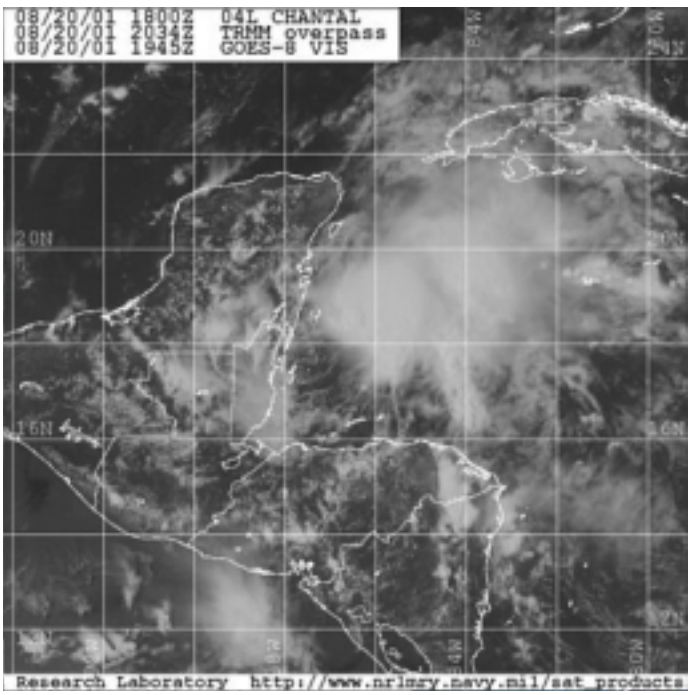
The structural changes of tropical cyclones upon interaction with vertical wind shear

E. A. Ritchie and R. L. Elsberry



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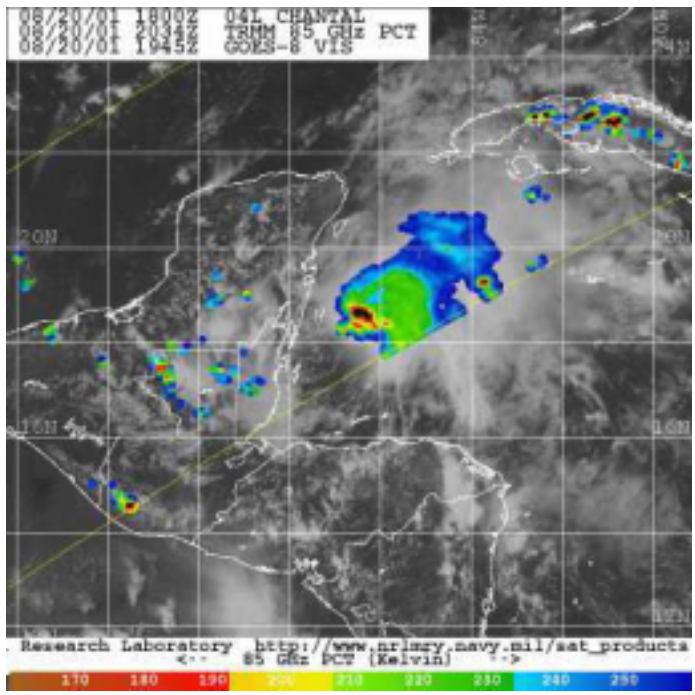


TRMM 85 GHz PCT 20/8/01 2034Z

A study sponsored by NASA CAMEX-4

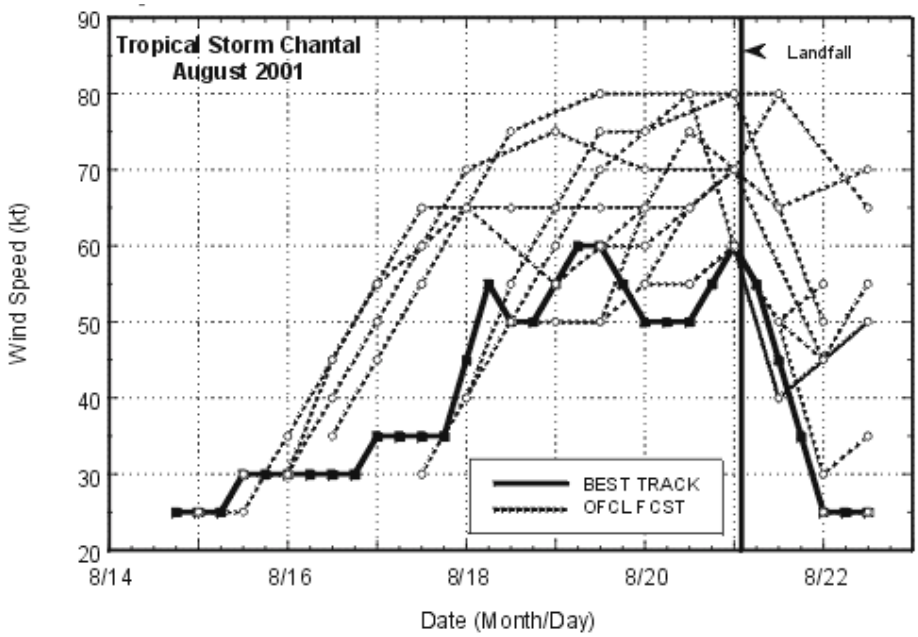


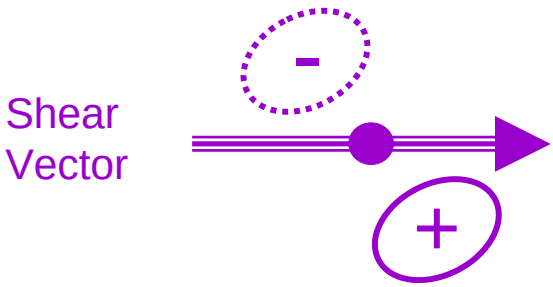
Figure 5: Selected (0000 and 1200 UTC) official intensity forecasts (dashed lines) for Tropical Storm Chantal, 14-22 Aug. 2001. The best track intensity is given by the thick solid line.

Acknowledgements: NHC 2001 Tropical Cyclone Report

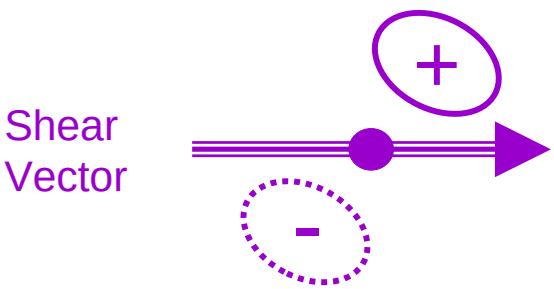
Background:- Idealized Modeling Studies

(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)



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

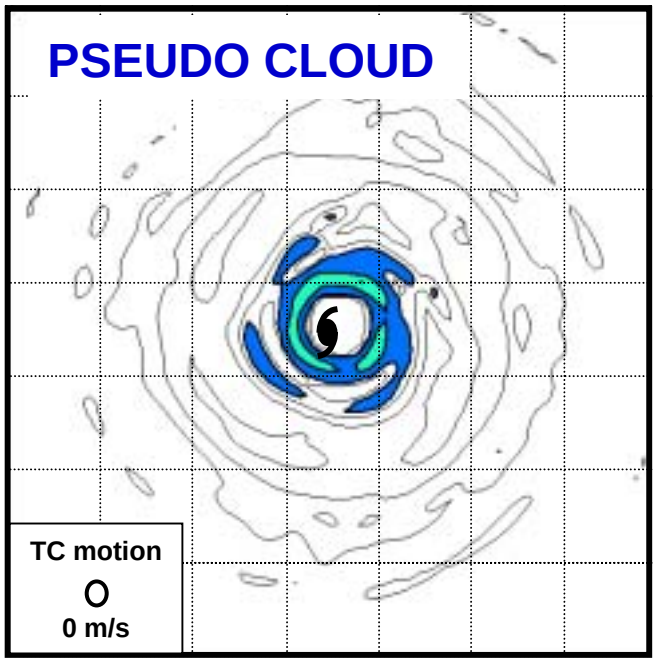


• Presume that convection is modulated by the areas of forced ascent/descent.

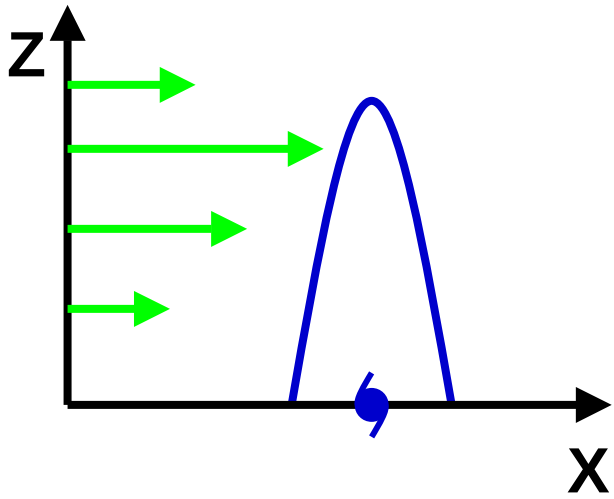
• Because the vertical shear environment forces a wave-number-one vertical motion pattern, a persistent convective asymmetry develops.

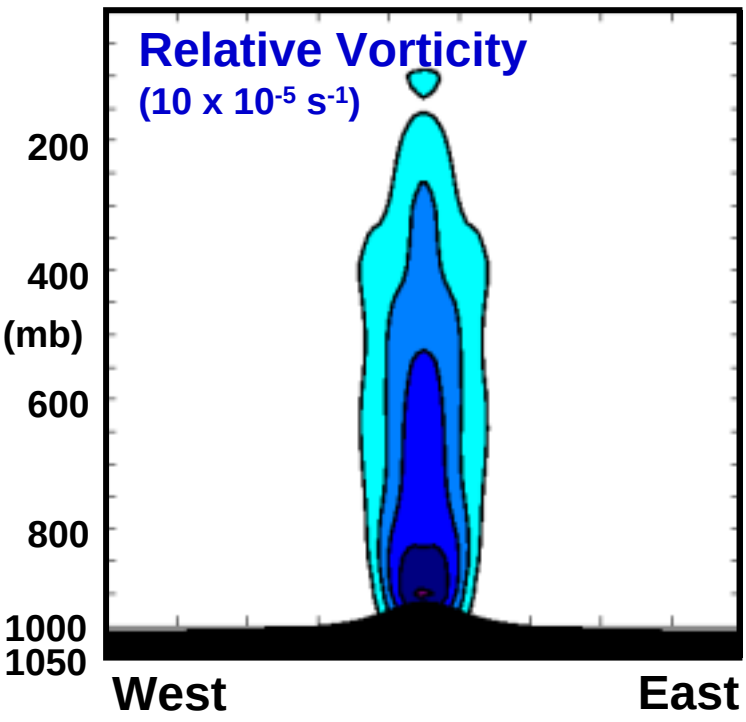
•Questions:-
• What effect does asymmetric convection have on the structure of a TC?
• How is the TC intensity affected by asymmetric convection?

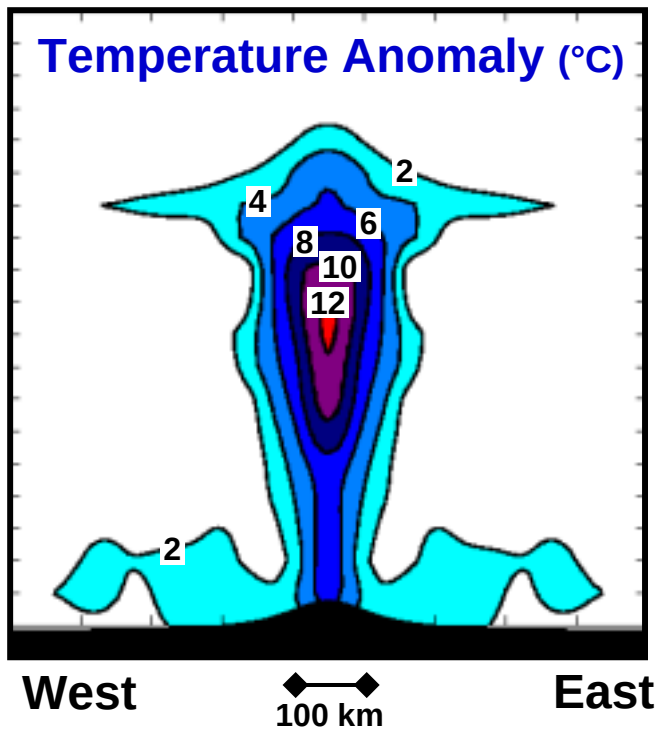
Initial symmetric TC structure



COAMPS
f plane
Strong 22 m/s

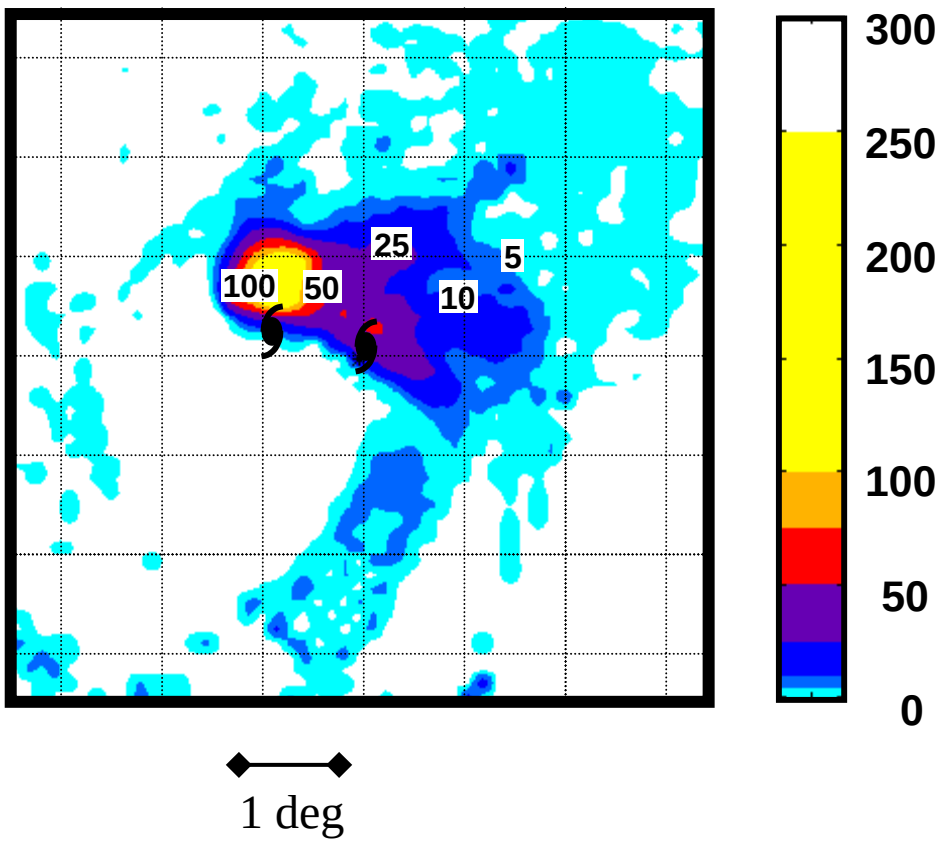




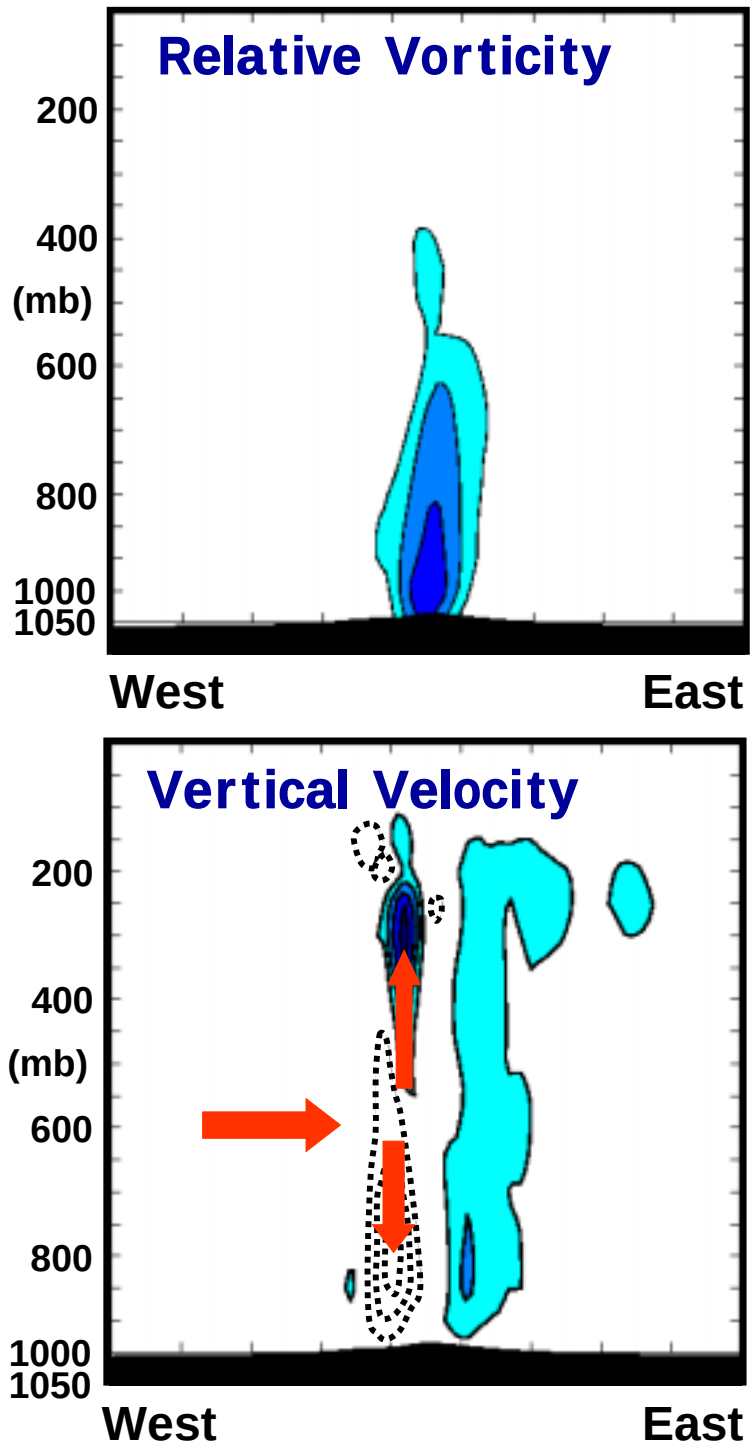


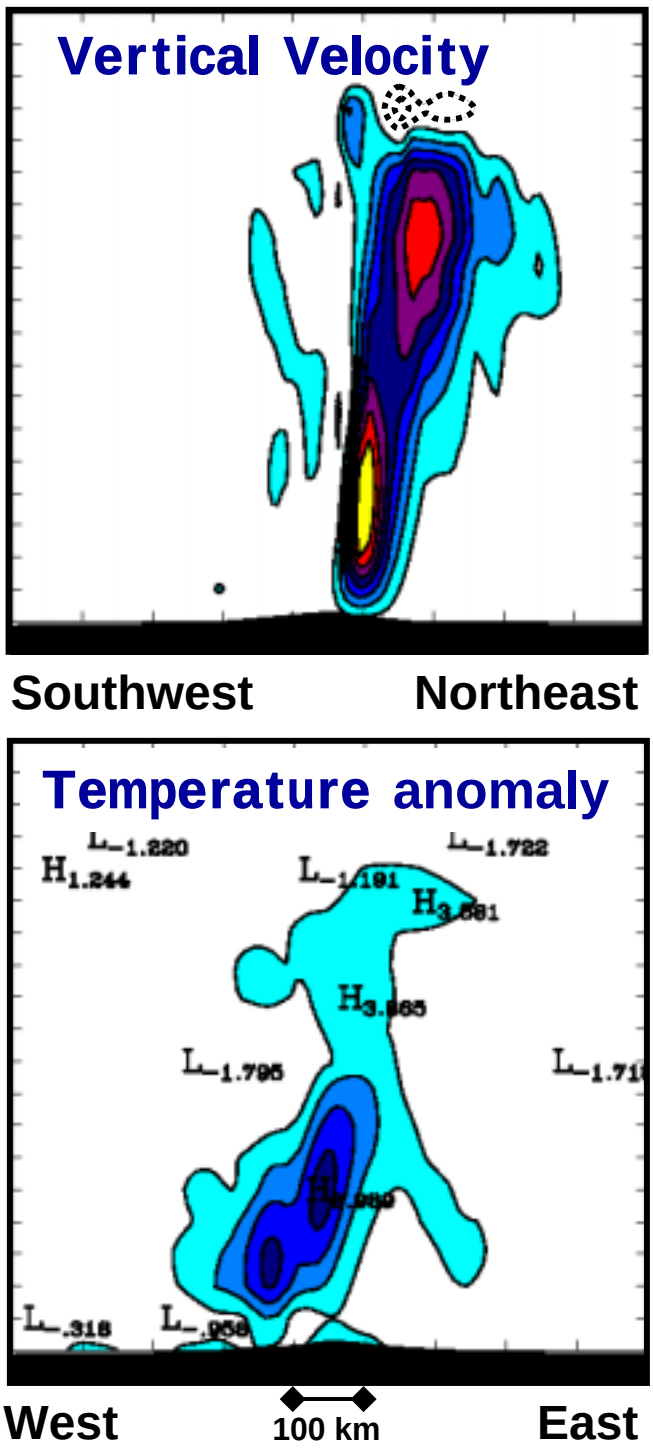
3-hourly Precipitation (12h-9h)

Strong Shear

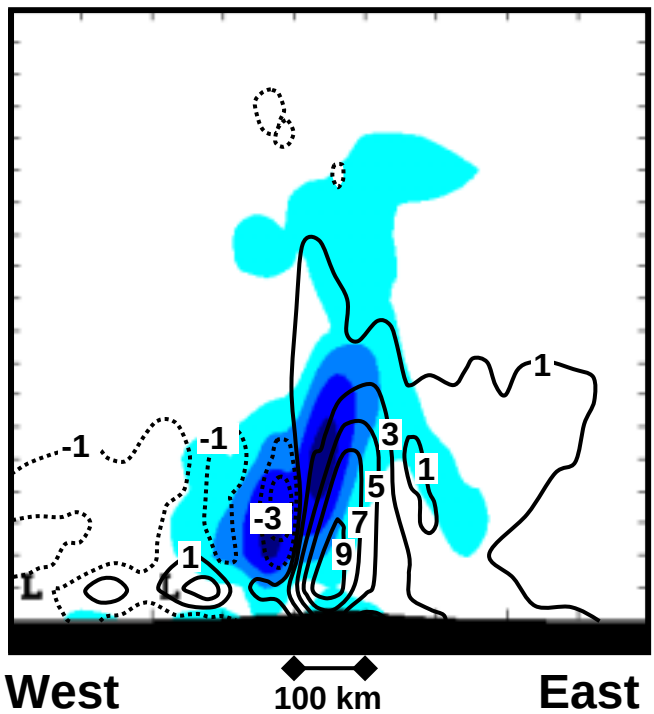


Strong Shear

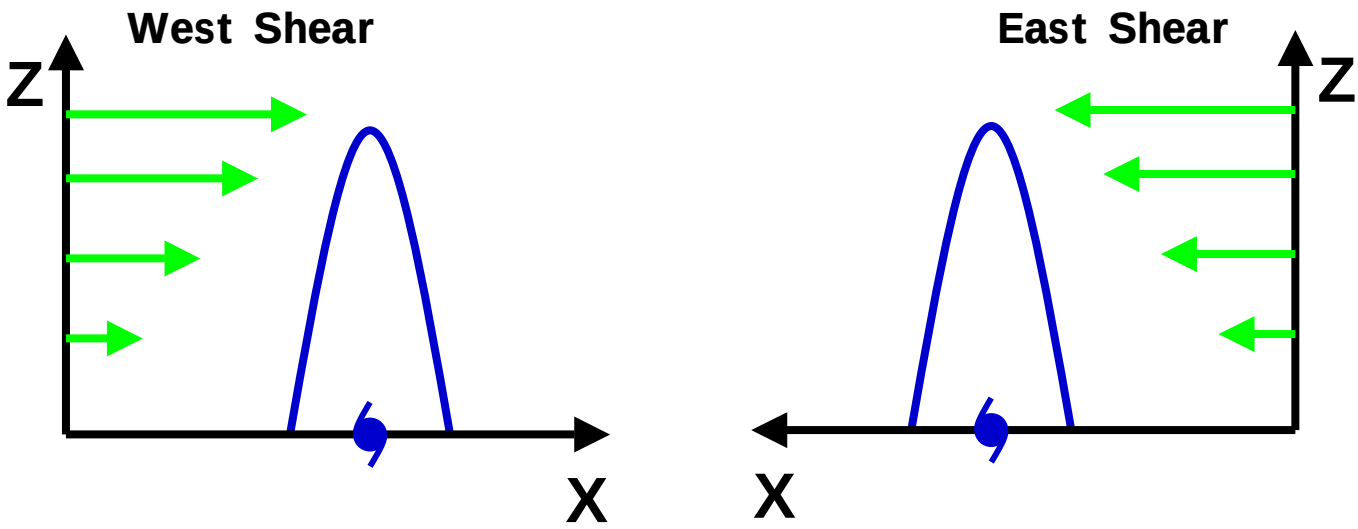


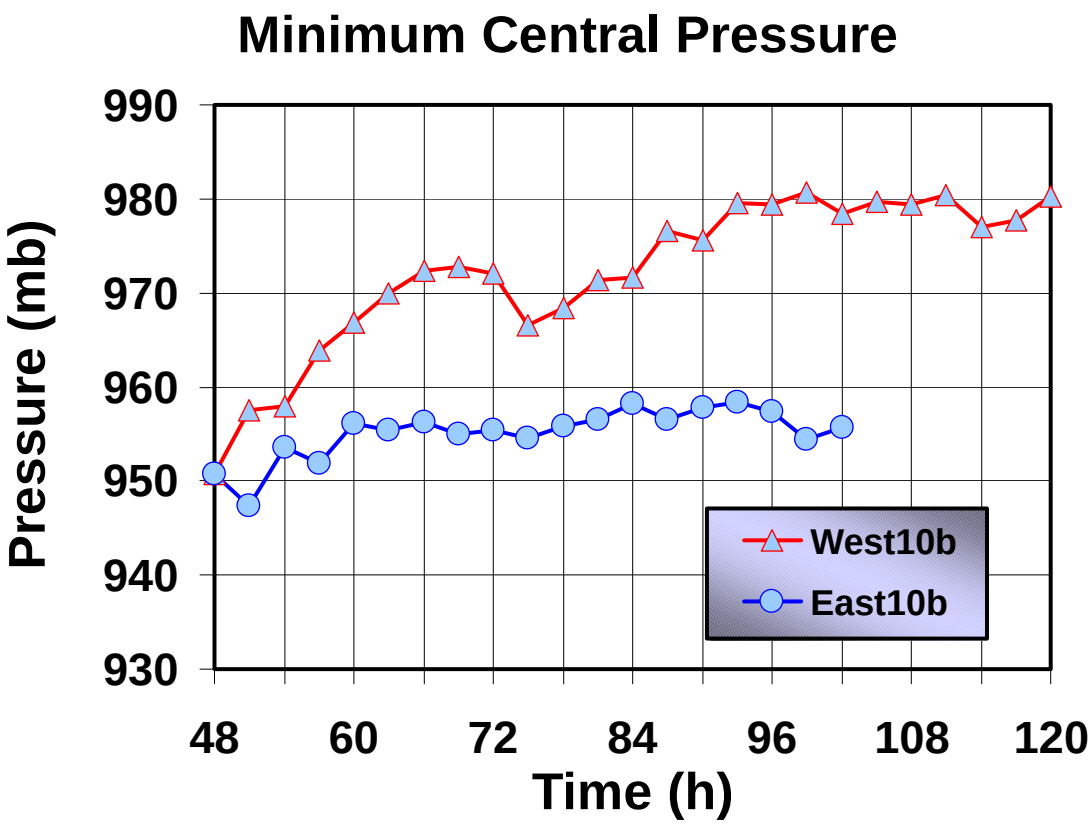


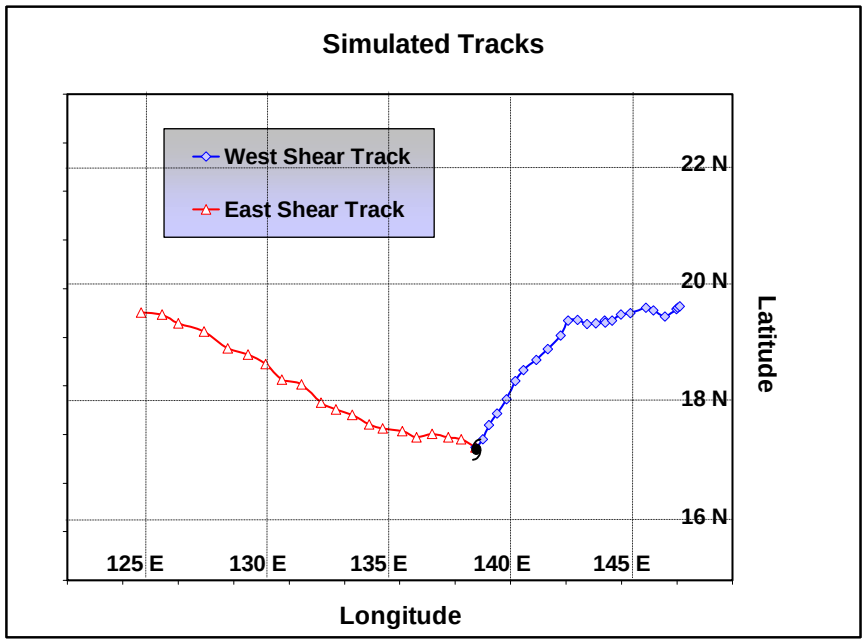
Temperature (K) & water vapor anomaly (g/kg)



MM5
β plane
10 m/s shear

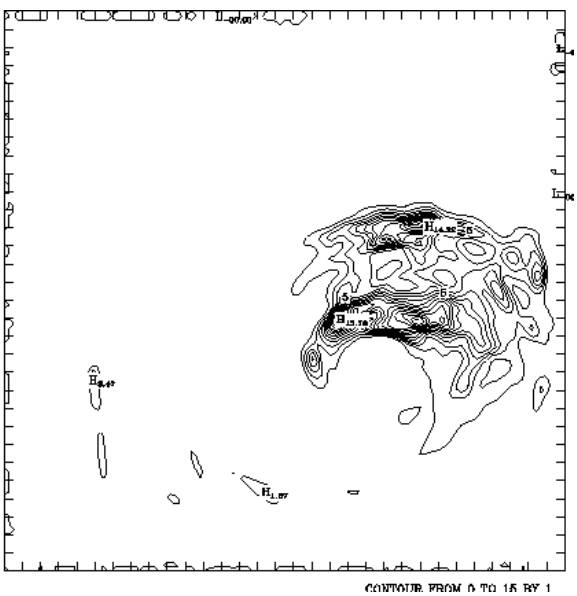




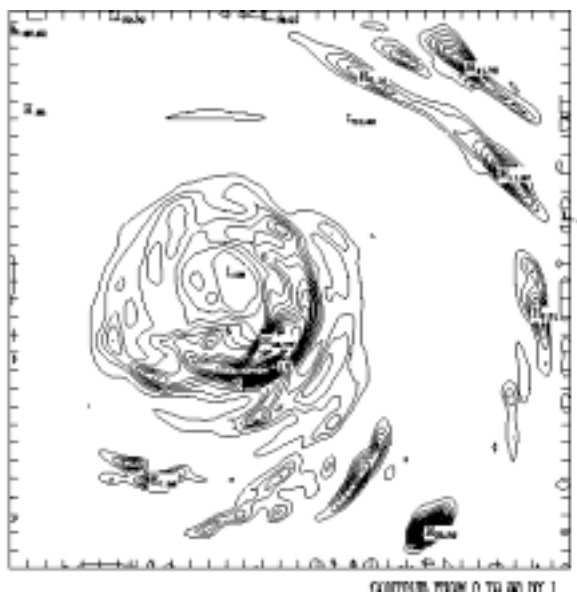


3-h precipitation

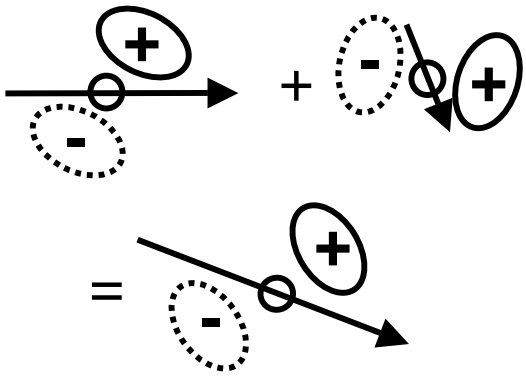
West 10 m/s **T = 87-84**



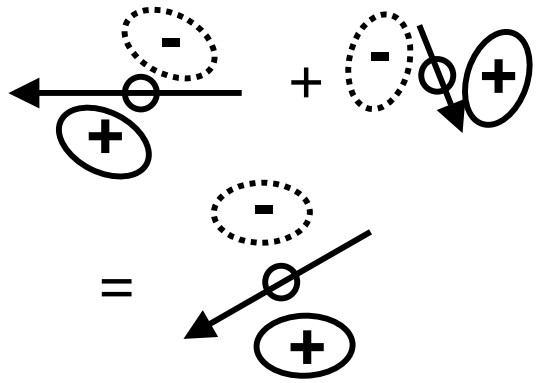
East 10 m/s **T = 87-84**



West 10 m/s



East 10 m/s

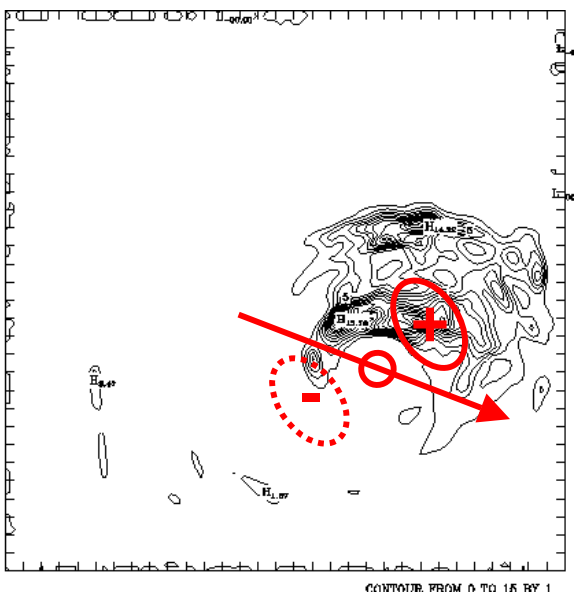


Motion Vector
4.4 m/s

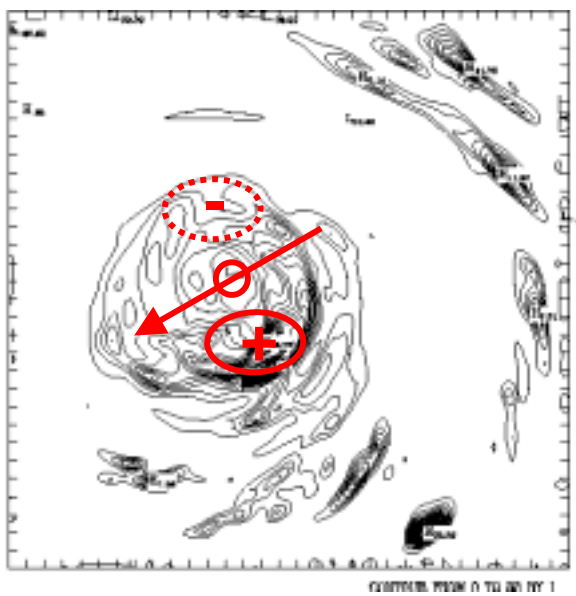
Motion Vector
6.5 m/s

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