Relationship between Typhoon Activities and ENSO Evolution in 2009/2010

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1 INTRODUCTION

▪ Detailed understanding of factors, when and how many typhoons in a year are occurred and what drives the annual or seasonal number of typhoon occurrence, is important because it is closely associated with disaster management, water supply, agricultural activities in the east or southeast Asian countries (Liu and Chan, 2012).

▪ El Nino and Southern Oscillation (ENSO) plays a crucial role to determine the large-scale circulation pattern as well as ascending and descending air motion in the tropical Pacific. Intra-seasonal and inter-annual frequency and spatial distribution of tropical cyclone occurrence in the region are greatly affected by ENSO cycle and its evolution (Maue, 2011; Kim *et al.*, 2012).

▪ But the studies focused on how tropical cyclone formation is affected according to when and how ENSO transition is occurred, are somewhat limited.

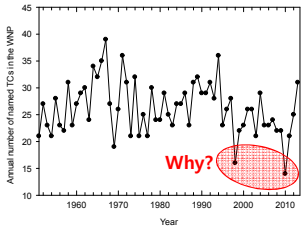

Fig. 1. Annual occurrence of named TCs in the western North Pacific since 1951, recording the minimum number (14) in 2010.

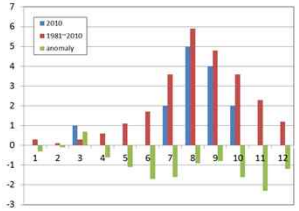

Fig. 2. Monthly occurrence of named TCs in the western North Pacific in 2010 with comparison of climatological normal (1981-2010).

< Scientific questions >
- Why are so small typhoons occurred in 2010 and 1998?
- Is there any change in the large-scale circulation pattern in the WNP?
- How is ENSO phase associated with the typhoon occurrence?
- Is there common features in meteorological fields between 2010 and 1998?

< Objectives >
- To clarify the relationship between the low typhoon activities and ENSO evolution in the western North Pacific

2 DATA

▪ Data used in this study are as follow :

- Annual and monthly number of named tropical cyclones in the western North Pacific since 1951 by RSMC-Tokyo (Japan Meteorological Agency)
- Geopotential height at 500 hPa, vertical wind shear at 850 vs. 200 hPa in 1997/98 and 2009/10 (resolution: 2.5°×2.5° with 17 vertical levels) by NCEP Reanalysis (R2)
- Sea surface temperature and its anomaly since 1981 by NOAA (optimum interpolated)
- Outgoing Longwave Radiation in in 1997/98 and 2009/10 by NOAA satellite series

3 RESULTS

Monthly Typhoon Occurrences

Table. 1. Monthly occurrence number of named TCs in the western North Pacific in 1998 and 2010 with comparison of climatological normal (1981-2010

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1998	0	0	0	0	0	0	1	3	5	2	3	2	16
2010	0	0	1	0	0	0	2	5	4	2	0	0	14
Normal (1981-2010)	0.3	0.1	0.3	0.6	1.1	1.7	3.6	5.9	4.8	3.6	2.3	1.2	25.6

Since 1951, the lowest typhoon occurrence was happened in 2010 over the KMA's responsible area for typhoon forecast (100E~180E, equator~60N) as fourteen. The second low was in 1998 as sixteen. Especially in 1998 only one typhoon was occurred until July, whereas only 3 in 2010 with no typhoons in November and December. It looks very rare and extraordinary case.

Atmospheric and Oceanic Features

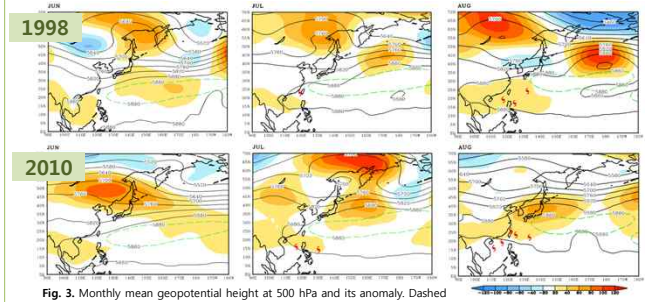

Fig. 3. Monthly mean geopotential height at 500 hPa and its anomaly. Dashed green line is climatological mean of 5880 geopotential meters.

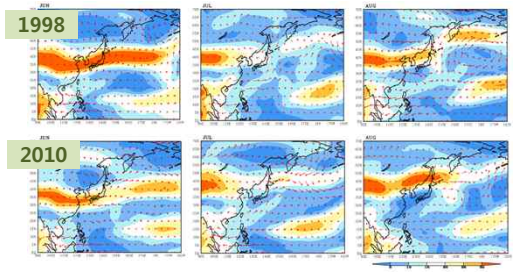

Fig. 4. Monthly mean wind field at 850 hPa and vertical wind shear between 850 and 200 hPa. Low level circulation and vertical wind shear fields show that there is no significant condition to suppress or interrupt the typhoon genesis.

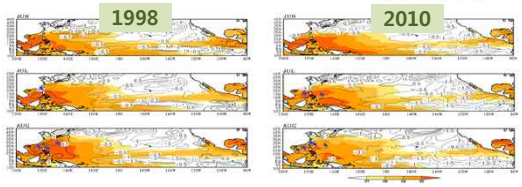

Fig. 5. Monthly SST and its anomaly field. Thermal condition over the western North Pacific Ocean looks favorable for typhoon genesis because warm ocean condition (above 27 deg. C was kept through the summer season.

ENSO Evolution in 1997/98 and 2009/10

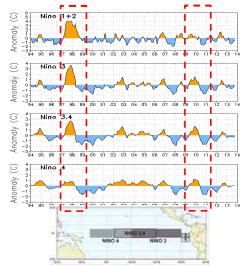

Fig. 6. Sea surface temperature anomaly in Nino 1+2, 3, 3.4, and 4. Strong El Nino was found in 1997/98 except for Nino 4.

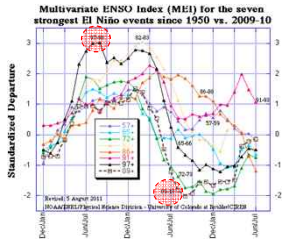

Fig. 7. Multivariate ENSO Index (MEI) for the seven strongest El Nino events since 1950. It is noted that large drop of the departure in 1997/98 and 2009/10 (Data courtesy : NOAA/CPC).

The widespread expansion of the western North Pacific High in the year of 1998 and 2010 in summer season seems to be closely related with rapid ENSO transition from strong El Nino to strong La Nina, although the relative magnitude of these two phenomena. The rapid transition may play a crucial role to change the Hadley and Walker circulation in the tropical and subtropical Pacific. More detailed modeling study on these two cases is needed.

4 CONCLUSION

- Recordable low typhoon occurrences in 2010 and 1998 were resulted from the western and southern expansion of the North Pacific High, suppressing the typhoon genesis in the climatological typhoon formation region.
- Low typhoon activities in 2010 and 1998 seem to be closely associated with the rapid ENSO transition. In particular, the transition from strong El Nino in the previous year to strong La Nina in the next year with relatively short time interval plays a crucial role to suppress the convective motion.
- It is found to be more strong El Nino in 1997/98 and more strong La Nina in 2009/10. But general features in the ENSO evolution and typhoon occurrence as well as large-scale circulation pattern over the western North Pacific (especially May to July) are very similar.

References

Kim, Joo-Hong, Chang-Hoi Ho, Hyeong-Seog Kim, Woosuk Choi, 2012: 2010 Western North Pacific Typhoon Season: Seasonal Overview and Forecast Using a Track-Pattern-Based Model. *Wea. Forecasting*, **27**, 730–743. doi: http://dx.doi.org/10.1175/WAF-D-11-00109.1.

Liu, Kin Sik, Johnny C. L. Chan, 2013: Inactive Period of Western North Pacific Tropical Cyclone Activity in 1998–2011. *J. Climate*, **26**, 2614–2630. doi: http://dx.doi.org/10.1175/JCLI-D-12-00053.1.

Maue, R. N., 2011: Recent historically low global tropical cyclone activity. *Geophys. Res. Lett.*, **38**, L14803, doi:10.1029/2011GL047711.

∗ **Acknowledgment** : This research is supported by the project "Management of National Typhoon Center" and ""Development and application of technology for weather forecast (NIMR-2013-B-1)" funded by KMA.