The structural changes of tropical cyclones upon interaction with vertical wind shear

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Figure 5: Selected (0000 and 1200 UTC) official intensity forecasts (dashed lines) for Tropical Storm Chantal, 14-22 Aug. 2001. The best track intensity is given by the thick solid line.

Acknowledgements: NHC 2001 Tropical Cyclone Report
Background: - Idealized Modeling Studies

(e.g., Jones 1995; DeMaria 1995; Bender 1997; Wang (submitted); Frank and Ritchie 1999; 2001; Ritchie and Elsberry 2001; ...)

**Dry Model** (Jones, DeMaria, Frank and Ritchie)

- Shear Vector

**Moist Model** (Bender, Frank and Ritchie, Ritchie and Elsberry)

- Shear Vector

- Presume that convection is modulated by the areas of forced ascent/descent.

- Because the vertical shear environment forces a wave-number-one vertical motion pattern, a persistent convective asymmetry develops.

**Questions:**
- What effect does asymmetric convection have on the structure of a TC?
- How is the TC intensity affected by asymmetric convection?
Initial symmetric TC structure

COAMPS
$f$ plane
Strong 22 m/s

Relative Vorticity
$(10 \times 10^{-5} \text{ s}^{-1})$

Temperature Anomaly (°C)
3-hourly Precipitation (12h-9h)

Strong Shear

1 deg

Shear Vector
Strong Shear

Relative Vorticity

Vertical Velocity

Temperature anomaly

West

East

Southwest

Northeast

1050 mb

1000 mb

800 mb

600 mb

400 mb

200 mb

West

East

100 km

Temperature anomaly
Temperature (K) & water vapor anomaly (g/kg)
MM5
\( \beta \) plane
10 m/s shear

Minimum Central Pressure

<table>
<thead>
<tr>
<th>Pressure (mb)</th>
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<tr>
<td>990</td>
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<td>950</td>
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<td>940</td>
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Time (h)

West10b
East10b
Simulated Tracks

Longitude

Latitude

West Shear Track

East Shear Track

3-h precipitation

West 10 m/s  T = 87-84

East 10 m/s  T = 87-84
West 10 m/s

East 10 m/s

Motion Vector 4.4 m/s

Motion Vector 6.5 m/s

3-h precipitation

T = 87-84

T = 87-84
Hypothesis: if the large-scale environment can be forecast with skill, then, by knowing enough about the effects of ideal shear on simulated TCs, we can use our knowledge of the predictable large-scale environment to predict the intensity and structural changes that will occur in TCs.

Missing Link: do these dynamic effects that we see in the ideal model studies occur in real TCs?
Motivation:

1. to examine real cases of TCs in vertical wind shear and determine the cause and effect relationship of asymmetric convection and large-scale patterns.

2. Understand these relationships and apply them to real-time forecasting.
Method:

1. Using cases from CAMEX field program, ingest data into model.
2. Integrate model 6 – 12 hours to spin up model microphysics.
3. Examine in combination with dropwindsondes and flight-level data for dynamic and thermodynamic structure, and microphysical observations for convective structure.
Finally:

Cases of interest:

- Chantal
- Erin
- Gabrielle
- Humberto

Data of interest:-

- Dropwindsondes
- Measurements of convection/microphysics
- Thermodynamic structure