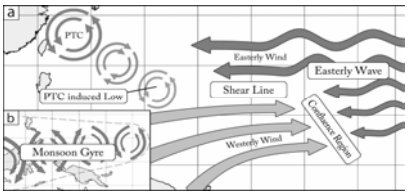
Environmental Flow Patterns of Tropical Cyclone Genesis over the Western North Pacific

#147

Ryuji YOSHIDA[1,2] and Hironori FUDEYASU[3]

1. RIKEN Center for Computational Science, 2. Kobe University, 3. Yokohama National University

Introduction: What characteristics do flow patterns have in TCG low-lev Env.?



Ritchie and Holland (1999; RH99)
- categorized into five flow patterns by a subjective analysis focusing on the synoptic scale phenomena.

Yoshida and Ishikawa (2013; YI13)
- proposed an objective analysis method to categorize TCG env. Into the five flow patterns.
- carried out climatological analysis.

However...

RH99 and YI13 analyzed environment (env.) conditions for tropical cyclone genesis (TCG) cases based on the best track data. Therefore, the characteristics of flow patterns in non-genesis period have not been studied.

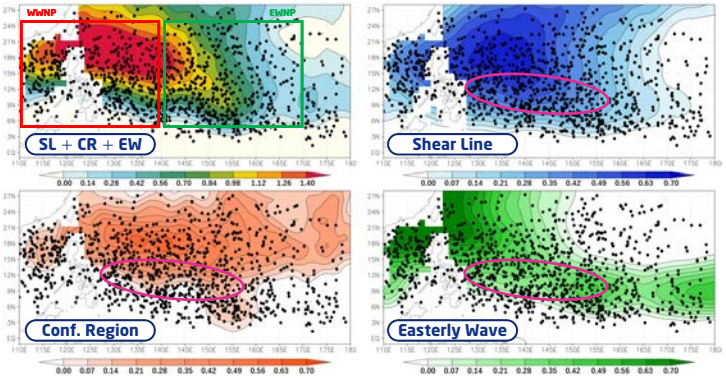
Questions: Flow patterns have...

- **What horizontal distributions over the western North Pacific (WNP)?**
- **What seasonal variability?**
- **What relationships with other env. parameters?**

Horizontal distribution and Seasonal variations of flow patterns

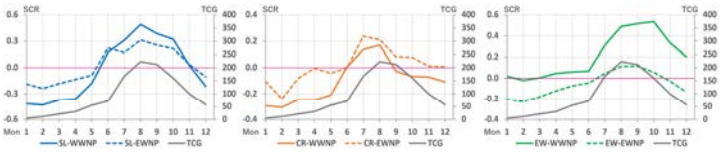
Horizontal distribution of mean score for JASO (1979-2016)

* dots indicate TCG locations in same period



Scores of flow patterns distribute over the similar area of TCG locations.

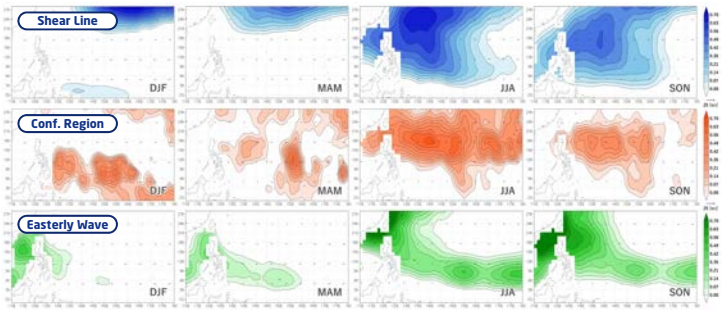
- SL : broadly in north-south direction, and mainly concentrated over the western side of WNP.
- CR : broadly in east-west direction around 18N.
- EW : broadly in east-west direction especially in lower latitude.



Scores of flow patterns have significant seasonal variability.

- SL : close to seasonal variability of TCG, especially in the WWNP.
- CR : be significant in early summer both in the WWNP and the EWNP.
- EW : be significant in late summer to autumn, especially in the WWNP.

Similar seasonal variabilities for TCG with each flow pattern are found in YI13. The TCG seasonal variability would be affected by the flow pattern's variability shown in these figures.



Horizontal distributions of flow patterns are also different in seasons.

- SL : significant only in boreal summer to autumn over the WNP.
- CR : found in all seasons, but becomes significant in summer.
- EW : elongate to eastern area of the WNP in summer to autumn.

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References

[1] Ritchie, E. A., and G. J. Holland, 1999: Large-scale patterns associated with tropical cyclogenesis in the western Pacific. Mon. Wea. Rev., 127, 2027–2043.

[2] Yoshida, R., and H. Ishikawa, 2013: Environmental factors contributing to tropical cyclone genesis over the western North Pacific. Mon. Wea. Rev., 141, 451–467,

Data and Analysis methods for climatological analysis over the WNP

Definition of Contribution Score

$$scr_{\mathrm{SL}} = \left(\frac{\partial u}{\partial y}\right)_{\mathrm{ave}} \exp(dist_{\mathrm{min}}) \quad \cdots\cdots (1)$$

$$SCR_{\mathrm{SL}} = \frac{scr_{\mathrm{SL}} - \mathrm{average}[scr_{\mathrm{SL}}]}{\mathrm{stddev}[scr_{\mathrm{SL}}]} \quad \cdots\cdots (2)$$

In Eq. 2, the score is normalized by an average and a standard deviation of a set in the analysis period.

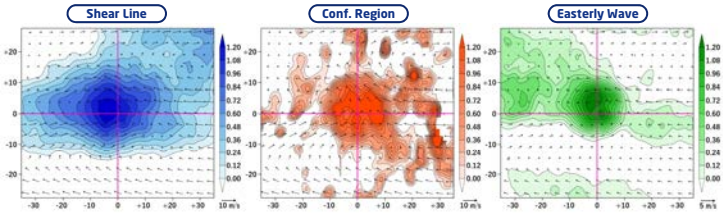
- $[scr_{\mathrm{SL}}]$ means a set of scores calculated by Eq. 1 at all grid points in the entire analysis period from 1979 to 2016.
- average and stddev were calculated in the area of Lat. 0-25N, Lon. 110E-180.
- 1 day lowpass filter for SL and CR, 1-4days bandpass filter were applied to the input data in order to eliminate smaller mesoscale structures.
- TCG is defined as the first record of each track data, and the genesis location and time are followed to the record.
- Target is focused on the high frequency patterns; SL, CR, and EW in this study.

- ✓ Carry out the YI13 objective analysis at all grid points at every time in the analysis period.
- ✓ It's not depended on the BESTTRACK data.
- ✓ We can get grid point values of contribution scores for each flow pattern.
- ✓ No artificial prescribed parameters are included; not relied on the result of previous studies.
- ✓ It's possible to evaluate significance of flow patterns comparing w/ the climatological mean.

atmospheric conditions	
dataset	JRA-55 data
resolution	horiz. 1.25 degrees, 6 hourly
period	38 years : (1979～2016)
variables	u850, v850

tropical cyclone track data	
dataset	JTWC best track
basin	western North Pacific
period	1979～2016 (38 years)
TC cases	1110 records are treated

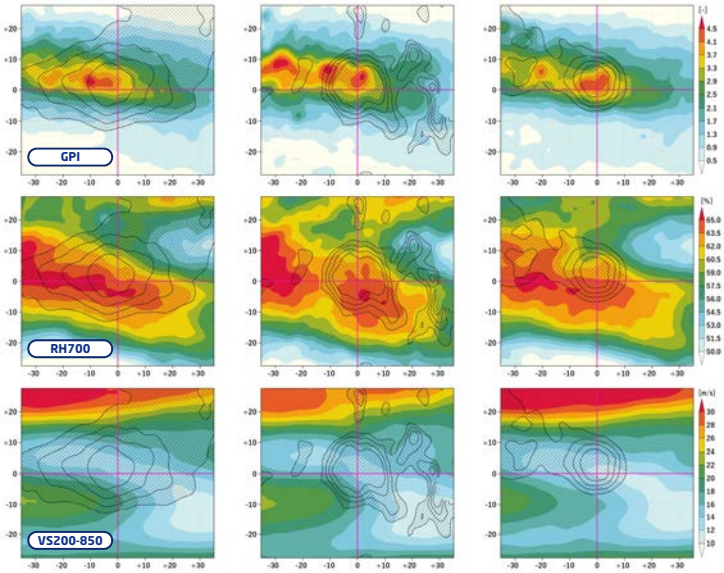
Characteristics in TCG cases and Relationships with other env. parameters



Scores are concentrated around TCG location.

SL : more broadly distributed. CR, EW : locally distributed.

* Scores are composited centering at the TCG location for cases which has a larger score than 0.5 for each pattern. The case numbers are 321, 133, 264 for SL, CR, and EW.



Env. parameters for each flow pattern are similar in distribution, but slightly different in strength.

- SL : slightly larger GPI and RH values than that of EW.
- CR : similar shape & strength to SL, but more local distribution than SL.
- EW : slightly weaker vertical shear of horizontal winds than SL & CR.

* These parameters are composited centering at the TCG location for cases which has a larger score than 0.5 for each pattern. The case numbers are same as above. Genesis Potential Index (GPI) is calculated following Emanuel and Nolan (2004).

Summary:

Horizontal distributions over WNP	• SL and CR distribute around east of Philippines islands. • EW distributes broadly in east-west direction at lower latitude.
Seasonal variability	• SL score is significant through summer season. • CR has a score value peak at early summer, and EW has a peak at late summer to autumn.
Relationships with other env. parameters	• Scores of each flow pattern has large value at TCG location. • Other environments seems to be arranged suitable for development of the disturbance at or near the TCG location.

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