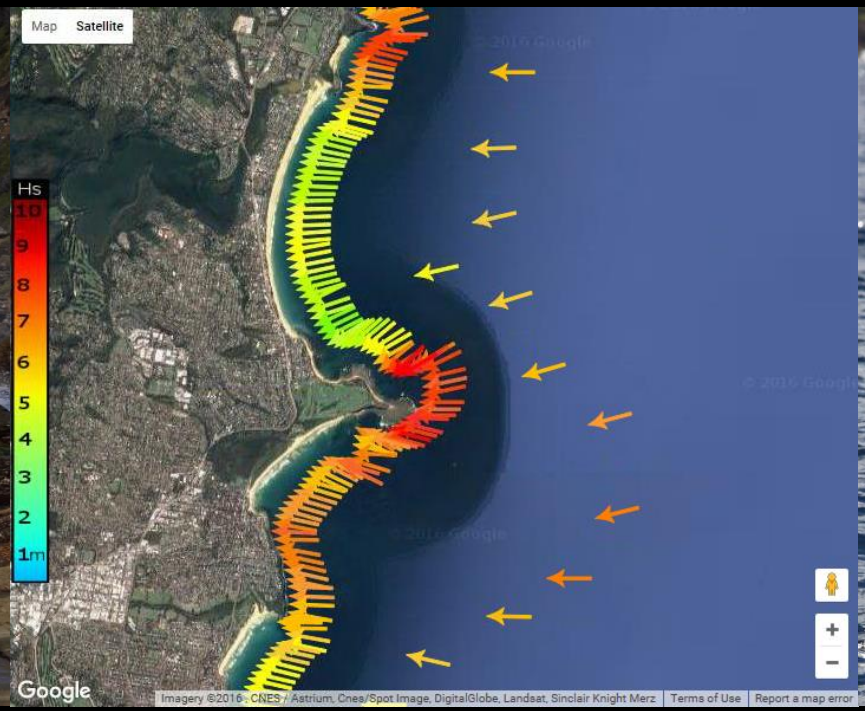
DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT | Environment, Energy & Science Group | Coastal & Marine Science Team

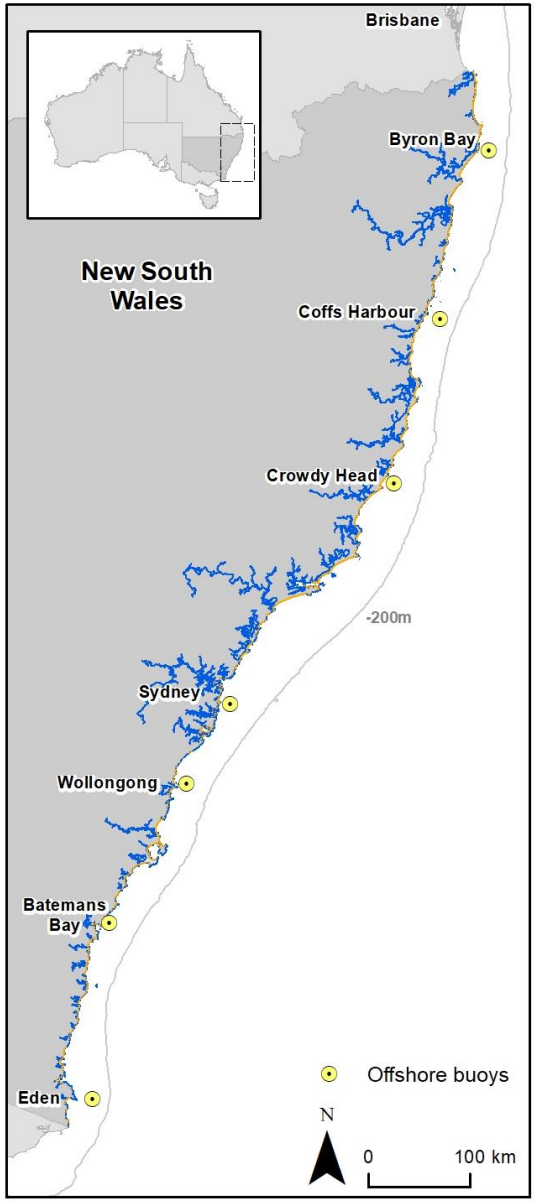
NSW Nearshore Waves Program

Wave observations and modelling to understand and manage coastal hazard risks

Dr Mike Kinsela, Senior Scientist (Coastal & Marine)



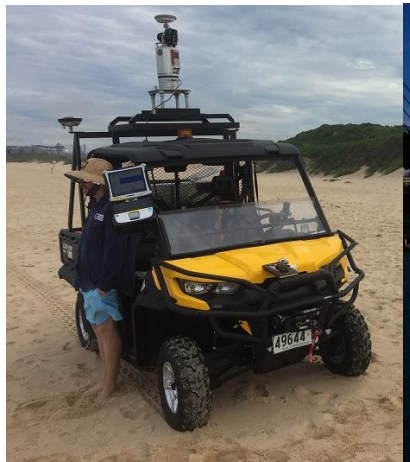
New South Wales, Australia



- About 1,000 km of ‘straight’ coastline (or 2,000 km including bays and headlands)
- Moderate-high energy, swell dominant wave climate with seasonal variablity
- 7 long-term deep-water (offshore) waverider buoys
  - Records since early 1970s
  - First directional buoy in 1992
  - All directional buoys since 2012
  - Operated by Manly Hydraulics Laboratory
- Reasonable understanding of the *deep-water* wave climates and abundant data for model comparisons

NSW Coastal and Marine Science Team

- Research to understand coastal processes, coastal hazards and coastal dynamics
- Science for coastal and marine management and planning
- Fundamental data describing coastal environments
- Data analysis and modelling tools



NSW GOVERNMENT

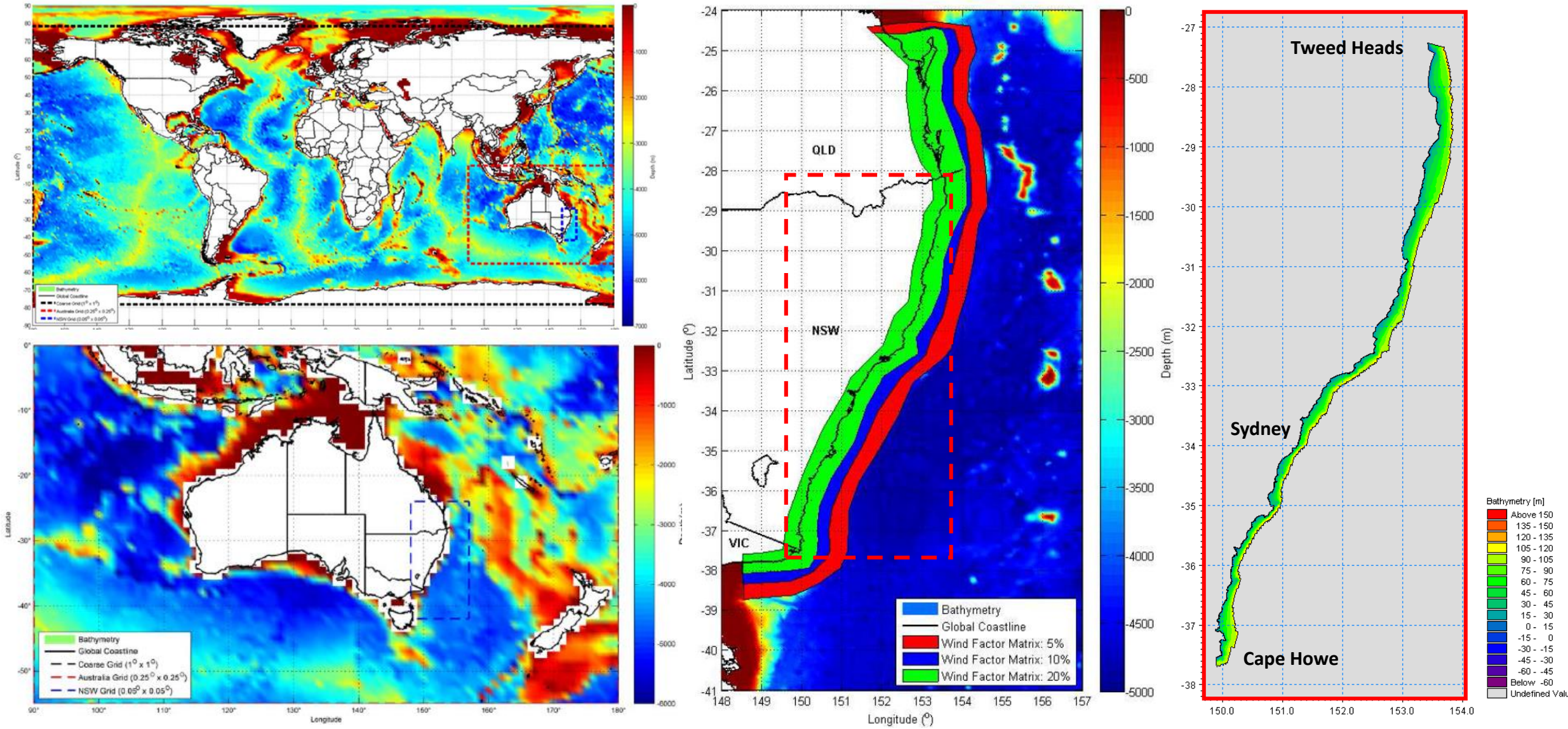
Baird AUSTRALIA

Manly Hydraulics Laboratory

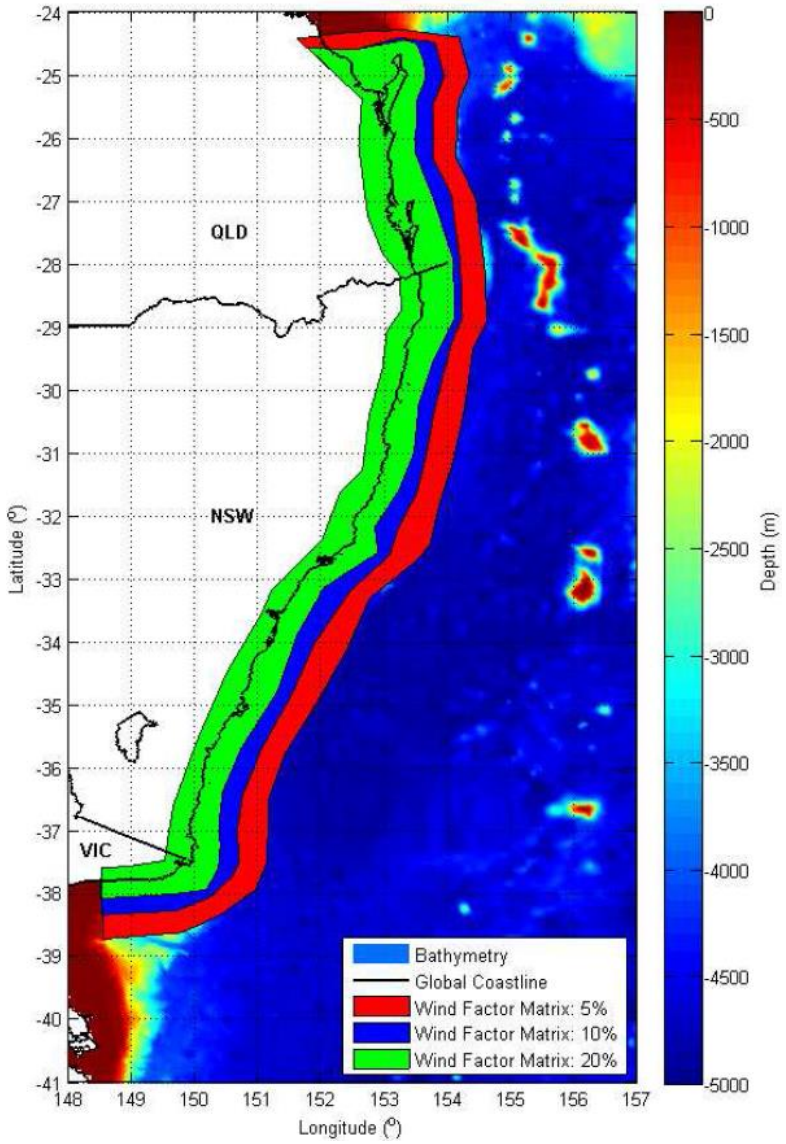
Nearshore wave modelling capability

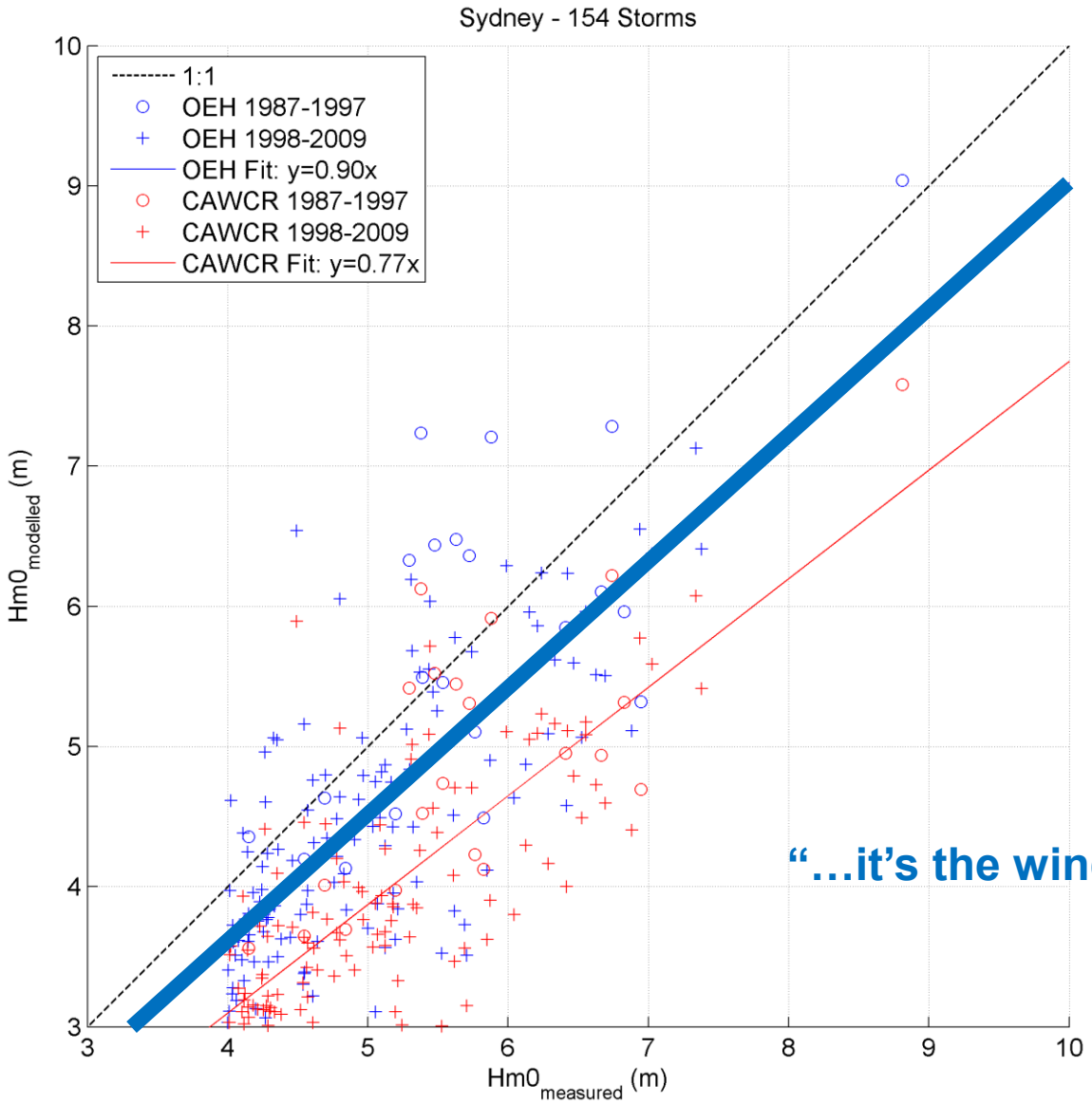
Tools for investigating and predicting coastal hazards

WAVEWATCH III global to nearshore wave modelling system



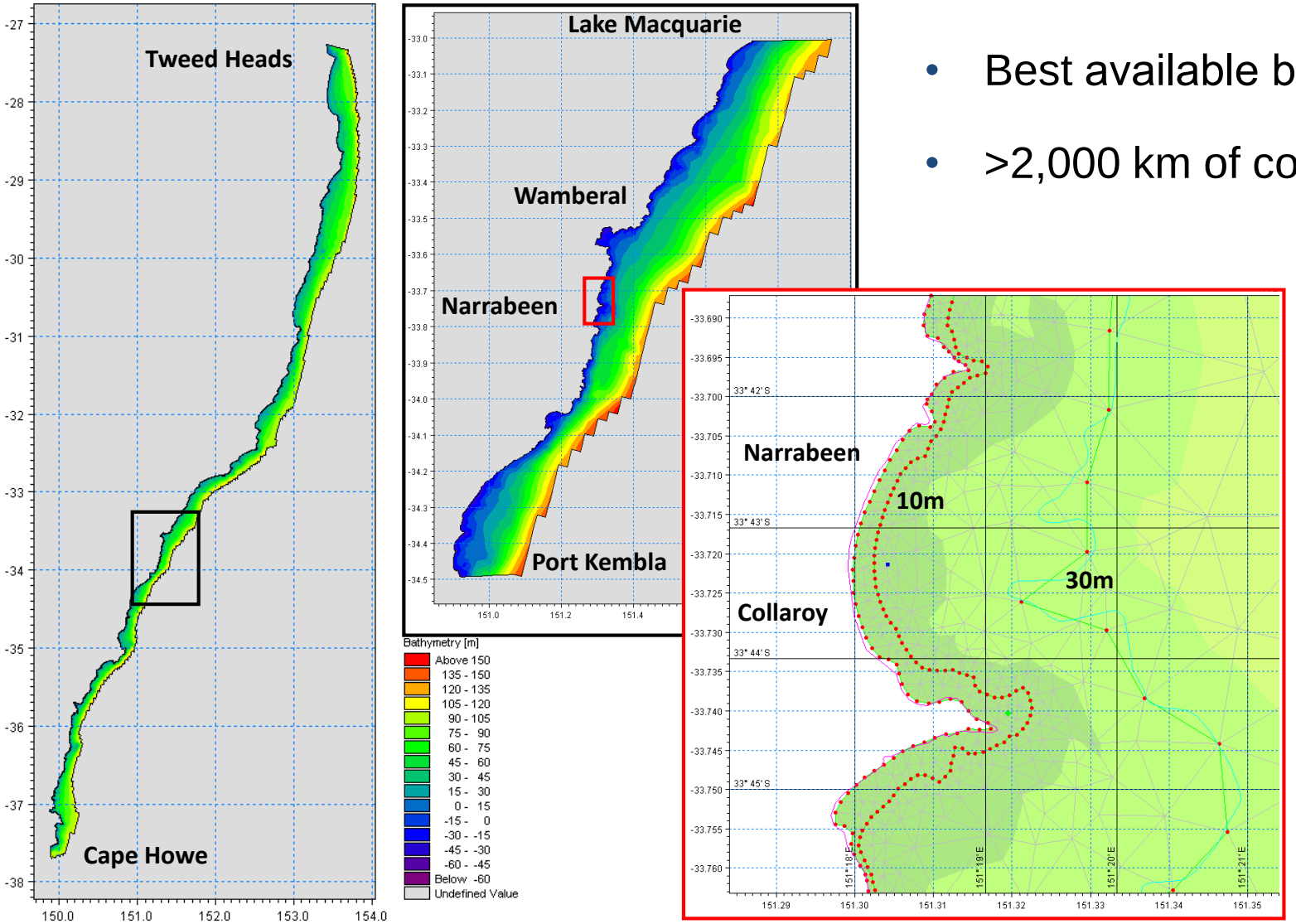
NSW ‘storm wave’ hindcast – enhanced CFSRR winds (1980-2018)





“…it’s the winds stupid”

State-wide nearshore WAVEWATCH-III model (with shallow-water physics)



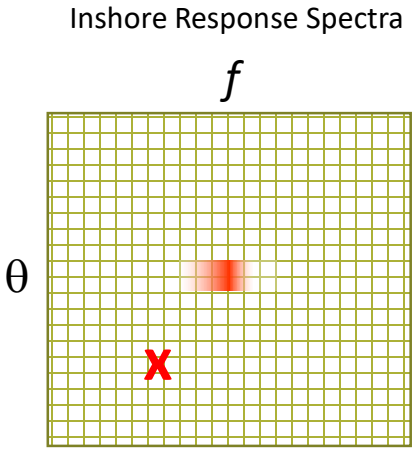
- Best available bathymetry data (at the time…)
- >2,000 km of coastline – c. 170,000 elements

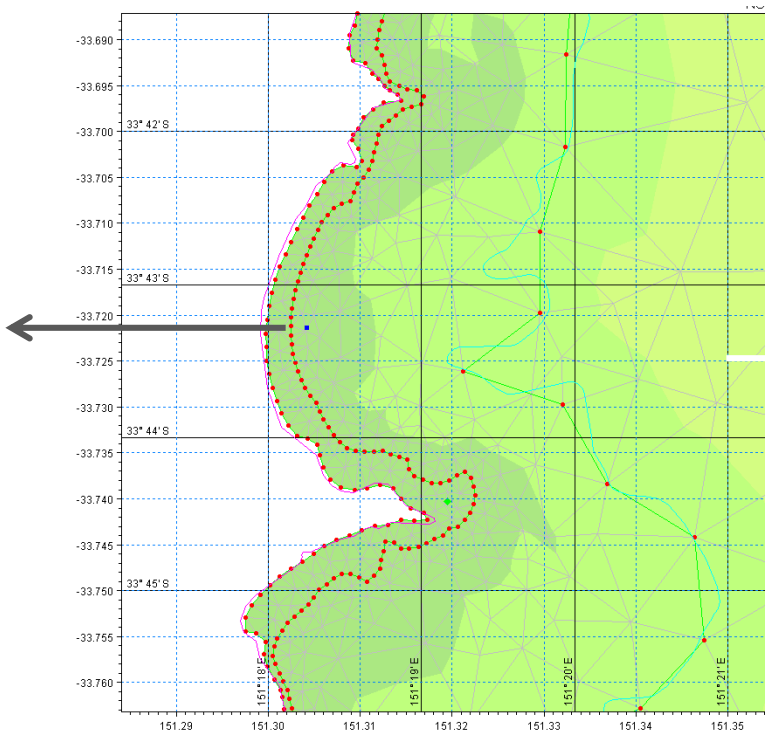
- > 14,000 nearshore transform nodes along the NSW coast
- **100 m** spacing in **10 m** water depth (13,313 nodes)
- **2.5 km** spacing in **30 m** water depth (1,197 nodes)
- Paired to offshore wave buoys and NSW WW-III model

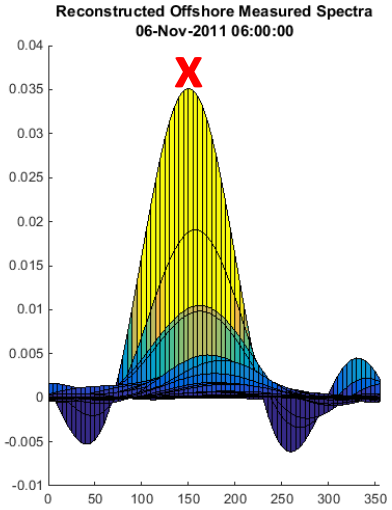
Spectral and parametric nearshore wave transformation functions

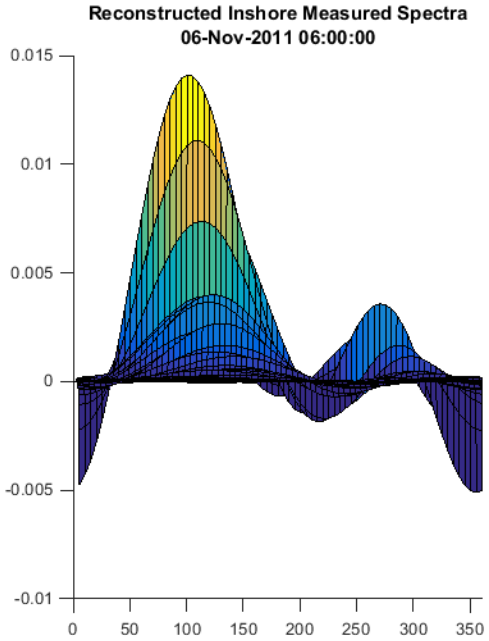
WAVEWATCH-III model v4.18 (NOAA)

NSW mesh + shallow-water physics









Transfer offshore spectral ordinates using individual **Inshore Response Spectra** for each ordinate (*Tp-ThetaP*)

Inshore wave condition is the cumulative sum of the scaled inshore spectra

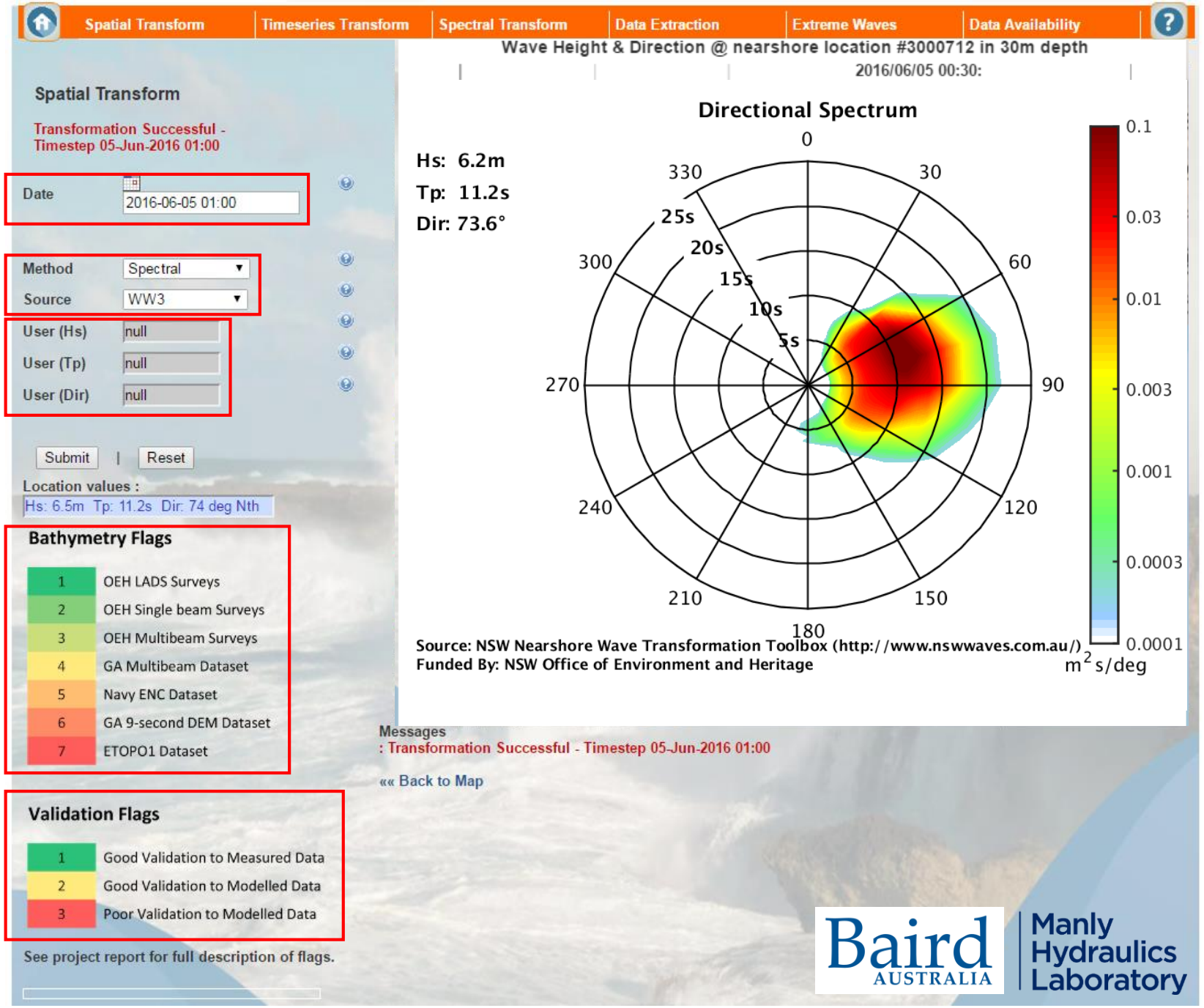
Date/Time (1980 to present)

Parametric or **Spectral** transformation
Wave buoy or **WAVEWATCH-III** source

Custom Wave Scenario - Hs/Tp/Dir

Bathymetry Quality Flags
How detailed is bathymetry at each node?

Transform Validation Flags
How accurate is transform at each node?



Nearshore wave modelling – limitations and areas for improvement

- High-resolution coastal bathymetry was scarce at the time of development of the nearshore bathymetry mesh

- Nearshore wave measurement data (e.g. buoy records) was even scarcer

- Spectral transformation functions are currently lacking H_{m0} dimension – not suitable for large wave heights

- Nearshore wave transformation toolbox not accessible for intended end-user stakeholders (e.g. local governments, engineering consultants)

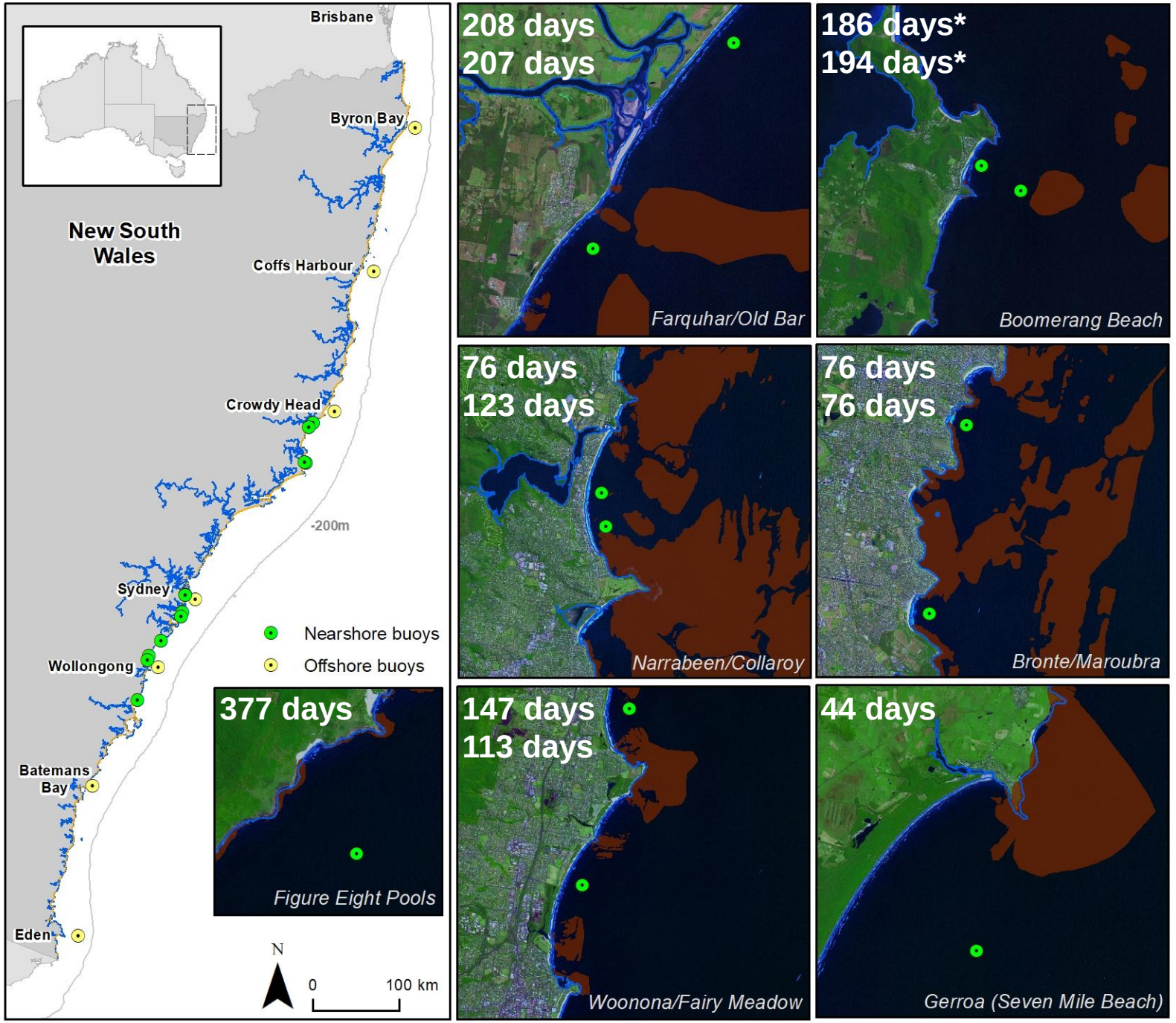
  forecast.waves.nsw.gov.au (rolling forecast version)

Nearshore wave buoy deployments

Fundamental data for wave model calibration/evaluation and local wave climate analysis

Nearshore wave observation program

- Wave buoy deployment program adding value to on-water operations (e.g. coastal seabed mapping)
- Sydney Institute of Marine Science (SIMS) collaboration to build a pool of wave buoy instruments
- IMOS (RAAP) funding in 2016/18 and NSW Government funding in 2019 to grow instrument pool
- Completed **48** service visits to **10** *Datawell DWR-G4* wave buoy deployments during 2016-2018
- Transition to *Spoondrift Spotter* wave buoys to reduce service visits and eliminate battery waste
- >**1800** ‘buoy days’ of hourly nearshore wave data collected at **12** locations during 2016-2019

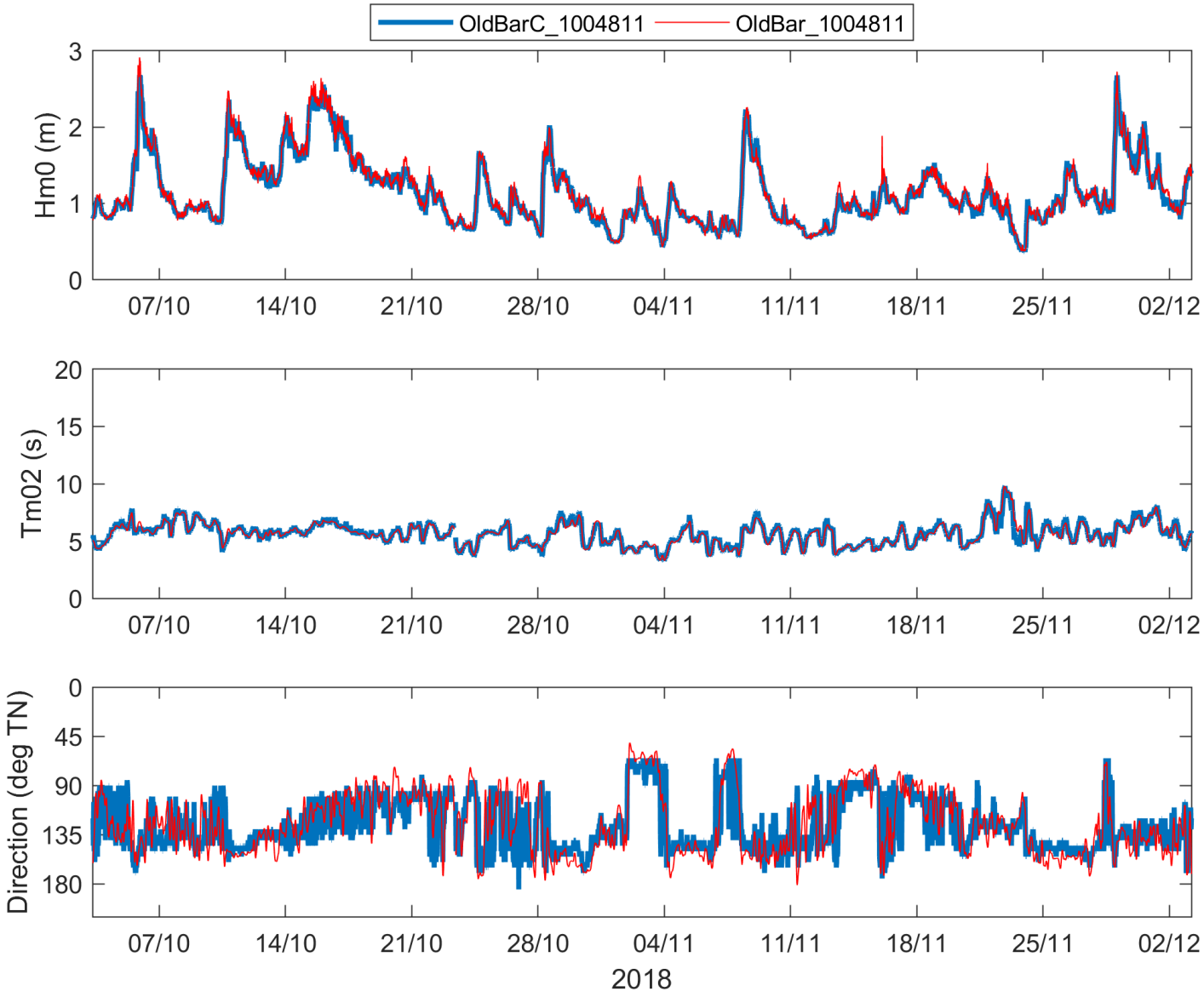

Brisbane
Byron Bay
New South Wales
Coffs Harbour
Crowdy Head
-200m
Sydney
Wollongong
Batemans Bay
Eden
Nearshore buoys
Offshore buoys
N
0
100 km
208 days
207 days
Farquhar/Old Bar
186 days*
194 days*
Boomerang Beach
76 days
123 days
Narrabeen/Collaroy
76 days
76 days
Bronte/Maroubra
377 days
Figure Eight Pools
147 days
113 days
Woonona/Fairy Meadow
44 days
Gerroa (Seven Mile Beach)

Deployment platform - *RV Bombora, 38 foot Stebercraft*

Service visits – biofouling, maintenance and data retrieval

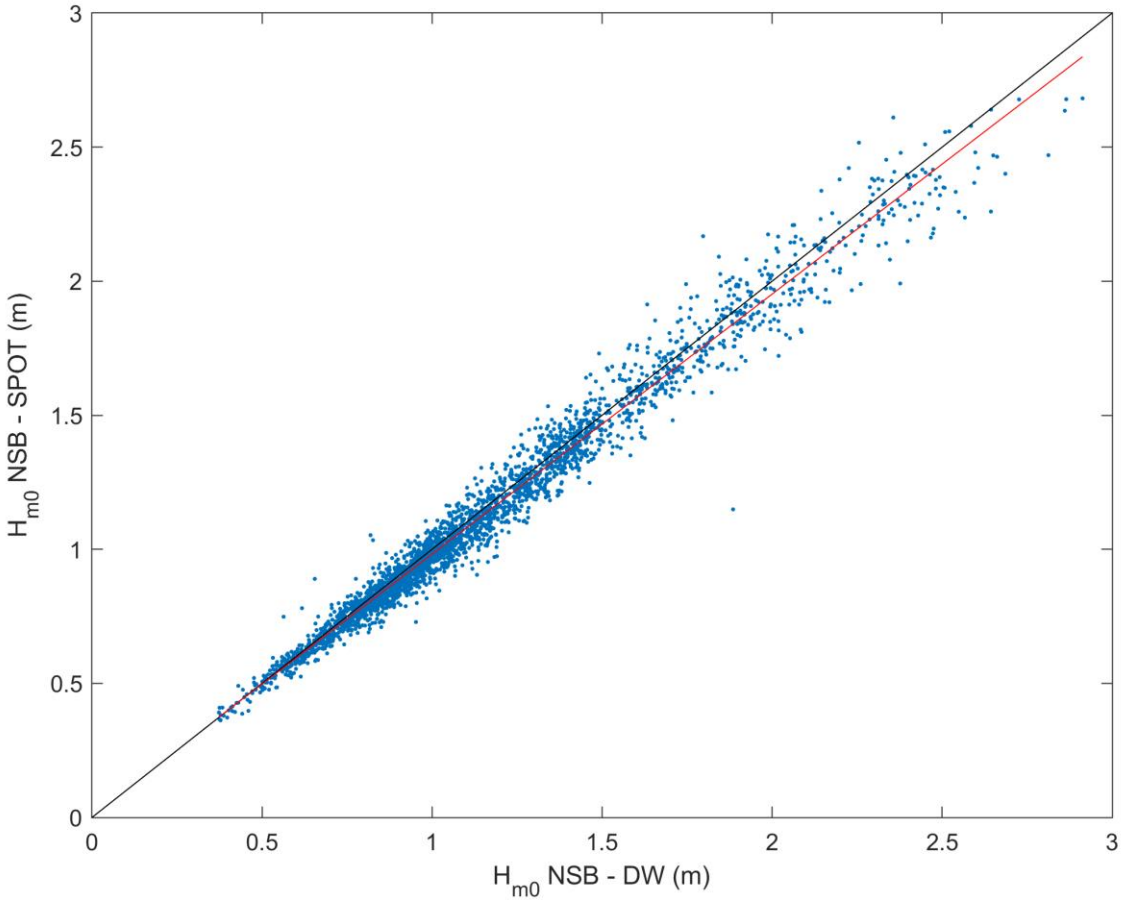
Datawell DWR-G4 *vs.* Sofar Spotter data comparison (12 m water depth)

Datawell DWR-G4 *vs.* Sofar Spotter data comparison (12 m water depth)

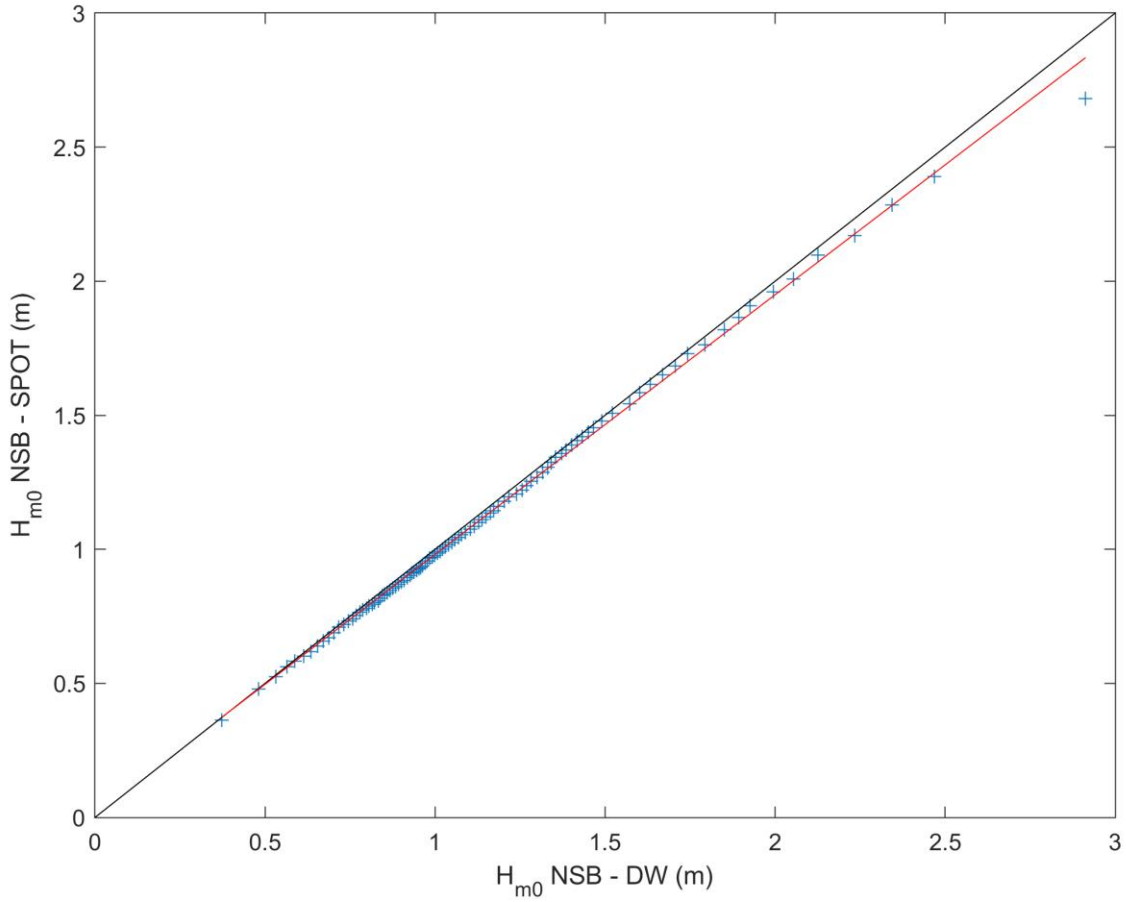


Datawell DWR-G4 *vs.* Sofar Spotter data comparison (12 m water depth)

H_{m0} – scatter plot

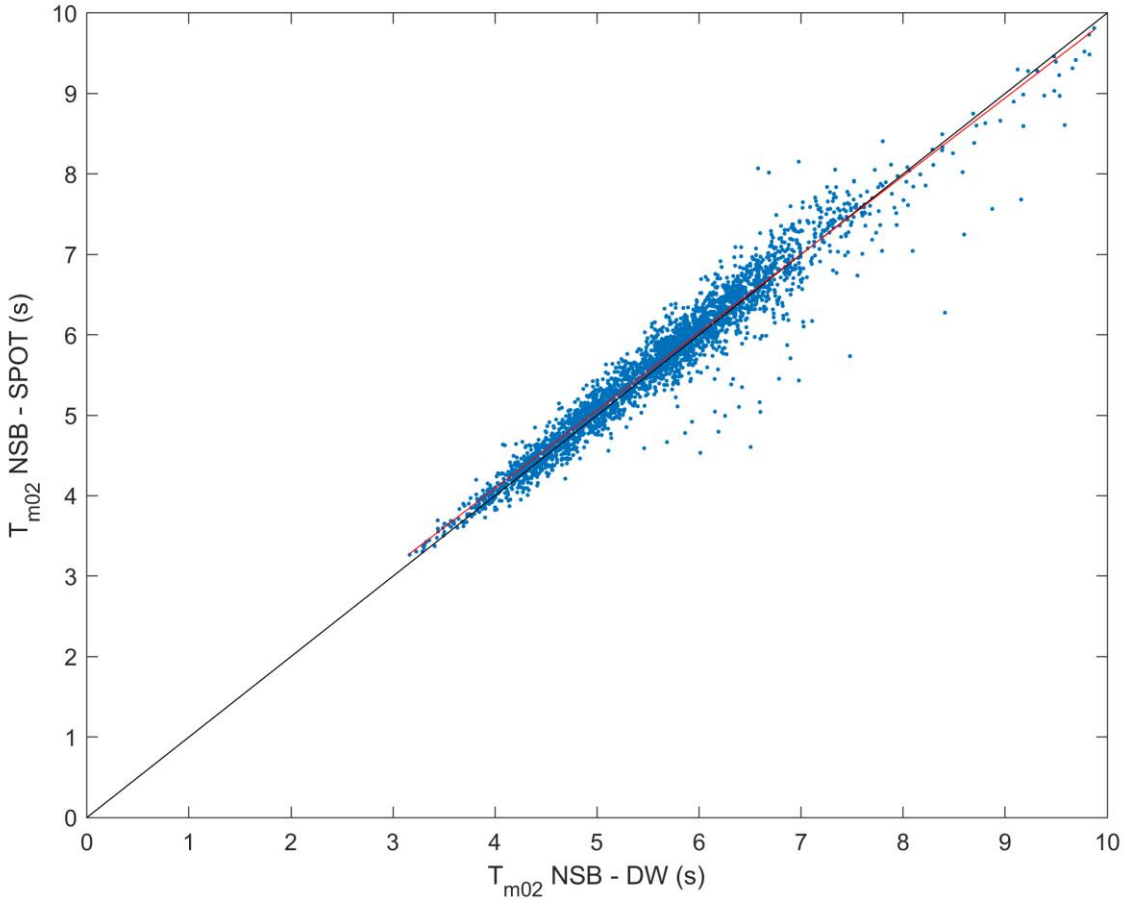


H_{m0} – quantile plot

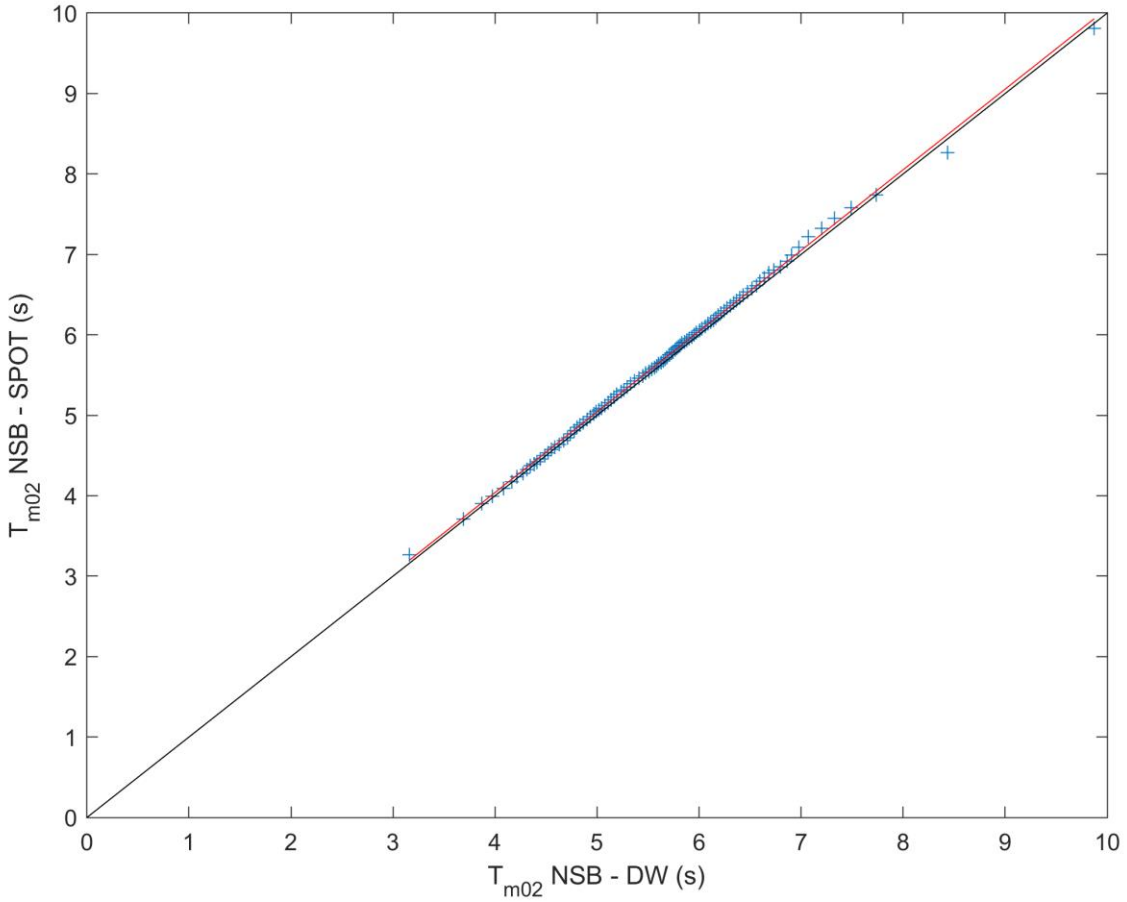


Datawell DWR-G4 *vs.* Sofar Spotter data comparison (12 m water depth)

T_{m02} – scatter plot

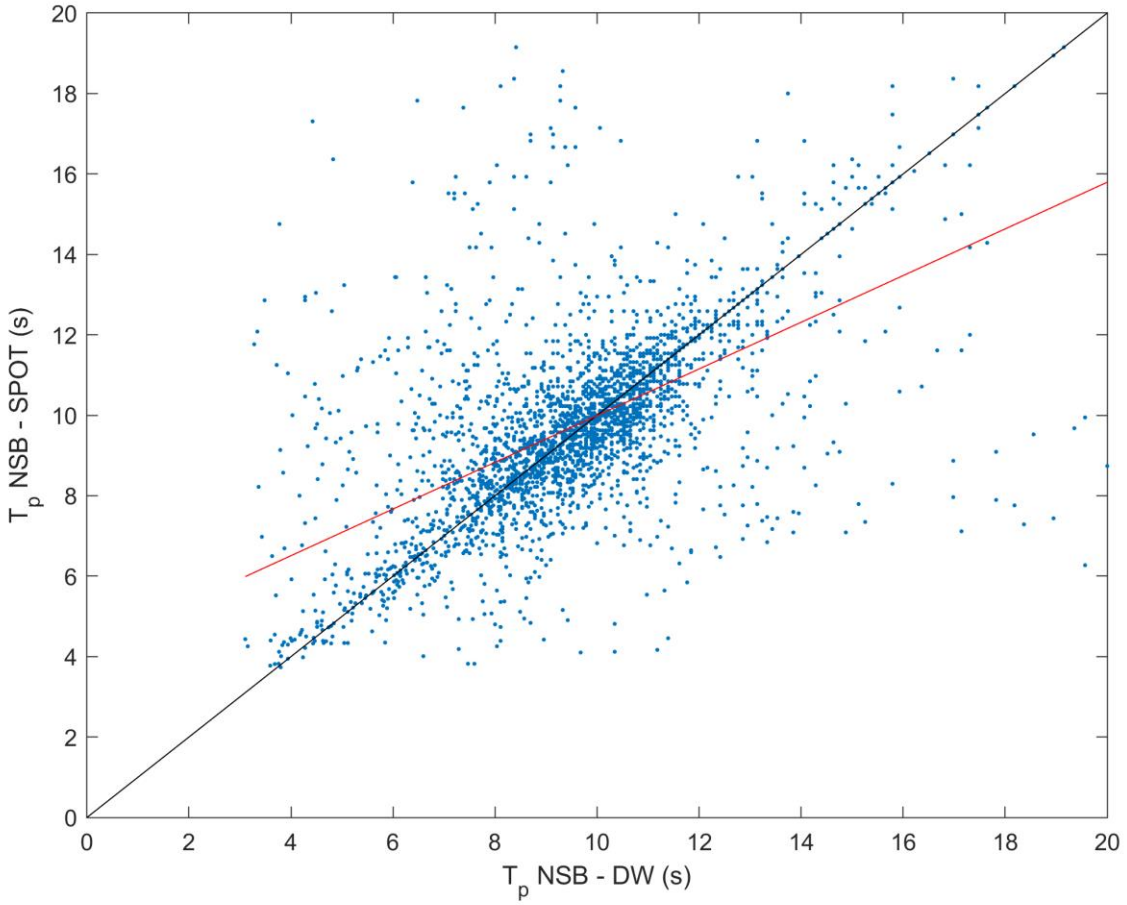


T_{m02} – quantile plot

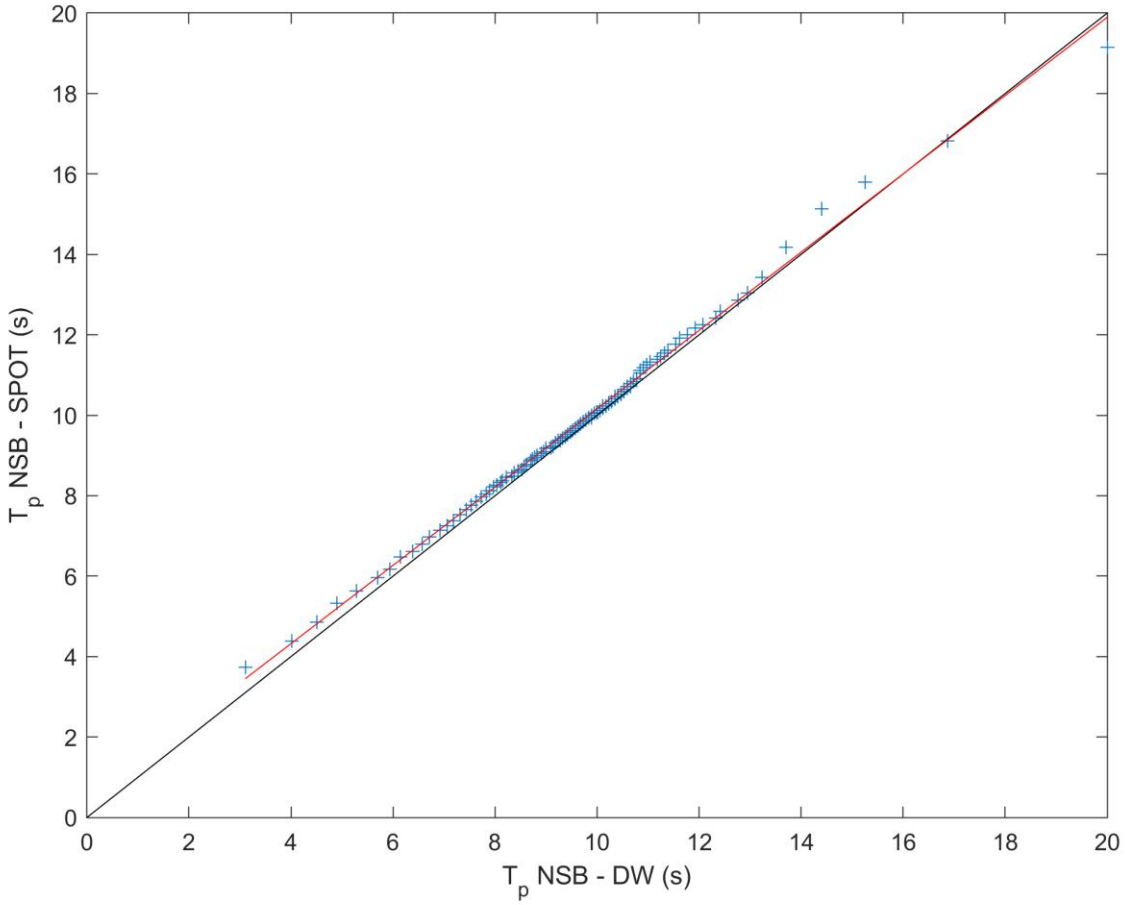


Datawell DWR-G4 *vs.* Sofar Spotter data comparison (12 m water depth)

T_P – scatter plot

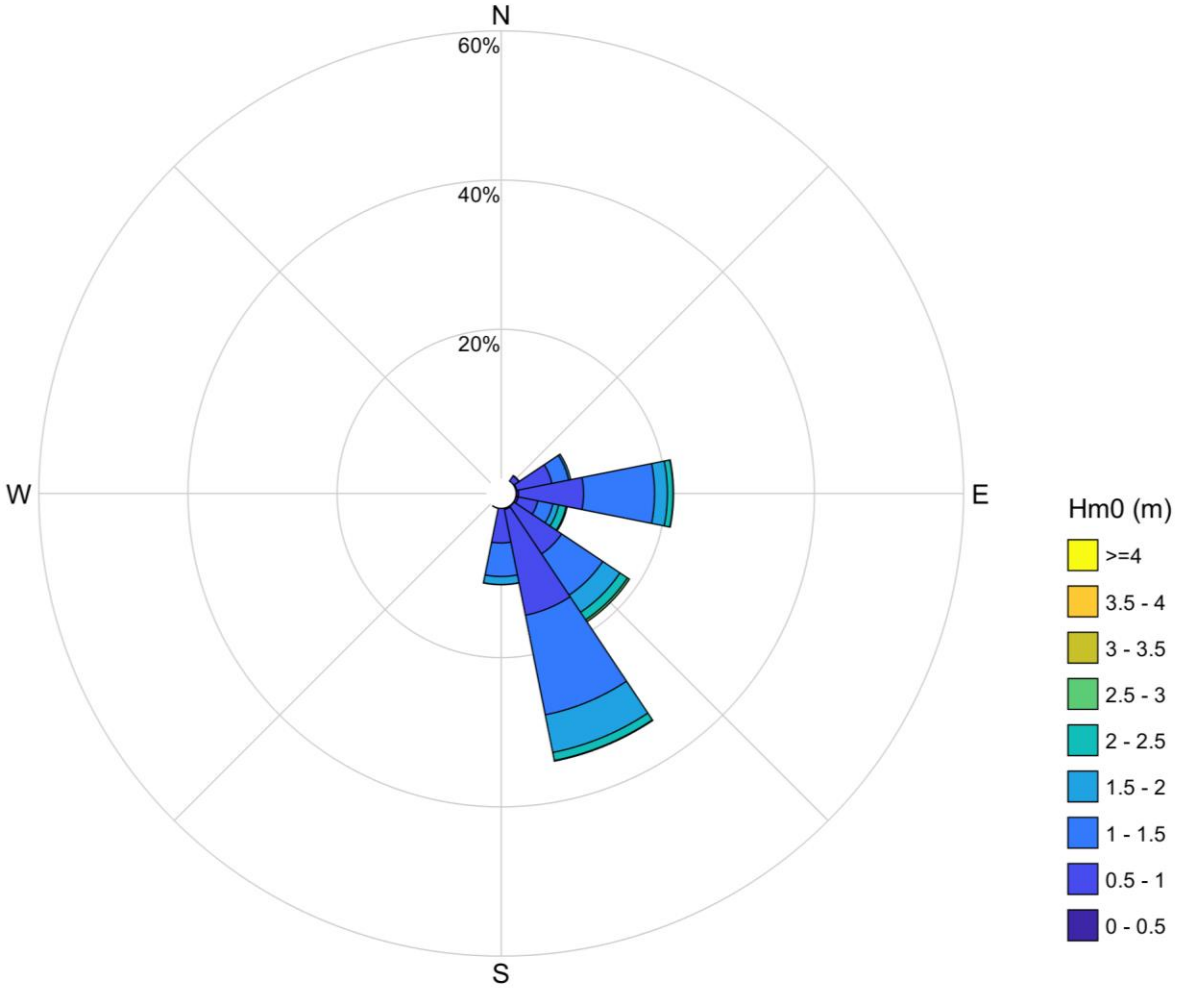


T_P – quantile plot

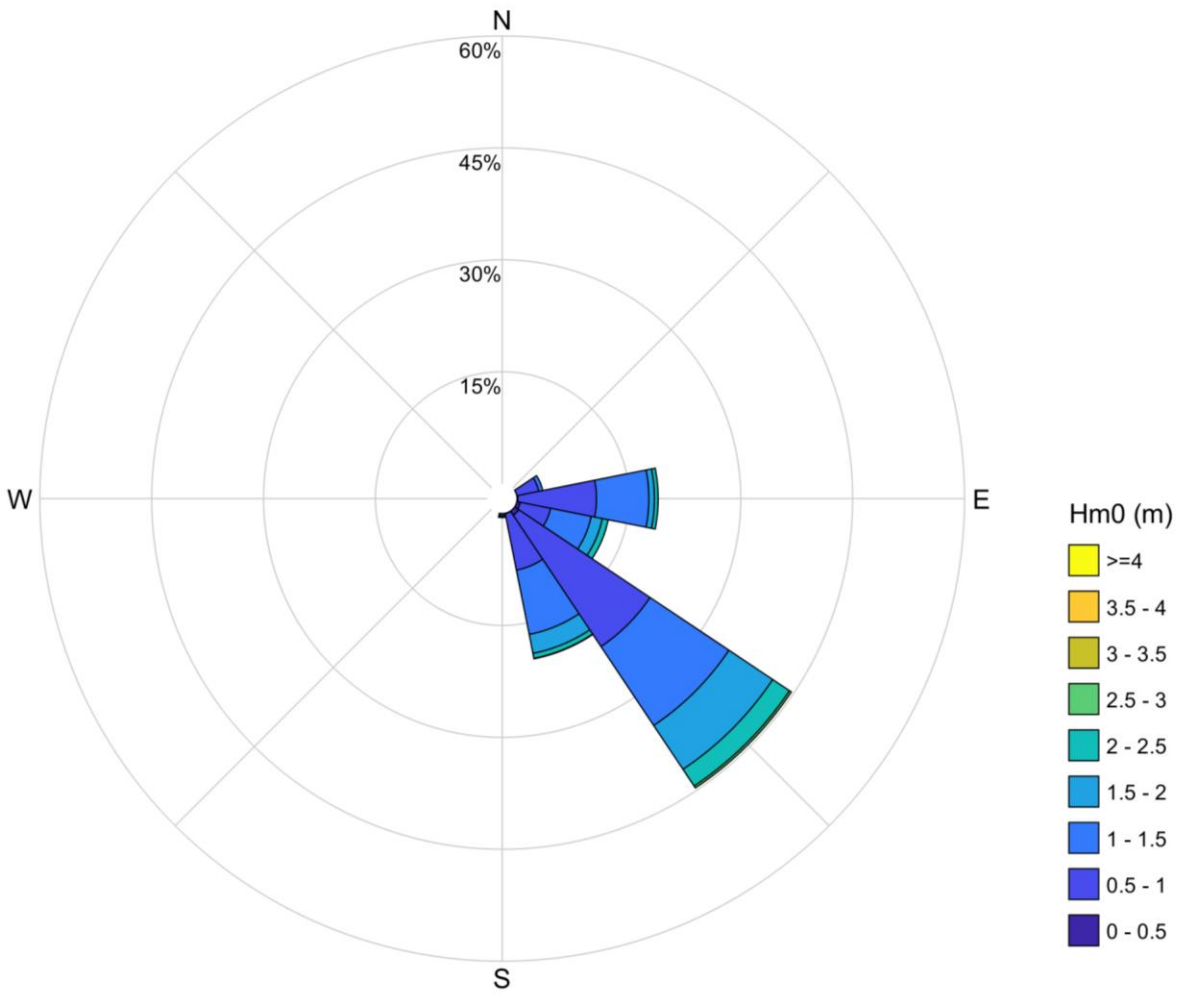


Datawell DWR-G4 *vs.* Sofar Spotter data comparison (12 m water depth)

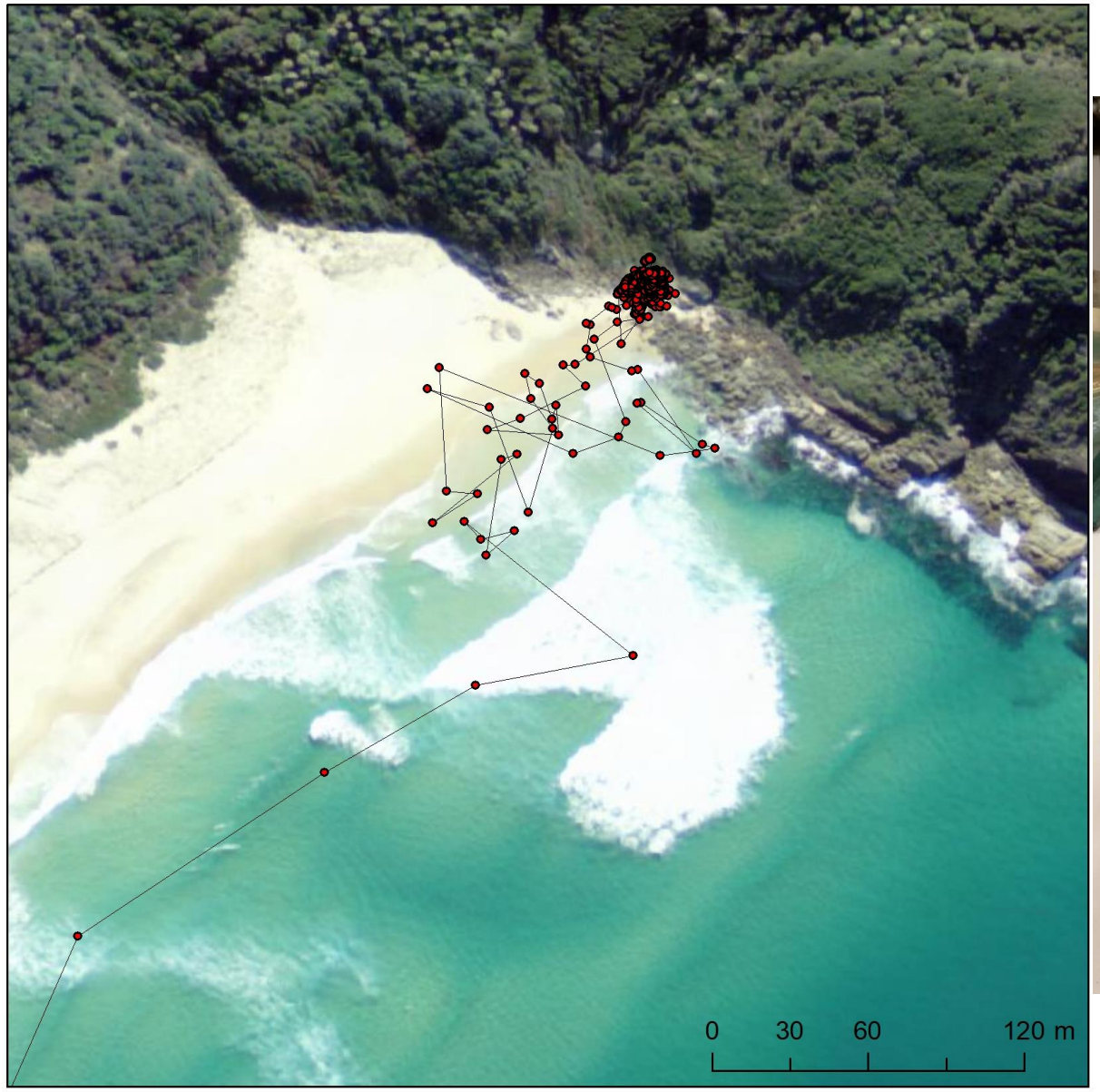
Datawell – H_{m0}/Dir



Spotter – H_{m0}/Dir

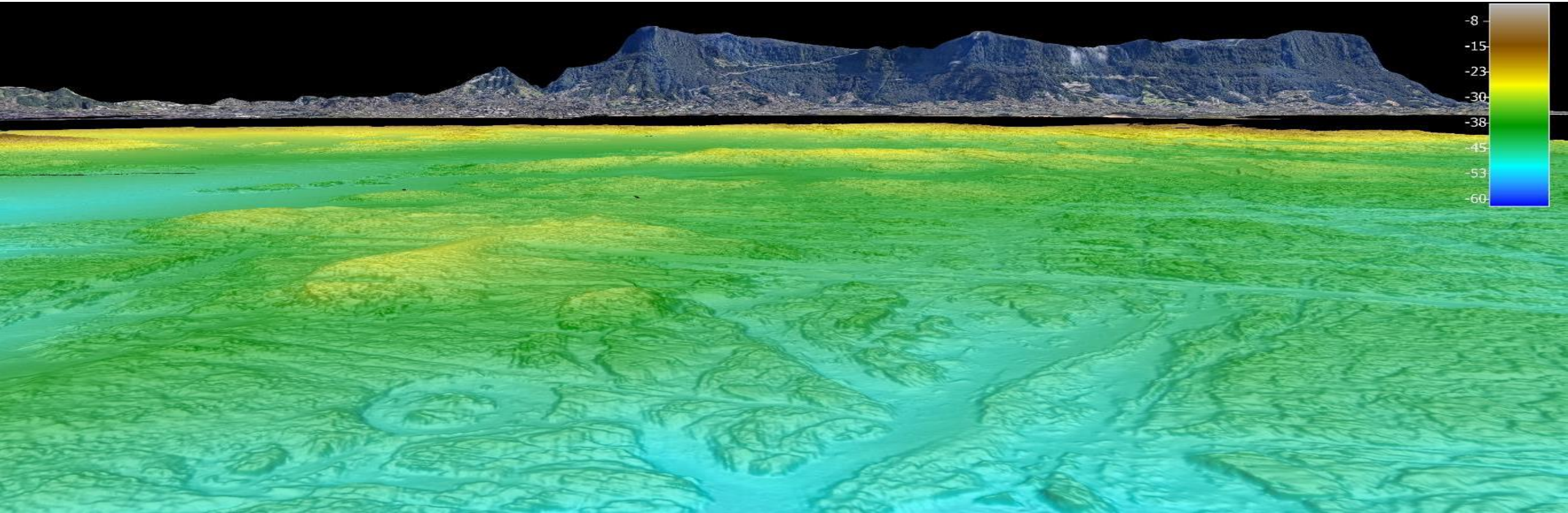


Is 12 the magic number – why do we deploy in 12 m water depth?

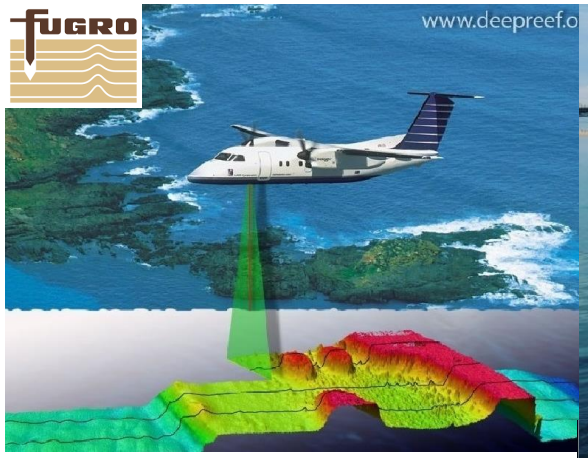


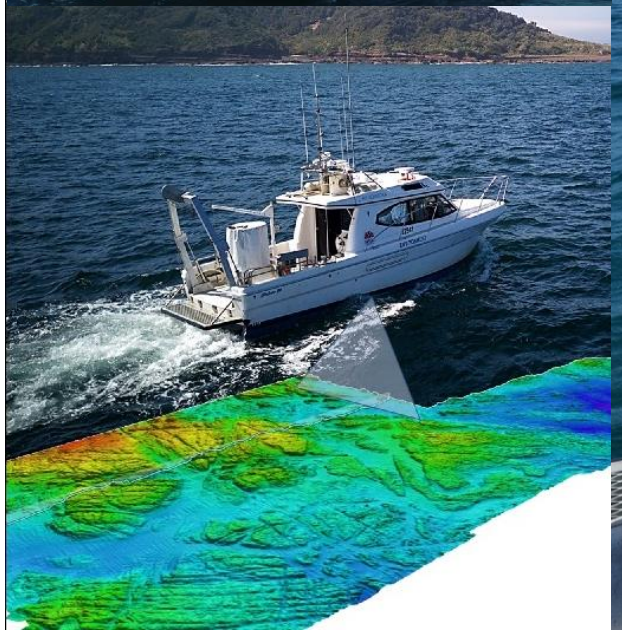
NSW Coastal Seabed Mapping Program

High-resolution bathymetry to improve nearshore wave modelling



State-wide seamless coastal LiDAR, targeted vessel-based seabed mapping





Coastal Management Reforms funding

– $7 million for state-wide science & data

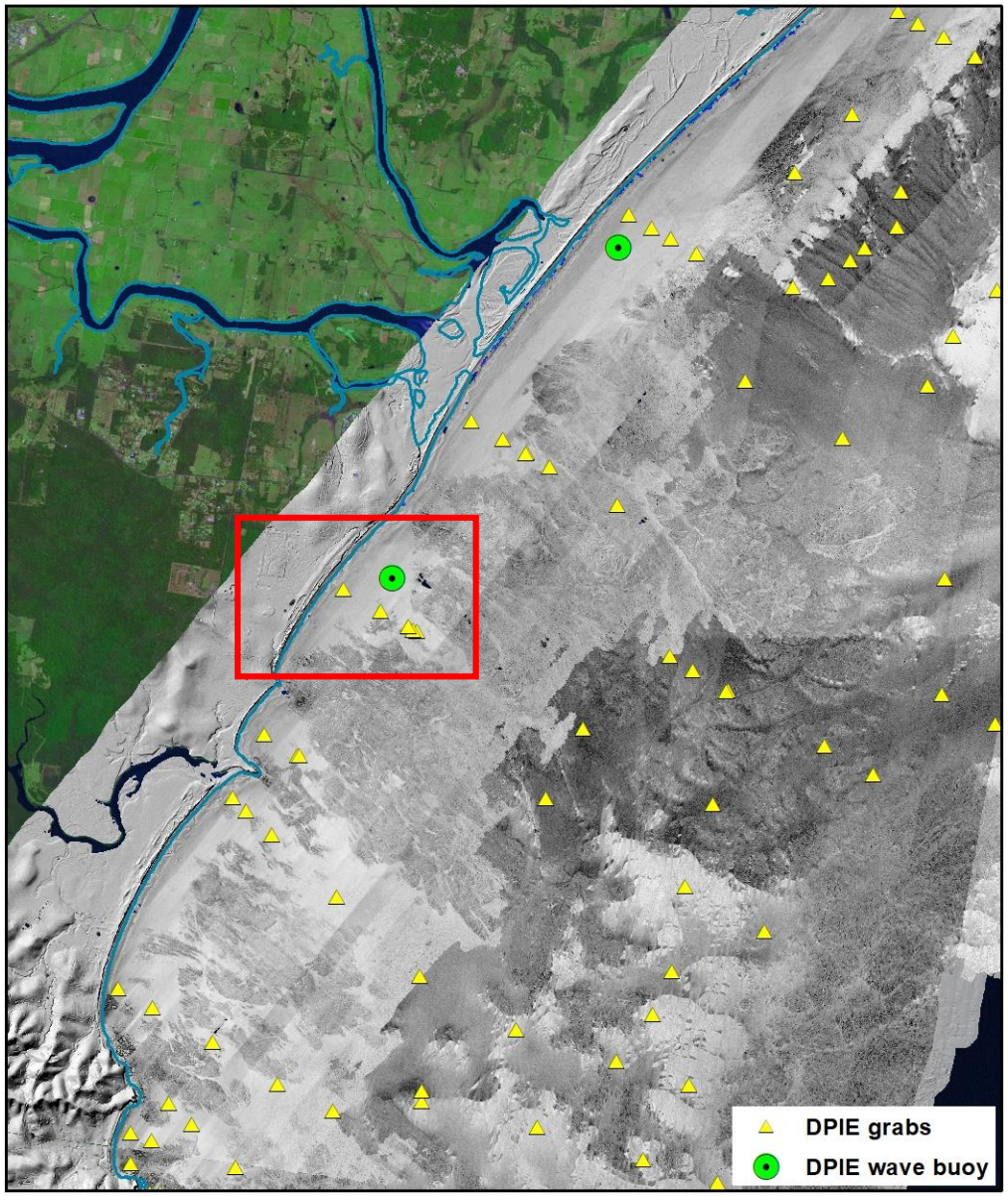
– inform preparation of Coastal Management Programs (CMPs)

– map coastal sediment compartments

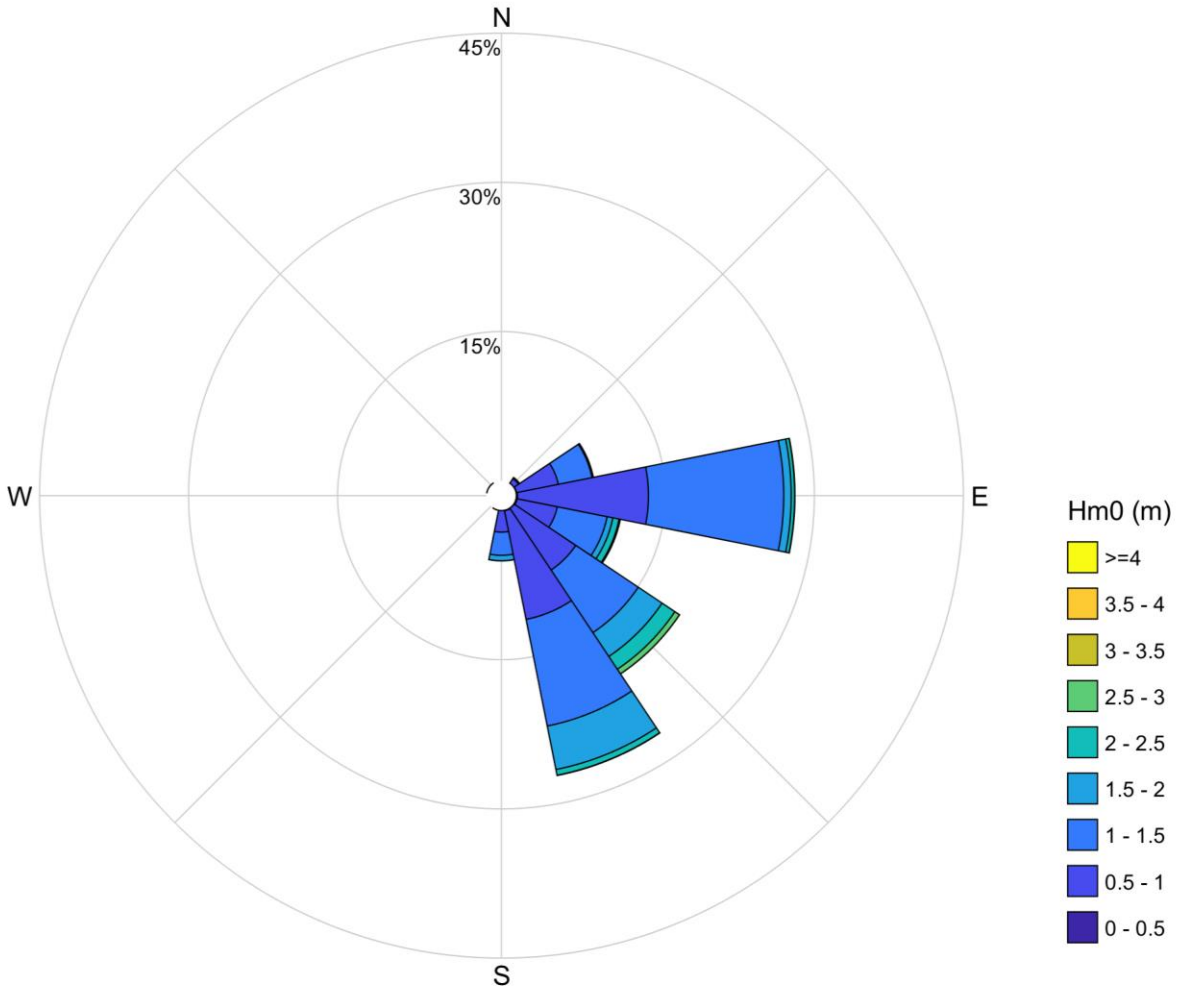
Test beds for developing / calibrating / evaluating nearshore wave models

Farquhar (12 m water depth)

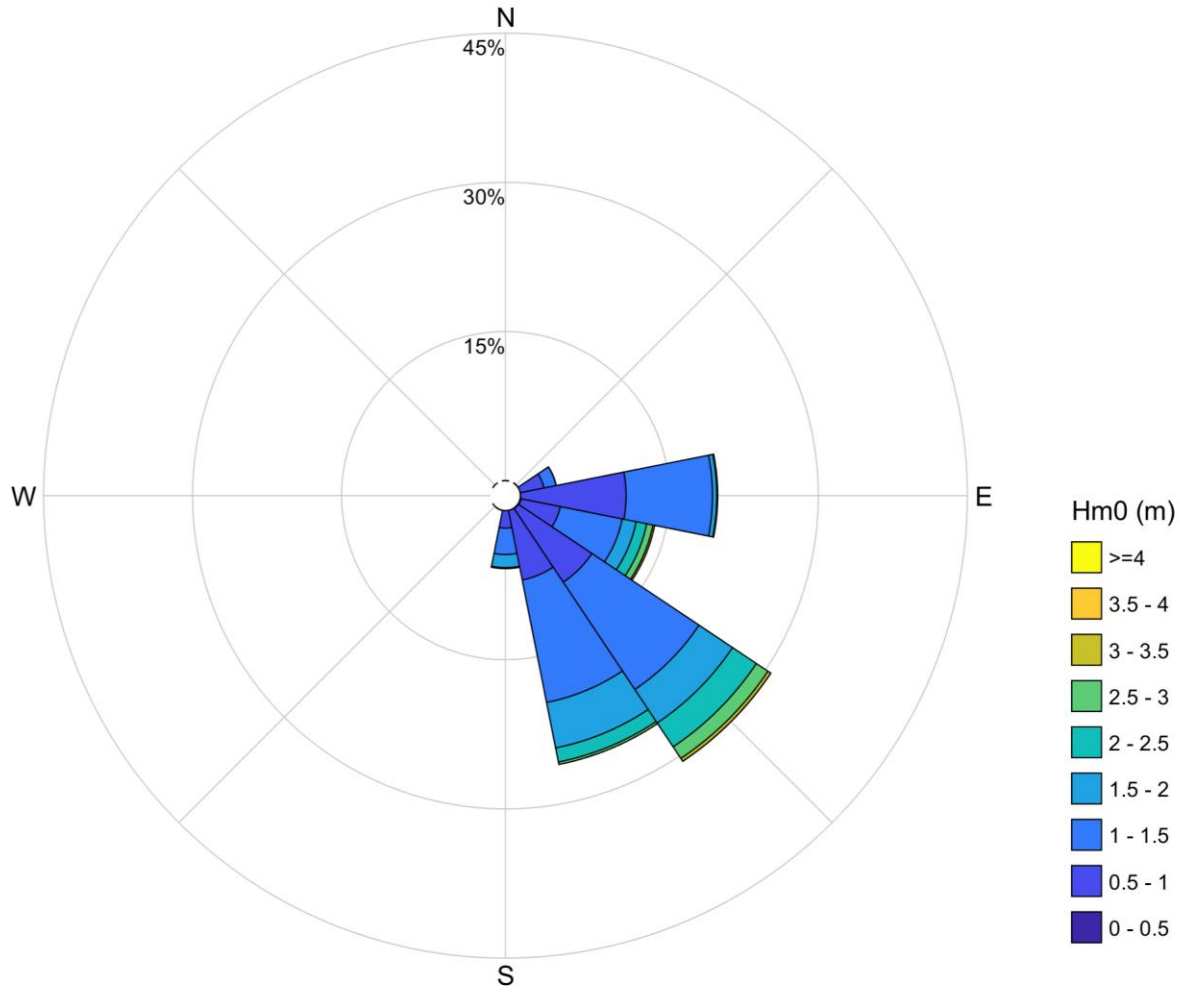
Old Bar (12 m water depth)



Nearshore wave buoy deployments – 16/8/2018 – 12/3/2019 (30 weeks)



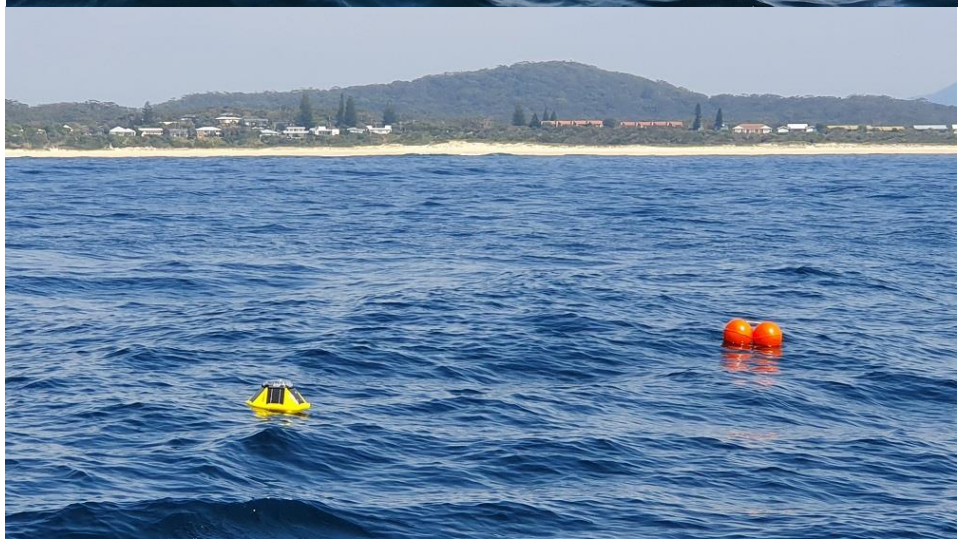
Old Bar (12 m water depth)



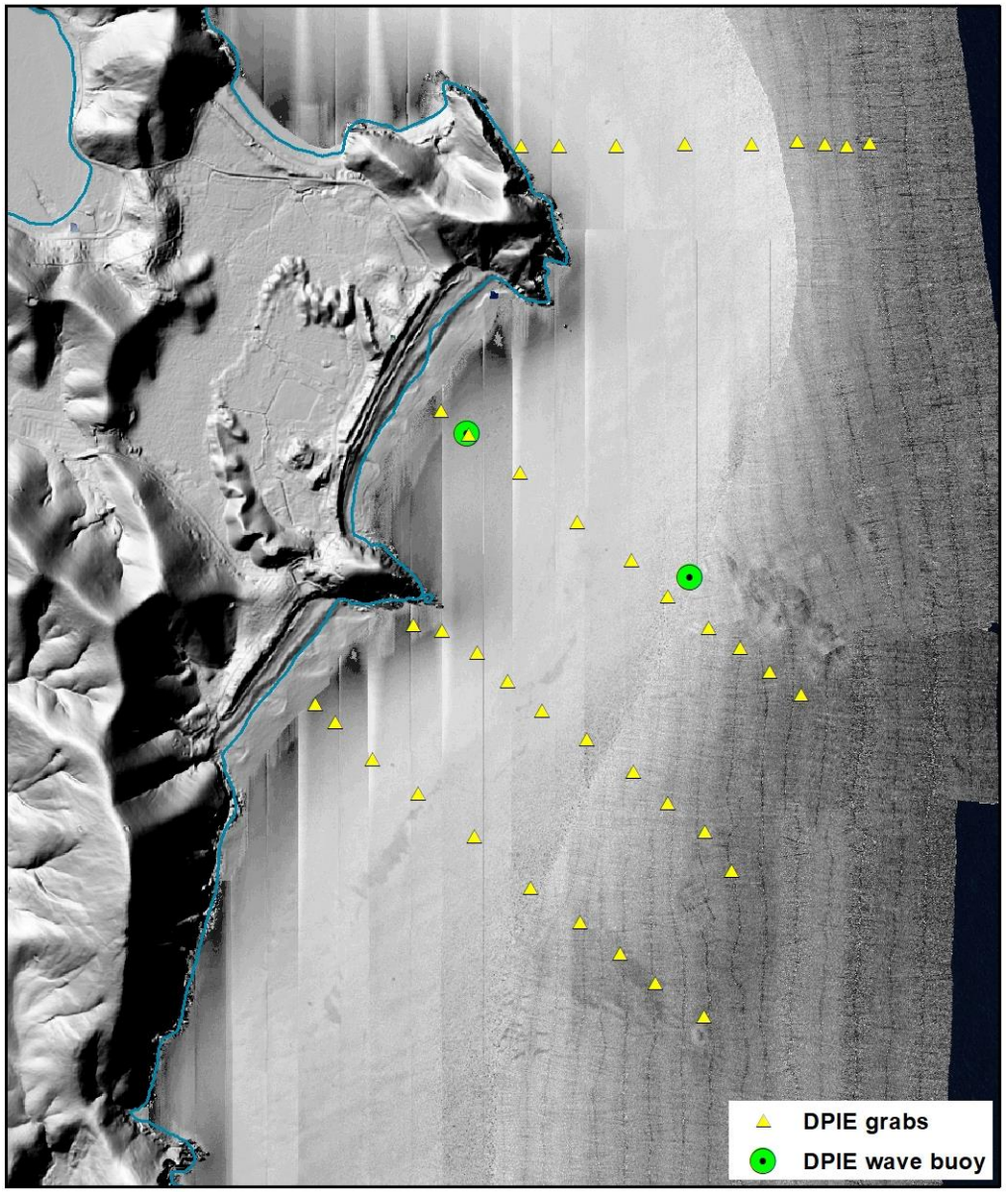
Farquhar North (12 m water depth)

Test beds for developing / calibrating / evaluating nearshore wave models

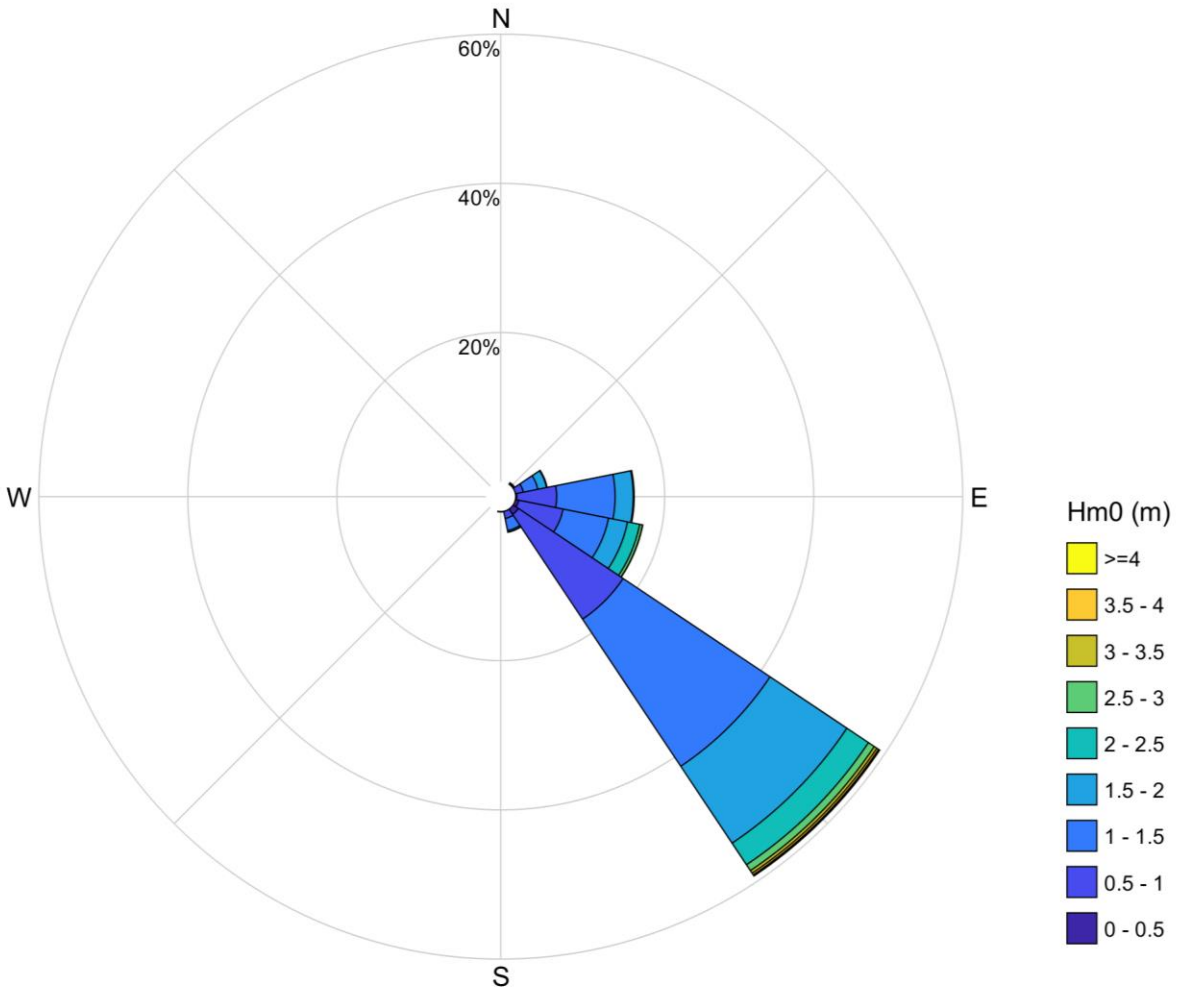
Boomerang (12 m water depth)



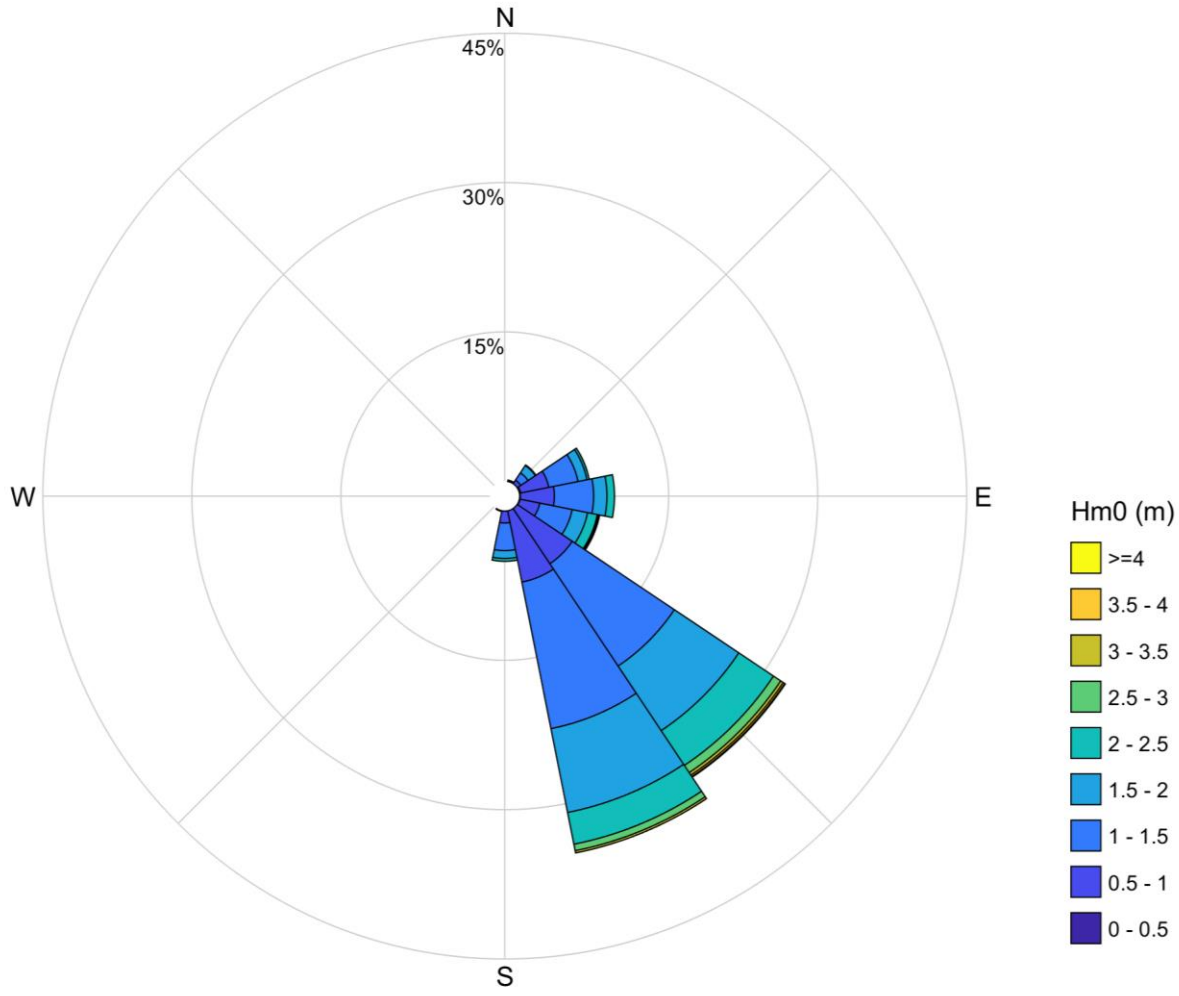
Boomerang (32 m water depth)



Nearshore wave buoy deployments – 21/3/2019 – ongoing (26* weeks)



Boomerang (12 m water depth)



Boomerang (32 m water depth)

NSW GOVERNMENT

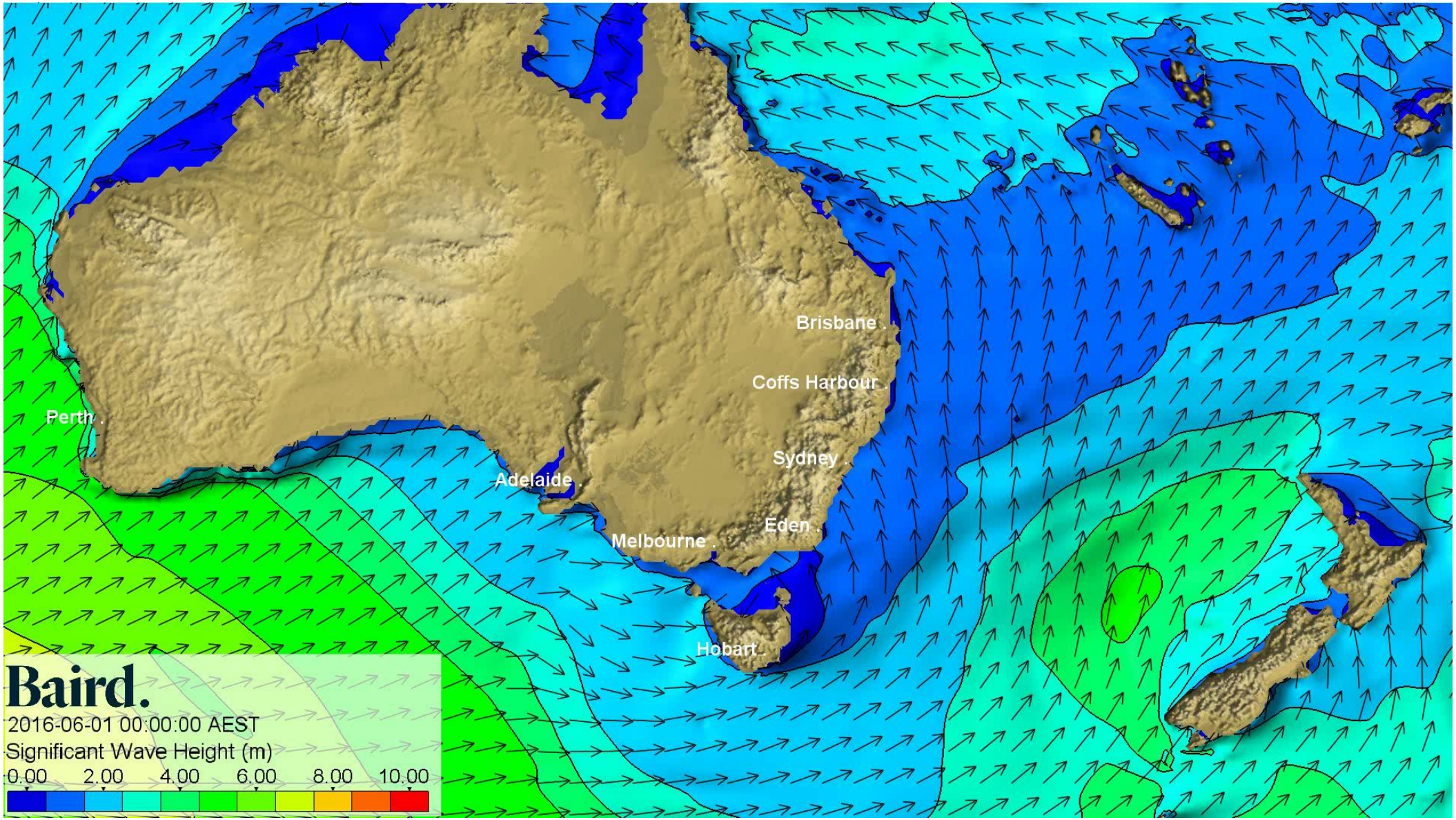
UNSW SYDNEY

Water Research Laboratory
School of Civil and Environmental Engineering

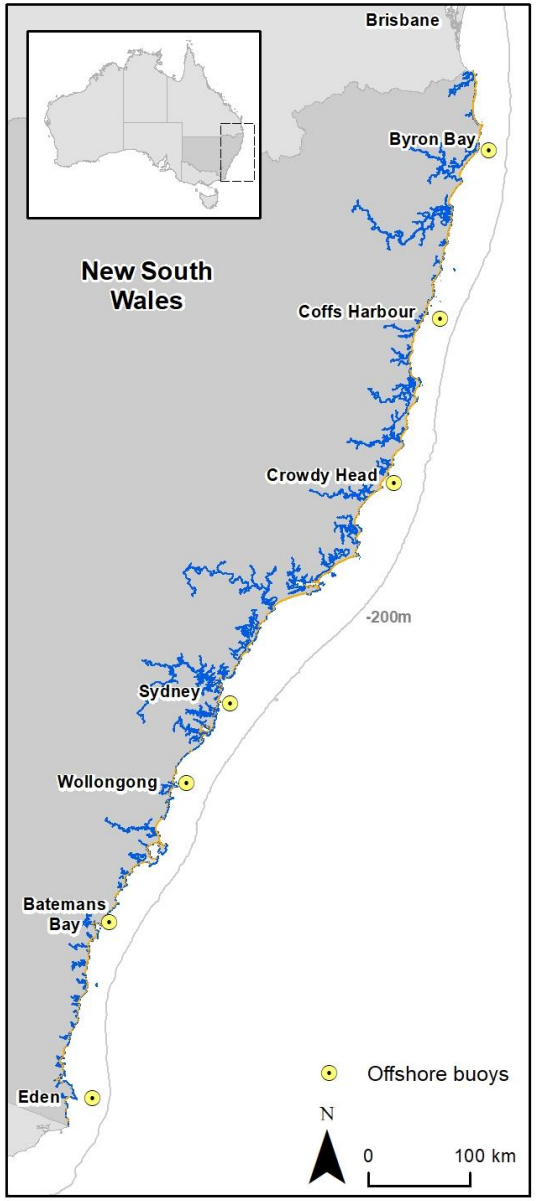
Beach response to severe coastal storms

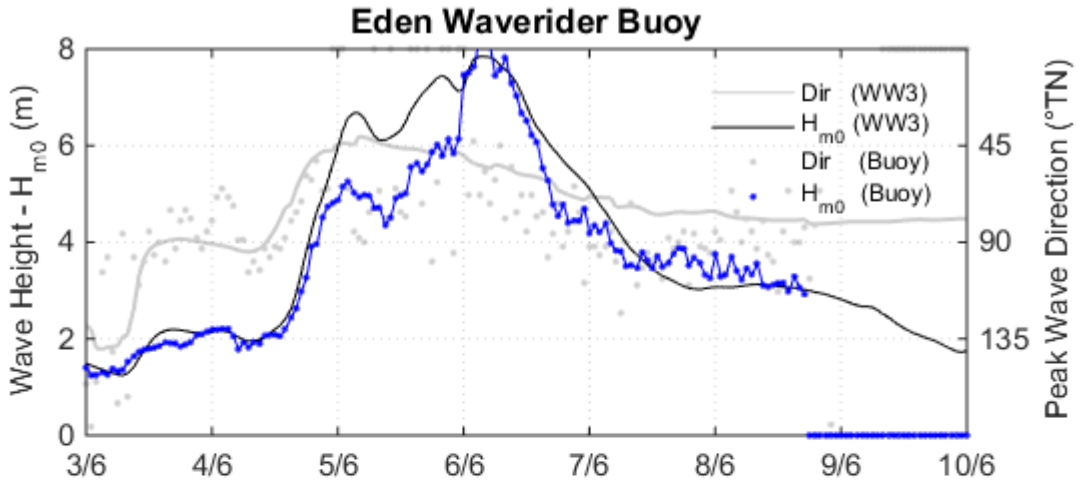
Investigating the drivers of exposure to beach erosion hazards

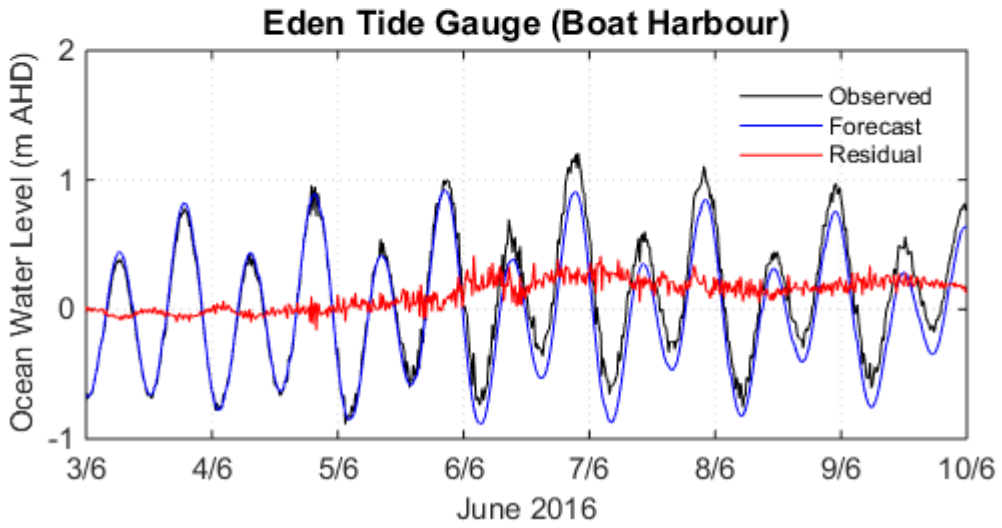

June 2016 storm evolution along east Australian seaboard



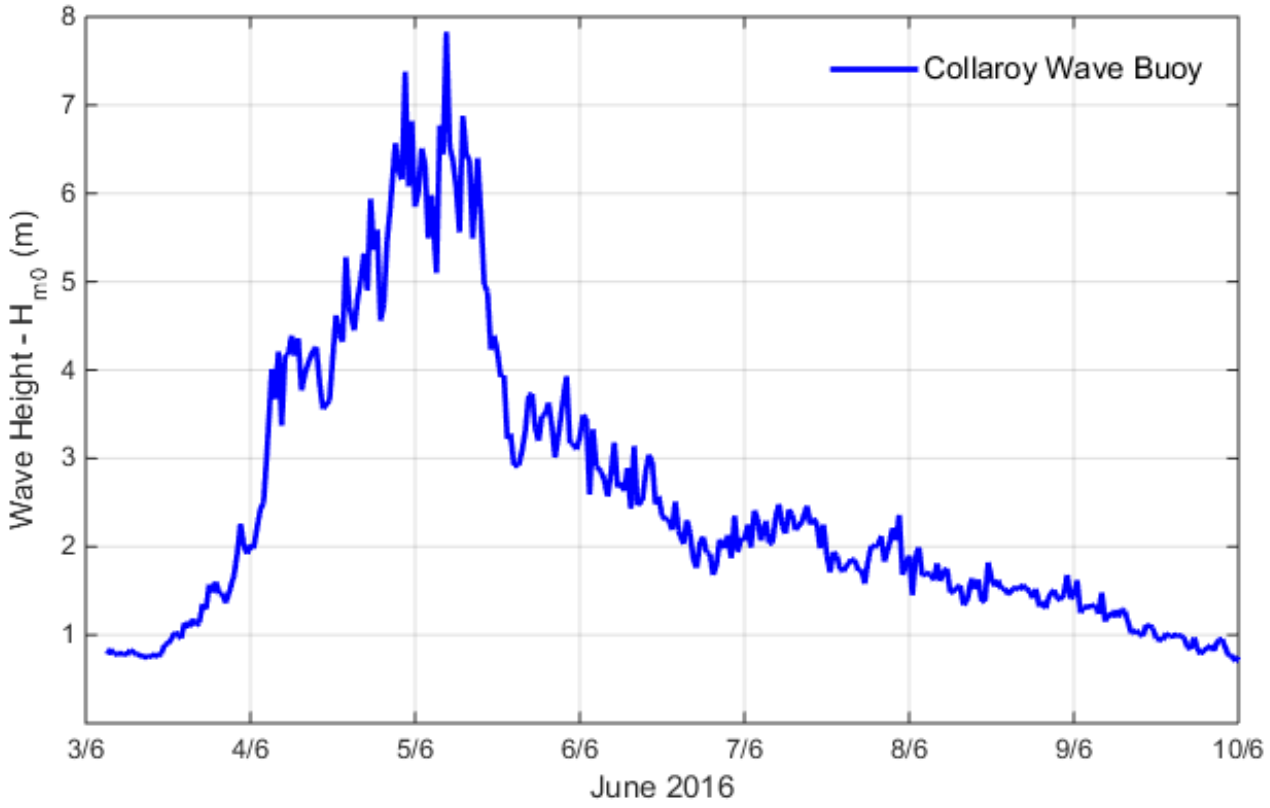
June 2016 storm wave conditions along NSW coastline





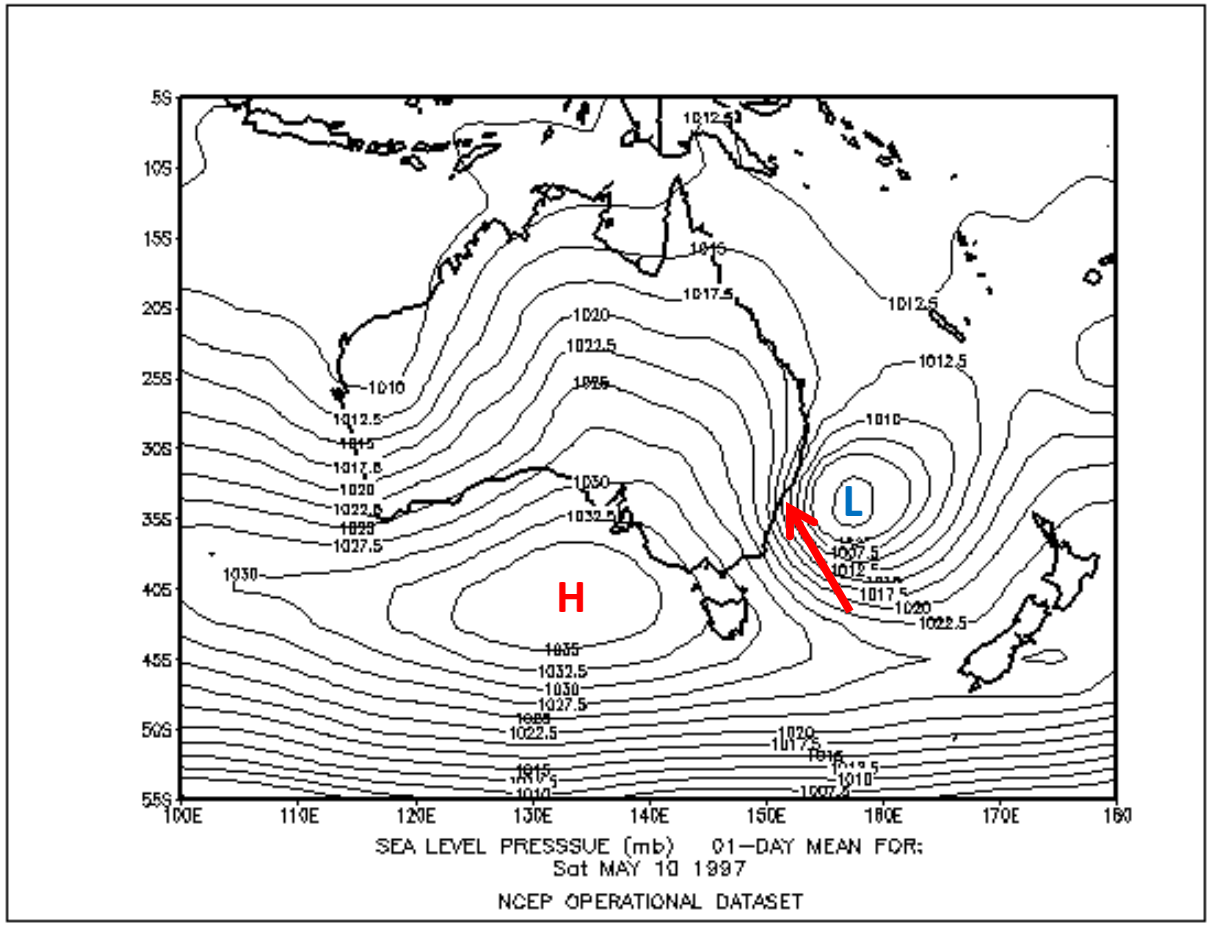


June 2016 storm wave conditions near shore at Collaroy Beach

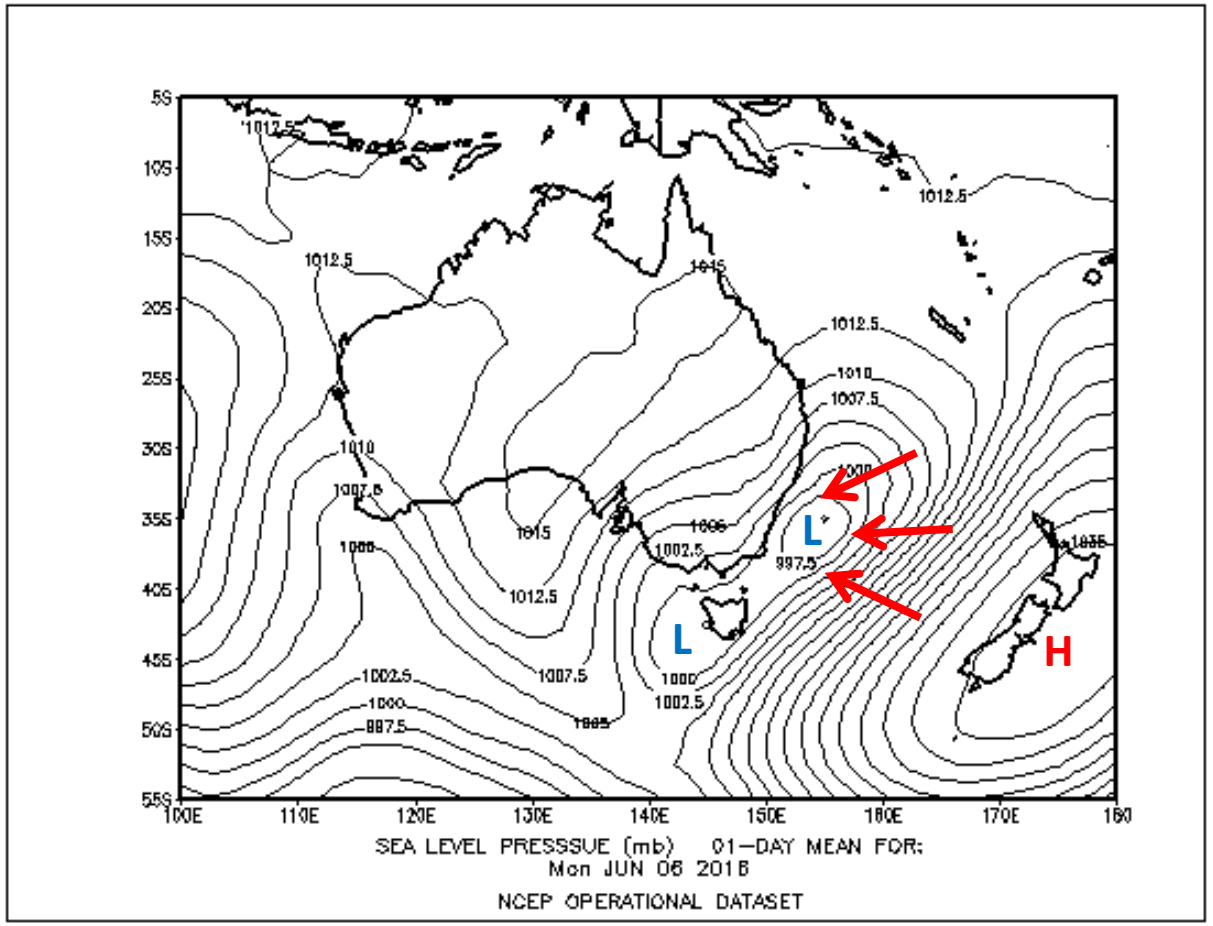


June 2016 storm an unusual synoptic pattern for an east coast storm

May 1997

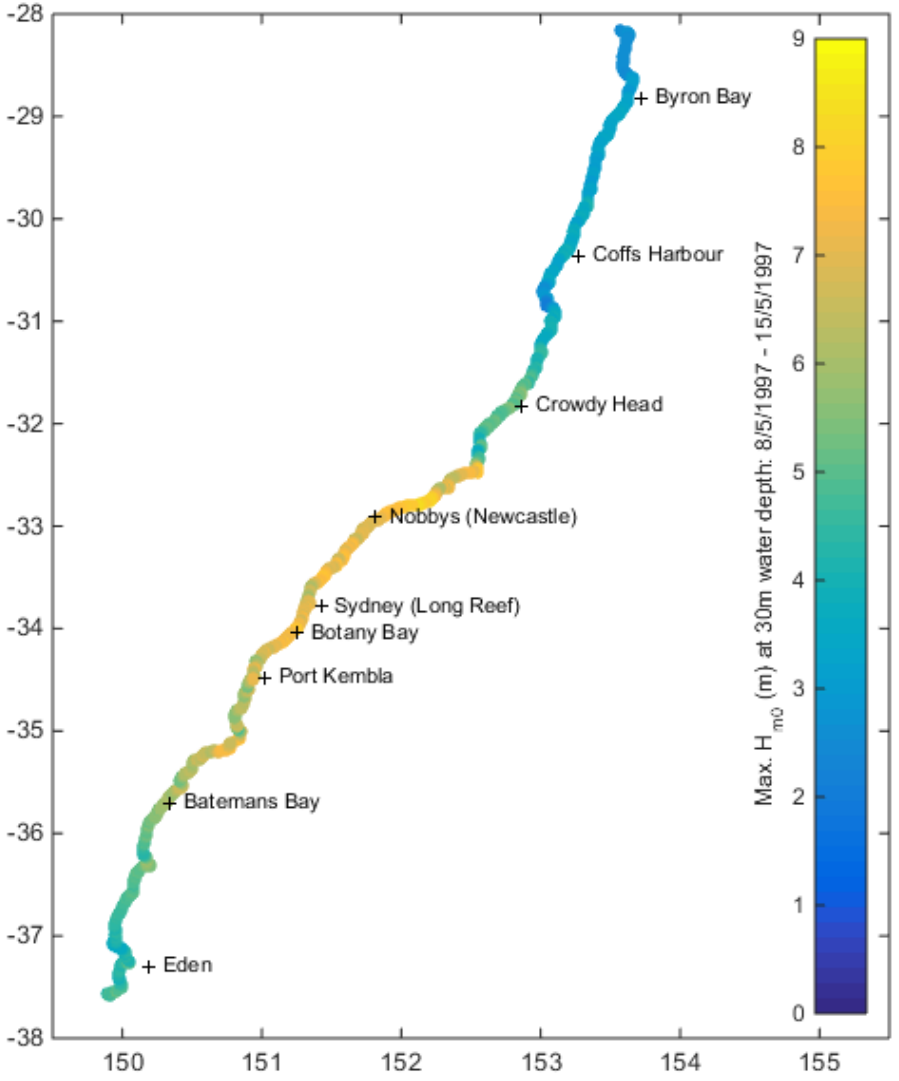


June 2016

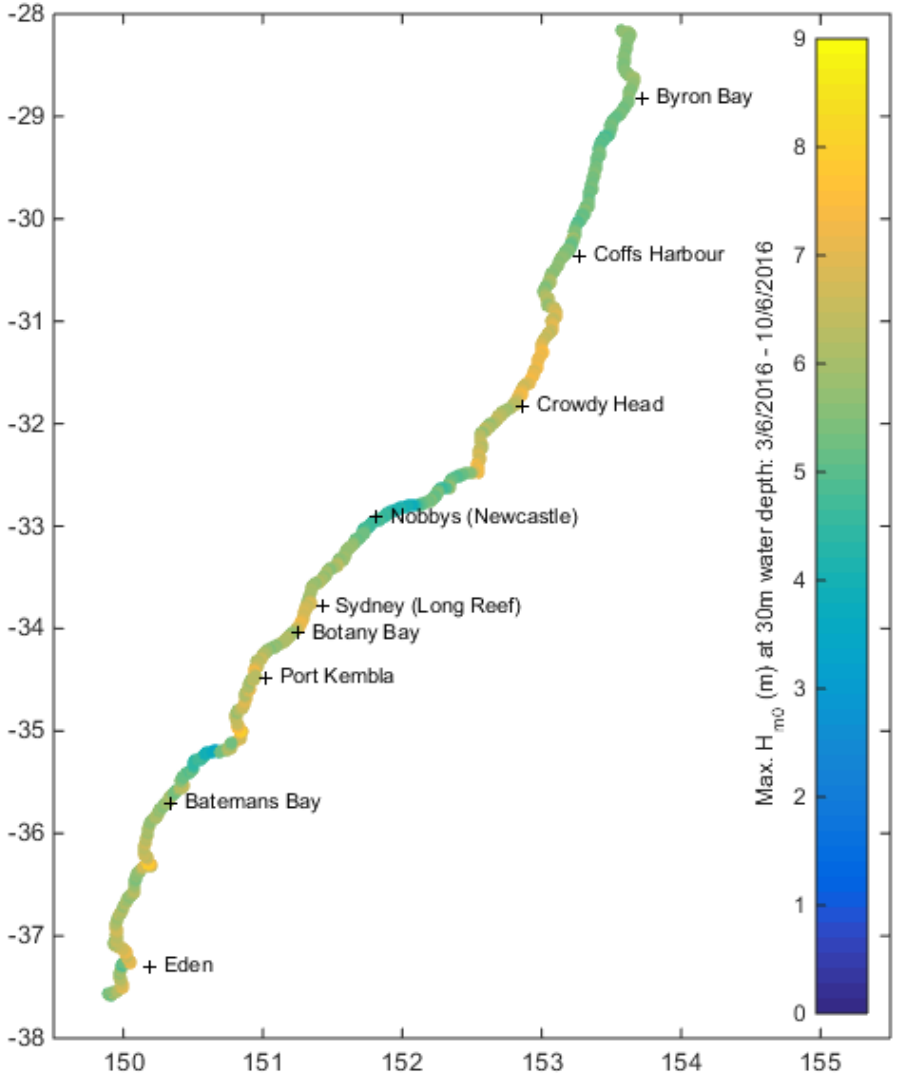


Comparison of peak storm wave height (H_{m0}) between storms

May 1997

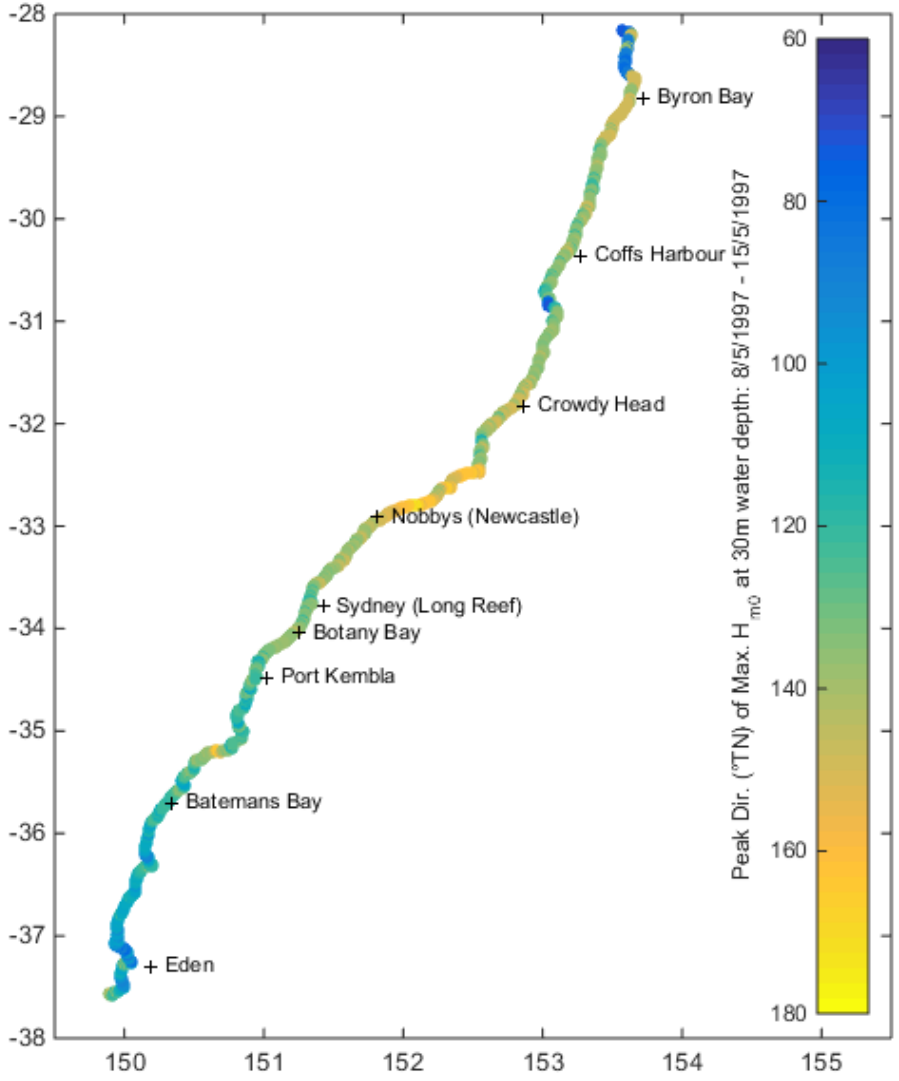


June 2016

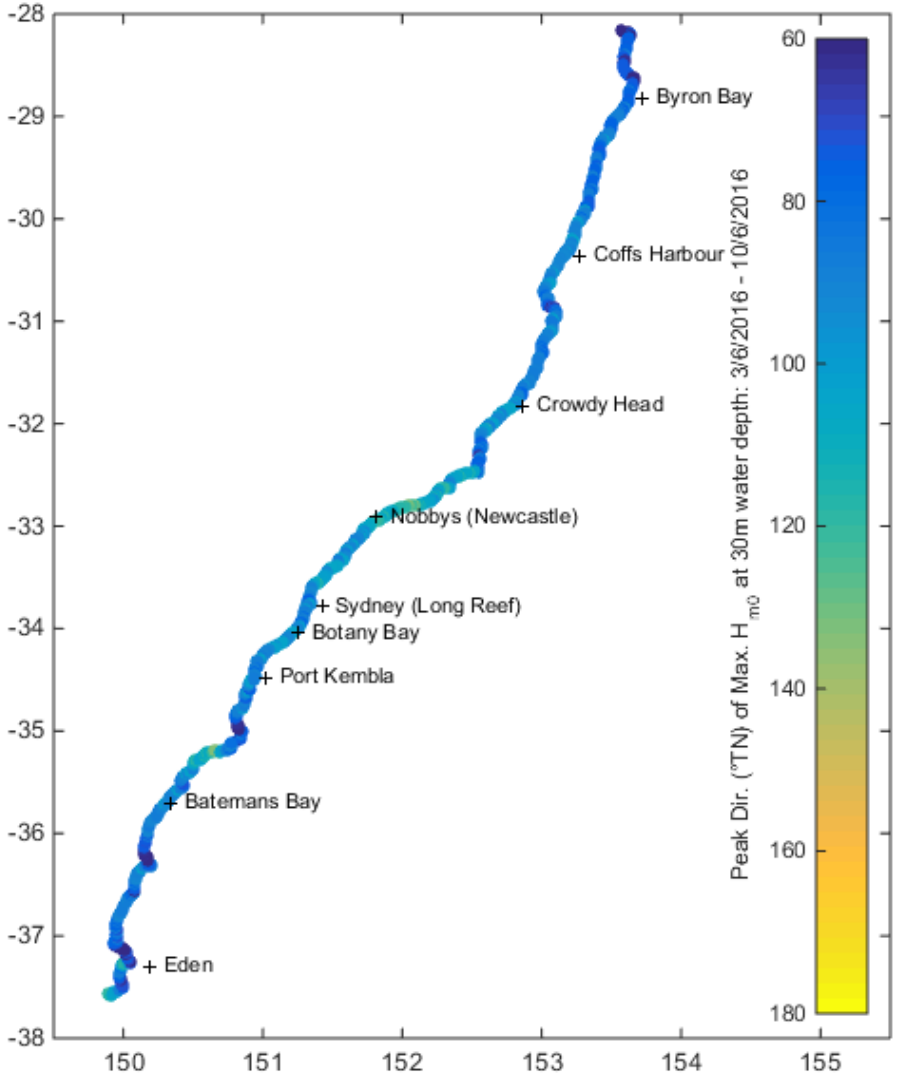


Comparison of wave direction during peak storm wave height

May 1997

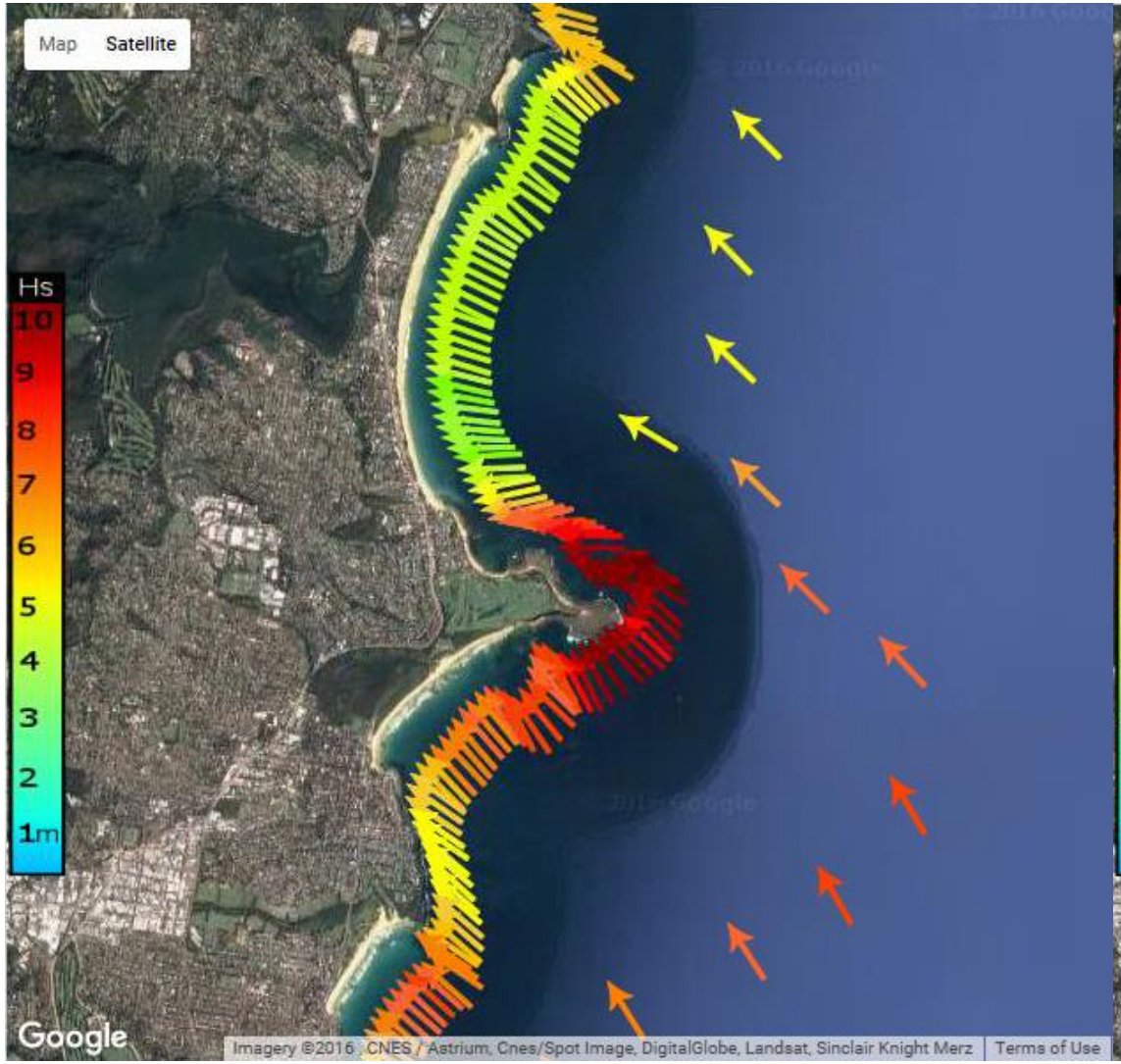


June 2016

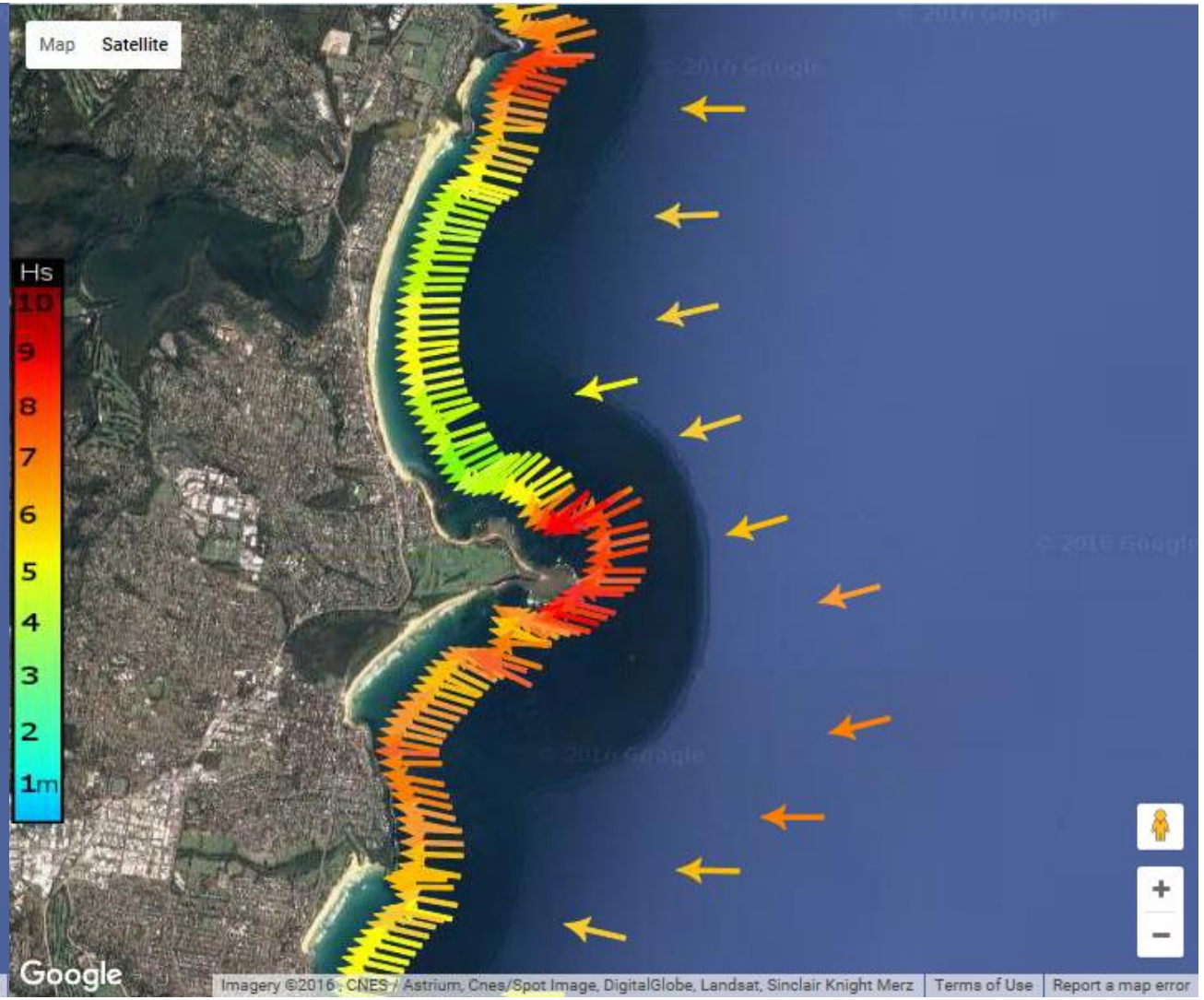


Comparison of wave height and direction at the coast

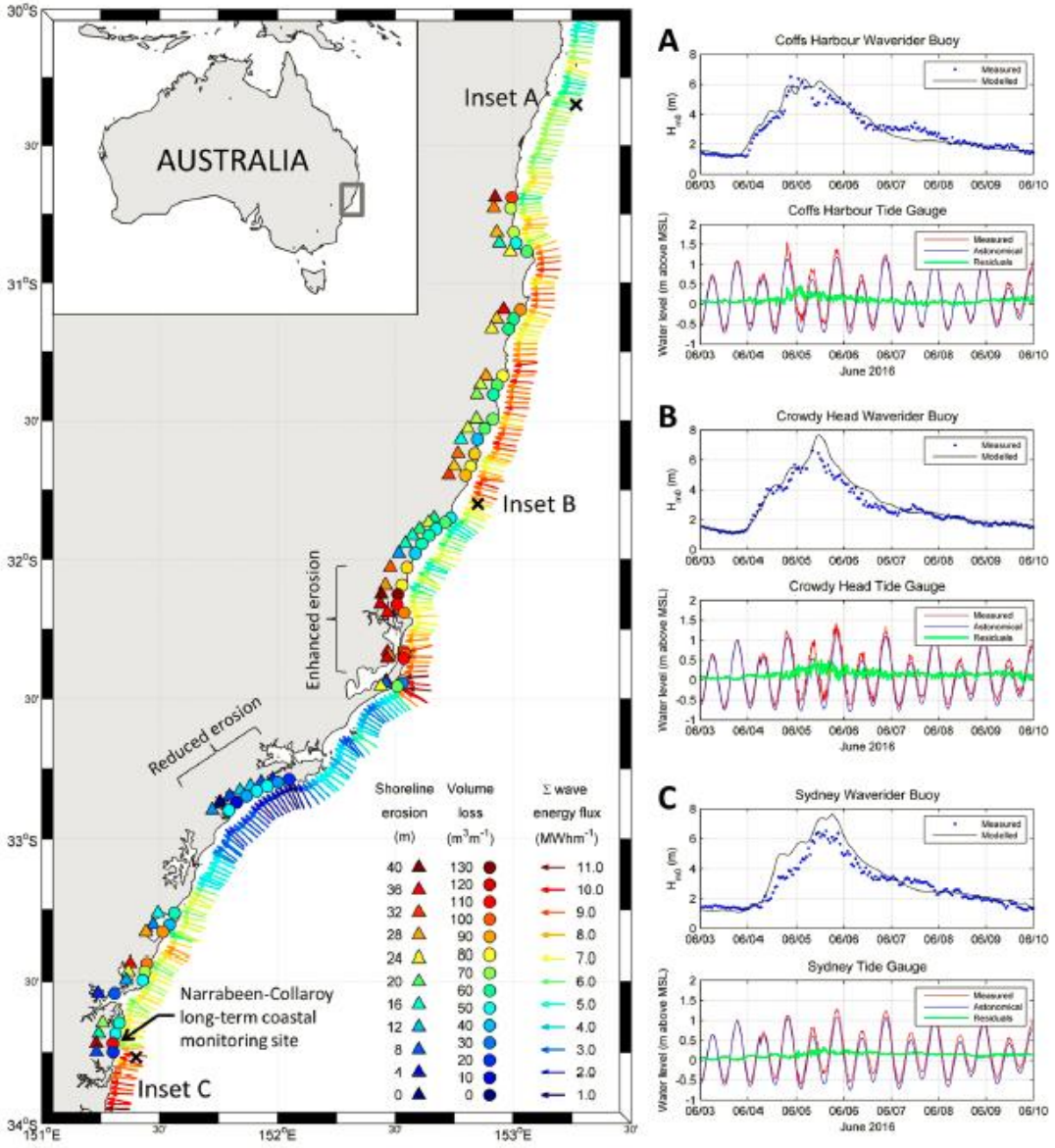
May 1997



June 2016



June 2016 storm – analysis of impacts and drivers of severe erosion



www.nature.com/scientificreports

SCIENTIFIC REPORTS

OPEN

Extreme coastal erosion enhanced by anomalous extratropical storm wave direction

Received: 23 January 2017
Accepted: 5 June 2017
Published online: 20 July 2017

Mitchell D. Harley[1], Ian L. Turner[1], Michael A. Kinsela[2], Jason H. Middleton[3], Peter J. Mumford[3], Kristen D. Splinter[1], Matthew S. Phillips[1], Joshua A. Simmons[1], David J. Hanslow[2] & Andrew D. Short[4]

- Compared observed erosion measured by pre/post-storm airborne LiDAR with nearshore wave energy flux and wave direction along the coast
- Easterly wave direction = higher wave energy in protected southern corners

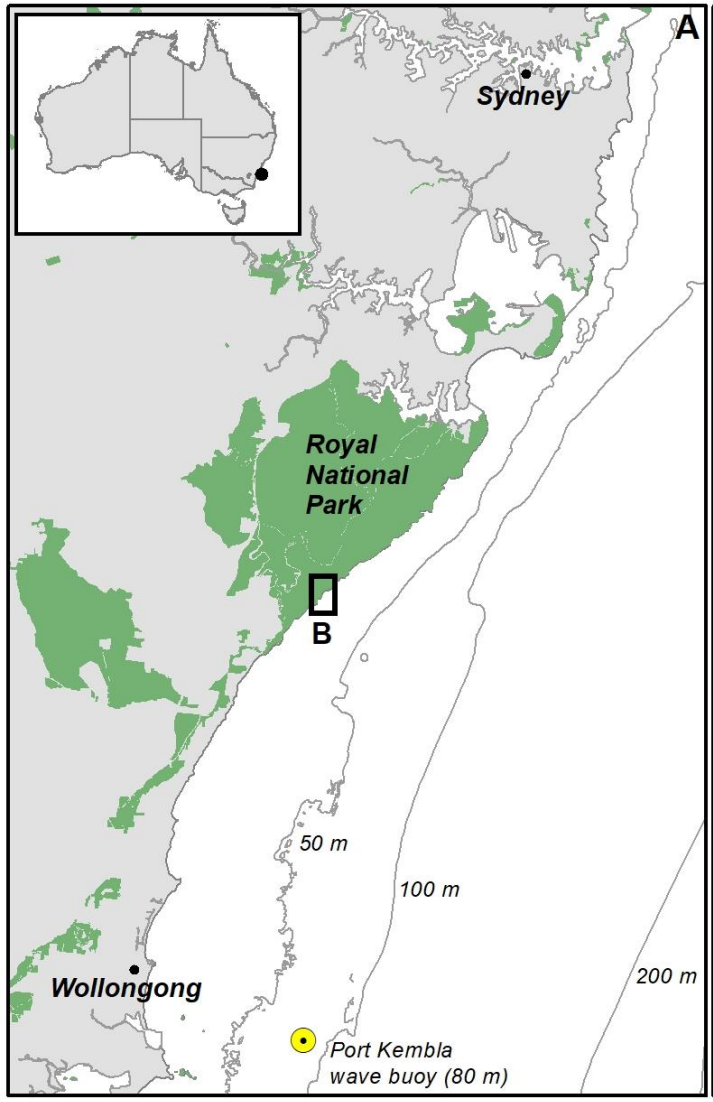
Figure Eight Pools wave risk forecast tool

Operational wave hazard forecast enabling safer visitation at a social media blackspot

Where’s Wallis? Risking Life and Limb at the Figure 8 Pools, Royal National Park, Sydney [Caitlin Wallis Blog]


NSW
Office of Environment & Heritage
NATIONAL PARKS & WILDLIFE SERVICE
N·S·W
THE UNIVERSITY OF NEWCASTLE
AUSTRALIA

A remote and dangerous setting in Royal National Park, Sydney



Comparison of measured nearshore and offshore wave climates

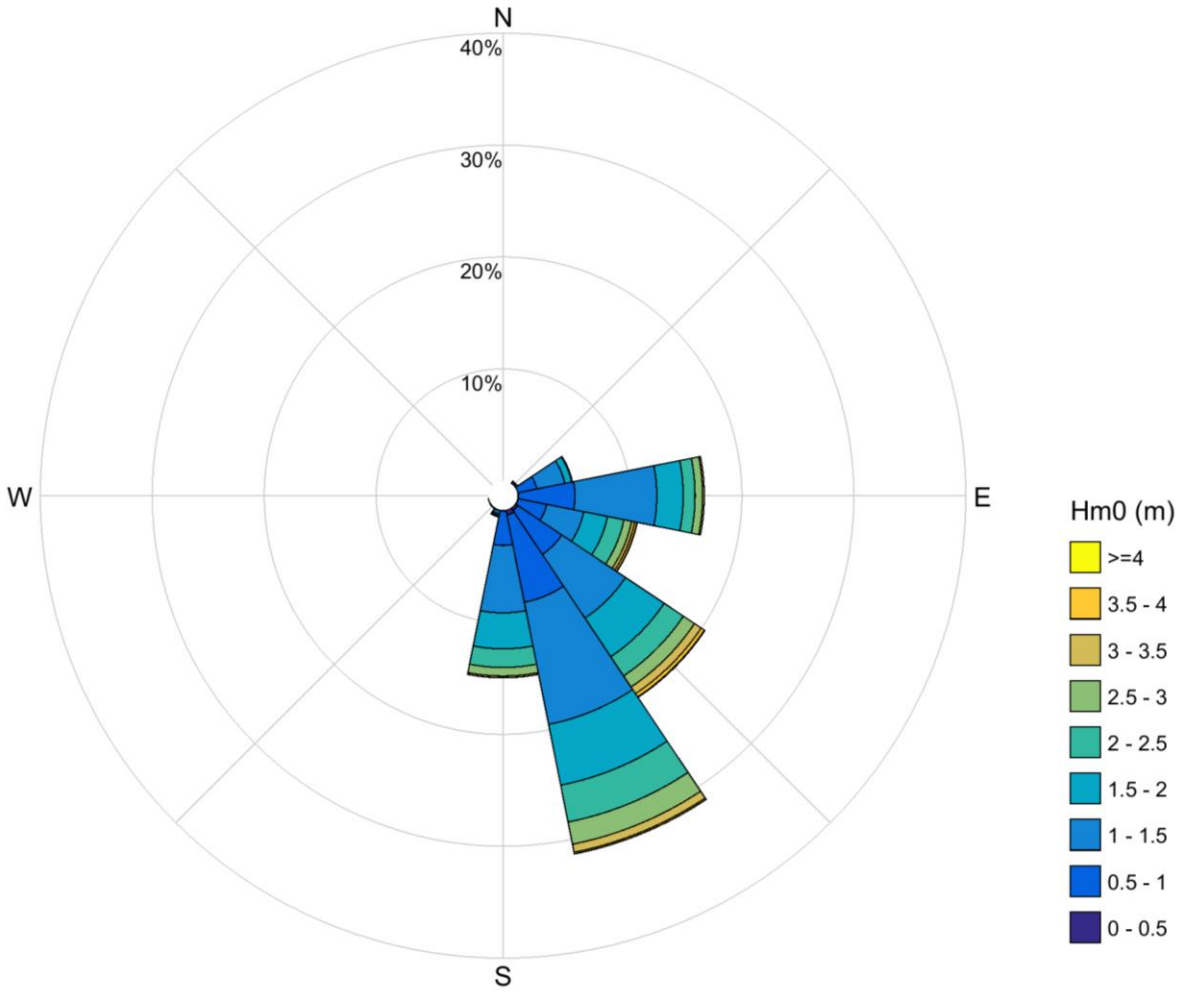
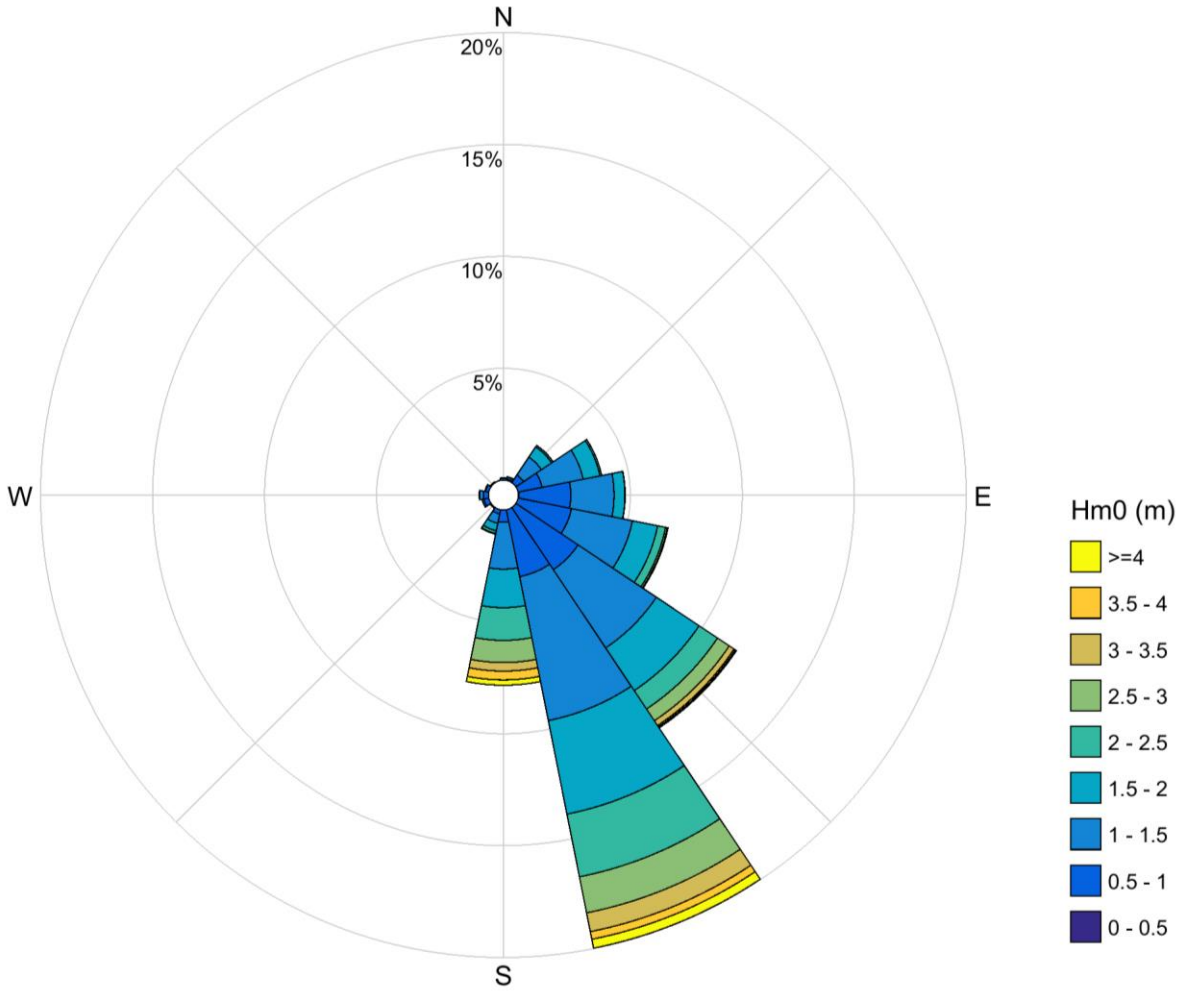
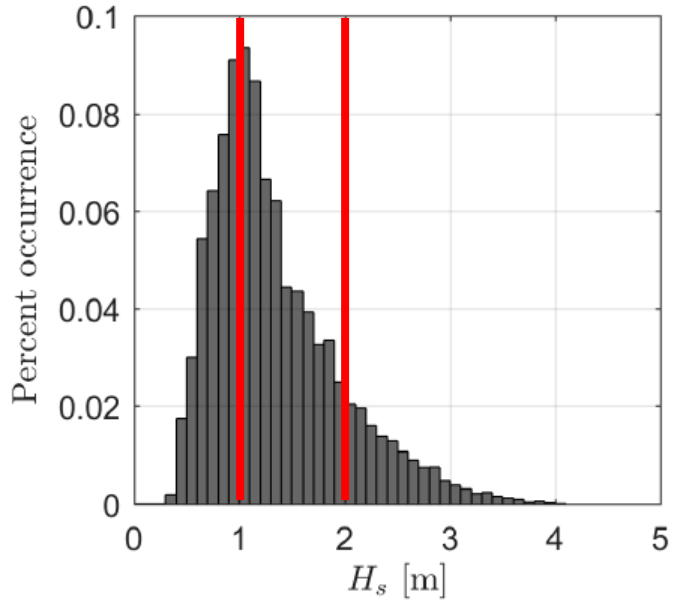


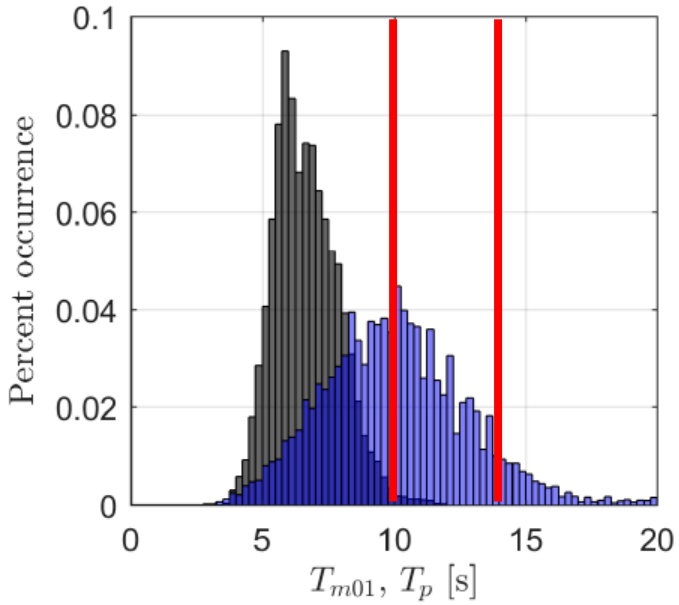
Figure Eight (30 m water)



Port Kembla (80 m water)

Transition to hazardous conditions occurs over modal wave conditions





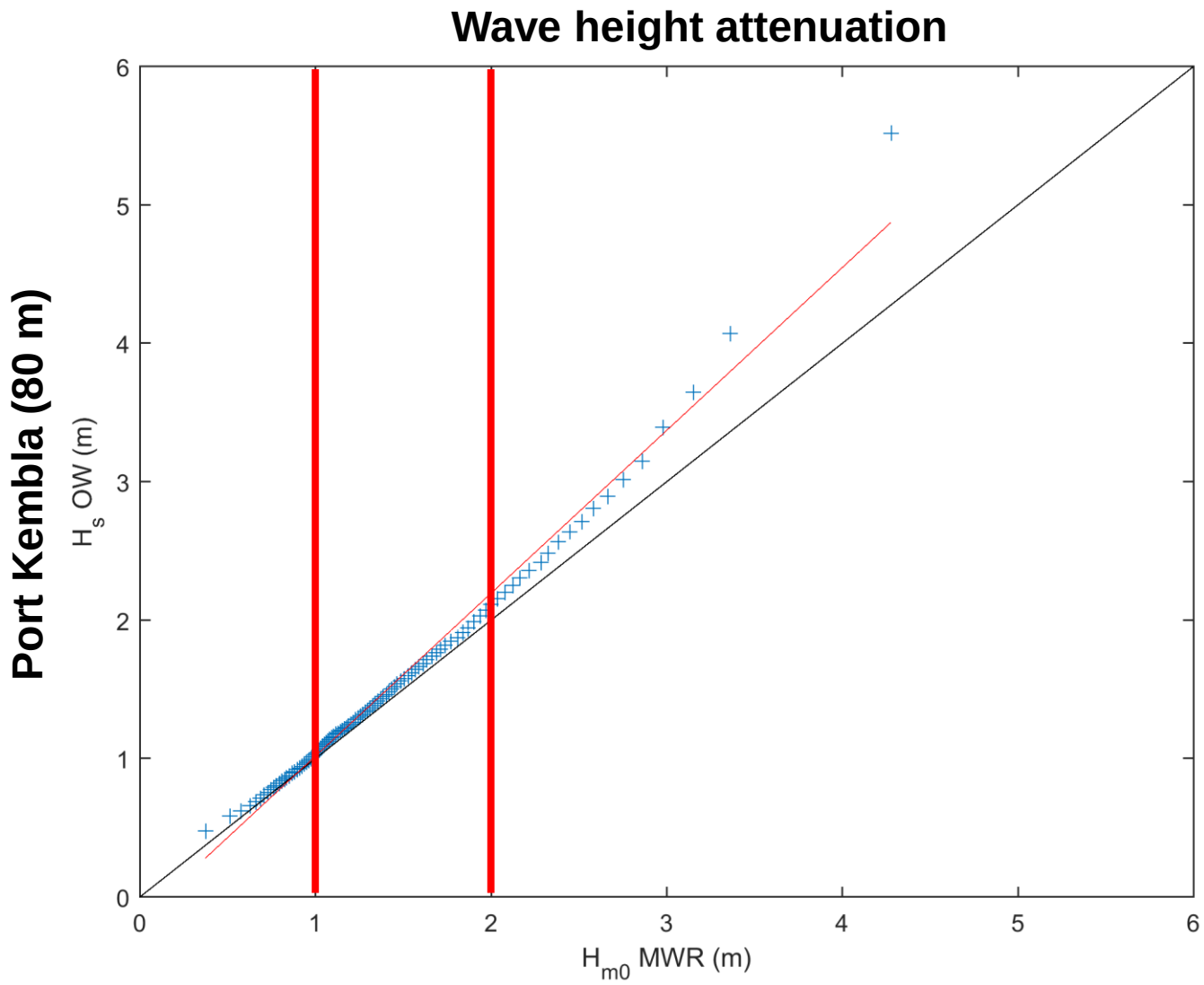


Figure Eight (30 m)

Wave Risk Forecast Tool ➡ visit our poster (PP27) to find out how!

DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT | Environment, Energy & Science Group | Coastal & Marine Science Team

NSW Nearshore Waves Program

Dr Mike Kinsela, Senior Scientist (Coastal & Marine) | michael.kinsela@environment.nsw.gov.au

Australian Ocean Data Network

environment.nsw.gov.au/research/ocean-and-coastal-waves.htm