January 2022 Outlook update for the 2021/22 Australian Tropical Cyclone Season

Long-Range Tropical Cyclone Outlook for Australia (TCO-AU)

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TCO-AU
Long-Range
Tropical Cyclone Outlook
for Australia
www.tcoutlook.com

TCO-AU is a new, long-range tropical cyclone outlook based on a method published in Scientific Reports (Magee et al., 2020) and the Journal of Applied Meteorology and Climatology (Magee & Kiem, 2020). Please see the disclaimer about use of this information in the "Interpreting TCO-AU" section.

Outlook Summary

The January 2022 Long-Range Tropical Cyclone Outlook for Australia (TCO-AU) suggests **near-normal to reduced TC activity** for the remaining 2021/22 Australian TC season (1st February to 30th April 2022). In total, **6 TCs** are expected for the Australian region (compared to a 1991-2020 average of 6),[1] however the probable range of TCs could lie between **4 and 7 TCs[2]**. There is a **69% chance the season will see above-normal TC activity** (6 TCs or more) and a 31% chance the season will see average or below-normal TC activity (6 TCs or less).

Expected average TC counts (and probable range) for the TC regions of Australia are summarised below:

- **Eastern region (AR-E):** 2 TCs (1-3 TCs). 24% chance of above-average TC activity (>2 TCs).
- **Northern region (AR-N):** 2 TCs (1-3 TCs). 30% chance of above-average TC activity (>2 TCs).
- **Northwestern sub-region (AR-NW):** 3 TCs (2-4 TCs). 26% chance of above-average TC activity (>3 TCs).
- **Western region (AR-W):** 4 TCs (3-5 TCs). 33% chance of above-average TC activity (>5 TCs).

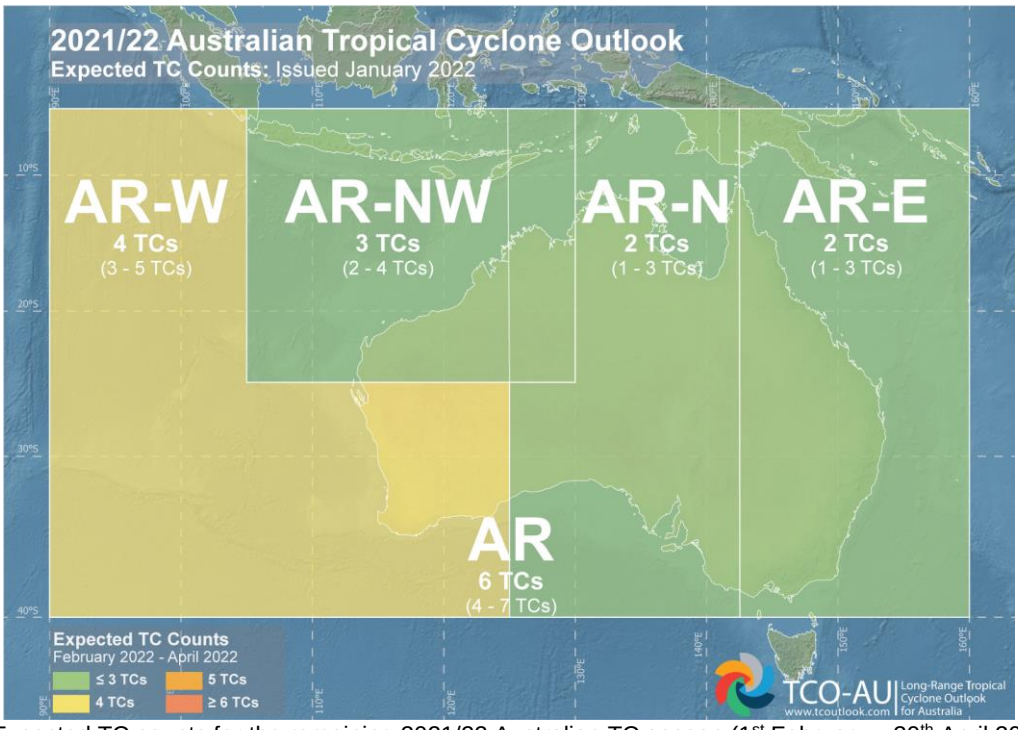

Figure 1. Expected TC counts for the remaining 2021/22 Australian TC season (1st February – 30th April 2022). See Table 1 for TC counts, including probable TC range.

[1] Australian region: 90°E-160°W.
[2] Probable range based on 95% confidence intervals.

Deterministic guidance

For the remaining 2021/22 Australian TC season, 6 TCs are expected (probable range of 4-7 TCs), suggesting near-normal to reduced TC activity when compared with the 1991-2020 average of 6 TCs.

Table 1: Summary of deterministic guidance. Average TC count (1991-2020), expected TC count including expected range (95% confidence intervals (CI)) for the remaining 2021/22 Australian tropical cyclone season (February 2022 – April 2022) and the difference between expected and average TC count.

	Average TC count (1991-2020[a])	**Expected TC Count** (Probable TC count range: 95% CI)	**Difference between expected and long-term average (TC)**
Australia (AR)	5.8	5.5 (4.3-6.9)	▼ 0.3
Eastern region (AR-E)	2.0	1.7 (1.1-2.5)	▼ 0.3
Northern region (AR-N)	2.1	1.9 (1.4-2.7)	▼ 0.2
Northwestern sub-region (AR-NW)	2.9	2.6 (1.9-3.5)	▼ 0.3
Western region (AR-W)	3.5	3.8 (3.1-4.6)	▲ 0.3

[a] Average TC counts (1991-2020) calculated for the February-April TC season.

Probabilistic guidance

Figure 2 summarises the long-range probabilistic outlook for the remaining 2021/22 Australian Tropical Cyclone Season (February - April 2022).

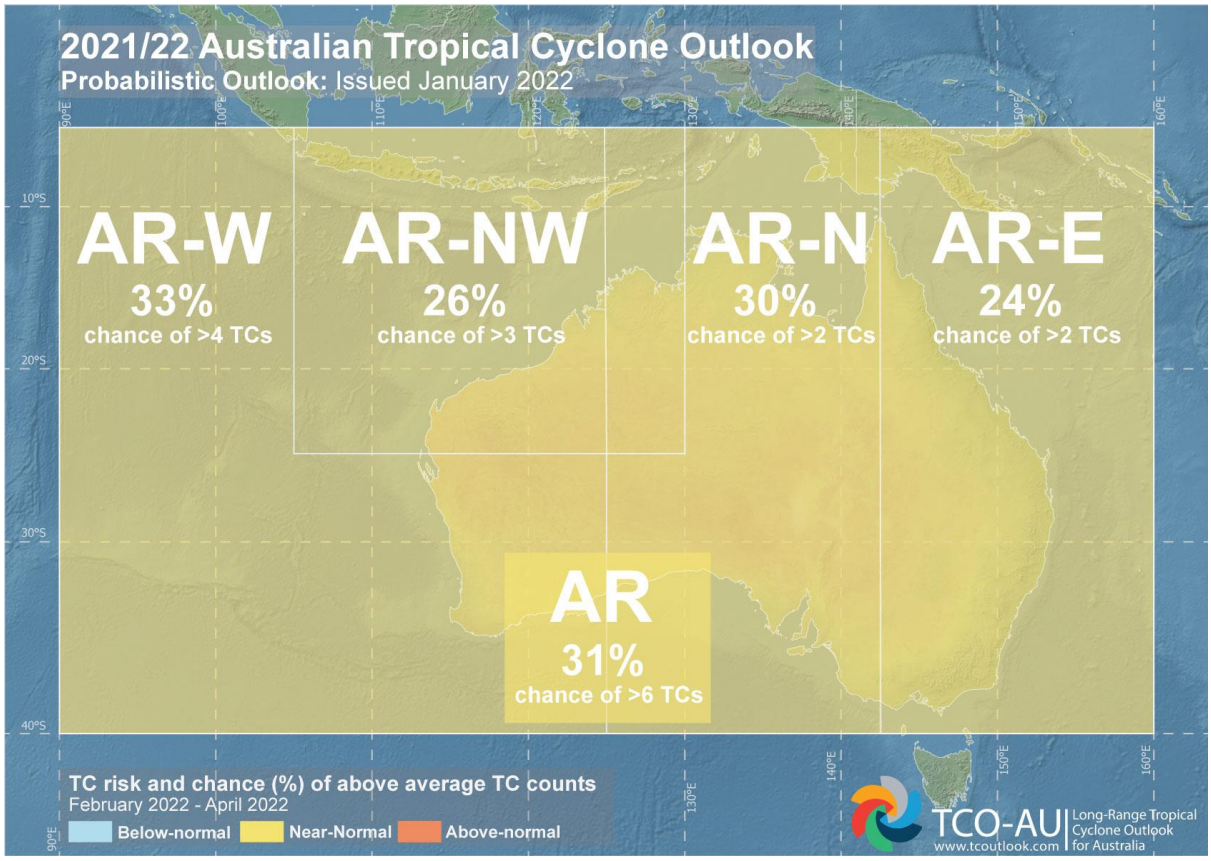

Figure 2. TC risk and probabilistic TC outlook for the remaining 2021/22 Australian TC season (1st February – 30th April 2022). Probabilities and probable TC range are summarised for each location. See Table 2 for tabular probabilities (including TC range).

- **Near-Normal**[3] TC activity is expected for the Australian region (31% chance of >6 TCs), the Eastern region (24% chance of >2 TCs), Northern region (30% chance of >2 TCs),

[3] Near-normal is defined as when the difference between expected TC counts and the long-term (1991-2020) average is between -20% and +20%.

Northwestern sub-region (26% chance of >3 TCs) and the Western region (33% chance of >4 TCs).

Table 2. Summary of probabilistic guidance. Calculation of difference between the long-term average and expected TC count (%), TC risk and the chance of near-normal, below-normal or above-normal TC activity for the remaining 2021/22 Australian TC season (February 2022 – April 2022).

	Long-term average TC count (1991-2020)	**Expected TC count**	**Difference between long-term average and expected TC count (%)**	**TC risk[a]**	**Chance of average or below-average TC activity (%)[b]**	**Chance of above-average TC activity (%)[b]**
Australia (AR)	5.8	5.5	-5%	Near-normal (reduced)	69%	31%
Eastern region (AR-E)	2.0	1.7	-15%	Near-normal (reduced)	76%	24%
Northern region (AR-N)	2.1	1.9	-10%	Near-normal (reduced)	70%	30%
Northwestern sub-region (AR-NW)	2.9	2.6	-10%	Near-normal (reduced)	74%	26%
Western region (AR-W)	3.5	3.8	+9%	Near-normal (elevated)	67%	33%

[a] TC risk is calculated using the percentage difference between expected TC counts and the 1991-2020 climatology. Near-normal risk is defined where the difference between expected and long-term average (1991-2020) TC counts is between -20% and +20%. Reduced (elevated) risk is defined where the difference between expected and long-term average (1991-2020) TC counts exceeds -20% (+20%).
[b] Chance of average or below-average TC activity and chance of above-average TC activity calculated using Poisson distributional process.

Predictors and climate influences relevant to 2021/22 TC season

El Niño-Southern Oscillation: A La Niña event is currently underway in the tropical Pacific Ocean. Statistical and dynamical SST models of the NINO3.4 region from the CPC/IRI indicate a **74% chance of La Niña conditions** for the remaining February-April 2022 TC season,[4] while the CPC/IRI official Probabilistic ENSO forecast suggests an **83% chance of La Niña conditions** for the same period.[5] According to ACCESS-S,[6] there is a **33% (8%) chance of La Niña conditions** by February 2022 (April 2022). La Niña conditions typically result in increased TC activity in Australia (Chand et al., 2019), with twice as many landfalling TCs during La Niña compared to El Niño and multiple landfalling TCs in Queensland during La Niña events (BOM, 2016). The Australian Bureau of Meteorology indicates that a transition back to ENSO neutral conditions is most likely in the second half of the TC season (February-April 2022).

Indian Ocean Sea Surface Temperatures: Statistical and dynamical guidance collected from five international climate models (BOM, CanSIPS, ECMWF, METEO and UKMO) indicate that IOD neutral conditions are most likely to persist until the end of April 2022.[7] According to ACCESS-S,[8] there is a **96% chance of IOD neutral conditions** by February 2022 and a **94% chance of IOD neutral conditions** by April 2022.

[4] IRI ENSO forecast (Published January 19 2022) https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-sst_table
[5] CPC/IRI ENSO Forecast (Published January 13 2022) https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-cpc_update
[6] Australian Community Climate Earth-System Simulator-Seasonal (ACCESS-S) ENSO (NINO3.4) outlooks (Climate model summary issued January 12 2022; updated January 18 2022) http://www.bom.gov.au/climate/model-summary/#tabs=Bureau-model&region=NINO34
[7] BOM Indian Ocean Dipole Outlook (Issued January 12 2022; Updated January 18 2022) http://www.bom.gov.au/climate/model-summary/#tabs=Indian-Ocean.
[8] Australian Community Climate Earth-System Simulator-Seasonal (ACCESS-S) IOD outlooks (Issued January 12 2022; Updated January 18 2022) http://www.bom.gov.au/climate/model-summary/#tabs=Bureau-model&region=IOD.

Model Validation

Model validation statistics compare key model performance metrics for (i) the modelled TC time series when trained on the entire 1970-2021 training period and (ii) the TC time series derived from the Leave-One-Out Cross-Validation (LOOCV)[9] step. The model with the highest LOOCV skill score (1970-2021) is selected as the superior model and is used to derive the seasonal TC outlooks. The statistics for the same model when trained on the entire 1970-2021 period are also summarised in Table 3. Model validation statistics (Table 3) offer important insights when considering outputs from TCO-AU.

Table 3. Summary statistics comparing model performance (predicted TCs compared with observed TCs) for the 1970-2021 training period (top values) and the Leave-One-Out Cross-Validation (LOOCV) time-series (bottom values in parentheses).

	Correlation	R^2	RMSE	Skill Score (%)[a]	Strike Rate (exact) (%)[b]	Strike Rate (±1) (%)[c]
Australia (AR)	0.68 (0.59)	0.46 (0.35)	1.51 (1.12)	45.8 (34.0)	29 (25)	69 (63)
Eastern region (AR-E)	0.66 (0.58)	0.44 (0.34)	1.02 (0.69)	43.5 (33.7)	42 (40)	90 (83)
Northern region (AR-N)	0.64 (0.51)	0.41 (0.26)	0.97 (0.72)	40.5 (23.3)	38 (33)	88 (85)
Northwestern sub-region (AR-NW)	0.54 (0.41)	0.29 (0.17)	1.20 (0.62)	29.0 (16.5)	23 (19)	81 (75)
Western region (AR-W)	0.57 (0.43)	0.32 (0.18)	1.26 (0.74)	32.2 (17.0)	35 (35)	79 (73)

[a] Skill score evaluates model performance over the specified training period. 100% represents a perfect outlook. 0% represents outlooks as accurate as the climatology. See Roebber and Bosart, (1996).
[b] Strike Rate exact is the % of seasons throughout the training period (1970-2021) where the prediction matched the observation.
[c] Strike Rate ±1 is the % of seasons throughout the training period (1970-2021) where the prediction matched the observation ±1 TCs.

Model Consensus

Evaluating model consensus provides an understanding of how well predictor models agree on the expected TC count and range. In total, 10 predictor models are trained per location. Figure 3 summarises the expected TC count and probable range for the 10 predictor models (TC count and confidence intervals) for the January 2022 outlook and the red dot indicates the model with the highest LOOCV skill score, which is the prediction selected to generate the outlook. The multi-model average (AV) is also included in Figure 3.

An automated variable selection algorithm selects the best combination of predictors for each of the 10 predictor models. In an update to the methodology published by Magee & Kiem (2020), a LOOCV time series is derived for each of the 10 predictor models (using the same indices identified by the automated variable selection algorithm). The model with the highest LOOCV skill score (Table 3) over the 1970-2021 training period is selected as the superior model and is used to derive the location-specific seasonal outlooks.

[9] The Leave-One-Out Cross-Validation (LOOCV) is a method of model cross-validation. Using this approach, the model is trained using n – 1 seasons to produce a hindcast number of events and is iteratively applied in a jackknife fashion to hindcast every historical season in the record. The subsequent time series provides a view of hindcast model skill.

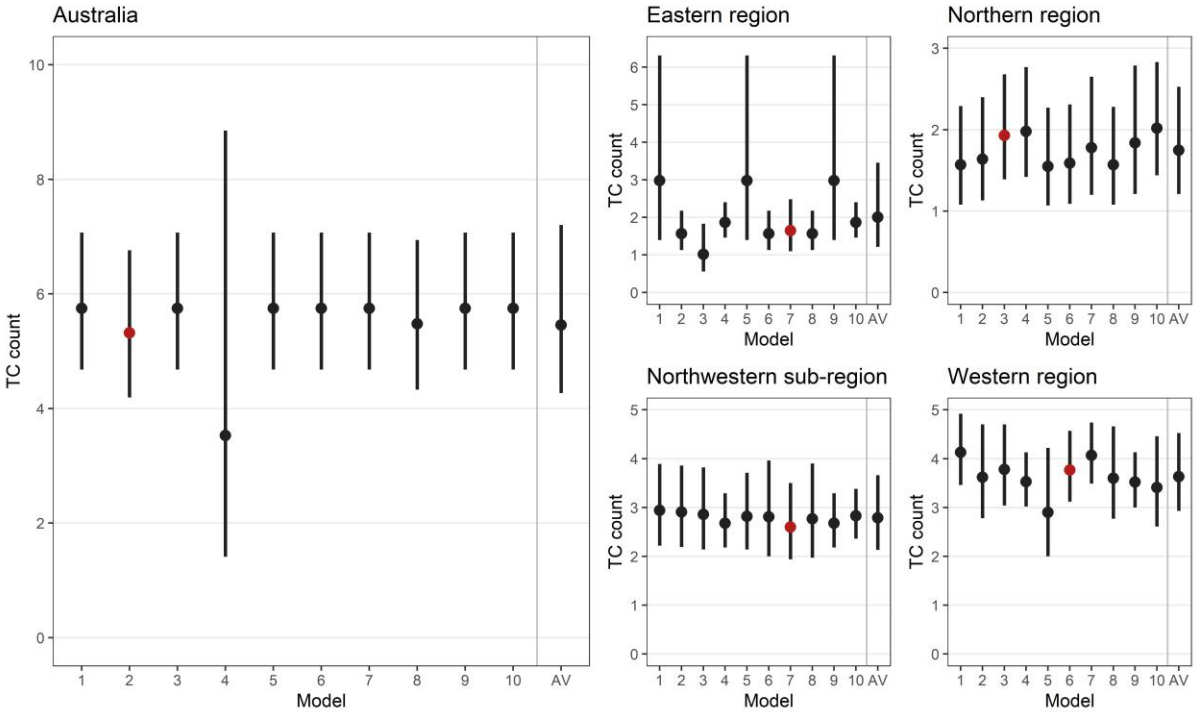

Figure 3. Comparison of predictor model consensus for expected TC counts (dot) and range (95% confidence intervals). Red dot indicates model selected due to superior model performance (highest LOOCV skill score). Models 1-10 refer to each unique predictor model. AV (average) refer to multi-model average (average of expected TC counts and range (95% confidence intervals)). A StepAIC function is applied to each set of predictor models to calculate the optimum combination of covariates (see Magee & Kiem (2020) for more information).

2021/22 TCO-AU Outlook schedule

The January 2022 TCO-AU outlook is the final update for the 2021/22 Southwest Pacific TC season. Archived guidance for the 2021/22 TC season is available here.

Interpreting TCO-AU

TCO-AU is a statistically-driven TC outlook for Australia. Rolling monthly updates will be provided between July and January so predictive models used in TCO-AU can consider the latest changes in ocean temperature and atmospheric variability. The following details should be considered when using TCO-AU:

- Guidance from TCO-AU does not and should not replace the advice provided by the Australian Bureau of Meteorology.
- Timescales associated with outlooks (months) are different to shorter-term weather forecasts (hours to days). In the case of long-range outlooks such as those presented here, TCO-AU provides guidance up to four months before the start of the Australian TC season. As such, it is possible for daily or weekly changes in predictors (i.e. ocean temperatures and atmospheric variability) to influence TC numbers and result in discrepancies with the long-range TC outlooks.
- Monthly TCO-AU guidance will track any changes in ocean temperature/atmosphere variability, which may result in changes in guidance from one monthly outlook to another. Subscribing to TCO-AU is the best way for end-users to stay up to date with the latest TCO-AU updates.
- Users should evaluate model skill (Table 3) and model consensus (Figure 3) to inform decision-making.

- TCO-AU is an experimental platform and should ideally be used in combination with other guidance for decision-making. TCO-AU does not accept any liability associated with decisions that are made using this guidance.
- It does not take a landfalling TC to cause significant and life-threatening impacts. Always be alert. Listen to the advice of the Australian Bureau of Meteorology and relevant state government authorities.

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