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Research Brief 2012/01

Verification of Forecasts of Tropical Cyclone Activity over the Western North Pacific and Number of Tropical Cyclones Making Landfall in South China and the Korea and Japan region in 2011

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1. Introduction

Since 2000, City University of Hong Kong has been issuing real-time predictions of the annual number of tropical cyclones (TCs) affecting the western North Pacific (WNP). Verifications of the predictions have shown that the predictions are mostly correct within the error bars. We also began to predict the number of TCs making landfall in South China (SC) and the Korea and Japan region (KJ) in 2009 and 2010 respectively.

These are all statistical predictions with predictors drawn from a large group of indices that represent the atmospheric and oceanographic conditions in the previous year up to the spring of the current year. The most prominent ones include the proxies for El Niño/Southern Oscillation (ENSO), the extent of the subtropical ridge, and the intensity of the India-Burma trough. Details can be found in Chan et al. (1998, 2001), and Goh and Chan (2010a ,b).

2. Verification of the 2011 forecasts

a. Summary of the forecasts issued

1) TC activity over the WNP

Our April forecasts issued on 09 May 2011 suggested "***near-normal activity for all the categories***". The June forecasts (issued on 04 July 2011) gave a similar forecast. Detailed numbers are summarized in Table 1, together with the observed numbers based on the warnings from JTWC and the Tokyo Regional Specialised Meteorological Center (RSMC).

Disagreement occurred among the warning centres on the intensity of one of the systems. Tokage was considered by RSMC Tokyo as having reached tropical storm intensity but not by JTWC.

Table 1. Forecasts of TC activity in 2011 issued in April and June.

2011	*Forecast*		*Observed*		*Normal*
	April	June	JTWC	RSMC	
Entire western North Pacific					
No. of TCs	31	31	27	---	31
No. of TCs with at least tropical storm intensity	27	27	20	21	27
No. of typhoons	16	15	10	10	17
Landfall in South China					
Early Season (May to Aug)	5	---	3	---	3
Late Season (Sep to Dec)	2	---	2	---	2
Main Season (Jul to Dec)	---	7	3	---	4
Whole Season (May to Dec)	6	---	5	---	5
Landfall in the Korea and Japan region					
Main Season (Jul to Dec)	---	7	5	---	3
Whole Season (May to Dec)	6	---	7	---	4

2) South China

The April forecast called for an above normal number of TCs making landfall along the South China coast in the early season (May to August), a normal number in the late season (September to December), and an above normal number overall. The forecast issued in

June also suggested the number of landfalling TCs to be above normal for the main season (July to December). Table 1 shows a summary of these forecasts, along with the observed number in 2011 and the normal values.

3) Korea and Japan region

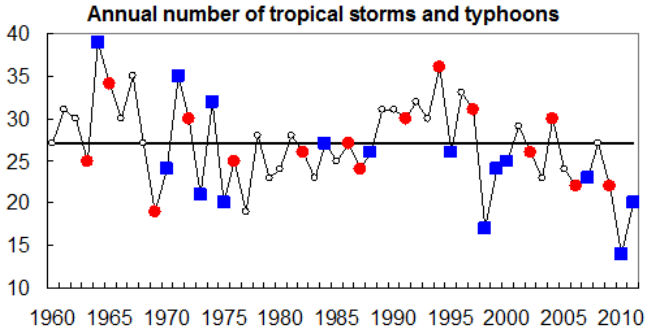
The April forecast called for an above normal number of TCs making landfall in the Korea and Japan region for the whole TC season. The June forecast further raised the TC number for the main season (July to December). Table 1 is a summary of the predictions made.

b. Verification and discussion

1) TC activity over the WNP

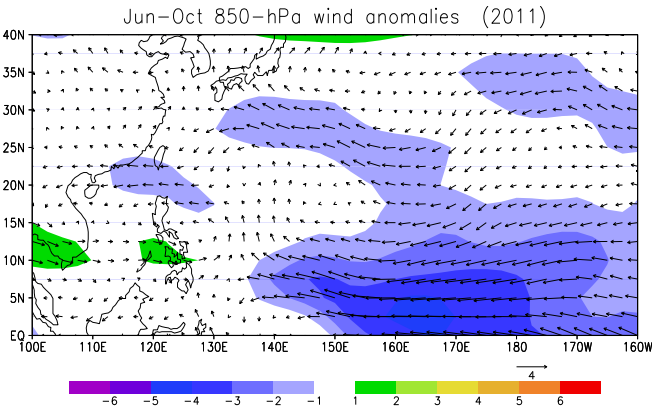
The TC activity over the WNP in 2011 was below normal. Based on the JTWC warnings, the number of TCs with at least tropical storm intensity is 20, which is 7 less than the normal number (the normal being 27) (see also Fig. 1). The typhoon activity is also below normal, with 10 typhoons which is 7 less than the normal number (the normal being 17). Our forecasts from both April and June over-predicted the TC activity and the possible reasons of which are discussed below.

Fig. 1. Annual number of tropical storms and typhoons between 1960 and 2011. The horizontal line indicates the climatological mean. Red circle and blue squares indicate the El Niño and La Niña years respectively.



As pointed out in the April forecast, the TC activity over the WNP appears to enter an inactive period since 1998. In the last 13 years, only two years (2001 and 2004) have the above-normal TC activity and the activity in most of the other years is below normal. Indeed, the inactive TC period 1998–2010 appeared to continue into 2011 and the number of tropical storms and typhoons in 2011 is below the climatological mean, which is the 12th out of the last 14 years since 1998 with a below-normal TC activity. Because this downward trend was not included in the prediction scheme, the predictions for 2011 suffer from the same problem as in the last few years in that they are all over-predictions.

Fig. 2. 850-hPa wind anomalies (vector) between June and October in 2011. Shadings indicate the zonal wind speed (interval = 1.0 m s^{-1}).



The La Niña event developed in 2010 weakened in the spring of 2011 but redeveloped in the summer. The mean Jun-Nov Niño3.4 index is -0.64, indicating a weak La Niña event in this period. The changes in atmospheric circulation associated with the La Niña event might be the factor affecting the TC activity. Previous studies suggest that in a La Niña year, easterly anomalies are generally found over the tropical WNP, resulting in the weakening of the monsoon trough and hence a lower TC activity (Wang and Chan 2002) (Table 2). In the 2011 TC season, strong easterly anomalies are found over the entire tropical WNP, with the maximum amplitude between 150°E and 180°E (Fig. 2). As a result, the monsoon trough is much weaker than normal in the eastern part

of the WNP. At the same time, the June-October vertical wind shear pattern shows positive anomalies over the subtropical WNP east of 150°E, indicating a stronger than normal vertical wind shear in this region (Fig. 3). Hence, the atmospheric conditions are therefore not favourable for TC genesis and development especially for the eastern part of the WNP. Indeed, the mean genesis location shifted westward and only three TCs formed over the tropical WNP east of 150°E, which is the typical pattern associated with a La Niña event.

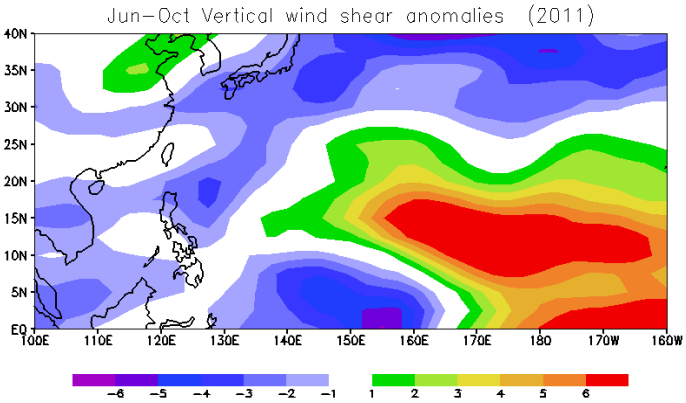
Table 2. Number of tropical storms and typhoons and number of typhoons in a La Niña year. Red and blue shadings indicate the above-normal and below-normal TC activity respectively.

	La Niña Year	Number of tropical storms and typhoons	Number of typhoons
Active period	1964	39	26
	1970	24	12
	1971	35	24
	1973	21	12
	1974	32	15
	1975	20	14
	1995	26	15
Inactive period	1984	27	16
	1988	26	14
	1998	17	9
	1999	24	12
	2000	25	15
	2007	23	15
	2010	14	8
	2011	20	10

2) South China

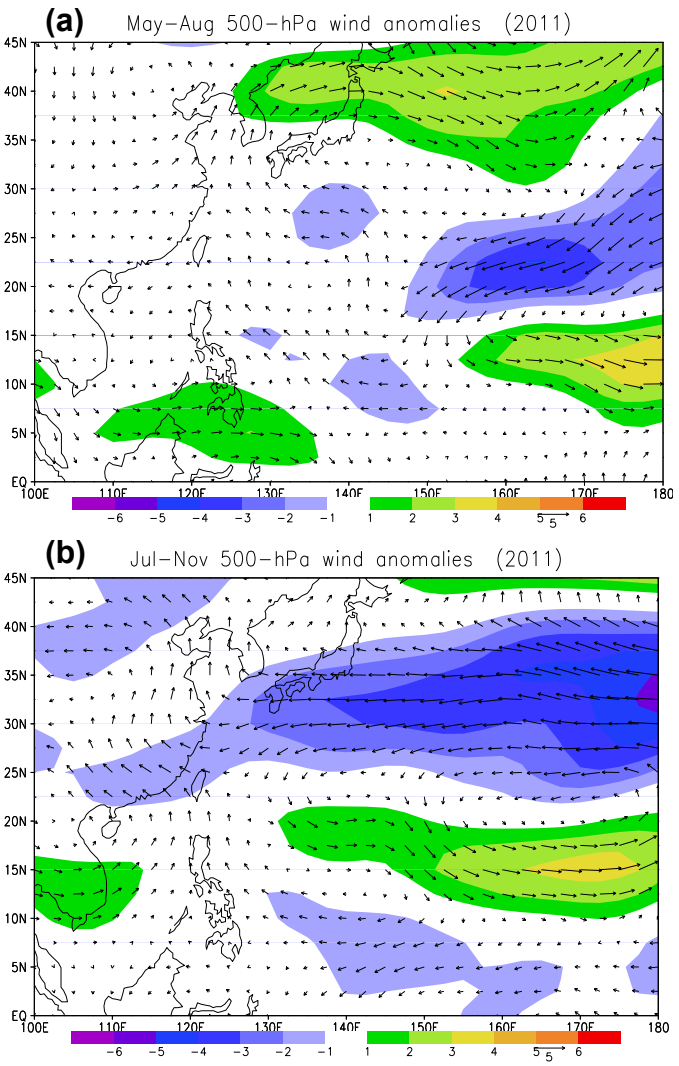
The observed number of TCs making landfall along the coast of South China was 3 in the early season, 2 in the late season, 3 in the main season, and 5 in the whole season. Apart from the prediction for the late season, which was perfect, the predictions for the number of landfalling TCs in the early and main seasons were overestimated, which also led to an overestimation of the predicted value for the whole season.

Fig. 3. 850-200-hPa vertical wind shear anomalies between June and October in 2011.



The number of TCs making landfall along the coast of South China depends on the TC activity over the WNP and the South China Sea (SCS) and the changes in the large-scale steering flow. The 500-hPa wind pattern in the early season shows that the anomalous zonal winds are small in the subtropical WNP west of 140°E (Fig. 4a). The changes in steering flow are not obvious in this region and the landfalling activity is therefore near normal in the early season. Thus, our April forecast over-estimated the number of landfalling TCs in the early season. The pattern for the main season shows westerly anomalies between 10°N and 20°N (Fig. 4b), which tend to steer TCs away from the SCS. Together with the below-normal overall TC activity over the WNP, fewer TCs entered the SCS from east of the Philippines and came close to the South China coast. In addition, the number of TCs formed over the SCS was also below the climatological mean. Thus, the number of landfalling TCs in the main season was below normal, which was lower than the predicted number from the June forecast.

Fig. 4. 500-hPa wind anomalies (vector) in the (a) early and (b) main seasons for 2011. Shadings indicate the zonal wind speed (interval = 1.0 m s^{-1}).

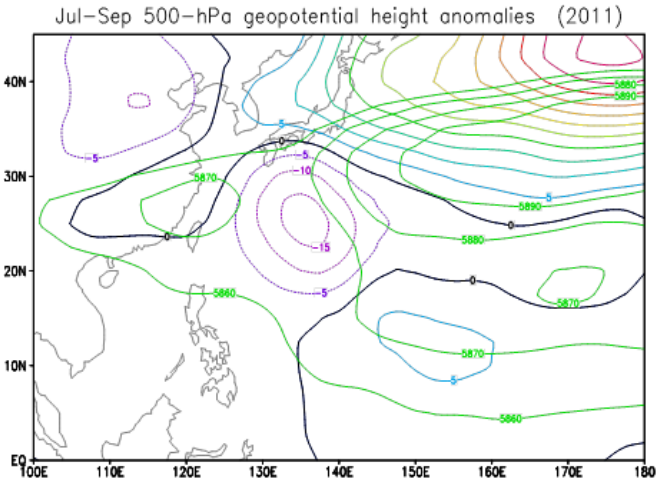


3) Korea and Japan region

The observed number of TCs making landfall in the Korea and Japan region was 5 in the main season and 7 in the whole season. Our forecasts from both April and June correctly predicted the above-normal landfalling activity in the main and whole seasons (Table 1). However, the June forecast slightly over-estimated the number of landfalling TCs in the main season.

As stated in the April forecast, our prediction for the above-normal number is based on the possible anomalous low at 500-hPa south of Japan in the peak season (July to September). Indeed, an anomalous low is found just south of Japan in the peak season, resulting in a break in subtropical high near this region (Fig. 5). Thus, more TCs recurved and entered the Korea and Japan region, which partly explain the above-normal TC landfalling activity.

Fig. 5. 500-hPa geopotential height anomalies between July and September in 2011. Thick contours indicate the geopotential height (contour interval = 10 m) ≥ 5860 m.



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