Forum for Operational Oceanography

Surface Waves Working Group Updates

Dr Salman Khan (chair on behalf of WG)

FOO SWWG aims to advise on:

- Wind-wave research and infrastructure priorities to support operational oceanography in Australia
- Potential improvements to Australia's capability, particularly in response to emerging fields in the area
- liaise with the broader community through presentations and interaction at meetings, workshops, and conferences

SWWG Membership (recent participation)

INDUSTRY

Craig Longmuir (Regional Harbour Master, Mackay)
Jonathan Barrat (Celcius Pro)
Damon Knight (Dalrymple Bay Coal Terminal)

GOVERNMENT

Stefan Zieger (BoM)
Nick Naderi (Qld Govt)
Matthew Bell (Defence)
Tom Doyle (NSW DPE)
Mark Kulmar/Galen Lewis/Matthew Phillips (MHL)
Daryl Metters/Gary Hart/Mark Schier/Nick Naderi/Paul Boswood (Qld DES)
Hugo Bastos de Oliveira (SARDI)
Darshani Thotagamuwage/Lei Tian/Reena Lowry / Tony Lamberto(WA DoT)
Richard King (PPA)

SERVICE PROVIDER

Greg Williams (Co-Chair, RPS)
Andrew Bradford (Baird)
Alex Zadnick (Metraweather),
Burak Uslu/Carsten Hoffman/Peter Obrien (OMC)
Henrique Rapizo/Stine Soresen/Alexis Berthot (Metocean Solutions)
Ruth Patterson (Elysium/USVs)

R&D

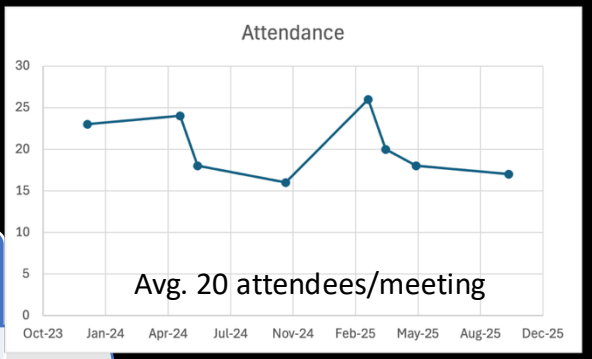
Salman Khan (Co-Chair, CSIRO)
Richard Saunders (Secretary, IMOS)
Mark Hemer (CSIRO)
Ryan Lowe/Jeff Hansen/Mike Cuttler (UWA)
Benedicte Pasquer ; Mark Rehbein (AODN)
Mitch Harley (UNSW)
Ron Hoeke (CSIRO)
Graziela Miot da Silva (Flinders)
Bozena Wojtasiewicz; Hemerson Tonin (AIMS)
Mike Kinsela (Newcastle Uni)
Alex Babanin (Melb Uni)

Seeking stronger Industry, Service Provider & Defence representation!

Highlights since last FOO
(Since Nov 2023)

- Coordinated input to the NMSP WPs (2025-35) – including industry inputs
- Organisation of the 4th Australia New Zealand Wind-Waves Symposium (17-18 Nov)
  - Revisit research priorities of 2017/18 via survey
- 8x Quarterly meetings
- 10 talks on a range of topics

Meetings since last FOO (Nov 2023)



Dec 2023

- 23 attendees
  - In-situ wave dataflow workshop + wave glossary
  - Value from industry-research partnership
  - Operational value from NRT buoy data

May 2024

- 24 attendees
  - IMOS CWB facility update
  - HF radar
  - Drifting buoys
  - NT buoy coverage
  - Met data for port operations
  - Collaborative AI for spotter data analysis

June 2024

- 18 attendees
- IMOS SRS Surface Waves sub-facility update
- EBS and diverse data
- NT lack of data and potential model biases
- Quiescent period in random seas for marine operations

Oct 2024

- 16 attendees
- QA/QC of displacement data & documentation
- Need for Aus offshore wave measurements and drifting deployments
- SOFS wave data value
- GTS and assimilation

Mar 2025

- 26 attendees
- NMSP 2025-35 overview
- Australia's changing oceans: Building knowledge for actionable outcomes
- Data through to information
- Urban and Coastal Development, Infr & Serv
- FOO + ANZWWS planning

Apr 2025

- 20 attendees
- NMSP WP updates by contributing members
- New data person in IMOS CWB facility
- ANZWWS planning, website, abstracts
- Planned on IMOS Live; auswaves.org; glossary of waves terms
- Qld buoy data issue on AODN identified and resolved

May 2025

- 18 attendees
- Updates and key recommendations from NMSP WPs
- Research Infrastructure
  - Offshore wave buoys; SRS; USVs
- Data through to info
- Urban and Coastal
- Australia's changing oceans

Oct 2025

- 17 attendees
- FOO and ANZWWS last call; abstracts
- Revisit wind-waves priorities survey
- SWWG update
- Perspectives from Santander waves 2025
- WIS2.0
- IMOS Live
- Focus of WG in 2026?

Discussions since last FOO (Nov 2023)

- Value of near real time wave buoy observations for marine operations
  - Event based sampling
  - GTS/WIS2.0 and data assimilation
  - Integration into IMOS Live
  - NRT visuals from new auswaves.org (IMOS CWB facility)
  - Integrated information from IMOS *OceanCurrent* national wave maps
- QA/QC of wave buoy displacement data
  - Review of IMOS CWB QA/QC documentation
- Qld buoys data issue on AODN identified and under investigation
- Australian HF radar waves

Discussions since last FOO (Nov 2023)

- Australian offshore wave measurements
  - Fixed sites pros and cons
  - Drifting buoys pros and cons
  - SOFS wave measurements
  - Satellite Remotely Sensed wave observations (Altimeters; SARs; CFOSat; SWOT…)
  - USVs
- Lack of wave buoy observations
  - NT identified as data scarce -> potential model biases
  - New NT sites via IMOS CWB facility
  - Unexploited met-ocean data collected during port operations
- Survey topics for the FOO SWWG for next 12 months

Surveyed – value derived in the last year

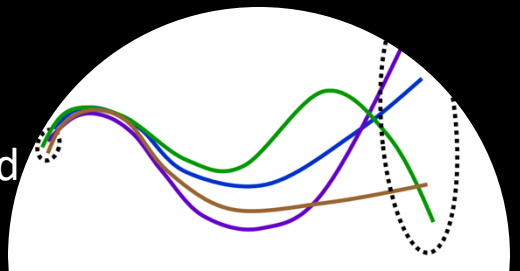
Industry–Academia Link
Provided insight into industry challenges and academic research developments.

Access to Cutting-Edge Knowledge
Enabled members to follow the latest research and advancements in wave forecasting.

Information Sharing and Input
Offered updates and opportunities for input on initiatives like CoastRI and IMOS coastal wave monitoring.

National Coordination
Served as a forum to stay informed about national activities related to waves, share information, and gather feedback.

Community Engagement
Facilitated communication across a diverse national wave science and operations community.



Technical Understanding
Improved knowledge of AODN network, nearshore wave transformation, and operational wave forecasting.

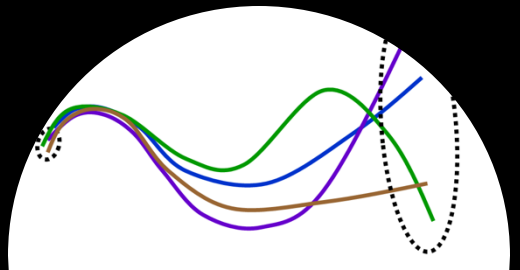
Surveyed - topics for WG next year

Enhanced Wave Visualization
Develop high-resolution, animated wave maps using best available data in an interactive format (similar to Windy), particularly beneficial for offshore port operations sensitive to waves and ground swell.

Emerging Observation Technologies
• Explore new surface wave monitoring methods such as drones, HF radar, and video imagery.
• Assess the role of cutting-edge observations (wave buoys, remote sensing like X-band radar and SRS, USVs) in operational oceanography.

AI/ML Applications
• Apply AI/ML for short-term wave prediction and anomaly detection.
• Investigate progress and future prospects of AI/ML in wave modeling.

Wave Measurement Accuracy
• Improve accuracy of wave buoys deployed in close proximity.
• Standardize and disseminate in-situ coastal wave monitoring and observation practices.

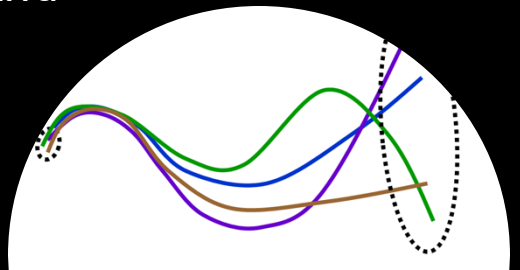


Surveyed - topics for WG next 12 months

Spectral Wave Analysis
• Compare spectral wave energy processing techniques and their applications.
• Include spectral wave forecasting in nearshore wave transformation.
• Provide spectral forecasting capabilities within AODN.

Forecasting Improvements
• Enhance swell arrival time and amplitude forecasting.

Industry and Research Integration
• Create opportunities for offshore industry to present emerging surface wave challenges.
• Connect wind-wave research priorities and learnings from ANZWWS and FOO to operational oceanography challenges.



Infrastructure update

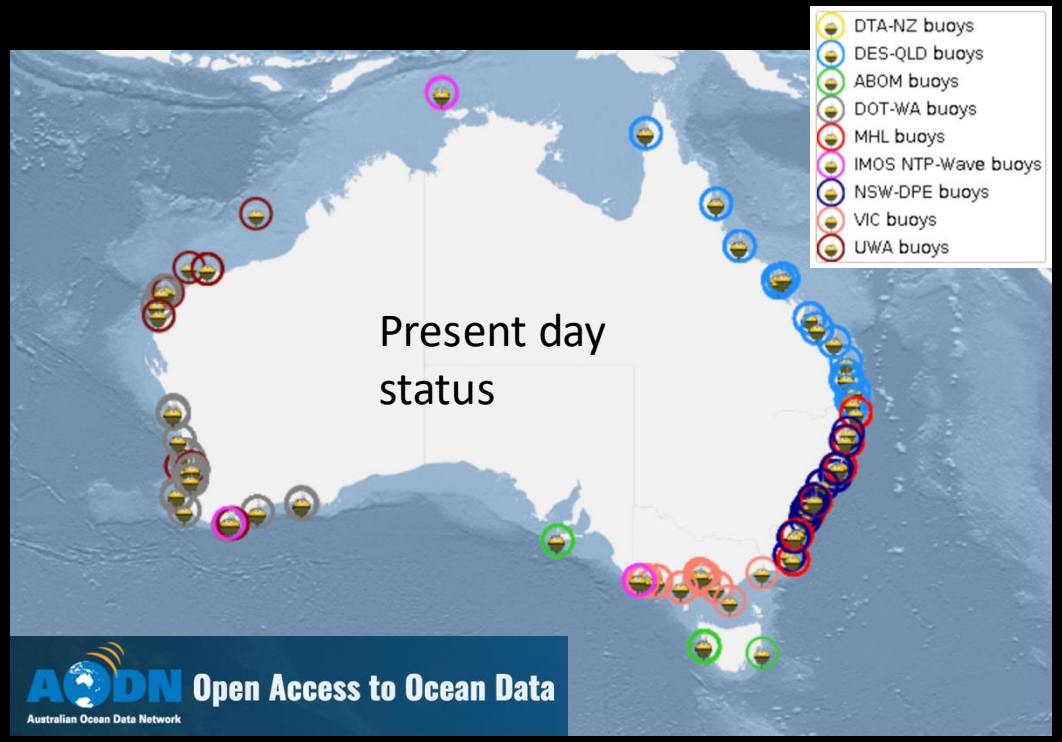
IMOS National Wave Archive (AODN)

Data captured from national custodians

- State Dept. (NSW DCCEEW + MHL, Qld DETSI, WA DoT), BoM, Pilbara Port Authority and Universities (Deakin, UWA, FlindersU) & SARDI
- Traditional waverider + Sofar spotter

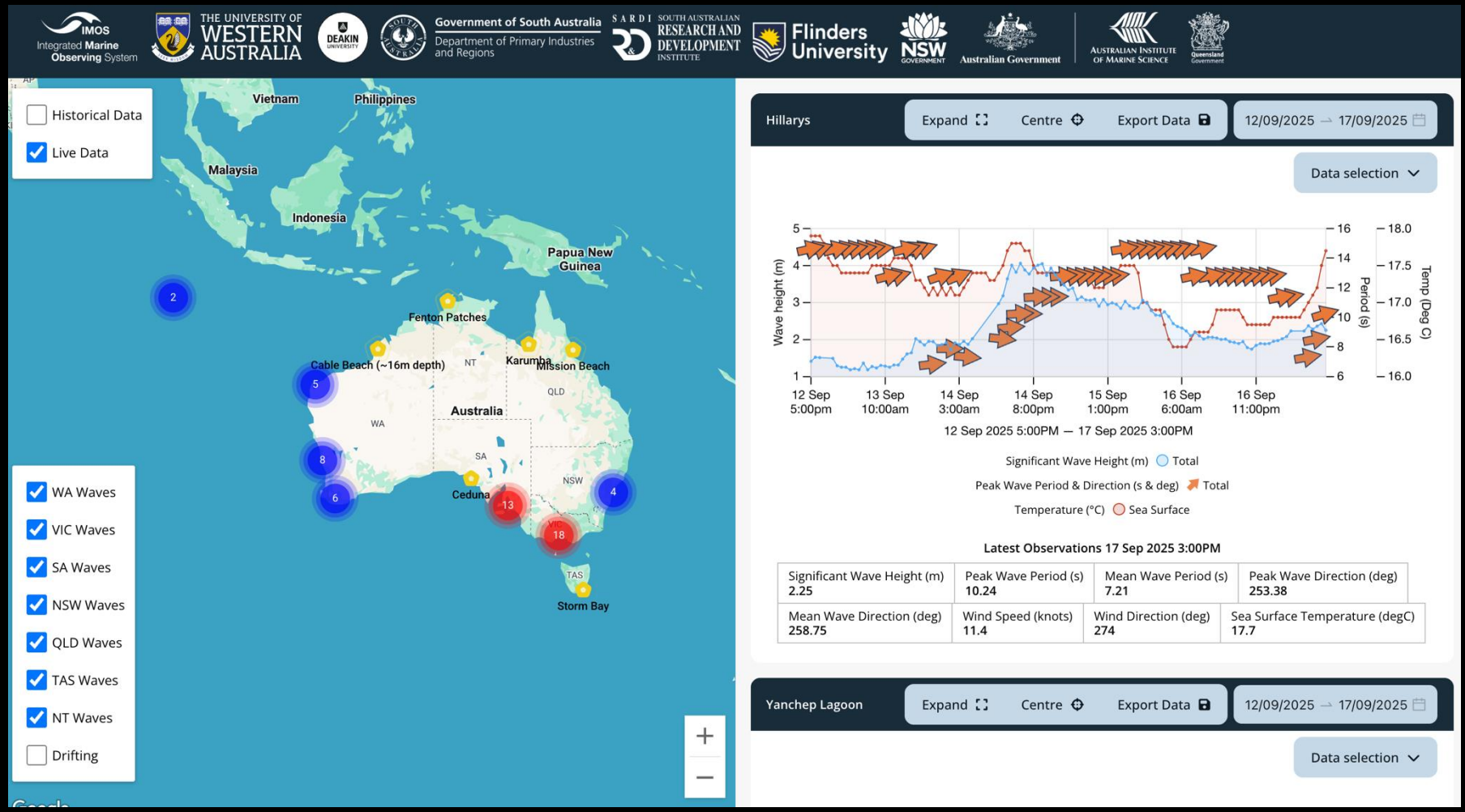
The enhanced National wave archive has

- Scalable workflows
- Documented standards and metadata
- Integral wave parameters
- Spectral data, Raw displacements (DM only)



Infrastructure update

auswaves.org (IMOS CWB facility)



Infrastructure update

IMOS SRS Waves sub-facility

CSIRO lead; Uni Melbourne partner

About

- National capability of long-term (~4+ decades) collection of satellite wave (and wind) observations
- Available via AODN and data descriptors published
- Regularly maintained and extended in time

Value

- Australian access to vast amount of fundamental ocean data
- Support Australian scientific and industrial community
- High national and international uptake
- Feeding back efforts, best practice to international agencies
- Strengthen partnerships with international agencies
- New missions CFOSat, SWOT, …

THE UNIVERSITY OF MELBOURNE

Altimetry

Significant wave height, period, wind at 10 m

+

Scatterometry

Wind vectors at 10 m

CSIRO

SAR

Directional ocean swell systems

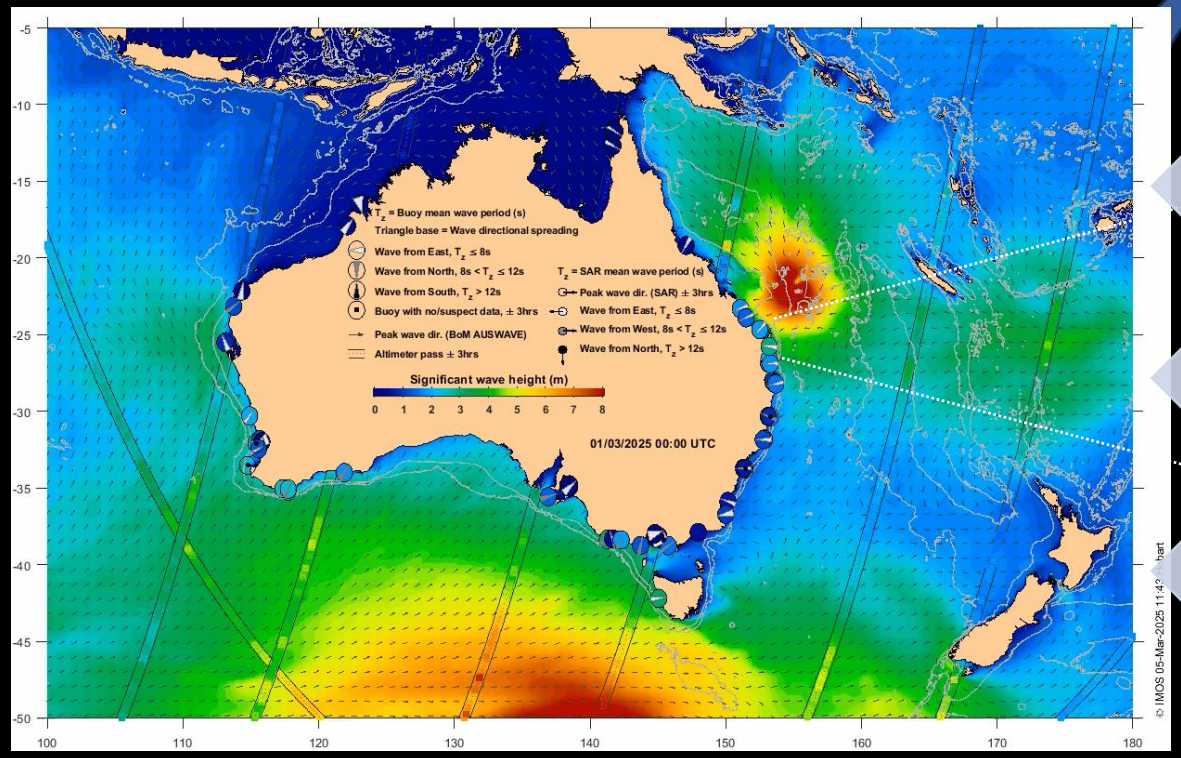
+

Coastal high-res wind vectors at 10 m

Infrastructure update

IMOS *OceanCurrent* Surface Waves

- Provide National-scale ***up to date, integrated*** observed wave information around Australia to the broader community
- Developed with WG inputs and feedback
- Leveraging enhancements in AODN national wave archive



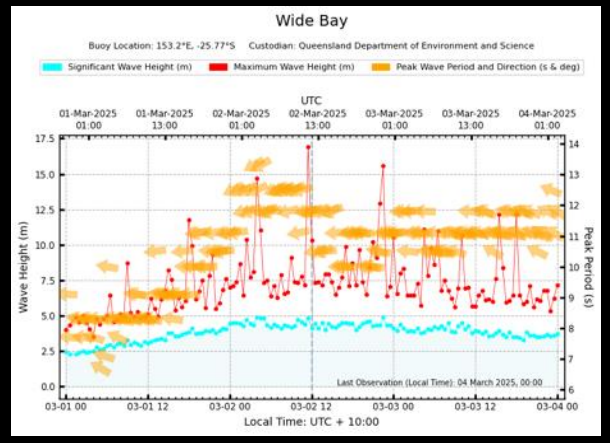
Issues reported back to AODN for improvements

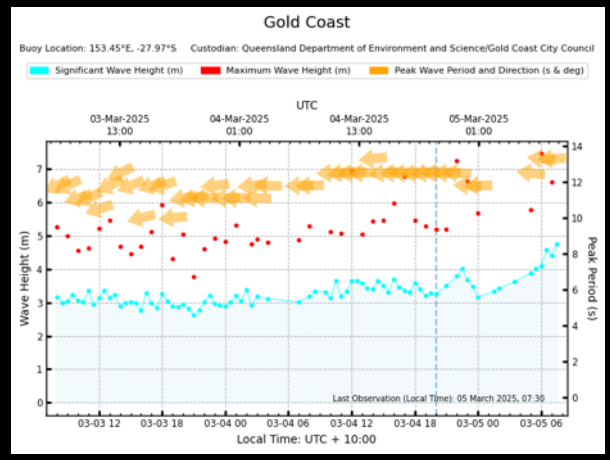
AODN → National wave buoy obs

- Altimeter
- SAR

→ Satellite wave obs

AUSWAVE-G3 regional → Background wave model





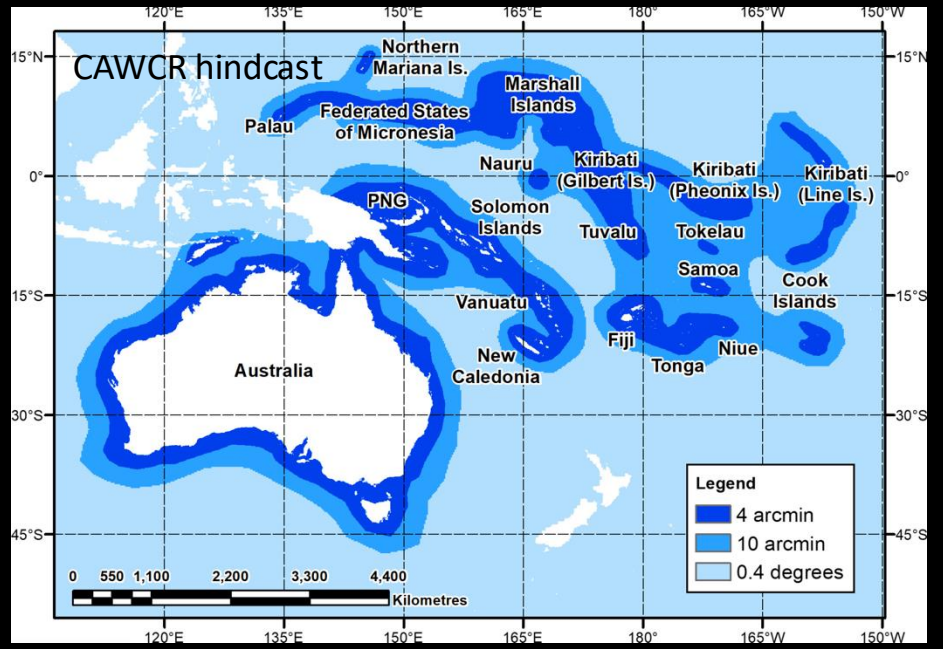
Australian Wave Model Datasets

Operational

- BoM AUSWAVE-G4 (1/16º - 1/8º; 75°S-75°N),
- NWS wave ensemble for TC season
- High-resolution forecast system around Barrow Island

Hindcasts

- CAWCR Wave Hindcast (1979-present; Durrant et al., 2014; Hemer et al., 2017; Grant et al., 2020)
- New Wave Hindcast for Australian Climate Service (WHACS) - 2025
- Coupled Coastal Hazards Prediction System (CCHaPS) : National Hindcast – 2025
  - + climate projections and prob. TC simulations
- Uni Melbourne Australian Coastal Wave Hindcast - 2025

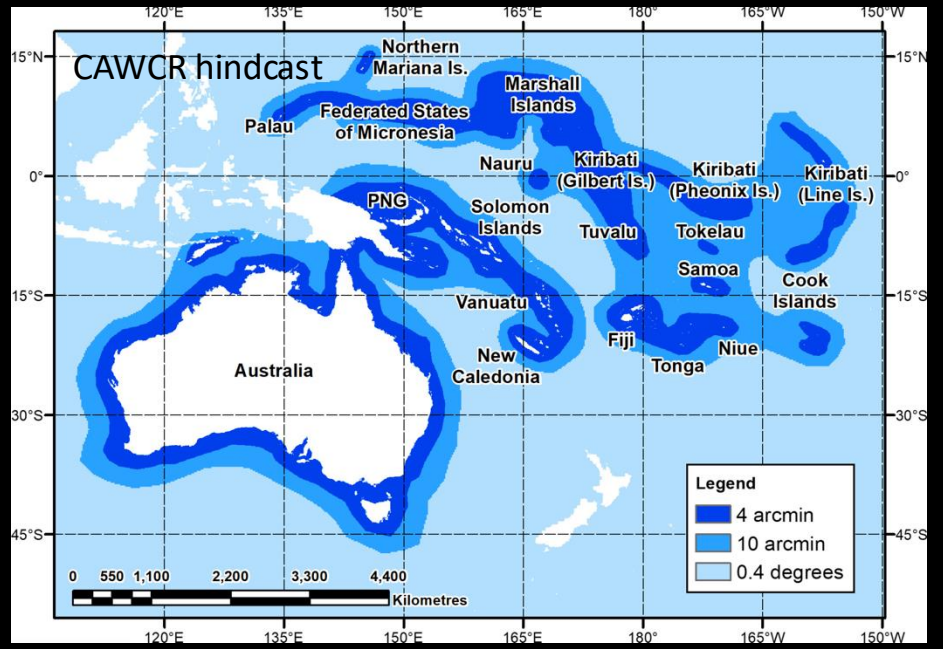


Australian Wave Model Datasets

Hindcasts

Several other regional/local hindcasts and downscaling also exist (State Govt. Departments, Unis, industry,..)

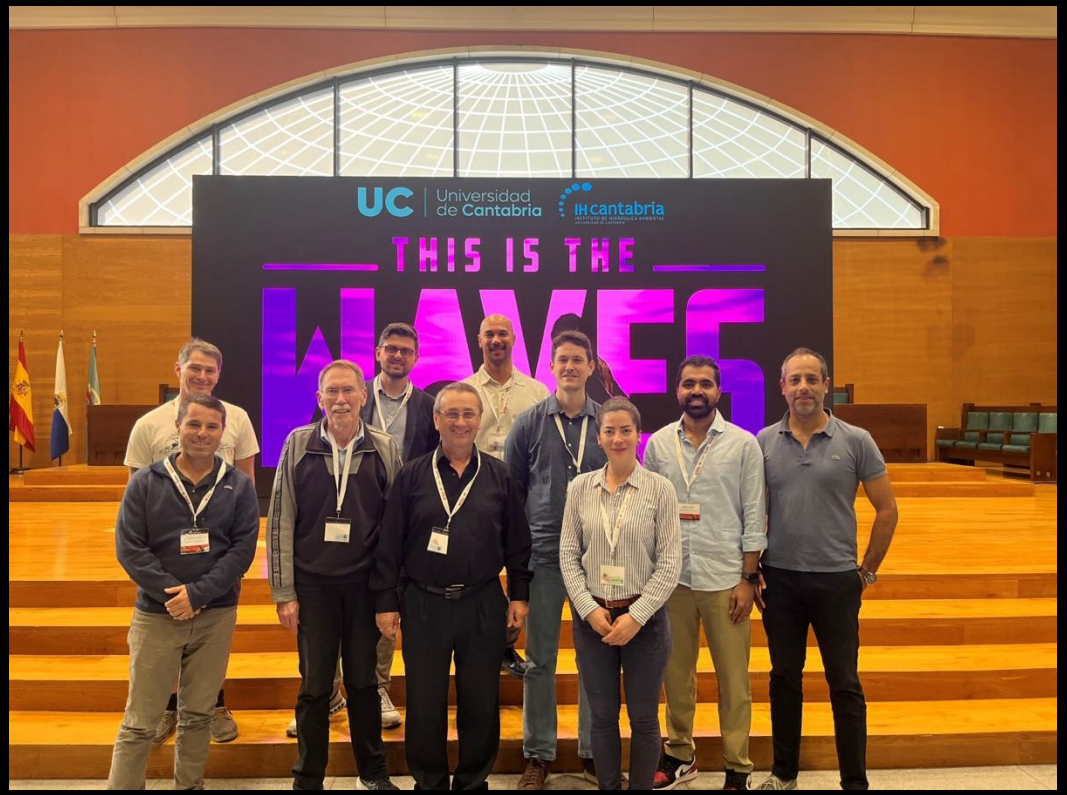
- NSW nearshore wave tool (hindcast 1950+; 10-day forecast; past storm event data)



Liaising at meetings and conferences

Strong international engagement of FOO SWWG members in international for a leading into the domestic Australia New Zealand Wind-Wave Symposium 17-18 Nov.

Santander Intl. Waves Conference



ESA Sea-State CCI User Meeting

4th Australia and New Zealand Wind Waves Symposium

17–18 November 2025

Indian Ocean Marine Research Centre

The University of Western Australia, Perth

TIDE BEYOND THE NUMBERS

IMOS Integrated Marine Observing System OFFICIAL

Baird. Innovation Engineered.

RBR rbr-global.com

Australia and New Zealand Wind Waves Symposium

- The event marks the recommencement (hopefully) of this series of conferences with the last held in 2017 in this same venue.
- This year formally extended to include New Zealand

2010

2013

2017


74 registrations for this event – the largest so far!
INDIAN
CSIRO
17th November 2025

Program Summary

- Wave climate & projections
- Tropical cyclones & extremes
- Wave transformation, coastal processes, infragravity waves
- Wave observations, remote sensing, forecasting, swell propagation
- Wave modelling and data assimilation
- Coastal modelling and hazards….

- Interactive session – Australian wind-waves research priorities revisited

Program Summary

- Two student presentation awards (Charlotte Uphues, FU and Travis Dawson, UWA)
- General consensus on value of the gathering
- Intent to get together biennially
- Next one priority for East coast location

Reviewing priorities for Australian wind-waves research

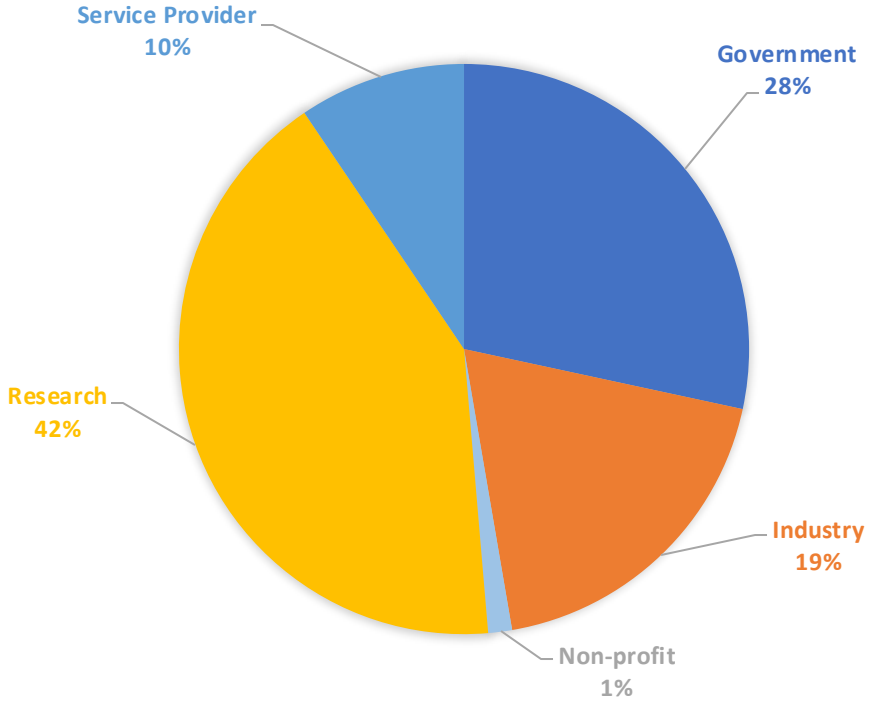
- In 2017 the Australian Forum for Operational Oceanography (FOO) Surface Waves Working Group was tasked with providing advice on national priorities for wave research
- The outcomes are described in Greenslade et al, 2020: 15 Priorities for Wind-Waves Research: An Australian Perspective. *Bull. Amer. Meteor. Soc.*, **101**, E446–E461, https://doi.org/10.1175/BAMS-D-18-0262.1.
- Need to review/revise/update
- Identify any emerging priorities
- Survey sent out on 23rd October – closing 21st November

Interim survey results

Summary of respondents

As of lunchtime 17 November: 74 respondents

Government	21
Industry	14
Non-profit	1
Research	31
Service Provider	7
Total	**74**



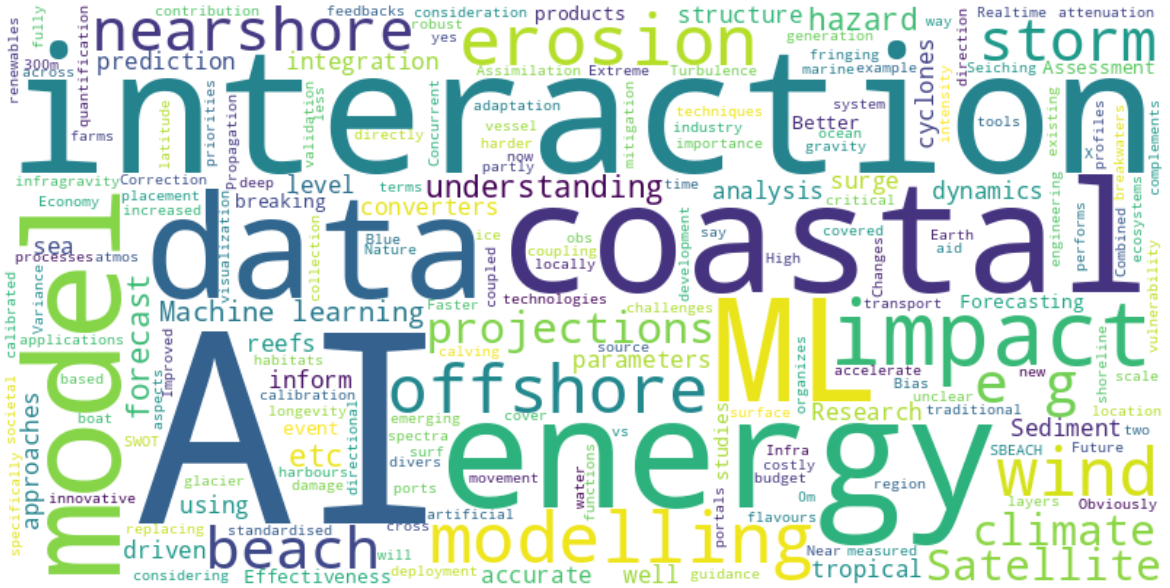
Sorted by current importance

	Priority	Current importance	Progress
13	Coastal wave impacts	8.26	5.66
1	Enhanced and updated nearshore bathymetry	8.23	6.19
3	Maintain and enhance wave buoy network	8.22	7.27
14	Improved understanding of future climate variability on coastal areas	8.20	5.76
8	Long-term beach / coastline monitoring	8.14	6.80
4	Data access and sharing	7.93	6.59
9	Nearshore modelling and forecasting	7.93	5.73
2	Extreme sea-states	7.54	6.10
11	Development of standardised QA/QC	7.51	5.63
6	Advancement of remote sensing capabilities for coastal environments	7.33	6.00
5	Ensemble wave modelling and forecasting	7.13	5.41
12	Better engagement of maritime industries with research	7.12	4.64
10	Development of wave data assimilation	6.81	6.02
15	Improved modelling of swell propagation	6.66	5.03
7	Wave-induced currents and transport	6.64	4.72

Emerging Priorities

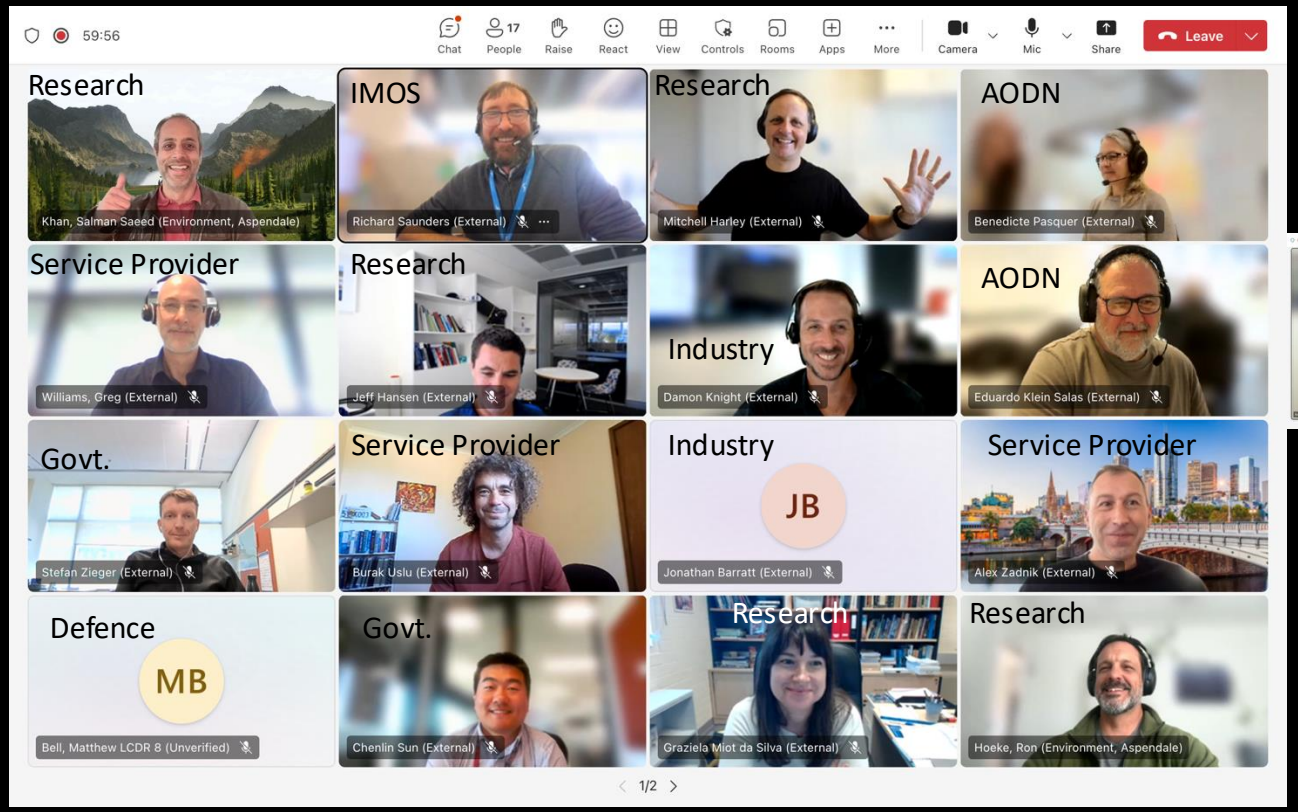
69 individual priorities

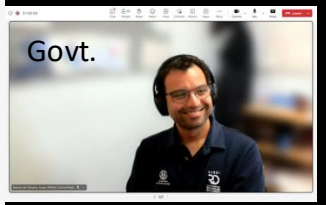
- **AI/ML**: 11 mentions
- **Coastal processes**: 7 mentions
- **Energy and renewables**: 7 mentions
- **Coastal Erosion**: 3 mentions
- **Forecasting**: 3 mentions
- **Climate projections**: 3 mentions
- **Satellite/remote sensing**: 3 mentions
- **Sediment transport**: 2 mentions



Key Messages

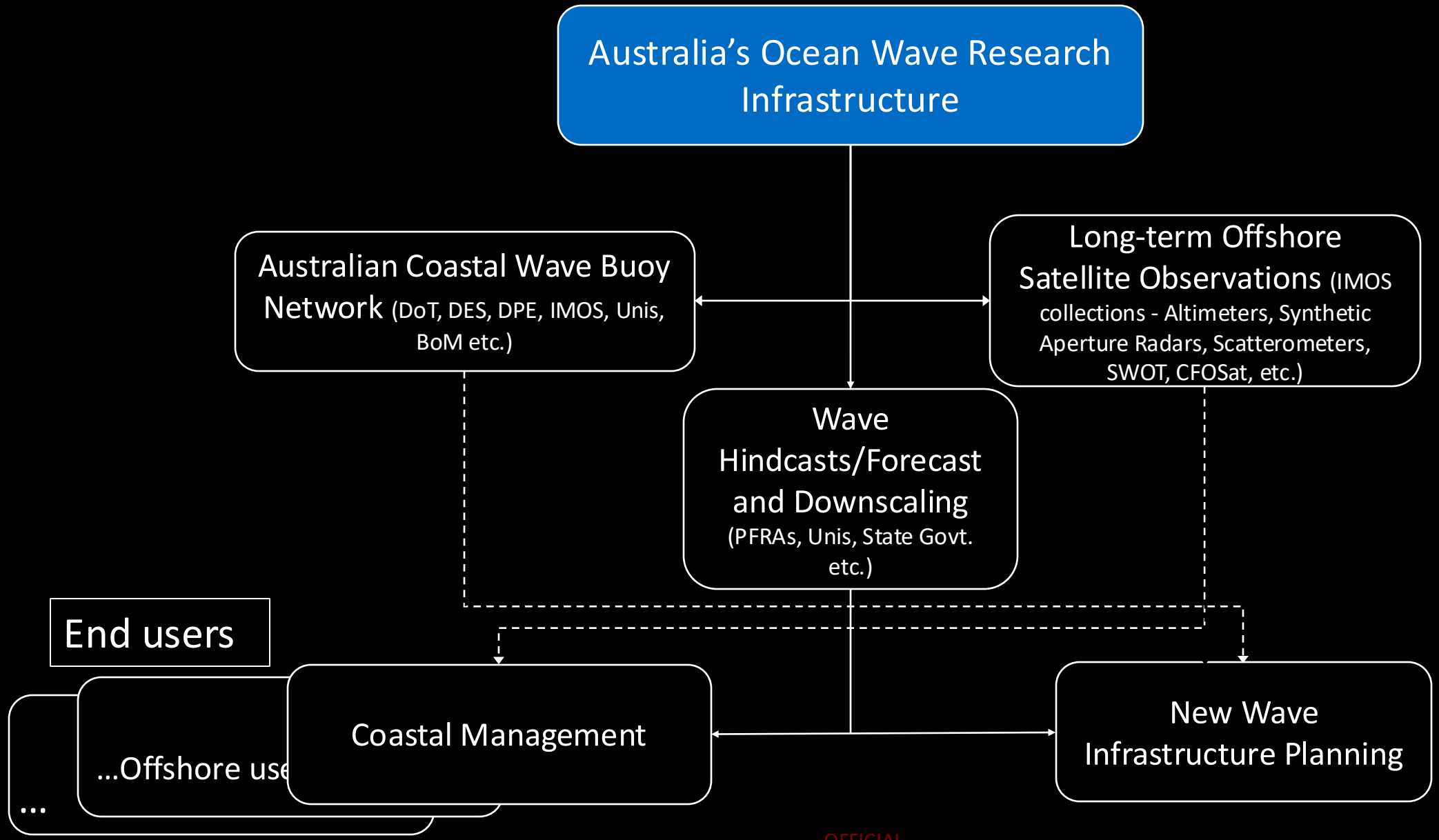
- SWWG is making key contributions to Australia's operational oceanography landscape
- Has momentum to continue to deliver
- Would benefit from greater industry and service provider representation (across multiple sectors)
- Provides a unique focal point for Australia's wave research and user communities (ANZWWS & FOO pillars)





End of Slides

Broad links between Aus Wave Infrastructure



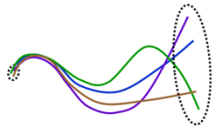
Results – Tier 1

1. Enhanced and updated nearshore and coastal bathymetry

2. Improved understanding of extreme sea-states

3. Maintain and enhance the in situ buoy network

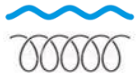
4. Improved data access and sharing



5. Ensemble and probabilistic wave modelling and forecasting

Results – Tier 2

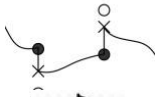
6. Advancement of remote sensing capabilities to measure wave conditions in coastal environments



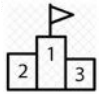
7. Improved understanding of wave-induced currents and transport

8. Long-term beach / coastline monitoring

9. Nearshore modelling and forecasting



10. Development of wave data assimilation



11. Development of a standardised data and QA/QC specification for wave observations

12. Better engagement of maritime industries with research

13. Improved understanding and prediction of coastal wave impacts

14. Improved understanding of the effect of future climate variability and change on coastal areas

15. Improved modelling of swell propagation

Interim survey results – 74 responses

Priority	Item	Current importance	Recent progress
1	Enhanced and updated nearshore bathymetry	8.23	6.19
2	Extreme sea-states	7.54	6.10
3	Maintain and enhance wave buoy network	8.22	7.27
4	Data access and sharing	7.93	6.59
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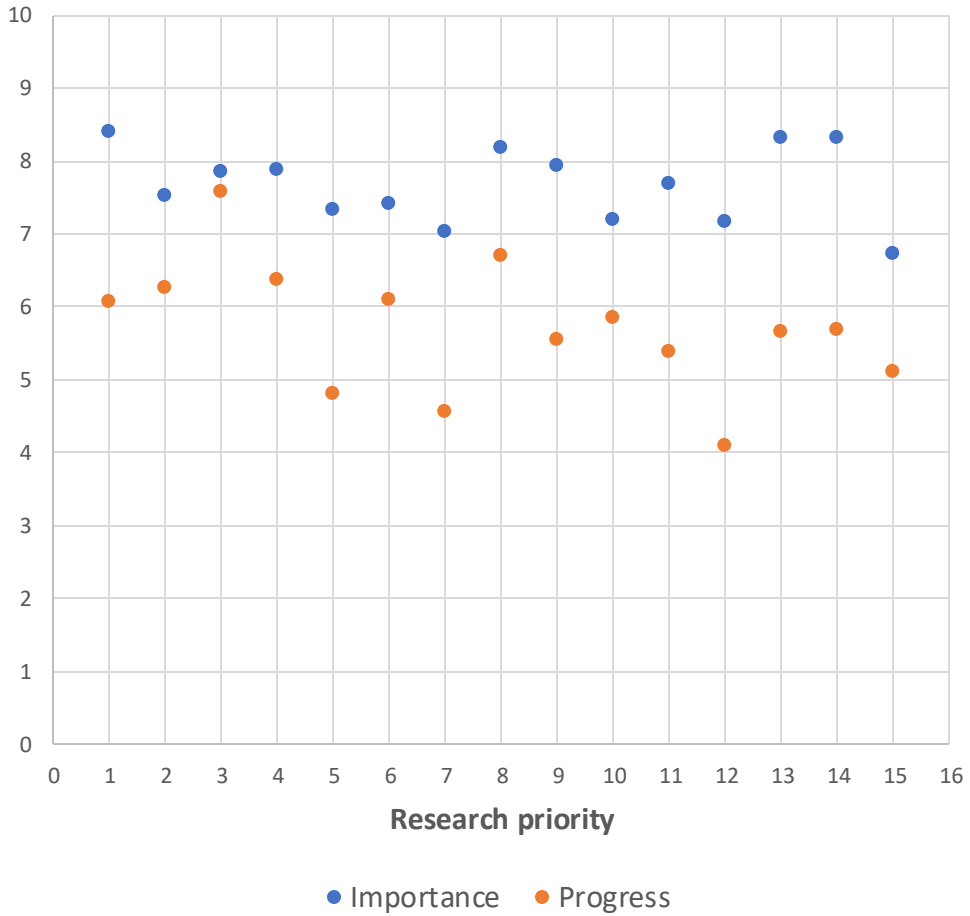

Sorted by recent progress

	Priority	Current importance	Progress
3	Maintain and enhance wave buoy network	8.22	7.27
8	Long-term beach / coastline monitoring	8.14	6.80
4	Data access and sharing	7.93	6.59
1	Enhanced and updated nearshore bathymetry	8.23	6.19
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12	Better engagement of maritime industries with research	7.12	4.64

Have you used the existing list of research priorities to guide your work?

- Around half of respondents said Yes
  - Supported funding applications (e.g. ARC) for projects such as nearshore and coastal bathymetry upgrades and expansion of observational networks
  - Guided collaborations, including studies on offshore sand sources, dredge impacts, and swell prediction
  - Influenced strategic research directions in climate projections, coastal hazard modelling, and extreme wave scenarios
  - Used as a reference for industry engagement and communication, helping align research with operational needs and sector priorities

Wind-wave priorities survey key message

- Yes, we probably do need to revise as there have been shifts in the priorities
- Those shifts are 1) a possible increase in the importance of research into coastal impacts and 2) emerging priority of AI/ML
- We (i.e. the waves WG and the community in general) are currently discussing the next steps
- And survey is still open! It would be great if you could continue to advertise and include the QR code for FOO attendees

Current Survey

Sent out October 23

Closes November 21

- For each priority 1-15
  - How important is each priority today?
  - Are you aware of any progress that has been made in this area?
  - Comments to explain the responses
- Have you used the existing list of research priorities to guide your work?
- Are there any emerging areas of research that should be considered?

AIR-SEA INTERFACE Wave Dynamics, Turbulence, Acoustics, Remote Sensing Conference

This event has passed

REGISTER HERE

Mon, 13 Jan, 9am - Fri, 17 Jan, 5pm AEDT

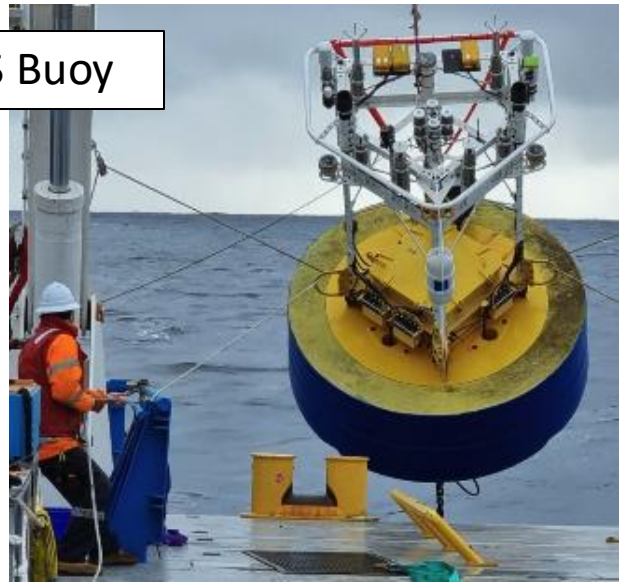
Melbourne Connect, Mezzanine Floor
Carlton VIC, Australia

THE UNIVERSITY OF MELBOURNE

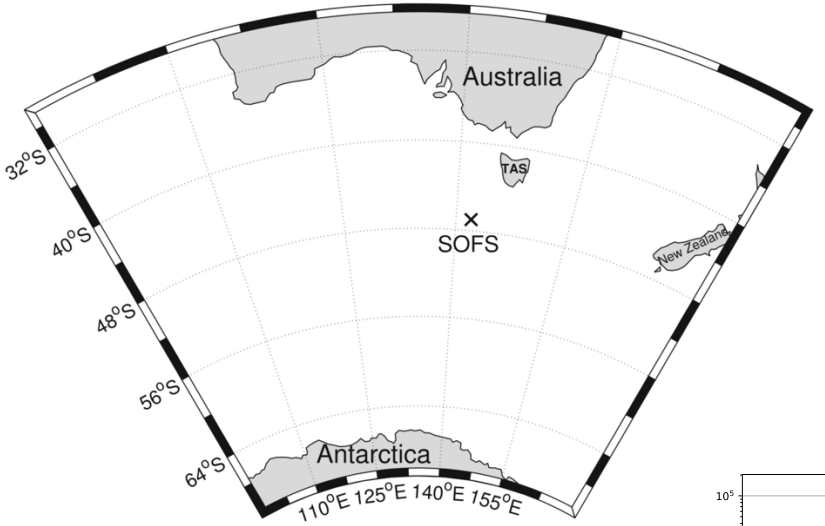
Infrastructure update

Southern Ocean Flux Station Buoy

SOFS Buoy



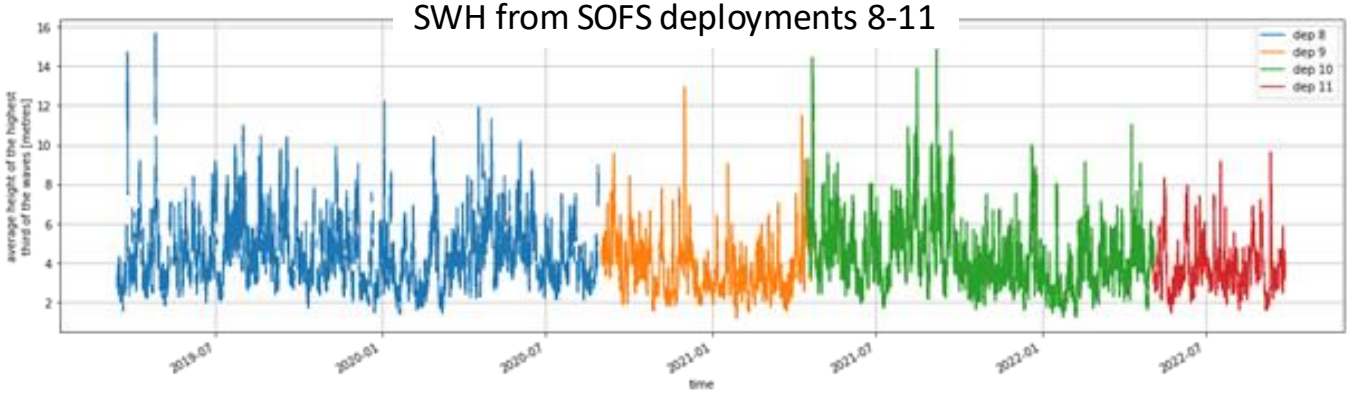
Credit: David Flynn (CSIRO)

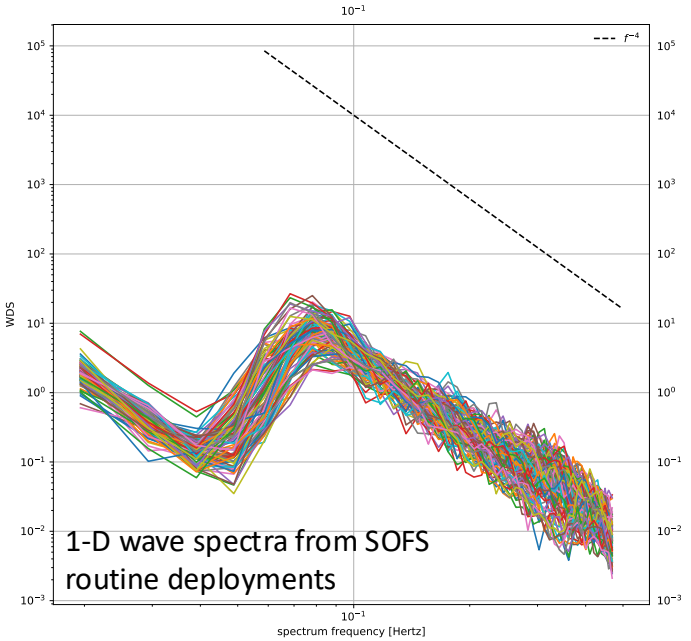


Depth ~4.5 km, wave measurements useful for cal/val:

- Routine deployments: MRU sensor + TriAxys WRB (every other deployment)
- Aligns nicely under satellite passes (CFOSat + SWOT)

SWH from SOFS deployments 8-11





1-D wave spectra from SOFS routine deployments