Summary of 2011 NW Pacific Typhoon Season and Verification of Authors' Seasonal Forecasts

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Summary

The 2011 NW Pacific typhoon season saw typhoon and tropical storm numbers well below the 1965-2010 norm although intense typhoon numbers were only slightly below-norm. The persistence and strengthening of La Niña conditions in the tropical Pacific was primarily responsible for the low activity. The TSR deterministic forecasts overpredicted activity.

The Tropical Storm Risk (TSR) consortium presents a validation of their seasonal probabilistic and deterministic forecasts for the NW Pacific basin ACE index, and of their deterministic forecasts for the numbers of NW Pacific intense typhoons, typhoons and tropical storms in 2011. These forecasts were issued on the 8th March, 5th May, 4th July and the 4th August 2011. The 2011 NW Pacific typhoon season ran from 1st January to 31st December 2011.

Features of the 2011 NW Pacific Season

- Featured 21 tropical storms, 10 typhoons, 7 intense typhoons and a total ACE index of 190. This is the third lowest number of typhoons (behind 1998 and 2010) since reliable records began in 1965. The total ACE index is the eighth lowest on record.
- 2011 was the fifth year in succession with an ACE index below the 1965-2010 climate norm. The average ACE index over the five year period 2007-2011 is the lowest five-year running average on record.
- 2011 was the least active NW Pacific typhoon season on record for late season activity (October to December inclusive), with just two tropical storms and no typhoons forming during this period.
- Tropical storm Washi was the world's deadliest tropical cyclone in 2011 striking Mindanao, Philippines - a region that rarely experiences tropical cyclones - on the 16th December. Washi brought over 200 mm of rain to some regions triggering disastrous flash flooding and killing over 1,000 people.
- Japan was struck by two typhoons in 2011. Typhoon Roke made landfall as a weak category 1 typhoon just west of Tokyo. Typhoon Ma-on brushed the Kii Peninsula in Honshu as a minimal typhoon with 1-min sustained winds near 65 kts and dropping up to 1200 mm of rainfall.
- The Philippines were struck by four typhoons in 2011. Three of these typhoons, Nanmadol, Nesat and Nalgae, were intense typhoons at landfall with 1-minute sustained winds of 110

kts, 105 kts and 130 kts respectively. Nesat was one of the costliest typhoons to have affected the nation with total damage estimated at around US$ 200mn. The last time the Philippines was struck by at least three intense typhoons was 2006.

Tropical Storm Catalogue 2011

NW Pacific Individual Storm Summary 2011					
No.	Name	Dates	Peak wind (kts)[x]	Typhoon category	Landfall country and storm category at landfall*
1	Aere	6-11 May	50	-	Philippines (TS)
2	Songda	20-29 May	140	5	Japan[+] (TS)
3	Sarika	9-11 Jun	35	-	-
4	Haima	16-24 Jun	35	-	China (TS), Vietnam (TS)
5	Meari	21-27 Jun	60	-	-
6	Ma-on	11-22 Jul	115	4	Japan[+] (1)
7	Tokage	15-16 Jul	35	-	-
8	Nock-Ten	24-30 Jul	65	1	Philippines (1), China (TS)
9	Muifa	25 Jul-8 Aug	140	5	N Korea (TS)
10	Merbok	3-8 Aug	80	1	-
11	Nanmadol	22-31 Aug	135	4	Philippines (3), Taiwan (1)
12	Talas	25 Aug-4 Sep	55	-	Japan[+] (TS)
13	Kulap	7-10 Sep	45	-	-
14	Noru	3-6 Sep	45	-	-
15	Roke	11-21 Sep	115	4	Japan[+] (1)
16	Sonca	14-20 Sep	85	2	-
17	Nesat	23-30 Sep	105	3	Philippines (3), China (1)
18	Haitang	24-26 Sep	35	-	-
19	Nalage	27 Sep-5 Oct	130	4	Philippines (4), China (TS)
20	Banyan	10-14 Oct	35	-	Philippines (TS)
21	Washi	13-19 Dec	55	-	Philippines (TS)

[x] 1-min sustained winds.

* Landfall is defined as the intersection of the surface centre of a tropical storm with a coastline.

[+] Mainland only.

TS = Tropical storm, 1-5 = Saffir-Simpson hurricane scale.

The tropical storm names and peak 1-minute sustained windspeeds are obtained from the following sources: Joint Typhoon Warning Center real time advisories, UNISYS weather site (*http://weather.unisys.com/hurricane/*), Julian Heming's Met Office Tropical Cyclone Website (*http://www.metoffice.gov.uk/weather/tropicalcyclone/observations.html*) and the City University of Hong Kong (*http://weather.cityu.edu.hk/*).

Verification of Forecasts

NW Pacific ACE Index and System Numbers

a) Deterministic forecasts

NW Pacific ACE Index and System Numbers in 2011					
		ACE Index ($x10^4$ knots^2)	Intense Typhoons	Typhoons	Tropical Storms
Average Number (±SD) (1965-2010)		295 (±100)	8.5 (±3.0)	16.4 (±3.8)	26.3 (±4.6)
Actual Number 2011		190	7	10	21
TSR Forecasts (±FE)	4 Aug 2011	281 (±79)	8.0 (±2.4)	17.9 (±3.0)	28.2 (±4.0)
	4 Jul 2011	294 (±84)	8.4 (±2.4)	18.1 (±3.1)	28.3 (±4.0)
	5 May 2011	266 (±84)	7.6 (±2.6)	17.7 (±3.1)	28.0 (±4.0)
	8 Mar 2011	275 (±90)	7.8 (±2.7)	17.5 (±3.3)	27.8 (±4.2)
City University of Hong Kong Forecasts	4 Jul 2011	-	-	15	27
	9 May 2011	-	-	16	27

b) Probabilistic forecasts

NW Pacific ACE Index 2011					
		Tercile Probabilities			RPSS
		below normal	normal	above normal	
Actual 2011		100	0	0	1
Climatology 1965-2010		33.3	33.3	33.3	0
TSR Forecasts	4 Aug 2011	29	47	24	-0.007
	4 Jul 2011	31	44	25	0.03
	5 May 2011	37	43	20	0.22
	8 Mar 2011	34	41	25	0.11

The TSR forecasts overpredicted NW Pacific typhoon activity in 2011 with all probabilistic forecasts except the May forecast showing minimal skill. The reasons for the overprediction were 1) the observed August-September Niño 3.75 SSTs were cooler than forecast at all lead times; 2) unusually stable conditions persisting over the NW Pacific basin throughout the summer and autumn which acted to suppress deep convection and storm formation; 3) unexpectedly low typhoon and tropical storm activity in Oct-Nov-Dec due to strengthening La Niña conditions.

The City University of Hong Kong (CUHK) forecasts also overpredicted NW Pacific typhoon activity in 2011 but were more skilful than TSR at all lead times. Further details on the CUHK forecasts and their verification may be obtained from *http://weather.cityu.edu.hk/tc_forecast.*

Environmental Factors in 2011

The principle underlying sound seasonal typhoon predictions is to forecast the key environmental conditions at the height of the NW Pacific typhoon season. TSR finds that the most important contemporaneous factor influencing the overall activity of the NW Pacific typhoon season is the August-September (AS) Niño 3.75 SST [region 180°-140°W, 5°S-5°N]. This predictor influences cyclonic vorticity (the spinning up of storms) in the main typhoon formation region. The Table below verifies our forecasts in 2011 for this predictor.

Predictor Forecasts 2011		
		AS Niño 3.75 SST (°C)
Actual Value 2011 (1965-2010 Anomaly)		-0.57
TSR Forecasts (±FE)	4 Aug 2011	-0.17 (±0.22)
	4 Jul 2011	-0.04 (±0.31)
	5 May 2011	-0.33 (±0.51)

All TSR forecasts correctly predicted the sign of the August/September Niño 3.75 SST but underpredicted the magnitude of the anomaly. This underprediction was partly why NW Pacific typhoon activity was overpredicted. The Niño 3.75 SST continued to cool from September to November 2011 as La Niña conditions re-developed in the tropical Pacific which acted to suppress NW Pacific typhoon activity towards the end of 2011. In addition, vertical stability over the NW Pacific basin was unusually low which further acted to suppress NW Pacific typhoon activity by inhibiting deep convection. These additional unpredictable factors meant that NW Pacific typhoon activity would have been overpredicted even if the AS Niño 3.75 SST had been predicted perfectly.

Definitions

Rank Probability Skill Score

The probabilistic skill measure employed is the rank probability skill score (*RPSS*) (Epstein 1969; Wilks 2006; Goddard et al 2003). Computation of *RPSS* begins with the rank probability score (RPS) which is defined as:

$$\sum_{m=1}^{N_{cat}} (CP_{Fm} - CP_{Om})^2$$

where N_{cat} = 3 for tercile forecasts. The vector CP_{Fm} represents the cumulative probability of the forecast up to category *m*, and CP_{Om} is the cumulative observed probability up to category *m*. The probability distribution of the observation is 100% for the category that was observed and is zero for the other two categories. For a perfect forecast *RPS* = 0. The *RPS* is referenced to climatology to give the *RPSS* which is defined as:

$$RPSS = 1 - \frac{RPS_{fcst}}{RPS_{ref}}$$

where RPS_{fcst} is the *RPS* of the forecast and RPS_{ref} (=RPS_{cl}) is the *RPS* of the climatology forecast. The maximum *RPSS* is 1; a negative *RPSS* indicates skill worse than climatology.

Total 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 winds > 95kts (110mph).
Typhoon	=	1 minute sustained winds > 63kts (73mph).
Tropical Storm	=	1 minute sustained winds > 33kts (38mph).
SD	=	Standard Deviation.
Terciles	=	Data groupings of equal (33.3%) probability corresponding to the upper, middle and lower one-third of values historically (1965-2010).

Forecasts for 2012

The issue dates for TSR outlooks for NW Pacific typhoon activity in 2011 are the 4th April, 4th May, 5th July and 6th August 2012. Forecasts will be deterministic and probabilistic.

References

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Tropical Storm Risk.com (TSR)

Tropical Storm Risk (TSR) offers a leading resource for predicting and mapping tropical storm activity worldwide. The public TSR website provides forecasts and information to benefit basic risk awareness and decision making from tropical storms. The new TSR Business service and web site offers real-time products of unrivalled accuracy for the detailed mapping and prediction of tropical storm windfields worldwide. The TSR consortium is co-sponsored by Aon Benfield, the leading reinsurance intermediary and capital advisor, RSA Insurance Group, the global insurance group, and Crawford & Company, a global claims management solutions company.