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Research Brief 2010/02

Forecasts of the number of tropical cyclones making landfall in (1) South China and (2) the Korea-Japan region in 2010

24 May 2010

1. South China

First, it would be useful to discuss the El Niño/Southern Oscillation (ENSO) condition as it contributes to a certain extent the frequency of landfalling tropical cyclones (TCs) along the South China coast (Goh and Chan 2010a). The El Niño event that began in mid to late 2009 and continued through the winter has shown signs of weakening. Indeed, forecast models from various climate centres have suggested that the ENSO condition is likely to return to near neutral as the Northern Hemisphere TC season progresses. Thus, the current year, which is a year after an El Niño event (EN+1 year), is very likely to be an ENSO-neutral year.

Our prediction scheme of the number of landfalling TCs along the South China coast is a statistical one based on both the atmospheric conditions and the ENSO and Pacific Decadal Oscillation (PDO) indices prior to the season (Goh and Chan 2010a). The predicted number for the early season (May to August) is **4**, which is slightly above the normal value of 3. On the other hand, the forecast for the late season (September to December) is **2**, which is equal to the normal value. This gives a total number of **6** TCs forecasted to be making landfall along the South China coast over the whole season, which is also slightly above the normal value of 5.

Liu and Chan (2003) found no significant patterns in the number of TCs making landfall on the South China coast in an EN+1 year. However, the authors also revealed that during the months of May and June in such years, the number of landfalling TCs tends to be below normal, which seems to disagree with the current forecast. But as Table 1 suggests, in the past 13 EN+1 years, 5 had an above-normal number of landfalling TCs. Furthermore, of the four ENSO-neutral years that are also EN+1 years, three had above-normal number of early landfalling TCs, and none below normal. One of the possible reasons for this year's above-normal prediction could be the anomalously high geopotential height over the western north Pacific between January and March of this year compared to the average EN+1 year (Fig. 1), and it is worth-noting that this anomalous high has been present since early February 2010 (Fig. 2). If this anomalous high continues to persist into the early TC season, it would be much easier for TCs formed over the western north Pacific to be steered into the South China Sea, increasing the chances of them making landfall along the South China coast.

Table 1. Comparison of TCs making landfall along the South China coast (SC) and affecting the KJ region in EN+1 years. Years marked with an asterisk (*) are ENSO-neutral years. Green and Blue colours indicate above-normal and below-normal TC activity years respectively.

Year	SC early season	SC late season	SC whole season	KJ whole season
1966*	4	0	4	7
1969	2	0	2	2
1973	6	3	9	3
1977	2	1	3	1
1978*	3	1	4	5
1983	2	2	4	4
1987	1	0	1	3
1988	1	5	6	0
1992*	5	0	5	3
1995	5	3	8	2
1998	0	1	1	5
2003*	4	0	4	4
2005	2	1	3	3

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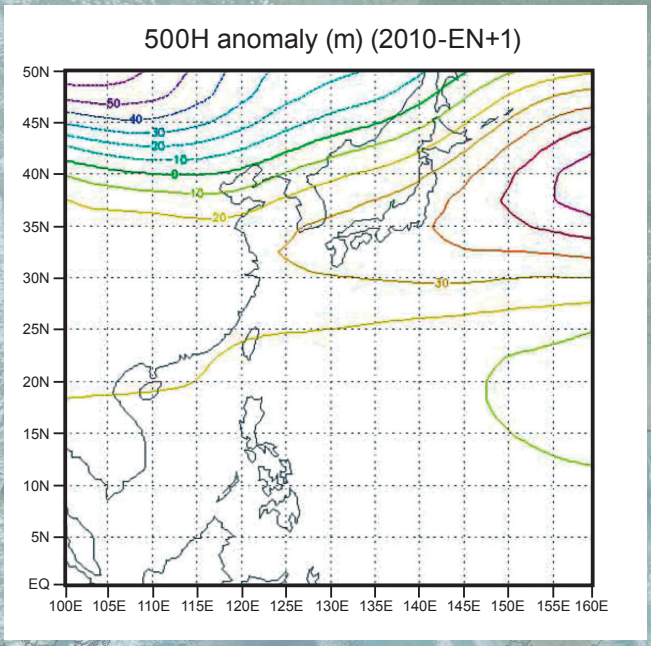


Fig. 1. January to March 500-hPa geopotential height difference between 2010 and the average EN+1 year.

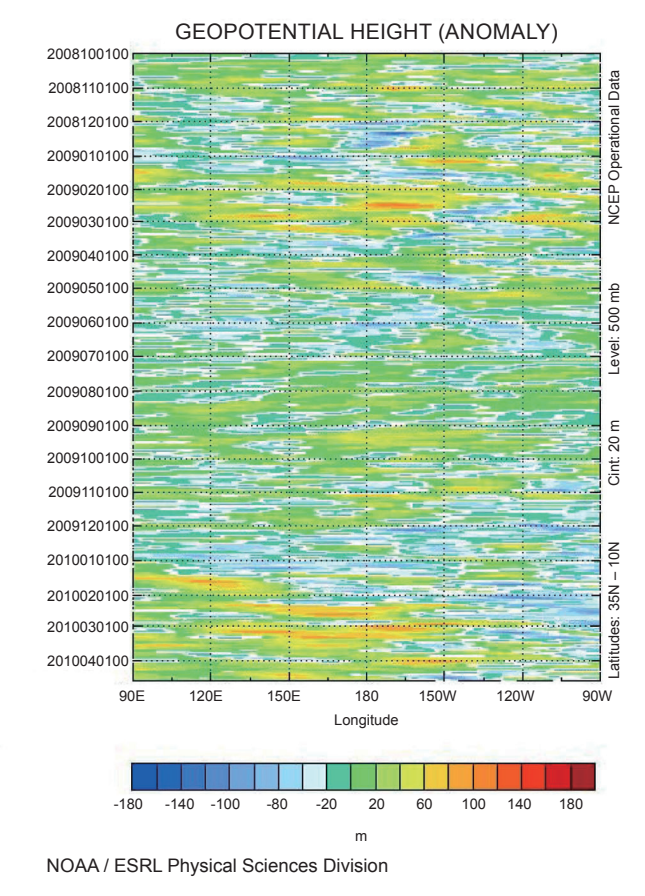


Fig. 2. Time-longitude section plot of 500-hPa geopotential height anomalies from October 2008 to mid-April 2010 over the western north Pacific. (Image provided by the NOAA/ESRL Physical Sciences Division, Boulder Colorado from their Web site at http://www.esrl.noaa.gov/psd/.)

As the ENSO condition is predicted to return to neutral in the latter part of the year, it is likely that the effect of ENSO on landfalling TCs during the late season might not be very prominent, which is consistent with the normal number being predicted.

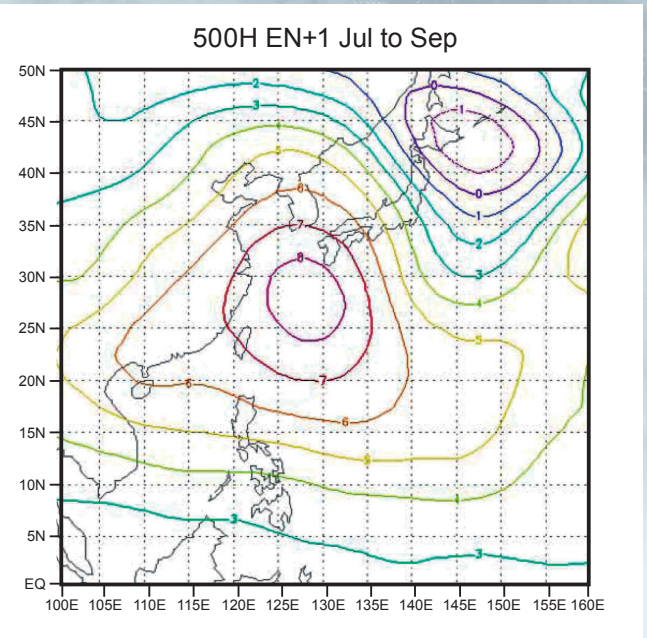
As discussed in Goh and Chan (2009a), an updated prediction for the late season will be issued in June.

2. Korea and Japan (KJ)

This is the first attempt in making a statistical prediction for the number of TCs affecting Korea and Japan (N_{KJ}), and should therefore be treated as experimental. Based on Goh and Chan (2010b), TCs that affect KJ are defined to be those that move to within 100 km of these two countries, rather than the actual landfall frequency, because many of the TCs that cause significant damage to Japan and Korea do not necessarily make landfall but pass close to their coast. The value of 100 km, though arbitrary, is chosen as it is greater or equal to the radius of maximum winds of most TCs. Further, the authors found that the behaviour of TCs affecting KJ are related to both thermodynamic and dynamic factors, such as 500-hPa and 850-hPa geopotential heights, 500-hPa zonal wind, 850-hPa vorticity, and the vertical wind shear between 200- and 850-hPa. In addition, they used the empirical orthogonal functions (EOFs) of these factors to construct predictors for forecasting the number of TCs for the whole season (May to December) in April and for the main season (July to December) in June.

The results from Goh and Chan (2010b) suggested that N_{KJ} in an EN+1 year tends to be below normal. This can be explained from the flow pattern composites of both 500-hPa geopotential height (500H) and 500-hPa zonal wind (500U) in EN+1 years, as the pattern of 500H shows an anomalous high south of Japan, causing anomalous northerlies over WNP (Fig. 3a) and preventing TCs from moving into the KJ region, while the composite of 500U indicates anomalous easterlies south of 20°N, steering TCs westwards (Fig. 3b).

3a



3b

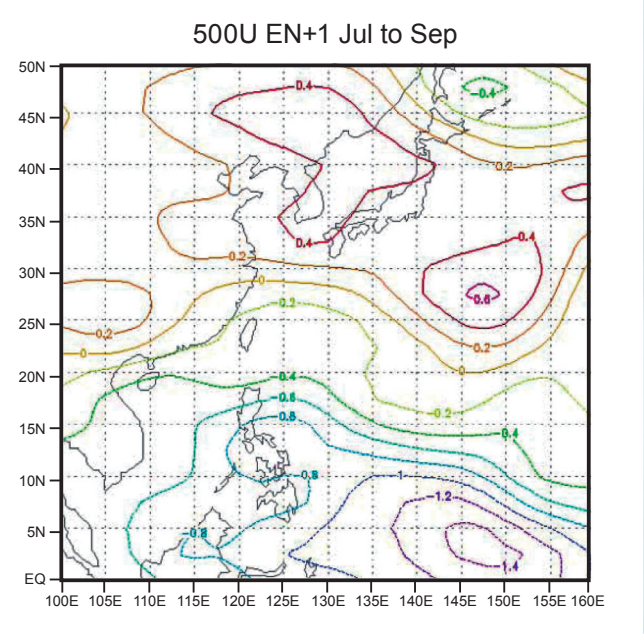


Fig. 3. Flow pattern anomalies in the peak season of EN+1 years for (a) 500H and (b) 500U.

However, for this year, the April prediction scheme predicts the number of TCs to affect Korea and Japan to be **6** for the whole TC season, which is above the normal value of 4 and deviates from the results based on the analyses of TC activity in previous years. Of the past 13 EN+1 years, 8 had below-normal number of TCs affecting KJ (Table 1). However, for those EN+1 year that are ENSO-neutral, N_{KJ} would tend to be normal or even above normal in one case (Table 1). An analysis of the 500H pattern during these years reveals an anomalous low situated over the WNP (Fig. 4a). This break in the subtropical high produces an anomalous southerly flow east of 150°E, which helps steer TCs in this area towards KJ. Since the ENSO is predicted to be returning to its neutral state later this year, it would be quite possible that N_{KJ} would be higher than the normal value. Thus, the above-normal prediction is still a plausible one.

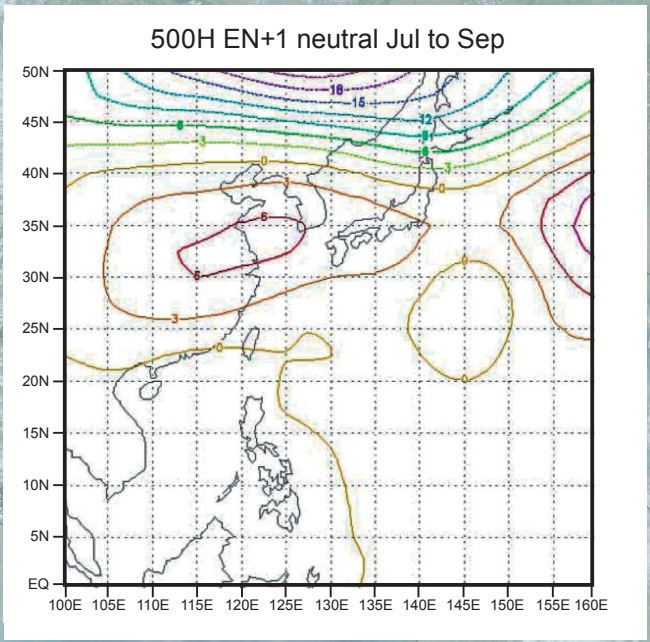
3. Summary of predictions

The number of landfalling TCs along the South China coast and affecting the Korea-Japan region is shown in Table 2.

Table 2. Summary of forecasts for TCs making landfall along the coast of South China, and those affecting Korea and Japan.

	Predicted	Normal
South China		
Early Season (May to August)	4 (slightly above normal)	3
Late Season (September to December)	2 (normal)	2
Whole Season	6 (slightly above normal)	5
Korea-Japan		
Whole season	6 (above normal)	4

4a



4b

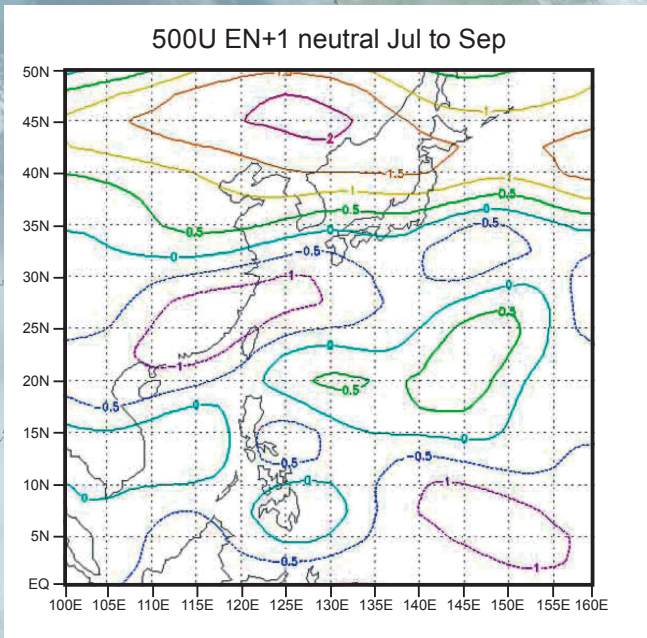


Fig. 4. Same as Fig. 3, but for EN+1 year being an ENSO-neutral year.

References

Goh, A. Z. C., and J. C. L. Chan, 2010a: An Improved Statistical Scheme for the Prediction of Tropical Cyclones Making Landfall in South China. *Weather and Forecasting*, DOI: 10.1175/2009WAF2222305.1

Goh, A. Z. C., and J. C. L. Chan, 2010b: Variations and Prediction of the Annual Number of Tropical Cyclone Affecting Korea and Japan. Submitted to *International Journal of Climatology*.

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