TRMM PR-derived latent heating compared with ELDORA retrievals during TCS-08 Experiment

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ABSTRACT

The NRL P3 ELDORA is a unique tool to observe the mesoscale convective systems (MCS) within pre-tropical cyclone (TC) disturbances. Two hypotheses have been proposed as to how the incipient TC surface vortex forms from the tropical disturbances via an interaction with a MCS. While the focus in the Top-down hypothesis is on the maximum potential vorticity (PV) in the middle levels involving a large stratiform region within the MCS, the focus in the Bottom-up hypothesis is on a maximum PV in lower levels in collaboration with a strong convective updraft region. One distinctive feature of the simulations of the Bottom-up process is a maximum in the latent heating profile that is lower in the troposphere in conjunction with large vertical velocities that favor spinup at lower levels.

The first space-borne radar (Precipitation Radar—PR) on the TRMM satellite has the capability to observe the vertical profile of latent heat release in many pre-TC disturbances over the past eleven years. The recently developed Spectral Latent Heating (SLH) algorithm provides latent heating rate (LHR) estimates from a cloud-resolving model look-up table based on the observed rain profile, the convective and stratiform classification, and the surface rain rate. Examination of the PR-derived LHR over numerous pre-TC tropical disturbances would greatly enhance the sample sizes for TC formation studies. However, the satellite-derived technique must be validated with in situ aircraft observations where possible.

In this study, we validate the PR-derived LHR using the thermodynamic retrievals from the NRL P-3 ELDORA observations during the TCS-08 experiment. We focus on two cases in which the PR overpasses were well correlated with the ELDORA observations: pre-Hagupit (flight 13) and Jangmi (flight 21). The TRMM PR LHR observations are obtained from http://www.eorc.jaxa.jp/TRMM/lh/. The ELDORA dataset requires a number of sequential steps that retrieve dynamics and microphysics. The ELDORA data for flights 13 and 21 are first corrected for navigation errors and automatically edited using the NCAR SOLO II software package. The edited reflectivity and Doppler velocity are interpolated to a
Cartesian grid, and synthesized using a variational approach. Using the derived three-dimensional winds, the horizontal and vertical gradient of pressure and temperature perturbations are calculated from the momentum and thermodynamic equations. Here the temperature perturbation field is calculated relative to the nearest dropsonde sounding from the US Air Force C-130 or the Taiwan DOTSTAR. The retrieved temperature field is used with the derived vertical motion field to calculate the LHR profile for comparison with the PR LHR profile. Both the satellite and aircraft retrievals have inherent error sources in their algorithms that must be considered. We finally discuss the possible application of the PR LHR in TC formation research and describe its advantages and limitations.