August Forecast Update for Northwest Pacific Typhoon Activity in 2021

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Forecast Summary

TSR reduces its July outlook and predicts the Northwest Pacific typhoon season in 2021 will likely witness an ACE index, intense typhoon numbers and typhoon numbers in the lower tercile historically.

The TSR (Tropical Storm Risk) early August forecast update for Northwest Pacific typhoon activity in 2021 anticipates a season with an ACE (Accumulated Cyclone Energy) index that is 20% below the long-term norm. This would likely place 2021 in the lowest one third of years since 1965 for Northwest Pacific typhoon activity. The forecast spans the period from 1st January to 31st December 2021 (95% of typhoons occur historically after 1st May) and employs data through to early August 2021. The forecast includes deterministic and probabilistic projections for overall basin activity, and deterministic projections for the ACE index and numbers of intense typhoons, typhoons and tropical storms. TSR reduces its forecast from early July due to a strengthening during the past month of the signals for a below-norm activity season. These signals concern ACE activity being 50% below norm during May-June-July 2021 and the June-July trade wind speed for the 2.5°N- 12.5°N, 120°E-180°E region being stronger than normal and thus inhibiting for current and upcoming cyclonic vorticity in the Northwest Pacific region where storms form. The TSR forecast is consistent also with the potential development of a weak La Niña event by September-October-November 2021. Forecast uncertainties remain but the precision of TSR's outlooks for upcoming Northwest Pacific typhoon activity issued in early August between 2003 and 2020 is good. We include robust forecast probability of exceedance information for the ACE index to quantify the forecast uncertainty.

NW Pacific ACE Index and System Numbers in 2021

		ACE Index	Intense Typhoons	Typhoons	Tropical Storms
TSR Forecast	2021	230	7	13	25
56-yr Climate Norm (±SD)	1965-2020	294 (±103)	9 (±3)	16 (±4)	26 (±4)
30-yr Climate Norm	1991-2020	300	9	16	25
10-yr Climate Norm	2011-2020	272	9	15	25
Forecast Skill at this Lead	2011-2020	74%	45%	0%	0%

Key: ACE Index = Accumulated Cyclone Energy Index = Sum of the squares of 6-hourly maximum sustained wind speeds (in units of knots) for all systems while they are at least tropical storm strength. ACE unit = $x10^4$ $knots^2$.
Intense Typhoon = 1 minute sustained wind > 95 kts = Hurricane category 3 to 5.
Typhoon = 1 minute sustained wind > 63 kts = Hurricane category 1 to 5.
Tropical Storm = 1 minute sustained wind > 33 kts.
SD = Standard deviation.
Forecast Skill = Percentage improvement in mean square error over running 10-year prior climate norm for the TSR publicly-released seasonal outlooks for 2011-2020.
Northwest Pacific = Northern hemisphere region west of 180°W including the South China Sea. Any tropical cyclone (irrespective of where it forms) which reaches tropical storm strength within this region counts as an event.

There is only a 6% probability that the 2021 NW Pacific typhoon season ACE index will be above-average (defined as an ACE index value in the upper tercile historically (>326)), a 38% chance it will be near-normal (defined as an ACE index value in the middle tercile historically (238 to 326) and a 56% likelihood it will be below-normal (defined as an ACE index value in the lower tercile historically (<238)). The 56-year period 1965-2020 is used for climatology.

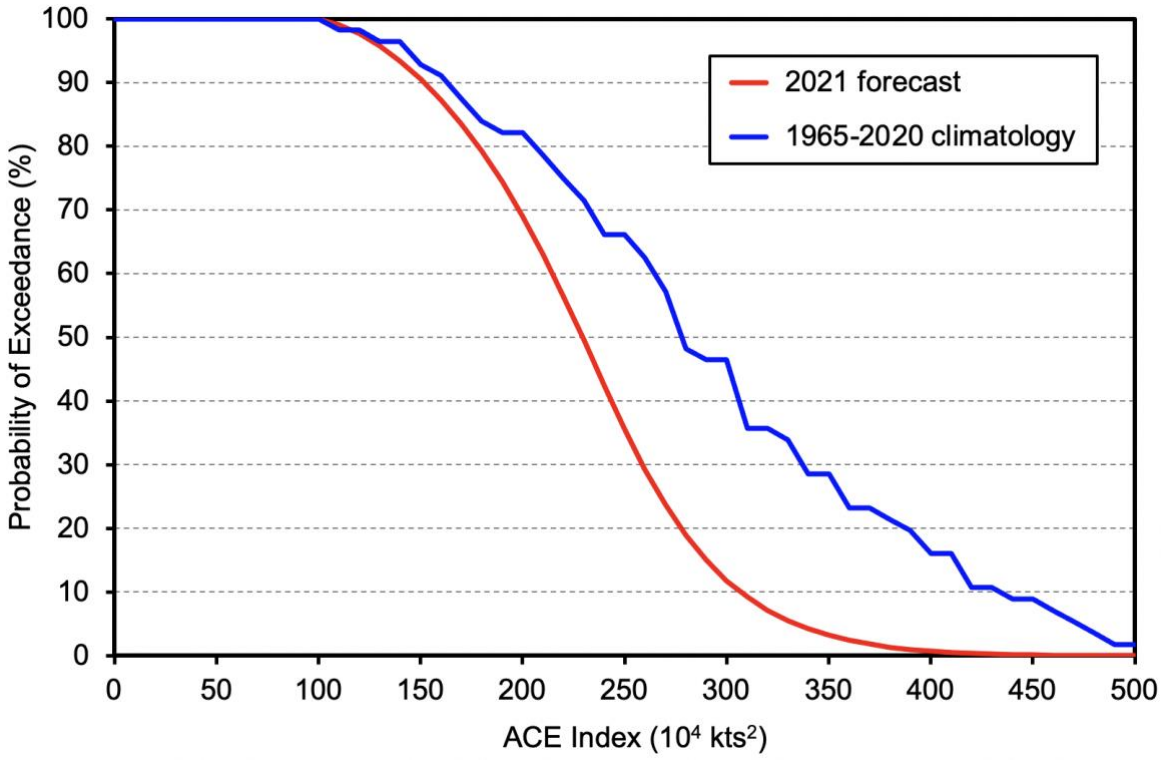
Key: Terciles = Data groupings of equal (33.3%) probability corresponding to the upper, middle and lower one-third of values historically (1965-2020).

The TSR forecast skills at this lead for typhoon numbers and tropical storm numbers 2011-2020 are zero due to a bad forecast issued in August 2011.

Forecast Probability of Exceedance Plot for the 2021 Northwest Pacific Typhoon Season

Seasonal outlooks for Northwest Pacific typhoon activity contribute to the anticipation of risk for insurance companies, other weather-sensitive businesses, and local and national governments. However, the uncertainty associated with such forecasts is often unclear. This reduces their benefit and contributes to the perception of forecast 'busts'. The robust assessment of risk requires a full and clear probabilistic quantification of forecast uncertainty with the forecast issued in terms of probability of exceedance (PoE). In this way the chance of each activity outcome occurring is clear for the benefit of users. Going forward TSR will be including robust forecast probability of exceedance (PoE) information based on the recommendation and methodology described in Saunders et al. (2020).

The figure below displays our current outlook for the Northwest Pacific ACE index in terms of PoE. The plot displays two PoE curves comprising the forecast PoE curve and the 1950-2020 climatology PoE curve. The forecast PoE curve is computed using a method similar to that described in section 3.3 of Saunders et al. (2020) while the climatology PoE curve is computed directly from observations. The figure specifies the current chance that a given ACE index will be reached in 2021 and how this chance compares to climatology.



Reference: Saunders, M. A., Klotzbach, P. J., Lea, A. S. R., Schreck, C. J., & Bell, M. M. (2020). Quantifying the probability and causes of the surprisingly active 2018 North Atlantic hurricane season. *Earth and Space Science*, *7*, e2019EA000852. https://doi.org/10.1029/2019EA000852

Predictors for 2021

TSR uses two predictors in its August forecast update for the Northwest Pacific ACE index in 2021. These predictors are: (1) The observed ACE activity up to the date of forecast issue; (2) The June-July 925 hPa trade wind speed for the region 2.5°N-12.5°N, 120°E-180°E. These predictors are used to make forecasts for the ACE index and intense typhoon numbers. Typhoon numbers and tropical storm numbers are forecast by using their observed regression with intense typhoon numbers.

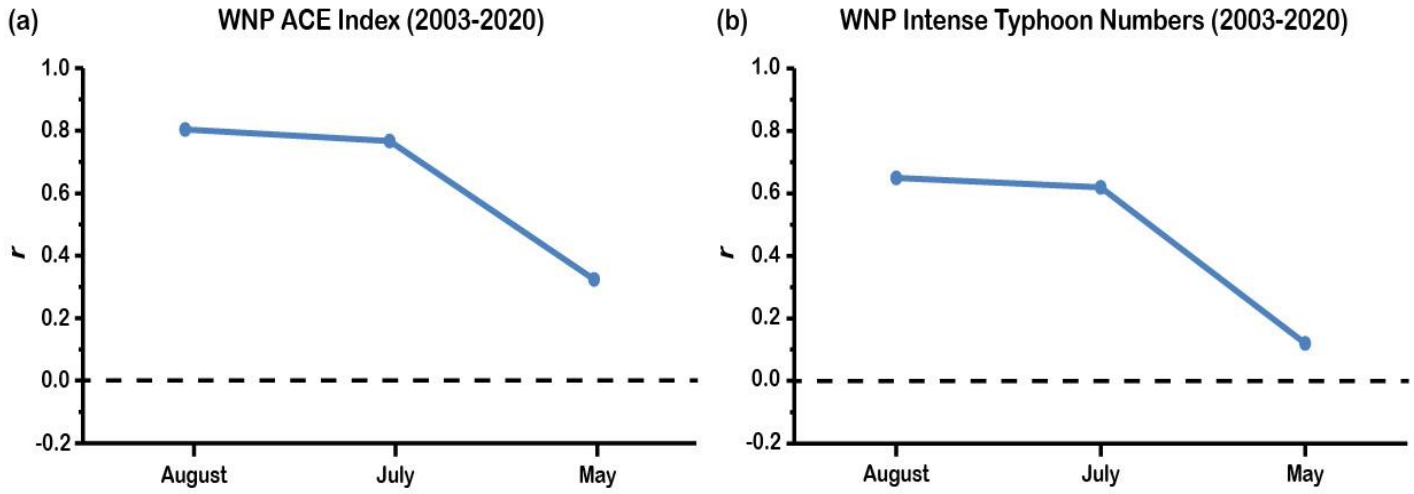
The two TSR predictors both point to the Northwest Pacific typhoon season in 2021 being below-norm. The observed 2021 ACE activity for the 3-months May-June-July 2021 was only 50% of norm. Below-norm ACE activity over these three months is linked to subsequent below-norm ACE activity. The June-July 2021 trade wind speed for the region 2.5°N-12.5°N, 120°E-180°E measured at 925 hPa was the 10th strongest since 1991. A stronger trade wind speed during June-July is linked to current and subsequent seasonal cyclonic vorticity over the Northwest Pacific region where intense typhoons form being below-norm. This in turn leads to fewer intense typhoons and to the ACE index being below-norm.

Our expectation that the Northwest Pacific ACE index and intense typhoon numbers in 2021 will likely lie in the lower tercile historically is consistent with the current (19th July 2021) ENSO outlook issued by the International Research Institute for Climate and Society that calls for the potential development of a weak La Niña event by September-October-November 2021.

Although uncertainties remain the precision of TSR's seasonal typhoon outlooks issued in early August between 2003 and 2020 is good as shown below.

The Precision of TSR Seasonal Forecasts 2003-2020

The figure below shows the skill of the TSR-publicly-released seasonal outlooks for Northwest Pacific ACE (left panel) and intense typhoon numbers (right panel) assessed for the 18-year period 2003-2020. Skill is shown as the Pearson correlation *r* between the forecast values (issued separately in early May, early July and early August) and the observed values. The figure shows low prediction skill from early May but good prediction skill (r = 0.6 to 0.8) by early July. The correlation skill for typhoon numbers for the 2003-2020 period (not shown) is lower than that for intense typhoon numbers at all forecast lead times.



Further Information

For more information about the TSR forecasts and their verifications for Northwest Pacific typhoon activity please see *https://www.tropicalstormrisk.com/for_typh.html*. This is the final TSR forecast update for the 2021 Northwest Pacific typhoon season.

Appendix – Predictions from Previous Months

a) Deterministic forecast

NW Pacific ACE Index and System Numbers 2021					
		ACE Index ($x10^4$ knots^2)	Intense Typhoons	Typhoons	Tropical Storms
Average Number (±SD) (1965-2020)		294 (±103)	9 (±3)	16 (±4)	26 (±4)
TSR Forecasts	9 August 2021	230	7	13	25
	7 July 2021	265	9	15	25
	11 May 2021	270	9	15	24

b) Tercile probabilistic forecast

NW Pacific ACE Index 2021				
		Tercile Probabilities (%)		
		below normal	normal	above normal
Climatology 1965-2020		33.3	33.3	33.3
TSR Forecasts	9 August 2021	56	38	6
	7 July 2021	32	49	19
	11 May 2021	42	40	18