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Operational Wave Ensemble Prediction System: AUSWAVE-EPS

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OUTLINE

- Overview of system
- Ensemble components
  - Bias corrected ECMWF ensemble
  - AUSWAVE-EPS
  - AUSWAVE-EPS initialisation
- Ensemble validation
  - Spread-skill diagrams
  - Reliability diagrams
  - Rank histograms
- Summary

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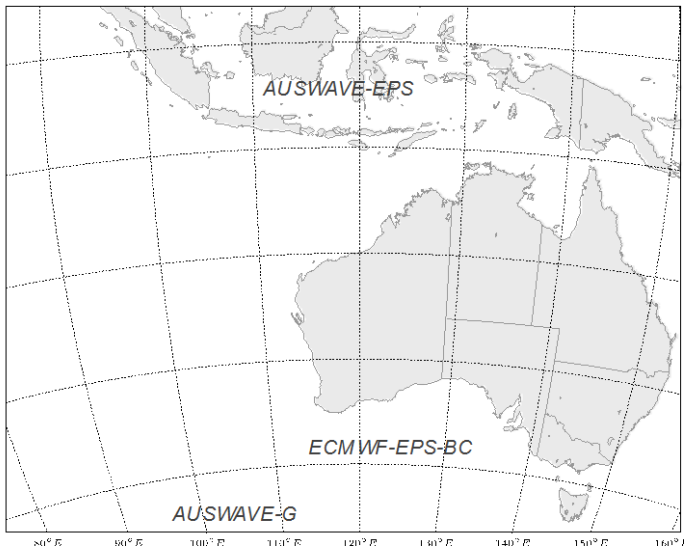
Overview

- Joint Industry Project
- Fixed domain over the Northwest shelf
- 51-member wave model ensemble
- 10-day forecasts every 12 hours (during TC season)
- Boundary conditions:
  - AUSWAVE-G
- Forcing:
  - Bias-corrected ECMWF NWP ensemble



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ECMWF-EPS to ECMWF-BC

- Based on European Centre for Medium-range Weather Forecast Ensemble Prediction System
  - 50 perturbed members
  - 1 control member
- Bias correction for Tropical Cyclones
  - Work by Harvey Ye, Saima Aijaz and Jeff Kepert (Severe weather R+D group at BoM)

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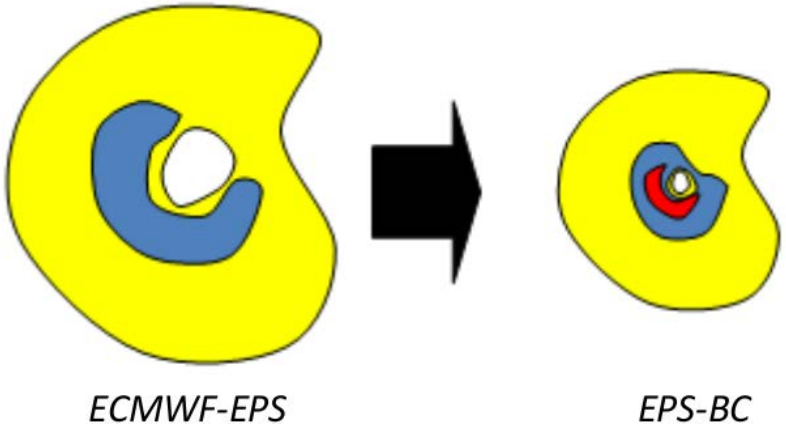
ECMWF-EPS to ECMWF-BC

- Operational process
  1. Identify TC's in ECMWF-EPS
  2. Calculate TC parameters
  3. Apply statistical correction
  4. Construct a new TC vortex and replace existing vortex in all ensemble members (where appropriate)



- Statistical correction has been developed based on comparison with Australian best track database and will be re-evaluated after each cyclone season

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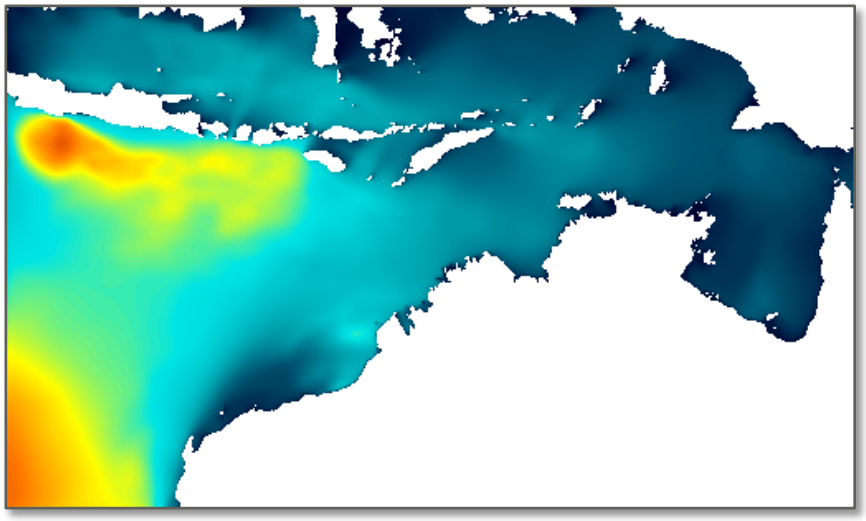
AUSWAVE-EPS

- WAVEWATCH III (version 4.18)
- ST4 source terms
- Boundary conditions from AUSWAVE-G (unperturbed)
- Spatial resolution: 8 km
- Spectral resolution:
  - 32 frequencies, 36 directions
- DBDB2 v3 bathymetry
- 51-members, 10-day forecasts
- Computational cost: ~50 minutes at 64 CPU's per member



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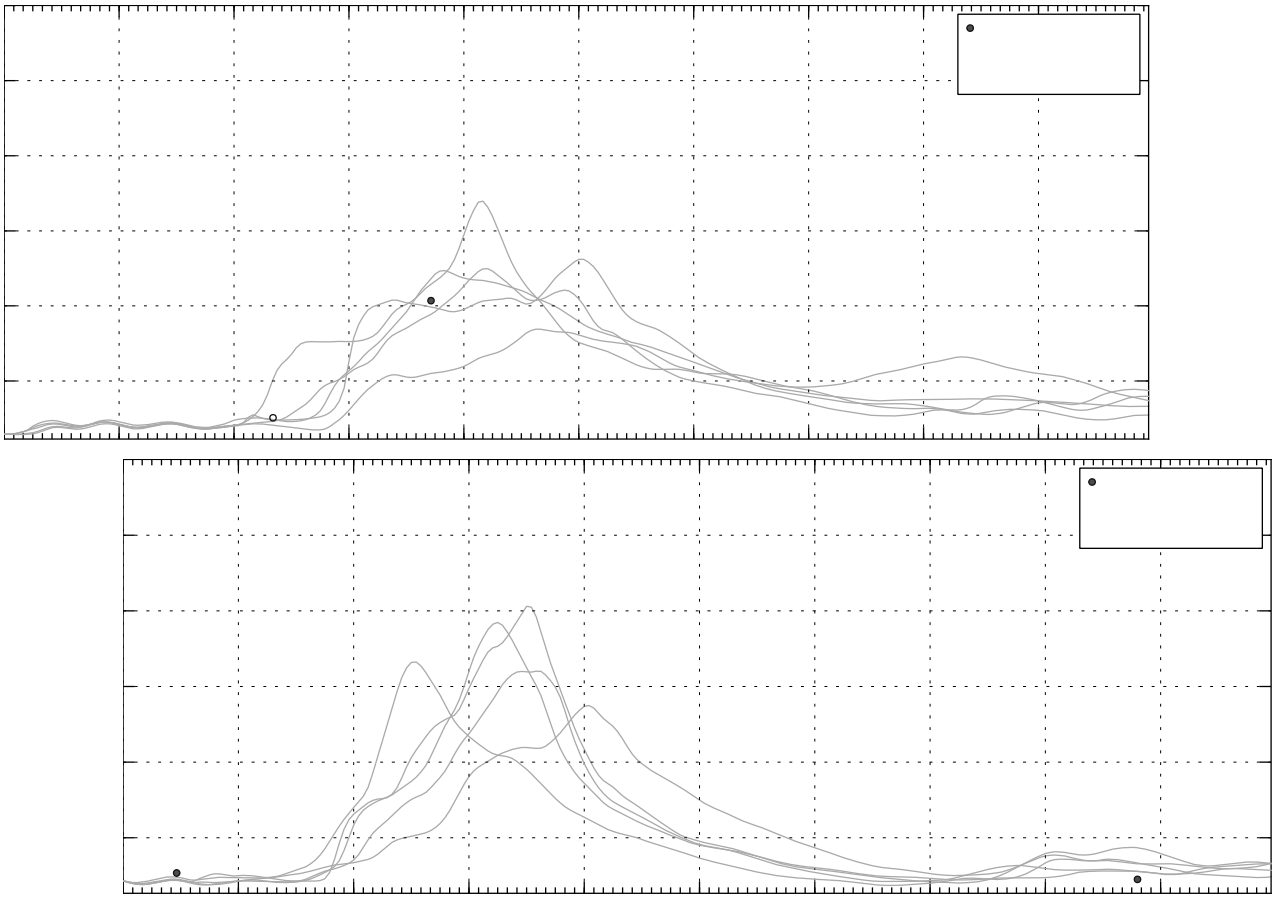
ENSEMBLE FORECASTS



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ENSEMBLE FORECASTS

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AUSWAVE-EPS – INITIALISATION

- What to use as the initial conditions for each wave ensemble member?
  - ECMWF-EPS ensemble members are independent between consecutive base-times (except control member)
- Match ensemble members by finding the ‘closest’ 12-hour forecast from previous base-time to the current 0-hour forecast and use corresponding 12-hour forecast wave field
- Case: TC in 0-hour forecast
  - Minimize cost function based on location, minimum pressure, maximum wind speed and radius to maximum wind speed
  - Location weighted most heavily
- Case: No TC in 0-hour forecast
  - Maximise the normalized spatial cross-correlation of MSLP

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ENSEMBLE VALIDATION

- Events:
  - Tropical Cyclone Olwyn
  - Tropical Cyclone Quang
  - Tropical depression 09U
- Observations from 3 locations (integral wave parameters)
- Not really enough data for verification of probabilistic forecasts
- Metrics
  - Spread-skill diagrams
  - Reliability diagrams
  - Rank histograms

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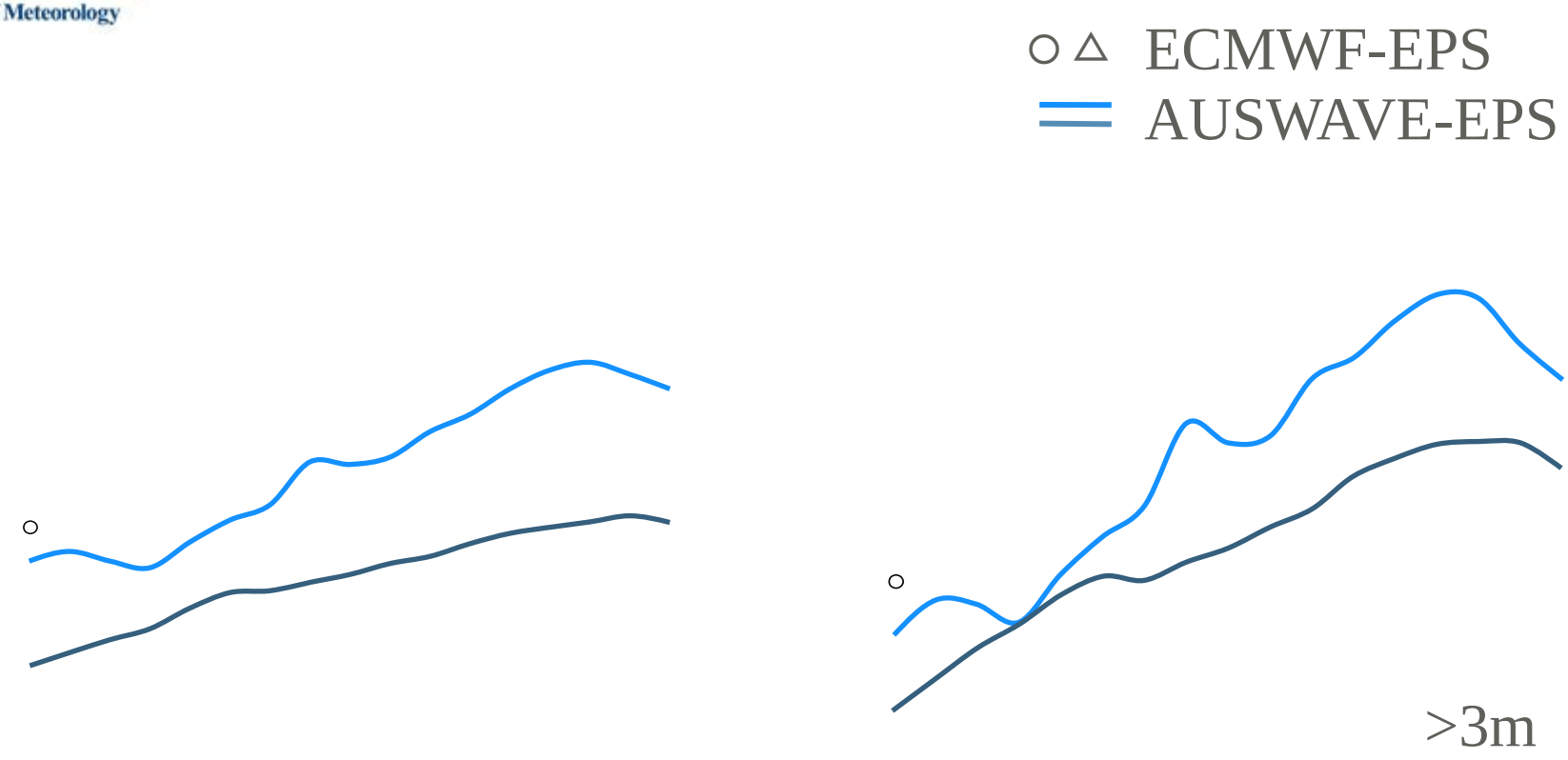
SPREAD – SKILL DIAGRAMS



Skill = rms error of ensemble mean

Spread = square root of mean ensemble variance

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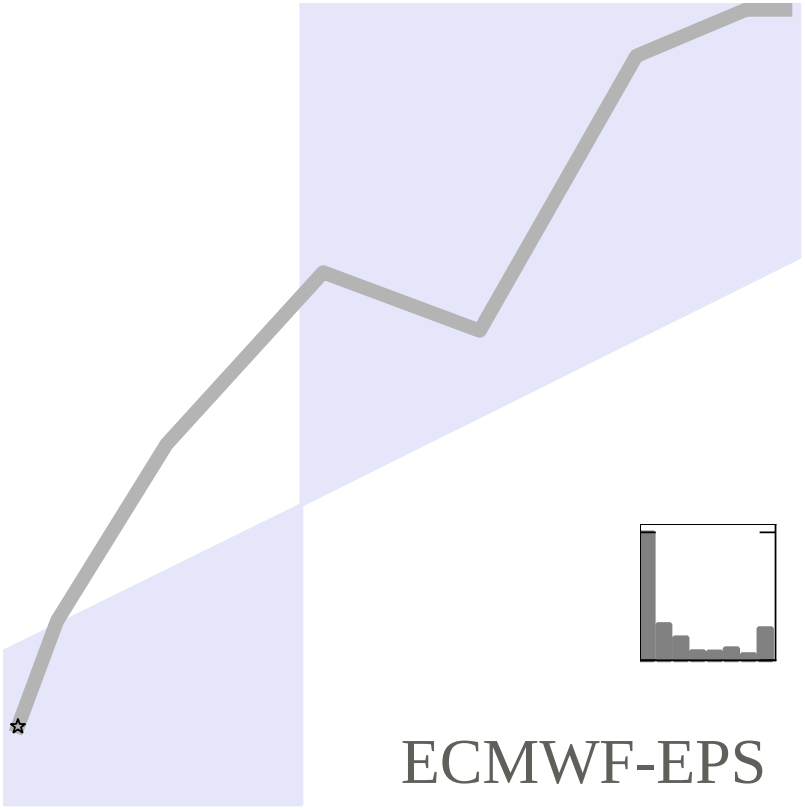
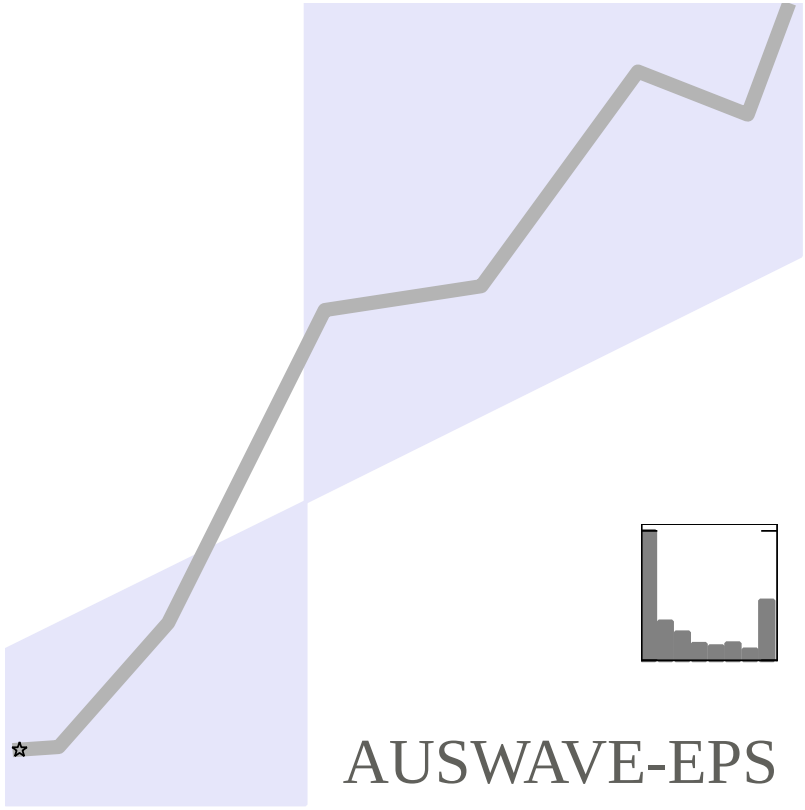
RELIABILITY DIAGRAMS

Significant wave height > 2.0m (+96 to +144 hours)



ECMWF-EPS



AUSWAVE-EPS

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RANK HISTOGRAMS

Significant wave height (+96 to +144 hours)

ECMWF-EPS

Z_{χ^2}=832 Z_{χ^2}=659 Z_{χ^2}=344

AUSWAVE-EPS

Z_{χ^2}=247 Z_{χ^2}=210 Z_{χ^2}=223

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SUMMARY

- An operational wave ensemble prediction system has been developed for forecasting waves from TCs on the northwest shelf of Australia
- Forced with winds from the ECMWF-EPS bias-corrected for TCs
- Developed technique to select ‘closest’ ensemble member to provide most appropriate AUSWAVE-EPS wave restart files
- Limited wave data for verification
  - Spread-skill diagrams, reliability diagrams, rank histograms (and Brier scores) show that skill in AUSWAVE-EPS is increased compared to that of the ECMWF wave ensemble

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Thank you…

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