Relationships between surface winds of Super Typhoon Lekima (2019) and topographic disturbances in eastern China

Wenbo Xue [1,2], Hui Yu [2,*], Shengming Tang [2]

[1]Chinese Academy of Meteorological Sciences, Beijing, China, [2]Shanghai tropical cyclone Institute/CMA, Shanghai, China

Introduction

- The topography impact on the wind field is one of the direct causes of phenomena like path deflection, intensity reduction, and heavy precipitation.
- Studies on the direct influence of topography, especially non-isolated continental topography, on the structure of tropical cyclone wind fields are relatively scarce.
- The study is determined to investigate the the relationships between the characteristics of surface wind field and topography based on the WRF simulation results of Super Typhoon Lekima (2019).

Methods and Materials

- Super typhoon Lekima (2019) is the strongest tropical cyclone landing in China in 2019.
- The simulation model used in our study is WRF 4.3.2. The simulation duration is 30 h from 0600 UTC to 1200 UTC on August 10 with the finest resolutions of 1 km (Fig.1).
- Barnes filter is a typical mesoscale filtering method proposed in the 1960s by Barnes (Fig. 2).

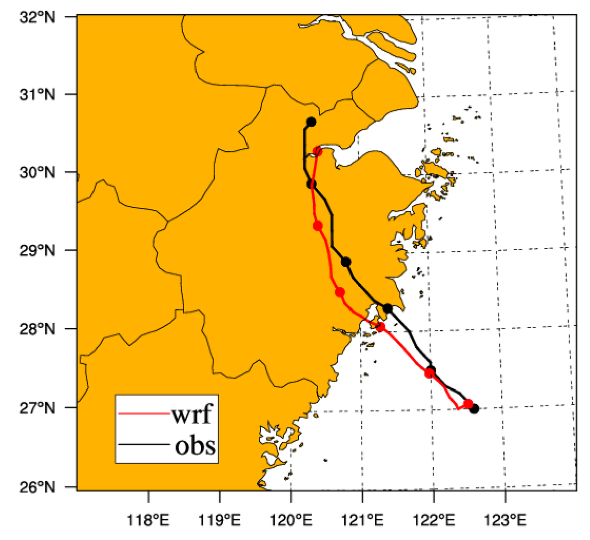

Fig. 1. The tracks from the best track data and WRF simulation.

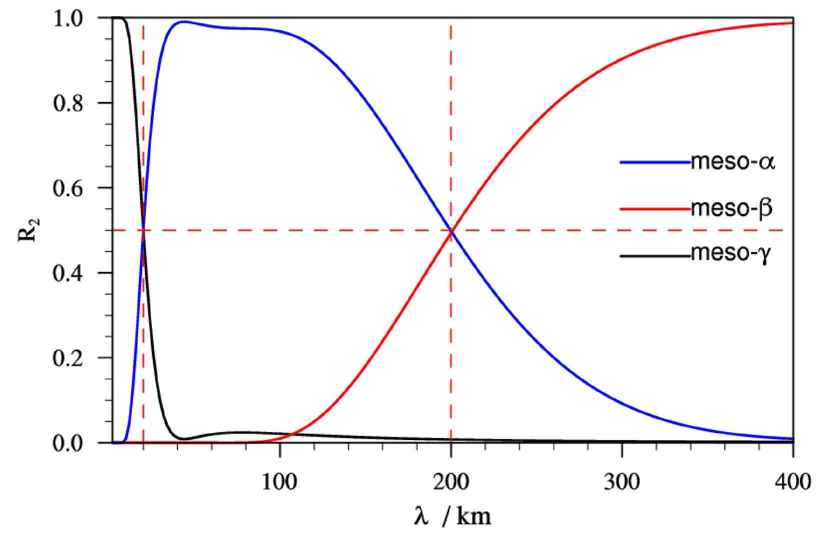

Fig. 2. The response function of the Barnes filter.

Results

- The statistical results indicate the smaller the scale of terrain disturbances and wind fields, the stronger their correlation.
- The statistical results showed that positive (negative) topographic disturbances always correspond to the disturbance airflow with the same (opposite) direction as the large-scale background field. In other words, **the positive (negative) topographic disturbances have acceleration (deceleration) effects on the large-scale airflow** (Fig. 3).
- The fitted relationship between topography and wind speed is affected by the large-scale airflow and characteristics of terrain disturbances. Whether the correlation is positive or negative is consistent with the direction of the large-scale background wind field. Moreover, the stronger the large-scale wind field, the smaller the scale of the terrain disturbance, the greater the disturbance wind speed caused by the terrain disturbance (Fig. 4).
- The acceleration and deceleration effects of terrain disturbances weaken with height below 3 km, reversing beyond this altitude compared to those near the surface, and have no significant impact on the large-scale wind field above 10 km (Fig. 5).

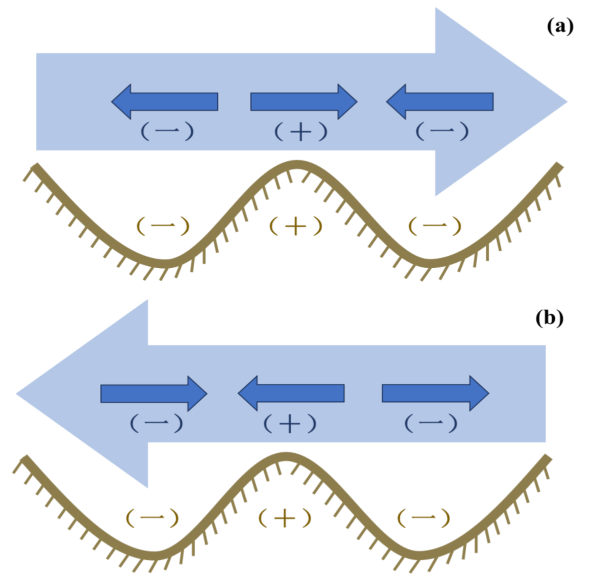

Fig. 3. Conceptual graph of the wind field distribution related to the topographic disturbance.

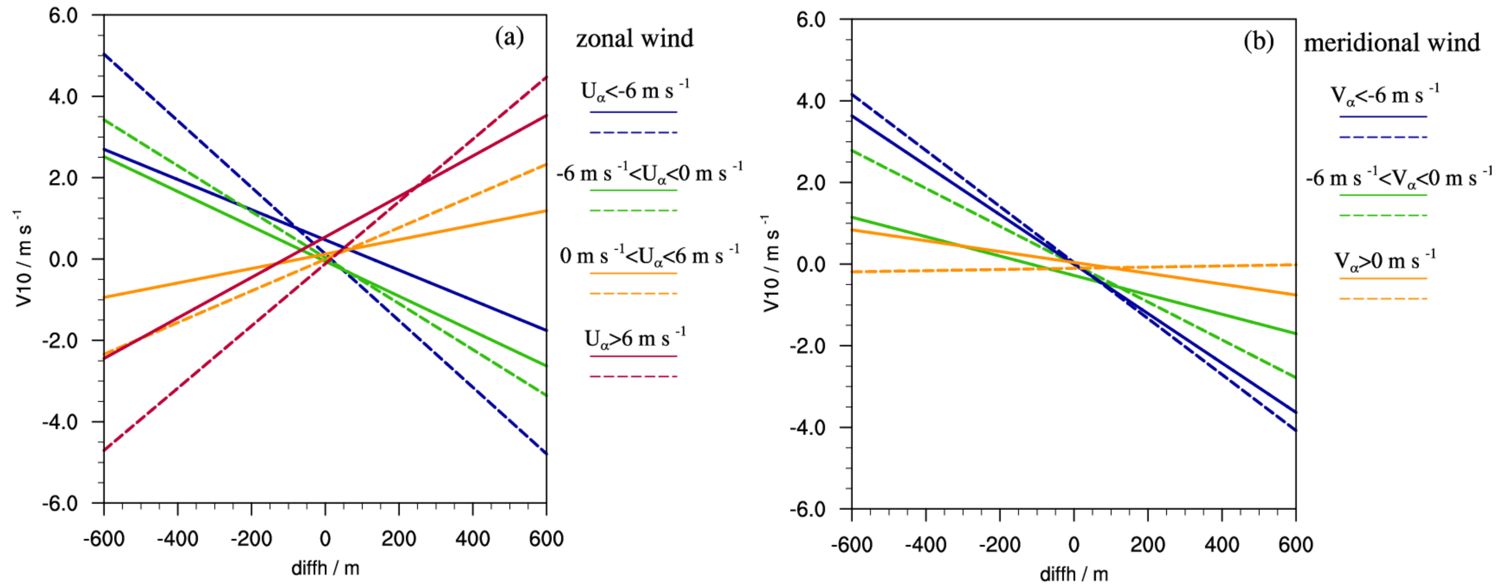

Fig. 4. The fitted linear relationships between topographic disturbance and 10-m wind.

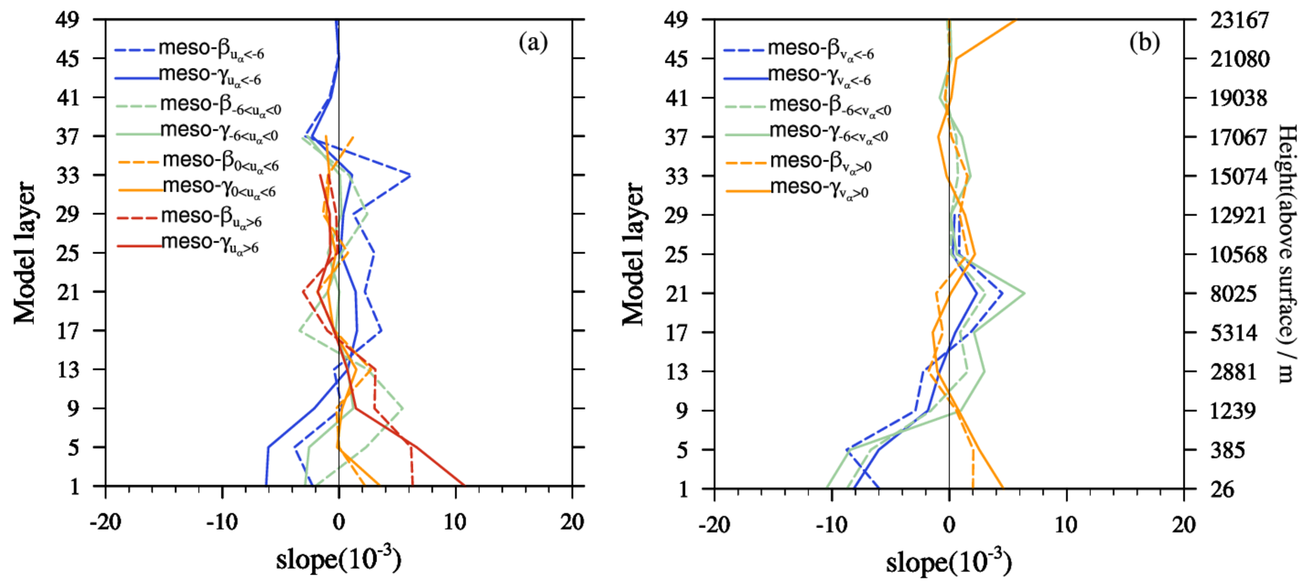

Fig. 5. The vertical variation of the slopes of linear fitting relationships between terrain disturbance and wind

Conclusions

- The smaller the scale of terrain disturbances and wind fields, the stronger their correlation.
- The positive terrain disturbance has an acceleration effect on the large-scale horizontal wind field, and the negative disturbance has a deceleration effect.
- The acceleration and deceleration effect of terrain disturbances is affected by the direction and intensity of the large-scale background wind field, as well as the scale and value of terrain disturbances.

Contact

Name: XUE Wenbo; YU Hui; TANG Shengming

Email: xuewb@typhoon.org.cn; yuh@typhoon.org.cn; tangsm@typhoon.org.cn

Website: https://www.camscma.cn/; https://www.sti.org.cn/

Phone: +8615611701110

References

1.Barnes S L. A technique for maximizing details in numerical weather map analysis[J]. Journal of Applied Meteorology and Climatology, 1964, 3(4):396-409.

2.Chow F K, Wekker S, Snyder B J. Mountain Weather Research and Forecasting[M]. Springer Netherlands, 2013

3.Safaei P, and Flay R.G.J. Comparison of Speed-Up Over Hills Derived from Wind-Tunnel Experiments, Wind-Loading Standards, and Numerical Modelling[J]. Boundary-Layer Meteorol, 2018, 168:213-246.