Media Release *12 October 2021*

2021-22 Southwest Pacific Tropical Cyclone Outlook

The NIWA and MetService assessment of named tropical cyclone (TC) activity indicates 9 to 12 named TCs could occur in the Southwest Pacific basin between November 2021 and April 2022. The seasonal outlook is for normal to slightly above normal activity in terms of overall named TCs in the region.

Tropical cyclones have a significant impact across the Southwest Pacific, with the season officially starting in November and lasting until the end of April. For the coming season, important differences are expected between the western and eastern halves of the Southwest Pacific basin and also for early and late season activity. Elevated TC presence is expected in and around the Coral Sea, especially during the late season between February and April. Risk of a TC interaction is expected to be higher across the maritime regions around the Coral Sea and in the subtropics between Fiji and New Caledonia. Reduced TC activity is expected east of the International Date Line.

Vanuatu and New Caledonia typically experience the greatest TC activity, with an average of about two or three named TCs passing close to those island nations each year. For this season, normal-to-elevated TC activity is expected for countries and territories around the Coral Sea, including Vanuatu, New Caledonia, the Solomon Islands and Papua New Guinea. Tonga and Fiji are expected to have normal TC activity. Near normal TC activity is expected for Wallis & Futuna, Tokelau and Niue. Normal-to-elevated TC activity is expected for the Austral Islands, while normal-to-below normal TC activity is forecast for the Society Islands. Tuvalu and most other islands to the east of the International Date Line, including the remainder of French Polynesia, the Cook Islands, Samoa and American Samoa, are expected to have reduced TC risk for the coming season. Despite the risk reduction in some locations, cyclones are still expected for countries that typically experience one or more named cyclones per year. At least three severe cyclones reaching category 3 or higher might occur anywhere across the region, so all communities should remain prepared.

On average, at least one ex-tropical cyclone passes within 550 km of New Zealand each year. For the coming season, the risk for an ex-tropical cyclone affecting New Zealand is considered above normal. If an ex-tropical cyclone comes close to the country, there is a near-equal probability of it tracking to either the east or west of the North Island, and landfall of a degrading ex-tropical cyclone is possible. Significant rainfall, extreme winds, hazardous marine conditions and coastal damage are all possible leading up to and during these events.

At present, sea surface temperatures across the eastern and central equatorial Pacific Ocean are below average and have been trending toward La Niña thresholds. Atmospheric circulation patterns related to ENSO (El Niño-Southern Oscillation) over French Polynesia and northern Australia indicate weak-to-moderate La Niña conditions exist at present. Oceanic and atmospheric forecasts for ENSO that cover the 2021/22 TC season suggest that a La Niña event has a 60-70% chance of development by December 2021, but that ENSO neutral conditions may be reached by the end of the TC season in April.

Tropical cyclones are categorised in strength from 1 to 5, with 5 being the most intense. Past seasons with conditions similar to present suggest several TCs that develop could intensify to

at least category 3 strength. For the coming season, at least 3 TCs are anticipated to reach or exceed category 3 strength, with mean wind speeds of at least 119 km/h. Category 5 strength cyclones, where sustained winds exceed 199 km/h, have occurred in many years with similar conditions like what exists ahead of the 2021/22 season (known as 'analogue' seasons). Therefore, all communities should remain alert and well-prepared for severe TC events.

New Zealand should also remain vigilant as the season unfolds. About half of the historic seasons used in the preparation of this outlook showed at least one ex-tropical cyclone passing within 550 km of the country; two of the most recent seasons showed multiple systems within the area around New Zealand. Significant wind, waves and rainfall are possible from ex-tropical cyclones that come into the mid-latitudes. The effects of ex-tropical cyclones can also be spread over a large area, particularly if the decaying ex-tropical cyclone interacts with mid-to-high latitude weather systems. An example of this situation in one of the identified analogue years (1981/82) illustrates how strong pressure gradients spanning New Zealand caused strong winds with damaging impacts (as with ex-TC Bernie).

All communities, regardless of changes in TC risk, should still remain vigilant and be aware if the regional climate situation (including ENSO) changes. As with most years, TC activity is expected to increase during the second half of the season from February-April. Early season TC activity is expected to be largely reduced, except near Fiji, and a potential start to cyclone activity may also occur close to or after the New Year.

NIWA, MetService, MétéoFrance, The Australian Bureau of Meteorology, NOAA and Pacific Island National Meteorological Services will all continue to track the progression of ENSO and TC activity, with an update to this guidance in January 2022, if needed.

It does not take a direct hit or a severe cyclone to cause significant damage or life-threatening weather. When dangerous weather is forecast, please heed the advice of your local meteorological service, civil defence, or disaster management offices.

New Zealand's National Institute of Water & Atmospheric Research (NIWA) led the formulation of this seasonal tropical cyclone outlook, along with contributions from Meteorological Service of New Zealand (MetService), the University of Newcastle and meteorological forecasting organisations from the Southwest Pacific, the Australian Bureau of Meteorology, MétéoFrance and the Pacific Island National Meteorological Services.

Contacts for comment

In New Zealand:

Mr. Ben Noll
Meteorologist, NIWA
Tel: +64 9 375 6334

Mr. Chris Brandolino
Principal Scientist – Forecasting and Media
Tel: +64 375 6335

Ms. Nava Fedaeff
Forecaster/Science Communicator, NIWA
Tel: +64 9 375 6337

Mr Chris Noble
Senior Meteorologist
MetService
Tel: +64 4 470 0806

Ms. Elke Louw
Manager, Severe Weather Services
TCWC (Tropical Cyclone Warning Centre) Wellington
MetService
Tel: +64 4 470 1175

In the Pacific Islands, please contact your local national meteorological service for information about how this guidance should be interpreted.
For Australia and associated offshore islands, please contact the Australian Bureau of Meteorology for information about how this guidance should be interpreted.
For French Polynesia, Wallis, Futuna and New Caledonia, please contact MétéoFrance regional offices for information about how this guidance should be interpreted.

Figure 1. Maps of tropical cyclone risk (top) based on Island Climate Update (ICU) consensus guidance (Table 1) and overall seasonal outlook for the number of named cyclones interacting with an island group (bottom) based on the 2021/22 ICU analogue tropical cyclone guidance (Table 2).

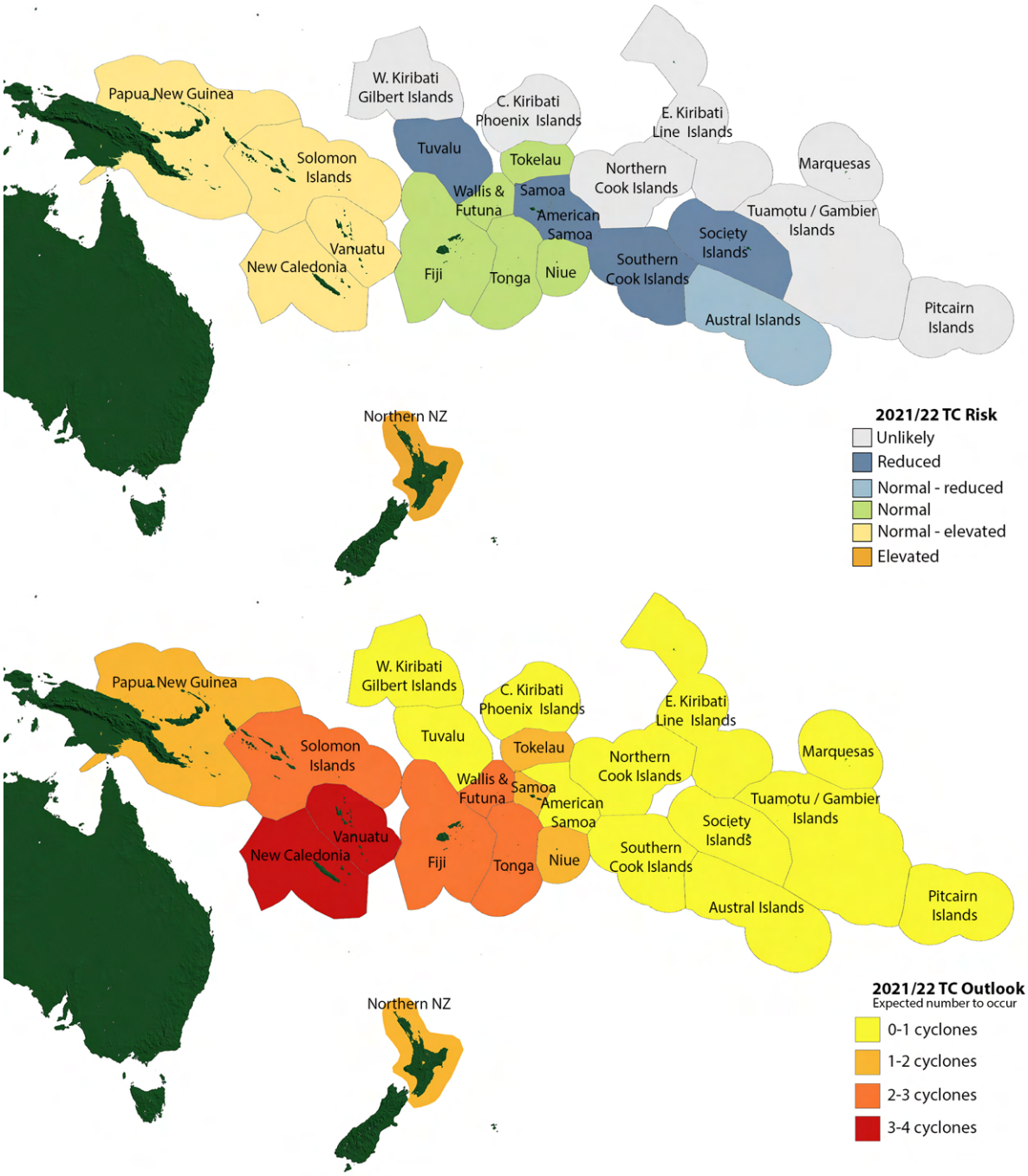


Table 1: Island Climate Update (ICU) consensus outlook for November 2021-April 2022 tropical cyclone activity based on combining NIWA analogue model, international dynamical climate model and TCO-SP deterministic statistical model outlook results. Indications for upcoming TC activity based on these joint methods that cover the SW Pacific basin for the 2021/22 season are stated in the "ICU Consensus" column and are also shown in Figure 1. Expected TC numbers are based on the NIWA analogue method (see Table 2) and supported by the TCO-SP deterministic method.

TC activity 2021/22	*NIWA Analogue*	*International Dynamical*		*TCO-SP Deterministic*	*ICU Consensus*	*Outlook Confidence*
SP Basin	Normal-Elevated	Normal	*	Normal	**Normal-elevated**	Moderate-high
Solomon Is.	Elevated	Normal-elevated	1	Reduced	**Normal-elevated**	Moderate
Papua New Guinea	Elevated	Normal-elevated		Normal	**Normal-elevated**	Moderate-high
N. New Zealand	Elevated	Elevated		Normal	**Elevated**	Moderate-high
Vanuatu	Elevated	Normal-elevated		Normal	**Normal-elevated**	Moderate-high
New Caledonia	Elevated	Normal-elevated		Normal	**Normal-elevated**	Moderate-high
Tonga	Normal-elevated	Normal		Reduced	**Normal**	Moderate
Fiji	Normal-elevated	Normal		Reduced	**Normal**	Moderate
Wallis & Futuna	Normal	Normal	2	Normal	**Normal**	High
Tokelau	Normal	Normal		Normal	**Normal**	High
Tuvalu	Reduced	Normal		Reduced	**Reduced**	Moderate-high
Niue	Normal	Normal	3	Reduced	**Normal**	Moderate-high
Samoa	Reduced	Normal-reduced		Reduced	**Reduced**	High
American Samoa	Reduced	Normal-reduced		Reduced	**Reduced**	High
Austral Is.	Normal-reduced	Normal-elevated	4	Reduced	**Normal-reduced**	Moderate
Society Is.	Normal	Reduced		Reduced	**Reduced**	Moderate-high
S. Cooks	Reduced	Reduced		Reduced	**Reduced**	High
N. Cooks	Unlikely	Unlikely	5	Elevated	**Unlikely**	Moderate-high
Tuamotu	Unlikely	Unlikely		Elevated	**Unlikely**	Moderate-high
W. Kiribati	Unlikely	Unlikely		Elevated	**Unlikely**	Moderate-high
Marquesas	Unlikely	Unlikely		Elevated	**Unlikely**	Moderate-high
Pitcairn	Unlikely	Unlikely		Elevated	**Unlikely**	Moderate-high
C. Kiribati	Unlikely	Unlikely		Elevated	**Unlikely**	Moderate-high
E. Kiribati	Unlikely	Unlikely		Elevated	**Unlikely**	Moderate-high

***TCO-SP model area of focus**

1. Island scale model
2. Northern SW Pacific region
3. Central SW Pacific region
4. Southeast SW Pacific region
5. Northeast SW Pacific region

Additional background information

Summary of analogue, dynamical and deterministic guidance for the ICU TC outlook

Analogue, dynamical and deterministic model guidance for the SW Pacific show relatively good agreement for the coming season (Table 1). The ICU consensus column is based on the combined outcomes for the three aforementioned types of seasonal outlook information. The consensus forms the basis for the full season (November-April) outlook for Southwest Pacific TC activity (and risk) for the 2021/22 season. It should be noted that there are only very minor differences in terms of the TC risk that are ascribed using the consensus method relative to previous years that used the analogue guidance supported by the dynamical guidance. Future work will evaluate (and validate) the outcome of each individual model vs the consensus-based approach.

Modern analogue guidance

TCs in the Southwest Pacific usually develop between November and April, occasionally develop in October and May, and very rarely develop in June – August. An analysis of past TC tracks in the SW Pacific indicate they are exceptionally unlikely in September, although systems in the past have formed during this time. Peak TC activity in the SW Pacific Basin is usually between January to March; however, severe TCs can occur at any time during the season.

Based on past seasons with similar background climate conditions to the present, TC activity in the coming season is expected to be elevated around the north Coral Sea including the Queensland coast, the fringes of Papua New Guinea, the Solomon Islands, Vanuatu and New Caledonia. In addition, TC activity is expected to be elevated across the northern Tasman Sea region, encompassing the maritime area near Norfolk Island, and to the west and east of New Zealand. Risk of TC occurrence is elevated for those aforementioned areas. On average, nearly half of the TCs that developed since the 1969/70 season have reached at least category 3 cyclones with mean wind speeds of at least 64 knots (119 km/h).

To find past analogues that describe the climate state leading into the upcoming TC season, the conditions for May 2021 through to the beginning of October 2021 were examined for the tropical Pacific. Similar situations from 1969 to the present were then identified from the historical record. For most of austral winter (June-August) and early spring 2021 (September), the ENSO system was in an ocean-dominant La Niña-like state. Those signals faded slightly while atmospheric La Niña signals grew in strength closer to the onset of austral spring.

The Australian Bureau of Meteorology's monitoring of the Niño3.4 region (central-western equatorial Pacific Ocean) shows monthly sea surface temperature anomalies of -0.25°C with early October weekly values reaching -0.45˚C. More significant negative temperatures of -0.5°C to -1.5°C exist at depth in the same region. This indicates the progression toward La Niña is less advanced relative to this time last year.

The available information from international forecasting centres that issue global climate outlooks and ENSO diagnostics support this outlook, and they are integrated by NIWA's National Climate Atmosphere and Hazards Centre. The collective guidance summarised by NIWA suggests a weak-to-moderate La Niña at the start of the TC season is likely (65% chance), with the likelihood of ENSO neutral conditions being lower (35% chance). ENSO

conditions for late summer to mid-autumn are expected to progress toward neutral. El Niño is not expected this season. As such, an additional element used to hone the historic analogues for the upcoming TC season included years when ENSO conditions during November-April were reminiscent of weak-to-moderate La Niña.

To help identify past ENSO conditions for the selection of analogue seasons, we used an ENSO index that combines the Southern Oscillation Index (SOI) with the most widely-used oceanic index of sea surface temperature anomalies in the equatorial central-western Pacific (NINO3.4). This joint ENSO index is described in Gergis and Fowler (2005) as the "Coupled ENSO Index" (CEI). Using the CEI, we selected analogue TC seasons for the 2021/22 outlook, highlighting seasons when the equatorial SSTs and the SOI were indicative of a transition from neutral ENSO conditions in winter-spring to La Niña conditions during summer-autumn.

Six analogue TC seasons (1981/82; 1984/85; 1985/86; 1996/97; 2008/09; 2013/14) partially typified the antecedent ENSO development for austral winter-early spring. Note that the selection of analogue seasons in this step of the outlook relates to the high-quality TC data period in the satellite era beginning in 1969/70 (52 seasons, for which the availability of TC track data are current only to the end of the 2019/20 season), and the limited number of similar analogues to this season (including rejected analogues). The selected seasons also include a mixture of weak-to-moderate La Niña (1984/85; 1985/86; 2008/09) and ENSO neutral (1981/82; 1996/97; 2013/14) conditions for the early, late and full TC season that align with the expected ENSO outlook.

NIWA's SW Pacific TC outlook spans four areas of responsibility overseen by international monitoring and forecast agencies (RMSC Nadi, TCWC Melbourne, TCWC Port Moresby and TCWC Wellington). We used a high-quality set of past TC tracks from the International Best Tracks Archive for Climate Stewardship (IBTrACS) which covers 135°E to 120°W longitude to draw on past TC track patterns for the seasonal outlook. The domain for the seasonal outlook encompasses a basin that is defined by climatological properties of TC occurrences rather than geopolitical or meteorological service administrative boundaries (Diamond et al., 2012). Based on the selection of analogues, elevated TC activity and risk is expected in and around the Coral Sea offshore of Queensland, near Papua New Guinea, and the area including and between the Solomon Islands, Vanuatu and New Caledonia. In addition, the north Tasman Sea (including Norfolk Island) is expected to see elevated TC activity. The outlook for the region to the east of the International Date Line largely shows reduced risk overall, but small areas of moderately increased TC track numbers clustered near the International Date Line close to Fiji and Tonga (Figure 2).

The analogue guidance also indicates normal risk of TC activity exists for Wallis and Futuna, the Society Islands, Niue and Tokelau (See Table 1 and Table 4; Figure 1, 2 & 3). Risk is normal-reduced for the Austral Islands, and reduced for Samoa, the southern Cook Islands, American Samoa and Tuvalu. The main TC genesis region is expected to lie within a band between 10 – 12°S (northwest of Vanuatu) to the west of the International Date Line but shifted slightly west of normal; however, the historic tracks indicate some systems may form east of the International Date Line. There is a clear signal for elevated risk of cyclones developing and tracking west of the International Date Line during both the early and late season. All analogue seasons had at least one cyclone of category 3 or greater strength, and a majority of the analogue seasons (5 out of 6) experienced a minimum of three severe cyclones (≥ category 3). Four of the six analogue seasons experienced at least one category 5 TC, which strongly indicates a system of that strength could occur this coming season. A total of 11 named cyclones are

expected during this coming season (spread of 9-12 based on past analogues), which is near normal to slightly above normal activity. It is worth noting however that half of the past analogues (three out of six) saw a late cyclone form outside the traditional season of November to April, and in two cases the late cyclone was severe (reaching category 3), demonstrating the need for communities to remain vigilant even beyond the traditional end of the season.

A split of the analogue TC seasons into early (November – January) and late (February – April) periods suggests TC activity will be elevated near Papua New Guinea, Vanuatu and New Caledonia during the early TC season (Figure 4). Four out of six of the analogues had storms that reached at least category 1 status at some time during late November or during December, which suggests the first named storm of the season may occur prior to the New Year. Activity, in general, is expected to increase during the late season, especially for islands west of the International Date Line that are located around the Coral Sea. The spatial anomalies shown for this TC outlook strongly indicate a reduced risk of TCs for Tuvalu, Samoa, American Samoa, most of French Polynesia (except the Austral Islands), and the southern Cook Islands.

Previous TC research has indicated cyclone track sinuosity reduces during La Niña but increases during neutral seasons (Malsale, 2011). This means that a mixture of TC track trajectories for the coming season are expected. TC intensity is partly related to how long developing cyclonic systems reside in the tropics and gain support for their growth from underlying warm waters. Nevertheless, lower strength TCs that have wandering tracks can still produce significant impacts on island communities and TCs of all strength should be monitored closely. In addition, the subtropical jet and South Pacific Convergence Zone (SPCZ[1]) mutually interact and contribute to shear (which can disorganise cyclone systems) during extra-tropical transition (ETT). Steering winds are expected to be displaced slightly southwest of normal, which may lead to reduced shear and increased retention of cyclone strength in the subtropics. The outcomes from this type of situation may include stronger ex-TC impacts for northern New Zealand.

The interplay of hemispheric-scale atmospheric circulation with the timing of short-term Madden-Julian Oscillation (MJO) activity on a 30 to 50-day cycle has significant bearing on regional TC activity. Increased frequency and more intense TC activity can be expected during the MJO 6-7 paired phase (Diamond and Renwick, 2015). Weekly statistical forecasts of TC genesis and TC activity for the SW Pacific basin are produced by MétéoFrance based on phasing of the MJO (Leroy and Wheeler, 2008). This guidance is useful for sub-seasonal regional TC guidance (see http://www.meteo.nc/espro/previcycl/cyclA.php.) Real-time MJO monitoring is also available from the Australian Bureau of Meteorology at http://www.bom.gov.au/climate/mjo/ and NOAA at https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CLIVAR/clivar_wh.shtml.

TC tracks that have previously undergone ETT at 25°S latitude (Diamond et al., 2013) cover a wide area spanning east and west of the International Date Line (~165°E – 165°W). For the historical TC tracks in the seasons we have selected as analogues for this outlook, there is a large spread for locations where systems underwent ETT. This presents significant uncertainties for maritime navigation risks related to TCs and ex-TCs. Nevertheless, the maritime region between New Caledonia and New Zealand including the north Tasman Sea

[1] The South Pacific convergence zone (SPCZ) is an extensive Southern Hemisphere atmospheric circulation feature that contains one of Earth's most expansive and persistent convective cloud bands.

and southern Coral Sea appears to have elevated risk for TC activity this season. Extra caution for vessels navigating that area (especially during the late season) is warranted.

Previous work indicates New Zealand interacts with at least one ex-tropical cyclone passing within 550 km of the country every year on average (Lorrey et al., 2014). Some years there are none, while in other years there are more than one. For the coming TC season, the risk for New Zealand is elevated. We identified nine ex-tropical cyclones using six analogue seasons in this outlook that passed close to New Zealand, which gives a rounded average of two ex-tropical cyclones per year. The historic TC tracks selected for this outlook that passed close to New Zealand indicate a near equal probability of decaying ex-tropical cyclones tracking offshore to either the east or west of the North Island (see Figure 3).

Dynamical climate model guidance

A synthesis of atmospheric and sea surface temperature (SST) guidance favours near average tropical cyclone (TC) activity for the 2021/22 SW Pacific TC season. Multi-model ensemble (MME) guidance is in good agreement and reflective of the presence of a weak-to-moderate La Niña event in the central Pacific that is likely for much of the upcoming TC season (Figure 5 and Figure 6). La Niña tends to elevate the risk for TC activity in the western part of the SW Pacific and reduce activity to the east, but every event is unique.

Mean sea level pressure (MSLP) is forecast to be near normal or below normal for much of the Southwest Pacific basin along and west of the International Date Line (Figure 6). This is likely indicative of the South Pacific Convergence Zone being displaced southwest of normal, a typical impact of La Niña, and one that can cause above normal rainfall for many islands. For island nations and territories that are located closer to the Equator, particularly north of 10˚ south latitude, drier than normal conditions are expected to elevate the risk of drought.

MME guidance points to near normal or below normal zonal mid-atmospheric wind shear across much of the Southwest Pacific TC basin. Slightly lower than normal wind shear is forecast across much of the tropical SW Pacific, especially east of the International Date Line. Atmospheric guidance shows a reduction in wind shear , resulting in a more favourable environment for TC genesis. If reduced atmospheric wind shear co-exists with other favourable environmental conditions, such as above average SSTs, then areas of increased TC activity are possible.

Deterministic statistical model

The Long-Range Tropical Cyclone Outlook for the Southwest Pacific (TCO-SP) product has been incorporated into the ICU outlook since the 2020/21 seasonal outlook to provide support for a consensus-based ensemble of TC risk. TCO-SP is based on a different method than the analogue and dynamical approaches. The TCO-SP method is calibrated using the IBTrACS data set and several key climate indices for the Southern Hemisphere (see Magee et al., 2020 and the supplementary material for more details). For the coming Southwest Pacific TC season, the deterministic TCO-SP outlook suggests 10 named TCs may form (probable range of 9-11), indicating near normal activity for the basin when compared with the 1981-2010 average of 11.4 TCs (Table 1, Table 4 and Figure 7). This TC count range overlaps with the analogue guidance.

References

Gergis, J., and A. M. Fowler, 2005. Classification of synchronous oceanic and atmospheric El Niño–Southern Oscillation (ENSO) events for palaeoclimate reconstruction. *International Journal of Climatology*, **25**: 1541–1565.

Diamond, H.J., and J.A. Renwick, 2015. The climatological relationship between tropical cyclones in the southwest Pacific and the Madden-Julian Oscillation. *International Journal of Climatology*, **35**: 676-686. doi: 10.1002/joc.4012.

Diamond, H.J., A.M. Lorrey, K.R. Knapp, and D.H. Levinson, 2012. Development of an enhanced tropical cyclone tracks database for the southwest Pacific from 1840-2011. *International Journal of Climatology*, **32**: 2240–2250. doi:10.1002/joc.2412.

Diamond, H.J., A.M. Lorrey, and J.A. Renwick, 2013. A Southwest Pacific tropical cyclone climatology and linkages to the El Niño–Southern Oscillation. *Journal of Climate*, **26**(1): 3-25. doi:10.1175/JCLI-D-12-00077.1.

Leroy, A., and M.C. Wheeler, 2008. Statistical prediction of weekly tropical cyclone activity in the Southern Hemisphere. *Monthly Weather Review*, **136**: 3637-3654.

Lorrey, A.M., G. Griffiths, N. Fauchereau, H.J. Diamond, P.R. Chappell, and J. Renwick, 2014. An ex-tropical cyclone climatology for Auckland, New Zealand. *International Journal of Climatology*, 34: 1157–1168. doi: 10.1002/joc.3753.

Magee, A.D., Lorrey, A.M., Kiem, A.S., Colyvas, K. 2020. A new island-scale tropical cyclone outlook for southwest Pacific nations and territories. *Scientific Reports*, 10, 11286, https://doi.org/10.1038/s41598-020-67646-7

Malsale, P. 2011. Analysis of tropical cyclone track sinuosity in the South Pacific region using ARCGIS. Unpublished MSc Thesis, University of the South Pacific, 155 Pages.

Figure 2: Number of TCs occurring for the main development season (November – April) in the Southwest Pacific (135°E to 120°W): (top panel) average number during 1981 to 2010 (normal); (centre panel) average number over selected five analogue seasons (Table 3); (bottom panel) departure from normal for the analogue seasons (difference between count in centre and top panels). For each year noted, that represents the start of the main development season (i.e. 1970 = November 1970-April 1971)

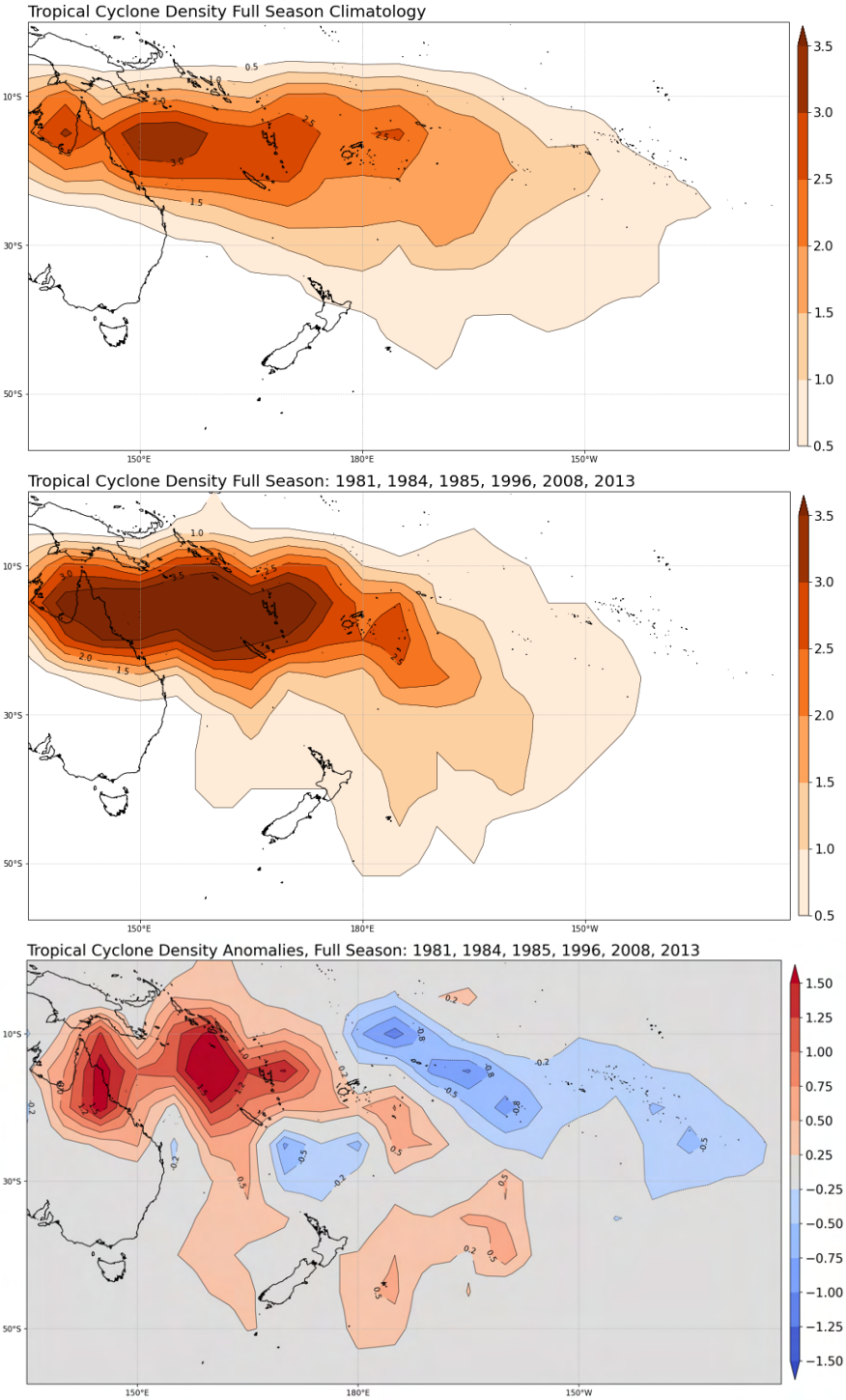


Table 2: The average number of TCs passing close to the main South Pacific Island groups between November and April based on analogue guidance, but contains subjective assessments in some cases to be consistent with the wishes of the national meteorological services involved in generating this regional outlook. In addition, subjective qualification of activity (and associated risk) also recognises the small differences between the actual TC counts for the analogue composites and climatological values. The table is therefore only generally indicative of how many cyclones might be expected for any given island group for the coming season. This information feeds into the final outlook for the season seen in Table 1.

Country/Territory	Climatology	Analogue seasons	Anomaly	% normal	Risk
Solomon Is.	1.2	2.5	1.3	210	Elevated
Papua New Guinea	0.9	1.9	1	210	Elevated
N. New Zealand	0.75	1.5	0	200	Elevated
Vanuatu	2.9	3.9	1	135	Elevated
New Caledonia	2.75	3.5	0.75	130	Elevated
Tonga	2.2	2.7	0.5	120	Normal-Elevated
Fiji	2.5	2.8	0.3	120	Normal-Elevated
Wallis & Futuna	2.2	2.2	0	100	Normal
Society Is.	0.7	0.7	0	100	Normal
Niue	1.8	1.7	-0.1	95	Normal
Tokelau	1.6	1.5	-0.1	95	Normal
Austral Is.	0.75	0.6	-0.15	80	Normal-Reduced
Samoa	1.7	1.1	-0.6	65	Reduced
Tuvalu	1.4	0.9	-0.5	65	Reduced
American Samoa	1.7	0.9	-0.8	55	Reduced
S. Cooks	1.3	0.6	-0.7	45	Reduced
N. Cooks	0.5	0.6	0.1	N/A	Unlikely
Tuamotu	0.2	0	-0.2	N/A	Unlikely
W. Kiribati	0.1	0	-0.1	N/A	Unlikely
Marquesas	0.1	0.1	0	N/A	Unlikely
Pitcairn	0	0	0	N/A	Unlikely
C. Kiribati	0	0	0	N/A	Unlikely
E. Kiribati	0	0	0	N/A	Unlikely

Table 3: Previous analogue seasons and intensity of TCs that occurred in the Southwest Pacific during the November-April TC season. Categorisation of TCs aligns to the Australian Bureau of Meteorology (BoM) scale. Italicised figures for category totals are the median of the count for that particular category instead of the mean.

Season	Number of storms Cat 1 or higher	Right: TC category (BoM scale)	Cat 1	Cat 2	Cat 3	Cat 4	Cat 5
1981/82	8		2	0	2	3	1
1984/85	14		4	4	3	2	1
1985/86	9		4	1	3	1	0
1996/97	14		5	3	4	2	0
2008/09	9		4	4	0	0	1
2013/14	11		6	2	1	0	2
Cat total	10.8		*4.0*	*2.5*	2.2	1.3	0.8
Rounded totals	11		4	3	2	1	1

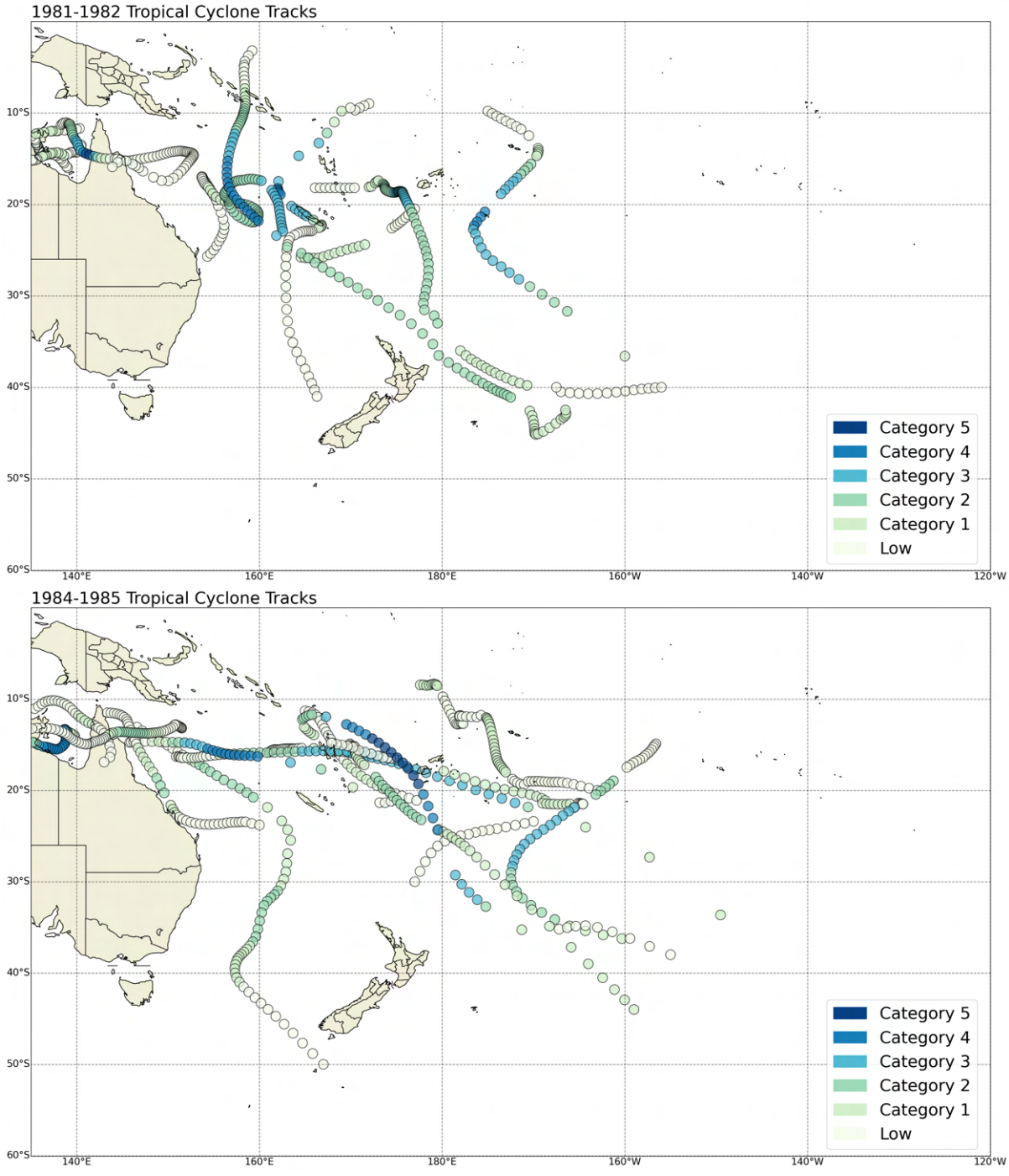
Analogue guidance summary

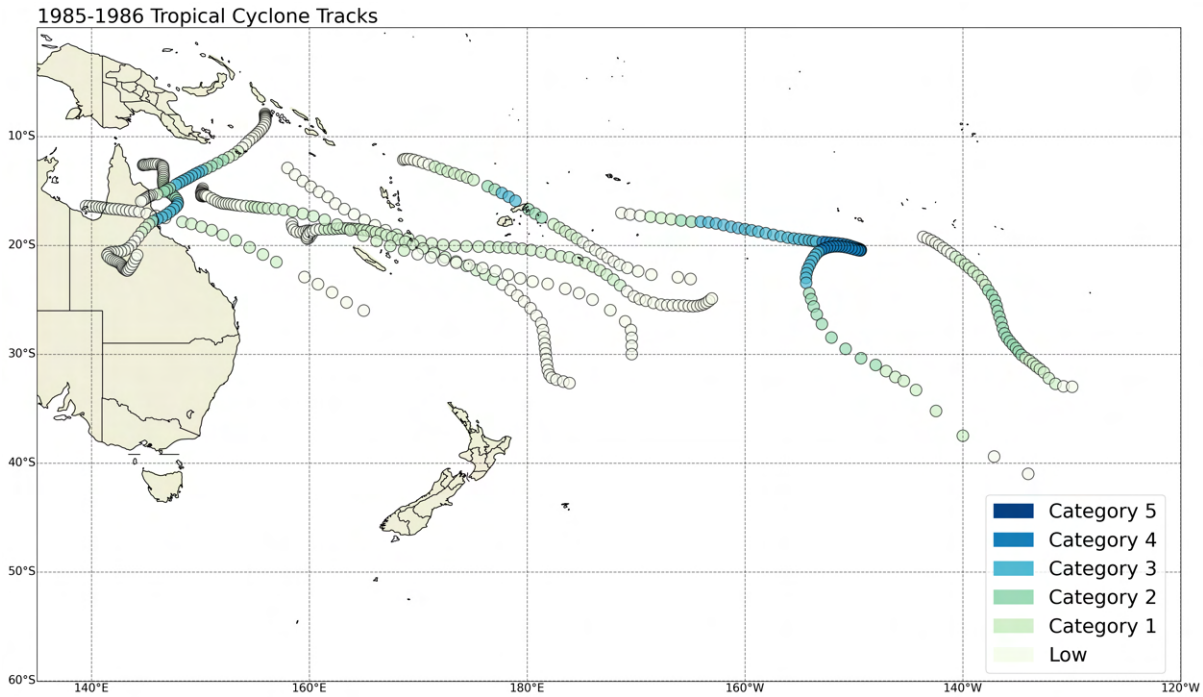
Based on the guidance from the NIWA analogue method, a conservative range of 9-12 named TCs could be expected during the 2021/22 season for the Southwest Pacific basin (135° E – 120° W). The spread for the estimated cyclone activity comes from the variation between six selected analogue seasons. The historic long-term seasonal average is just over 10 named TCs for the SW Pacific basin. There is moderate disagreement between the analogues for the total number of cyclones for this season, with half indicating slightly below normal and half indicating near or above normal activity.

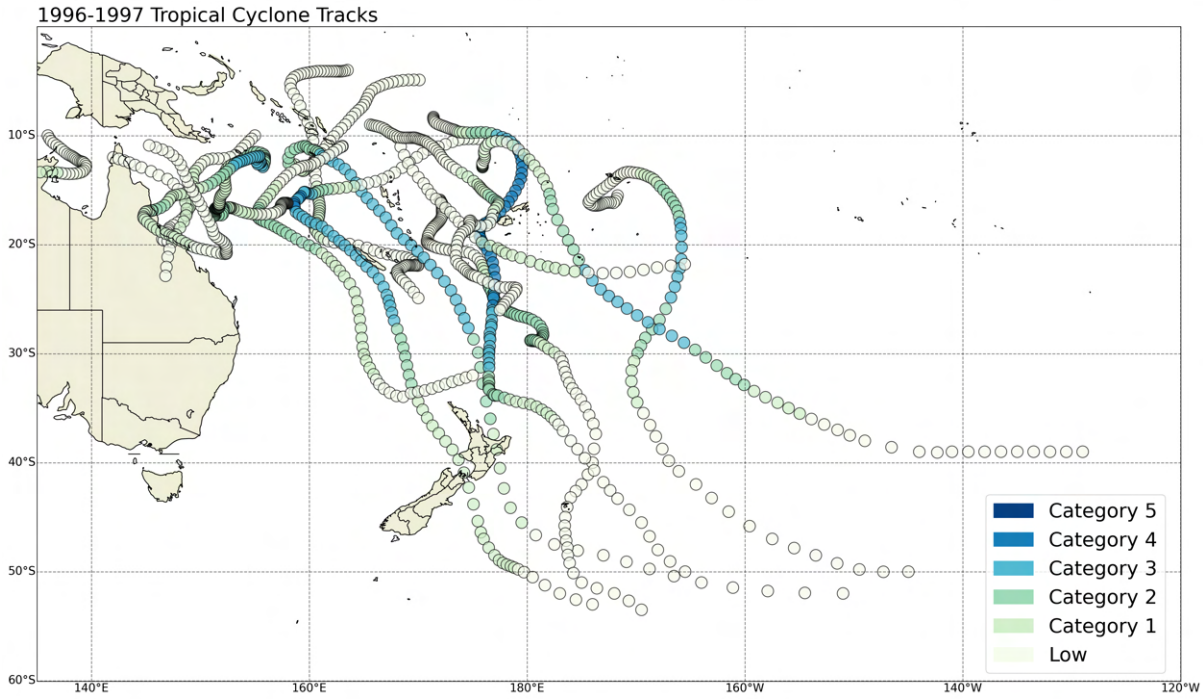
A potential combination of 3-4 cyclones may reach severe category 3 or higher status. The long-term TC climatology and the analogues we have identified indicate that a category 5 cyclone may occur (see Table 3). All of the historic analogue seasons indicate at least one cyclone of category 4 strength or higher could occur. A majority of the historic analogues selected for the 2021/22 outlook (five out of six) indicate multiple severe TCs (at least three or more) that were equivalent to or greater than category 3 occurred in seasons similar to the present. This provides confidence in the statistical outlook for expected cyclone strengths and support for a conservative range of 3-5 severe tropical cyclones for this outlook. We have subjectively rounded the total mean count upward from 10.8 to 11 this season to include the possibility of a category 5 cyclone based on current conditions and expected outcomes for the coming season.

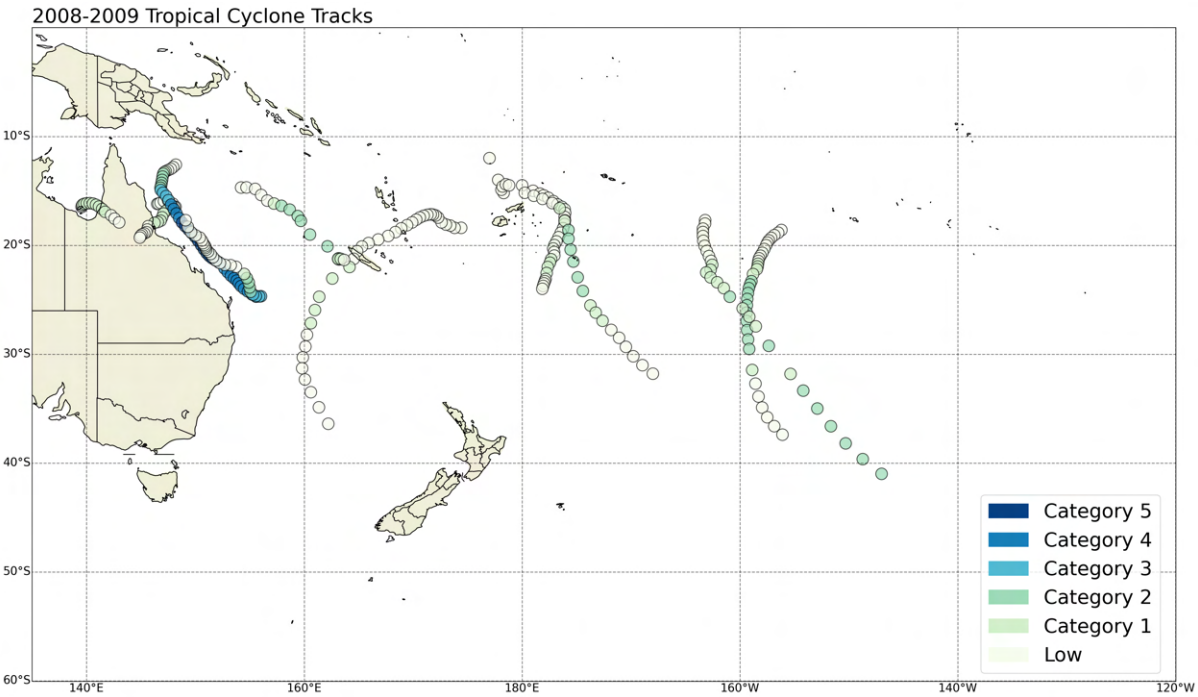
For the selected analogues, most show at least one ex-tropical cyclone came within 550 km of New Zealand. Some of the seasons had no ex-tropical cyclone interactions (1984/85, 1985/86, 2008/09) while others had multiple systems interact with both the North and South Island (1996/97 & 2013/14). The rounded average interaction for New Zealand with an ex-tropical cyclone this coming season is two named systems. Some of the decaying ex-tropical cyclone systems were also associated with high rainfall, damaging winds and amplified coastal wave conditions. The risk of an interaction for New Zealand (with at least one cyclone coming within 550 km of the country) for the 2021/22 season is elevated. There is a near-equal probability of a decaying ex-tropical cyclone tracking to the east or west of the North Island based on historic track data (Figure 3).

Figure 3: Plots of TC tracks and major tropical lows that were monitored for analogue seasons used in the 2021/22 seasonal forecast for the full season (November - April). Track data are courtesy of International Best Tracks Archive for Climate Stewardship (IBTRaCS).




1985-1986 Tropical Cyclone Tracks
10°S
20°S
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
140°W
120°W
Category 5
Category 4
Category 3
Category 2
Category 1
Low


1996-1997 Tropical Cyclone Tracks
10°S
20°S
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
140°W
120°W
Category 5
Category 4
Category 3
Category 2
Category 1
Low


2008-2009 Tropical Cyclone Tracks
10°S
20°S
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
140°W
120°W
Category 5
Category 4
Category 3
Category 2
Category 1
Low

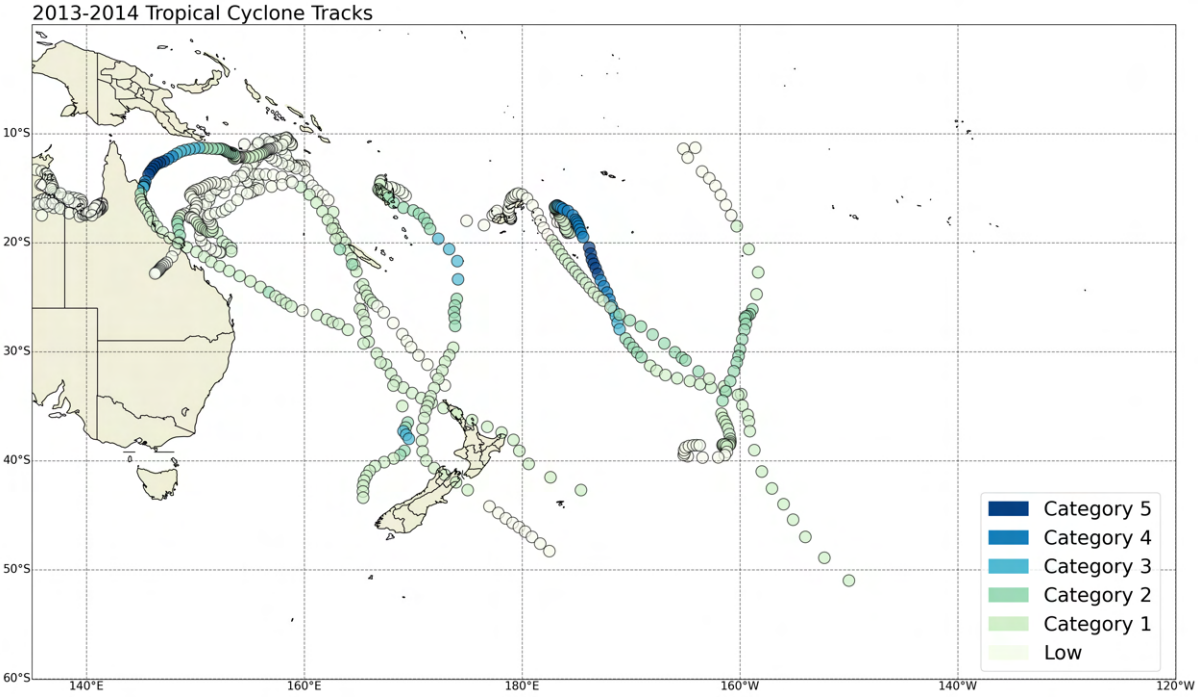
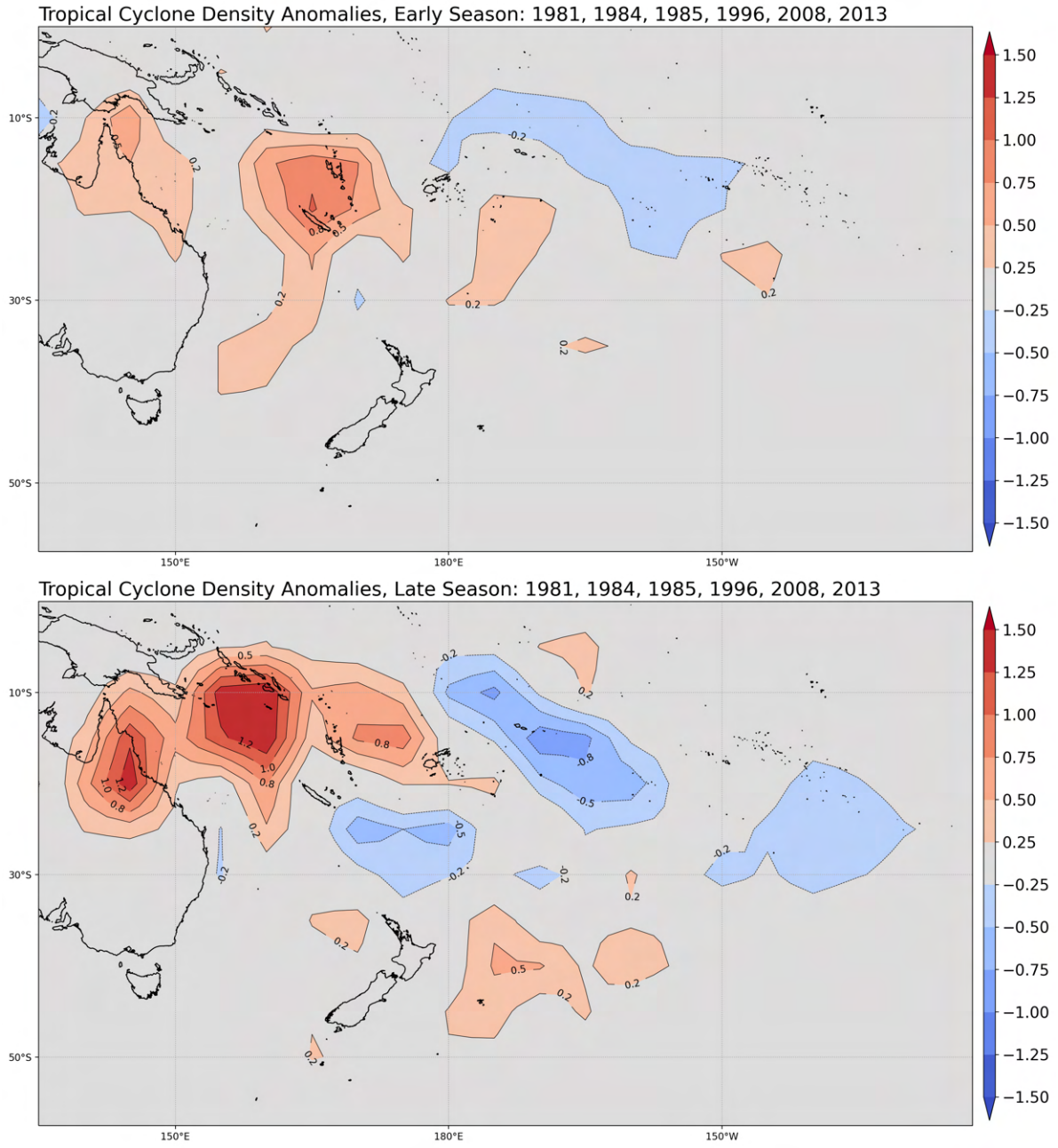

2013-2014 Tropical Cyclone Tracks
10°S
20°S
30°S
40°S
50°S
60°S
140°E
160°E
180°E
160°W
140°W
120°W
Category 5
Category 4
Category 3
Category 2
Category 1
Low

Figure 4: Early season (November to January; top panel) and late season (February to April; bottom panel) anomaly plots for selected TC analogue seasons (data courtesy of International Best Tracks Archive for Climate Stewardship (IBTrACS)). The year label notes the first month in the analogue year selection (i.e. for the early TC season "1970" = November 1970, December 1970, January 1971; and for the late TC season "1970" = February – April 1971).



Dynamical Guidance Summary

A synthesis of model atmospheric and SST guidance favour near average TC activity for the 2021/22 Southwest Pacific TC season. However, there is the potential for above normal storm occurrences near northern New Zealand and around the Coral Sea region. Normal or below normal activity is expected to occur to the east of the International Date Line, with the exception of the Austral Islands.

ECMWF seasonal guidance, November 2021-April 2022
The Accumulated Cyclone Energy, or ACE forecast:
October 2021 ECMWF seasonal guidance indicates near normal (80% of normal) seasonal accumulated cyclone energy (ACE). ACE is a metric derived from tropical cyclone intensity and duration, averaged across the basin as a whole.

Tropical storm (cyclone) density anomaly is forecast to be near normal, overall, for much of the basin. However, regional variations show elevated activity near New Zealand, the Coral Sea, and the Austral Islands, while much of the rest of French Polynesia and the Cook Islands show reduced activity.

Tropical storm (cyclone) and hurricane frequency (category 3 or higher):
ECMWF seasonal guidance indicates a near normal amount of tropical cyclones and severe TCs (86% and 82% of normal, respectively).

Collectively, this guidance supports a near normal number of TCs (category 1 or higher) and at least a near normal amount of severe TCs (category 3 or higher) across the Southwest Pacific basin for the 2021/22 tropical cyclone season.

The dynamical guidance generally agrees with the analogue guidance for TC count and severity but is less widespread in its coverage of enhanced TC activity. The dynamical guidance has clusters of enhanced activity north of New Zealand, in the Coral Sea along coastal Queensland, and in the subtropics near the Austral Islands. Reduced activity is forecast over the Society Islands and Cook Islands. It is worth noting that the long-range dynamical outlook from September 2021 showed clusters of activity near New Caledonia and Vanuatu and another in the Coral Sea along coastal Queensland, and reduced activity near Samoa, American Samoa, the Cook Islands and the Society Islands. As such, parts of this outlook appear to be stable, while other aspects have been changeable as of late.

NB: The ECMWF forecast domain for ACE is from 160˚E to 120˚W. The Southwest Pacific basin covers 135˚E to 120˚W, therefore the forecast generated by NIWA extends 25˚ westward than the ECMWF forecast domain.

Figure 5. Multi-model ensemble forecast rainfall anomaly (mm/day), December 2021-February 2022; green (brown) shades indicate above (below) normal forecast rainfall

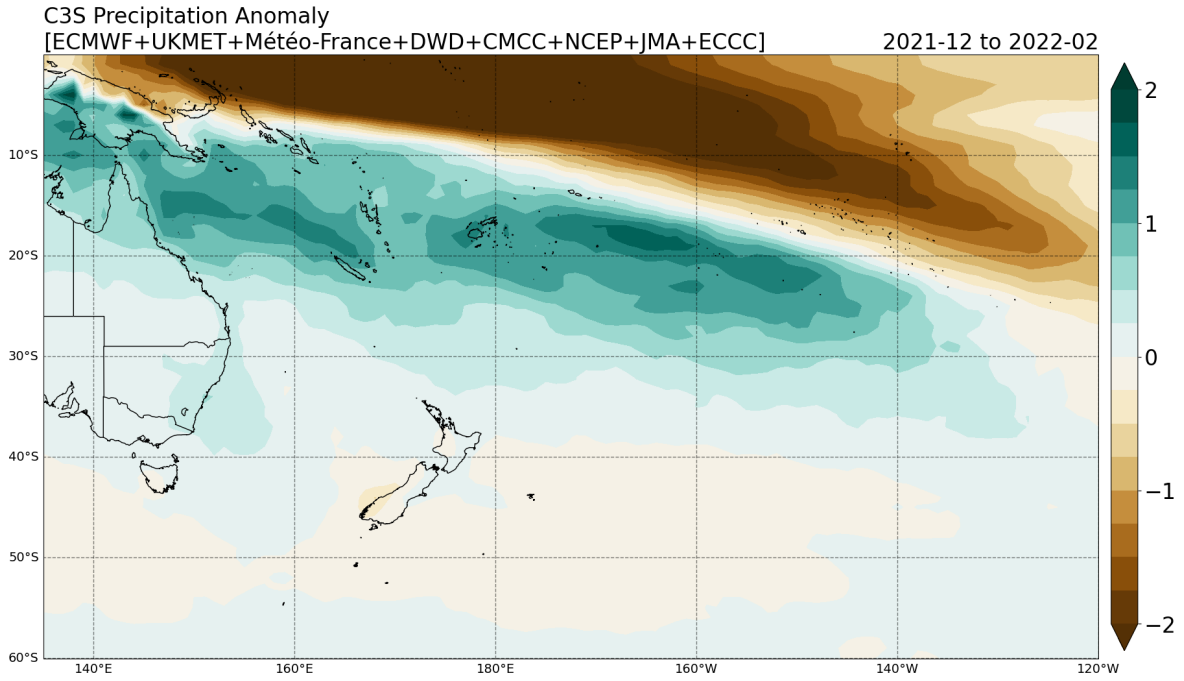
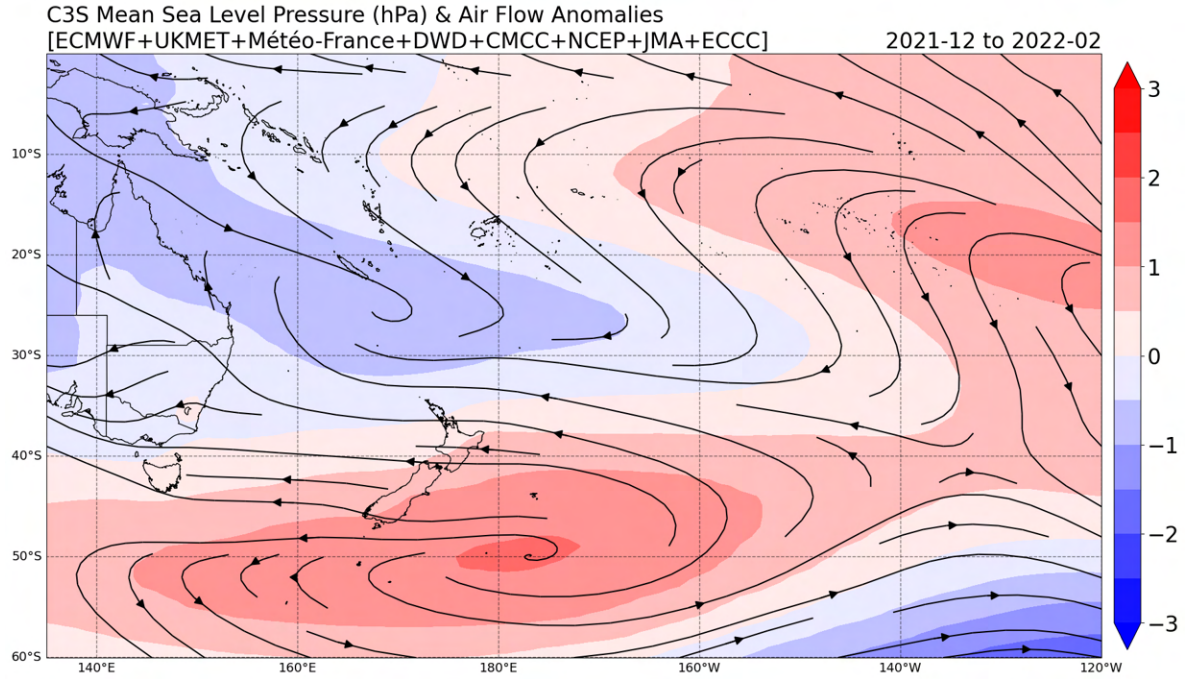


Figure 6. Multi-model ensemble forecast air pressure anomaly (hPa), December 2021-February 2022; red (blue) shades indicate above (below) normal air pressure; areas of below normal pressure in the tropics can indicate an increased potential for tropical cyclone genesis



Information about the dynamical models used: information on ECMWF model skill can be found here for: tropical cyclones, severe tropical cyclones, and ACE. An overview of the multi-model ensemble used to create the rainfall and air pressure plots can be found here.

TCO-SP (University of Newcastle) deterministic model summary

TCO-SP is a long-range tropical cyclone outlook based on a multivariate statistical method generated using Poisson Regression (Magee et al., 2020) recently published in *Scientific Reports*. This is the second year the product is available and we have incorporated it into the ICU outlook because it provides a different view from analogue and dynamical approaches. For the coming 2021/22 season, the deterministic TCO-SP outlook for Southwest Pacific TC season suggests 10 named TCs may form (probable range of 9-11), indicating normal activity for the basin when compared with the 1981-2010 average of 11.4 TCs (Table 4 and Figure 7). See https://tcoutlook.com/swpacific/ for more details related to this part of the outlook.

Table 4: Expected TC counts including expected range (95% confidence intervals (CI)) for the 2021/22 Southwest Pacific tropical cyclone season (October 2021 update), difference from long term average TC count (1981-2010).

		Long-term average TC count (1981-2010[b])	**Expected TC Count** (Probable TC count range: 95% CI)	**Difference between expected and long-term average (TC)**
	Southwest Pacific	11.4	10.1 (9.0-11.3)	▼ -1.3
Island Scale Models	Fiji	3.0	1.7 (1.1-2.6)	▼ -1.3
	Solomon Islands	3.1	1.5 (0.9-2.3)	▼ -1.6
	New Caledonia	2.9	2.8 (1.9-4.0)	▼ -0.1
	Vanuatu	2.5	2.3 (1.6-3.4)	▼ -0.2
	Tonga	2.0	1.1 (0.6-1.9)	▼ -0.9
	Papua New Guinea	1.7	1.3 (1.0-1.8)	▼ -0.4
	Northern New Zealand	0.4	0.5 (0.1-1.2)	▲ +0.1
Subregional models[a]	**N SWP** (Tuvalu, Wallis & Futuna, Tokelau)	2.1	2.2 (1.2-3.9)	▲ +0.1
	C SWP (Samoa, American Samoa, Niue)	2.7	1.9 (1.4-2.6)	▼ -0.8
	SE SWP (Southern Cook Islands, Society Islands, Austral Islands)	2.3	1.6 (0.4-2.2)	▼ -0.7
	NE SWP (Northern Cook Islands, E Kiribati: Line Islands, Marquesas, Tuamotu Archipelago, Gambier Islands, Pitcairn Islands)	1.6	2.3 (0.9-3.1)	▲ +0.7

[a] Sub-regional models – where individual island TC climatology shows less than 1.5 TCs per season, geographically neighbouring EEZs have been merged to increase sample size (Click here for more information).
[b] Average TC counts calculated for November-April TC season.

Specific to the NE SWP domain, which includes several island groups, the multi-model average based on the 10 models used in TCO-SP is ~2.3 TCs (see Figure 7). The majority of the models indicate elevated activity, likely due to the influence of Southern Annualr Mode and Indian Ocean SST variability (used in the prediction model). In addition, the skill score of the chosen NE SWP model (which has been selected using an objective convention) is quite high. Regardless, when rounded, the expected TC count (2 TCs) for the NE SWP domain is the same as the average TC count (1.6 TCs). The above-average risk profile for this region, however, considers the percentage difference between the normal and forecast TC numbers (1.6 vs 2.3 = 44% increase). This means that the TCO-SP outlook for islands located in the NE SWP domain have relatively elevated risk from normal, which diverges from analogue and dynamical guidance.

Figure 7. Expected TC count including probable range (95% confidence intervals) for the 2021/22 Southwest Pacific Tropical Cyclone Season based on TCO-SP (Magee et al., 2020). Expected TC counts are summarised for the Southwest Pacific (panel a) and island-scale and sub-regional locations (panel b).