Pre-Season Forecast for NW Pacific and Japan Landfalling Typhoons in 2001

Issued: 15th June, 2001

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Forecast Summary

NW Pacific typhoon activity and typhoon strikes on Japan are expected to be close to the 1991-2000 average in 2001

The Tropical Storm Risk (TSR) consortium presents a pre-season forecast for NW Pacific tropical storm, typhoon and intense typhoon numbers in 2001, and for tropical storm and typhoon strike numbers on Japan. These forecasts span the NW Pacific season from 1st January 2001 to 31st December 2001. With over 90% of annual typhoon activity occurring after 1st June they are effectively 'pre-season'. These forecasts are based on data available through the end of May 2001. Examples of a new product are included showing our 10-year hindcast skill with 95% confidence intervals as a function of monthly lead out to 5 months. This product allows users to assess forecast skill and uncertainty at leads of their choosing. Our early June predictions are better than climatology by ~40% for basin typhoon and intense typhoon numbers. Our main predictor is the August-September forecast sea surface temperature for the Nino 4 index region adjacent to the Date Line. We anticipate a neutral value for Nino 4 during the typhoon season peak in 2001.

1a. NW Pacific Total Numbers in 2001

		Intense Typhoons	Typhoons	Tropical Storms
TSR Forecast (±SD)	2001	8.7(±2.1)	17.5 (±3.1)	26.1 (±3.4)
Average (±SD)	1991-2000	9.1 (±3.5)	17.8 (±5.3)	28.8 (±5.9)
Average (±SD)	1971-2000	8.2 (±3.4)	17.0 (±4.1)	27.2 (±4.6)

Key:	Intense Typhoon	=	1 Minute Sustained Wind > 95Kts	=	Hurricane Category 3 to 5
	Typhoon	=	1 Minute Sustained Wind > 63Kts	=	Hurricane Category 1 to 5
	Tropical Storm	=	1 Minute Sustained Wind > 33Kts		
	SD	=	Standard Deviation		
	Forecast Error	=	Standard Deviation of Independent Hindcast Errors for 1991-2000		
	Landfall Strike Category	=	Maximim 1 Minute Sustained Wind of Storm Coming Within 30km of Land		
	NW Pacific Region	=	Northern Hemisphere Region West of 180° West		
	Japan	=	Islands North of 31.0°N (for Purpose of Forecast)		

1b. Japan Landfalling Numbers in 2001

		Typhoons	Tropical Storms
TSR Forecast (±SD)	2001	2.2 (±1.1)	3.4 (±1.5)
Average (±SD)	1991-2000	2.4 (±1.2)	4.1 (±1.8)
Average (±SD)	1971-2000	1.8 (±1.3)	3.2 (±1.8)

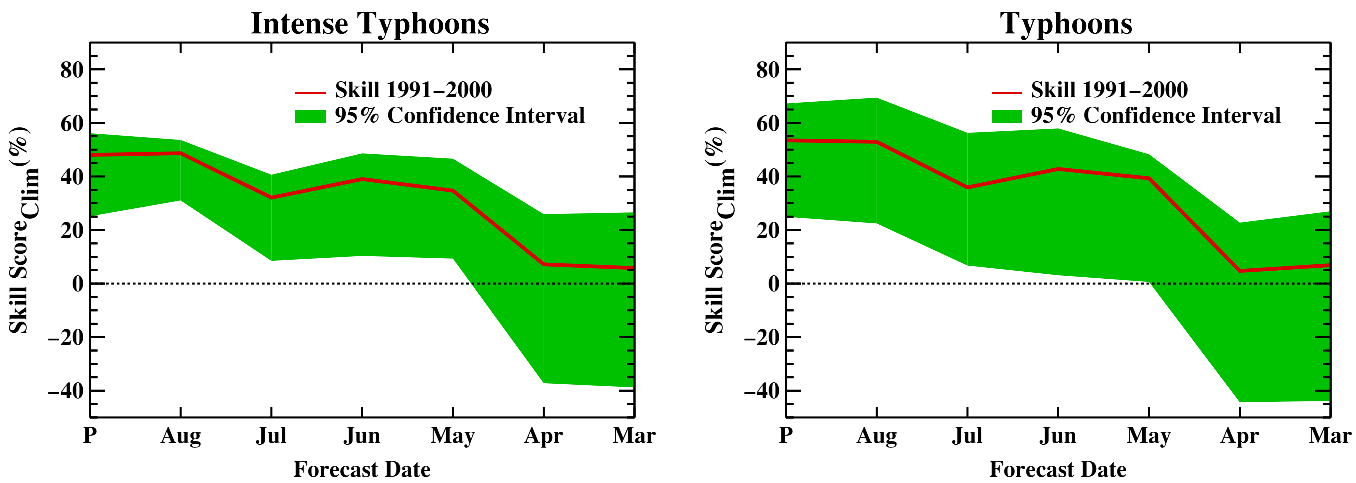
Japan landfalling intense hurricanes are not forecast since we have no skill at this lead.

2. TSR Hindcast Skill Versus Lead Time 1991-2000

How would the *TSR* NW Pacific forecast model have performed as a function of lead time had it been available in previous years? The figures below show the *TSR* model skill and associated 95% confidence interval at monthly leads out to 5 months for basin intense typhoon numbers and typhoon numbers. Skill is assessed over the last ten years 1991 to 2000. Full details of the skill score measure and confidence interval calculation are given in §3. The 'P' on the abscissa denotes the skill with perfect predictors, that is with climate information through to the end of September. The 'Forecast Date' indicates that the forecast is issued on about the 7th of the month in question, this permitting climate information from the previous month to be assimilated into the model. For an early June forecast the *TSR* mean 10-year skill improvements over a running 10-year prior climatology are as follows (a running 20-year prior climatology leads to generally higher skills):

NW Pacific Basin Typhoons:	43%
NW Pacific Basin Intense Typhoons:	39%
Japan Landfalling Tropical Storms:	17%
Japan Landfalling Typhoons:	10%

NW Pacific Basin Numbers



For each strength category the forecast skill rises steadily from the beginning of April. There is little skill present, on average, before April. This 'spring' predictability barrier exists in our Nino 4 main predictor. Positive skill is present to 95% confidence from early May for typhoon and especially intense typhoon numbers. The models with perfect predictors provide a 50-55% skill improvement over climatology.

3. Skill Score and Uncertainty

Several methods are in use to assess the skill of forecast models (eg Wilks, 1995; von Storch and Zwiers, 1999). We employ the percentage improvement in root mean square error over a climatological forecast ($RMSE_{cl}$). For simplicity we denote this skill measure as 'Skill Score $_{Clim}$ (%)' in the above figures. We consider this is a robust skill measure which is immune to the bias problems associated with the Percentage of Variance Explained and Percentage Agreement Coefficient skill measures. For climatology we employ a running 10-year average prior to each forecast year. Positive skill indicates the model does better than a climatology forecast, negative skill indicates that it does worse than climatology.

We compute confidence intervals on our forecast skill using the bootstrap method (Efron, 1979; also see Efron and Gong, 1983; LePage and Billiard, 1992; Wilks, 1995). This tests the hypothesis that the model forecasts are more skilful than those from climatology to some level of significance. We apply the bootstrap by randomly selecting (with replacement) 15 actual values together with their associated predicted and climatology forecast values to provide a fresh set of hindcasts for which the $RMSE_{cl}$ skill measure can be calculated. This process is repeated many times (2,000 in this case) and the results histogrammed to give the required skill score. Provided that the original data are independent (in distribution and in order), the distribution of these recalculated values maps the uncertainty in the forecast skill about the original value over a 15-year period. 95% two-tailed confidence intervals for this uncertainty are then readily obtained.

4. Predictors and Key Influences for 2001

Our model exploits the predictability of tropical Pacific sea surface temperatures (SSTs). Anomalous patterns of SST are the primary source of tropical Pacific atmosphere forcing at seasonal and interannual timescales. The main predictors in our model are:

a) August-September forecast Nino 4 (5°S - 5°N, 150°W - 160°E) SST. This is forecast from an in-house amended version of the ENSO-CLIPER forecast model (Knaff and Landsea, 1997). Nino 4 SSTs are linked to low level wind anomalies (and thus to vertical wind shear) over the NW Pacific main typhoon genesis area. This is our main predictor for basin intense typhoon and typhoon numbers, and for Japan landfalling tropical storm and typhoon numbers in neutral ENSO years such as 2001.
b) April-May lagged SSTs from the tropical and sub-tropical northwest Pacific. The region 15°N - 27.5°N, 120°E - 180°E is our secondary predictor for basin intense typhoon numbers. Other areas are used as predictors for basin tropical storm numbers.

The key factor behind our forecast of neutral activity in 2001 is our anticipated neutral value (1971-2000 climatology) for August-September Nino 4 SST of +0.27°C.

5. Basin Definitions and Data Quality

In accordance with the definition in Chapter 1 of the *Global Guide to Tropical Cyclone Forecasting*, World Meteorological Organisation Report No. 560, 1993, the NW Pacific basin is defined, for the purposes of this forecast, as the northern hemisphere region west of 180°W. The speed assigned to a given storm is the highest 1-minute sustained windspeed achieved within this region, irrespective of whether the storm first develops in the East or West Pacific. We use tropical cyclone best track data provided by Dr C J Neumann, though due to concerns about data quality, we focus on records post 1971.

6. Forecast Methodology

Our forecast model is statistical. We model the interannual variability in typhoon numbers using a Gaussian distribution. In selecting predictors we apply the Chow parameter stability test, as used in economics, to ensure persistence and stability. This involves running the same regression over subsections of the data to test the hypothesis that the regression parameters obtained for the subsets are not significantly different from those found for the whole regression, against the alternative that one or more are different. This hypothesis must be satisfield at the 5% level for a predictor to prove stable and acceptable.

We obtain forecasts for landfalling events by a composite approach. We select those years with contemporaneous Nino 4 SST anomalies within ±0.5°C of our August-September 2001 forecast SST value (approximately 1-standard error) and calculate the mean and standard deviation of the number of storms for these years.

Forecast skill is assessed by rigorous hindcast testing over the period 1991-2000. We use only prior years in identifying the predictors and in calculating the regression relationship for each future year to be forecast - ie the hindcasts are performed in strict 'forecast' mode. Thus 1991 activity is forecast using 1972-1990 data, 1992 using 1972-1991 data, etc..

7. Monthly Updated Forecasts

For the 2001 and subsequent NW Pacific typhoon seasons, *TSR* offers monthly updated forecasts from early April to early August for each basin and landfalling strength category listed in §1. The figures on page 2 show the *TSR* forecast skill and uncertainty as a function of lead month. Please contact Dr Mark Saunders (mas@mssl.ucl.ac.uk) if you are interested in this service.

8. Potential Benefits

Typhoons are the most costly and deadly natural disaster affecting much of Japan, South Korea, Taiwan, the Philippines and coastal areas in other southeast Asian countries. The annual damage bill and fatality rate from tropical storm and typhoon impacts in southeast Asia 1990-1998 averages, respectively US $3.3 billion (at 2000 prices) per year and 740 deaths [information from Munich Re]. Typhoon Bart, which struck Japan on 22nd September 1999, caused economic (insured) losses of US $3.3 billion ($ 3.0 billion) respectively, and ranks as the second highest natural catastrophe insurance loss of 1999. Skilful long-range forecasts of seasonal typhoon activity and typhoon strike numbers can benefit society, business and government by reducing - through the available lead-time - the risk and uncertainty inherent to varying active and inactive storm seasons.

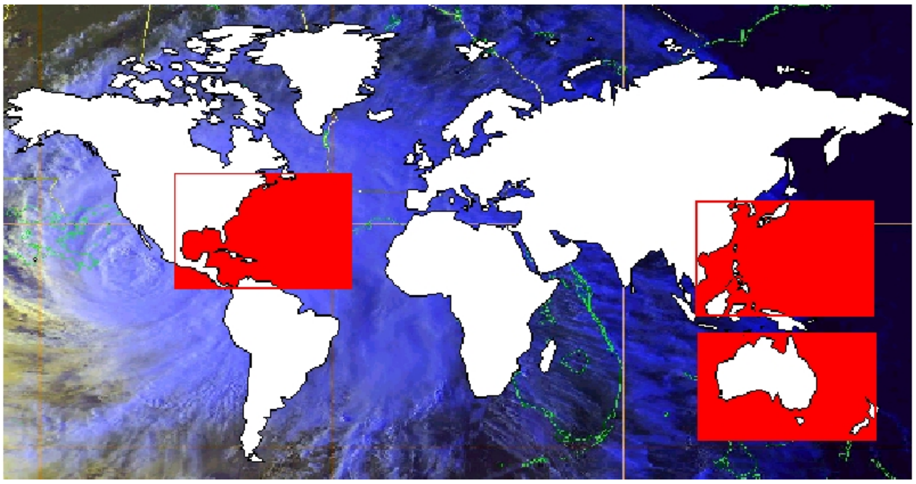
9. Tropical Storm Risk.com (TSR)

TropicalStormRisk.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 leading UK insurance industry experts and scientists at the forefront of seasonal forecasting. The *TSR* insurance expertise is drawn from *Benfield Greig*, a leading independent global reinsurance and risk advisory group, the *Royal and Sun Alliance* insurance company, and from the UK composite and life company *CGNU Group*. 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.

Acknowledgements

The *TSR* venture is administered by Mrs Alyson Bedford of the Met. Office. We wish to thank, David Simmons (Benfield Greig Group), Julia Graham (Royal and Sun Alliance) and Mike Cooper (CGNU

Group) for industrial liaison. We acknowledge meteorological input from Dr Mike Davey (Met. Office), statistical advice from Dr Richard Chandler (Department of Statistical Science, University College London), computing assistance from Frank Roberts and Justin Mansley (UCL), and web site assistance from Steve George (UCL).



The three tropical cyclone basins under research by the TSR Tropical Storm Risk team.