Summary of 2005 NW Pacific Typhoon Season and Verification of Authors' Seasonal Forecasts

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Summary

A year with near-average activity as defined by the basin ACE (Accumulated Cyclone Energy) index and by the numbers of intense typhoons and typhoons, but below-average when assessed in terms of numbers of tropical storms. The TSR probabilistic forecasts correctly predicted the near-average ACE index activity from March. The TSR deterministic forecasts correctly predicted the number of intense typhoons from May, and only slightly overpredicted the ACE index and numbers of typhoons and tropical storms at all leads from March.

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 2005. These forecasts were issued monthly from 7th March 2005 to 5th August 2005 for the 2005 NW Pacific typhoon season which ran from 1st January to 31st December 2005. All TSR forecasts were correct to within one standard error. The basin ACE index was slightly overpredicted at all leads due to the August-September Nino 3.75 (region 180^{o}-140^{o}W, 5^{o}S-5^{o}N) sea surface temperatures being slightly cooler than predicted.

Features of the 2005 NW Pacific Season

- The 2005 NW Pacific season featured 24 tropical storms, 16 typhoons, 9 intense typhoons and an ACE index of 285 x10^{4} knots^{2}. This is the quietest season since 2000.
- China was struck by eight storms - typhoons Longwang, Damray, Khanun, Sanvu, Matsa, Haitang and tropical storms Talin and Washi. Together they killed 294 people and caused over US$ 3bn in damage.
- Vietnam was affected by four storms - tropical storms Damrey, Vicente and Washi, and typhoon Kai_Tak. In total 103 people were killed and the damage was over US$ 250 million.
- Taiwan was struck by three powerful typhoons - Talin, Haitang and Longwang. Together they killed 13 people, injured 139 more and caused over US$ 40 million in damage.
- In contrast to 2004 the Japanese mainland had only two typhoon landfalls in 2005. Typhoon Nabi struck southern Japan bringing 1-min sustained winds of 78 mph and up to 1.3m (51in) of rain. Nabi killed 27 people and caused US$ 37 million in damage. Typhoon Mawar brushed Tokyo bringing 1-min sustained winds of 67mph and cutting power to thousands of homes. Three people were killed and four were injured.

Tropical Storm Catalogue 2005

NW Pacific Individual Storm Summary 2005					
No.	Name	Dates	Peak wind (kts)[x]	Typhoon category	Landfall country, storm and category at landfall*
1	Kulap	13-18 Jan	60	-	-
2	Roke	13-17 Mar	65	1	Phillippines (1)
3	Sonca	20-26 Apr	115	4	-
4	Nesat	30 May-10 Jun	125	4	-
5	Haitang	11-19 Jul	140	5	Taiwan (3), China (1)
6	Nalgae	20-23 Jul	50	-	-
7	Banyan	21-27 Jul	60	-	-
8	Washi	28-31 Jul	45	-	China (TS), Vietnam (TS)
9	Matsa	31 Jul-06 Aug	90	2	China (1)
10	Sanvu	10-13 Aug	65	1	Phillippines (TS), China (1)
11	Mawar	19-26 Aug	130	4	Japan[+] (2)
12	Guchol	20-25 Aug	60	-	-
13	Talim	26 Aug-01 Sep	125	4	Taiwan (3), China (TS)
14	Nabi	29 Aug-06 Sep	140	5	Japan[+] (2)
15	Khanun	05-11 Sep	115	4	China (2)
16	Vicente	16-18 Sep	40	-	Vietnam (TS)
17	Saola	20-26 Sep	90	2	-
18	Damray	21-27 Sep	90	2	China (2), Vietnam (TS)
19	Longwang	25 Sep-02 Oct	130	4	Taiwan (4), China (1)
20	Kirogi	10-19 Oct	125	4	-
21	Kai_Tak	28 Oct-02 Nov	90	2	Vietnam (TS)
22	Tembin	07-11 Nov	45	-	Phillippines (TS)
23	Bolaven	13-20 Nov	75	1	Phillippines (TS)
24	25W	18-20 Dec	35	-	-

* Landfall is defined as the intersection of the surface centre of a tropical storm with a coastline.
[+] Mainland only.
[x] 1-min sustained winds.
TS = Tropical storm.

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* and Julian Heming's Met Office Tropical Cyclone Website (*http://www.met-office.gov.uk/sec2/sec2cyclone/tcver.html*).

Verification of Forecasts

NW Pacific ACE Index and System Numbers

a) Deterministic forecasts

NW Pacific ACE Index and System Numbers in 2005					
		ACE Index ($x10^4$ knots^2)	Intense Typhoons	Typhoons	Tropical Storms
Average Number (±SD) (1965-2004)		305 (±99)	8.6 (±3.0)	16.9 (±3.7)	26.7 (±4.5)
Actual Number 2005		285	9	16	24
TSR Forecasts (±SD)	5 Aug 2005	328 (±78)	9.4 (±2.5)	17.5 (±2.9)	27.6 (±3.7)
	7 July 2005	333 (±83)	9.5 (±2.5)	17.5 (±2.9)	27.6 (±3.7)
	7 June 2005	328 (±84)	9.4 (±2.7)	17.5 (±2.9)	27.6 (±3.7)
	5 May 2005	314 (±80)	8.9 (±2.6)	17.5 (±2.9)	27.6 (±3.7)
	7 Mar 2005	340 (±91)	9.8 (±2.7)	16.1 (±3.3)	25.9 (±4.0)
Chan Forecasts	24 June 2005	-	-	16	25
	27 April 2005	-	-	15	24

b) Probabilistic forecasts

NW Pacific ACE Index 2005					
		Tercile Probabilities			RPSS
		below normal	normal	above normal	
Actual 2005		0	100	0	1
Climatology 1965-2004		33.3	33.3	33.3	0
TSR Forecasts	5 Aug 2005	14	51	35	0.42
	7 July 2005	14	48	38	0.35
	7 June 2005	16	48	36	0.36
	5 May 2005	19	51	30	0.45
	7 Mar 2005	15	43	42	0.21

In 2005, the NW Pacific accumulated tropical cyclone wind energy (ACE Index) was close to the 40-year climate norm. With the exception of the intense typhoon forecasts, the TSR forecasts slightly overpredicted the total activity at all leads but all forecasts were correct to within one standard error. The May forecast performed best overall. All probabilistic forecasts showed positive skill with the May forecast having the highest skill.

Chan's predictions for tropical storm and typhoon numbers were better than TSR's. Chan's forecasts performed well this year, correctly predicting the number of tropical storms in his April forecast and correctly forecasting the number of typhoons in his June forecast. As a result, it was hard for TSR to improve upon Chan's forecasts. Further details on the Chan forecasts and their verification may be obtained from *http://aposf02.cityu.edu.hk/~mcg/tc_forecast/*

Environmental Factors in 2005

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^{o}-140^{o}W, 5^{o}S-5^{o}N]. This predictor influences cyclonic vorticity (the spinning up of storms) in the main typhoon formation region. The Table below verifies our forecasts for this predictor.

Predictor Forecasts 2005		
		AS Niño 3.75 SST (^{o}C)
Actual Value 2005 (1965-2004 Anomaly)		0.05
TSR Forecasts (±FE)	5 Aug 2005	0.28 (±0.14)
	7 July 2005	0.33 (±0.23)
	7 June 2005	0.28 (±0.28)
	5 May 2005	0.13 (±0.33)

All the TSR forecasts slightly overpredicted the magnitude of the AS Niño 3.75 anomaly and this led to a slight overprediction of the NW Pacific ACE index. The May forecast proved best overall.

Definitions

Rank Probability Skill Score

The probabilistic skill measure employed is the rank probability skill score (*RPSS*) (Epstein 1969; Wilks 1995; 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 (1965-2004).

Forecasts for 2006

The TSR extended range forecast for the 2006 NW Pacific typhoon season will be issued in early March 2006 followed by monthly forecast updates through to early August. Forecasts will be deterministic and probabilistic.

References

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Tropical Storm Risk.com (TSR)

Tropical Storm Risk.com (TSR) is a venture which has developed from the UK government-supported TSUNAMI initiative project on seasonal tropical cyclone prediction. The TSR consortium comprises experts on insurance, risk management and seasonal climate forecasting. The TSR industry expertise is drawn from *Benfield*, the leading independent reinsurance intermediary, *Royal & SunAlliance*, the global insurance group, and from *Crawford & Company*, a global claims management solutions company. The TSR scientific grouping brings together climate physicists, meteorologists and statisticians at *UCL* (University College London) and the *Met Office*. TSR forecasts are available from http://tropicalstormrisk.com.

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