September Long-Range Outlook for the 2020/21 Australian Tropical Cyclone Season
Long-Range Tropical Cyclone Outlook for Australia (TCO-AU)

Outlook issued: 23rd September 2020 (v1)
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TCO-AU is a new, long-range tropical cyclone outlook based on a method recently 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 September Long-Range Tropical Cyclone Outlook for Australia (TCO-AU) suggests normal to above normal TC activity for the coming 2020/21 Australian TC season (1st November 2020 to 30th April 2021). In total, 11 named TCs are expected for the Australian region1, ~10% more than the 1981-2010 average (10 TCs)2; however, the probable range of named storms could lie between 9 and 15 TCs3. There is a 47% chance the season will see above-average (12 TCs or more) activity. There is a 23% chance the season will be near normal (10-11 TCs) and a 30% chance that the number of named TCs in the Australian region will be below average (9 TCs or more).

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

* Eastern region (AR-E): 4 TCs (3-6 TCs), 55% chance of ≥4 TCs.
* Northern region (AR-N): 3 TCs (2-5 TCs), 37% chance of ≥4 TCs.
* Northwestern sub-region (AR-NW): 4 TCs (3-6 TCs), 45% chance of ≥5 TCs.
* Western region (AR-W): 6 TCs (5-8 TCs). 39% chance of ≥7 TCs.

Figure 1. Expected TC counts for 2020/21 Australian TC season. See Table 1 for TC counts, including probable TC range.

1 Australian region: 90°E-160°W.
2 Named TCs within the Australian region (90°E-160°W) tropical cyclone season (November-April).
3 Probable range based on 95% confidence intervals.
Statistical and dynamical guidance from international climate models indicate that **La Niña conditions** are most likely to develop before the start of the 2020/21 Australian TC season. 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). TCO-AU is updated monthly between September and January (see 2020/21 Outlook schedule), so any changes to ocean temperature/atmosphere variability will be included in the TCO-AU models as the 2020/21 Australian TC season draws closer.

**Deterministic guidance**

For the coming 2020/21 Australian TC season, 11 named TCs are expected (probable range of 9-15 TCs), suggesting above normal TC activity when compared with the 1981-2010 average of 10.1 TCs.

**Table 1**: Expected TC counts including expected range (95% confidence intervals) for the 2020/21 Australian tropical cyclone season (September 2020 update) and difference from 1981-2010 average TC count.

<table>
<thead>
<tr>
<th>Region</th>
<th>Long-term average TC count (1981-2010)</th>
<th>Expected TC Count (Probable TC count range: 95% CI)</th>
<th>Difference between expected and long-term average (TC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia (AR)</td>
<td>10.1</td>
<td>11.4 (8.7-14.9)</td>
<td>▲ 1.3</td>
</tr>
<tr>
<td>Eastern region (AR-E)</td>
<td>3.1</td>
<td>3.9 (2.5-6.0)</td>
<td>▲ 0.8</td>
</tr>
<tr>
<td>Northern region (AR-N)</td>
<td>3.7</td>
<td>3.1 (2.1-4.6)</td>
<td>▼ -0.6</td>
</tr>
<tr>
<td>Northwestern sub-region (AR-NW)</td>
<td>5.4</td>
<td>4.4 (3.2-6.0)</td>
<td>▼ -1.0</td>
</tr>
<tr>
<td>Western region (AR-W)</td>
<td>6.5</td>
<td>6.0 (4.5-8.2)</td>
<td>▼ -0.5</td>
</tr>
</tbody>
</table>

* Average TC counts (1981-2010) calculated for November-April TC season.

**Probabilistic guidance**

Figure 2 summarises the long-range probabilistic outlook for the 2020/21 Australian Tropical Cyclone Season.

![Figure 2. Probabilistic TC outlook for the November-April 2020/21 TC season. Probabilities and probable TC range are summarised for each location. See Table 2 for tabular probabilities (including TC range).](image)

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4 IRI ENSO forecast (Published September 18 2020) [https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/](https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/)

5 For the 2021/22 Australian TC season, TCO-AU will be updated every month between July and January.
- **Above Normal** TC activity is expected for Australia (47% chance of 12 TCs or more) and for the Eastern region (55% chance of 4 TCs or more)
- **Normal** TC activity is expected for the Western region (39% chance of 7 TCs or more)
- **Below normal** TC activity is expected for the Northern region (37% chance of 4 TCs or more) and the Northwestern region (45% chance of 5 TCs or more).

Table 2. Probability and TC count range of below-normal, normal and above-normal TC activity for the 2020/21 Australian TC season. Due to the discrete nature of the Poisson distribution used in the modelling, approximate terciles are calculated.

<table>
<thead>
<tr>
<th></th>
<th>Below Normal</th>
<th>Normal</th>
<th>Above Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Probability</td>
<td>TC count</td>
<td>Probability</td>
</tr>
<tr>
<td>Australia (AR)</td>
<td>30%</td>
<td>≤9</td>
<td>23%</td>
</tr>
<tr>
<td>Eastern region (AR-E)</td>
<td>25%</td>
<td>≤2</td>
<td>20%</td>
</tr>
<tr>
<td>Northern region (AR-N)</td>
<td>63%</td>
<td>≤3</td>
<td>17%</td>
</tr>
<tr>
<td>Northwestern sub-region (AR-NW)</td>
<td>55%</td>
<td>≤4</td>
<td>17%</td>
</tr>
<tr>
<td>Western region (AR-W)</td>
<td>61%</td>
<td>≤6</td>
<td>14%</td>
</tr>
</tbody>
</table>

* Terciles for each region are the number of TCs associated with the bottom third, middle third and top third of the Poisson distribution with the predicted number of TCs for the period 1970-2020 for that region. Due to the discrete nature of the Poisson distribution and the small numbers of TCs, the probabilities within the three bands will often not be exactly one third.

### Predictors and climate influences relevant to 2020/21 TC season

**El Niño Southern Oscillation**: Statistical and dynamical guidance from international climate models indicate a **70-80% chance of La Niña conditions** for Austral spring and summer (September-February). According to ACCESS-S², the probability of **La Niña conditions by October 2020**, is 94.9%. 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). In August 2020 SST anomalies (1961-1990) in the NINO3.4 region were -0.4°C, but weekly NINO3.4 anomalies show a cooling trend and were -0.7°C in the week between 06/9/2020 and 13/9/2020. SSTs in the NINO3.4 region are expected to cool further as the November-April Australian TC season draws closer.

**Indian Ocean Sea Surface Temperatures**: Statistical and dynamical guidance collected from six international climate models indicate the possibility of IOD negative conditions (BOM, METEO and UKMO cross IOD negative thresholds (-0.4°C)) by the start of the Australian Tropical Cyclone Season. The co-occurrence of IOD negative and La Niña conditions is not unusual. According to ACCESS-S¹¹, there is only a 19% chance of IOD negative conditions by November 2020 (80% chance of IOD neutral conditions). Model consensus should improve in the coming months. TCO-AU is updated monthly, so any changes will be considered as the 2020/21 TC season draws closer.

### Model Verification

Model verification statistics compare model performance during the training period (1970-2020 November-April TC season). Model verification statistics (Table 3) offer important insights when considering outputs from TCO-AU. The model with the highest training period (1970-2020) skill score is selected as the superior model and is what is summarised in Table 3.

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² Due to the discrete nature of the Poisson distribution and the small numbers of TCs, the probabilities within the three bands will often not be exactly one third. As such, 6 TCs for are forecasted for the Western region compared to the 1981-2010 climatology of 6.5 TCs. This is only a difference of 0.5 TCs, so normal TC activity was selected for the region.

²² The co-occurrence of IOD negative and La Niña conditions is not unusual. According to ACCESS-S¹, there is only a 19% chance of IOD negative conditions by November 2020 (80% chance of IOD neutral conditions). Model consensus should improve in the coming months. TCO-AU is updated monthly, so any changes will be considered as the 2020/21 TC season draws closer.


⁸ Australian Community Climate Earth System Simulator-Seasonal (ACCESS-S) ENSO (NINO3.4) outlooks (Climate model summary issued September 14 2020, Updated September 15 2020) http://www.bom.gov.au/climate/model-summary/?tabs=Bureau-model&region=NINO34


Table 3. Summary statistics comparing model performance (predicted TCs compared with observed TCs) for 1970-2020 training period. In total, 10 unique predictor models are evaluated per location and the one with the highest skill score is selected to generate the monthly outlook.

<table>
<thead>
<tr>
<th>Location</th>
<th>Correlation</th>
<th>$R^2$</th>
<th>RMSE</th>
<th>Skill Score (%)</th>
<th>Strike Rate (exact) (%)</th>
<th>Strike Rate ($\pm$1) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia (AR)</td>
<td>0.77</td>
<td>0.60</td>
<td>2.32</td>
<td>59.55</td>
<td>18</td>
<td>53</td>
</tr>
<tr>
<td>Eastern region (AR-E)</td>
<td>0.74</td>
<td>0.55</td>
<td>1.26</td>
<td>55.15</td>
<td>29</td>
<td>67</td>
</tr>
<tr>
<td>Northern region (AR-N)</td>
<td>0.64</td>
<td>0.41</td>
<td>1.20</td>
<td>41.21</td>
<td>33</td>
<td>82</td>
</tr>
<tr>
<td>Northwestern sub-region (AR-NW)</td>
<td>0.59</td>
<td>0.35</td>
<td>1.77</td>
<td>35.09</td>
<td>14</td>
<td>49</td>
</tr>
<tr>
<td>Western region (AR-W)</td>
<td>0.72</td>
<td>0.52</td>
<td>1.70</td>
<td>51.75</td>
<td>12</td>
<td>71</td>
</tr>
</tbody>
</table>

*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 (1970-2020) where the prediction matched the observation.

*c Strike Rate $\pm$1 is the % of seasons throughout the training period (1970-2020) where the prediction matched the observation $\pm$1 TCs.

Model Consensus

Model consensus provides an understanding of how well predictor models agree on the expected TC counts and range. In total, 10 predictor models are trained per location and the model with the highest skill score (Table 3) over the 1970-2020 training period is selected as the superior model. Figure 3 summarises predictor model consensus (TC count and confidence intervals) for the September outlook. The multi-model mean is also summarised. The red dot indicates the superior model.

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 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).
2020/21 Outlook schedule

Pre-season TCO-AU outlooks will be generated in September and October, while in-season outlooks will be generated every month between November and January. Table 4 outlines the remaining TCO-AU outlook schedule for the 2020/21 Australian Tropical Cyclone Season.

Table 4. TCO-AU outlook schedule for the 2020/21 Australian Tropical Cyclone Season

<table>
<thead>
<tr>
<th>Outlook</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-season outlook</td>
<td></td>
</tr>
<tr>
<td>October TC Outlook</td>
<td>21st October 2020</td>
</tr>
<tr>
<td>In-season outlook</td>
<td></td>
</tr>
<tr>
<td>November TC Outlook</td>
<td>18th November 2020</td>
</tr>
<tr>
<td>December TC Outlook</td>
<td>23rd December 2020</td>
</tr>
<tr>
<td>January TC Outlook</td>
<td>20th January 2021</td>
</tr>
</tbody>
</table>

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 outlooks, particularly 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 your local meteorological office and/or disaster management office.

Questions? Contact:
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12 From the 2021/22 Australian TC season onwards, TCO-AU guidance will be generated monthly between July-January.
References


