August 2021 Long-Range Outlook for the 2021/22 Southwest Pacific Tropical Cyclone Season

Long-Range Tropical Cyclone Outlook for the Southwest Pacific (TCO-SP)

Outlook issued: 18th August 2021 (v1)

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TCO-SP
Long-Range
Tropical Cyclone Outlook
for the Southwest Pacific
www.tcoutlook.com

TCO-SP is a long-range tropical cyclone outlook based on a method published in Scientific Reports. Please see the disclaimer about the use of TCO-SP outlooks in the "Interpreting TCO-SP" section.

Outlook Summary

The August 2021 Long-Range Tropical Cyclone Outlook for the Southwest Pacific (TCO-SP) suggests **near-normal** TC activity for the coming 2021/22 Southwest Pacific TC season (1st November 2021 to 30th April 2022). In total, **10 TCs** are expected for the Southwest Pacific region[1], 1 TC less than the 1981-2010 average (11 TCs); however, the probable range of TC could lie between **8 and 12 TCs**. There is a **72% chance that the season will see average or below average TC counts (11 TCs or less)** and a 28% chance the season will see above-average TC counts (12 TCs or more).

Expected average TC counts for island-scale and sub-regional outlooks are summarised in Figure 1 (see Table 1 for detailed deterministic guidance):

- **Near-normal[2]** TC activity is expected for the entire Southwest Pacific (10 TCs), Fiji (3 TCs), New Caledonia (3 TCs), Tonga (2 TCs), Papua New Guinea (2 TCs), N SWP (2 TCs), C SWP (3 TCs) and the SE SWP (2 TCs).
- **Below-normal[3]** TC activity is expected for the Solomon Islands (1 TC), Vanuatu (2 TCs) and the NE SWP (1 TC).
- **Above-normal[3]** TC activity is expected for Northern New Zealand (1 TC).

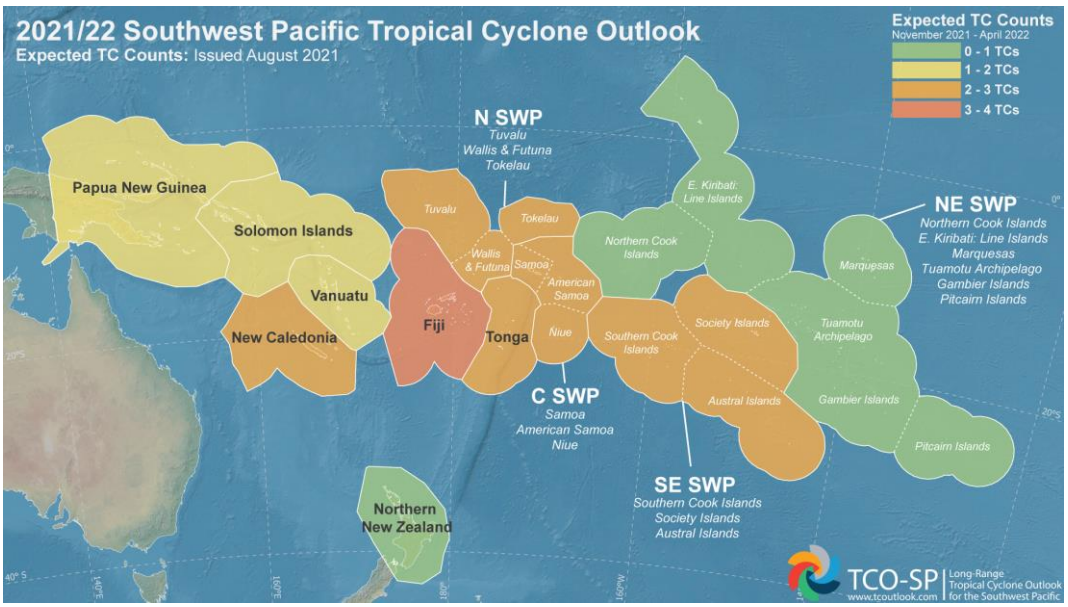

Figure 1. Expected TC counts for the November-April 2021/22 TC season. See Table 1 for TC counts, including probable TC range.

[1] Southwest Pacific region: 135°E-120°W.
[2] Near-normal is defined as when the difference between expected TC counts and the long-term (1981-2010) average is between -20% and +20%.
[3] Below-normal (above-normal) activity is defined as when the difference between expected TC counts and the long-term average (1981-2010) exceeds -20% (+20%).

Deterministic guidance

For the coming 2021/22 Southwest Pacific TC season, 10 TCs are expected (probable range of 8-12 TCs), suggesting near-normal activity when compared with the 1981-2010 average of 11.4 TCs (Table 1 and Figure 2).

Table 1: Summary of deterministic guidance. Average TC count (1981-2010), expected TC count including expected range (95% confidence intervals (CI)) for the 2021/22 Southwest Pacific tropical cyclone season

		Average TC count (1981-2010[b])	**Expected TC count** (Probable TC count range: 95% CI)	**Difference between expected and average TC count**
	Southwest Pacific	11.4	9.8 (7.9-12.1)	▼ -1.6
Island Scale Models	Fiji	3.0	3.0 (2.0-4.5)	► 0.0
	Solomon Islands	3.1	1.3 (0.9-2.0)	▼ -1.8
	New Caledonia	2.9	2.6 (1.4-3.1)	▼ -0.3
	Vanuatu	2.5	1.6 (1.1-2.3)	▼ -0.9
	Tonga	2.0	2.4 (1.8-3.2)	▲ +0.4
	Papua New Guinea	1.7	1.7 (1.0-2.7)	► 0.0
	Northern New Zealand	0.4	0.8 (0.3-1.9)	▲ +0.4
Subregional models[a]	**N SWP** (Tuvalu, Wallis & Futuna, Tokelau)	2.1	2.0 (1.0-4.0)	▼ -0.1
	C SWP (Samoa, American Samoa, Niue)	2.7	2.6 (1.7-4.0)	▼ -0.1
	SE SWP (Southern Cook Islands, Society Islands, Austral Islands)	2.3	2.2 (1.1-4.4)	▼ -0.1
	NE SWP (Northern Cook Islands, E Kiribati: Line Islands, Marquesas, Tuamotu Archipelago, Gambier Islands, Pitcairn Islands)	1.6	0.8 (0.3-2.0)	▼ -0.8

(August 2021 update) and difference between expected and average TC count.

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

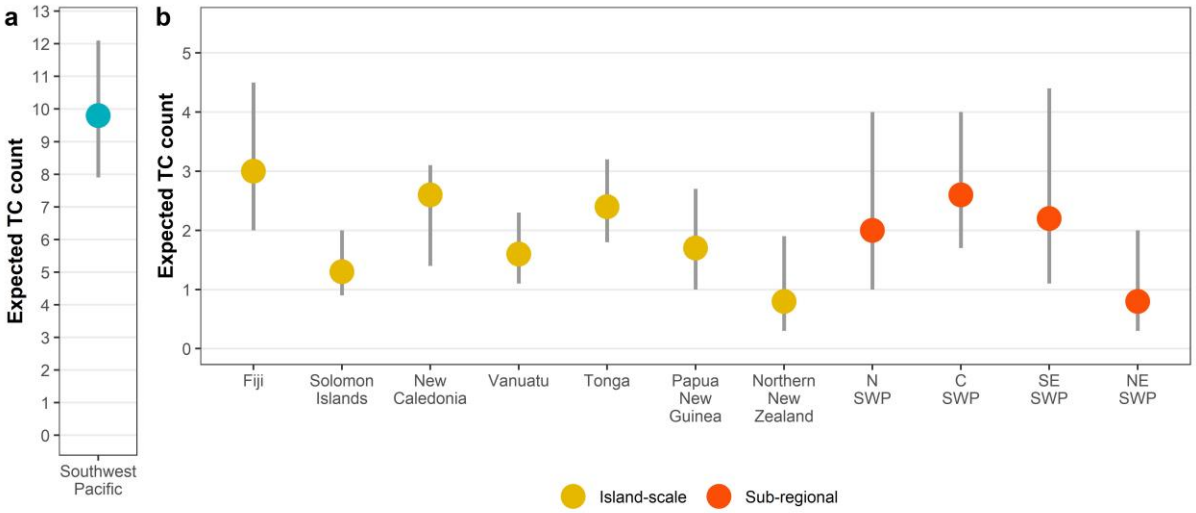

Figure 2. Expected TC count including probable range (95% confidence intervals) for the November-April 2021/22 Southwest Pacific tropical cyclone season. Expected TC counts are summarised for the Southwest Pacific (panel a) and island-scale and sub-regional locations (panel b).

Probabilistic guidance

Figure 3 summarises the probabilistic outlook for the 2021/22 Southwest Pacific Tropical Cyclone Season.

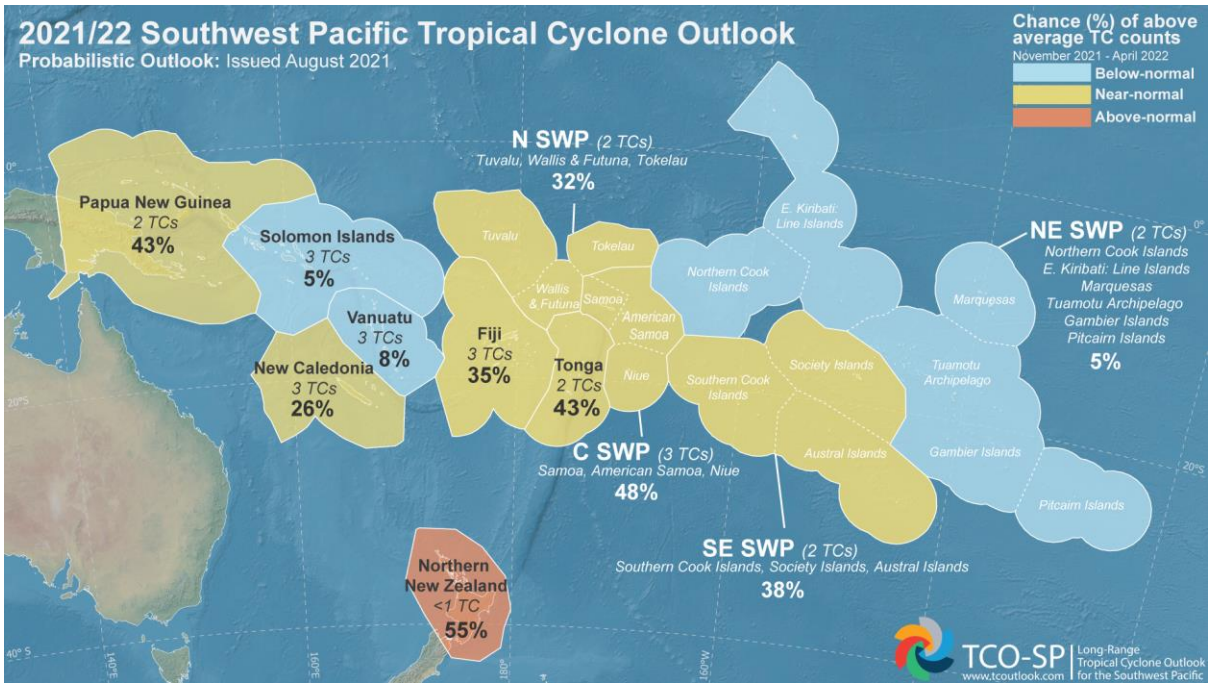

Figure 3. Probabilistic TC outlook for the November-April 2021/22 Southwest Pacific tropical cyclone season (August 2021 update). TC counts (italics) refer to the 1981-2010 climatology (average TC counts). The chance (%) of above-average TC counts are summarised. See Table 2 for tabular probabilities of above-average and below-average TC counts.

- **Near-normal**[4] TC activity is expected for the entire Southwest Pacific (28% chance of 12 or more TCs), Fiji (35% chance of 4 or more TCs), New Caledonia (26% chance of 4 or more TCs), Tonga (43% chance of 3 or more TCs), Papua New Guinea (43% chance of 3 or more TCs), N SWP (32% chance of 3 or more TCs), C SWP (48% chance of 4 or more TCs) and the SE SWP (38% chance of 3 or more TCs).
- **Below-normal**[5] TC activity is expected for the Solomon Islands (5% chance of 4 or more TCs), Vanuatu (8% chance of 4 or more TCs) and the NE SWP (5% chance of 3 or more TCs).
- **Above-normal**[5] TC activity is expected for Northern New Zealand (55% chance of 1 or more TCs).

[4] Near-normal is defined as when the difference between expected TC counts and the long-term (1981-2010) average is between -20% and +20%.
[5] Below-normal (above-normal) activity is defined as when the difference between expected TC counts and the long-term average (1981-2010) exceeds -20% (+20%).

Table 2. Summary of probabilistic guidance. Calculation of difference between the long-term average and expected TC count (%), TC risk and chance of near-normal, below-normal or above-normal TC activity for the 2021/22 Southwest Pacific tropical cyclone season.

		Long-term average TC count (1981-2010)	**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]**
	Southwest Pacific	11.4	9.8	-14%	Near-normal	72%	28%
Island Scale Models	Fiji	3.0	3.0	0%	Near-normal	65%	35%
	Solomon Islands	3.1	1.3	-58%	Below-normal	95%	5%
	New Caledonia	2.9	2.6	-10%	Near-normal	74%	26%
	Vanuatu	2.5	1.6	-36%	Below-normal	92%	8%
	Tonga	2.0	2.4	+20%	Near-normal	57%	43%
	Papua New Guinea	1.7	1.7	0%	Near-normal	57%	43%
	Northern New Zealand	0.4	0.8	+100%	Above-normal	45%	55%
Subregional models	**N SWP** (Tuvalu, Wallis & Futuna, Tokelau)	2.1	2.0	-5%	Near-normal	68%	32%
	C SWP (Samoa, American Samoa, Niue)	2.7	2.6	-4%	Near-normal	52%	48%
	SE SWP (Southern Cook Islands, Society Islands, Austral Islands)	2.3	2.2	-4%	Near-normal	62%	38%
	NE SWP (Northern Cook Islands, E Kiribati: Line Islands, Marquesas, Tuamotu Archipelago, Gambier Islands, Pitcairn Islands)	1.6	0.8	-50%	Below-normal	95%	5%

[a] TC risk is calculated using the percentage difference between expected TC counts and the 1981-2010 climatology. Near-normal risk is defined as when the difference between expected TC counts and the long-term (1981-2010) average is between -20% and +20%. Below-normal (above-normal) risk is defined as when the difference between expected TC counts and the long-term average (1981-2010) exceeds -20% (+20%).
[b] Chance of average or below-average TC activity and chance of above-average TC activity calculated using the Poisson distributional process.

Predictors and climate influences relevant to 2021/22 TC season

El Niño-Southern Oscillation: ENSO neutral conditions have persisted since early 2021. Statistical and dynamical SST models of the NINO3.4 region from the CPC/IRI indicate a **41% chance of La Niña conditions** for the first three months of the SWP TC season (November 2021-January 2022),[6] while the CPC/IRI official Probabilistic ENSO forecast suggests a **69% chance of La Niña conditions** for the same period.[7] According to ACCESS-S,[8] there is a **49% chance of La Niña conditions** by November 2021. The onset of La Niña conditions typically results in increased TC activity towards the west/southwest of the Southwest Pacific basin (Magee et al., 2017). TCO-SP is updated monthly, so any changes in ocean temperatures or atmospheric variability related to ENSO will be considered in the TCO-SP updates to follow.

[6] IRI ENSO forecast (Published July 19 2021) https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-sst_table
[7] CPC/IRI ENSO Forecast (Published August 12 2021) https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-cpc_update
[8] Australian Community Climate Earth-System Simulator-Seasonal (ACCESS-S) ENSO (NINO3.4) outlooks (Climate model summary issued August 12 2021; updated August 17 2021) http://www.bom.gov.au/climate/model-summary/#tabs=Bureau-model&region=NINO34

Indian Ocean Sea Surface Temperatures: Statistical and dynamical guidance collected from five international climate models indicate that four models (BOM, ECMWF, METEO and UKMO) are likely to exceed IOD negative SST thresholds by November 2021.[9] According to ACCESS-S,[10] there is a 56% chance of IOD negative conditions by November 2021 and a 25% chance by December 2021. TCO-SP is updated monthly, so any changes in Indian Ocean SST variability will be considered in the TCO-SP updates to follow.

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)[11] step. The model with the highest LOOCV skill score (1970-2021) is selected as the superior model and is used to derive the island-scale and sub-regional seasonal 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-SP.

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) for the August long-range outlook for the 2021/22 Southwest Pacific tropical cyclone season.

		Correlation	R^2	RMSE	Skill Score (%)[a]	Strike Rate (exact) (%)[b]	Strike Rate (±1) (%)[c]
	Southwest Pacific	0.76 (0.64)	0.57 (0.42)	1.32 (2.09)	57 (41)	12 (10)	52 (38)
Island Scale Models	Fiji	0.54 (0.22)	0.29 (0.05)	1.32 (1.11)	29 (22)	31 (29)	71 (67)
	Solomon Islands	0.72 (0.63)	0.52 (0.39)	1.39 (1.07)	52 (39)	25 (23)	75 (67)
	New Caledonia	0.82 (0.74)	0.67 (0.55)	1.00 (0.95)	67 (54)	35 (23)	87 (83)
	Vanuatu	0.57 (0.49)	0.32 (0.24)	1.26 (0.69)	32 (24)	21 (21)	69 (67)
	Tonga	0.49 (0.28)	0.24 (0.08)	1.39 (0.77)	24 (19)	31 (29)	75 (69)
	Papua New Guinea	0.66 (0.47)	0.44 (0.22)	0.97 (0.71)	44 (20)	37 (35)	90 (81)
	Northern New Zealand	0.59 (0.34)	0.34 (0.11)	0.73 (0.49)	34 (12)	52 (40)	96 (90)
Subregional models	**N SWP** (Tuvalu, Wallis & Futuna, Tokelau)	0.82 (0.65)	0.67 (0.42)	0.90 (1.02)	67 (37)	42 (29)	92 (85)
	C SWP (Samoa, American Samoa, Niue)	0.73 (0.59)	0.53 (0.34)	1.33 (1.14)	53 (32)	29 (27)	71 (65)
	SE SWP (Southern Cook Islands, Society Islands, Austral Islands)	0.84 (0.70)	0.71 (0.50)	1.06 (1.08)	71 (48)	37 (31)	87 (79)
	NE SWP (Northern Cook Islands, E Kiribati: Line Islands, Marquesas, Tuamotu Archipelago, Gambier Islands, Pitcairn Islands)	0.85 (0.75)	0.72 (0.56)	1.06 (0.92)	72 (56)	42 (35)	90 (83)

[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.

[9] BOM Indian Ocean Dipole Outlook (Issued August 12 2021; updated August 17 2021) http://www.bom.gov.au/climate/model-summary/#tabs=Indian-Ocean.
[10] Australian Community Climate Earth-System Simulator-Seasonal (ACCESS-S) IOD outlooks (Issued August 12 2021; updated August 17 2021) http://www.bom.gov.au/climate/model-summary/#tabs=Bureau-model&region=IOD.
[11] 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.

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. 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 et al., (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. Figure 4 summarises the expected TC count and probable range for the 10 predictor models (TC count and confidence intervals) for the August 2021 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 4.

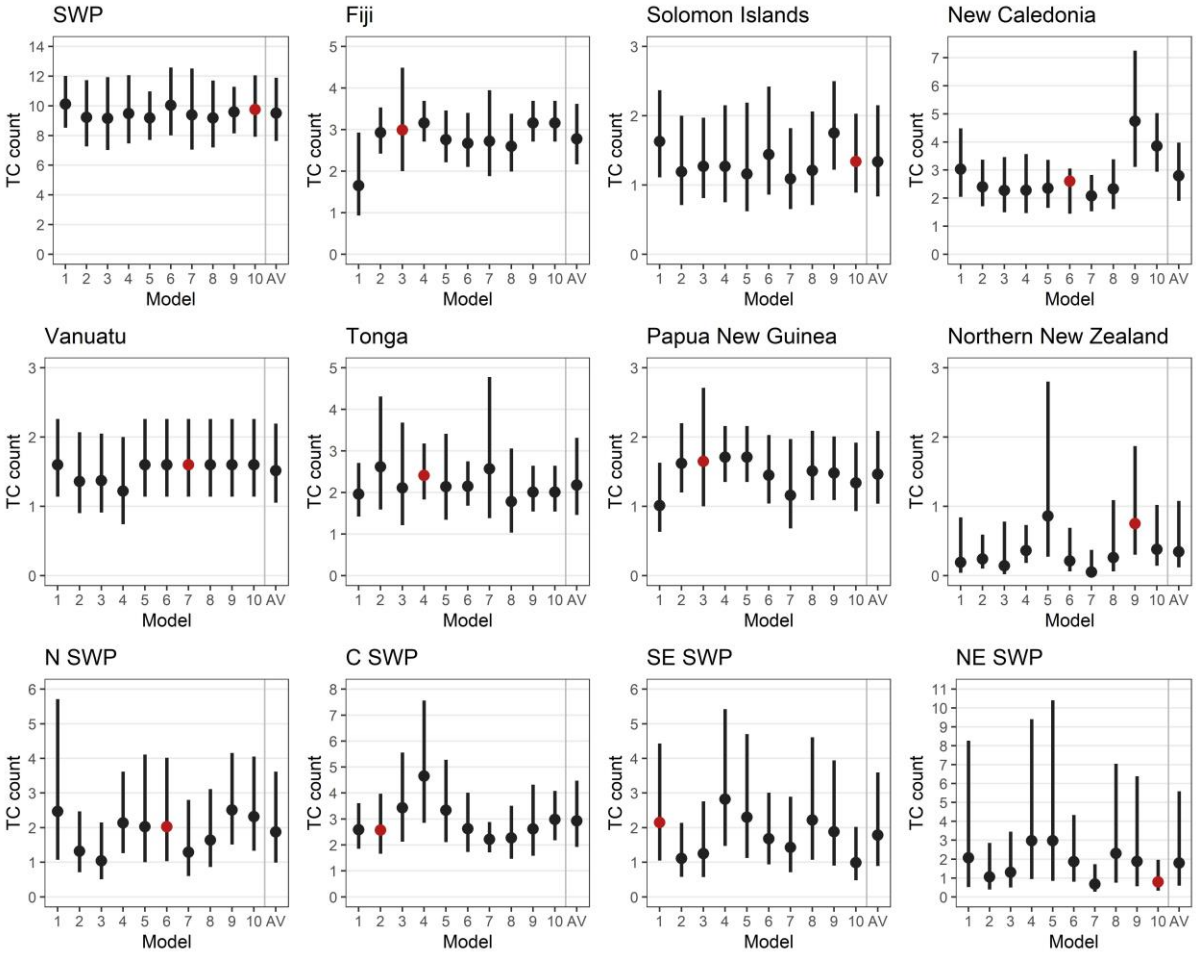

Figure 4. Comparison of predictor model consensus for expected TC counts (dot) and probable range (95% confidence intervals). Red dot indicates model selected due to superior model performance (highest skill score from the LOOCV time series). Models 1-10 refer to each unique predictor model. AV (average) 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 et al. (2020) for more information).

2021/22 TCO-SP update schedule

Pre-season TCO-SP outlooks are be generated every month between July and October, while in-season outlooks are be generated between November and January. Table 4 outlines the TCO-SP outlook schedule for the 2021/22 Southwest Pacific Tropical Cyclone Season. Guidance from the October TCO-SP outlook will be included in the NIWA-led Southwest Pacific Tropical Cyclone Outlook that is produced through the Island Climate Update (ICU).

Table 4. TCO-SP update schedule for the 2021/22 Southwest Pacific Tropical Cyclone Season

	Outlook	Date
Pre-season outlook	July TC Outlook	23rd July 2021
	August TC Outlook	18th August 2021
	September TC Outlook	22nd September 2021
	October TC Outlook	20th October 2021
In-season outlook	November TC Outlook	17th November 2021
	December TC Outlook	22nd December 2021
	January TC Outlook	19th January 2022

Interpreting TCO-SP

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

- **Guidance from TCO-SP does not and should not replace the advice provided by your local Pacific Island National Meteorological Service.**
- Guidance from TCO-SP will be considered in the consensus-based Island Climate Update TC outlook led by NIWA (to be released in October 2021) (see https://niwa.co.nz/climate/southwest-pacific-tropical-cyclone-outlook).
- 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-SP provides guidance up to four months before the start of the Southwest Pacific 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-SP 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-SP is the best way for end-users (e.g. Pacific Island Meteorological Services) to stay up to date with the latest TCO-SP updates.
- Users should evaluate model skill (Table 3) and the predictor model comparison (Figure 4) to inform decision-making.
- TCO-SP updates for the 2021/22 TC season will use the 1981-2010 climatology. From the 2022/23 Southwest Pacific TC season onwards, TCO-SP will use the 1991-2020 climatology.
- TCO-SP is an experimental platform and should be used in combination with other guidance for decision-making. TCO-SP 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. TCs that pass neighbouring Pacific Island nations can also cause significant damage. Always be alert. Listen to the advice of your local meteorological office and/or disaster management office.

Questions? Contact:

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