The Bureau of Meteorology

WGSIP25

Bureau Update

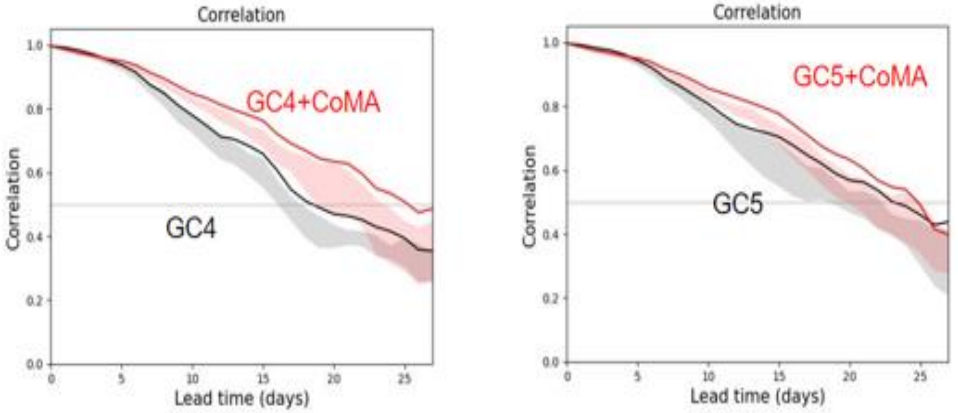
Debbie Hudson

Nov 2024

Modelling R&D

- Evaluation of recent UKMO global model configurations (GA8, GC4, GAL9, GC5) (28-day forecasts)
- Evaluation of CoMorph convection scheme for S2S prediction
- Evaluation of "GloSea-GC5" preliminary hindcast set (GC5 is potential model for BOM next seasonal prediction system ACCESS-S3)
- ENKF ocean data assimilation
- Investigation of systematic errors in the tropical Indian Ocean that affect seasonal prediction
- Investigating ML models for S2S prediction

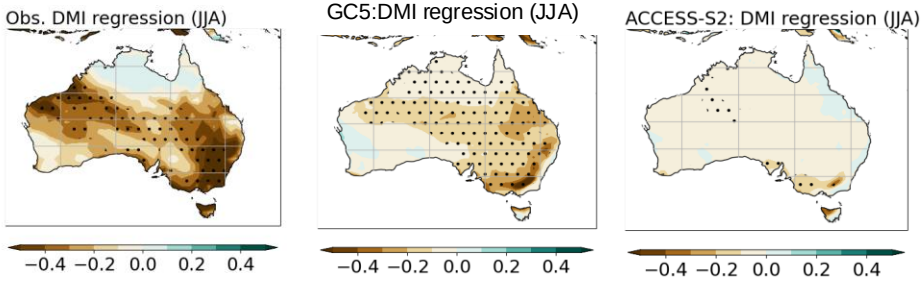
Improved MJO prediction skill using CoMorph-A convection scheme in the UM



Lines: ensemble mean; Shading: range from ensemble members

Correlation of the bivariate RMM index (60-start dates; 5 member ensembles)

GloSea-GC5 preliminary seasonal hindcast assessment



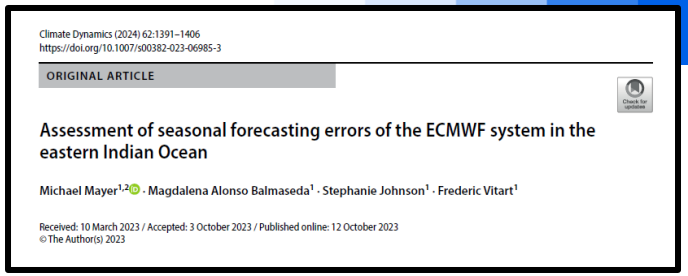
Improved forecasts of IOD and teleconnection to Australia (above: rainfall)

Zhu, H.; Hudson, D.; Li, C., Shi, L.; White, B.; Young, G.; Stirling, A. ; Whitall, M.; Lock, A.; Lavender, S.; Stratton, R. 2024. **Impacts of the new UM convection scheme, CoMorph-A, over the Indo-Pacific and Australian regions**. Journal of Southern Hemisphere Earth Systems Science, https://doi.org/10.1071/ES23011.

Li, C., Hudson, D., Zhou, X., Zhu, H., Wheeler, M., Young, G., Marzin, C., Roberts, L. 2023. **Biases and teleconnections in GC5 – insights for seasonal prediction and Australia.** Journal of Southern Hemisphere Earth Systems Science. 73, 262-279, https://doi.org/10.1071/ES23010

Systematic errors in the tropical E Indian

Comparing GloSea-GC5, GloSea6, ACCESS-S2 and SEAS5


Climate Dynamics (2024) 62:1391–1406
https://doi.org/10.1007/s00382-023-06985-3

ORIGINAL ARTICLE

Assessment of seasonal forecasting errors of the ECMWF system in the eastern Indian Ocean

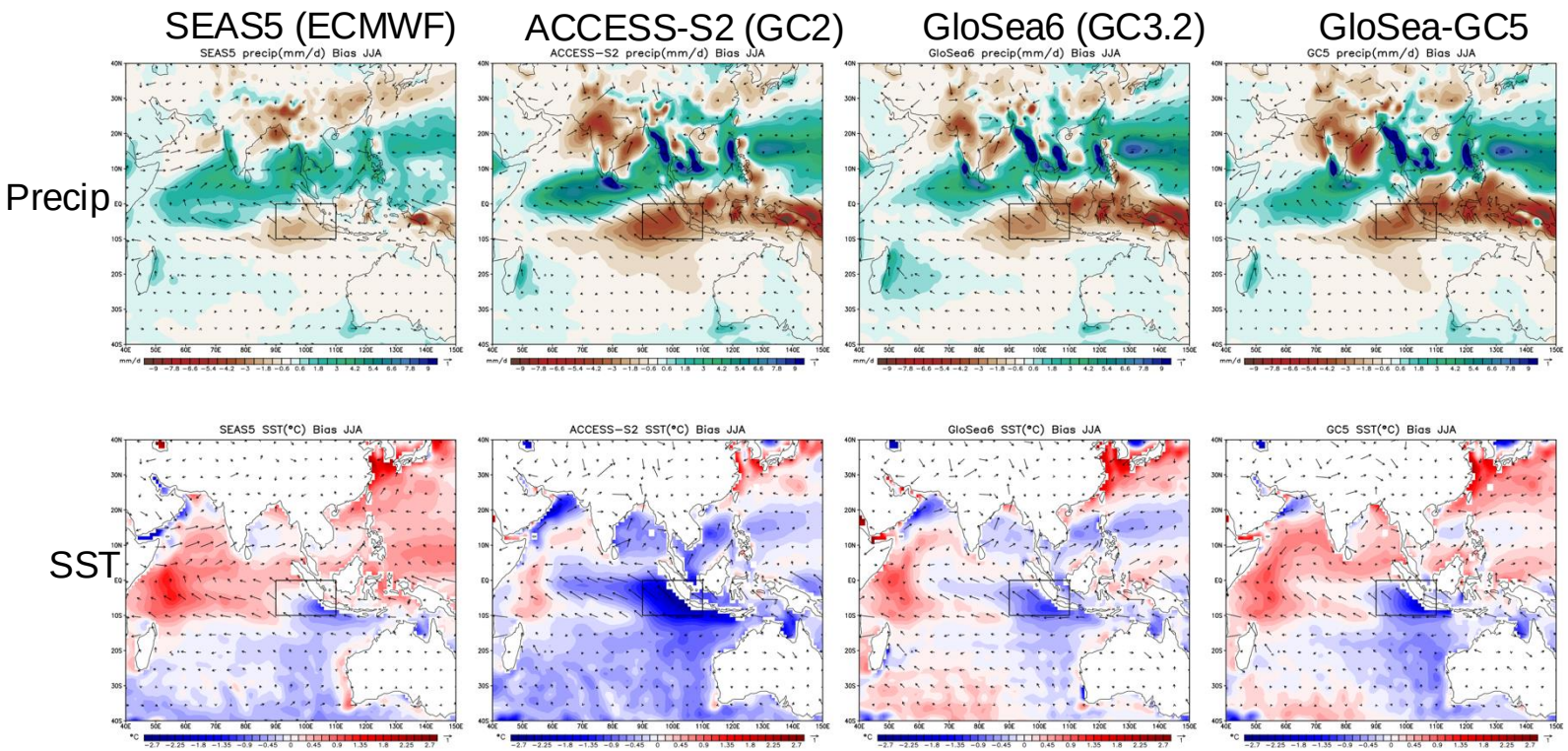
Michael Mayer[1,2] · Magdalena Alonso Balmaseda[1] · Stephanie Johnson[1] · Frederic Vitart[1]

Received: 10 March 2023 / Accepted: 3 October 2023 / Published online: 12 October 2023

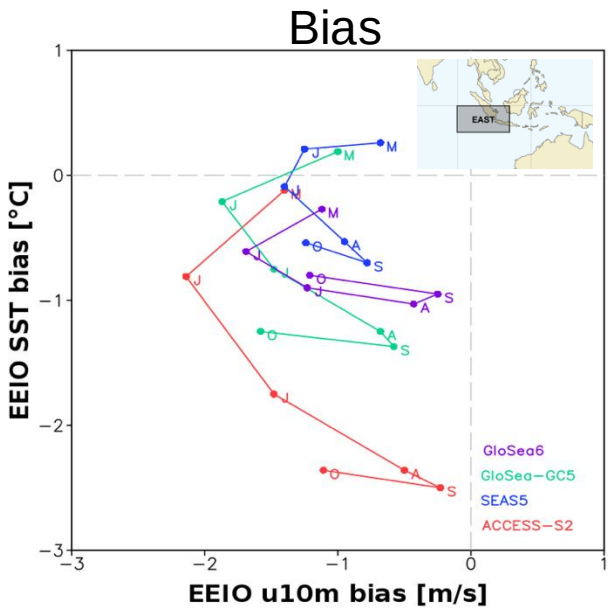
Diagnostics following Mayer et al paper

JJA precipitation, SST and wind biases (init 1 May)

System
SEAS5 (ECMWF)
GloSea-**GC5**
GloSea6 (uses **GC3.2**)
ACCESS-S2 (uses **GC2**)



Co-evolution of SST and u10-wind for EEIO region (IOD-E) (May to Oct)



Hudson et al (in preparation)

Working with Michael Mayer (ECMWF), Jamie Kettleborough (UKMO) and Charline Marzin (UKMO)

From: Li Shi

Investigating ML models for NWP and S2S

Initial investigation with pre-trained ML models: GraphCast and FourCastNetV2(SFNO)

Note: they were not developed with S2S in-mind

Experimental Testbeds/Hindcasts

Extended hindcast:
38 years
1st and 16th each month (912 starts)
6-h timestep autoregressive
42-day forecast

- Covers the same period as the ACCESS-S2 hindcast, allowing for comparison with our operational seasonal model
- But, period overlaps with ML training period

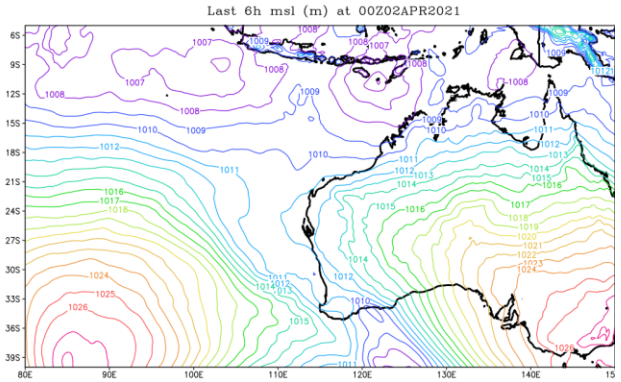
Mini-hindcast:
Jan 2022 – Jun 2024
1st and 16th each month (60 starts)
6-h timestep autoregressive
28-day forecast

- Several of the latest dynamical model versions from the Met Office are being evaluated over this testbed
- The period is out-of-sample used for ML training
- Evaluation of anomalies? Statistical significance of results? Enough samples of climate drivers?

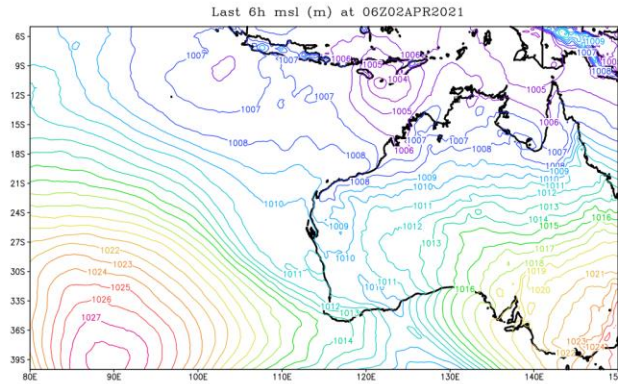
De Burgh-Day et al. (in preparation)

Case Studies

A tropical cyclone example: TC Seroja

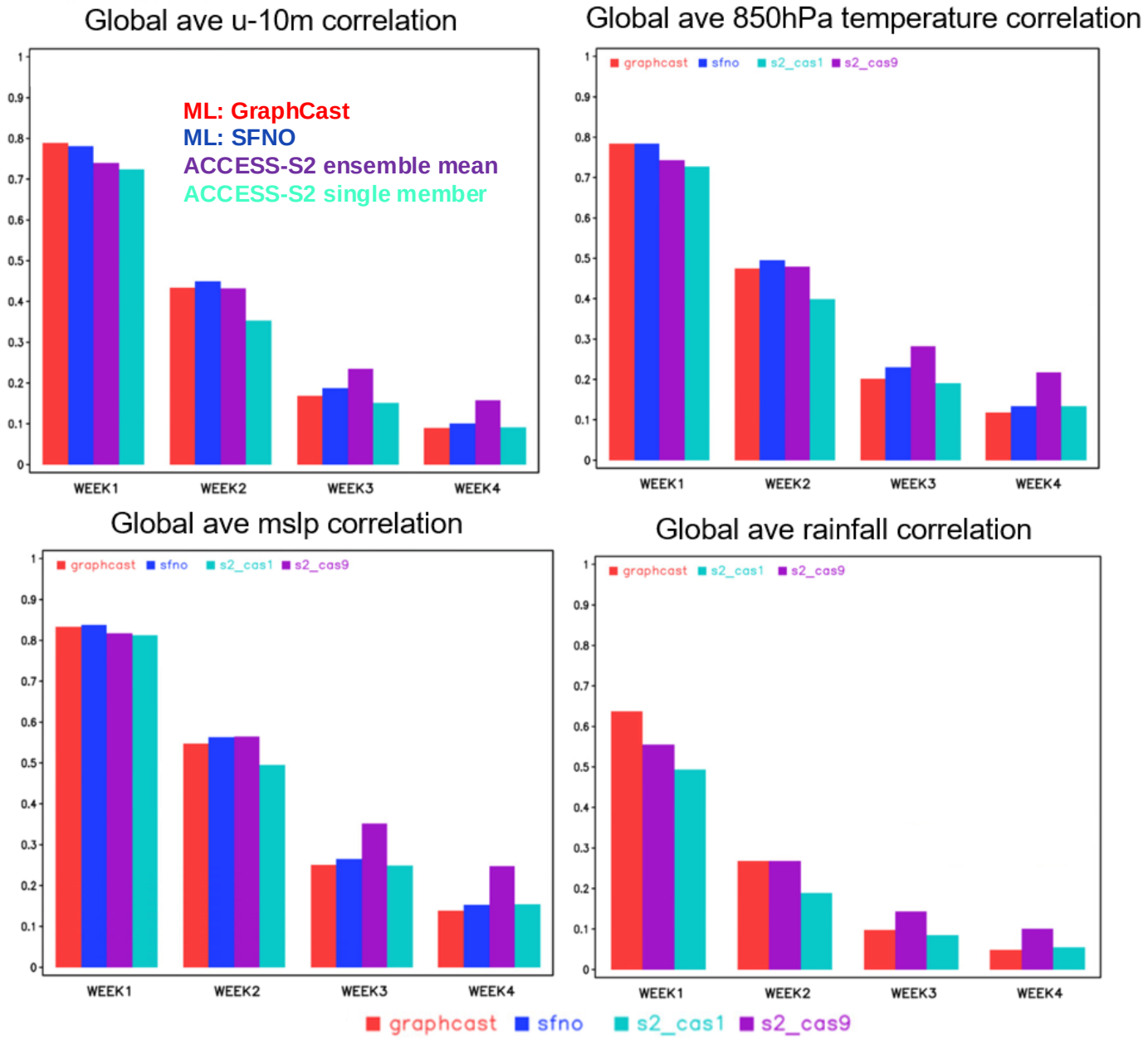


TC Seroja in **ERA5**



Forecast of TC Seroja using **GraphCast**

38-year hindcast: weekly skill



Compare ML models to ACCESS-S2 9-member ensemble mean and single member

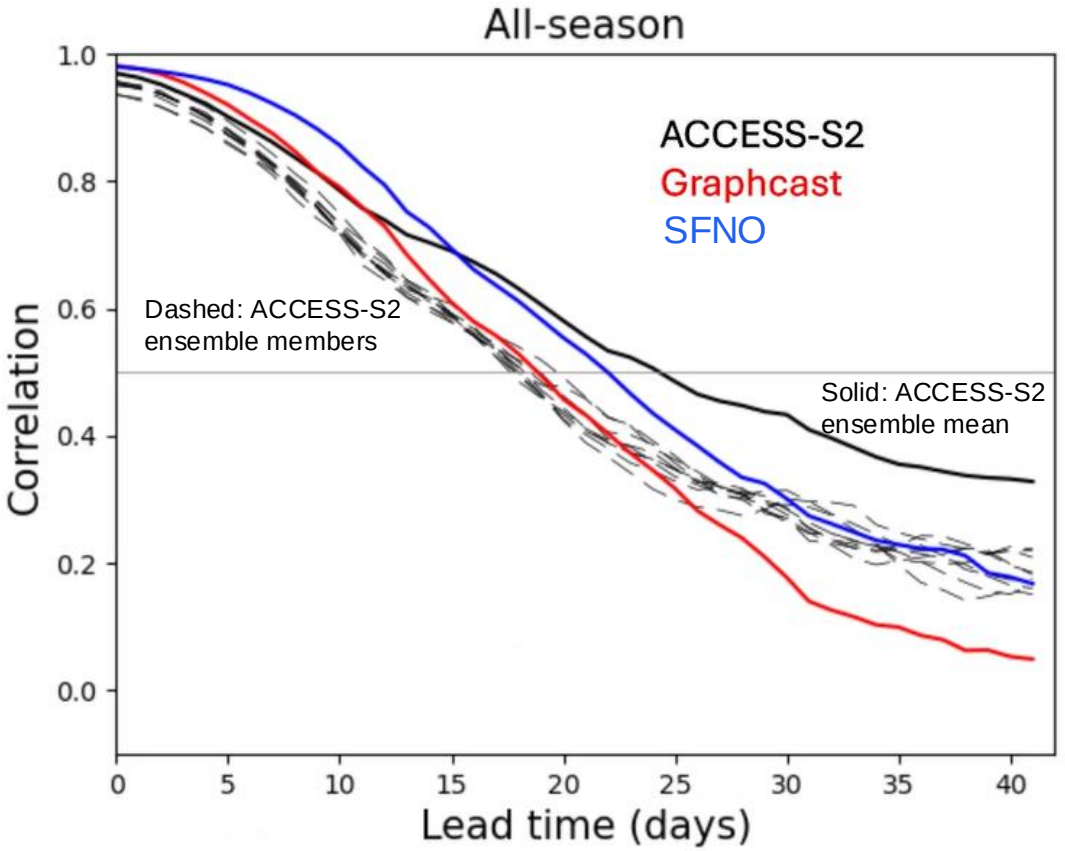
- ML models slightly better in weeks 1 and 2
- For *most* variables, at weeks 3 and 4, ACCESS-S2 single member is similar to ML models
- Gains in skill to week 3 and 4 from ACCESS-S2 ensemble
- Will an ML ensemble approach see the same skill gains over a single member?

De Burgh-Day et al. (in preparation)

From: Li Shi

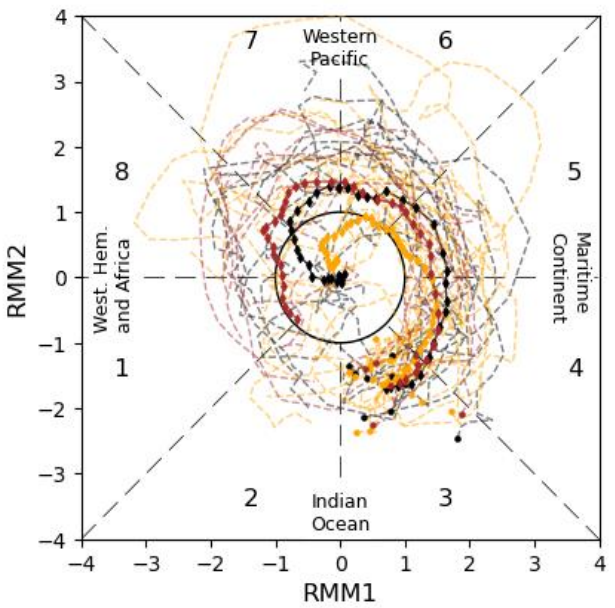
38 year hindcast evaluation - MJO

- MJO Correlation (wind components of RMM only)
- 9-member ensemble ACCESS-S2
- Single-member ML models

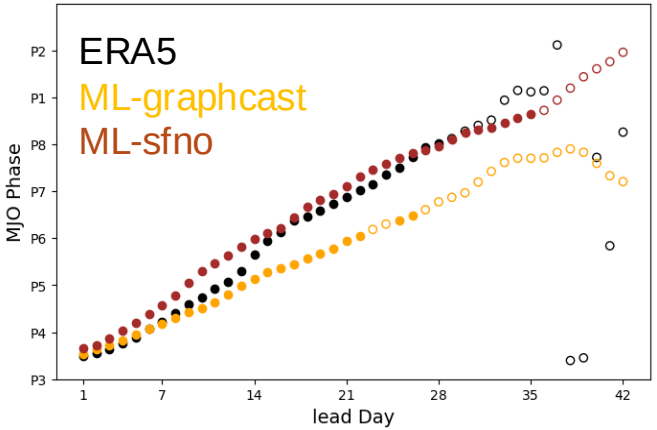


- Composites of MJO events by initial phase
- GraphCast propagation too slow; SFNO close to ERA5 (and similarly for NCEP/NCAR reanalysis)

Example for MJO's starting from Phase 3



Composite MJO speed
(starting in Phase 3)



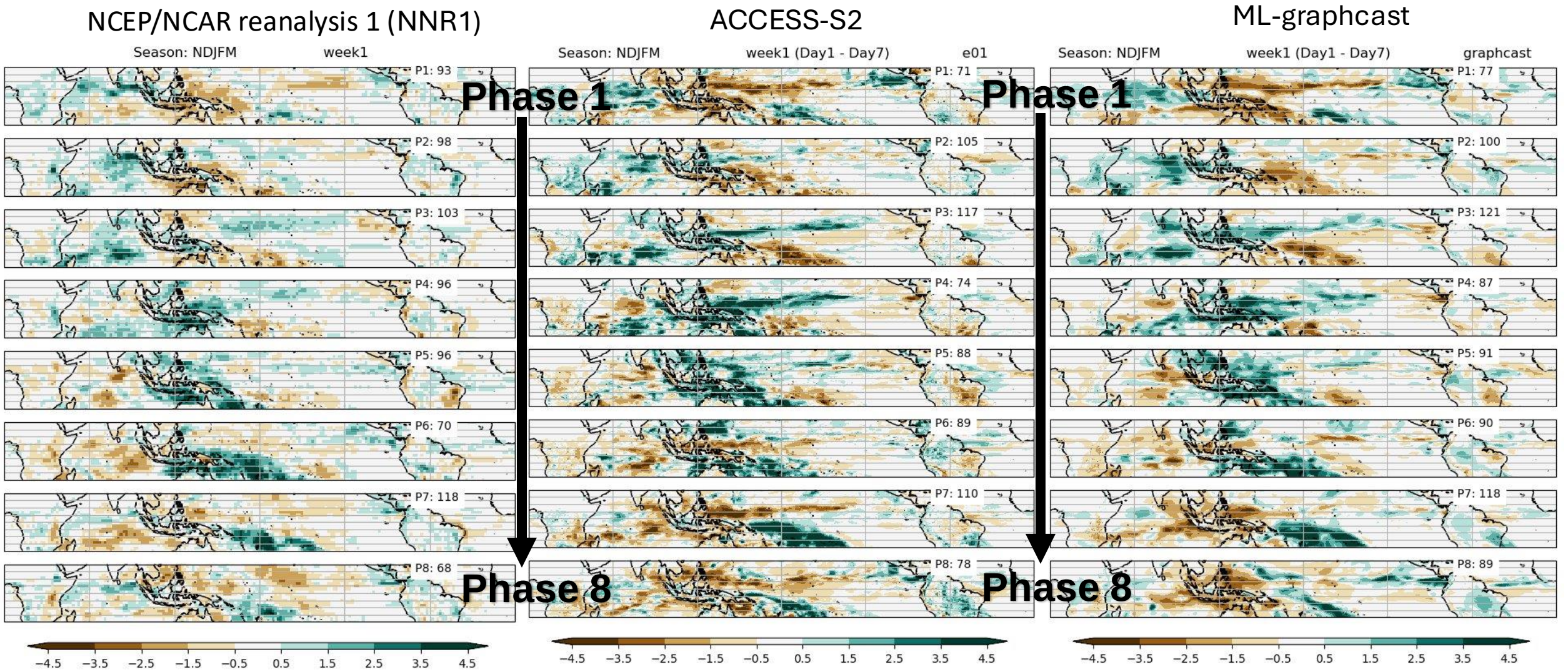
Open circles for MJO amplitude<1

De Burgh-Day et al. (in preparation)

From: Chen Li

38 year hindcast evaluation – MJO rainfall composites

Week 1 (days 1-7)

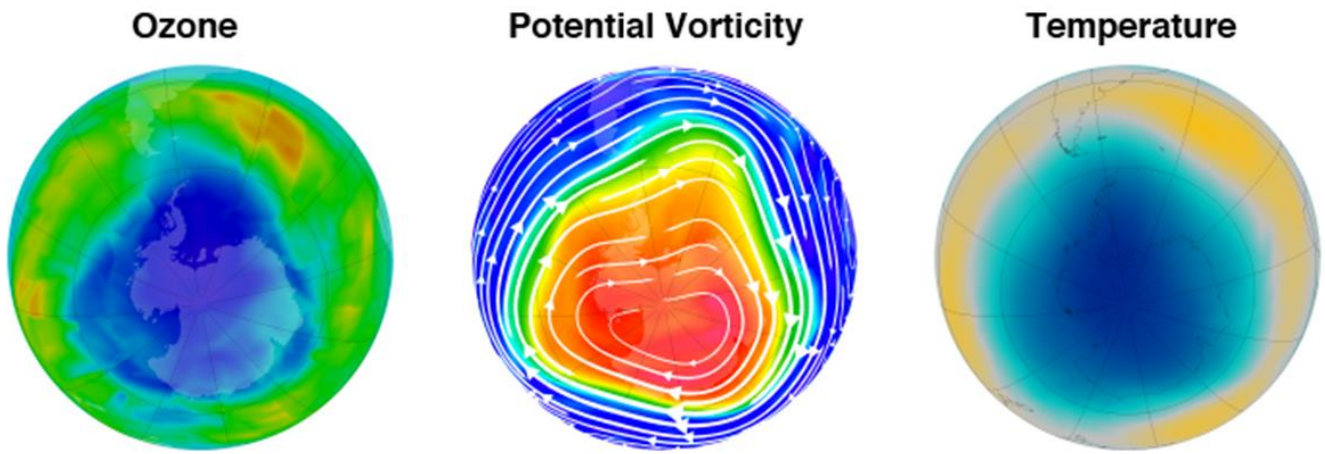


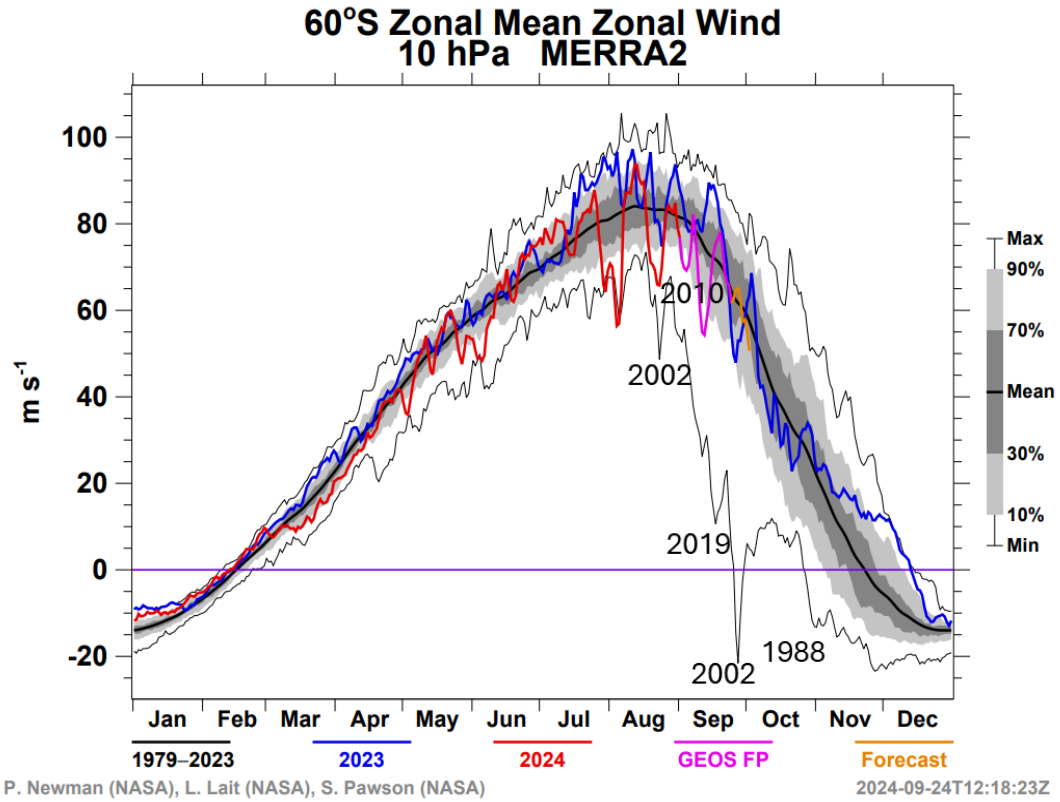
De Burgh-Day et al. (in preparation)

From: Chen Li

Polar vortex and ozone variability

- The Antarctic polar stratosphere continues to surprise
- In 2024 we observed two episodes of rapid stratospheric warming in July and August (both reaching new records for the time of year), corresponding to a weaker vortex and delayed start to spring ozone depletion.
- Almost coincidentally, the tropospheric SAM went very negative, affecting surface weather.
- How predictable was this?
- Can we improve predictions with better ozone?





E-P Lim, C Lucas, M Wheeler (BOM) + M Jucker (UNSW)

Other

- Developing a **Bureau strategy for ML in weather/climate forecasting** and the plan going forwards
- Planning to operationalise **marine heatwave outlooks** (C Spillman) (https://research.csiro.au/cor/research-domains/climate-impacts-adaptation/marine-heatwaves/dynamical-forecasting-of-marine-heatwaves/)
- Developed method for **statistical 'seamless blending'** our weather (i.e. ADFD) and subseasonal-to-seasonal (i.e. ACCESS-S) forecasts (R Taggart, M Griffiths, M Wheeler, C Spillman)
- Investigating simulations/forecasts with and without Hunga Tonga–Hunga Ha'apai **(HTHH) volcano** (C Lucas)
- Developing **seasonal total water level forecasts** for Australian coastline (tide predictions + sea level rise + storm surge statistics + ACCESS-S2 seasonal SSH anomalies) (R Holmes, C Spillman)
- Encouraging adoption of **Relative Nino indices** by seasonal forecasting centres (M Wheeler)
- ACCESS-S2 contributions to **Copernicus C3S and the S2S** Project (C Spillman, P Smith)

The Bureau of Meteorology

Thank you

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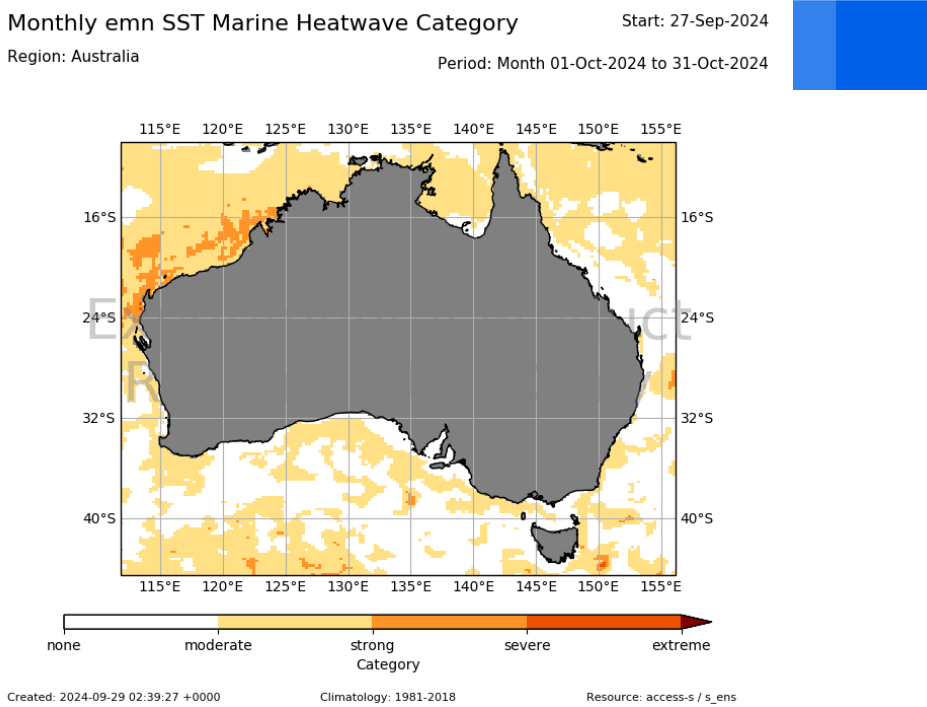
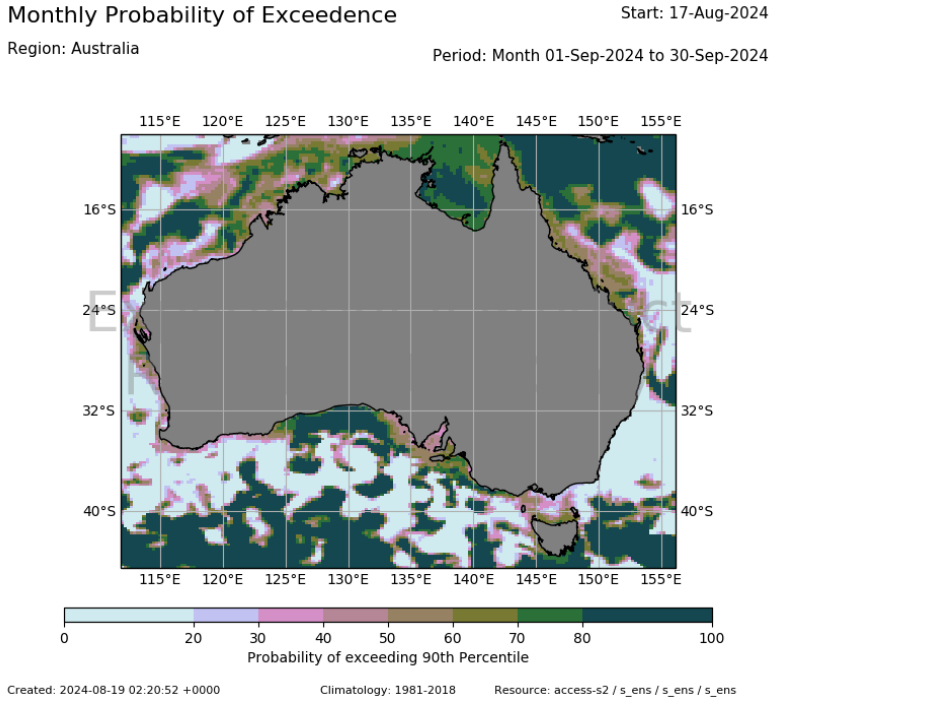
Operational marine heatwave outlooks

- Prototype seasonal MHW forecast products running in trial mode
- Used in national and targeted briefings
- Process to operationalise forecasts underway
- Planned public release mid 2025 as part of the seasonal ocean outlook product suite

Project: https://research.csiro.au/cor/research-domains/climate-impacts-adaptation/marine-heatwaves/dynamical-forecasting-of-marine-heatwaves/

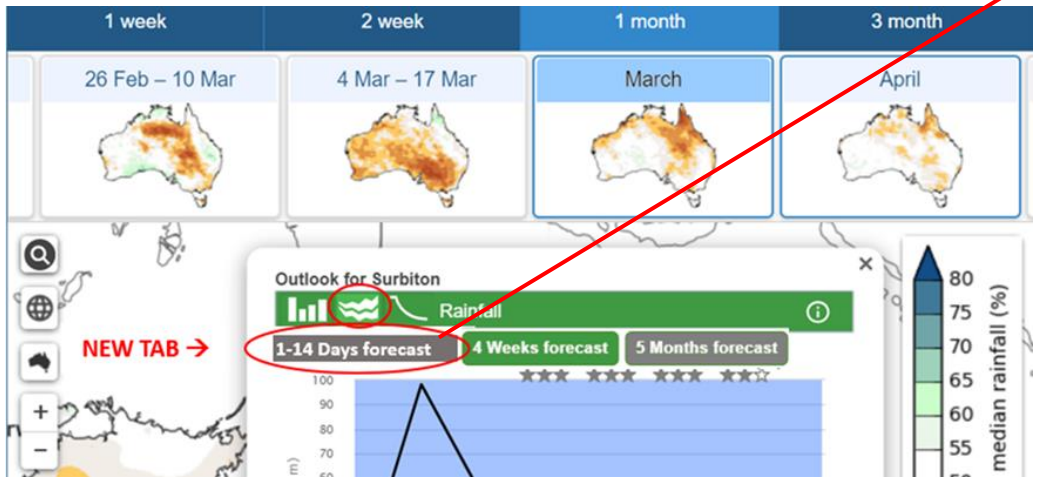
Smith & Spillman (2024); Smith, Spillman, Hobday & Hartog et al (in prep)

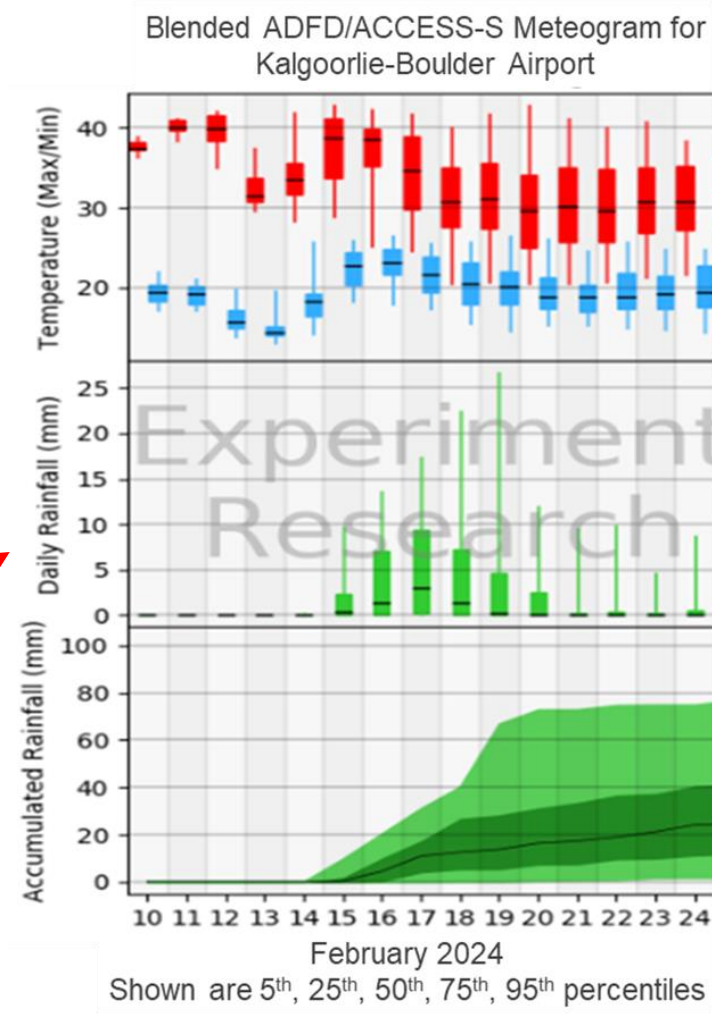




Seamless blending forecasts across timescales

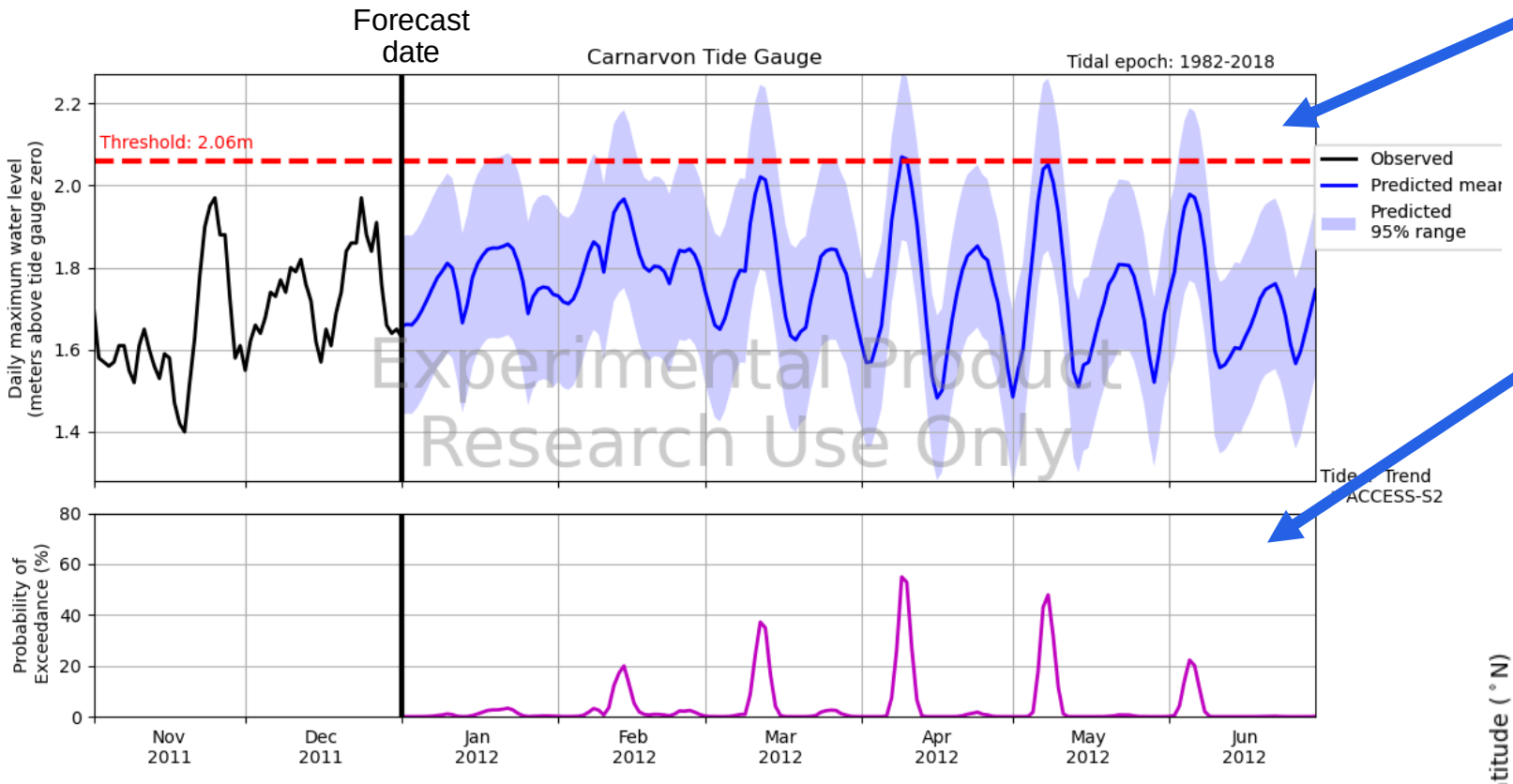
- We have developed a method of 'seamless blending' our weather (i.e. ADFD) and subseasonal-to-seasonal (i.e. ACCESS-S) forecasts.
- We adjust the 99 ACCESS-S ensemble members to be consistent with ADFD for the days they overlap.
- This will allow for:
  - Consistency between our weather and subseasonal-to-seasonal forecasts;
  - Increased skill for all products that include information for the next 7 days;
  - Possibility for extending the daily forecast beyond day 7;
  - Having forecasts across all time-scales available in a single location.





R Taggart, M Griffiths,
M Wheeler, C Spillman

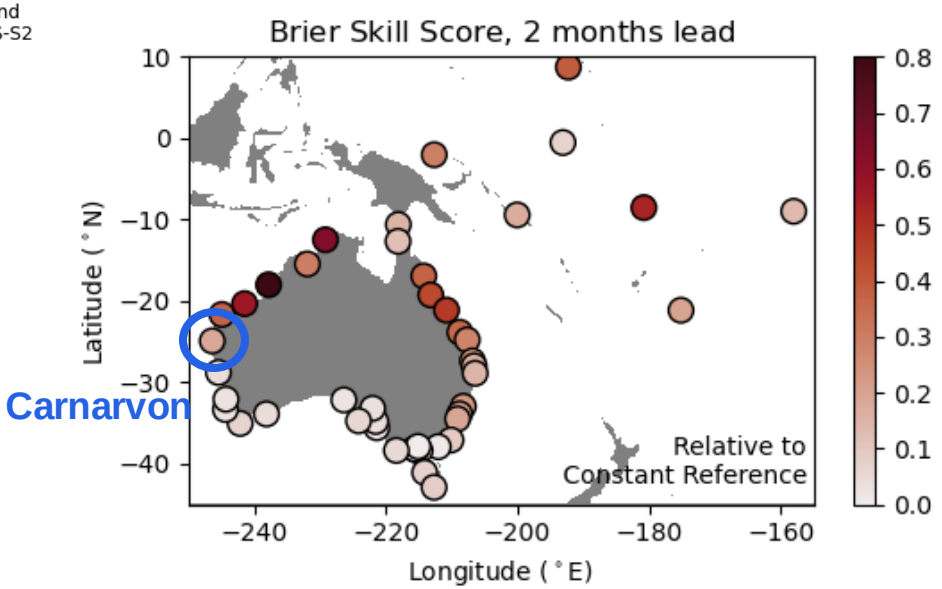
Seasonal total water level forecasts for the Australian coast



Total water level forecast combining:

- tide predictions
- sea level rise
- storm surge statistics
- ACCESS-S2 seasonal anomalies

Daily probability of **High Tide Flooding**



Through the Australian Climate Service (ACS), we are developing an early warning system for High Tide Flooding

Holmes, Smith & Spillman (in review)
Holmes, Richet, Hague, Smith and Spillman (in prep)

Performance best where tides are largest and worst where storm surges are dominant