Bureau of Meteorology ACCESS-S2

Multi-Week Tropical Cyclone Guidance

Overview

The Bureau of Meteorology makes available multi-week tropical cyclone (TC) strike probability forecasts http://www.bom.gov.au/climate/pacific/outlooks/ for use by National Meteorological Services from the Australian Community Climate Earth-System Simulator – Seasonal (ACCESS-S) model. For more information on ACCESS-S go to http://www.bom.gov.au/climate/ahead/about/model/access.shtml. While seasonal TC forecasts such as those at http://access-s.clide.cloud/files/tropical_cyclones/forecast/nw_pacific/ provide information on the potential number of TCs within a region, they do not provide information on when or where these TCs might occur within the season. Weekly TC forecasts provide finer scale time and location specific probabilistic information outlining the chance of and potential location of tropical cyclone occurrence within a week 1-4 period.

The ACCESS-S tropical cyclone tracker identifies points on the globe which are conducive to TC formation over a forecast period of weeks. To accomplish this, various thresholds for TC development need to be met and sustained. Outputs of the model are then presented in two ways: The first is a raw model forecast, which is a forecast based on the model 'world' only (which may not match the real-world exactly). The second, a calibrated forecast, is the raw model forecast adjusted to the real-world.

Currently week 2 (day 8-14) and week 3 (day 15-21) raw and calibrated forecasts are presented and updated each day within a region's tropical cyclone season. While there is significant prediction skill at week 1 these forecasts are not presented as they would occur at the same time as operational weather scale TC forecasts and therefore to avoid confusion week 1 ACCESS-S TC forecasts are not presented.

The ACCESS-S2 hindcast indicates overconfidence both in the southern hemisphere and in the northwest Pacific, including in the case of calibrated forecasts. This is however an improvement on ACCESS-S1. This means the model will present elevated TC development more often than what is observed.

The raw and calibrated model forecasts should be considered together to capture the best forecast information available; a brief description of both available products is shown below followed by a brief interpretation guide and associated references.

1. Raw model tropical cyclone formation probability plots

Tropical Cyclone strike probabilities using a 27.2 knots or 50.4 km/h minimum wind threshold at 850 hPa are computed by finding the proportion of forecast model tracks which pass within 300 km of each grid point (the probability comes from running the ACCESS-S model 33 times per day and finding the number of times out of 33 the model forecasts a tropical cyclone at each location). Forecasts for the period 9 to 15 February 2024 are presented as an example (Figure 1). Note the greater precision available in raw model plots.

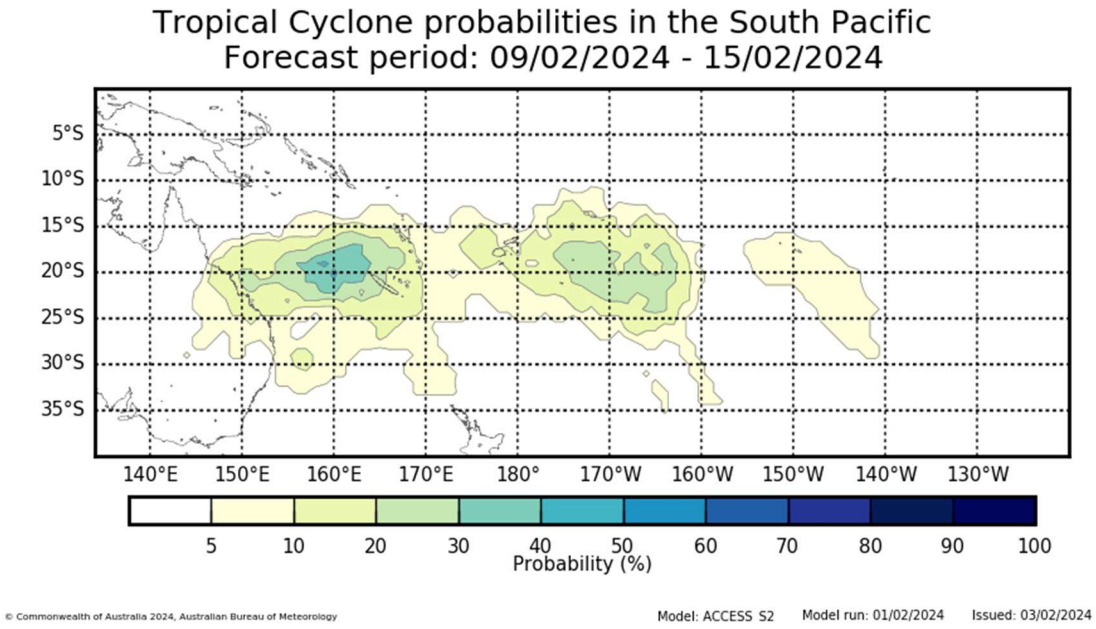

Figure 1. Raw model strike probability forecast for the southern hemisphere region.

2. Calibrated model tropical cyclone formation probability plots

Calibrated probabilities (e.g. Figure 2) have the best skill and reliability, particularly with week 3 and 4 forecasts. Calibration means the model forecasts are adjusted to the 'real world' based on historical occurrence which increases the skill of the forecast. However, by constraining the model to the historical record some of the spatial resolution is lost (see the relatively large grids in Figure 2). A combination of the lower probabilities and coarser resolution that occurs through calibration means that we lose the very high probability events which are evident in the raw model probabilities (Figure 1).

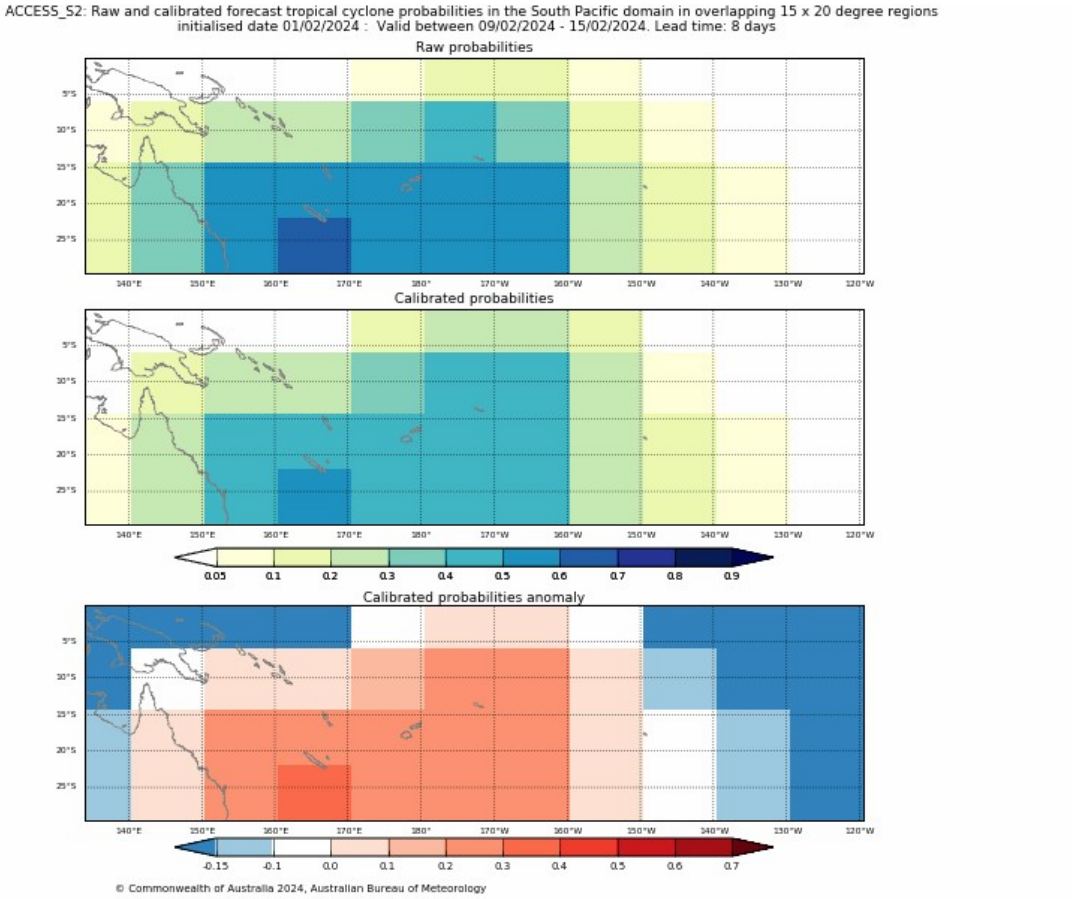

Figure 2. Calibrated model strike probability forecast in overlapping 15 x 20-degree regions. a) Raw model probabilities, b) calibrated model probabilities, c) calibrated model anomaly probabilities.

3. Interpretation guide

Figure 3 shows the difference from normal chances of TC formation and is intended to be used as the primary forecast tool for assessing the risk of tropical cyclone occurrence over a region, this is the same data as for the bottom panel of the calibrated forecast plot (Figure 2) shown in a little more detail.

The plot shows the chances of a tropical cyclone forming with respect to the historical occurrence. The historical computation of 'normal' probability is computed across the entire southern hemisphere. So generally, for any week between Nov-Apr, there is a 20% chance of a storm occurring somewhere in the southern hemisphere. This value has been shown to vary little regionally or temporally. The sub-regional detail comes from calibrating the forecast to historically observed events, highlighting areas which have a historical higher chance for TC formation.

The blue and white shading indicates the risk is low due to conditions not being favourable for cyclogenesis between 9 – 15 February 2024. The red shading indicates an increase in the chances for tropical cyclone formation with probabilities of 30% or greater a significant increased risk when compared to the historical record.

A forecast which maintains a steady chance of cyclone formation over two-three days is a good indicator of future cyclone genesis. Probabilities between 10-30% indicate increased cyclogenesis risk, with probabilities above approximately 30% indicating significant tropical cyclone formation risk (Figure 3) for a specific location.

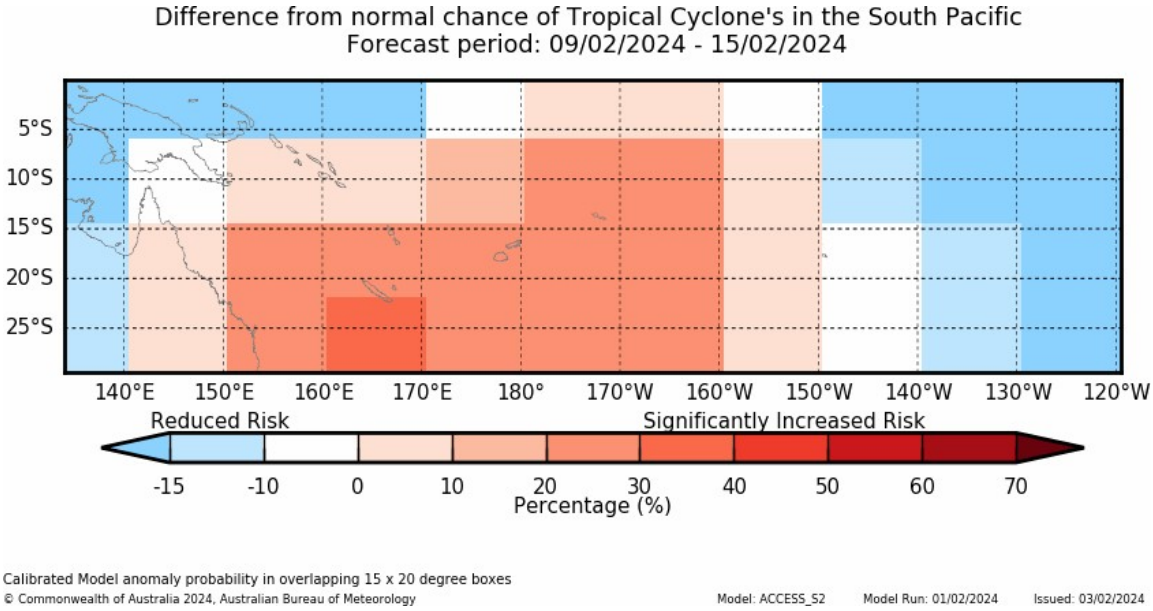

Figure 3. Calibrated model anomaly probability forecast in overlapping 15 x 20-degree regions.

4. Model tropical cyclone formation probability skill assessment

Hindcast model skill for 1981-2018 has been assessed using the Brier Skill Score (Table 1) and reliability skill metrics. A forecast has skill if the BSS is greater than zero, with 1.0 being the perfect forecast. A perfectly reliable forecast as shown in (Figure 4-5) would feature all points of the solid dotted line falling onto the diagonal (i.e. an event with a forecast probability of 40% will be observed 40% of the time). Table 1 shows greater than zero BSSs for weeks 2-4 for both hemispheres and higher BSSs for calibrated and Western North Pacific forecasts. Even though week 4 southern hemisphere forecasts have skill as defined by the BSS metric, they are not presented as the skill is marginal. We note that hindcast reliability for all regions indicates some overconfidence at high forecast probabilities, even after calibration.

Southern Hemisphere	**Week 1 (Days 4-7)**	**Week 2 (Days 8-14)**	**Week 3 (Days 15-21)**	**Week 4 (Days 22-28)**
Raw	0.256	0.117	0.047	0.003
Calibrated	0.251	0.133	0.081	0.054

Western North Pacific	**Week 1 (Days 4-7)**	**Week 2 (Days 8-14)**	**Week 3 (Days 15-21)**	**Week 4 (Days 22-28)**
Raw	0.349	0.267	0.203	0.177
Calibrated	0.338	0.249	0.195	0.181

Table 1. Brier Skill Score for (top) the Southern Hemisphere, (bottom) the north west Pacific, for the cross validated model hindcast 1981-2018.

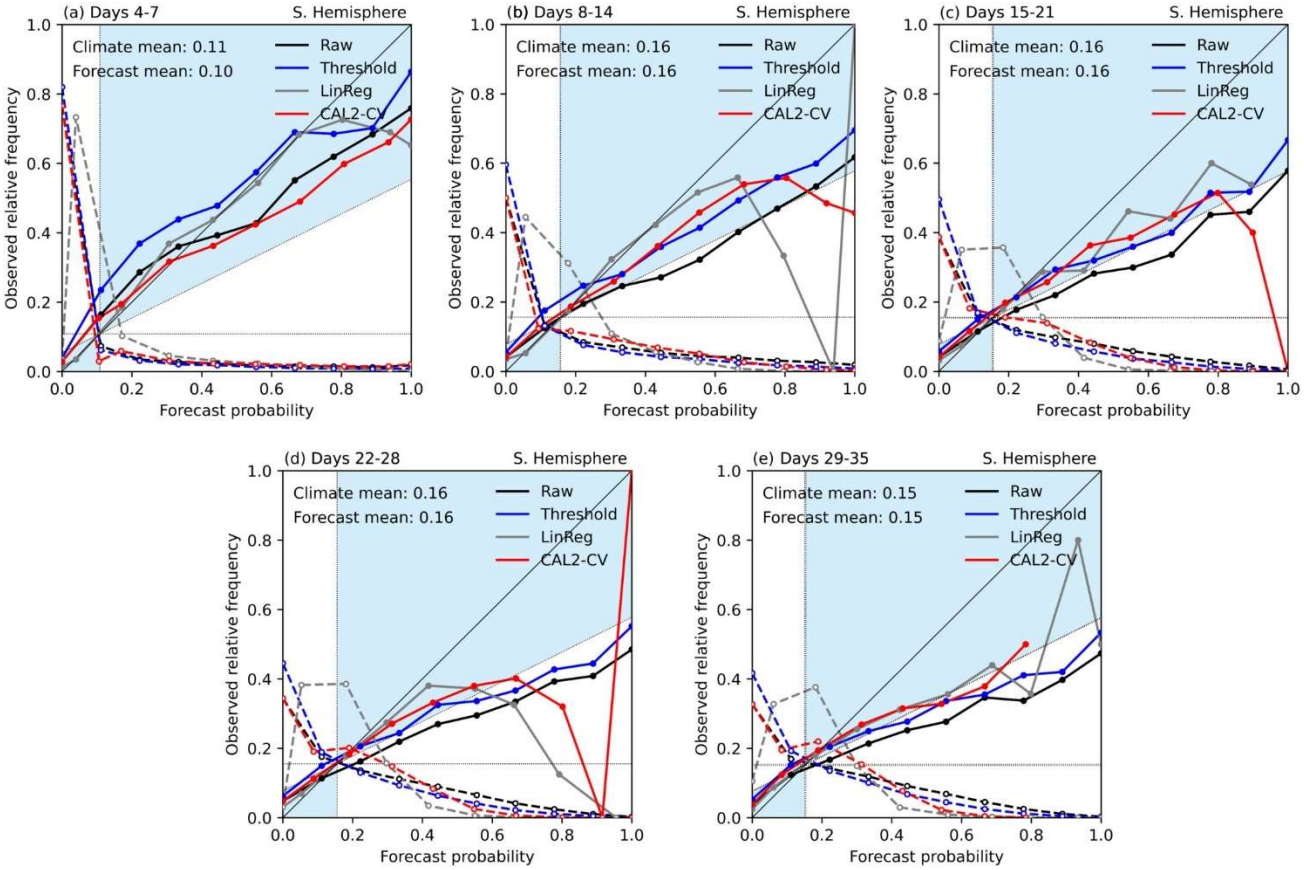

Figure 4. Reliability diagrams for the Southern Hemisphere for ACCESS-S2 using four different processing methods (raw model tracks, raw model tracks with wind speed threshold, calibrated-probabilities CAL2-CV, and the linear regression-based calibration LinReg) for forecast days (a) 4–7 (week 1), (b) 8–14 (week 2) and (c) 15–21 (week 3), (d) 22–28 (week 4) and (e) 29–35 (week 5). Hindcasts starting 1st and 16th of the month, November–April 1981–2018.

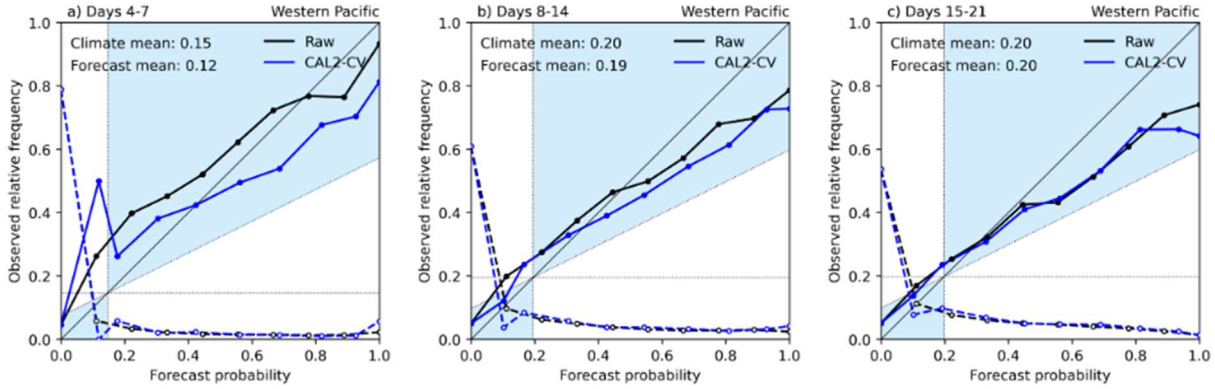

Figure 5. Reliability diagrams for the North West Pacific for ACCESS-S2 for raw model tracks (black) and calibrated-probabilities CAL2-CV (blue) for forecast days (a) 4–7 (week 1), (b) 8–14 (week 2) and (c) 15–21 (week 3). Hindcasts starting 1st and 16th of the month, January-December 1981–2018.

5. References

Camp, J., Gregory, P., Marshall, A., Greenslade, M., Wheeler, M. 2023: Multiweek tropical cyclone prediction for the Southern Hemisphere in ACCESS-S2: Maintaining operational skill and continuity of service. Quarterly Journal of the Royal Meteorological Society. 149 (757), 3401-3422. https://doi.org/10.1002/qj.4563

Gregory PA, Camp J, Bigelow K, Brown A, 2019: Sub-seasonal predictability of the 2017–2018 Southern Hemisphere tropical cyclone season. Atmos Sci Lett. 20:e886. https://rmets.onlinelibrary.wiley.com/doi/pdf/10.1002/asl.886

Gregory, P., F. Vitart, R. Rivett, A. Brown, and Y. Kuleshov, 2020: Subseasonal Forecasts of Tropical Cyclones in the Southern Hemisphere Using a Dynamical Multimodel Ensemble. Wea. Forecasting, 35, 1817–1829, https://doi.org/10.1175/WAF-D-20-0050.1.