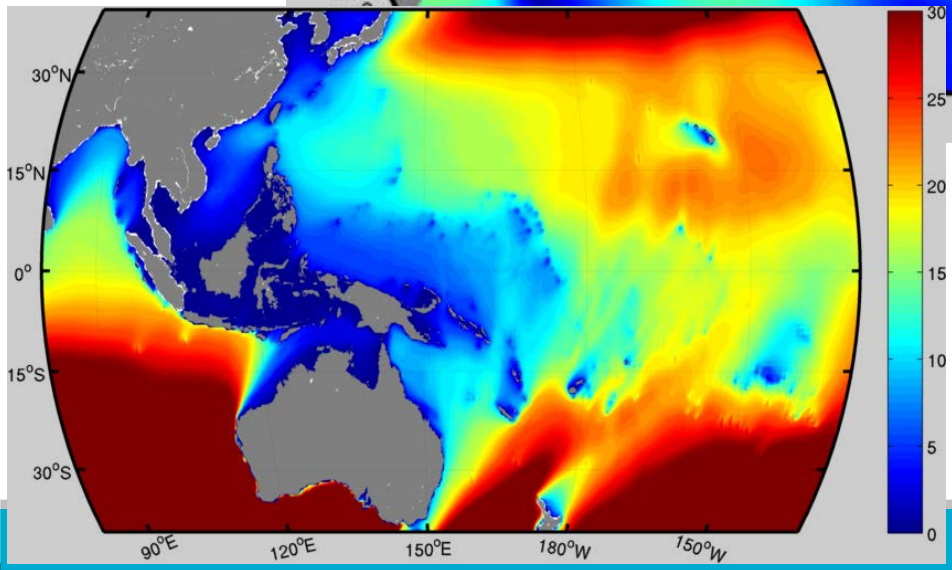


Retrospective: methods

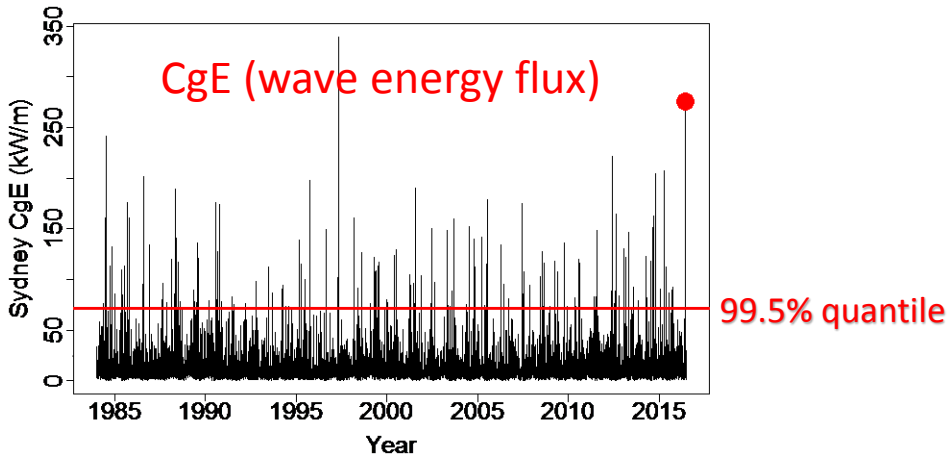


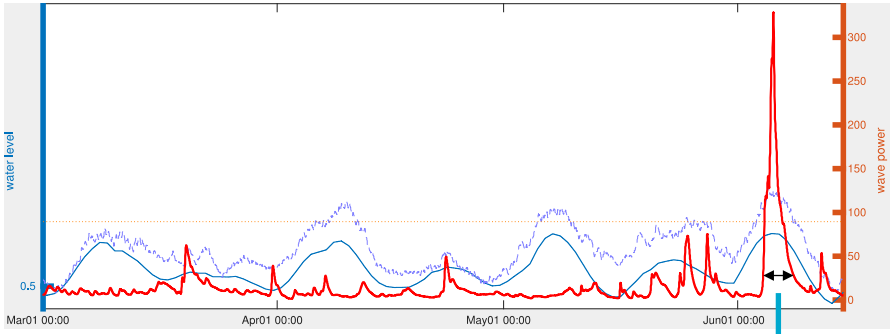


Gesla.org:
Woodworth et al. (2016) *Towards a global higher-frequency sea level dataset*.

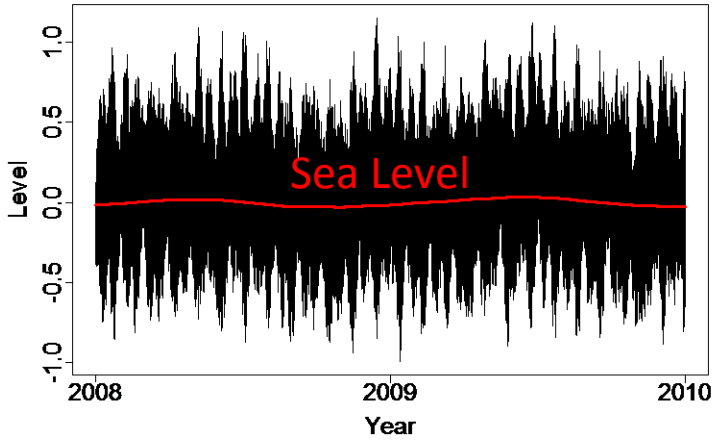
*Durrant, Greenslade, Hemer, Trenham. (2014) *A global wave hindcast focussed on the Central and South Pacific*. CAWCR Tech. Report. No. 70.
*http://doi.org/10.4225/08/523168703DCC5

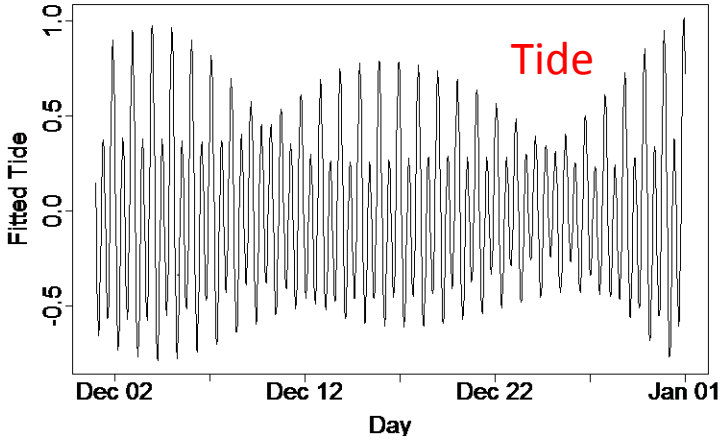
Retrospective: methods

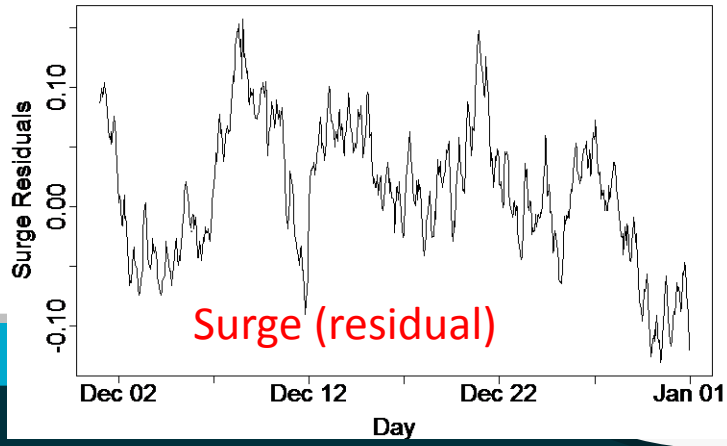




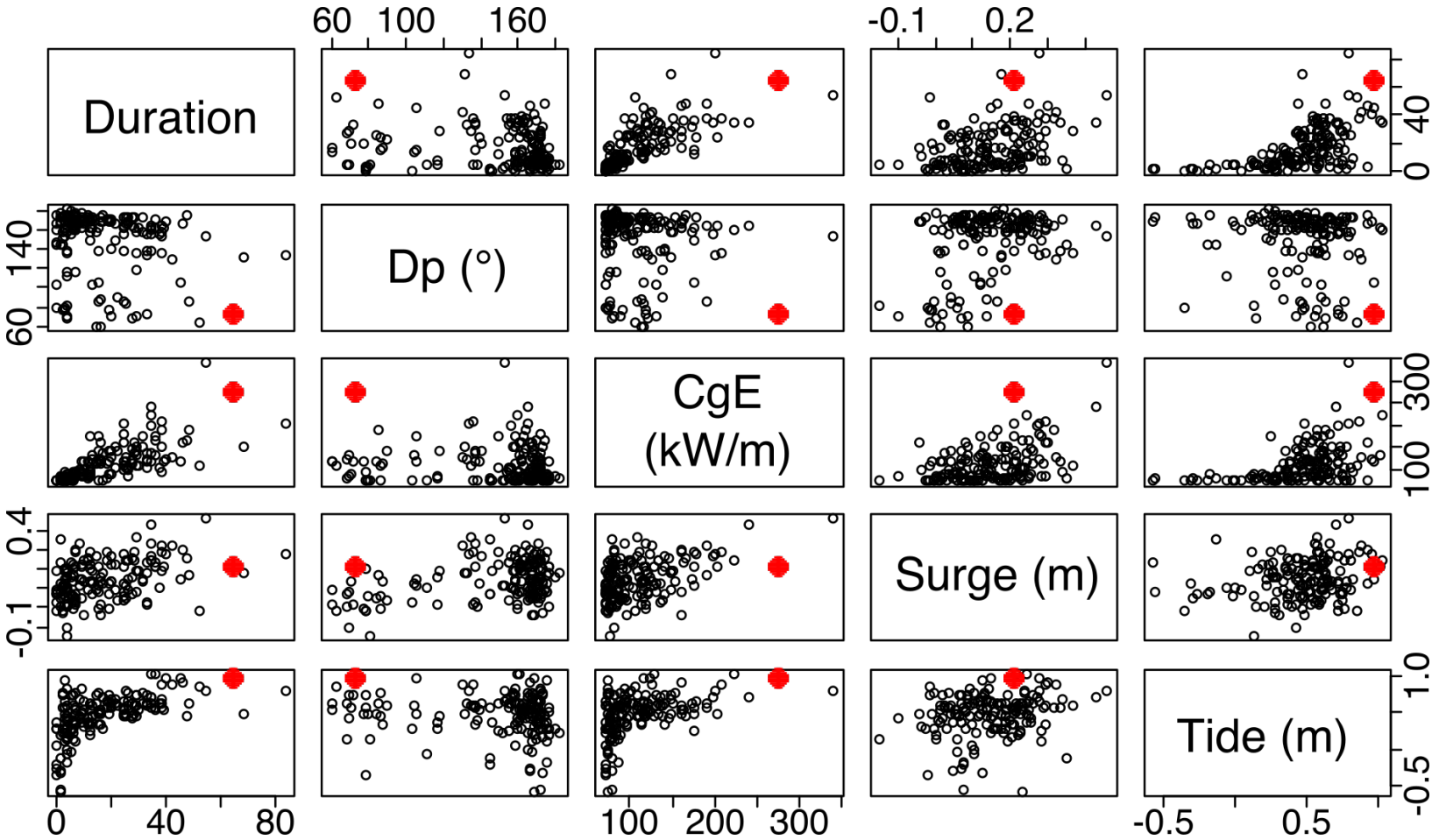
Event Duration



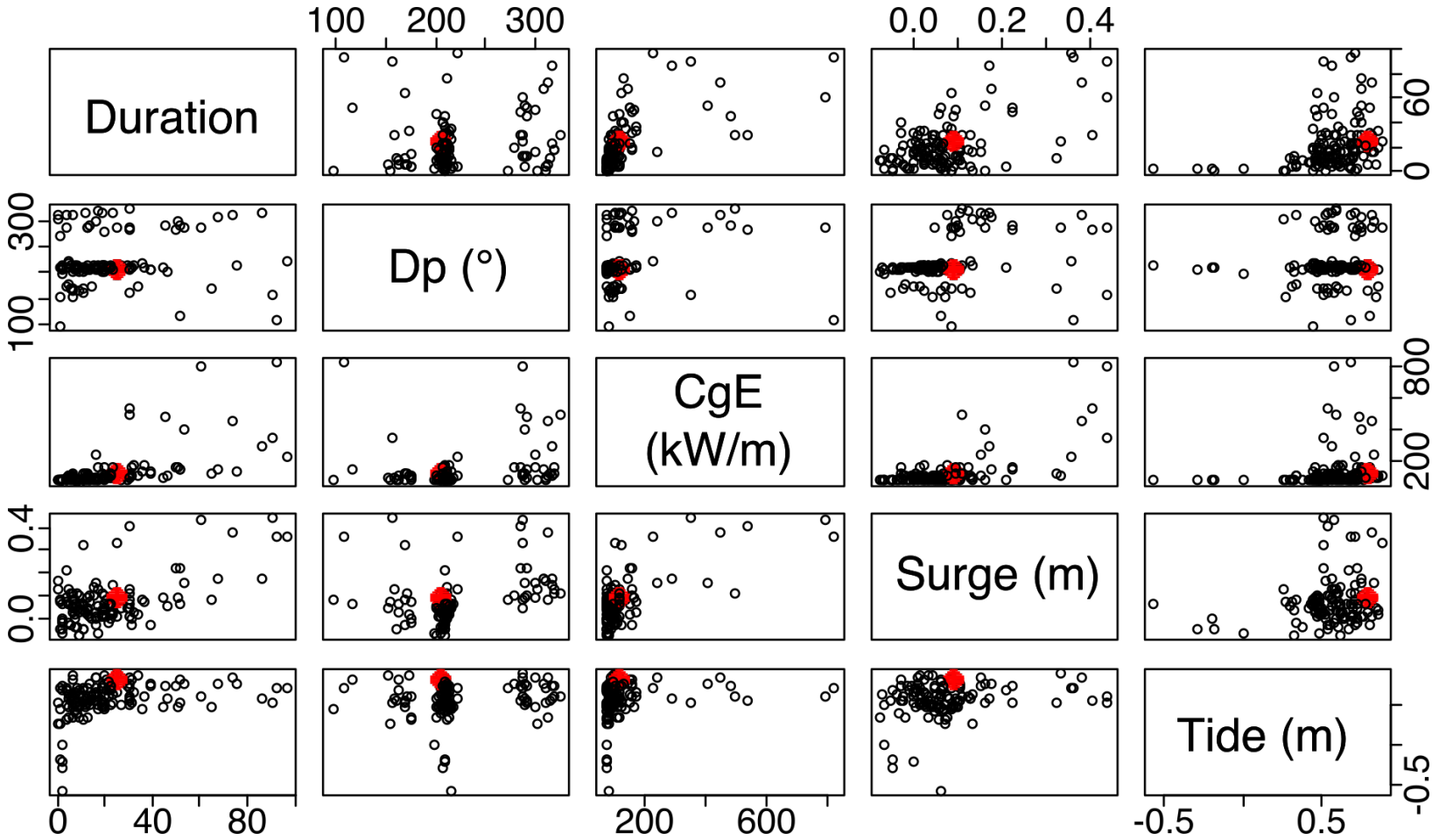




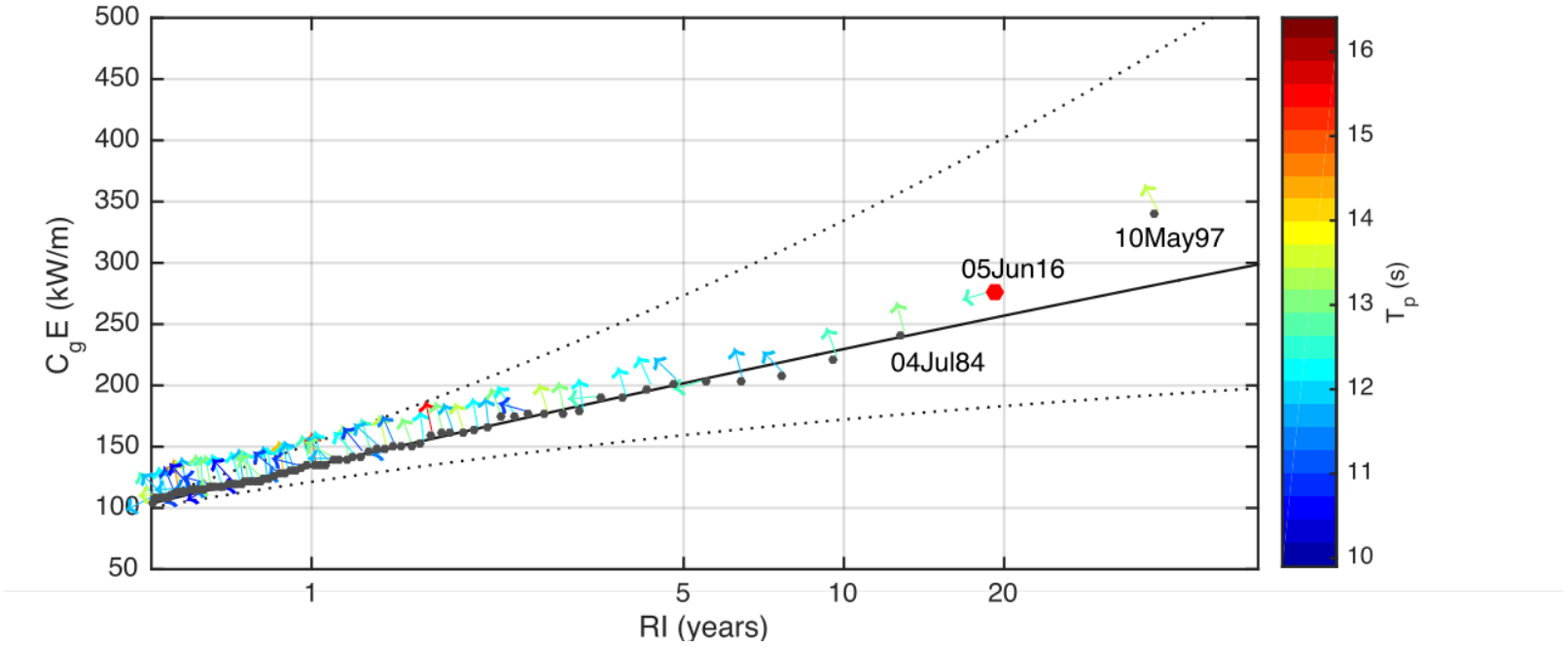
Retrospective: results: Collaroy-Narrabeen



Retrospective: results: Coral Coast

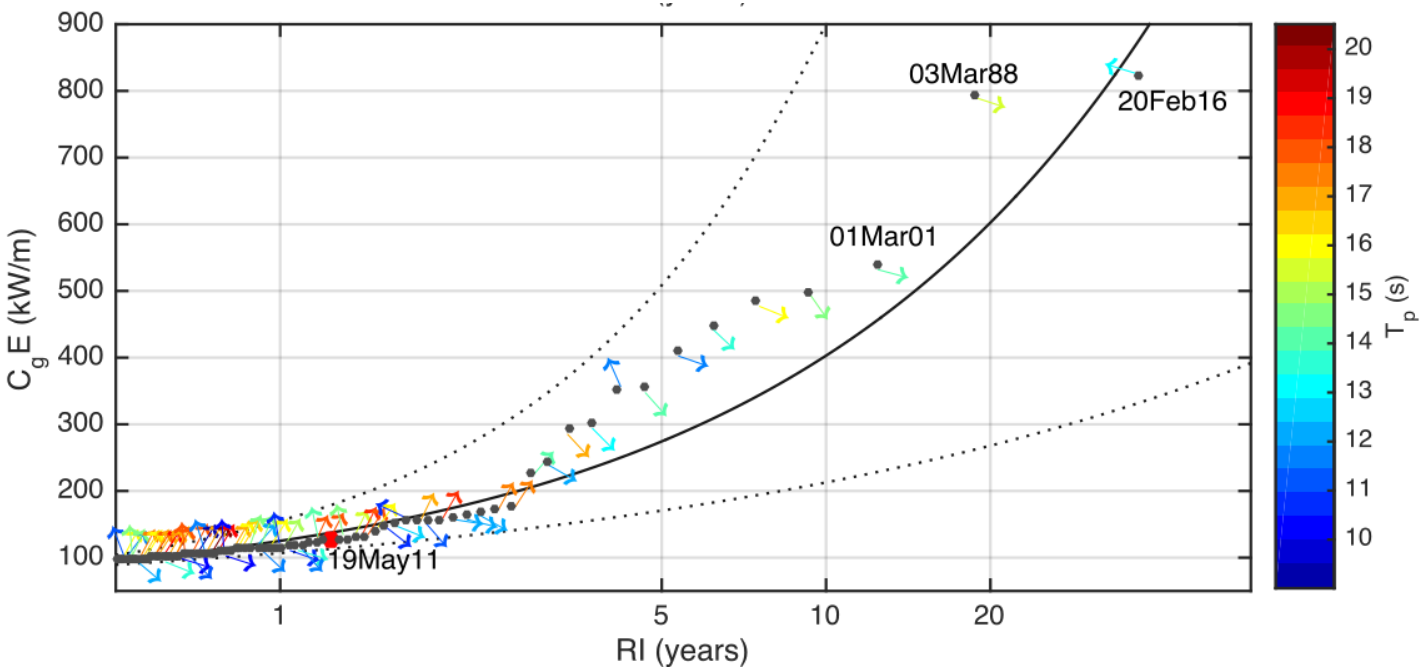


Retrospective:
results: Collaroy-Narrabeen



2nd highest CgE event in record (~20 year ARI)
Similarly long duration
Only CgE event>~2-3 year ARI with Dp from ENE
Coincided with very high astronomical tide

Retrospective:
results: Coral Coast



CgE event ~2-3year ARI
Not unusual direction
Coincided with very high astronomical tide
Are wave runup or sea level to blame?

Retrospective of events: preliminary conclusions

In some situations – (e.g. Sydney's Collaroy-Narrabeen event) large scale information (wave hindcast) can be used to identify important proximate information.

In other situations – (e.g. Fiji's Coral Coast) details of local dynamics obscure large scale proximate information

*Inclusion (empirically or analytically) of local dynamics? E.g. inclusion of storm wave dynamics in a total water level (TWL) calculations?

Retrospective: results: Collaroy-Narrabeen

Inclusion (empirically or analytically) of local dynamics:

Total Water Level (TWL) = **Runup** + Tide + Storm Surge + (Sea Level)

R2% – the 2% exceedance level of wave runup and setup

Sandy Beaches

$$R_{2\%} = 1.1\left\{0.35\ \tan\beta(H_0L_0)^{1/2} + \frac{\left[H_0L_0(0.563\ \tan\beta^2 + 0.004)\right]^{1/2}}{2}\right\}$$

Stockdon, et al. "Empirical parameterization of setup, swash, and runup." *Coastal engineering* 53.7 (2006): 573-588.

Reefs

Method 1

$$\bar{\eta}_2 = b_1\hat{H}_b + b_0,$$

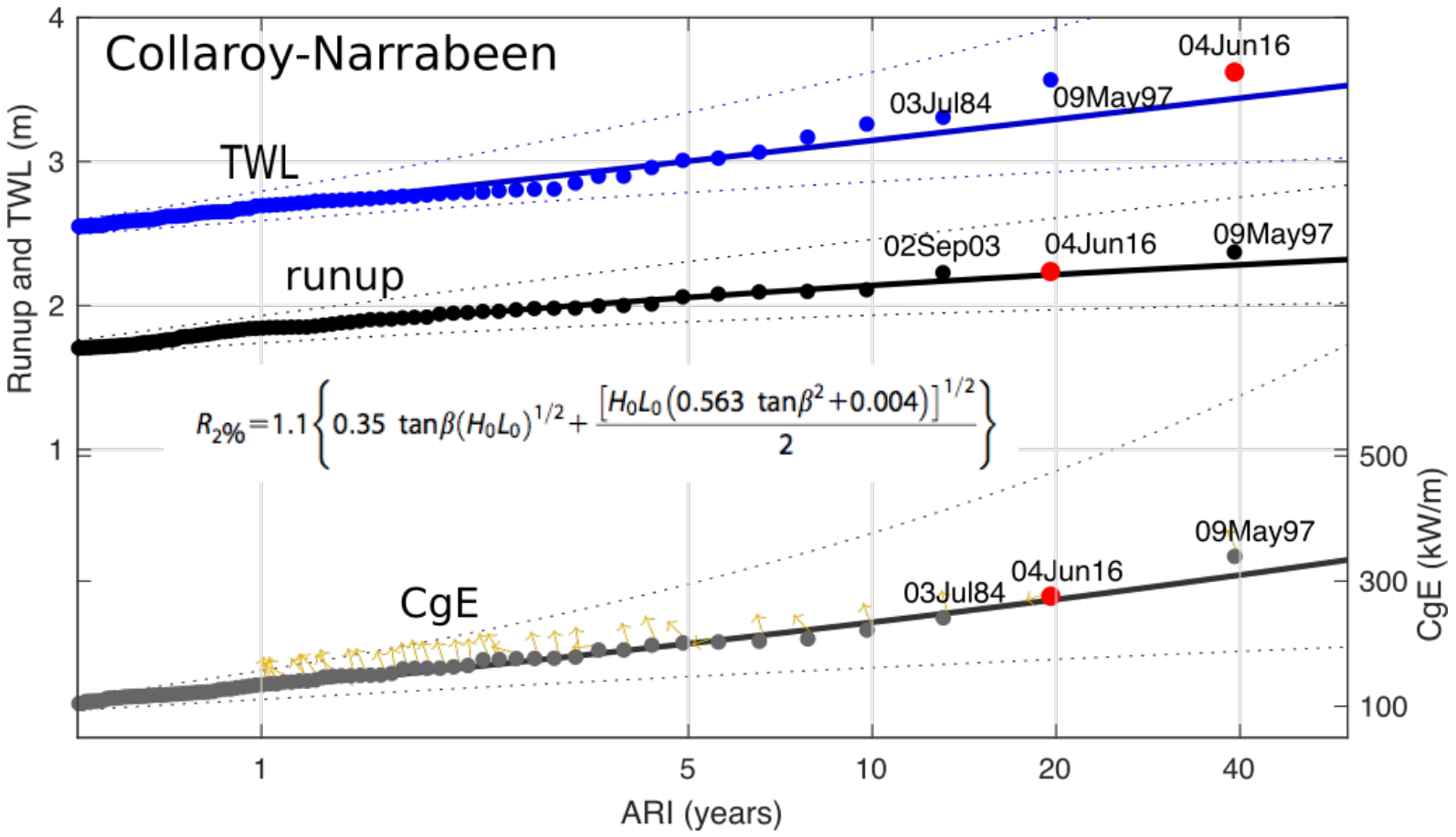
$$\hat{H}_b = \left[H_o^2T_o(4\pi)^{-1}\cos(\theta_o - \theta_N)\sqrt{\gamma_s g}\right]^{2/5}$$

Method 2

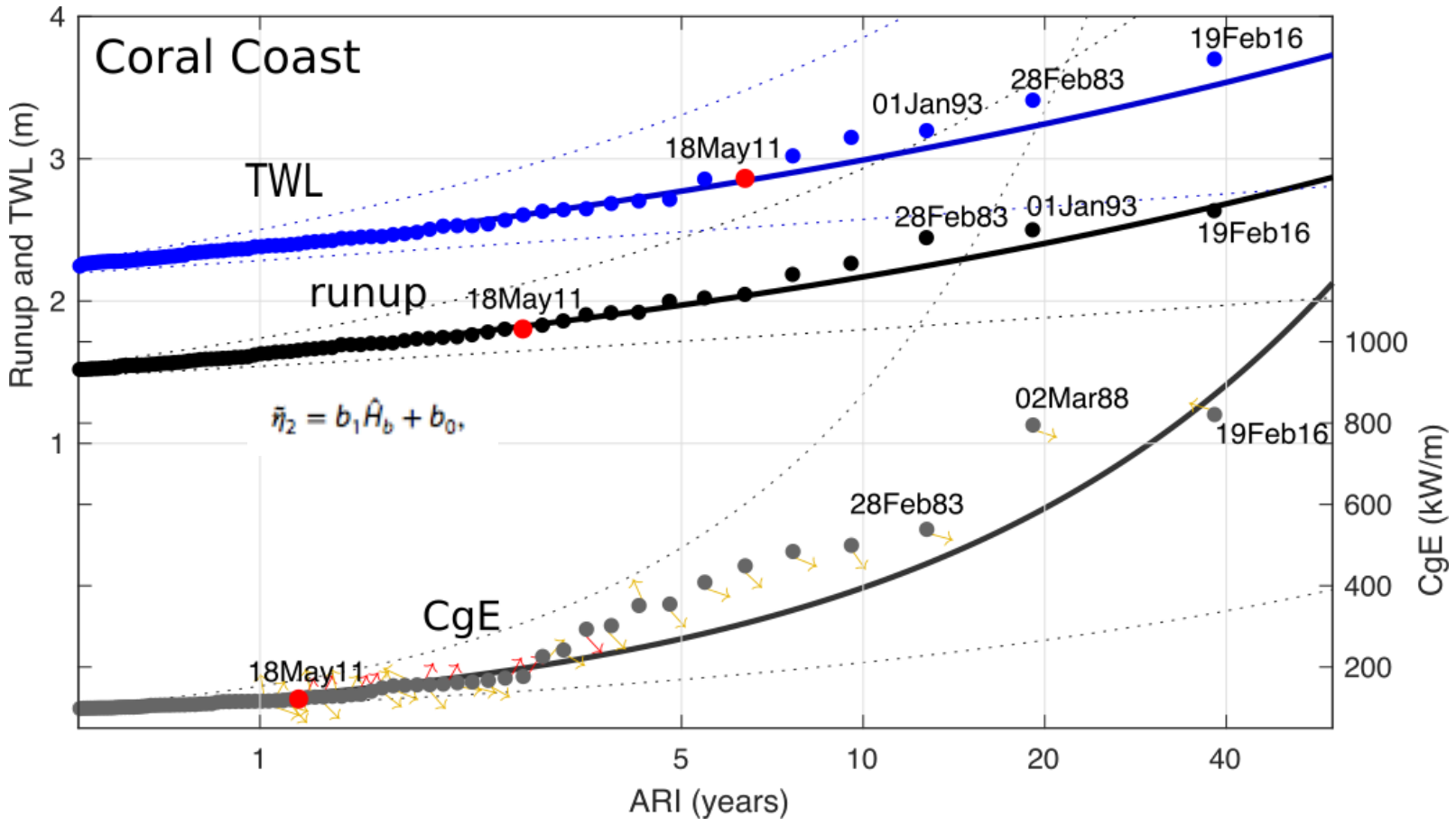
$$\hat{\eta}_2 = \overline{\eta} + b\sigma,\ \ \sigma = 0.25\sqrt{H_{ss}^2 + H_{ig}^2}$$

Merrifield, et al. "Observations and estimates of wave-driven water level extremes at the Marshall Islands." *Geophysical Research Letters* 41.20 (2014): 7245-7253.

Retrospective:
results: Collaroy-Narrabeen

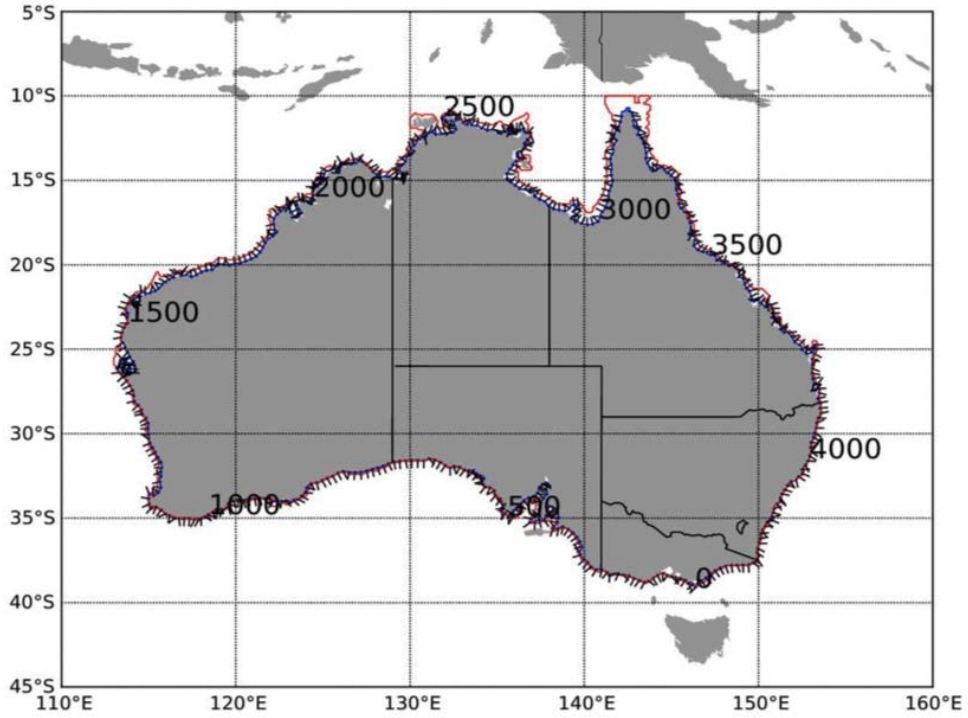


Retrospective: results: Coral Coast



Retrospective:
Future Work:

- Refine/investigate empirical methods
- Explore (many) other events
- Investigate attribution of sea level variability and rise in events



O'Grady, McInnes, Hoeke. "Forecasting maximum wave setup hazards around Australia." *Australasian Coasts & Ports Conference 2015*.

Thanks …

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