Investigating Sea Level Rise from the AHD to the AR6 Baseline Period

Julian O'Grady| 5th September 2022
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Australia's National Science Agency

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Overview

- Impacts of sea level rise.
- AHD
- Background on observed sea level rise (tide gauges and satellites)
- Three approaches to get from AHD to AR6

2

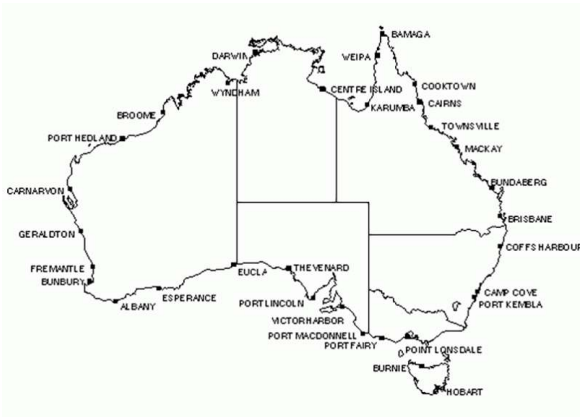
Impacts of Sea level rise

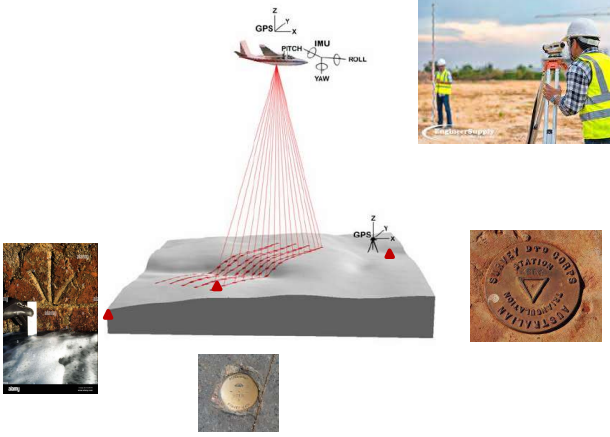
- Sea level rise will cause an <u>exponential</u> increase in both
  - current coastal flooding
  - the likelihood of low probability extreme sea level events (AEPs)
- Impacts for ports
  - Flooding of coastal assets (e.g. wharfs)
  - Waves can reach higher to damage coastal protection (e.g. rock revetments)
  - Disruption and closure of road transport routes.

3

Australian Height Datum

In 1971, AHD was introduced as the official vertical datum of Australia to measure the height of land, and was based on the mean sea level recorded by thirty tide gauges (TG) around Australia in the late 1960s (for mainland Australia) and early 1970s (Tasmania)





Geoscience Australia

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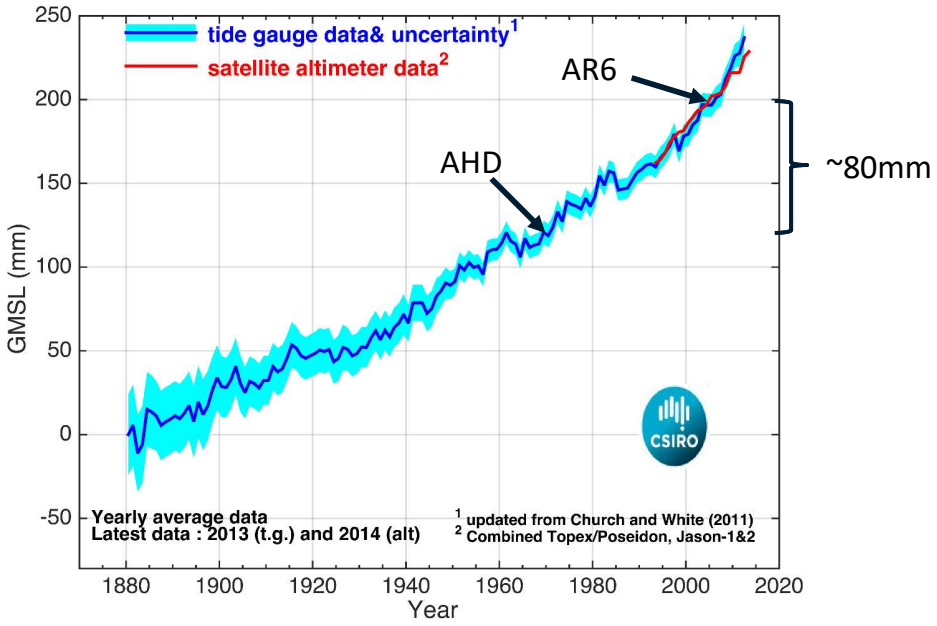
Global observed sea level rise



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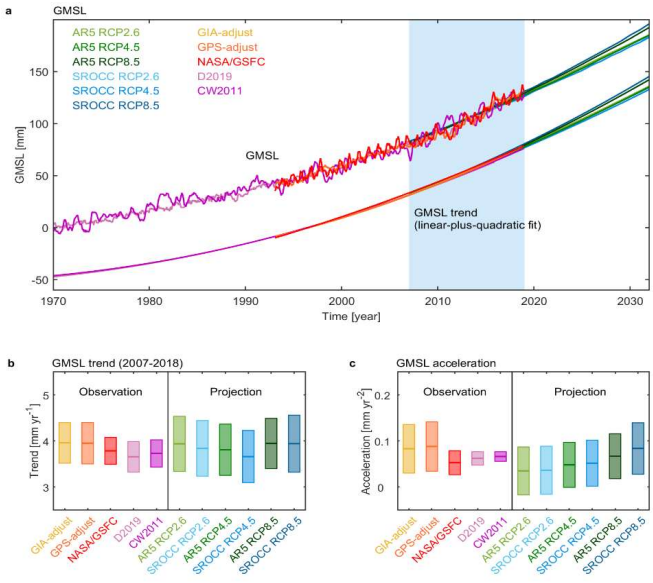
Global estimates of observed and modelled future sea level rise



"Our study indicates that IPCC (AR5 & SROCC) sea level projections are consistent with observations, in terms of both trend and acceleration."

Xuebin Zhang CSIRO

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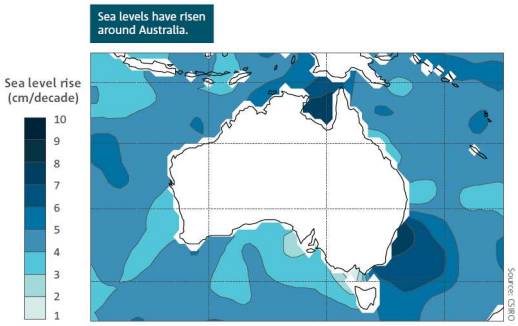
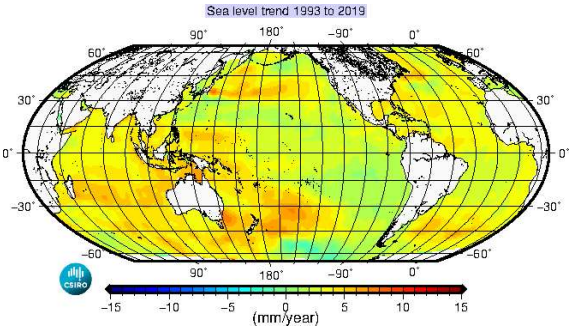
The long-term altimetry sea level record is typically restricted to the offshore region, beyond 25–50 km, while changes closer to Australia's shoreline are estimated from tide gauge measurements at a limited number of locations. Local coastal processes, the effects of vertical land motion, and changes in site and/or reference levels affect local estimates of sea level change. For example, estimates from nearshore tide gauge measurements may differ from estimates derived from satellite altimetry tens of kilometres offshore. Nevertheless, tide gauges with good long-term records around Australia show overall changes in sea level rise consistent with offshore observations from satellite altimetry.

Rising sea levels pose a significant threat to coastal communities by amplifying the risks of coastal inundation, storm surge and erosion. Coastal communities in Australia are already experiencing some of these changes.



The rate of sea level rise around Australia measured using satellite altimetry, from 1993 to 2019.



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Australian sea levels—Trends, regional variability and influencing factors

Neil J. White [a,*], Ivan D. Haigh [b,c,d], John A. Church [a], Terry Koen [e], Christopher S. Watson [f], Tim R. Pritchard [e], Phil J. Watson [e], Reed J. Burgette [f,g], Kathleen L. McInnes [a], Zai-Jin You [h], Xuebin Zhang [a], Paul Tregoning [i]

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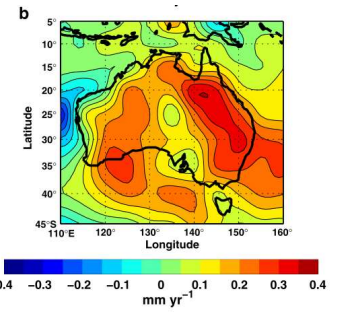
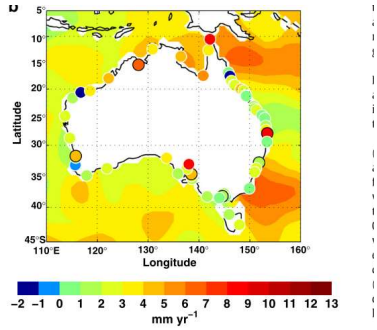


Fig. 7. (a) Trends in local atmospheric pressure from the HadSLP2 data set from 1966 to 2010; (b) equivalent trends in sea level from applying the inverse barometer effect using the atmospheric pressure changes shown on the top panel relative to the time-varying over-ocean global-mean atmospheric pressure.



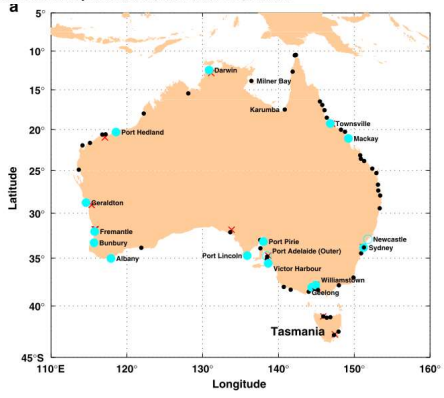


Fig. 10. Sea-level trends from January 1993 to December 2010 from satellite altimeters (colour contours) and tide gauges (coloured dots), both expressed as OVMSL–(a) trends prior to removal of the ENSO signal and b) trends following the removal of the ENSO signal. The red dot on the east coast at 28°S is Gold Coast Seaway—see text. Mean trend differences between altimeter/tide gauge pairs are less than 0.4 and 1.0 mm yr^{-1} (tide gauge mean lower) on panels (a) and (b) respectively. Standard deviations are 2.0 and

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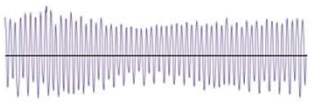
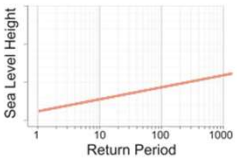
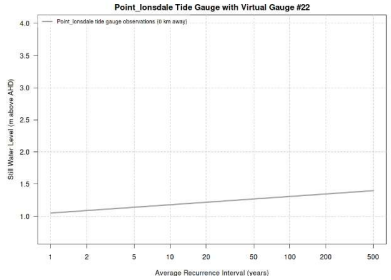
Every centimetre of SLR counts towards an **exponential** increase in extreme sea level AEPs

Sea level rise will increase the frequency of extreme sea levels, and reduce the time between extreme events occurring (i.e. return periods).





Source: McInnes et al, AMOJ (2015)



MF = exp(SLR/scale)

```
"Multiplication factor for 8cm of SLR = 4.2"
"Multiplication factor for 9cm  of SLR = 5"
"Multiplication factor for 13cm  of SLR = 10.2"
"Multiplication factor for 18cm  of SLR = 60.8"
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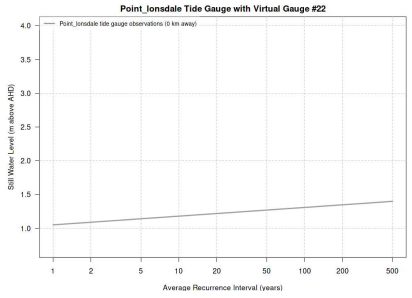
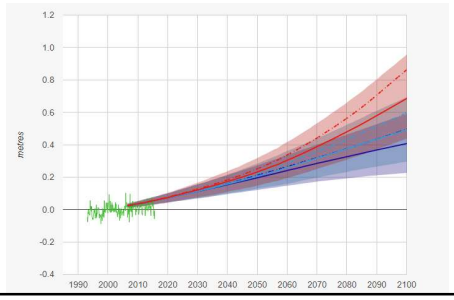
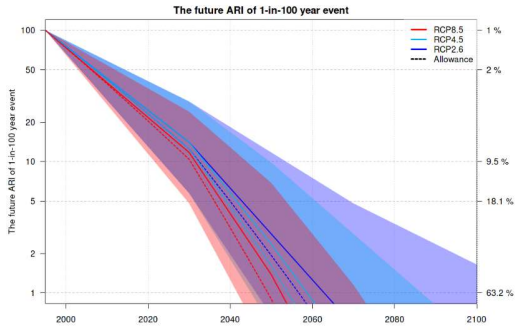
Canute 3

Climate Systems

National Environmental Science Program







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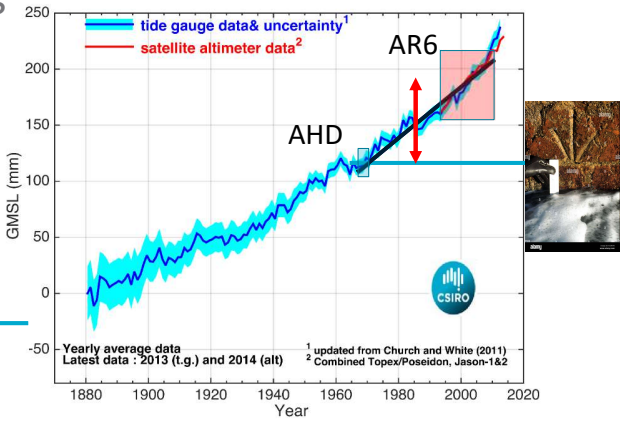
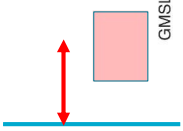
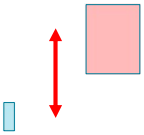
Three Methods for calculating AHD to AR6 Baseline



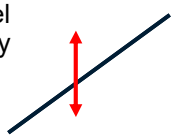
1. 1) Mean sea level (1995 to 2014) less (minus) the AHD survey value.



2. 2) Mean sea level (1995 to 2014) less (minus) mean sea level (1967-1969) for mainland Australia and (1971) for Tasmania.



3. 3) The linear trend in TG sea level per year (1976-2014) multiplied by the number of years (2005-1967).



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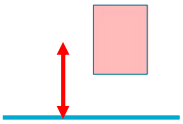
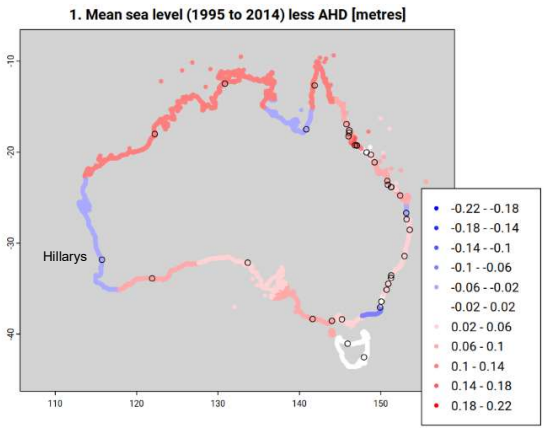


- 37 tide gauges published AHD sites mostly on the east coast.
  - BoM NTC ABSLMP
  - QLD MSQ
  - NSW-OEH MHL
- Some newer tide gauges surveys of AHD could have inaccuracies that span the network of existing survey markers (extending 100s of km). Instrument error and VLM.



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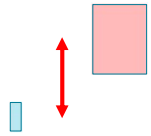
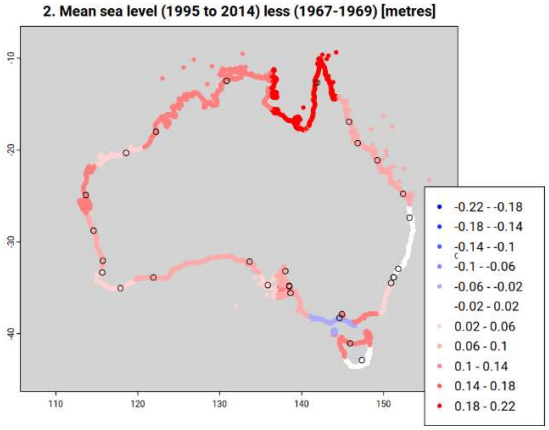
- 30 tide gauges in GESLA3
- Minimum 80% of data
- More evenly spread around the nation





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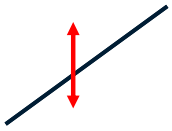
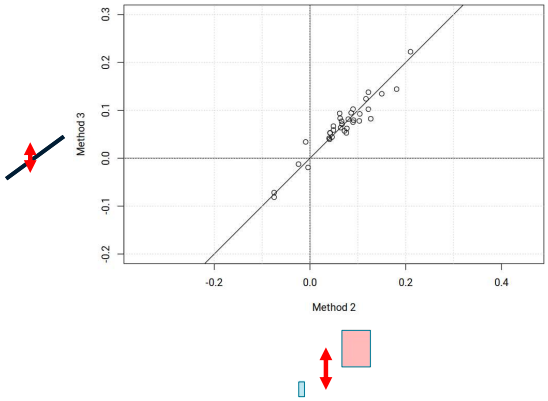
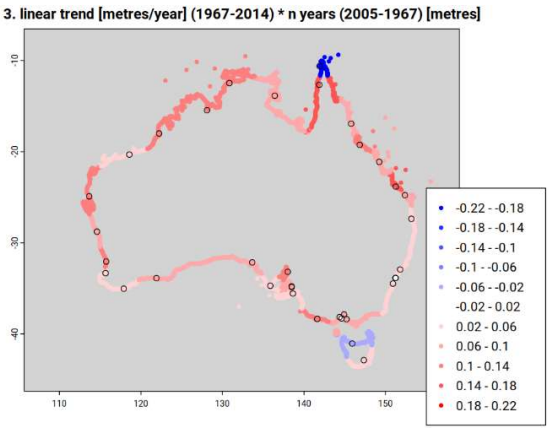
- 36 Tide gauges
- Strong correlation between methods 2 and 3







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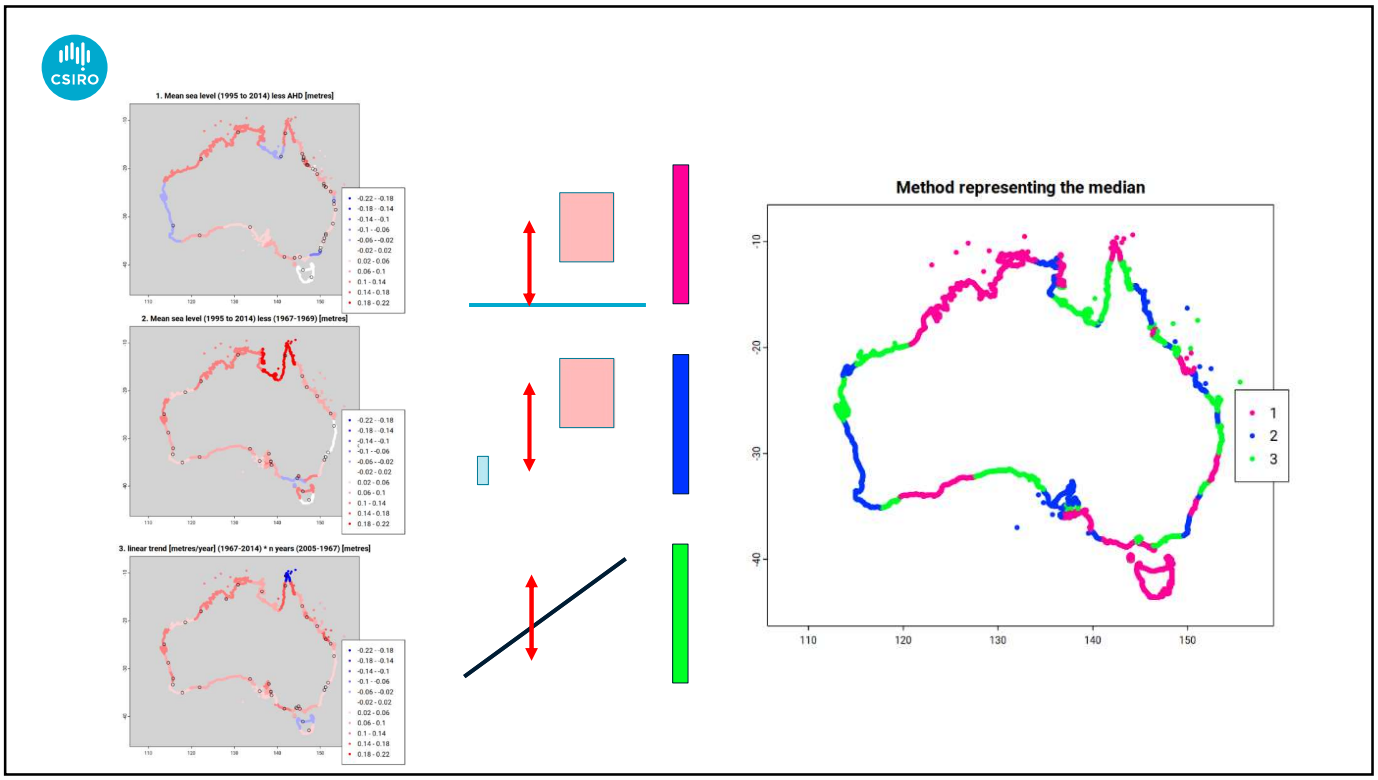
1. Mean sea level (1995 to 2014) less AHD [metres]
2. Mean sea level (1995 to 2014) less (1967-1969) [metres]
3. linear trend [metres/year] (1967-2014) * n years (2005-1967) [metres]
-0.22 - -0.18
-0.18 - -0.14
-0.14 - -0.1
-0.1 - -0.06
-0.06 - -0.02
-0.02 - 0.02
0.02 - 0.06
0.06 - 0.1
0.1 - 0.14
0.14 - 0.18
0.18 - 0.22
Method representing the median
1
2
3
110
120
130
140
150
-10
-20
-30
-40

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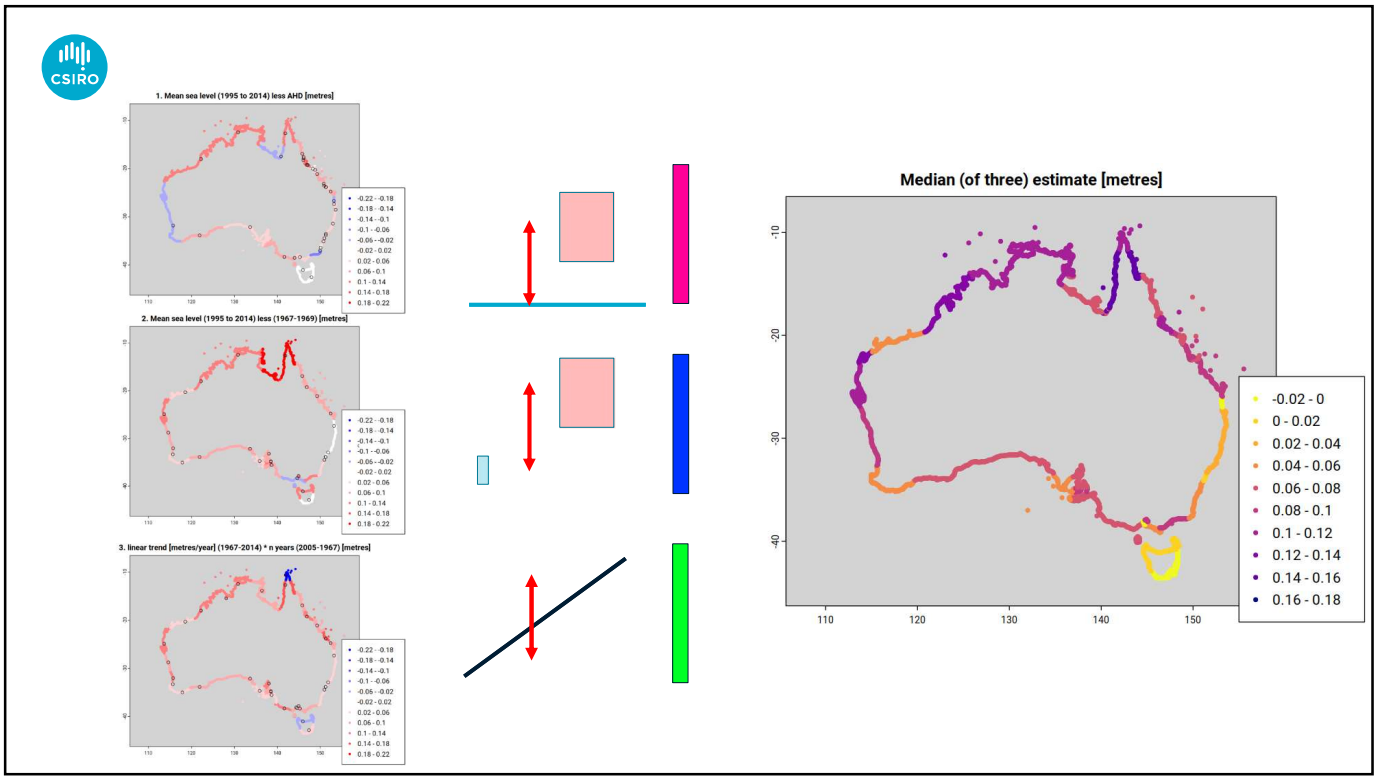
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-0.22 - -0.18
-0.18 - -0.14
-0.14 - -0.1
-0.1 - -0.06
-0.06 - -0.02
-0.02 - 0.02
0.02 - 0.06
0.06 - 0.1
0.1 - 0.14
0.14 - 0.18
0.18 - 0.22
Median (of three) estimate [metres]
-0.02 - 0
0 - 0.02
0.02 - 0.04
0.04 - 0.06
0.06 - 0.08
0.08 - 0.1
0.1 - 0.12
0.12 - 0.14
0.14 - 0.16
0.16 - 0.18
110
120
130
140
150
-10
-20
-30
-40

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Further work

- CSIRO to revise the drivers of observed regional of SLR around Australia
- Use in combination with AR6 SLR projections to estimates future sea levels relative to AHD (e.g. via Canute). To inform coastal inundation mapping.

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Image credit: https://fizzymag.com/articles/fraser-island-restored-to-aboriginal-name-k%E2%80%99gari

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