13A.3 **LATENT HEATING STRUCTURE OF HURRICANES FROM TRMM MEASUREMENTS**

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1. INTRODUCTION

It is well established that the diabatic heating distribution in both space and time represents an important thermal forcing mechanism with regard to monsoon circulations, tropical and mid-latitude circulations, and the general circulation of the atmosphere. Thus, determination of the temporal and spatial variations of vertical heating could be a vital aid for numerical weather forecasting and climate prediction. Despite the importance of the 4-dimensional structure of diabatic heating in governing atmospheric motions, there has been no dependable method for observing diabatic heating distributions globally. This deficiency is particularly acute over the oceanic regions because of the lack of adequate conventional datasets. Fortunately, satellite measurements provide an alternative data source over oceans.

Surface precipitation retrieved from satellite-based passive microwave measurements have already been proven to be quantitatively useful (Wilheit et al., 1994; Yang and Smith, 1999a). Moreover, latent heating estimation from Special Sensor Microwave Imager (SSM/I) measurements has been discussed by several investigators (Olson et al., 1999; Tao et al., 1993; Yang and Smith, 1999b). The Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI), launched in 1997, has finer spatial resolution than the SSM/I, and TRMM measurements have already had important impacts on atmosphere-related research activities. Latent heating estimation from TMI measurements is one of the key objectives of TRMM. Here, preliminary estimates of latent heating rates in hurricanes are presented in order to demonstrate the general credibility of the TMI heating products, which should be available in the near future.

2. DATASETS AND METHODOLOGY

Four selected hurricanes observed by the TRMM satellite over the Pacific and Atlantic Oceans are included in this study. Surface rain rates and latent heating profiles from the prototype Version 6 TMI retrieval algorithm are the main data source. Heating profiles from MM5 hurricane simulations will also be used to compare to the retrieved heating profiles.

The rain/heating retrieval algorithm is based on a Bayesian technique (Olson et al., 1996). In this method, the expected values of a set of retrieved parameters (including the surface rain rate and heating profiles) are estimated by calculating their statistical means from an ensemble of cloud resolving model-generated atmospheres that are radiatively consistent with the satellite-observed brightness temperatures. Many improvements have been introduced into the prototype Version-6 TMI algorithm, such as an expanded cloud model database with improved microphysics, a convective/stratiform separation technique for over-land applications, and a more consistent cloud-free radiance reference technique.

3. PRELIMINARY RESULTS

Preliminary results for the four hurricane cases indicate that latent heating distributions are different at different stages of the hurricane life cycle. Latent heating vertical structure has asymmetrical characteristics even at the most intense stage of the hurricane. Presented in Fig. 1 is an example of the vertical cross-section of latent heating from Supertyphoon Paka on 16 December 1997, during its most intense stage. The upper-left panel is the heating vertical cross-section along the satellite track, while the upper-right panel is derived from cross-track data, which has greater horizontal resolution. The bottom left panel is the azimuthal-mean heating structure, and the bottom right panel is the mean heating profile over an area within 1-degree radius of Paka' eye location. It is evident that the mean heating peak, which has a magnitude of 4 ^{o}K hr^{-1}, occurs at 6-7 km altitude. Positive heating is indicated above 2 km, while there is modest cooling near the surface. The azimuthal-mean heating structure reveals maximum heating close to the 6-km level in the eye wall region. Just outside of the eye wall region, there is heating aloft with cooling at lower levels, and then a secondary heating maximum coinciding with the location of a major spiral rainband of the typhoon. Cooling below 5 km away from eye wall corresponds to anvil clouds in typhoon. The eye well

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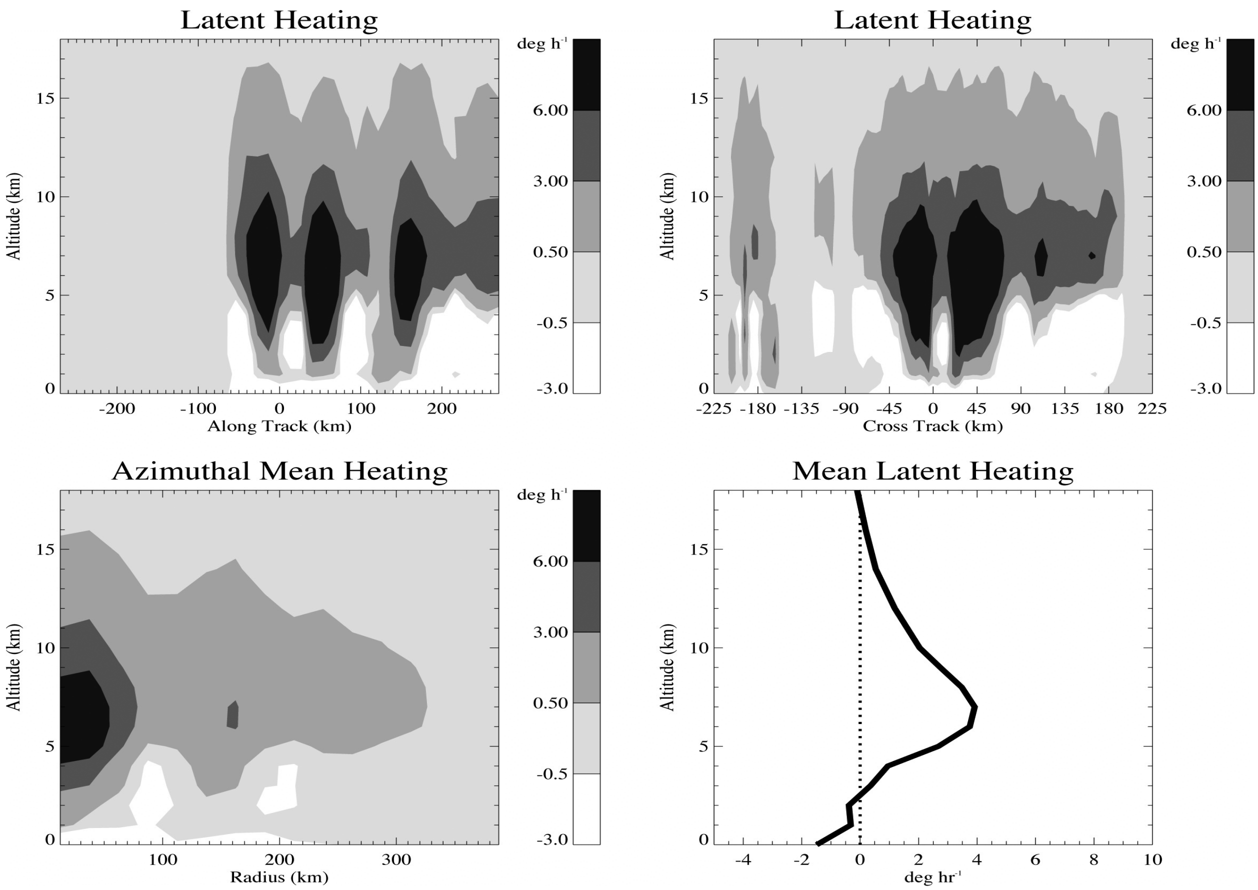

Fig. 1. Plots of latent heating distributions in Supertyphoon Paka (1997)

and spiral rainband convective heating structures are clearly seen in the along-track plot. The maximum heating is not at the same altitude along-track, and the heating distribution is asymmetric about the eye. The eye wall and the anvil clouds are also evident in the cross-track section.

Compared to estimated heating distributions from previous studies (e.g., Rodgers et al., 2000), the retrieved heating structures shown in this preliminary study appear reasonable. However, there are still some issues to be resolved. For example, the evaporative cooling near the surface appears to be too strong. Also, the heating/cooling couplet in the eye region is unrealistic. We plan to compare the retrieved heating distributions to MM5-simulated heating distributions.

4. REFERENCES

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