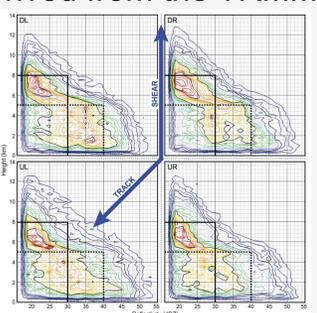
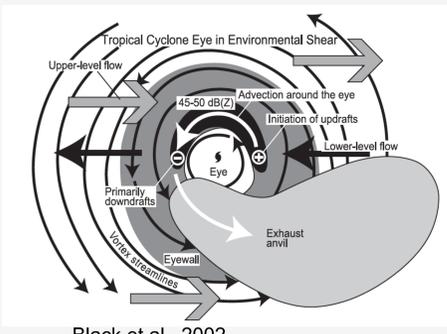


## Introduction

Previous studies of TRMM satellite data have documented statistical variations of the vertical structure of precipitation in tropical cyclones (Hence and Houze 2011). These have been used to make inferences about the nature of eyewall convection and how it varies in relation to environmental shear. This study determines whether aircraft Doppler radar measurements of vertical, tangential, and radial velocity are consistent with the reflectivity statistics derived from the TRMM PR.



Hence and Houze 2011

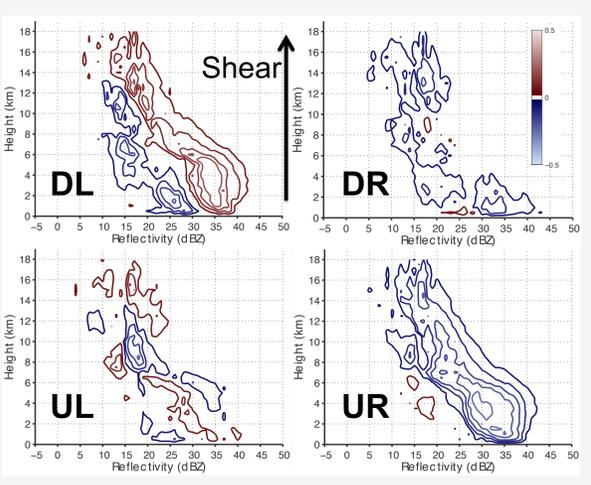


Black et al., 2002

## Data and Methodology

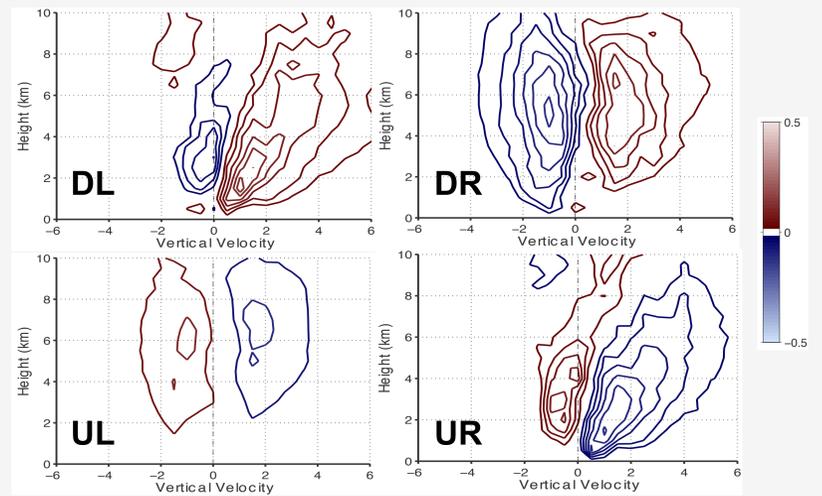
- NOAA P3 Tail Radar (X band) analyses from HRD
- Hurricane strength storms from 2003 – 2010
- Vertical shear from the SHIPS database
- Normalize radius by the radius of maximum wind at 2 km to account for size variability
- Anomaly CFADs created by subtracting total eyewall CFAD from shear-oriented quadrant CFADs
- Strong updrafts and downdrafts analyzed through radial-height distributions and cross sections of reflectivity and velocity.

## Reflectivity - Eyewall



- DL: highest occurrence of high reflectivity at low levels (mature convection)
- UR: distinct lack of high reflectivity at low levels (decaying convection)

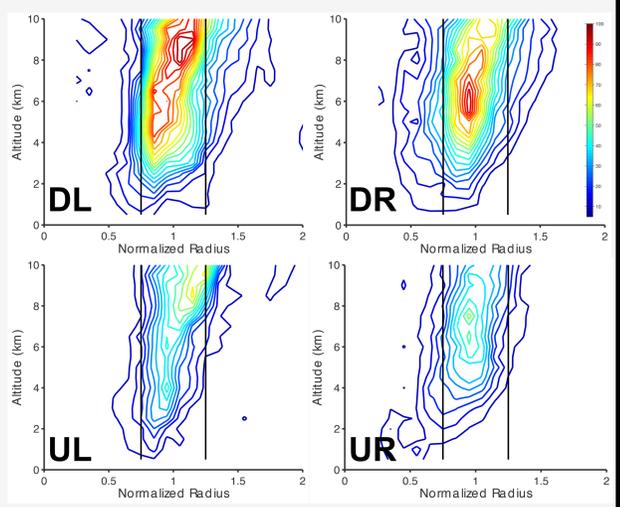
## Vertical Velocity - Eyewall



- Higher frequency of upward motion downshear and downward motion upshear.
- Convection growth from DR to DL and subsequent decay upshear consistent with Hence and Houze 2011

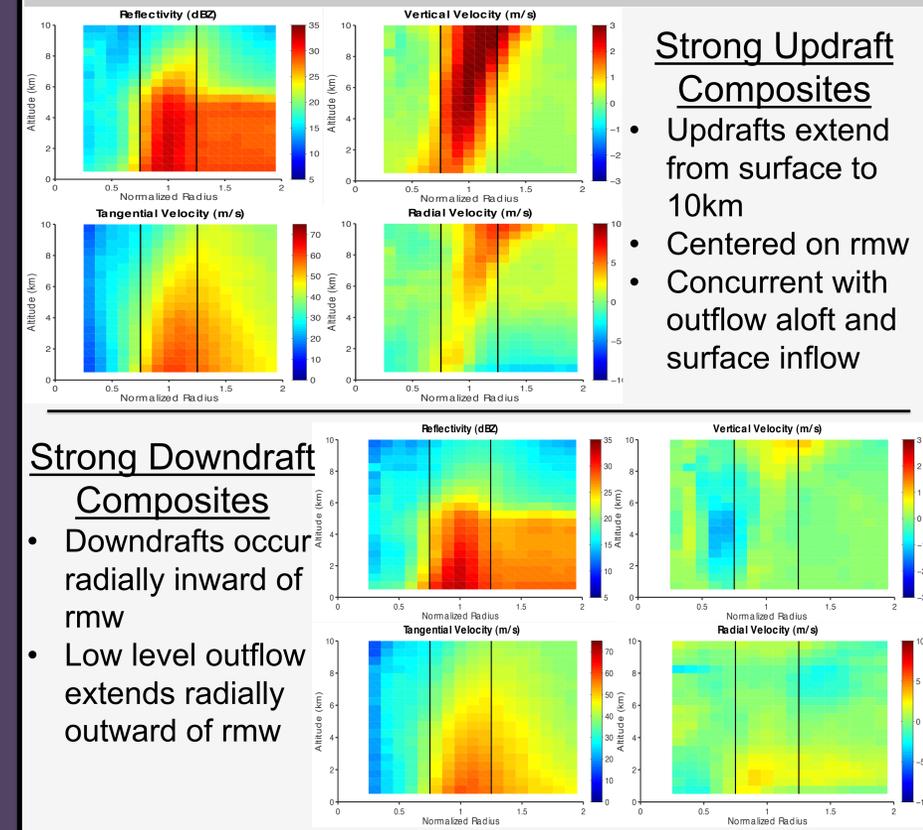
## Intense Drafts

- Updrafts
- $w > 5$  m/s
- Fewer intense updrafts as convection initiates DR, but number increases as convection matures DL
- Strongest drafts occur aloft



- Downdrafts
- $w < -4$  m/s
- Strongest signal in UL quadrant and weakest DR
- Maximum frequencies found radially inward of rmw

## Cross Sections

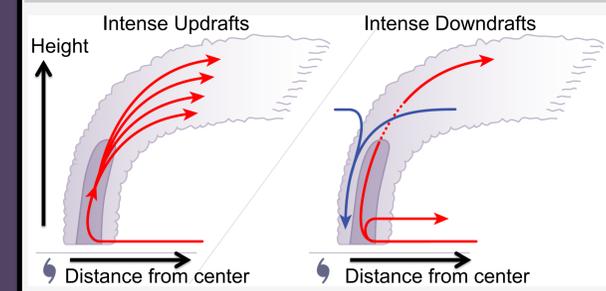


- Strong Updraft Composites
- Updrafts extend from surface to 10km
- Centered on rmw
- Concurrent with outflow aloft and surface inflow

### Strong Downdraft Composites

- Downdrafts occur radially inward of rmw
- Low level outflow extends radially outward of rmw

## Schematics



- Consistent with radial velocity cross sections
- Overturning circulation is markedly different in each case

## Summary

Analysis of reflectivity and vertical velocity is consistent with statistics derived in previous studies from the TRMM PR.

- Convection initiates DR with weaker vertical velocities and moderate hydrometeor size then maturing DL where the strongest vertical velocities and reflectivity returns are found.
- Convection decays upshear. Downdrafts peak UL.

A new result from this study is:

- Intense updrafts are collocated with low level inflow and upper level outflow, while intense downdrafts are found in conjunction with low level outflow extending beyond the radius of maximum wind.