Structural characteristics of the core region of T-PARC Typhoon Sinlaku in a vertically sheared environment

Annette M. Foerster, M. M. Bell, P. A. Harr, S. C. Jones
Motivation

Previous studies on the structure of the eyewall region of mature tropical cyclones in vertical shear utilizing Doppler radar data:

- Radar reflectivity and vertical velocity have strong asymmetries:
  - Highest radar reflectivities generally to the left of the shear vector
  - Updraft formation in the downshear quadrants
  - Lower-tropospheric downdrafts with upper-tropospheric updrafts right of the shear vector
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Investigate the structure of Typhoon Sinlaku in westerly shear at a very late stage of its lifecycle
Dataset (19 Sep 2008)

Flighttracks:
- blue: C-130
- green: P-3

Data Sources:
1. Dual Doppler Radar data (ELDORA)
2. Dropsonde data
3. Flight level data
4. MTSAT AMVs
5. ECMWF operational analysis

Data Assimilation:
- Splines
- Analysis at mesoscale
- Utilizing Radar and Aircraft Instrumentation (SAMURAI, Bell et al. 2012)
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3D Reflectivity

19 Sep 2008, 03.50-04.15 UTC

Yellow: 26 dBZ surface (max. height: 9 km)
Magenta: 34 dBZ surface (max. height: 6 km)
Convective cells at different stages of their lifecycle:

- Largest area of high values to the northeast (mature cells)
- Three peaks of higher values to the west (dissipating cells)
- Gap in reflectivity to the southeast

Yellow: 26 dBZ surface (max. height: 9 km)
Magenta: 34 dBZ surface (max. height: 6 km)
3D Reflectivity

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Vortex structure

Vortex Tilt

- Center defined as maximizing the tangential wind at the RMW (Marks et al. 1992)

- Anticyclonic change with height (as shear)
Vortex structure

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![Diagram showing Vortex Tilt with latitude and longitude markers at different altitudes.]

- 0.5 km
- 4.5 km
- 8.5 km
Vortex structure

Vortex Tilt

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- Anticyclonic change with height (as shear)

Horizontal wind speed

Anticyclonic change with height (as shear)
Investigation according to the shear vector

Splitting SAMURAI domain into quadrants

Shear vector: $\vec{v}_{\text{Shear}} = \vec{v}_{H,400\,\text{hPa}} - \vec{v}_{H,900\,\text{hPa}} = 7.5 \, m \, s^{-1}$
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CFADs

Contoured Frequency by Altitude Diagrams

Source: Yuter and Houze (1995)
SW (upshear right)  NE (downshear left)
NE convectively much more active
distribution is broader
higher reflectivities at all levels
flatter slope
CFADs Reflectivity

SW (upshear right)

Distribution is broader
Higher reflectivities at all levels
Flatter slope
CFADs Reflectivity

SW (upshear right)

NE (downshear left)

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Area Coverage of Vertical Velocity
Area Coverage of Vertical Velocity

SW (upshear right)

-1 m/s
0 m/s
1 m/s

-NE (downshear left)

NE: ascent at all levels
SW: lower-level down-, upper-level updrafts

strongest vertical velocities at mid levels
Area Coverage of Vertical Velocity

**SW (upshear right)**

-0 m/s
-1 m/s
1 m/s

**NE (downshear left)**

-NE: ascent at all levels
-SW: lower-level down-, upper-level updrafts

strongest vertical velocities at mid levels
Area Coverage of Vertical Velocity

- **NE**: ascent at all levels
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- NE: ascent at all levels
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Summary

- Observational analysis of the eyewall region of Sinlaku
- Shear modifies reflectivity, velocity and vortex tilt
- Reflectivity consistent with convective cell formation downshear and dissipation upshear
- Downshear: broad ascent
- Upshear: mixed ascent and descent
- Convective structure is generally consistent with Black et al. (2002) and Reasor and Eastin (2012), even though Sinlaku is near its extratropical transition
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