Summary of 2007 NW Pacific Typhoon Season and Verification of Authors' Seasonal Forecasts

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Summary

A year with a moderate La Niña leading to below-norm storm activity. The basin ACE (Accumulated Cyclone Energy) index in 2007 was approximately 30% below its 1965-2006 norm value. The TSR deterministic forecasts generally overpredicted the ACE index although intense typhoon numbers were well predicted at all leads. The probabilistic forecasts for the basin ACE index showed skill between March and June but little skill for July and August.

The Tropical Storm Risk (TSR) consortium presents a validation of their seasonal probabilistic and deterministic forecasts for the NW Pacific basin ACE index, and deterministic forecasts for the numbers of intense typhoons, typhoons and tropical storms in 2007. These forecasts were issued on the 6th March 2007 and monthly from the 3rd May 2007 to the 6th August 2007 for the 2007 NW Pacific typhoon season which ran from 1st January to 31st December 2007.

Features of the 2007 NW Pacific Season

- The 2007 NW Pacific season featured 25 tropical storms, 15 typhoons, 8 intense typhoons and an ACE index of 208 x10^4 knots^2. This is the lowest ACE index since 1999 and the seventh lowest since reliable records began in 1965.
- Three typhoons struck the Japanese mainland. Typhooon Usagi made landfall on the southern island of Kyushu with 1-minute sustained winds of 105 mph. Typhoon Man-yi struck the southern islands of Kyushu and Shikoku with 1-minute sustained winds of around 100 mph killing 3 people. Typhoon Fitow hit central Japan with 1-minute sustained winds of around 75 mph killing 50 people.
- Taiwan was hit by two major typhoons causing substantial damage. Typhoon Krosa struck with wind gusts of over 115 mph and brought a metre of rain in places leading to damage estimated at around US$ 600m. Typhoon Sepat struck central Taiwan with 1-minute sustained winds of 120 mph and up to 39 inches of rain causing damage to agriculture estimated at US$ 1.14 bn. Sepat later struck Fujan Province in China as a minimal typhoon killing 39 people and causing US$ 658 m in damage.
- Typhoon Wipha struck Fuding, China with 1-minute sustained winds of 115 mph. Nearly two million people were evacuated. Nine people were killed and damage was estimated at over US$ 880 m.
- Typhoon Lekima made landfall in Vietnam as a severe tropical storm destroying 100,000 houses and killing 42 people.
- 2007 had the lowest ACE index on record for a year with at least eight intense typhoons.

Tropical Storm Catalogue 2007

NW Pacific Individual Storm Summary 2007					
No.	Name	Dates	Peak wind (kts)[x]	Typhoon category	Landfall country and storm category at landfall*
1	Kong_Rey	31 Mar-5 Apr	90	2	-
2	Yutu	17-22 May	125	4	-
3	Toraji	4-5 Jul	35	-	China (TS)
4	Man-yi	8-15 Jul	135	4	Japan (2)[+]
5	Usagi	28 Jul-3 Aug	120	4	Japan (2)[+]
6	06W	2-6 Aug	35	-	-
7	Pabuk	5-9 Aug	65	1	Taiwan (TS), China (TS)
8	Wutip	7-9 Aug	40	-	Taiwan (TS)
9	Sepat	12-19 Aug	140	5	Taiwan (3), China (1)
10	Fitow	28 Aug-7 Sep	85	2	Japan (1)[+]
11	Danas	7-11 Sep	60	-	-
12	Nari	12-16 Sep	120	4	South Korea (1)
13	Wipha	15-19 Sep	135	4	China (3)
14	Fransisco	23-25 Sep	45	-	China (TS)
15	Lekima	30 Sep-3 Oct	70	1	Vietnam (1)
16	Krosa	1-8 Oct	130	4	Taiwan (4), China (TS)
17	Haiyan	6-6 Oct	40	-	-
18	Podul	6-7 Oct	40	-	-
19	Lingling	12-13 Oct	40	-	-
20	Kajiki	19-21 Oct	110	3	-
21	Faxai	26-27 Oct	40	-	-
22	Peipah	3-9 Nov	75	1	Phillippines (1)
23	Tapah	11-12 Nov	35	-	-
24	Hagibis	18-27 Nov	85	2	Phillippines (TS)
25	Mitag	20-27 Nov	95	2	Phillippines (1)

[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 best track data, Gary Padgett's monthly global tropical cyclone summaries issued through the tropical storms mailing list at *tropical-storms@tstorms.org*, 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 2007					
		ACE Index ($x10^4$ knots^2)	Intense Typhoons	Typhoons	Tropical Storms
Average Number (±SD) (1965-2006)		305 (±97)	8.7 (±3.0)	16.8 (±3.6)	26.7 (±4.4)
Actual Number 2007		208	8	15	25
TSR Forecasts (±SD)	6 Aug 2007	294 (±76)	8.3 (±2.4)	16.9 (±2.9)	26.8 (±3.7)
	4 July 2007	306 (±81)	8.7 (±2.4)	16.9 (±2.9)	26.8 (±3.7)
	4 June 2007	269 (±82)	7.5 (±2.6)	16.9 (±2.9)	26.8 (±3.7)
	3 May 2007	281 (±79)	7.9 (±2.6)	16.9 (±2.9)	26.8 (±3.7)
	6 Mar 2007	264 (±91)	7.3 (±2.7)	14.8 (±3.2)	24.3 (±3.9)
Chan Forecasts	25 June 2007	-	-	14	25
	23 April 2007	-	-	14	24

b) Probabilistic forecasts

NW Pacific ACE Index 2007					
		Tercile Probabilities			RPSS
		below normal	normal	above normal	
Actual 2007		100	0	0	1
Climatology 1965-2006		33.3	33.3	33.3	0
TSR Forecasts	6 Aug 2007	30	49	21	0.04
	4 July 2007	26	47	28	-0.11
	4 June 2007	42	43	15	0.36
	3 May 2007	36	46	18	0.21
	6 Mar 2007	45	39	15	0.41

All the TSR forecasts overpredicted the ACE index but predicted well the number of intense typhoons. The ACE index in 2007 was exceptionally low for a year with eight intense typhoons, and reflects the short lifetimes of the storms this year. The short lifetimes were due to most of the storms developing in the western half of the basin (west of 140°E) which meant they tended to pass over land or cooler water more quickly. This is typical of a La Niña year. The TSR March forecast performed best. The TSR probabilistic forecasts between March and June showed skill but the July and August forecasts performed poorly. The latter was due to the AS Niño 3.75 SST anomaly in these months being overpredicted. This in turn was due to the rapidly developing La Niña in August-September being underpredicted.

Chan's predictions for tropical storm and typhoon numbers in 2007 were, in general, better than TSR's with the exception of the TSR March forecast which was comparable in skill to both of Chan's forecasts. Further details on the Chan forecasts and their verification may be obtained

from *http://weather.cityu.edu.hk/tc_forecast*

Environmental Factors in 2007

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 2007 for this predictor.

Predictor Forecasts 2007		
		AS Niño 3.75 SST (°C)
Actual Value 2007 (1965-2006 Anomaly)		-0.47
TSR Forecasts (±FE)	6 August 2007	-0.14 (±0.21)
	4 July 2007	-0.01 (±0.29)
	4 June 2007	-0.39 (±0.43)
	3 May 2007	-0.25 (±0.46)

All the TSR forecasts underpredicted the magnitude of the AS Niño 3.75 anomaly although the May and June forecasts were correct to within one standard error. This underprediction resulted in an overprediction of the basin ACE index, particularly for July and August. The reason for the large overprediction of the AS Niño 3.75 anomaly in July and August is unclear, although other ENSO prediction models similarily overpredicted AS Niño 4 (a similar region to Niño 3.75) anomalies at these lead times. The TSR June forecast proved best overall.

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 (1965-2005).

Forecasts for 2008

The TSR extended range forecast for the 2008 NW Pacific typhoon season will be issued in early March 2008 followed by monthly forecast updates from May through to early August. Forecasts will be deterministic and probabilistic.

References

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Tropical Storm Risk.com (TSR)

Founded in 2000, *Tropical Storm Risk* (TSR) offers a leading resource for forecasting the risk from tropical storms worldwide. The venture provides innovative forecast products to increase risk awareness and to help decision making within the (re)insurance industry, other business sectors, government and society. The TSR consortium is co-sponsored by Benfield, the world's leading independent reinsurance and risk intermediary, Royal & Sun Alliance, the global insurance group, and Crawford & Company, a global claims management solutions company. The TSR scientific grouping brings together climate physicists, meteorologists and statisticians at University College London and the Met Office.

Tropical Storm Risk has won two major insurance industry awards during the past four years. In 2006 TSR was awarded the prestigious Risk Management Award at the British Insurance Awards, and in 2004 won the British Insurance Award for London Market Innovation of the Year.

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