TROPICAL CYCLONE SEASON OUTLOOK

2018/19 - AUSTRALIAN REGION

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SUMMARY for 2018/19:

Neutral to weak El Nino conditions are expected through the 2018/2019 Australian tropical cyclone season. These conditions should result in a slightly below average of Tropical Cyclones (TC) over the Australian Region, with about 7 expected and with 4 becoming Severe Tropical Cyclones (STC). Accumulated Cyclone Energy (ACE) is expected to be near the climatological average across the three regions, with about 5-6 coastal impacts across all regions.

INTRODUCTION:

Researchers have established that some large-scale weather and ocean phenomena produce notable effects on the number and distribution of tropical cyclones in various regions e.g. Gray et al (1984), Nicholls (1985), Solow and Nicholls (1990), Ramsay et al (2008), Ramsay et al (2017).

One of the most important of these phenomena is the Southern Oscillation which is a “seesaw” fluctuation of atmospheric pressures in the tropical regions between Indonesia and the central Pacific Ocean. This has been quantified by means of an index, the Southern Oscillation Index (SOI), which utilizes the atmospheric pressures at Darwin and Tahiti.

An oceanographic phenomenon that is related to the SOI is known as the ENSO (El Niño Southern Oscillation) Cycle. ENSO Cycle has two phases, El Niño and La Niña. In an El Niño event the sea surface temperatures (SSTs) over the central equatorial Pacific Ocean area, known as NIO3.4, are warmer than normal by greater than 0.8 degrees. An El Niño is usually related to a negative SOI. In a La Niña event the SSTs are cooler than normal by greater than 0.8 degrees, normally corresponding to a positive SOI. SST anomalies between -0.8 and +0.8 degrees are considered in the neutral range.

Both the SOI and its Darwin component during the months of June to September have been found to correlate with the number and distribution of tropical cyclones in the Australian region during the following tropical cyclone season. More recent work by Liu (2010) showed that the NINO 4, further to the east of NINO3.4, may provide a better indicator of the number of TC over Australia.
Indian Ocean SSTs also play a part in determining rainfall and the number and distribution of TCs over northwestern Australian waters. The Indian Ocean Dipole (IOD) index (DMI) is an indicator of the SST over the east and west Indian Ocean (Saui 1999), with recent literature indicating that when the IOD is negative TC tend to be closer to the Australian coast, however it has been neutral for most of this year to August. The index is forecast to be above normal during October but return to the neutral range through the upcoming cyclone season, the influence of the IOD this season should therefore be small.

Recent work on the influence of Indian Ocean temperatures (Ramsey 2017) has developed an index called the Transverse Indian Ocean Dipole (TIOD), which is based on the difference in sea surface temperature (SST) anomaly between two areas (05S-20S, 90E-120E) - (15S-30S, 60E-85E) using data from 1969 onwards. This index shows a significant correlation with TC numbers (de-trended) over the Australian region with a positive TIOD correlated with a greater number of cyclones and a negative value with a below average number of TC's. This paper also noted that since about 1998, the skill of ENSO as a predictor of TC numbers in the Australian region has diminished (Dowdy 2014).

**METHOD:**

**Statistical method**

The ocean and the atmosphere are closely related in terms of their dynamics with the ocean being the more slowly changing. Thus, the status of the El Niño together with the sea surface temperature distributions and their differences from normal throughout the rest of the Southern Hemisphere give an indication of the dynamics currently operating in the atmosphere. Similar mechanisms are presumed to give similar results.

Past seasons are found in which the driving mechanisms are similar to those operating in the present season, as shown by the indices (SOI and NINO3.4) and their trends. Then the past associated tropical cyclone seasons can be analyzed and used as an indication for the likely up-coming season.

This method, known as the “analogue” technique, was used by McCormack (1980) and has since been used successfully by various forecast centers.

In practical terms the technique is a little limited in that other related tropical phenomena are not considered, as the literature and the available databases do not include them. Such phenomena include tropical lows, cloud clusters and other monsoonal activity which do not develop into tropical cyclones but can still interrupt operations both onshore and offshore.

The period of record considered for the analogue years has been restricted to the post satellite era which is 1969 to the present. Tropical cyclone statistics were calculated over the same period.
**Dynamic method**

Coupled climate global circulation models (CGCM) supply medium range weather forecasts, which although not expected to be able to forecast individual cyclones, are thought to be able to predict the frequency of occurrence (Leslie et al, 2007). Work is ongoing in this area at a number of centres.

An ensemble of medium range forecasts, taken from multiple climate models, is used to forecast the expected changes in the sea surface temperatures in the Eastern Pacific Ocean (NINO 3.4 index, including the NCEP’s Climate Forecast System (CFSv2) and the Australian Bureau Meteorology POAMA model. This was used in extrapolating the analogue technique into the upcoming cyclone season over Australia and refining the select years based on the expected future index changes.

Australian Bureau Meteorology POAMA model forecasts were also examined for the change in the IOD during the upcoming cyclone season.

**ANALYSIS:**

**Global Climate Models**

During 2018 in the NINO3.4 region over the eastern Pacific Ocean (from 20-170°W longitude and 5°N-5°S) showed negative SST anomalies in January gradually increasing to become weakly positive in May but remaining within the neutral range.

All dynamic and most statistical climate models forecast SST anomalies to continue to increase and by December become weak El Nino conditions although some models remain in the neutral range. The great majority of models then decrease values slightly in the new year but remain slightly positive but remain inside the neutral range. The BoM POAMA model lies slightly above the average of the rest of the dynamical models.

Therefore, neutral to weakly El Nino conditions are expected throughout the Australian region during the 2018/2019 cyclone season.

The IOD is forecast to be positive during October but return to neutral range from December, and the influence of the IOD should be small.

The TIOD for August 2018 SST anomaly data has a value of -0.6. The TIOD is usually calculated using the September value, and should this value remain at a similar level it would suggest a below average number of tropical cyclones across the Australian region in the 2018/2019 season. The SST’s around the northern Australian region are a little above average, which may slightly enhance cyclone development in the early season.
Analogues

The best analogue years based on current indices (over the past few months) and forecast trends are 1969/1970, 1976/1977, 1977/1978, 1993/1994, 1994/1995, 2003/2004 and 2014/2015, which are all years with conditions over the past few months very similar to those in 2018 (slightly below to become slightly above average). These years trended similar to the dynamic model forecasts, above average in the late summer and autumn. Seasons 1991/1992 and 2012/2013 did not follow the forecast of the dynamic models and were removed from the analogue for this season. A summary of the NINO3.4 anomaly from these analogue years can be seen in Figure 1 below.

![NINO3.4_AnaLogue_Years - 8_months_previous_and_8_months_post_from_1st_Oct_2018.png](image)

**Figure 1** - Time Series of current and forecast indices for 2018 (red), and NINO3.4 during Analogue Years.

Tracks for the 7 individual analogue years for each basin can be seen in Appendix A.
Other Agencies’ Outlooks

- The International Research Institute for Climate and Society (IRI) (http://portal.iri.columbia.edu/) indicates neutral or weakly El Nino conditions through the tropical cyclone season.

- The Australian Bureau of Meteorology (BoM) forecasts neutral to weak El Nino conditions through the tropical cyclone season along with slightly warmer than average sea surface temperatures around northern Australia. Their TC Season Outlook for the season has not yet been issued.

CONCLUSIONS for the 2018/19 Tropical Cyclone Season:

Based on the current atmospheric dynamics and the analogue years selected the main conclusions as summarized in Table 1 (below) are:

For the whole Australian region (0 - 30°S and 105 - 160°E):

1. The total number of TCs in the Australian region should be below normal, approximately 7 in total (range 5-10). Some of these may affect more than one area, with about 6 coastal impacts expected;
2. The TC season should start mid-November and finish in late April;
3. TCs should be active for a slightly below average number of days during the season. The number of expected TC days is 29.

For the Northwest Shelf and Timor Sea (0 - 30°S and 105 - 125°E):

1. About 3-4 TCs (range 2-6), which is near average, of which 2-3 may be severe, with the Accumulated Cyclone Energy index (ACE) slightly above normal;
2. Expected season: Mid-December to mid-April, most activity during March;
3. Up to 2 TC’s may be expected to cross the coast;
4. The number of expected TC days is 20;
5. One tropical low could be expected to develop, but not reach TC intensity within the region.

For the Arafura Sea and West Gulf of Carpentaria (0 - 30°S and 125 - 138°E):

1. 1-2 TC’s (range 0-4), which is average, with one TC possibly severe and ACE near normal;
2. Expected Season: Mid-Dec to early-April, with most activity during March;
3. One TC may be expected to cross the coast;
4. The number of expected TC days is 5, the longer-term average;
5. Two tropical lows could be expected to develop, but not reach TC intensity within the region.

For the Coral Sea (0 - 30°S and 138 - 160°E):

1. About 3-4 TC (range 2-7) which is about average, of which 1-2 may be expected to be severe and ACE about normal;
2. Expected season: mid-November to mid-April, with most activity during March;
3. 2-3 TC could be expected to cross the coast;
4. The number of expected TC days is 13 slightly below usual.
Plots of tropical cyclone tracks for each of the analogue years for each region are included in Appendix A. In addition, a plot of TC tracks across the whole region for all 7 analogue years has been included.

DATA SOURCES

Offshore Weather Services would like to thank the Australian Bureau of Meteorology and NOAA's Climate Prediction Center for the indices and SST's used in this report. Thanks also to Hamish Ramsey of CSIRO for providing additional information on the TIOD. The Australian Bureau of Meteorology's tropical cyclone database tracks were used to generate the historic statistics for the regions.
REFERENCES


Table 1

TC Season Outlook 2018/2019 - Australian region

Analogue years based on SOI, SST ¹


Tropical Cyclone activity ²

<table>
<thead>
<tr>
<th>Region</th>
<th>All regions</th>
<th>NW 105E - 125E</th>
<th>N 125E - 138E</th>
<th>NE 138E - 160E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of TCs (&lt;996hPa)</td>
<td>7</td>
<td>3-4</td>
<td>1-2</td>
<td>3-4</td>
</tr>
<tr>
<td>Long Term Average</td>
<td>9</td>
<td>4-5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Possible range TCs in 2018/19</td>
<td>5-10</td>
<td>2-6</td>
<td>0-4</td>
<td>2-7</td>
</tr>
<tr>
<td>TC days ³, ⁴</td>
<td>29</td>
<td>20</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>1969 – 2017 TC days Average</td>
<td>35</td>
<td>19</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>No. of Severe TCs (&lt;970hPa)</td>
<td>4</td>
<td>3</td>
<td>0-1</td>
<td>1-2</td>
</tr>
<tr>
<td>No of T. Lows ⁵</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>No. of Coastal Impacts ⁶</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>2-3</td>
</tr>
<tr>
<td>ACE ⁷ (10⁴ kt²)</td>
<td>43.7</td>
<td>28.7</td>
<td>4.4</td>
<td>16.7</td>
</tr>
<tr>
<td>ACE Long Term Average (10⁴ kt²)</td>
<td>45.9</td>
<td>24.7</td>
<td>4.7</td>
<td>17.5</td>
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<tr>
<td>Date of first TC ⁶</td>
<td>Mid-November</td>
<td>Mid-December</td>
<td>Mid-December</td>
<td>Mid-November</td>
</tr>
<tr>
<td>Date of last TC ⁶</td>
<td>Mid-April</td>
<td>Mid-April</td>
<td>Early-April</td>
<td>Mid-April</td>
</tr>
<tr>
<td>Months of most activity ⁶</td>
<td>March</td>
<td>March</td>
<td>March</td>
<td>March</td>
</tr>
</tbody>
</table>

SOI: Neutral-weak El Nino

Notes:

¹ - SOI Southern Oscillation Index
- SST Sea Surface Temperature represented by NINO3.4
³ - If 2 cyclones are active in one region at the same time, the day is counted twice.
⁴ - Total for all regions can be less than the sum of each region as Cyclones moving between regions on a particular day count as a day in each region.
⁵ - Tropical Lows that remains below TC intensity within the region.
⁶ - Derived from regional values.
⁷ - Accumulated Cyclone Energy index

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Appendix A
Analogue Year Tropical Cyclone Tracks
All Region Analogue Tracks

Figure 2 – Tropical Cyclone tracks for Australia for all 7 analogue years.
North West Australia Analogue Tracks

**Figure 3** – Tropical Cyclone tracks for NW Australia for the 1969/70 TC Season

**Figure 4** – Tropical Cyclone tracks for NW Australia for the 1976/77 TC Season
Figure 5 – Tropical Cyclone tracks for NW Australia for the 1977/78 TC Season

Figure 6 – Tropical Cyclone tracks for NW Australia for the 1993/94 TC Season
Figure 7 – Tropical Cyclone tracks for NW Australia for the 1994/95 TC Season

Figure 8 – Tropical Cyclone tracks for NW Australia for the 2003/04 TC Season
Figure 9 – Tropical Cyclone tracks for NW Australia for the 2014/15 TC Season
Northern Australia Analogue Tracks

**Figure 10** – Tropical Cyclone tracks for N Australia for the 1969/70 TC Season

**Figure 11** – Tropical Cyclone tracks for N Australia for the 1976/77 TC Season
Figure 12 – Tropical Cyclone tracks for N Australia for the 1977/78 TC Season

Figure 13 – Tropical Cyclone tracks for N Australia for the 1993/94 TC Season
Figure 14 – Tropical Cyclone tracks for N Australia for the 1994/95 TC Season

Figure 15 – Tropical Cyclone tracks for N Australia for the 2003/04 TC Season
Figure 16 – Tropical Cyclone tracks for N Australia for the 2013/14 TC Season
North East Australia Analogue Tracks

Figure 17 – Tropical Cyclone tracks for NE Australia for the 1969/70 TC Season
Figure 18 – Tropical Cyclone tracks for NE Australia for the 1976/77 TC Season

Figure 19 – Tropical Cyclone tracks for NE Australia for the 1977/78 TC Season
Figure 20 – Tropical Cyclone tracks for NE Australia for the 1993/94 TC Season

Figure 21 – Tropical Cyclone tracks for NE Australia for the 1994/95 TC Season
Figure 22 – Tropical Cyclone tracks for NE Australia for the 2003/04 TC Season

Figure 23 – Tropical Cyclone tracks for NE Australia for the 2013/14 TC Season