Summary of 2010 NW Pacific Typhoon Season and Verification of Authors' Seasonal Forecasts

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Summary

The 2010 NW Pacific typhoon season was the least active season since reliable records began in the mid 1960's. The season experienced even fewer storms than the North Atlantic in 2010. The exceptionally low activity was linked to one of the strongest La Niña events on record. The TSR deterministic forecasts correctly predicted a below-average activity season from early July but still overpredicted the total 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 2010. These forecasts were issued on the 8th March, 5th May, 6th July and the 4th August. The 2010 NW Pacific typhoon season ran from 1st January to 31st December 2010.

Features of the 2010 NW Pacific Season

- The least active season since reliable records began in the mid 1960's.
- Featured just 14 tropical storms and 8 typhoons. The previous records for the least number of tropical storms and typhoons in a NW Pacific season were 17 and 9 respectively set in 1998. The ACE index of 115 x10^4 knots^2 was the second lowest on record after 1999.
- Experienced fewer tropical storms and a lower ACE index than the North Atlantic in 2010. This has happened only once before - in 2005 - for tropical storms, and has happened only three times before for the ACE index. A 'normal' typhoon season experiences nearly three times more storm activity than the North Atlantic.
- No Japanese-mainland landfalling typhoon. This is only the second such occurrence since 1988.
- The fourth consecutive year with a below-norm ACE index. The last occasion with four such consecutive years was 1978-1981. (The 1965-2009 climate norm for the ACE index is 295 x10^4 knots^2).
- Typhoon Megi was the strongest tropical cyclone anywhere in the world in 2010 with peak 1-minute sustained winds of 155 kts (180 mph). Megi struck the Philippines with 1-minute sustained winds near 160 mph killing 31 people and causing total losses of around US$ 255m. Megi was the most powerful typhoon to strike the Philippines since typhoon Zeb in 1998. Megi also caused flash flooding and landslides on Taiwan and later struck China as a strong tropical storm causing a further US$ 410m in overall damage.

- Typhoon Kompasu was the strongest storm to strike the Seoul (S Korea) metropolitan area in 15 years. 1-minute sustained winds were near 65 kts (75 mph).

Tropical Storm Catalogue 2010

NW Pacific Individual Storm Summary 2010					
No.	Name	Dates	Peak wind (kts)[x]	Typhoon category	Landfall country and storm category at landfall*
1	Omais	21-26 Mar	50	-	-
2	Conson	11-17 Jul	75	1	Philippines (TS)
3	Chanthu	18-22 Jul	75	1	China (1)
4	Dianmu	8-12 Aug	55	-	-
5	Mindulle	22-24 Aug	60	-	Vietnam (TS)
6	Lionrock	27 Aug-2 Sep	55	-	China (TS)
7	Kompasu	30 Aug-2 Sep	100	3	S Korea (1)
8	Namtheun	30 Aug-1 Sep	40	-	-
9	Malou	2-7 Sep	45	-	-
10	Meranti	8-10 Sep	65	1	China (1)
11	Fanapi	14-20 Sep	105	3	Taiwan (3), China (1)
12	Malakas	20-25 Sep	90	2	-
13	Megi	13-23 Oct	155	5	Philippines (5), China (TS)
14	Chaba	21-30 Oct	115	4	-

[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 2010					
		ACE Index ($x10^4$ knots^2)	Intense Typhoons	Typhoons	Tropical Storms
Average Number (±SD) (1965-2009)		299 (±97)	8.6 (±3.0)	16.6 (±3.6)	26.6 (±4.3)
Actual Number 2010		115	4	8	14
TSR Forecasts (±FE)	4 Aug 2010	217 (±78)	6.1 (±2.5)	13.4 (±3.0)	22.8 (±3.8)
	6 Jul 2010	236 (±83)	6.7 (±2.4)	13.6 (±3.0)	23.0 (±3.8)
	5 May 2010	321 (±80)	9.2 (±2.5)	14.6 (±3.0)	24.1 (±3.8)
	8 Mar 2010	284 (±88)	8.1 (±2.6)	14.8 (±3.3)	24.2 (±3.8)
Chan Forecasts	24 Jun 2010	-	-	15	23
	26 Apr 2010	-	-	16	24

b) Probabilistic forecasts

NW Pacific ACE Index 2010					
		Tercile Probabilities			RPSS
		below normal	normal	above normal	
Actual 2010		100	0	0	1
Climatology 1965-2008		33.3	33.3	33.3	0
TSR Forecasts	4 Aug 2010	61	33	6	0.72
	6 Jul 2010	51	38	11	0.55
	5 May 2010	15	43	42	-0.62
	8 Mar 2010	27	43	30	-0.12

The TSR forecasts overpredicted NW Pacific typhoon activity in 2010. However, below-average activity was correctly predicted from July onwards. The August forecast performed best overall. The reasons for the overprediction were firstly, the forecast August-September Niño 3.75 SSTs at all leads being warmer than observed, and secondly, the total activity being below what would be expected even if the Niño 3.75 SST had been predicted correctly. The March and May forecasts performed worse than the July and August forecasts, as Niño 3.75 SST anomalies at these lead times were forecast to be near-neutral instead of moderately negative.

The Chan forecasts also overpredicted NW Pacific typhoon activity in 2010. The TSR forecasts were better than Chan for typhoon numbers and comparable for tropical storm numbers. Further details on the Chan forecasts and their verification may be obtained from *http://weather.cityu.edu.hk/tc_forecast.*

Environmental Factors in 2010

Without doubt the exceptionally low typhoon activity in 2010 is linked to one of the strongest La Niña events on record. La Niña is a cooling of the equatorial tropical Pacific. The strong 2010/11 La Niña began in May 2010 and persisted and intensified throughout the 2010 typhoon season.

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 2010 for this predictor.

Predictor Forecasts 2010		
		AS Niño 3.75 SST (°C)
Actual Value 2010 (1965-2009 Anomaly)		-1.38
TSR Forecasts (±FE)	4 Aug 2010	-0.90 (±0.20)
	6 Jul 2010	-0.71 (±0.29)
	5 May 2010	0.18 (±0.45)

The July and August TSR forecasts performed well in 2010 correctly predicting 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. Even taking into account the strongly negative AS Niño 3.75 SST, 2010 NW Pacific typhoon was below what was expected. It is clear that an additional factor also acted to suppress NW Pacific typhoon activity in 2010; one possibility was the unusually high vertical stability present over the tropical Pacific during the peak of the typhoon season (August-September). This high stability would have inhibited deep convection and, as a result, suppressed tropical cyclone formation.

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 2011

The issue dates for TSR outlooks for NW Pacific typhoon activity in 2011 are the 8th March, 4th May, 5th July and 5th August 2011. 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.