ABSTRACT

The thesis consists of three projects. Each of these projects is a diagnostic study of the interaction between strong convective events and the background atmosphere. In all projects, we use a satellite rainfall dataset to identify strong rain events. We then use radiosonde soundings to generate composite anomaly patterns of meteorological variables about the strong rain events.

In Project 1, we examine temperature, relative humidity, and divergence anomalies about strong convective events in the Western Tropical Pacific. A low-level convergence coupled to a midlevel divergence develops prior to peak rainfall. A midlevel convergence coupled to a low-level divergence develops after peak rainfall. Strong surface cold pools develop in response to high rainfall. Observations were compared to models and reanalyses. In general, models and reanalyses do not fully represent the timing, strength, and altitude of the mid-level convergence and divergence features. The surface cold anomaly is also underestimated in models. These discrepancies suggest that the mesoscale downward transport of mid-level air into the boundary layer in models may be too weak.

In Project 2, we investigate the impact of convection on the background distribution of a chemical tracer (ozone). Negative ozone anomalies and higher frequency of midlevel cloud tops occur in a layer between 3 and 8 km prior to peak rainfall. Negative ozone anomalies in the upper troposphere develop in response to high rainfall. Chemistry transport model simulations also exhibit negative ozone anomalies at upper and midlevels. However, the ozone anomalies in the model are symmetric about peak rainfall and are more persistent than observations.

In Project 3, we identify regional variations in the interaction between convection and the background atmosphere. In all four regions, deep convection imposes cooling in the lower and warming in the upper troposphere. In mid-latitudes, convection is associated with stronger anomalies in surface pressure, geopotential height, and CAPE. Over land, a low-level warm anomaly develops prior to peak rainfall and the surface cold pool that develops during peak rainfall is more persistent. The PV generated prior to peak rainfall, is advected towards the surface after peak rainfall and may play a role in hurricane genesis.