# 16c.8 A NUMERICAL SIMULATION OF THE LANDFALL TROPICAL CYCLONES

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## 1. INTRODUCTION

The problem of tropical cyclone (TC) landfall has received more attention in recent years especially after it has been listed as one of the foci of the US Weather Research Program. The earlier modeling efforts by Ooyama (1969), Rosenthal (1971), Tuleya (1978) and Tuleya (1984) have given some characters of the landfall TC. This study therefore represents an attempt to investigate the physical processes that, under idealized conditions, lead to changes in the rainfall distribution in a TC prior to, during and after landfall using the mesoscale model MM5. The following experiments on f-plane and without mean-flow are performed: turning off the sensible heat flux over land (Expt. 2), turning off the moisture flux over land (Expt. 3), and setting the roughness length to be 0.25 m over land (Expt. 4). The movement of TC is represented by movement of the coastline.

## 2. RESULTS OF THE BASIC EXPERIMENTS ON THE EFFECTS OF PBL FLUXEX

The results suggested that cutting off the moisture flux over land should have a profound effect on the TC characteristics. In Expt.3, before and when TC landfall, the maximum rainfall primarily occur in upper and upper left quadrants. The distributions of rainfall in Expt.3 ( shown in Fig. 1 ) and 4 before landfall are very similar, because the change in the roughness length of the underlying surface causes a change in the wind speed in the PBL, which will then change the moisture flux. The moisture flux on the land surface is smaller than that on the sea surface due to the loss of wind speed in the PBL on the land in Expt.4. These results also suggest that the moisture flux is very important to determine the rainfall pattern before and when TC landfall, and the convergence/divergence in the onshore/offshore area does not play the key role to determine the distribution of precipitation.

## 3. EFFECT OF MOISTURE FLUX

While TC landfall, moisture flux on the land is less than that on the sea, but it is not always favorable to reduce the rainfall. As a fact, it usually increases the rainfall in right ahead, ahead and left areas related to the TC and reduce it behind. The reason is that the dry air on the land and moist air on the sea is advected by horizontal wind into the inner area of the TC, the low-upper distributions of dry and moist air should decrease/increase the instability. The inflow of dry/moist air in lower levels with moist/dry air in upper levels should decreased/increased the instability in the lower levels. The asymmetric distributions of $\frac{\partial \theta_{se}}{\partial z}$ in Expt.3 indicate that the air in the lower levels in inner areas to the east and north of TC center are more unstable than those to the west and south of the TC in lower levels, oppositely, east and north of the TC are more stable than west and south in the higher levels before landfall. The increased/decreased instability will lead to increase/decrease of upward motion, so the anomalous upward motion begin to the east and north of TC in lower levels and increased to west and south in high levels. The rainfall anomaly caused by upward motion is not directly occur in east and north, because the rainfall occurs only after the air is raised up certain height, not in the very low levels. For TC, the average horizontal wind speed is very large, when the air is raising up, it is anti-clockwise advected to down-flow areas, so the enhanced rainfall exists from northwest

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to southwest of the TC due to the anomalous upward motion.

## 4. REFFERENCES


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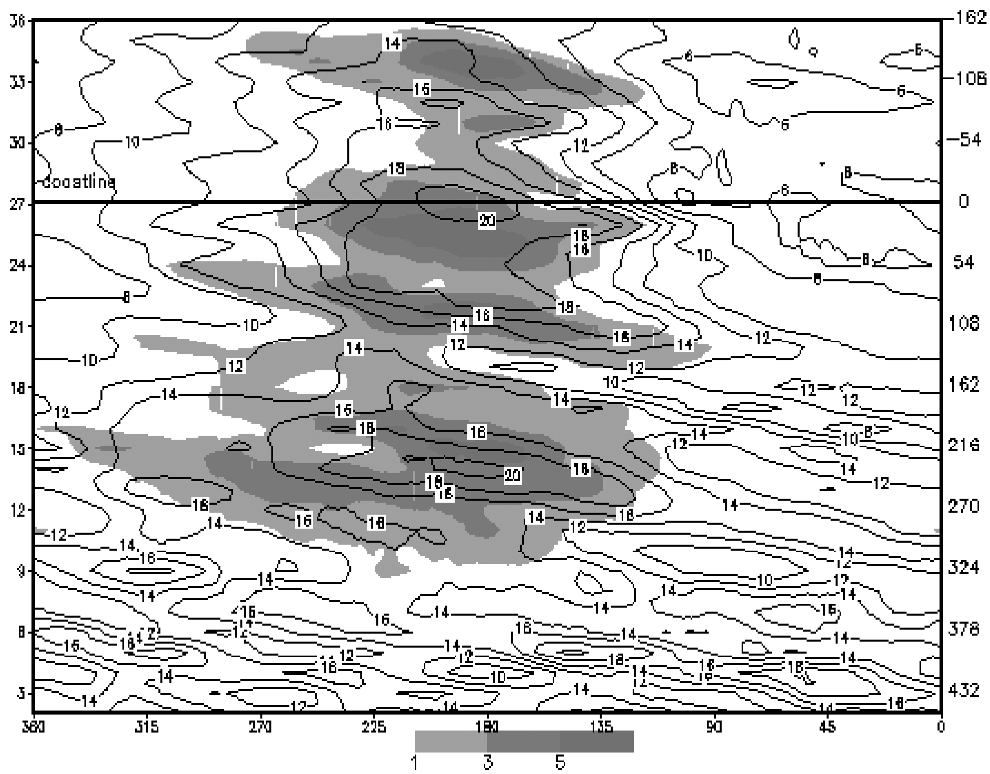


Fig. 1 Cylindrical summed 1 h rainfall ( cm ) from 1 to 36 h in Expt. 3, shaded is the increased rainfall compare to the control run. The 1 h rainfall is obtained by radially summing the hourly rainfall within each 15-km, 1 degree azimuth box (centered on the TC center ) out to 300 km at each degree from east. X-axes is the degree relative to east ( anti-clockwise, $1^{o}$ ), left y-axes is the integrating time and right y-axes is the distance of the TC center relative to the coastline in km.