Tropical Transition: The Genesis of Tropical Cyclones from Extratropical Disturbances

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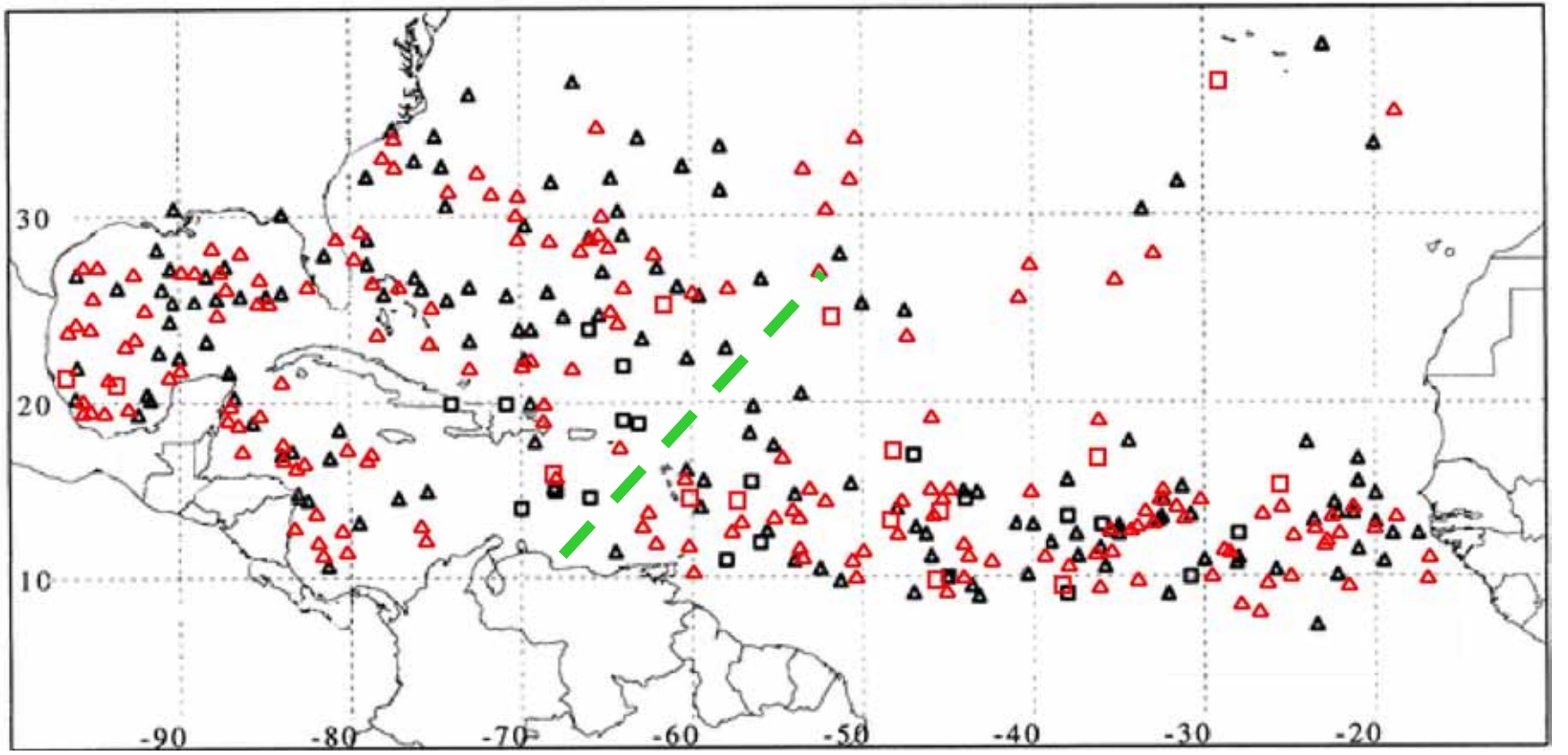
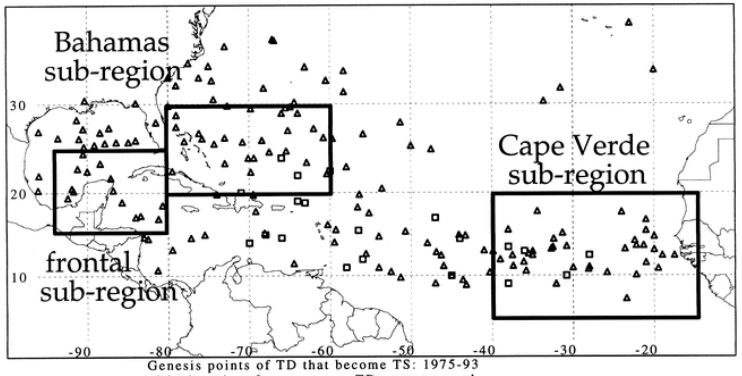
Atlantic Genesis (1975-2005)

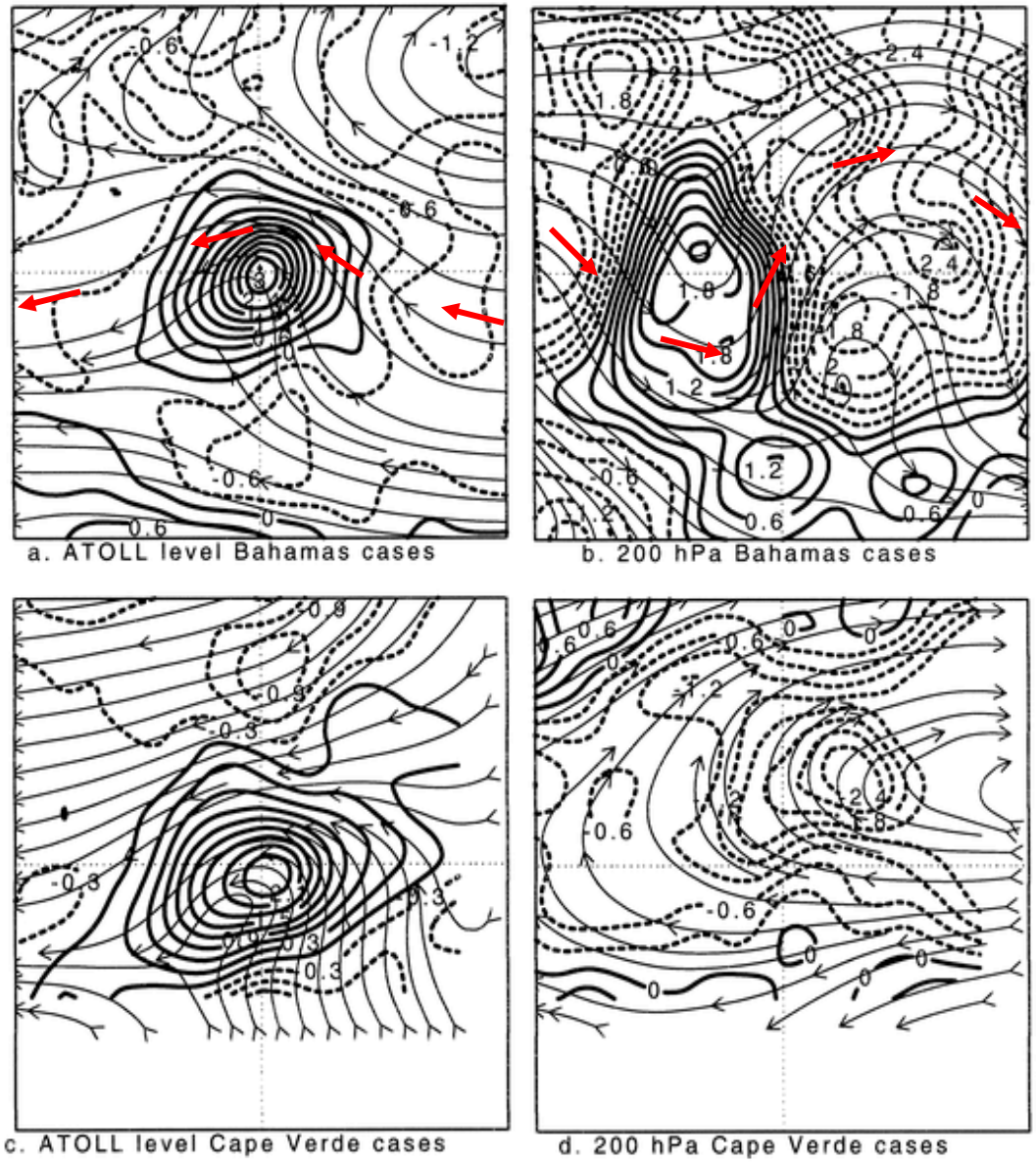


Black = 1975-1993
Red = 1994-2005

Bracken and Bosart (2000)
Monthly Weather Review



Genesis points of TD that become TS: 1975-93 and lysis points for overwater TDs equatorward of 25N for TDs that don't become TS: 1975-87


a. ATOLL level Bahamas cases
b. 200 hPa Bahamas cases
c. ATOLL level Cape Verde cases
d. 200 hPa Cape Verde cases

Shear exists in composite of developing depressions over Western Atlantic.

Tropical Transition

- Subtropical or Extra-tropical precursors
  - Cold-core upper tropospheric lows
  - Fronts
  - Mesoscale Convective Vortices
- Initially cold-core (vorticity maximizes at 700 hPa or above)
- May involve easterly waves
- Relies on finite vertical wind shear
  - Diabatic-baroclinic development (strong precursor)
  - Organization of convection (weak precursor)

Atlantic Tropical Transitions by Season

(defined as having non-tropical origin)

Year	TTs	Other
2000	4	9
2001	8	7
2002	9	3
2003	6	9
2004	5	10
2005	8	19
total	40	57

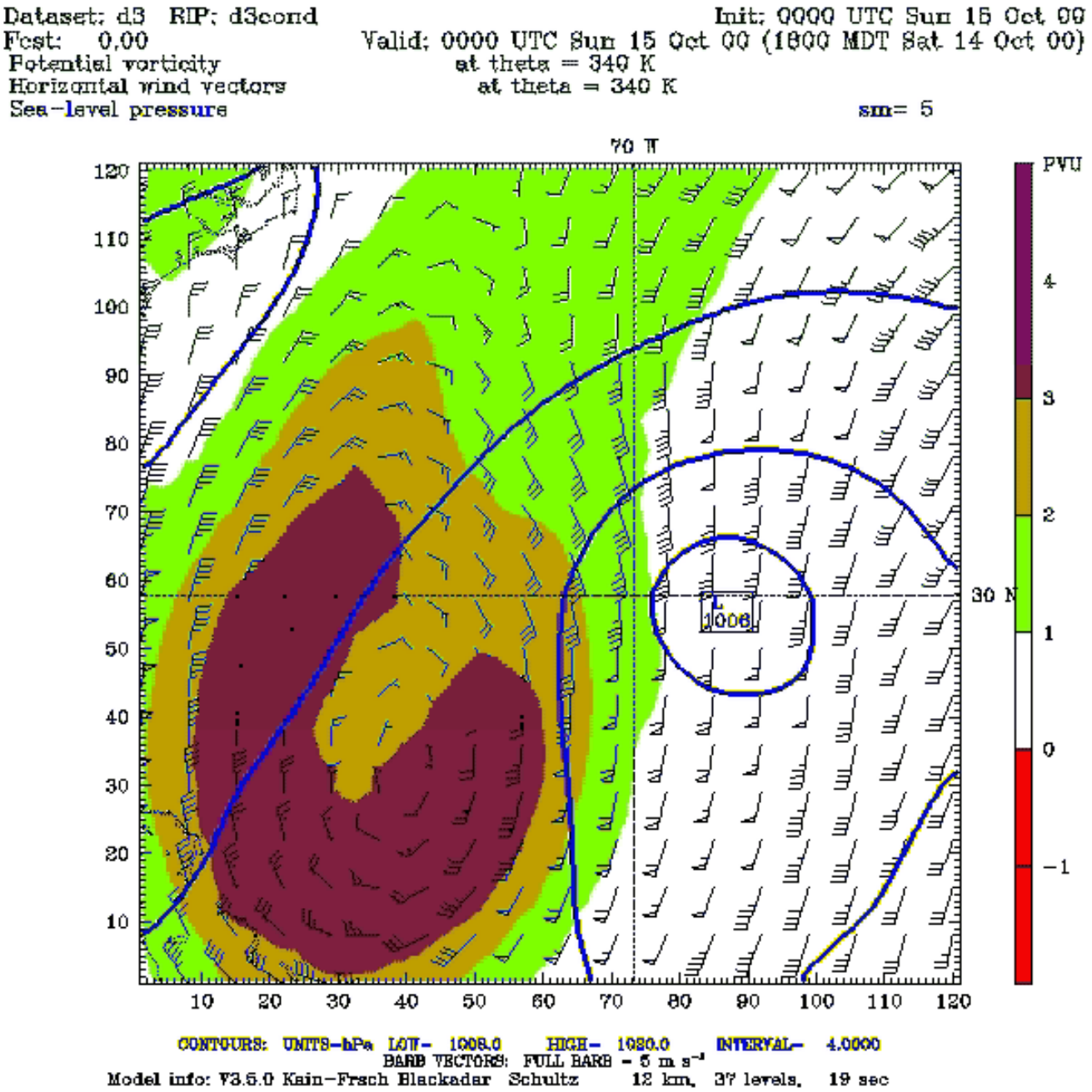
MM5 Simulation of Michael (2000)

Potential Vorticity (PVU) and Wind on 340 K q Sfc.

Sea-level Pressure

Start: 00 UTC 15 Oct. 2000

End: 00 UTC 17 Oct. 2000



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MM5 Simulation of Hurricane Michael (2000)

§Nested 12.3-km grid

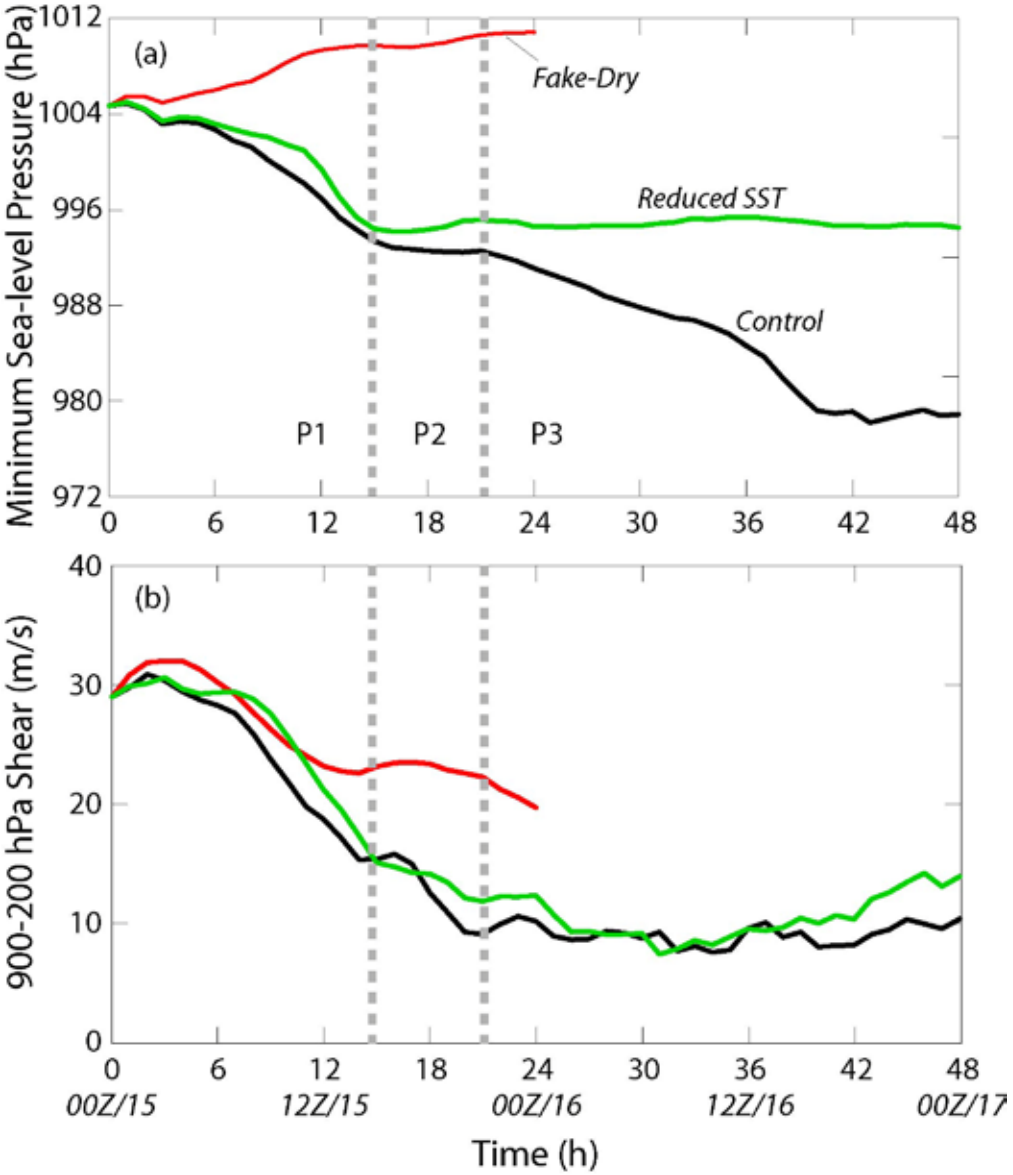
§Cold start from global analysis (NCEP)

§48-h integration

§Kain-Fritsch CP

§Blackadar PBL

§Schultz Cloud Physics



Davis and Bosart, 2003: Monthly Weather Review

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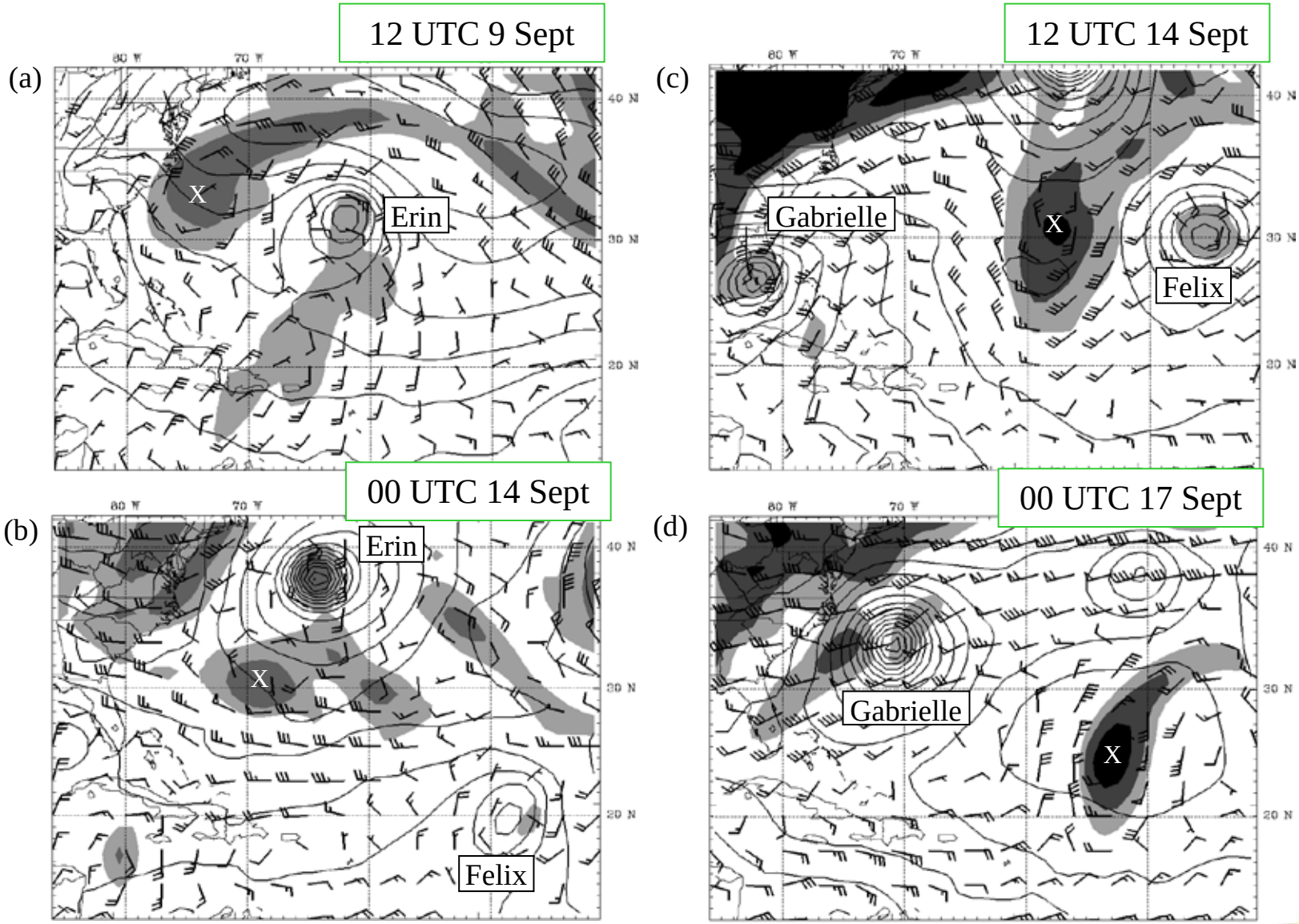
PV and Wind on 340 K Isentropic Surface



21 March, 2006

60th IHC

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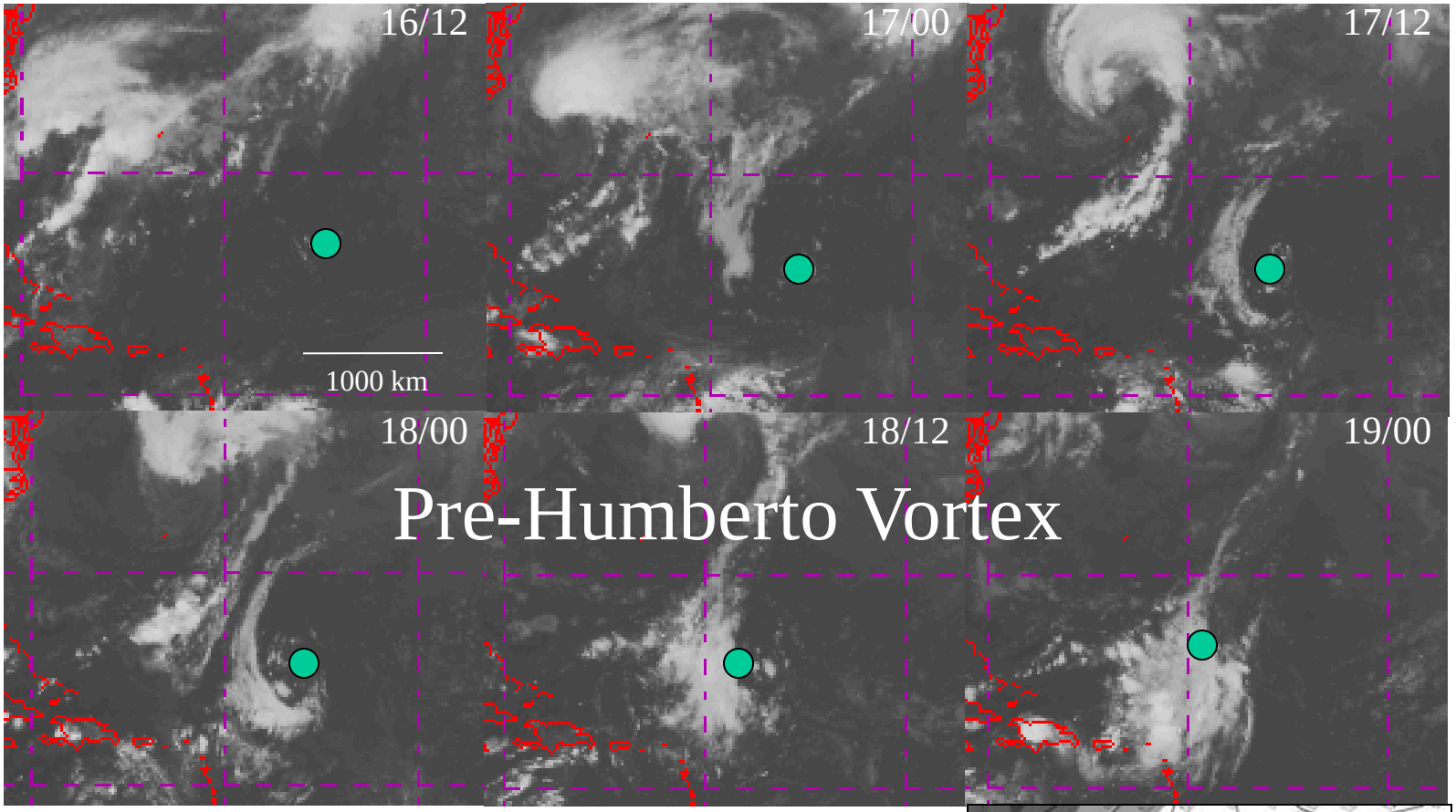
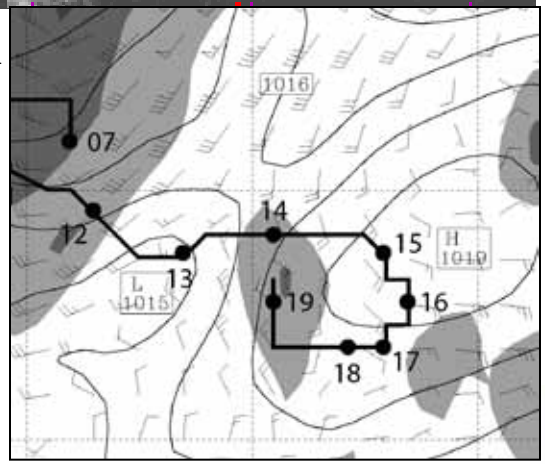


IR Satellite Images 12Z 16 Sept. to 00Z 19 Sept. 2001

Vortex centroid location on 340 K sfc.

Images obtained from
http://weather.unisys.com/archive/sat_ir/



340 K PV at
00 UTC 19
Sept.

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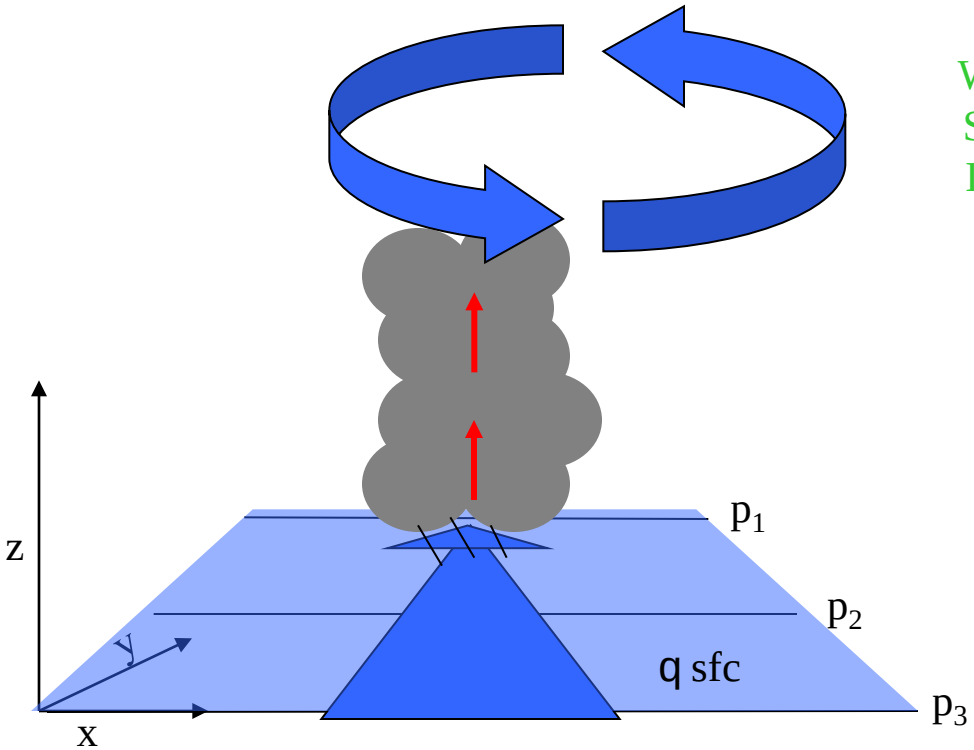
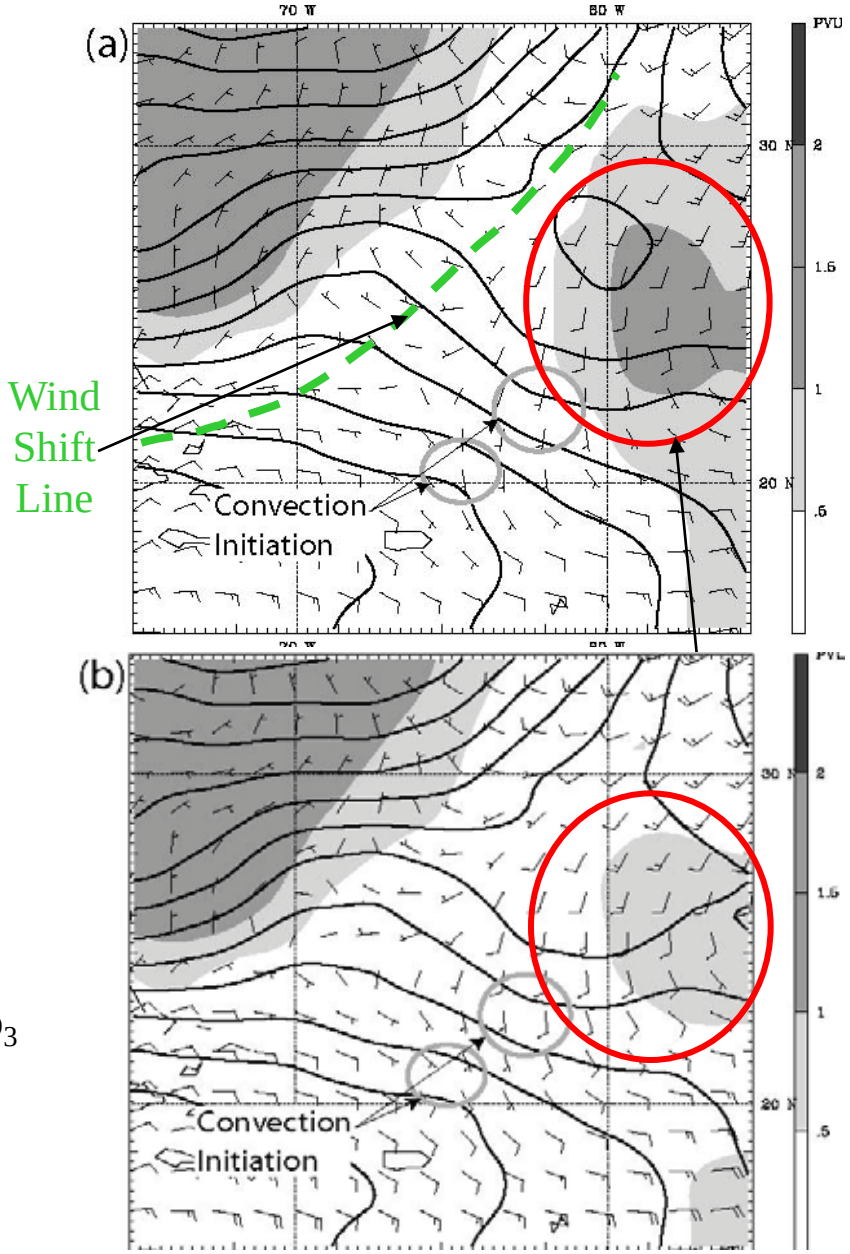
Modification of Wind Profile



Control



"Weak" PV

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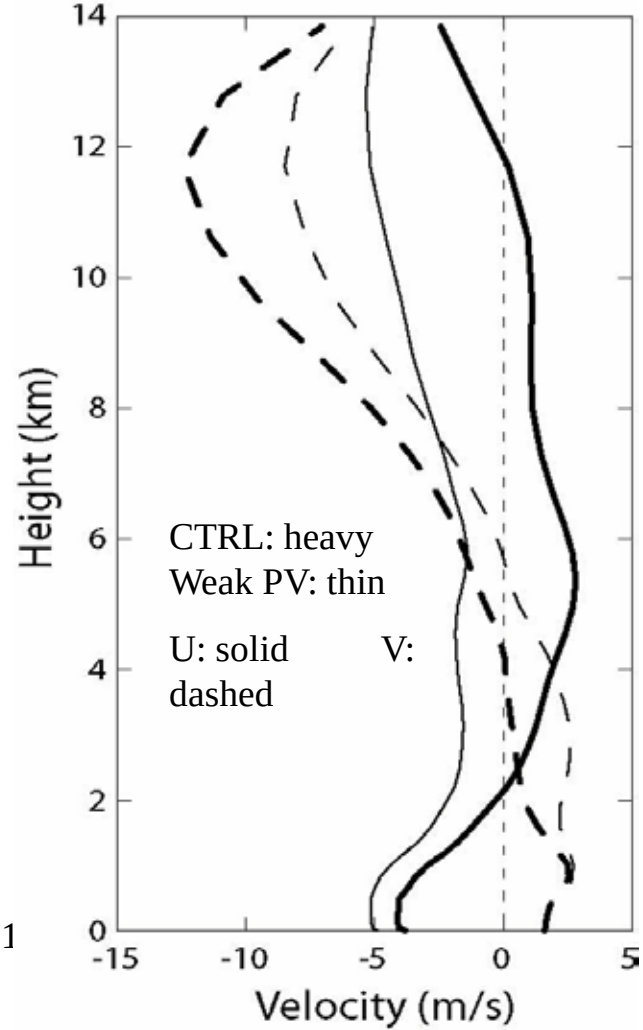
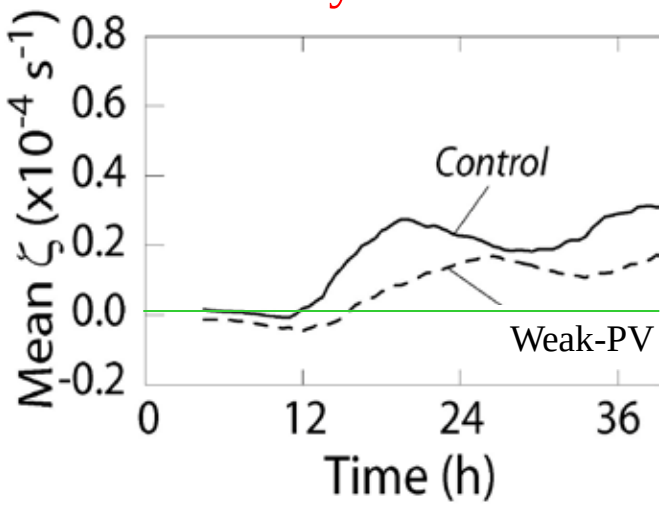
Slower Development Without Shear

CTRL simulation is initialized with more shear on flank of upper-tropospheric cold low



Wind Profiles prior to convection

Vorticity time-series

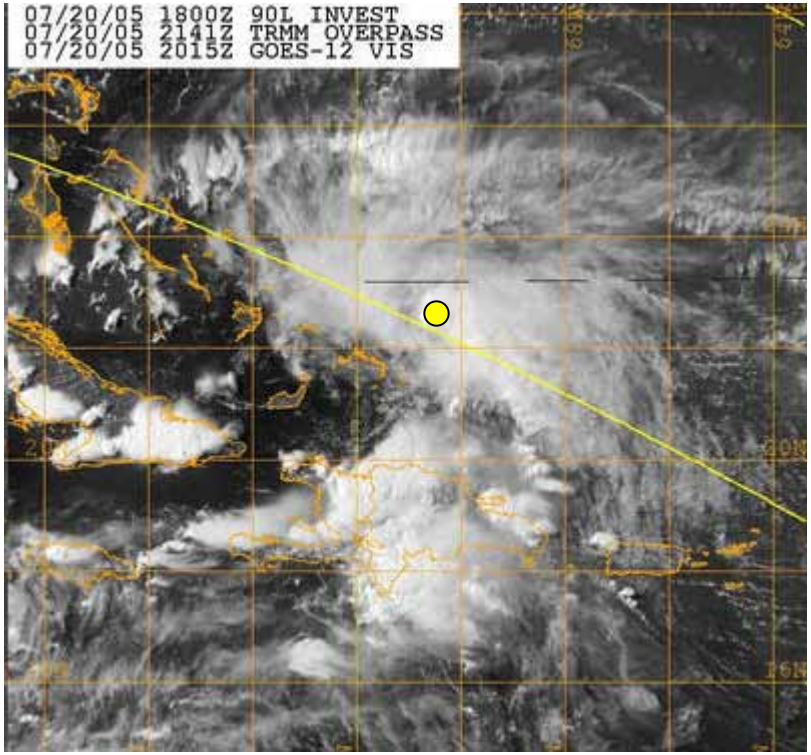


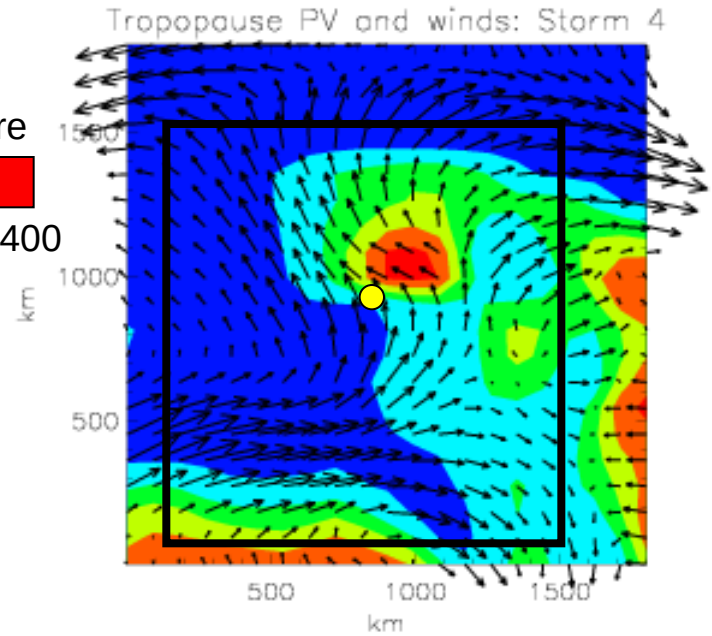
What About 2005?

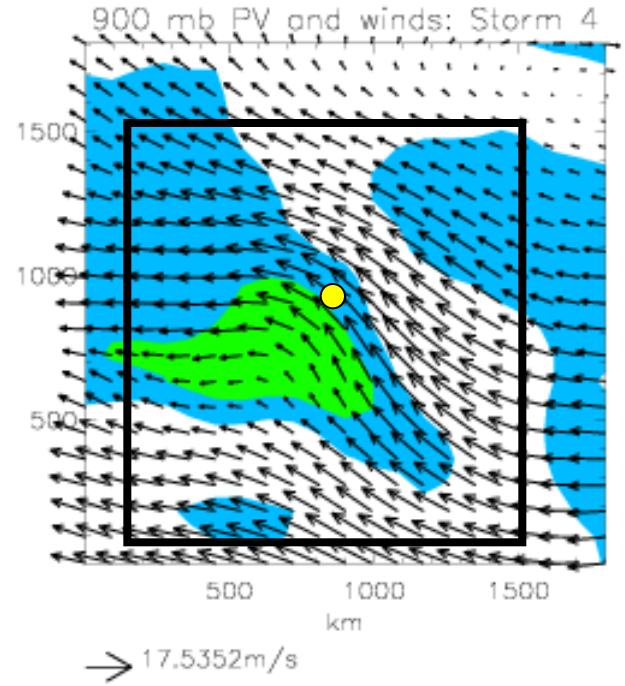
Franklin

Tropopause Potential Temperature

320 330 340 350 360 370 380 390 400







900 hPa Potential Vorticity (PVU)

-0.25 0.0 0.25 0.5 1.0 1.5 2.0

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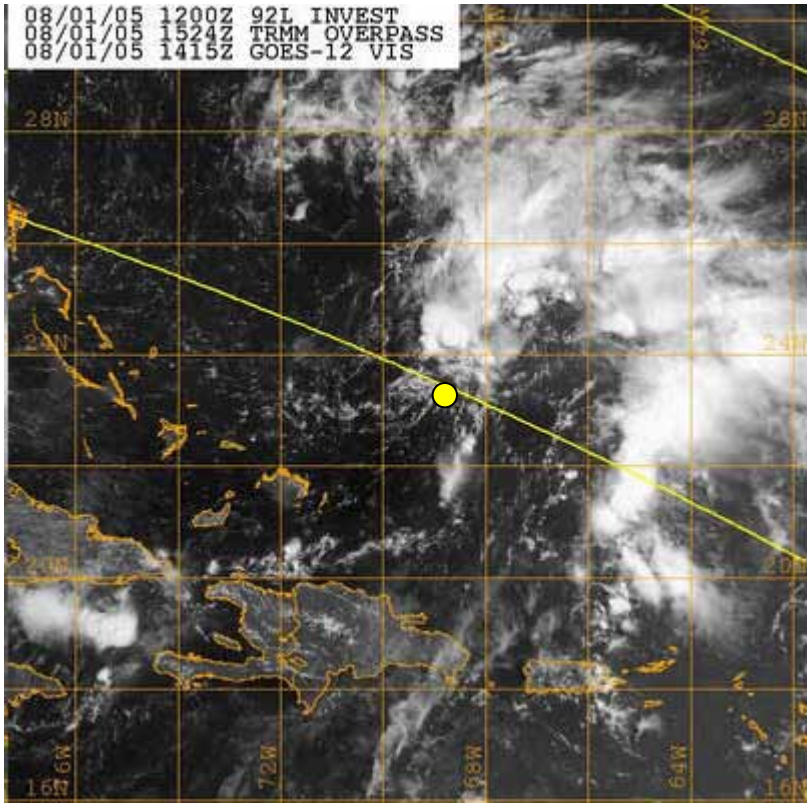
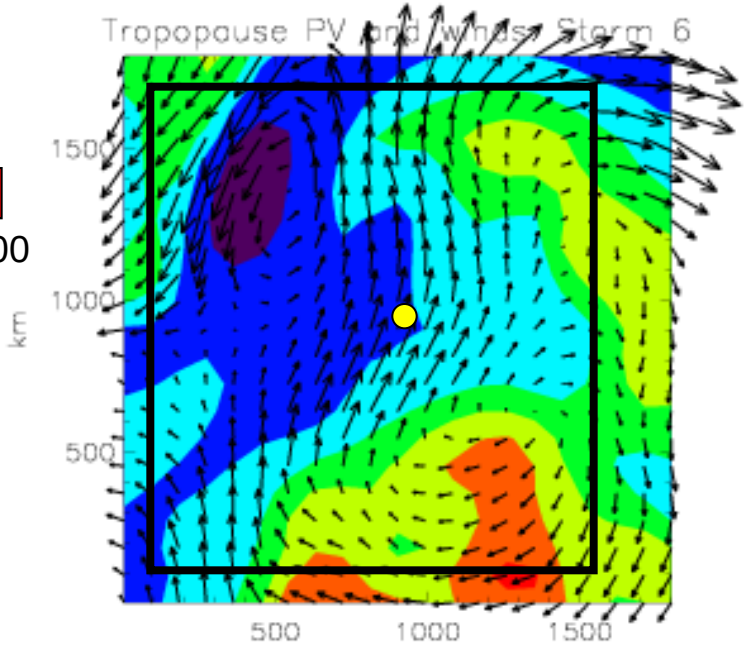
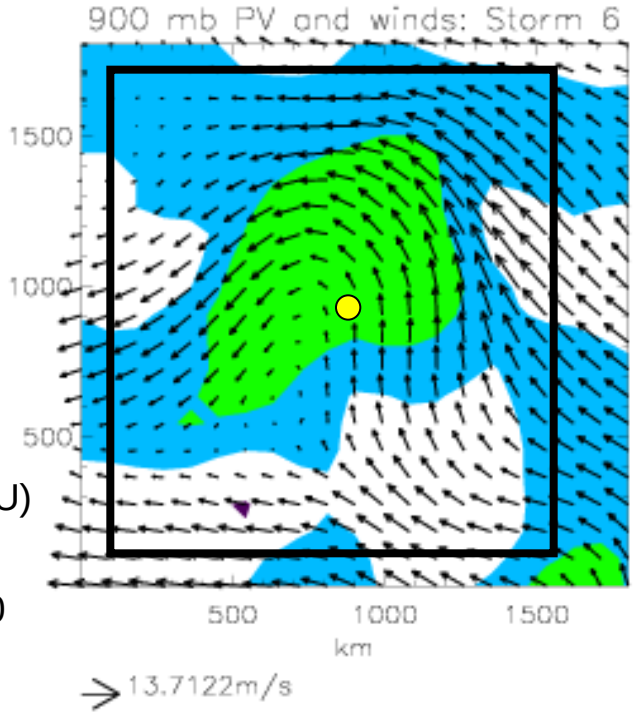
Harvey

Tropopause Potential Temperature

320 330 340 350 360 370 380 390 400







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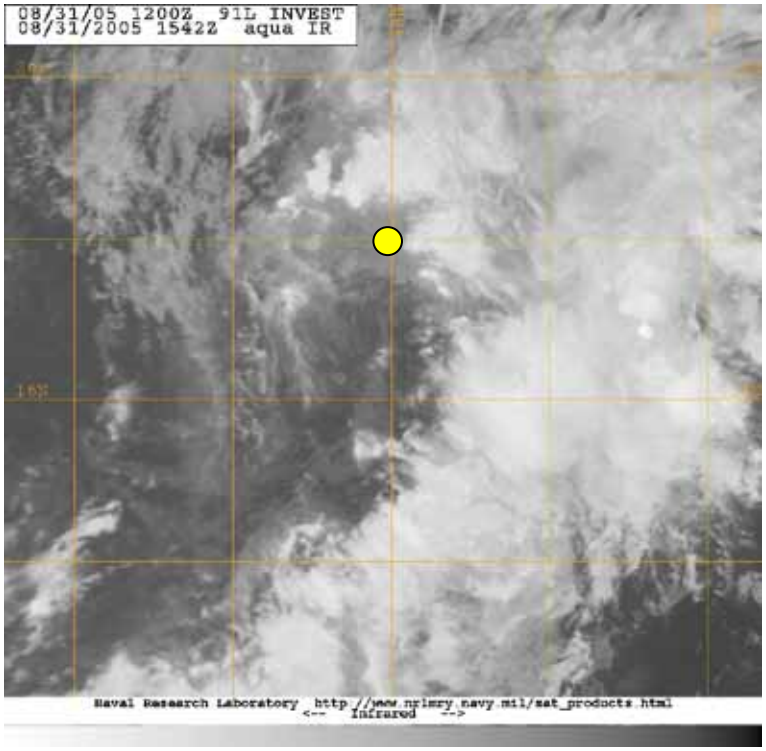
Maria

Tropopause Potential Temperature

320 330 340 350 360 370 380 390 400



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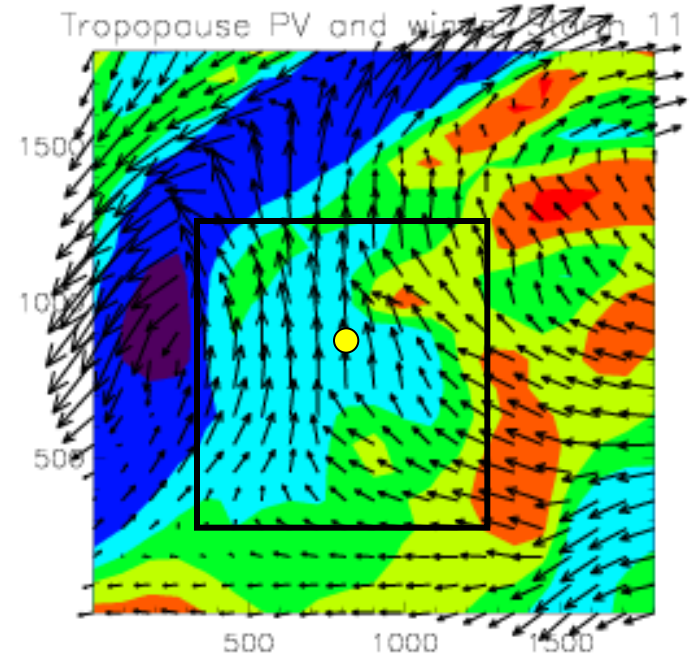

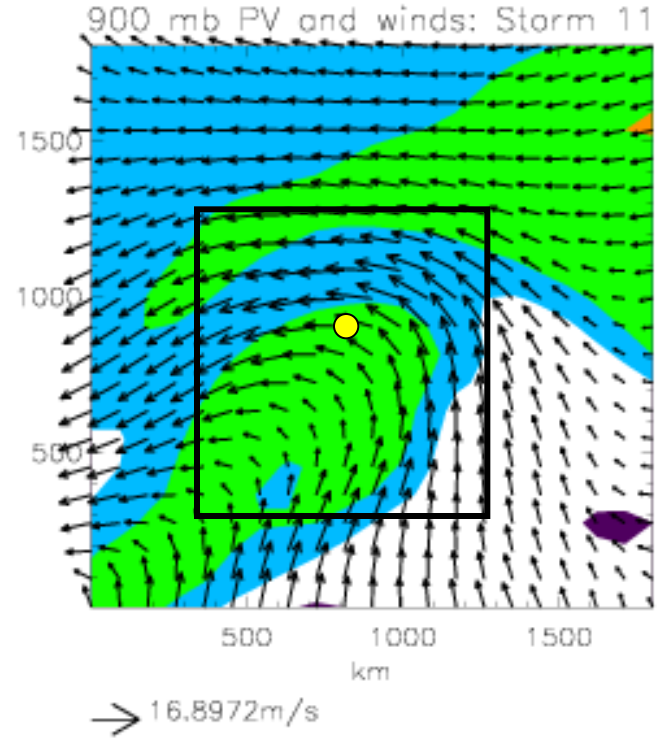

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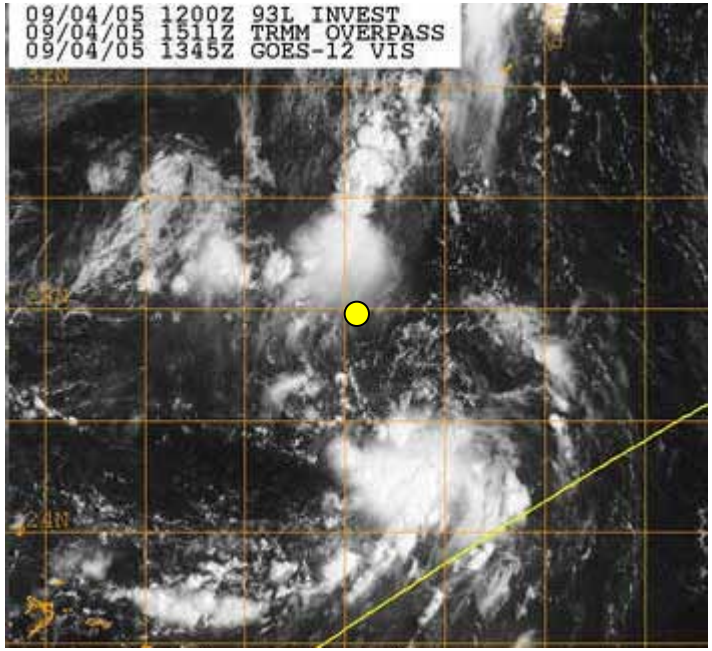
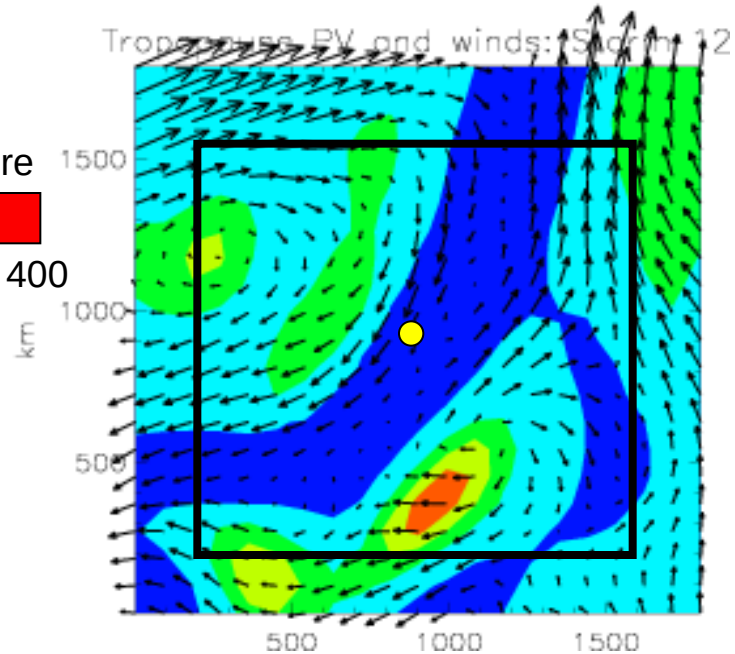
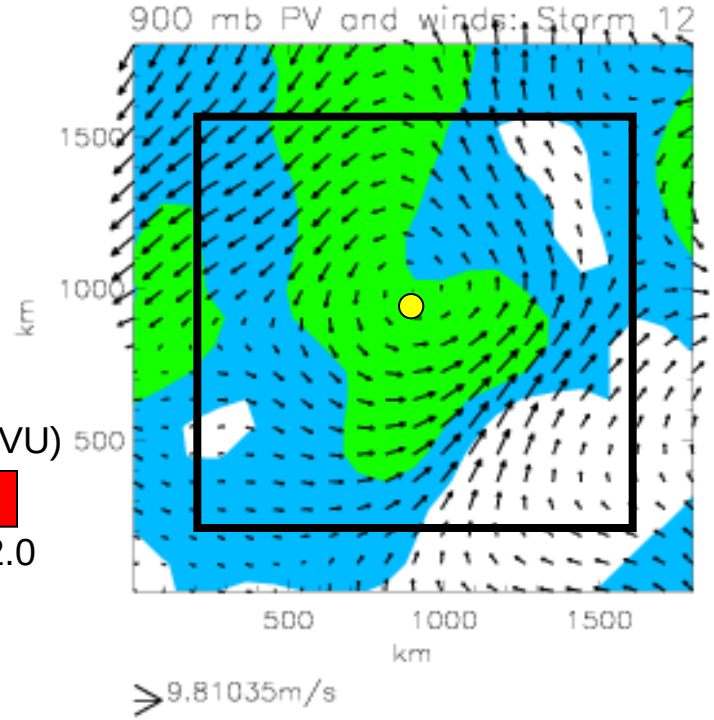
Nate

Tropopause Potential Temperature

320 330 340 350 360 370 380 390 400







900 hPa Potential Vorticity (PVU)

-0.25 0.0 0.25 0.5 1.0 1.5 2.0

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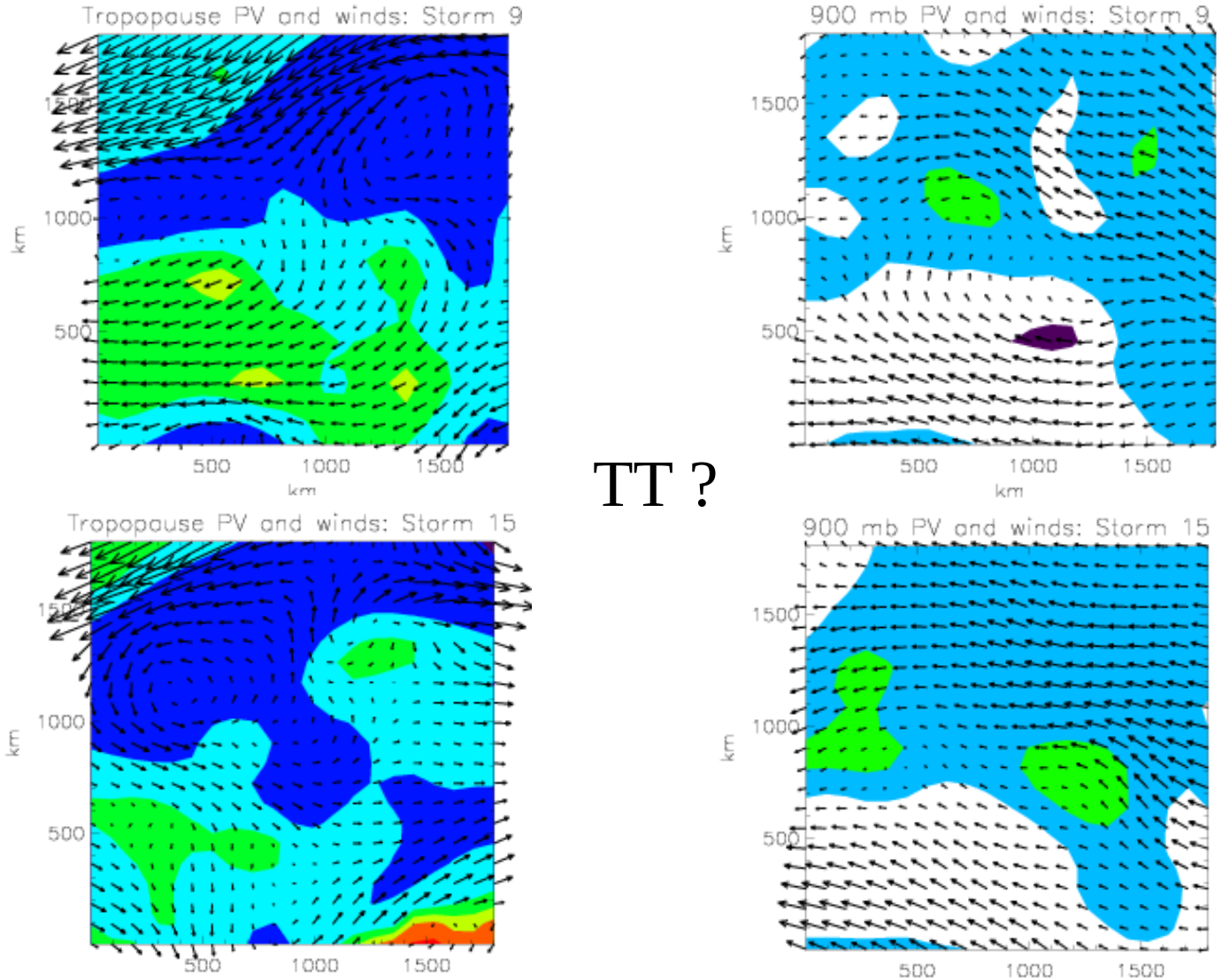
Katrina

Rita



TT ?

Tropopause Potential Temperature

320 330 340 350 360 370 380 390 400

900 hPa Potential Vorticity (PVU)

-0.25 0.0 0.25 0.5 1.0 1.5 2.0

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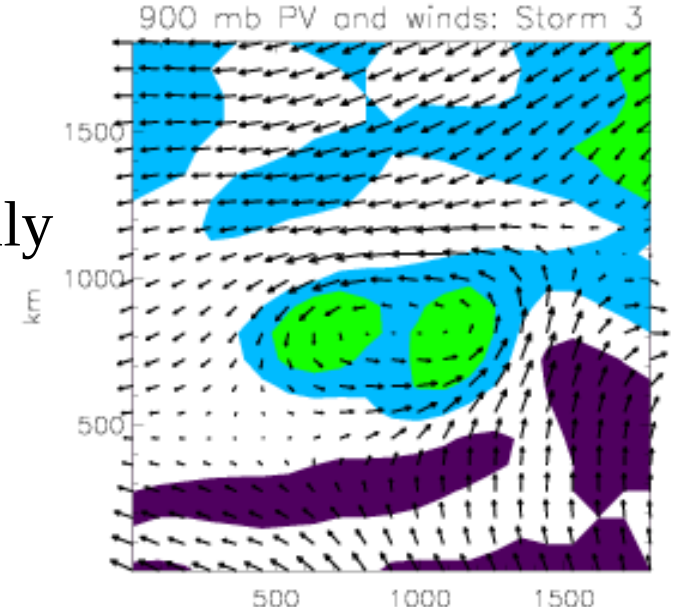
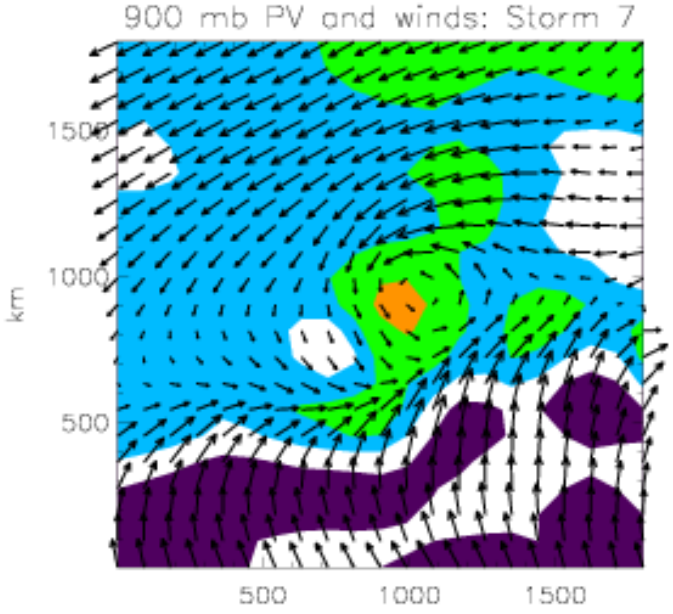
Emily

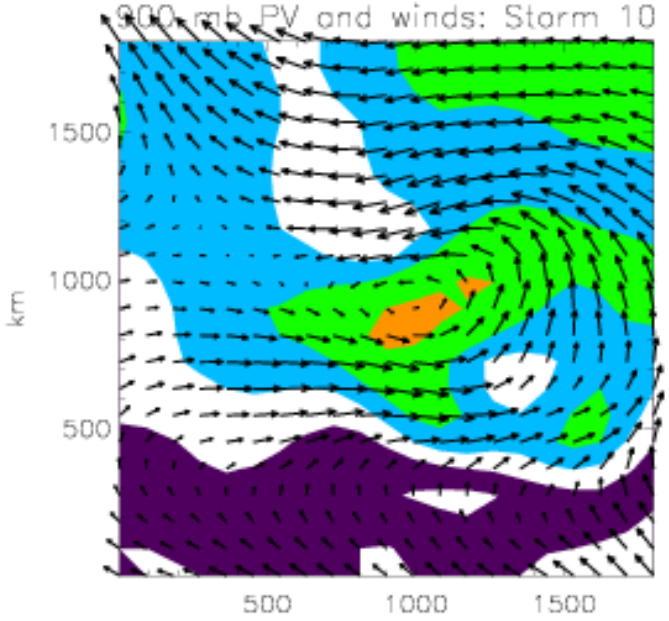


Irene

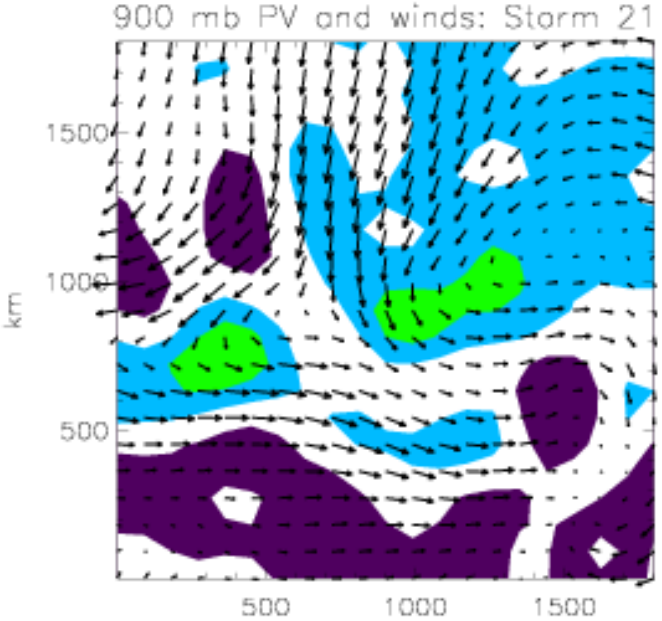


I T C Z ?

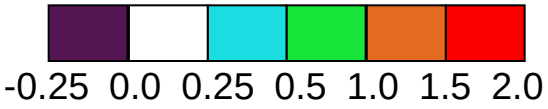
Lee



Beta



900 hPa Potential Vorticity (PVU)



21 March, 2006

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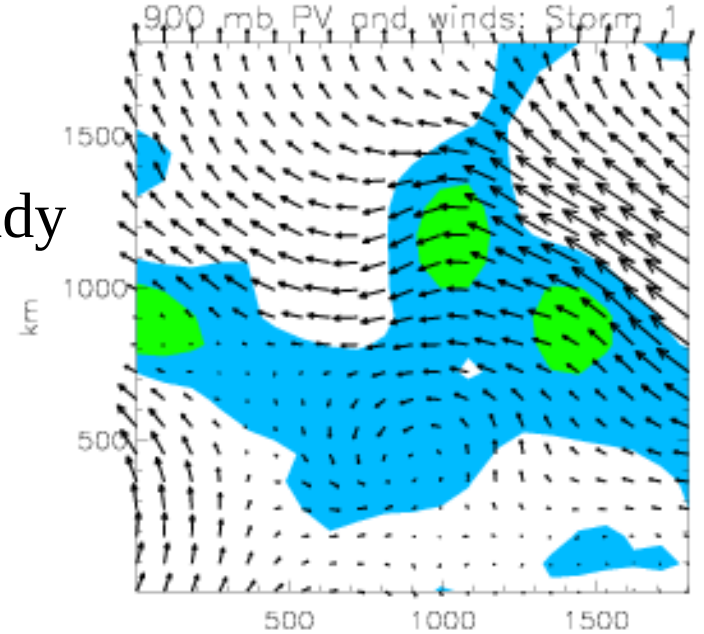
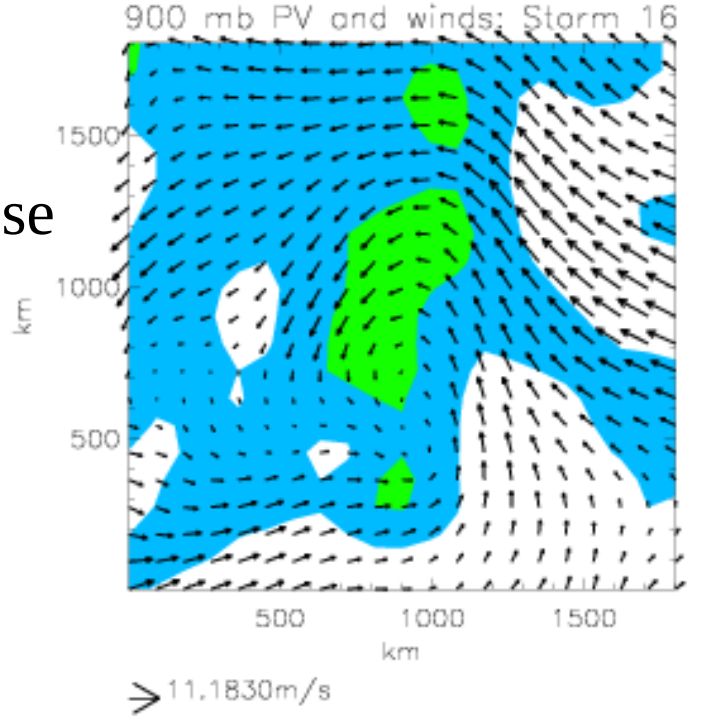
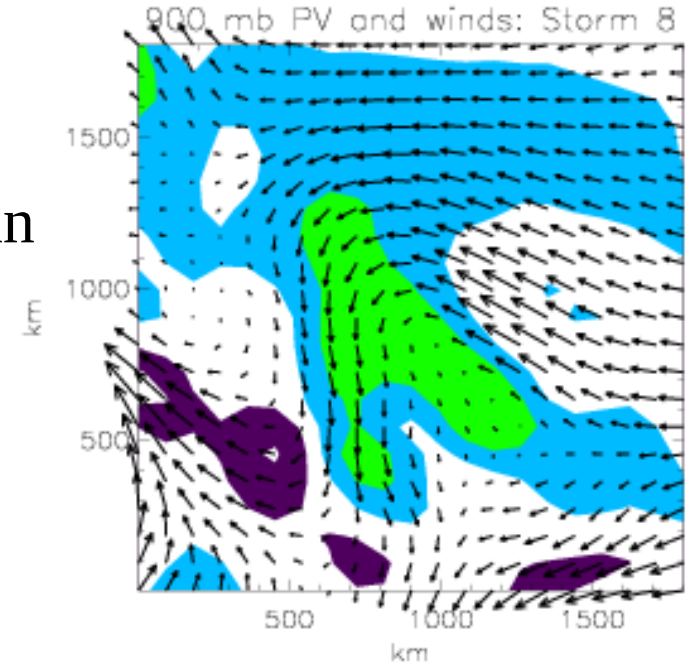
Cindy



Jose



Stan



Wave Accumulation?

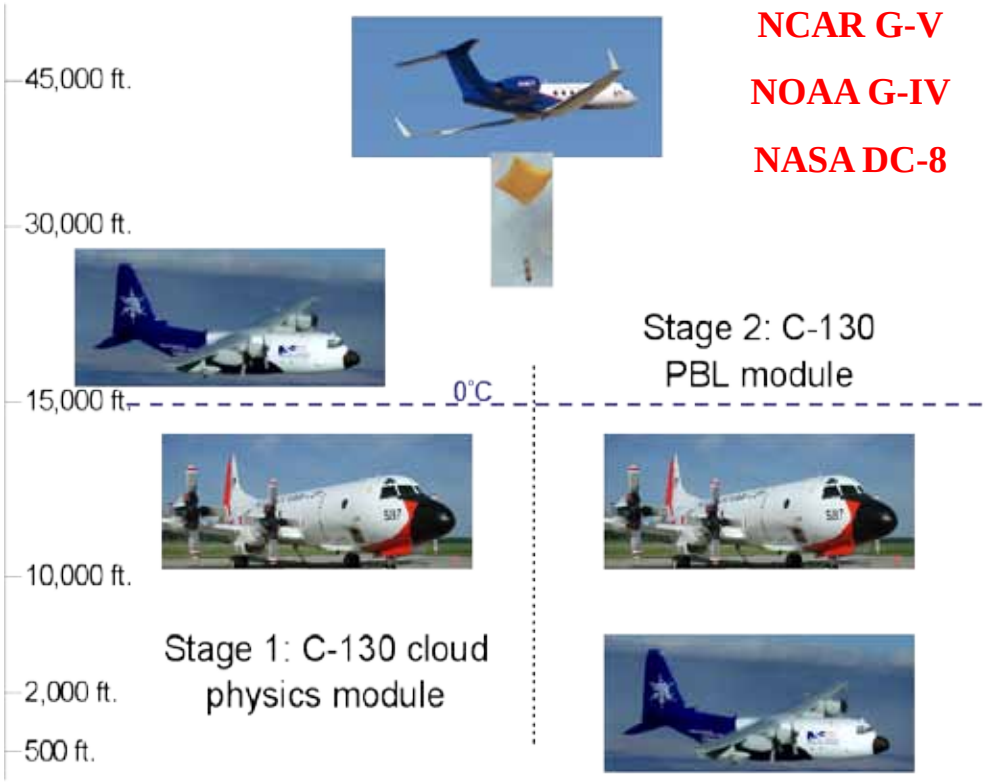
$dU/dx < 0$

Western Atlantic Genesis Issues

- Large-scale influences (waves, troughs)
- Mesoscale (MCSs, MCVs, fronts)
- Convective scale (convective bursts, VHTs)
- Numerical prediction capability
- Critical observations?

WATTAGE

Western Atlantic Tropical Transition and Genesis Experiment (2008)



NCAR G-V

NOAA G-IV

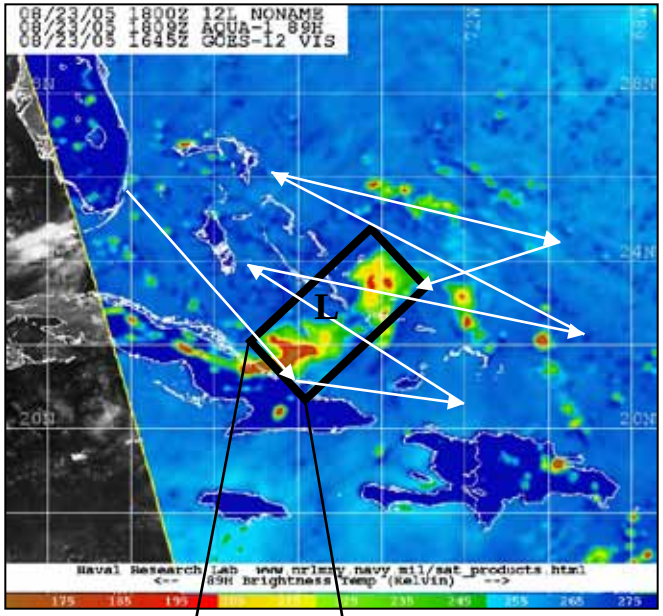
NASA DC-8

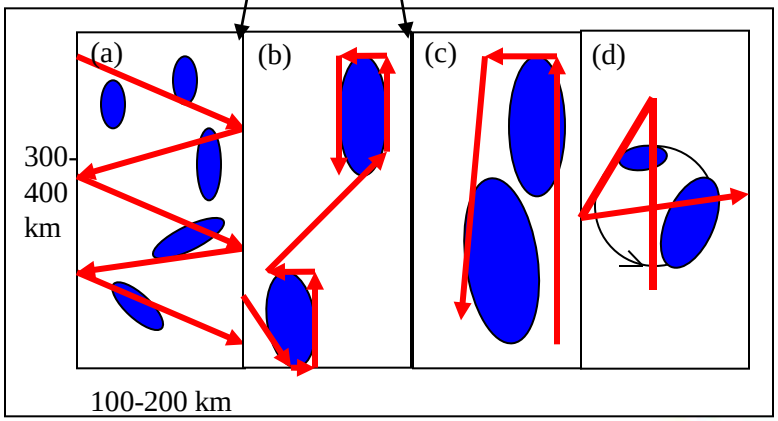
NCAR C-130

NRL P-3

NOAA P-3

UAVs





Conclusions

Key Points about Tropical Transition

§Vertical shear organizes convection => vorticity production

§Convection decreases shear => warm core formation

§TT can occur with easterly waves: issue is shear => upper trough, lower tropospheric mesoscale ascent

General Points

§Broad spectrum of genesis mechanisms, strong hints apparent in analyses

- §*Wave genesis*
- §*TT*
- §*ITCZ*

§Multi-scale observations crucial for sorting out genesis mechanisms and improving prediction