A Tropical Cyclone Landfall Research Program (CLATEX) In China

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1. Introduction

A national key research program on tropical cyclone landfall was launched in 2002 to study the tropical cyclone structure and intensity change, track turning, wind and rainfall distribution around the period of landfall as well as the sustaining mechanism for tropical cyclone over land. A field experiment on landfalling tropical cyclone with acronym of CLATEX (China Landfalling Typhoon Experiment), a part of the landfall research program, was implemented in July-Aug. 2002. The scientific objective of CLATEX is to get better undstanding of the impact of land topography on the structure and intensity change, track turning, wind and rainfall distribution of the coastal typhoons. On the other hand, CLATEX should acquire intensive data from various sources of boundary layer and upper level of the landfalling typhoons to initiate the relevant theoretical study for the research program.

2. Deployment of the Field Experiment

The experiment site was set up in Hailingdao island lying to the coastal area of west Guangdong province where tropical cyclones made landfall frequently.

The monitoring ocean domain in south China sea for 24 and 48 hours surveillance (Fig. 1) was adopted in the operation of the experiment.

Fig. 1 Monitoring ocean domain target for typhoon in the CLATEX

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The criterion of target typhoon selection and the activation/termination for the intensive observation program were settled before the experiment. Some advanced instruments such as doppler radar, wind-profiler, ultra sonic anemometer, optical rain gauge, radio-sonde, satellite observation, automatic weather stations, tower gradient observation and conventional surface observations etc. were employed (Fig. 2). CLATEX made more account of the variations of the boundary layer structure of the storm arisen from the topography effect around the period of landfall.

Fig. 2 Boundary layer observation system for landfalling tropical cyclone.

3. Primitive Results

Tropical storm Vongfong (0214) was selected as a target typhoon in the experiment which meet the criterion. The eye of Vongffong when it made landfall was in the 100km west to the experiment site Hailingdao island. After the data process and observation study, some results were found primitively.

3.1 Vertical velocity

In the middle and lower layer of atmosphere, the vertical velocity increased dramatically when Vongfong approached the land. The vertical velocity was rather strong, it was around 2.0m/s from the wind-profiler in several hours before it made landfall then decreased gradually after the landfall.

3.2 Wind distribution

Asymmetric wind distribution appeared before landfall associated with Vongfong. Large scale strong winds appeared in the

right side of the storm. A convergence area was formed due to the confluence of southly winds with the coastal topography east to the storm center.

Strong winds appeared few hours before landfall. Maximum gust exceeds 40m/s from the ten-meter tower observation. The maximum wind is 28m/s around the height of 1500-2000m whereas it got down to 18m/s suddenly around the height of 100m from the wind-profiler right after landfall.

The asymmetric wind, cloud and thermal structures of Vongfong were analyzed based on the assimilation of the data from different sources of TRMM, TBB, Doppler radar, wind-profiler and AWS etc.

3.3 Rainfall

Maximum rainfall in the island was 100mm/h one hour before landfall and decreased/ceased suddenly right after landfall according to the data from optical rain gauge. The data also show the strong meso scale convective activity in the right side of Vongfong just before landfall

3.4 Boundary layer characteristics

The SNR (signal to noise ratio) data of the wind profiler demonstrate that the turbulence developed up to more than 5km several hours before landfall whereas got down back to 1500-1000m several hours after the landfall. The variation of the boundary layer thickness was coincident with turbulent development.

The turbulent spectra of the wind components (u.v and ω) and the temperature under the strong winds still fit the local isotropic turbulent theory, ie. 2/3 law.

The maximum momentum flux appeared couple hours before landfall and decrease rapidly after the landfall which was coincident with the turbulent developing process.

Only small amount of sensible heat flux was found from the ultra sonic anemometer but there exists quite strong latent heat flux before the landfall. Vongfong got intensification in a short period right before landfall. It was wondering if there exists some relation with the latent heat flux, but anyway, the coastal intensification has a close relation with the intrusion of a weak cold air (Liang, 2002).

All the observations show that there are distinct difference features of boundary layer transfer and storm structure before and after landfall. Some features would closely be related to the storm decaying mechanism after it made landfall.

4. Further Study

Field experiment for landfalling tropical cyclones still needs to be done in the following years. Study would focus on the intensity change arises from the structure variation in the period of landfall and the impact of the boundary layer transfer on the structure and intensity change.

Wind and rainfall distribution is another important area (Chen 2002) to be studied in the next stage. Especially the causes of the asymmetric distribution of winds/rainfall and the occurrence of the extreme high winds and rains induced by landfalling tropical cyclones will be the priority in the research program.

CLATEX would like to develop an international cooperation with other coastal tropical cyclone field experiments and landfall research program around the world to initiate the research on the physical mechanism for different aspects of the tropical cyclone landfall.

5. Summary

Data analysis shows that the wind and rainfall distribution and strength of Vongfong were quite different in the period of before and after landfall. SNR shows clearly the variation of turbulence development and the boundary layer thickness. The fluxes of momentum and heat in the boundary layer would affect the tropical cyclone structure and time period of sustention over the land.

References

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