The Impact of Vapor Transportation on the Sustaining of Tropical Cyclones over Land

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1. Introduction

The characteristics of landfalling tropical cyclones(TC) are quite different. Some of them will quickly dissipate (6-12 hours, refer to STC) right after they touch the ground surface while others will be sustainable over land for a long period (3-5 days, refer to LTC) after they made landfall. Statistical analyses demonstrated that the severe calamities were closely related to those typhoons who were sustained over land for longer time period. Therefore, it is necessary to study the sustaining mechanism of TC over land.

Previous studies (Chen 2003) suggested that a landfalling TC would sustain over land for longer time if it could draw enough vapor from environmental circulation. In this study, we will compare vapor transportation features of LTC with STC, then use a mesoscale model to testify the effects of vapor transportation on the maintenance of a LTC.

2. Methodology

Diagnostic analyses and numerical simulations were employed in this study with composite data of 7 cases of LTC and 7 cases of STC which made landfall on Chinese coastal area. The vapor transportation features of these two categories of tropical cyclones were contrasted based on NCEP reanalysis 2.5-degree grid data.

The numerical simulations were performed using the PSU/NCAR MM5v3 model with 60km/20km resolution and 43×43/91×91 grid points. The control simulation was integrated for 60h since 12h after landfall. Five sets of sensitive experiments were performed with different vapor transportations and contrasted with the control one.

3. Result

Composite analysis results indicate that the vapor transportations of LTC and STC have different characteristics. LTC connects with the lower layer southwesterly moisture channel after its landfall while the STC disconnects with such moisture channel.

Typhoon Bilis (2000), one of LTC, made landfall in Fujian province of China on the 23rd of Aug. 2000. Despite Bilis got weakening into a depression, it was still an intact circulation system in the next 2~3 days because it was in connection with a lower southwesterly moisture jet. Tabel1 depicts a comparison of the minimum sea level pressure (P_{min}) from the control and the sensitive simulations. Bilis' intensity decreased obviously if it was without the vapor transportation from all lateral boundaries, the TC circulation dissipated after 42h simulation. The vapor transportation from the south boundary has the most distinct impact rather than the other three boundaries in those experiments.

Integration	0	6	12	18	24	30	36	42	48	54	60
Control	995	997	998	998	998	998	999	999	999	999	999
NA	995	998	999	1000	1001	1002	1003	1005	1006	1007	1008
NS	995	998	999	999	1000	1001	1003	1004	1005	1006	1007
NE	995	997	999	999	999	999	1000	1000	1001	1001	1001
NW	995	998	999	999	998	999	1000	1000	1000	1000	1000
NN	996	998	999	999	998	999	999	1000	1000	1000	1000

Table1. Numerical simulation results of the P_{min} in different integration hours (NS, NE, NW, NN, NA refer to the experiments without vapor transported from the south, east, west, north and whole lateral boundaries of the model domain respectively)

4. Conclusion

The lower layer moisture channel connects with the tropical cyclone circulation which will be favorable to sustaining a TC over land. The vapor from the south boundary plays an important role for tropical cyclone sustention over land.

5. References

Chen L.S., Xu X. .D., Luo Z. X. and Wang J. Z., Introduction to Tropical Cyclone Dynamics. Meteorological Press. 2002.317pp

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