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The Characteristic of the Boundary Layer Heights in Landing Typhoon Utor and Mujigae

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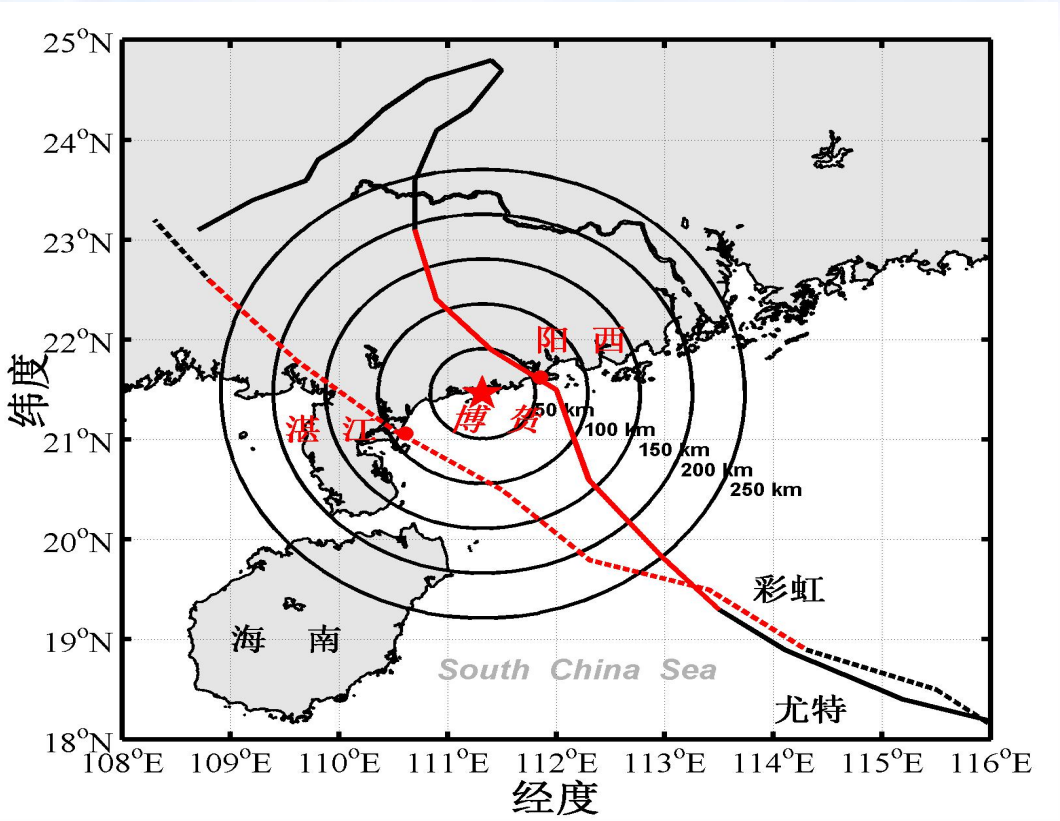
Introduction

- The typhoon boundary layer is a special class of the planetary boundary layer that refers to the bottom layer of the atmosphere in typhoon, which regulates the radial and vertical distributions of momentum ,heat and moisture at its top that are closely related to typhoon development and intensity.
- The simulated typhoon intensity is very sensitive to the selection of the height of the typhoon boundary layer in typhoon models.
- Zhang et al. (2011a) used thermodynamic and dynamical method to define hurricane boundary layer height, and pointed out that there is no consensus in defining hurricane boundary layer height.
- The purpose of this paper is to use observational data from GPS sounding to study the characteristic of the typhoon boundary layer height in landing typhoon Utor and Mujigae.

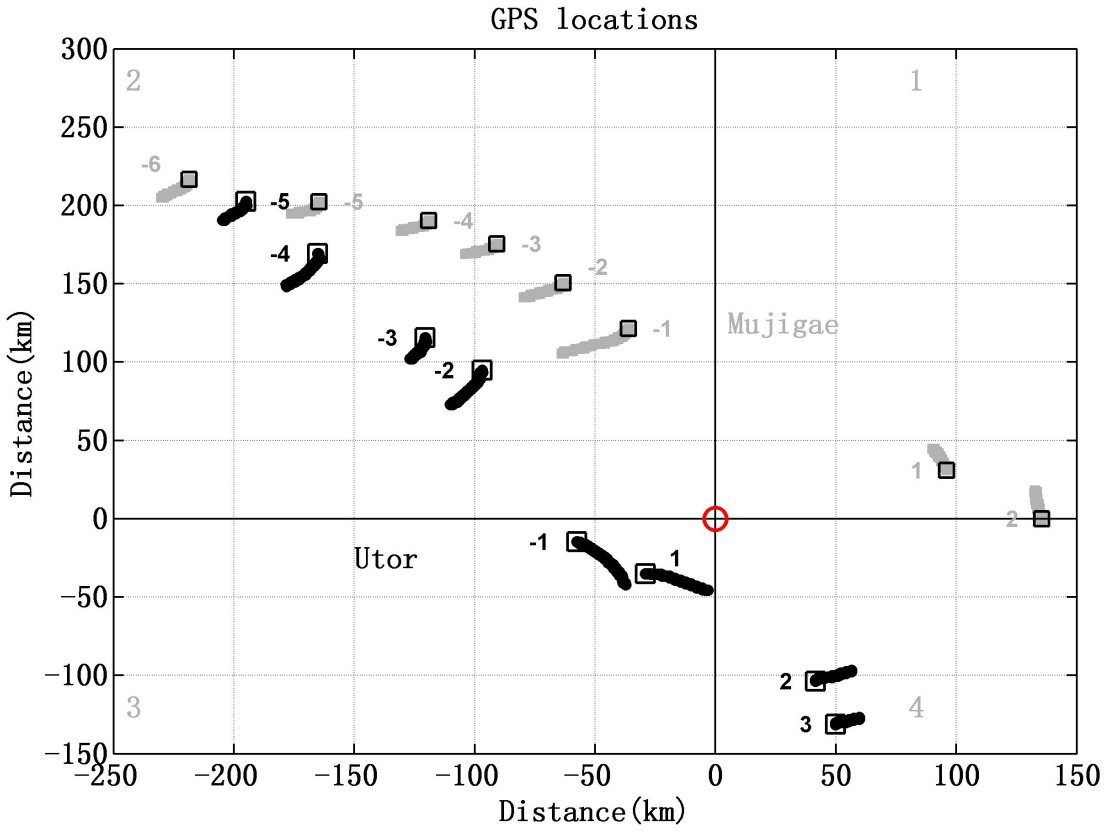
Data and Method

Description of the Two Typhoon Events



编号	台风名称	登陆时间	登陆地点	最低气压（hPa）	最大风速（m/s）	强度	探空次数	观测起始时间
1311	尤特（Utor）	8/14 15:50	广东阳西	955	42	强台风	8	201308 13-14
1522	彩虹（Mujigae）	10/4 14:10	广东湛江	940	50	强台风	8	201510 03-04

Data and Method



The distribution of the GPS locations relative to the storm center

Utor:
before landing: -5~-1,
about 60~200 km
after landing : 1~3
about 50~120 km

Mujigae :
before landing: -6~-1
about 100~250 km
after landing : 1~2
about 100~140 km

Data and Method

Defining typhoon boundary layer height:

✓ Thermodynamics: the mixed layer depth (Z_i).

a) The top of the mixed layer to be defined as being where θ increases by 0.5 K from its mean value in the lowest 150 m (Anthes and Chang 1978).

$$Z_i = Z(\theta - \overline{\theta_{0-150}})$$

✓ Dynamics:

a) The height of the maximum wind speed (h_{umax}).

$$h_{umax} = H(U_{max})$$

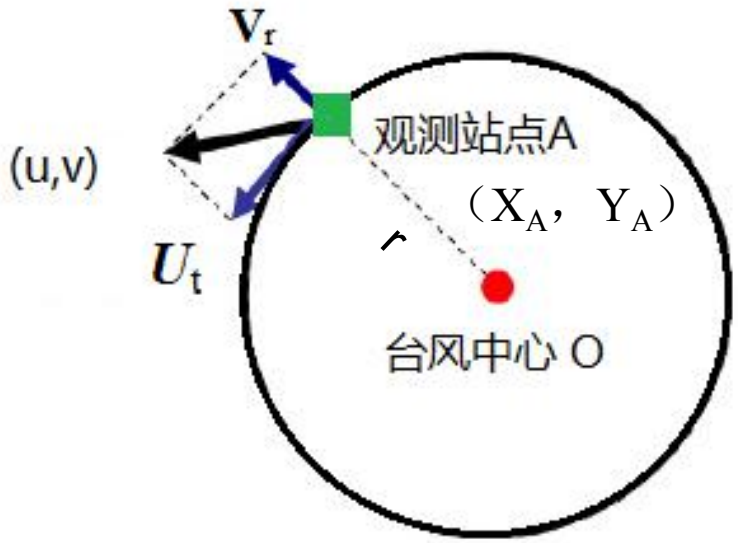
b) The inflow layer depth (h_{infl}).

- Taking the height where the radial velocity is 10% of the peak inflow as the (h_{infl}).

$$h_{infl} = H(10\%V_{r\,max})$$

(Zhang et al., 2011a)

Results and Discussion

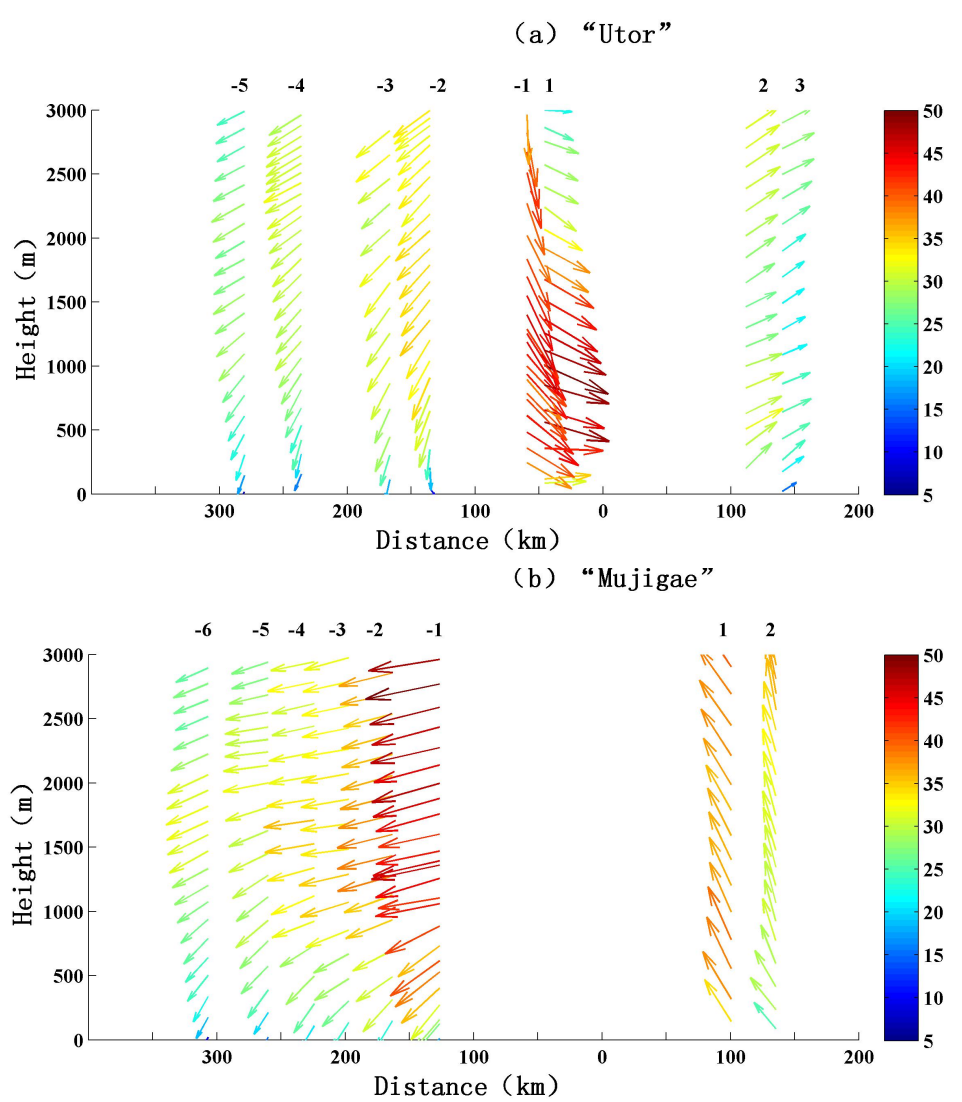


The total wind: $\vec{V} = (\overrightarrow{V_x} - \mathrm{Vcx}, \overrightarrow{V_y} - \mathrm{Vcy})$

The radial velocity: $|\overrightarrow{V_r}| = |\vec{V}| \cdot cos < \vec{V}, \overrightarrow{n_r} >$

The tangential wind: $|\overrightarrow{U_t}| = (|\vec{V}|^2 - |\overrightarrow{V_r}|^2)^{1/2}$

Results and Discussion

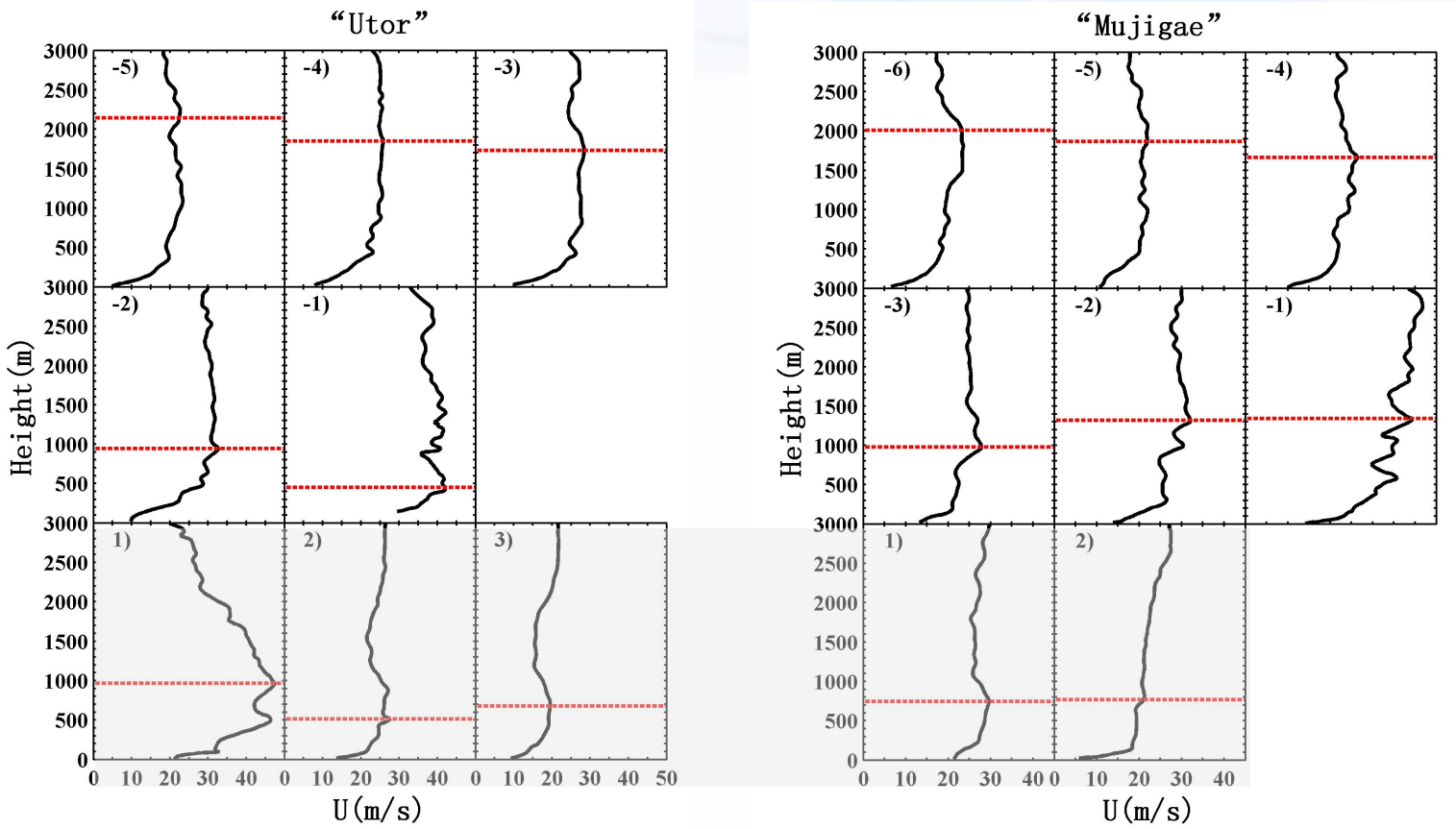


The wind speed vertical distributions

Utor:
before landing:
northeast to northwest
after landing :
northwest to southwest

Mujigae :
before landing:
northeast
after landing :
southeast

Results and Discussion



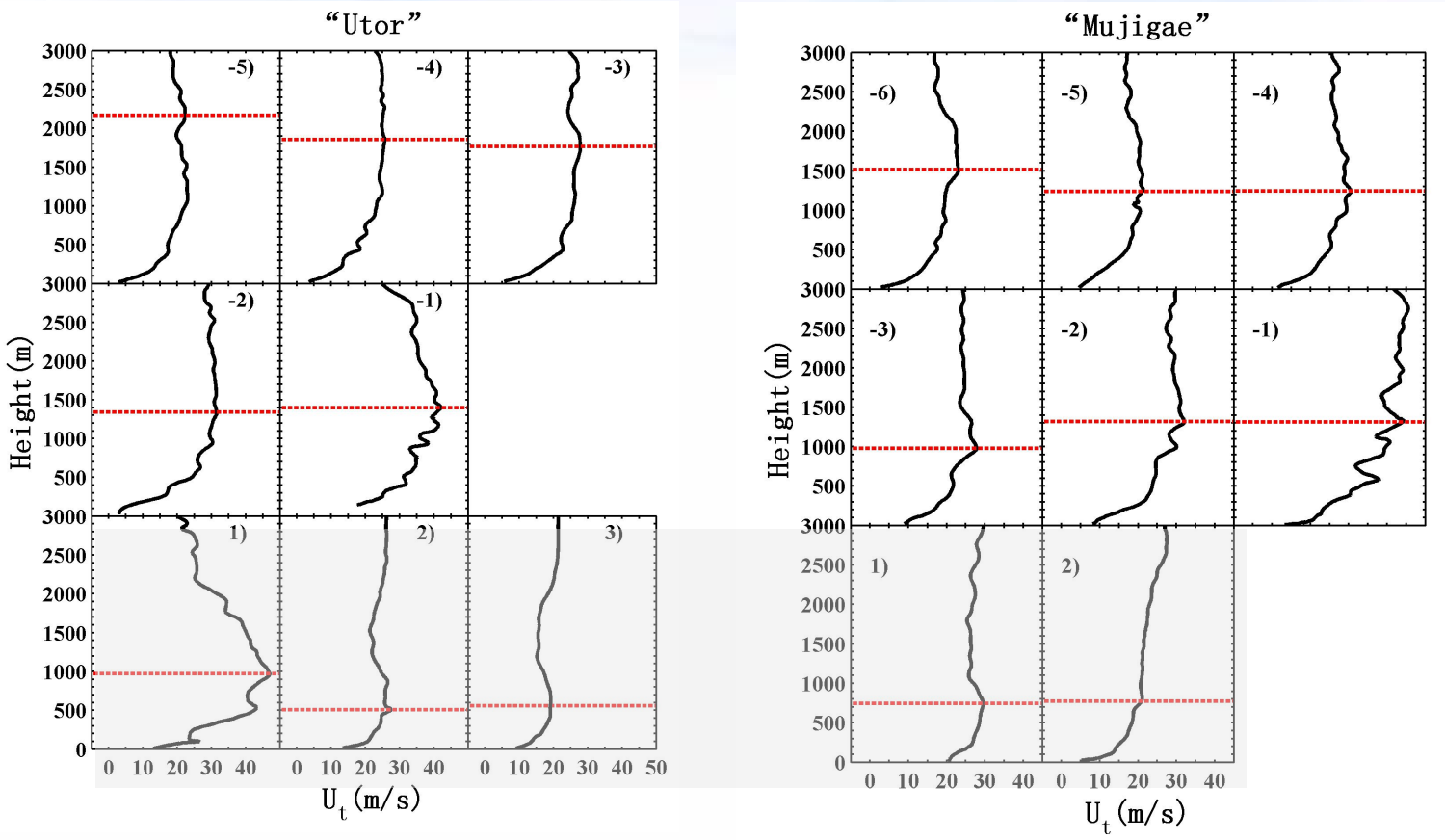
before landing

after landing

The wind speed profiles (the red lines are h_{umax})

The h_{umax} decreases with the decreasing distance to the typhoon center. Before> after

Results and Discussion



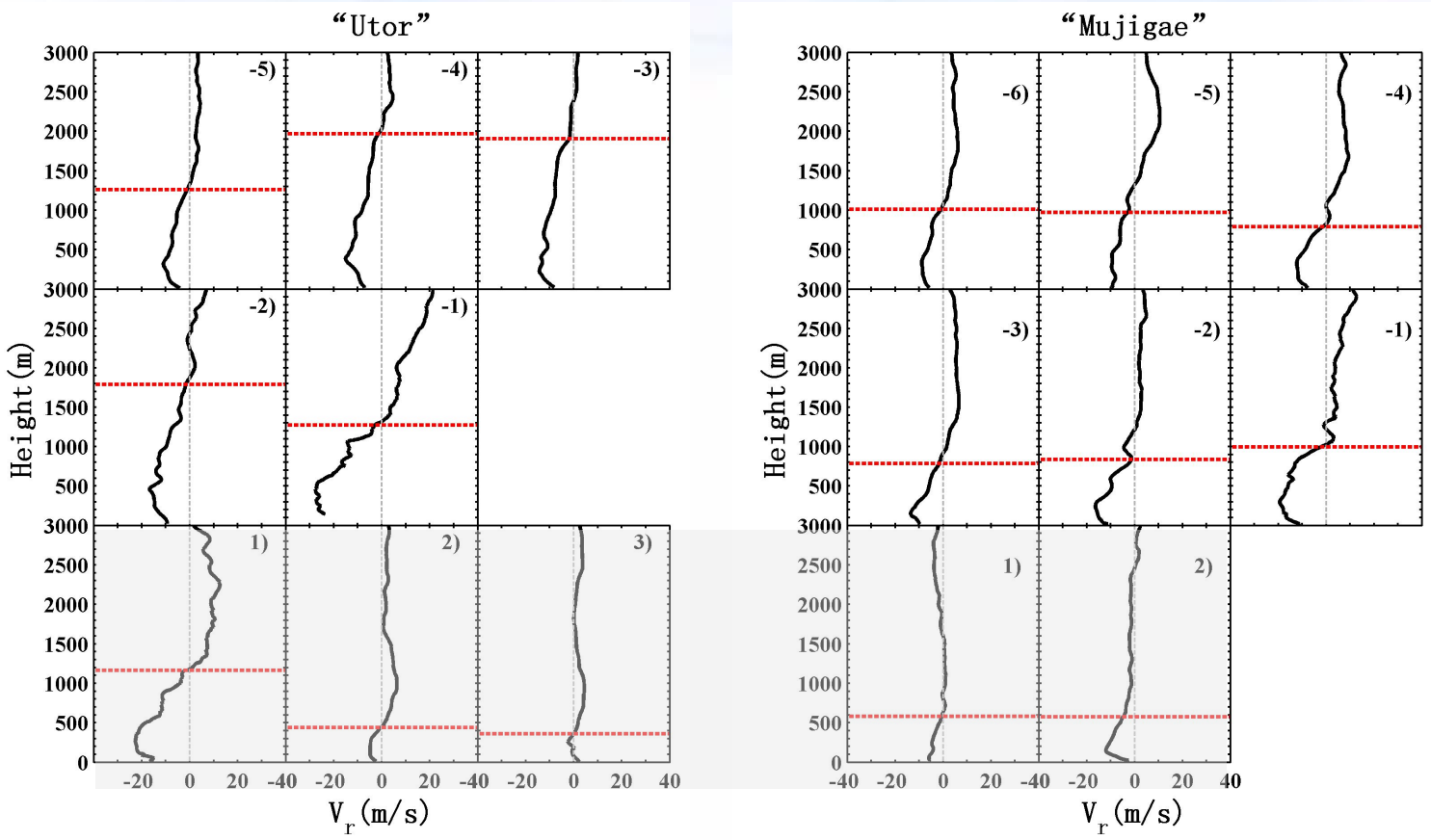
before landing

after landing

The tangential wind speed profiles (the red lines are h_{ut})

The h_{ut} decreases with the decreasing distance to the typhoon center. Before> after

Results and Discussion



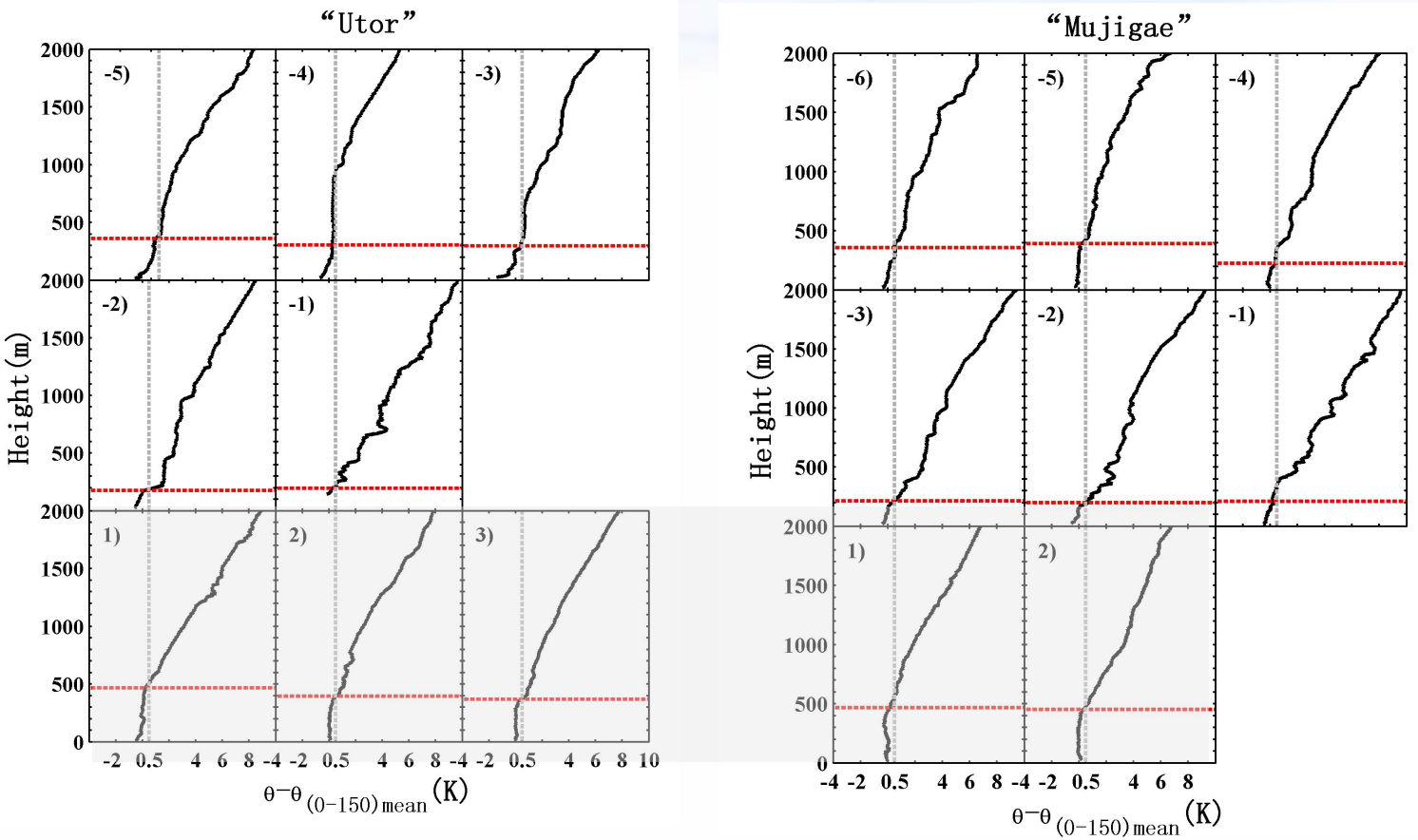
before landing

after landing

The radial velocity profiles (the red lines are h_{infl})

Before> after

Results and Discussion



The $\theta - \overline{\theta_{0-150}}$ profiles (the red lines are Z_i)

The Z_i decreases with the decreasing distance to the typhoon center. Before< after

before landing

after landing

Results and Discussion

	Utor				Mujigae			
$\bar{h}$ (units: m)	h_{umax}	h_{ut}	h_{infl}	Z_i	h_{umax}	h_{ut}	h_{infl}	Z_i
before landing	1450	1700	1600	300	1500	1250	850	280
after landing	720	700	650	450	750	750	550	480

$$h_{umax}, h_{ut}, h_{infl} > Z_i$$

$$h_{umax}, h_{ut}, > h_{infl}$$

Conclusions

1. There are significant differences between before and after typhoon landing in the aspect of h_{umax} and h_{infl}, h_{umax} is above h_{infl}.

2. The h_{umax} and h_{ut} and Z_{i} are found to decrease with the decreasing distance to the typhoon center before and after typhoon landing.

3. There is a clear difference between the thermodynamic and kinematic boundary layer height in typhoon Utor and Mujigae, Z_{i} is $< 500\mathrm{m}$, which is much shallower than h_{umax} and h_{infl}, but Z_{i} is little difference between before and after typhoon landing.

Thank you!