Wave ensemble forecast system for tropical cyclones in the Australian region

Stefan Zieger   Diana Greenslade Jeff Kepert

28 November 2018

ITF – industry technology facilitator

- Supported by Shell, Woodside, Chevron and INPEX

- Published in Ocean Dynamics (2018) 68:603-625
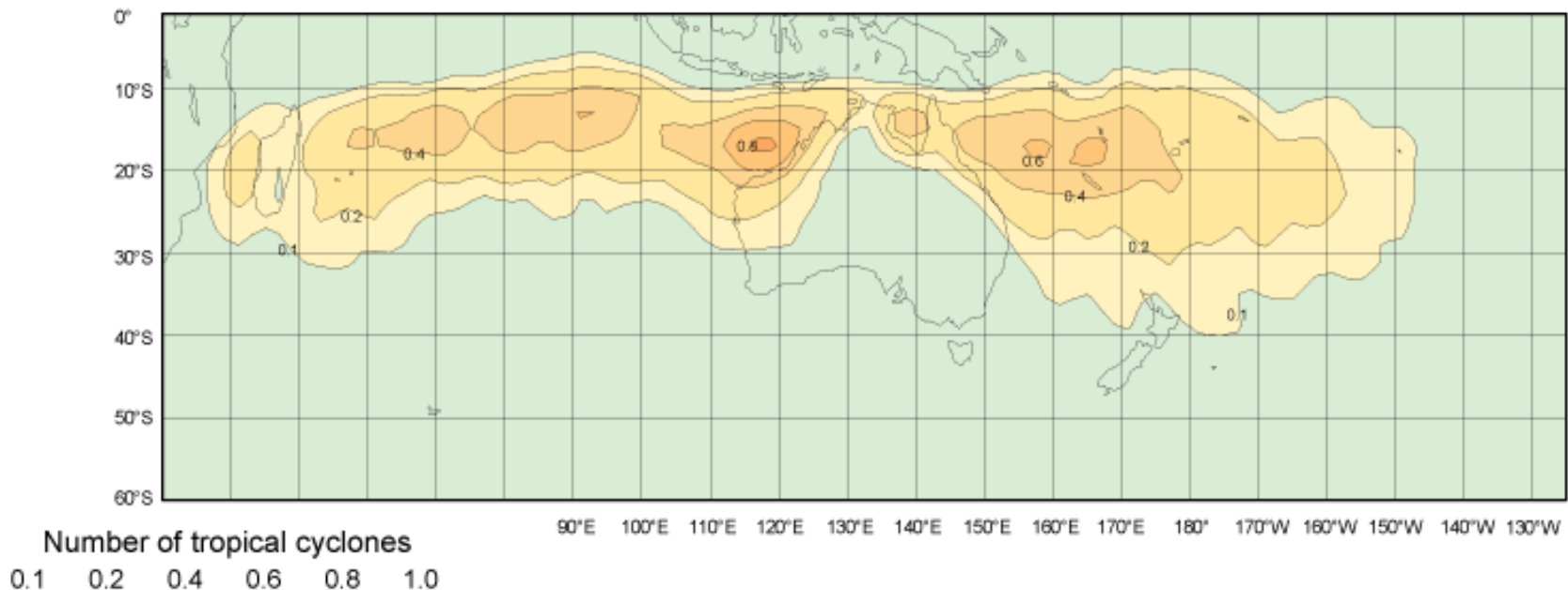

Ocean Dynamics (2018) 68:603–625
https://doi.org/10.1007/s10236-018-1145-9

Wave ensemble forecast system for tropical cyclones in the Australian region

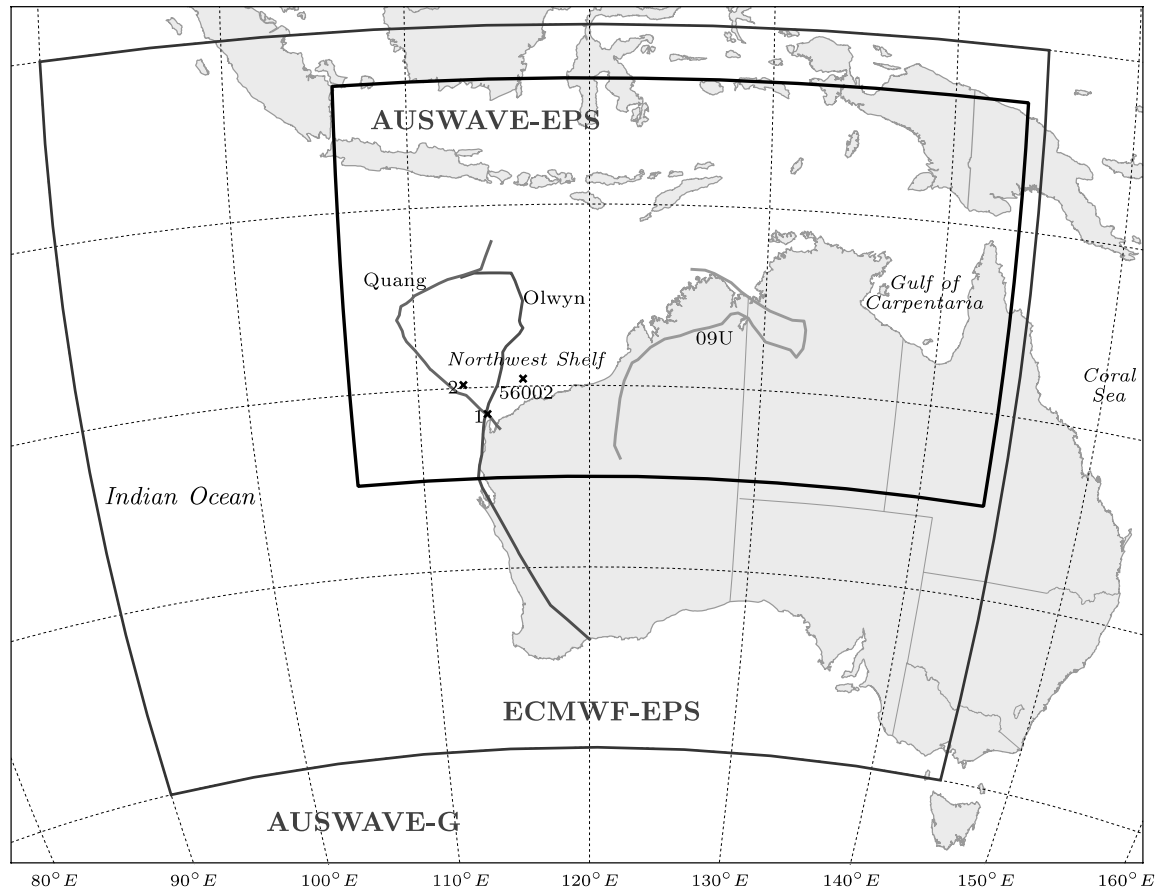Stefan Zieger[1] · Diana Greenslade[1] · Jeffrey D. Kepert[1]

North-west shelf Region

- On average 10.5 tropical cyclones per year in the Australian region

- On average 6.5 tropical cyclones per year passing the North-west shelf

Number of tropical cyclones

0.1 0.2 0.4 0.6 0.8 1.0

http://www.bom.gov.au/climate/maps/averages/tropical-cyclones/

ITF tropical cyclone forecast system

- Two basetime runs a day

- Forecast length 10 days

- AUSWAVE-G (1/4°, forced with 3 hourly wind speed and sea ice concentration)

- EPS-BC (51 ECMWF ensemble members 1/4°)

- AUSWAVE-EPS (8km, 3 hourly, boundary updated hourly)
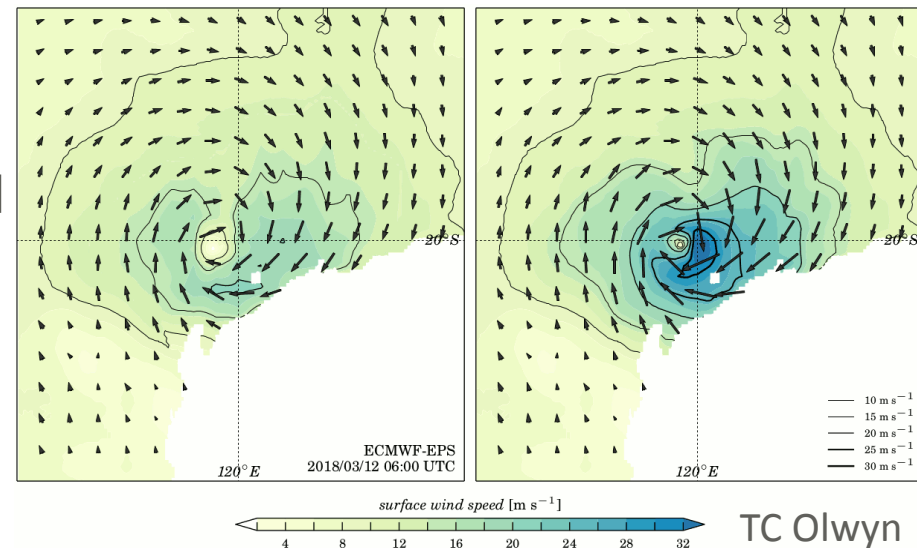
- Fixed domain

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)
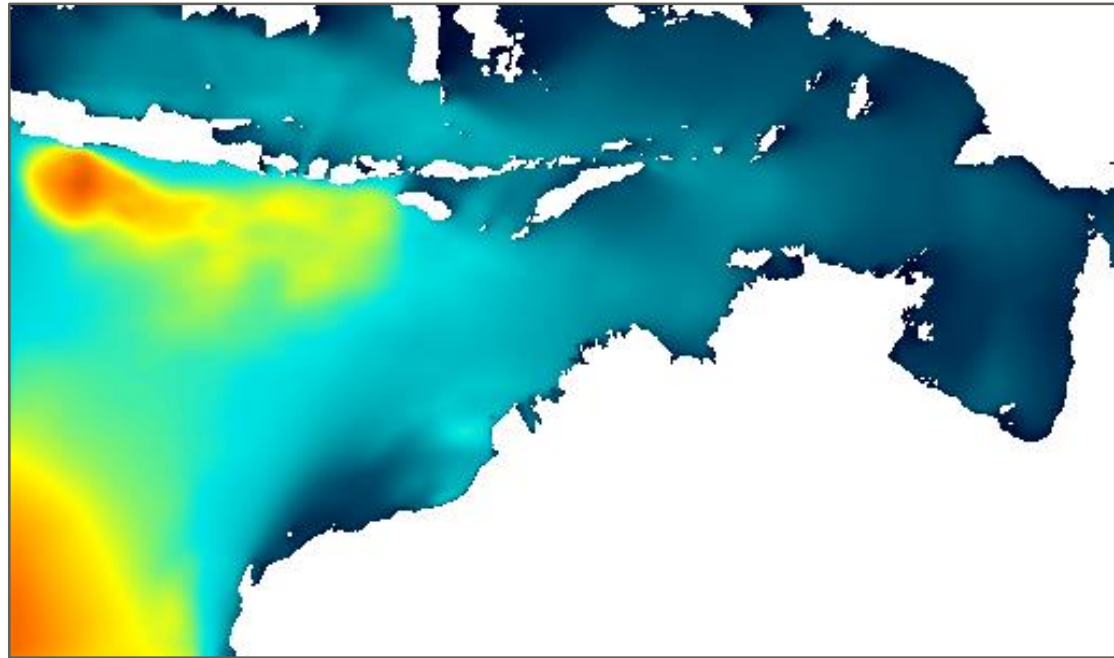
ECMWF-EPS – BIAS CORRECTION

- 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)

ECMWF-EPS
2018/03/12 06:00 UTC

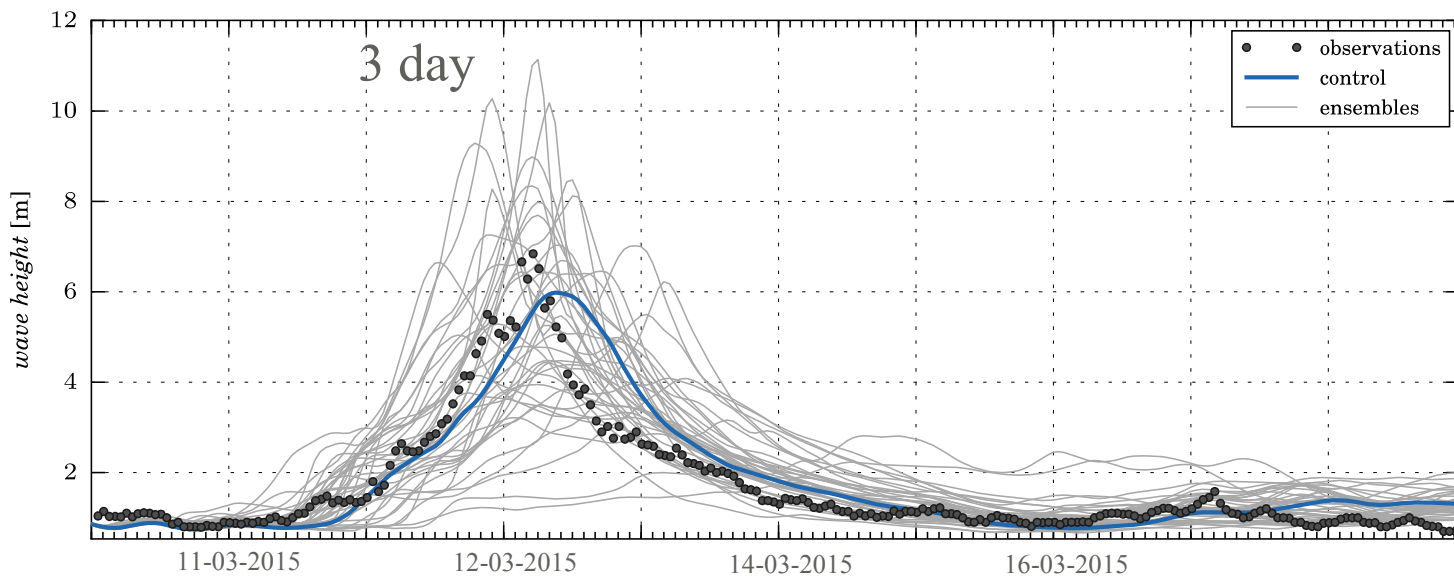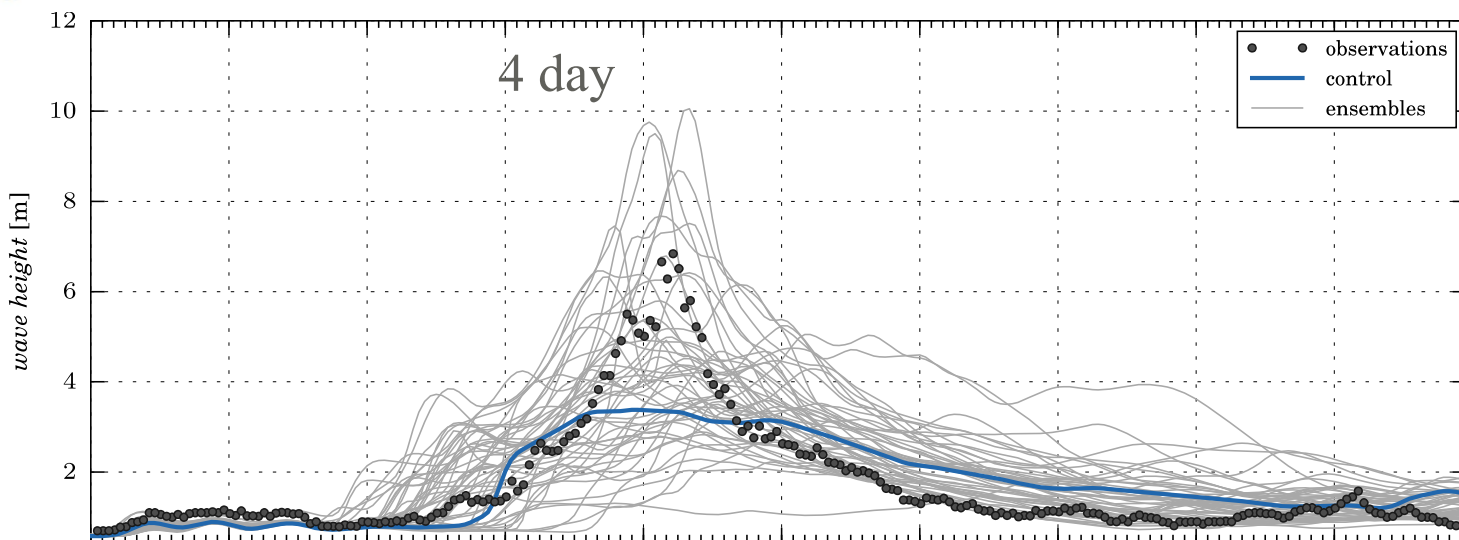surface wind speed [m s^{-1}]

TC Olwyn

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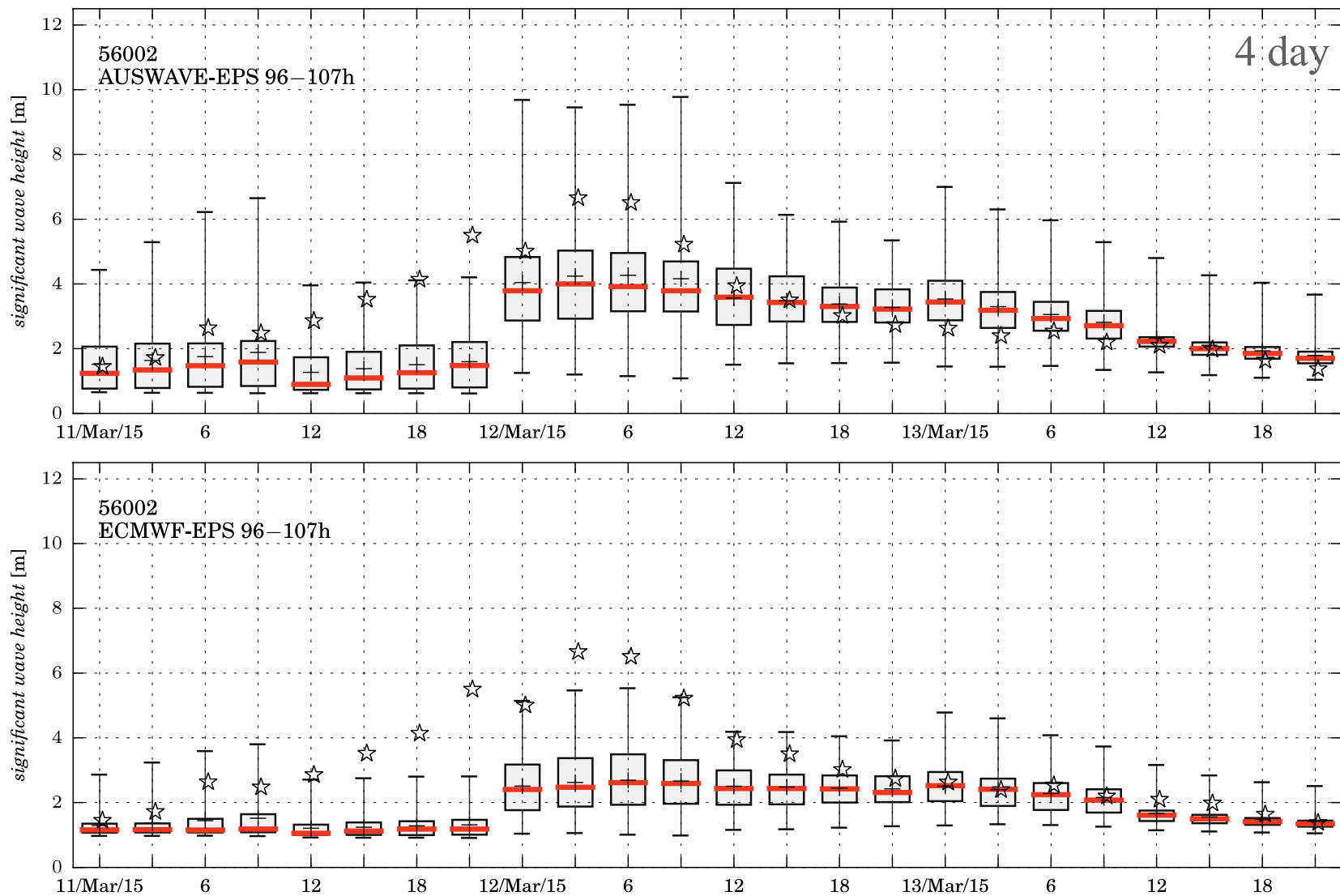
AUSWAVE-EPS

- Configured from AUSWAVE-G operational wave model

- Boundary conditions from AUSWAVE-G (unperturbed)

- ST4 source terms

- 8-km resolution, DBDB2 v3 bathymetry

- 32 frequencies

- 36 directions

- Forecast length 240h (cost: ~50 min. at 64 CPU's per member)

ENSEMBLE FORECASTS

TC Olwyn
56002
AUSWAVE-EPS

ENSEMBLE FORECASTS

ENSEMBLE FORECASTS
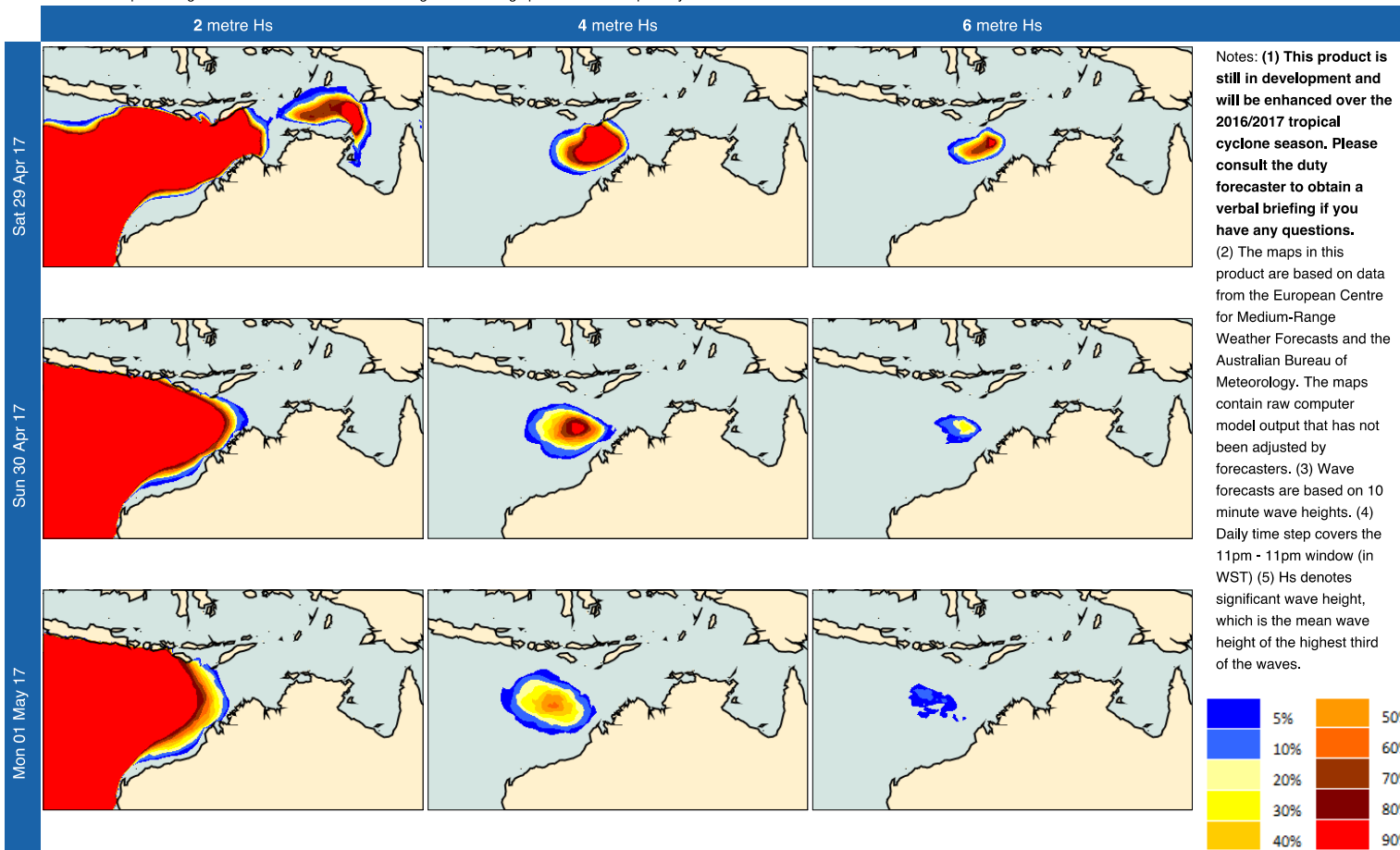

Wave Risk Forecast Map
Ensemble Members: 51   Model Base Time: 20:00 Fri 28 Apr 2017 WST   Issue Time: **06:00 Sat 29 Apr 2017 WST**
Next Issue: 18:00 Sat 29 Apr 2017 WST

Phone: 08 9263 2205

Presented as percentage of model scenarios with wave heights exceeding specific threshold per day.

2 metre Hs	**4** metre Hs	**6** metre Hs

Notes: **(1) This product is still in development and will be enhanced over the 2016/2017 tropical cyclone season. Please consult the duty forecaster to obtain a verbal briefing if you have any questions.** (2) The maps in this product are based on data from the European Centre for Medium-Range Weather Forecasts and the Australian Bureau of Meteorology. The maps contain raw computer model output that has not been adjusted by forecasters. (3) Wave forecasts are based on 10 minute wave heights. (4) Daily time step covers the 11pm - 11pm window (in WST) (5) Hs denotes significant wave height, which is the mean wave height of the highest third of the waves.

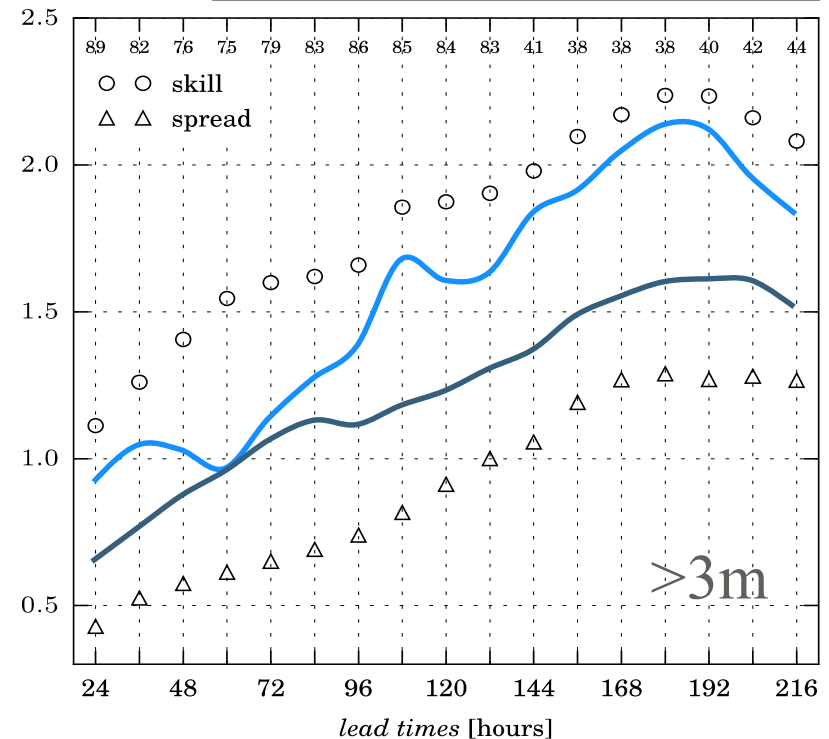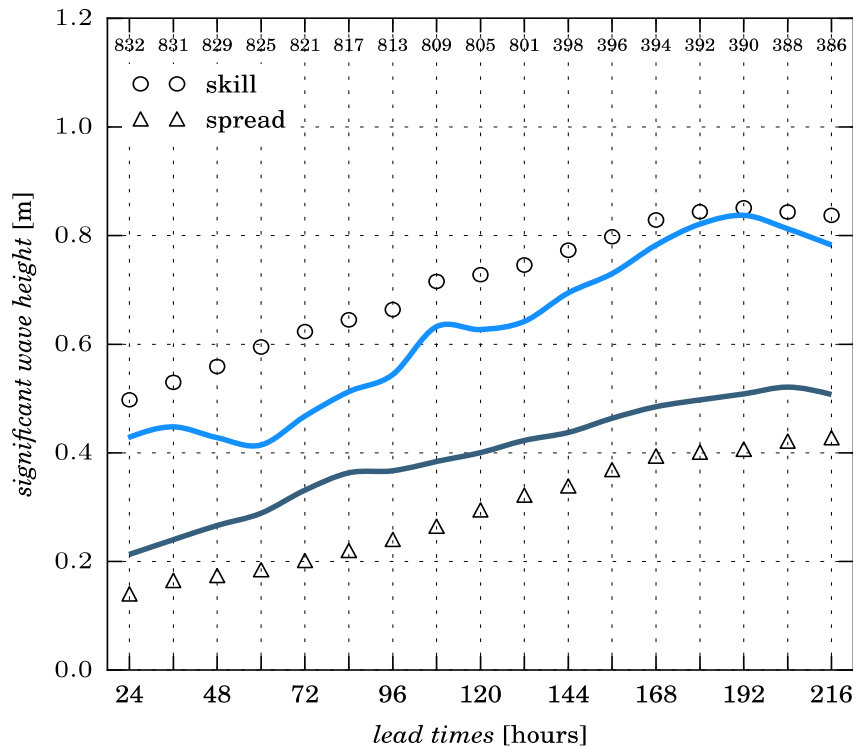| 5% | 50% |
10%	60%
20%	70%
30%	80%
40%	90%

1 to 3 day

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 prob. forecasts

- Metrics

  - Spread-skill diagrams

  - Rank histograms
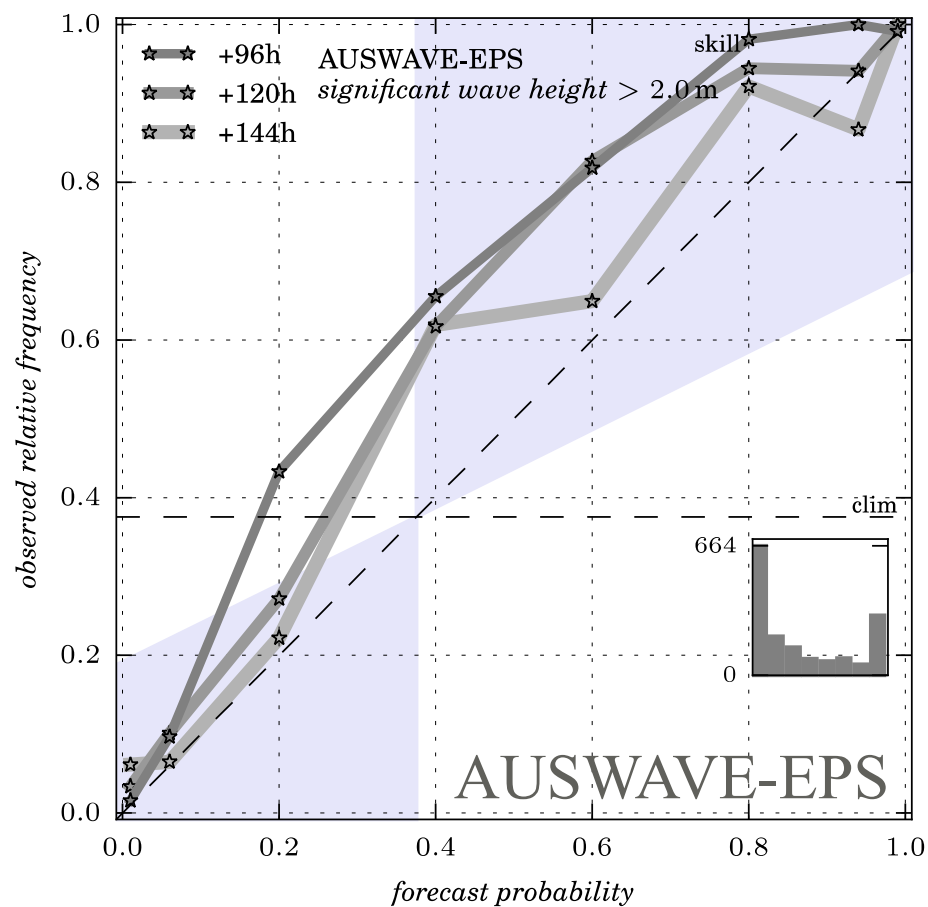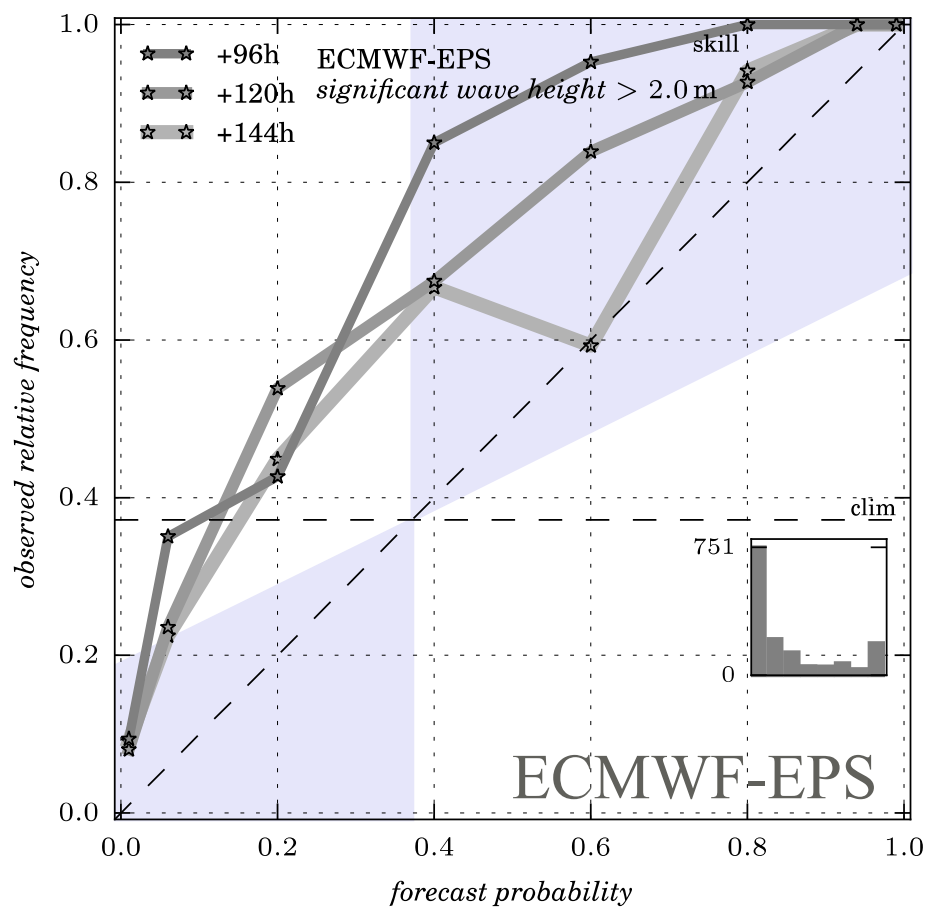
  - Reliability diagrams

SPREAD – SKILL DIAGRAMS

Skill = rms error of ensemble mean

Spread = square root of mean ensemble variance

RELIABILITY DIAGRAMS

Significant wave height > 2.0m (4 to 6 days)

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

Thank you…

Stefan Zieger

+61 3 9669 4813

stefan.zieger@bom.gov.au