A WRF Simulation of the Asymmetric Rapid Intensification and Trough Interaction of Tropical Storm Gabrielle (2001)

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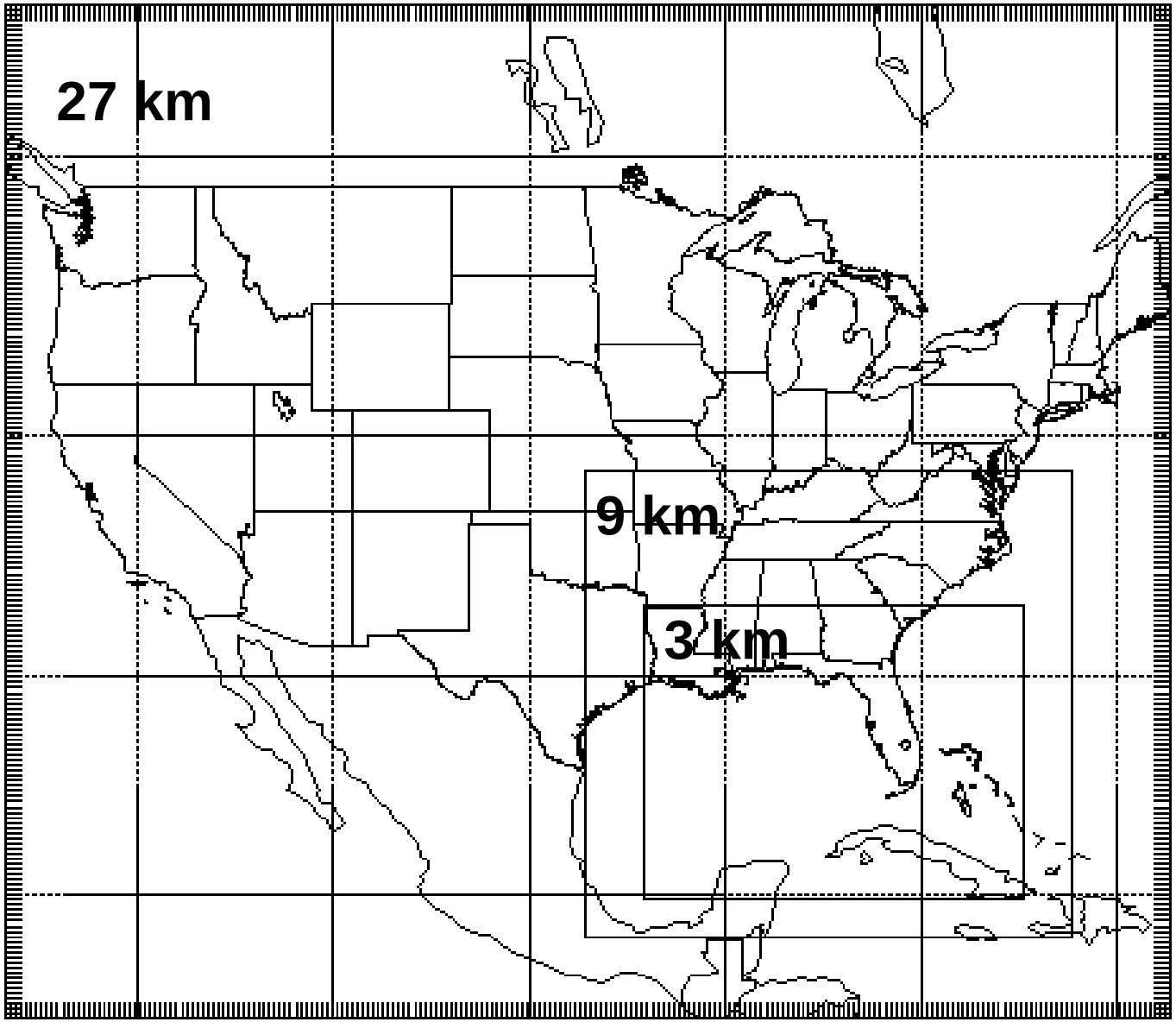
Motivation

- Rapid Intensification
  - 20 hPa fall < 3 hrs
  - High shear – 13 ms^{-1}
    - Asymmetric
- Upper tropospheric trough interaction
- Convective Cell
  - DSL

Goals

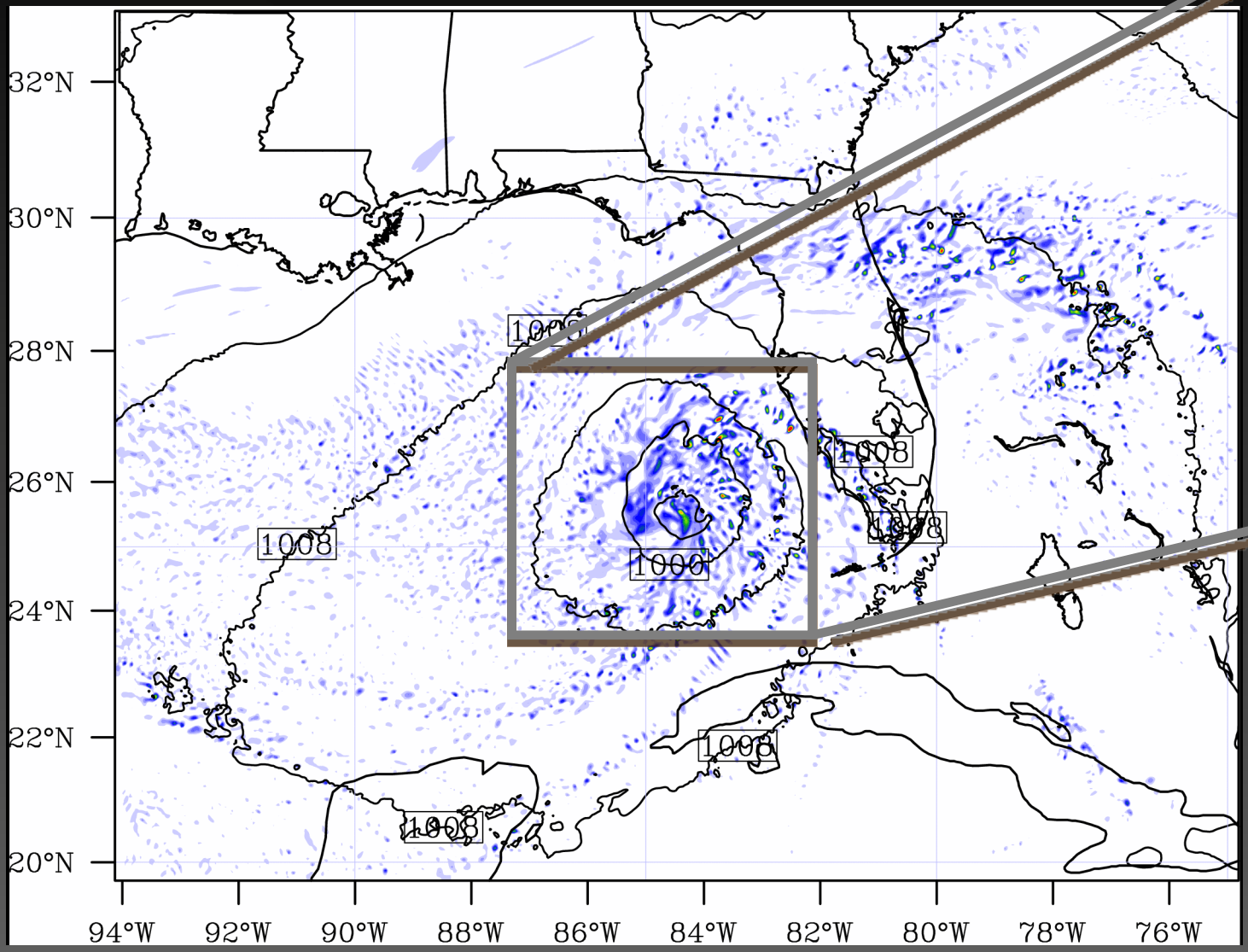
- Evaluate model
  - Reproduce intensification
- GFS Initial State
  - 1 deg

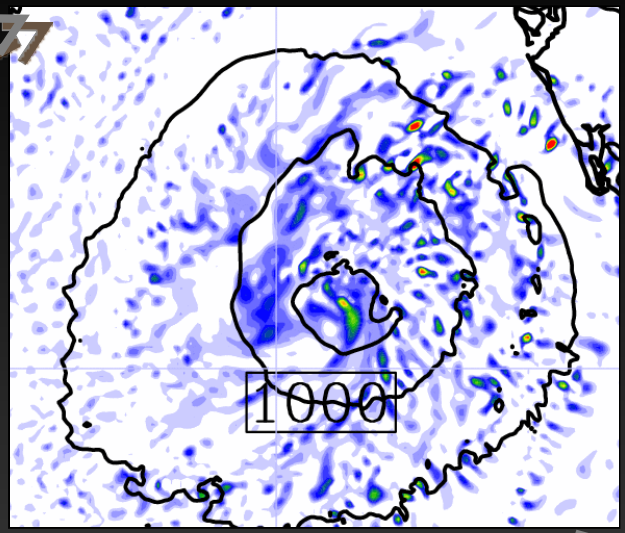

27 km
9 km
3 km

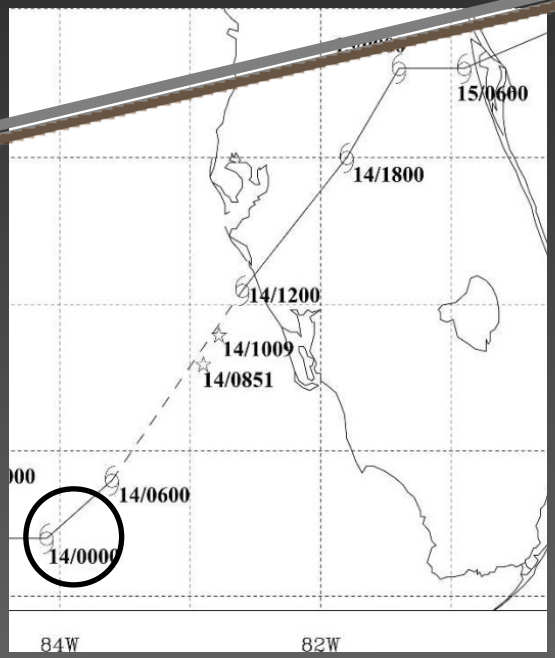
Simulations

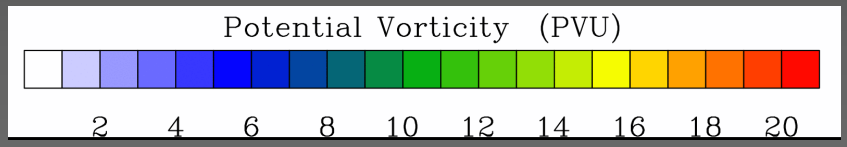
- WRF 3.2
- Microphysics 6 - Single Moment 6 class scheme
  - qi, qc, qr, qg, qv, qs
  - Suitable for high resolution simulations
- Cumulus Parameterization 1- Kain Fritsch (27km/9km only)
- Initialized at 1200 UTC 13th of September 2001

850 hPa PV 0000UTC









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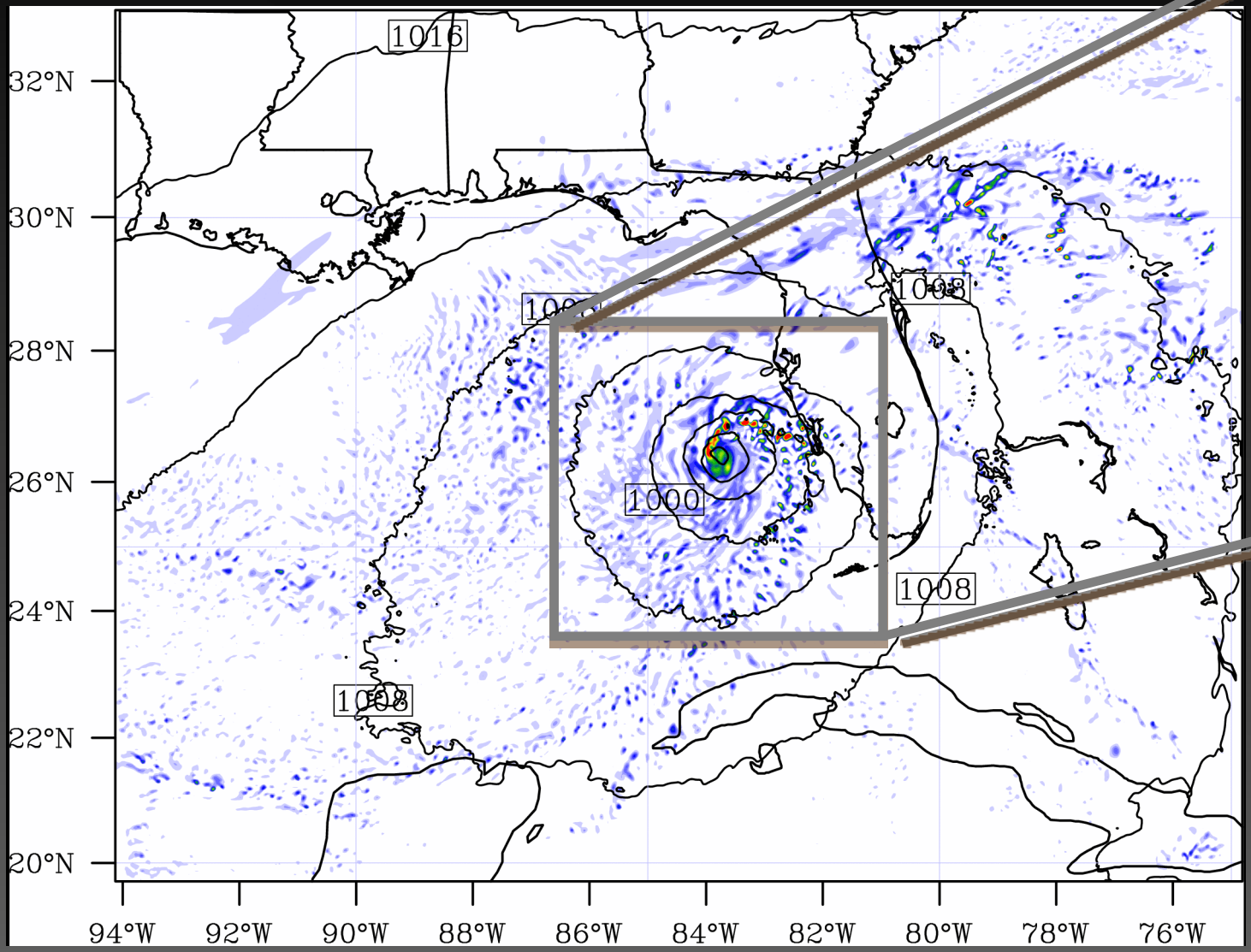
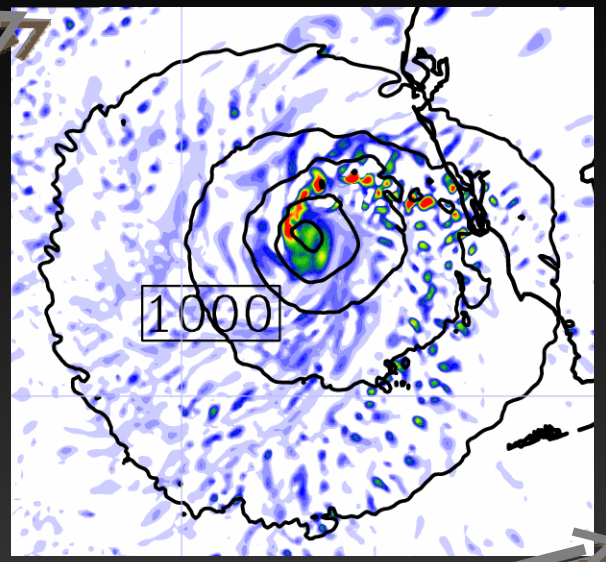
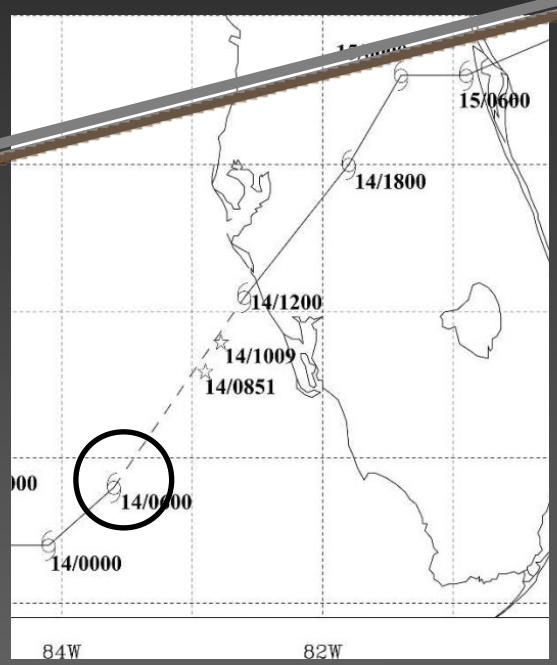
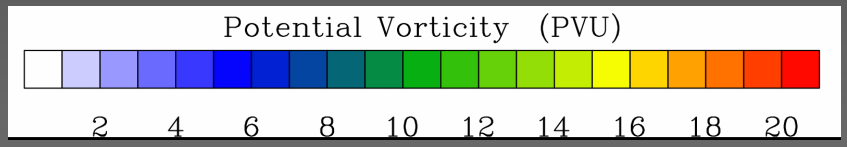
850 hPa PV 0600UTC









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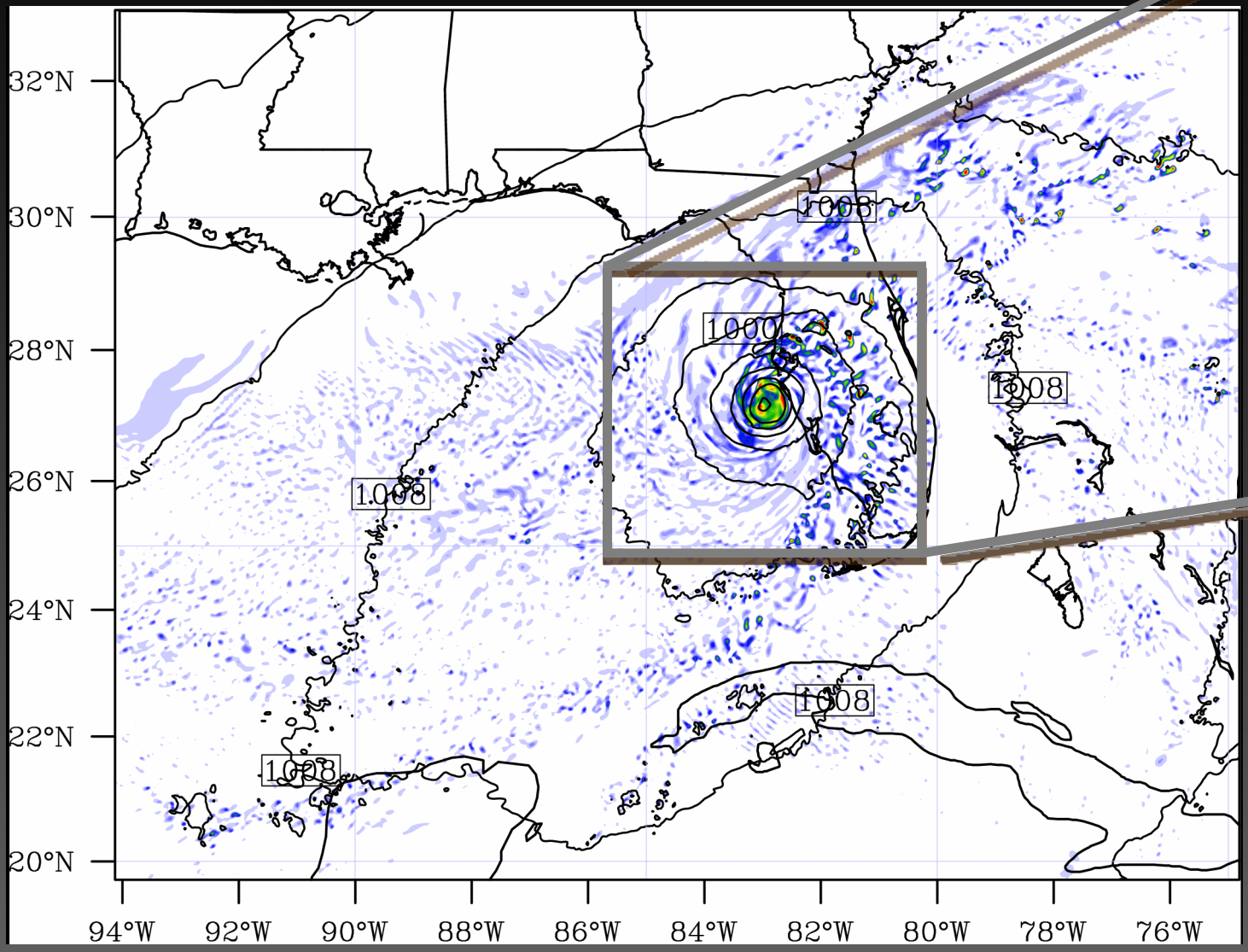
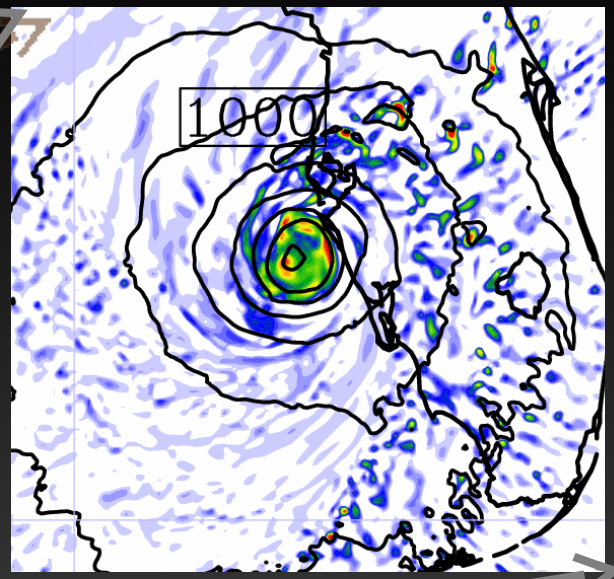
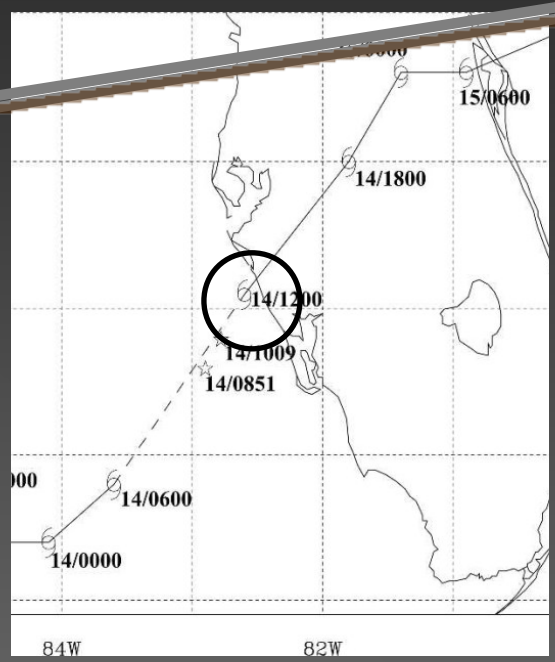
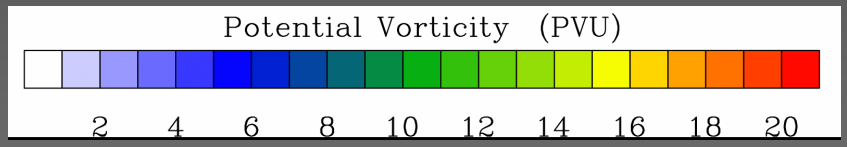
850 hPa PV 1200UTC









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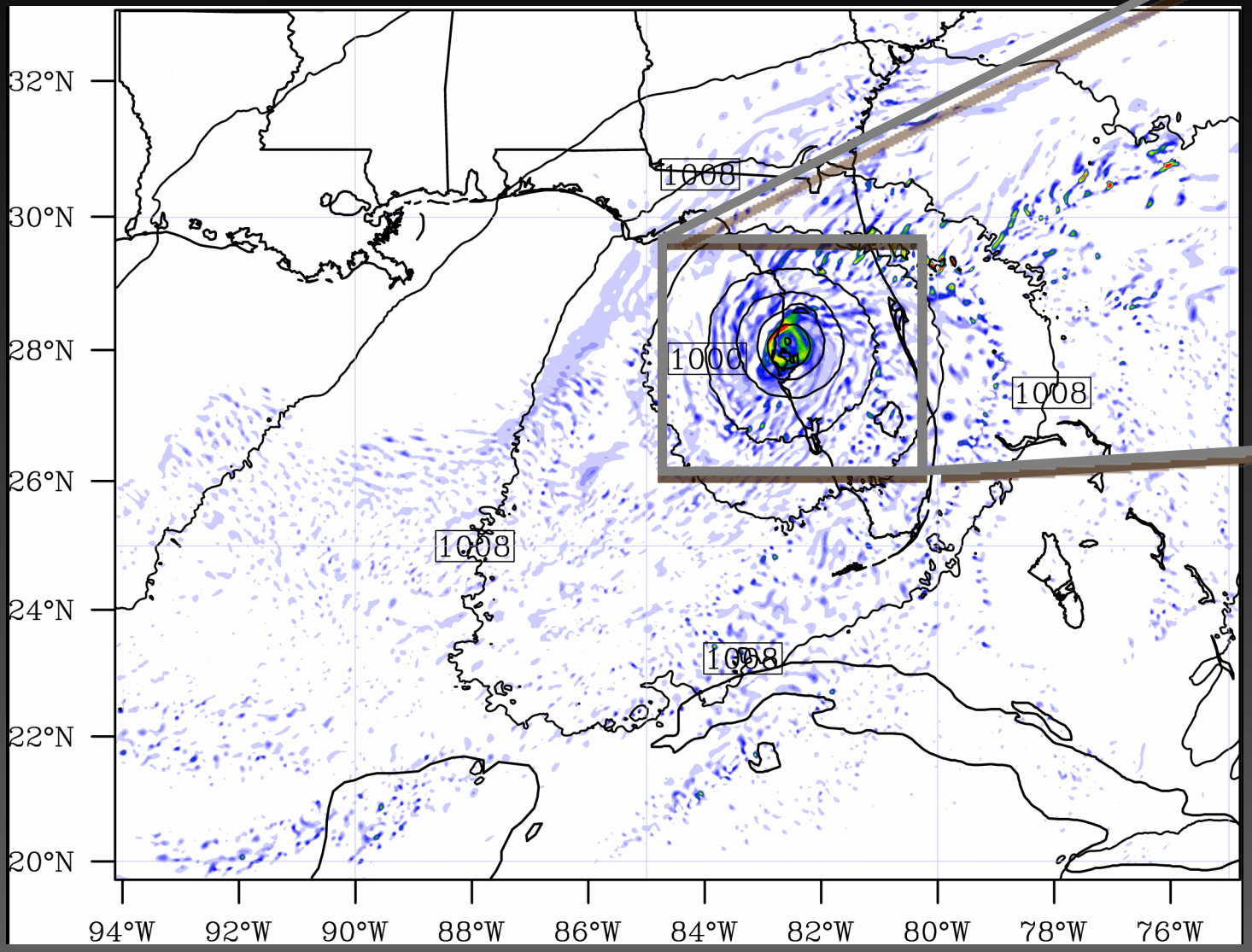
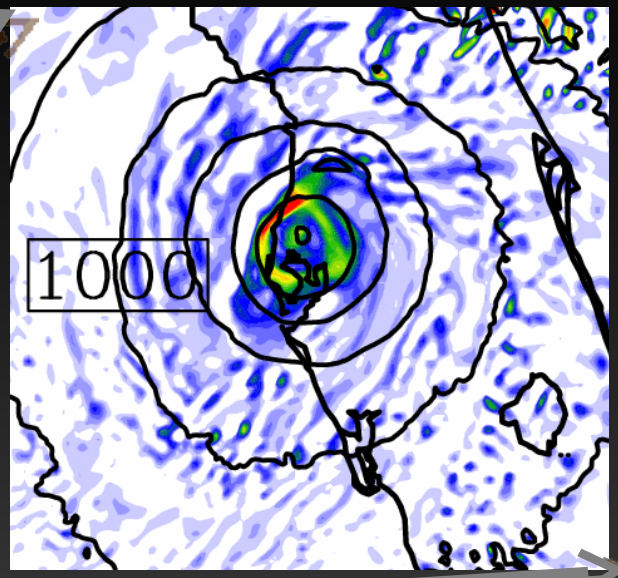
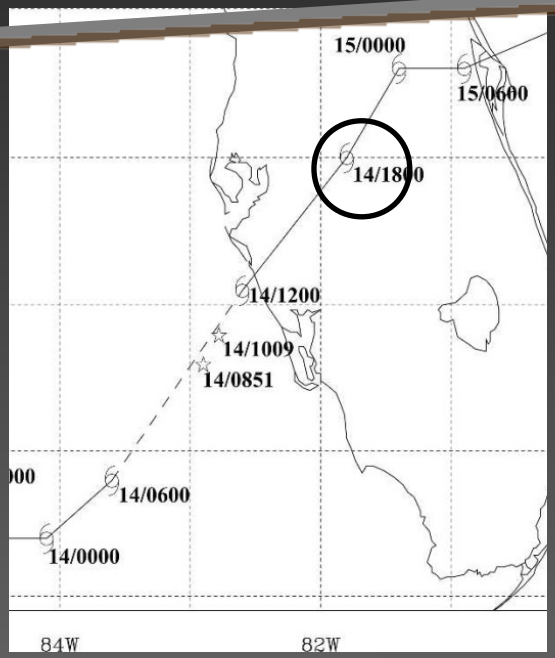
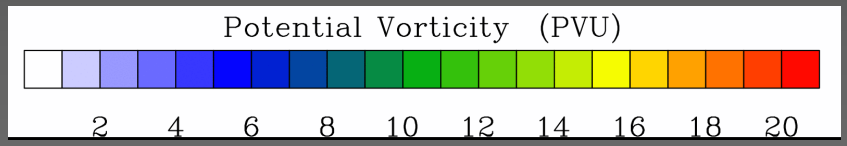
850 hPa PV 1800UTC









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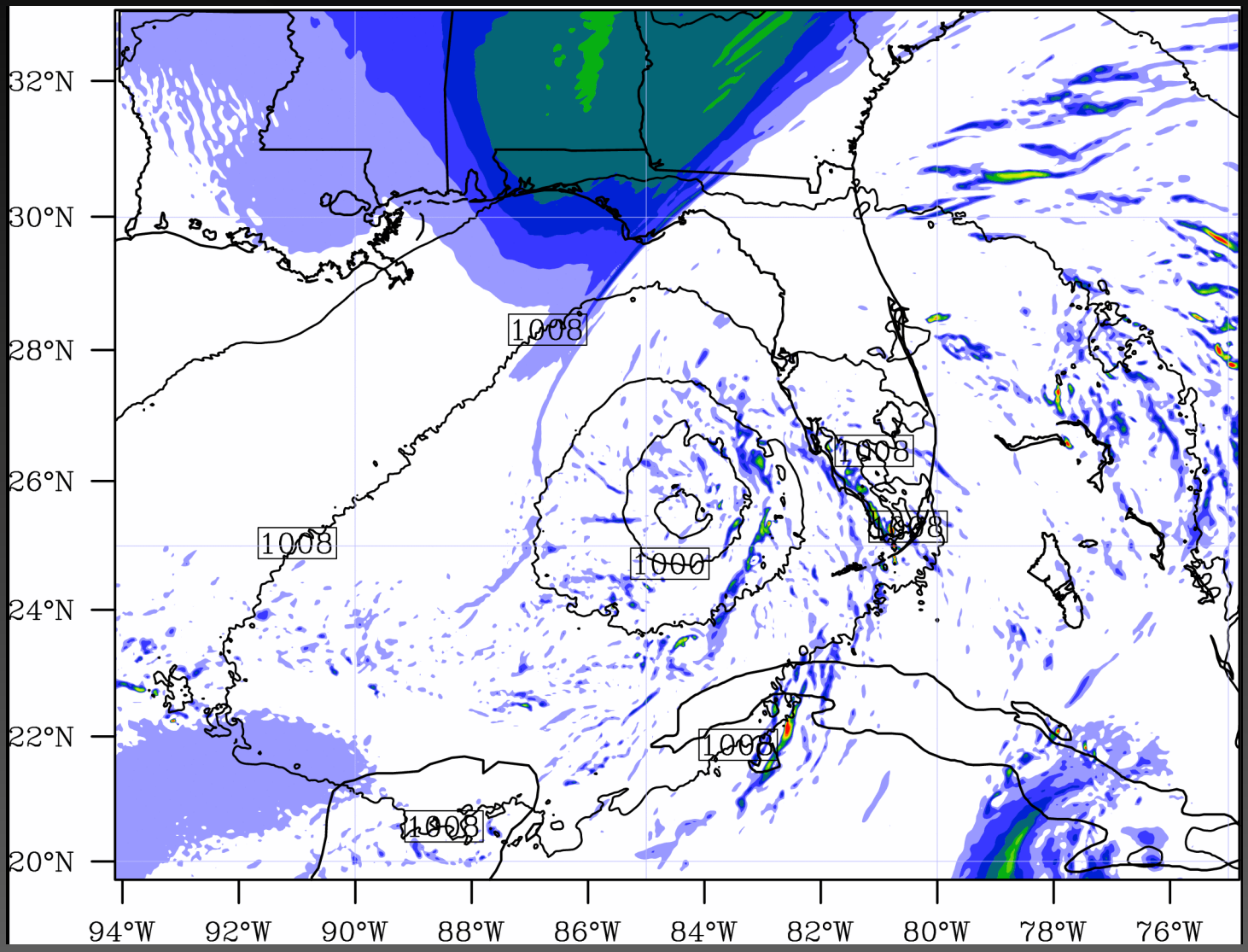
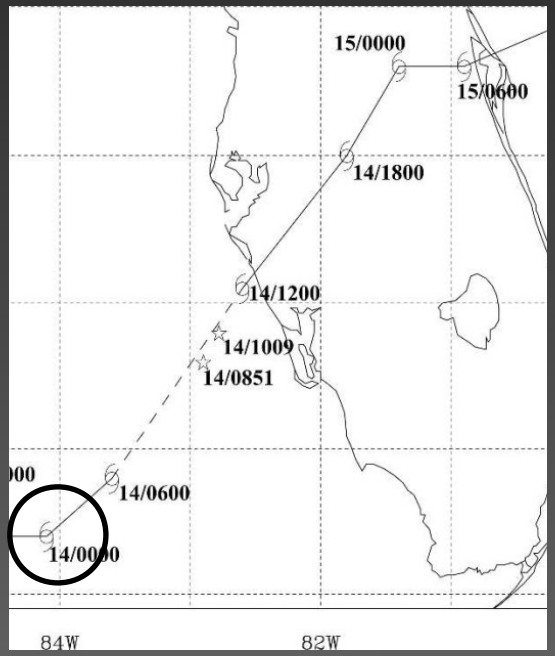
200 hPa PV 0000 UTC





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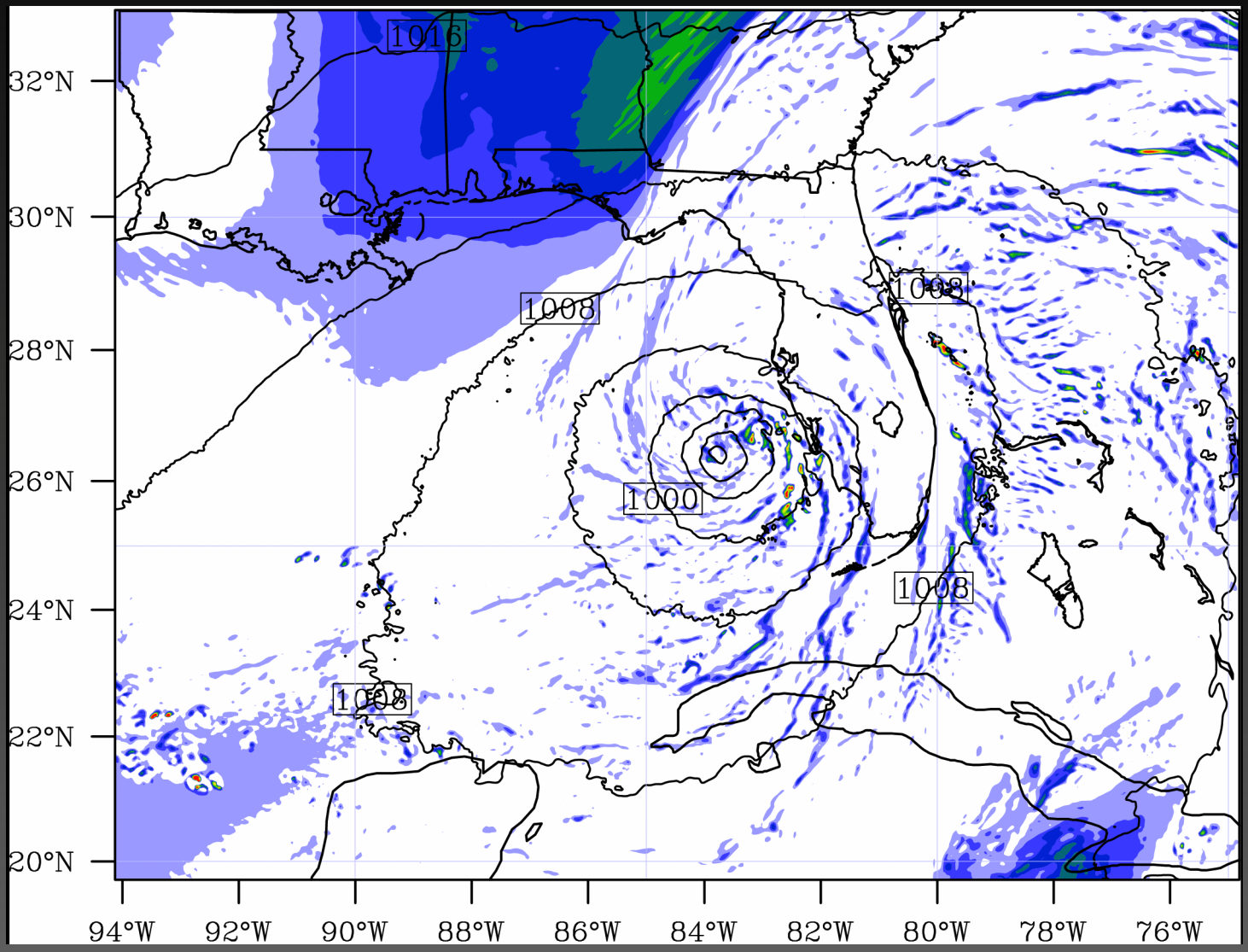
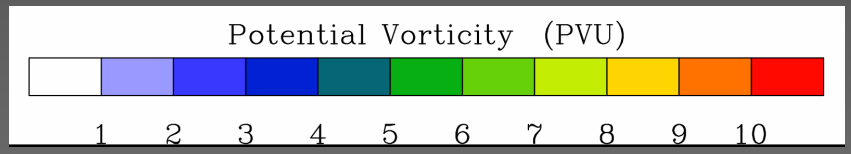
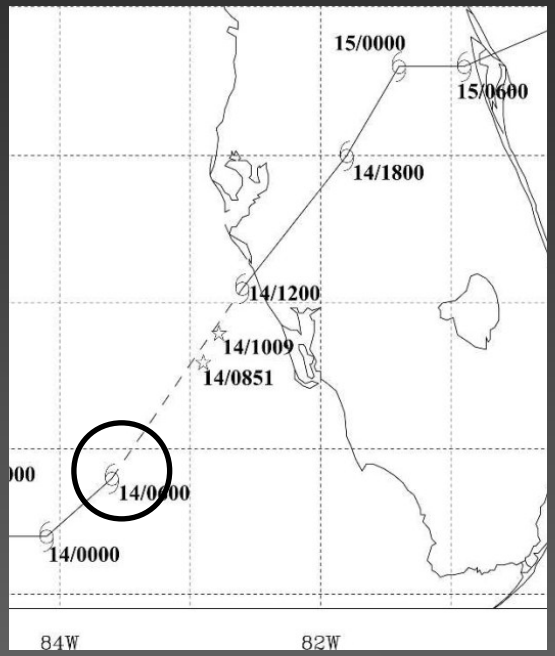
200 hPa PV 0600 UTC







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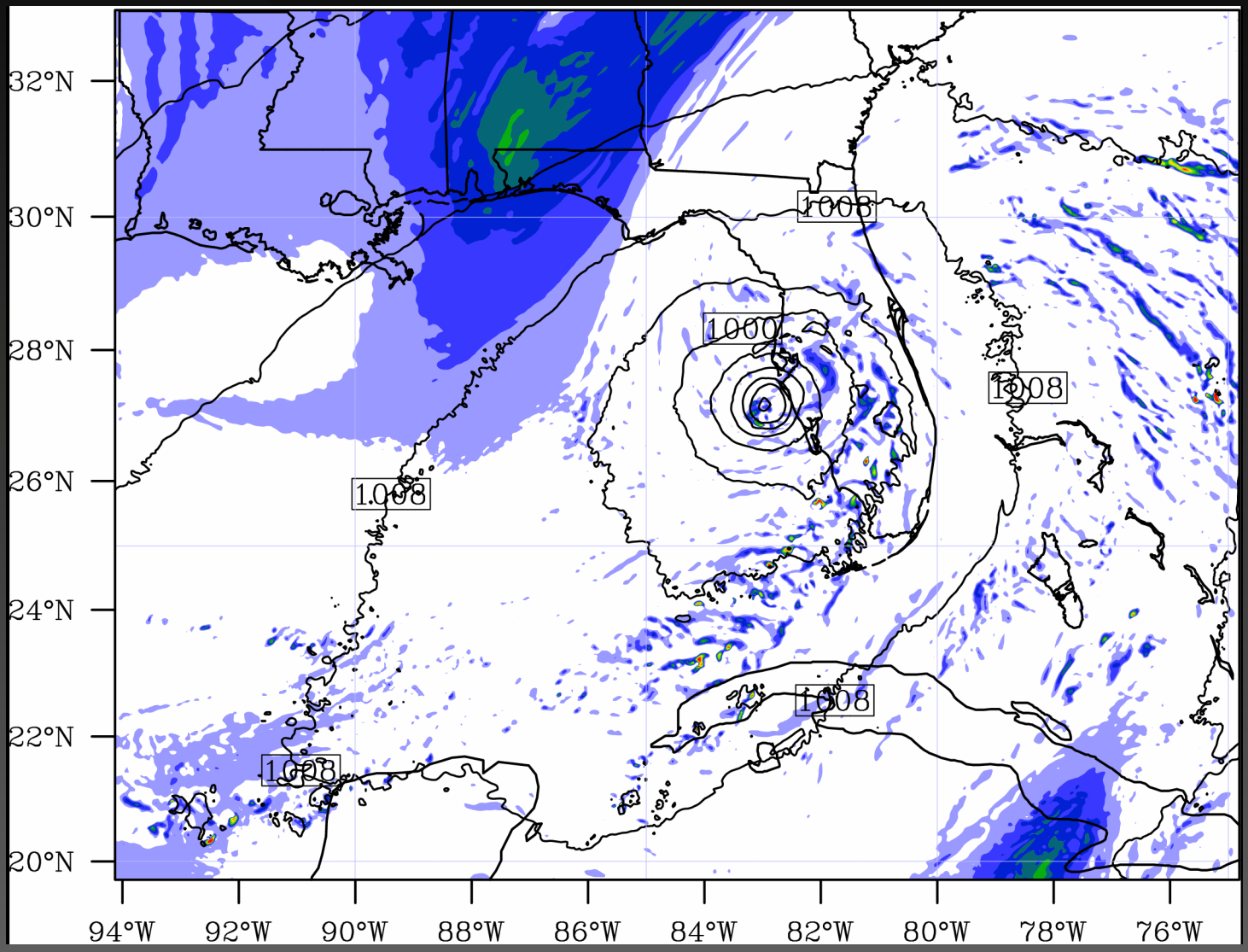
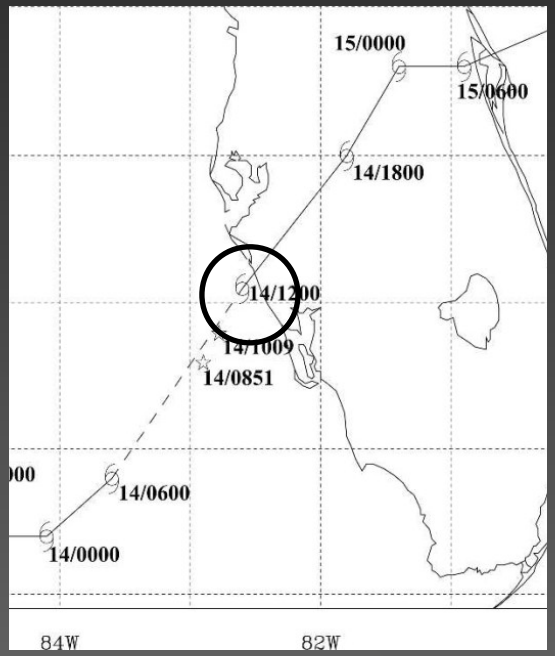
200 hPa PV 1200 UTC





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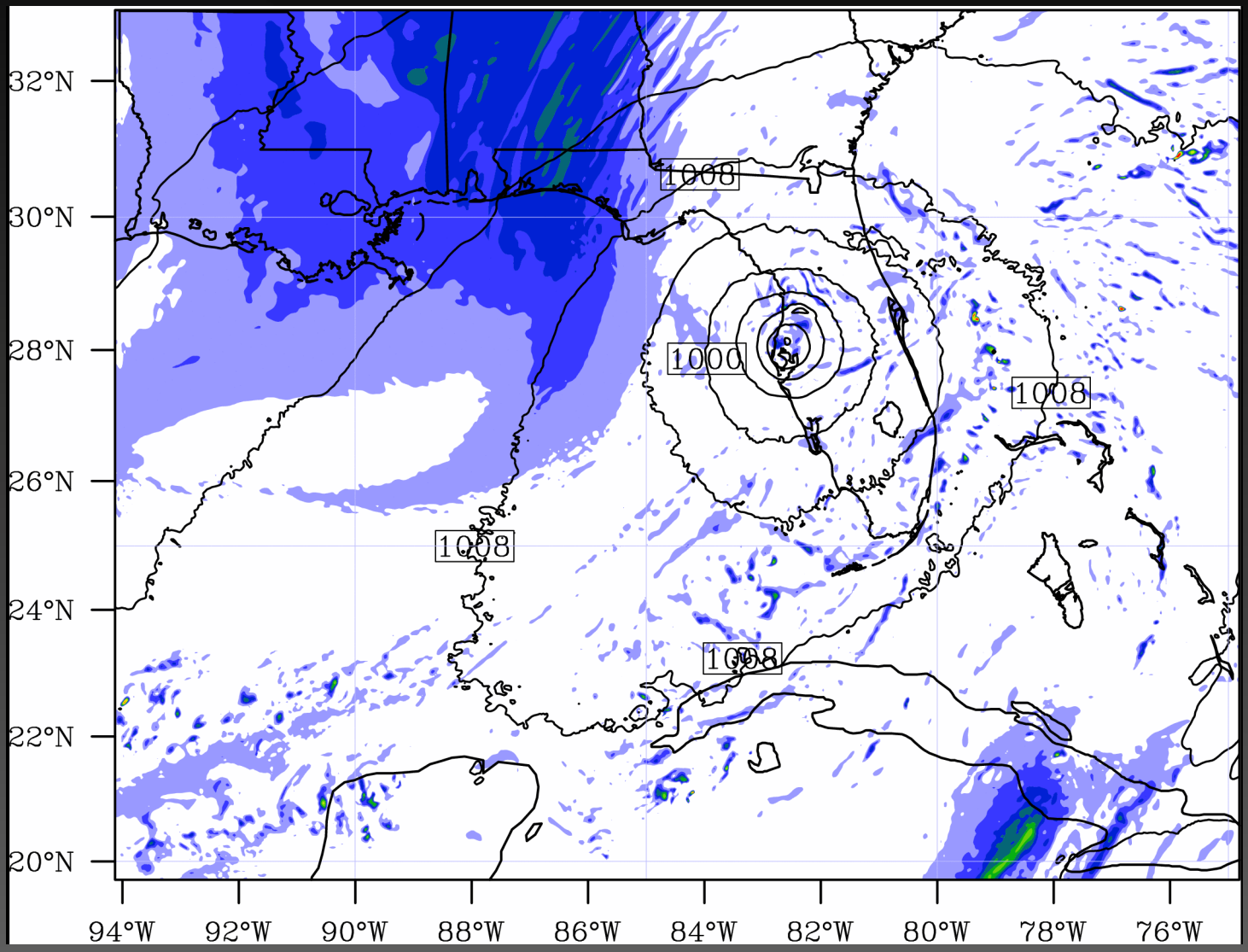
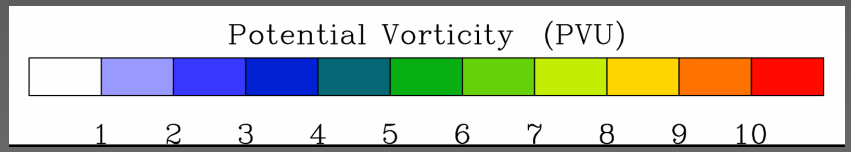
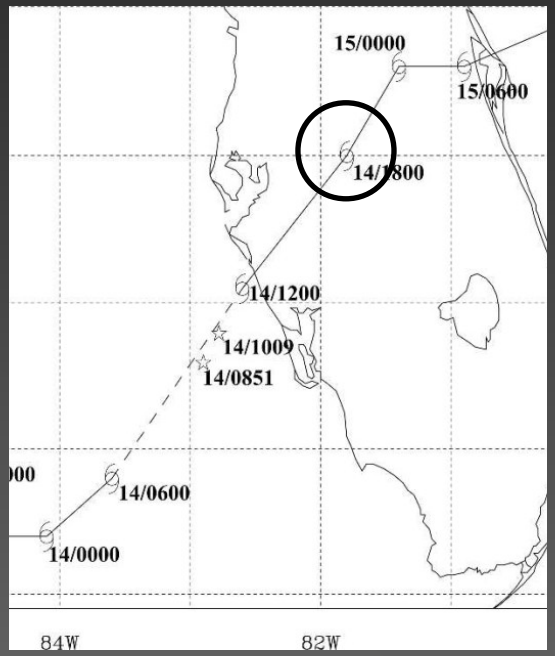
200 hPa PV 1800 UTC







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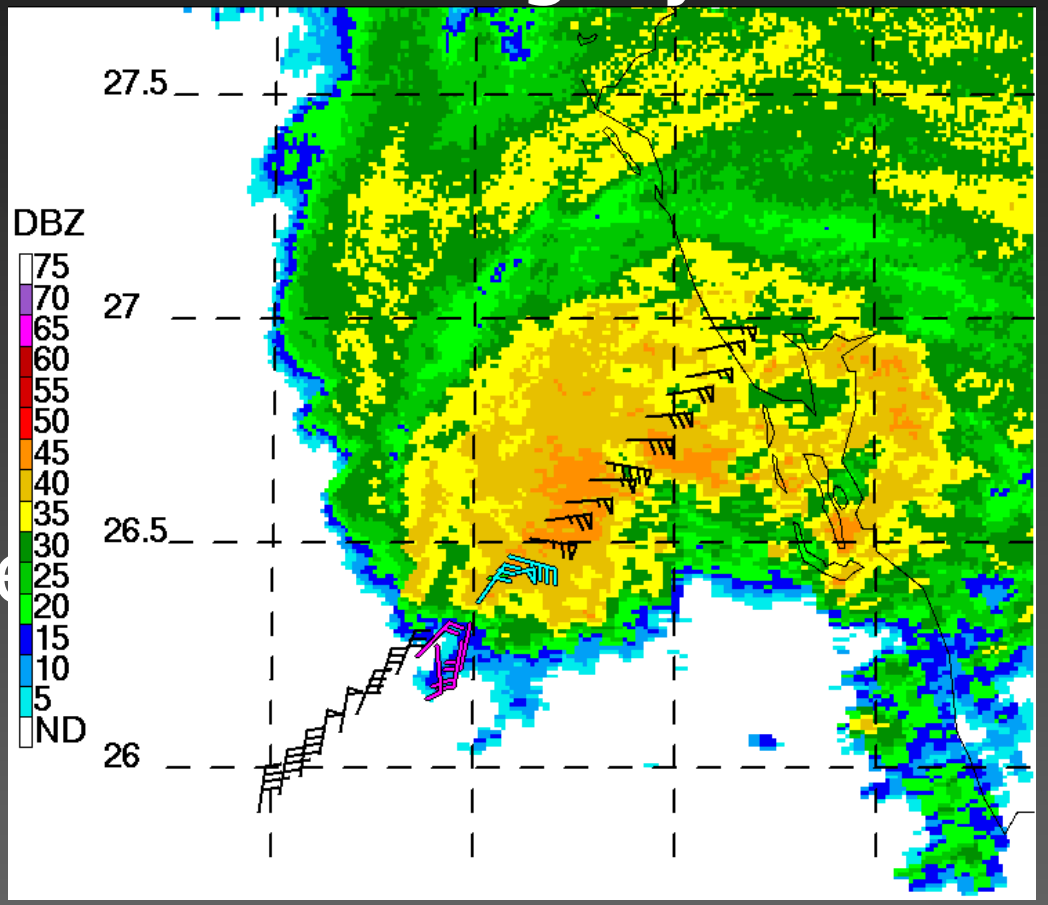
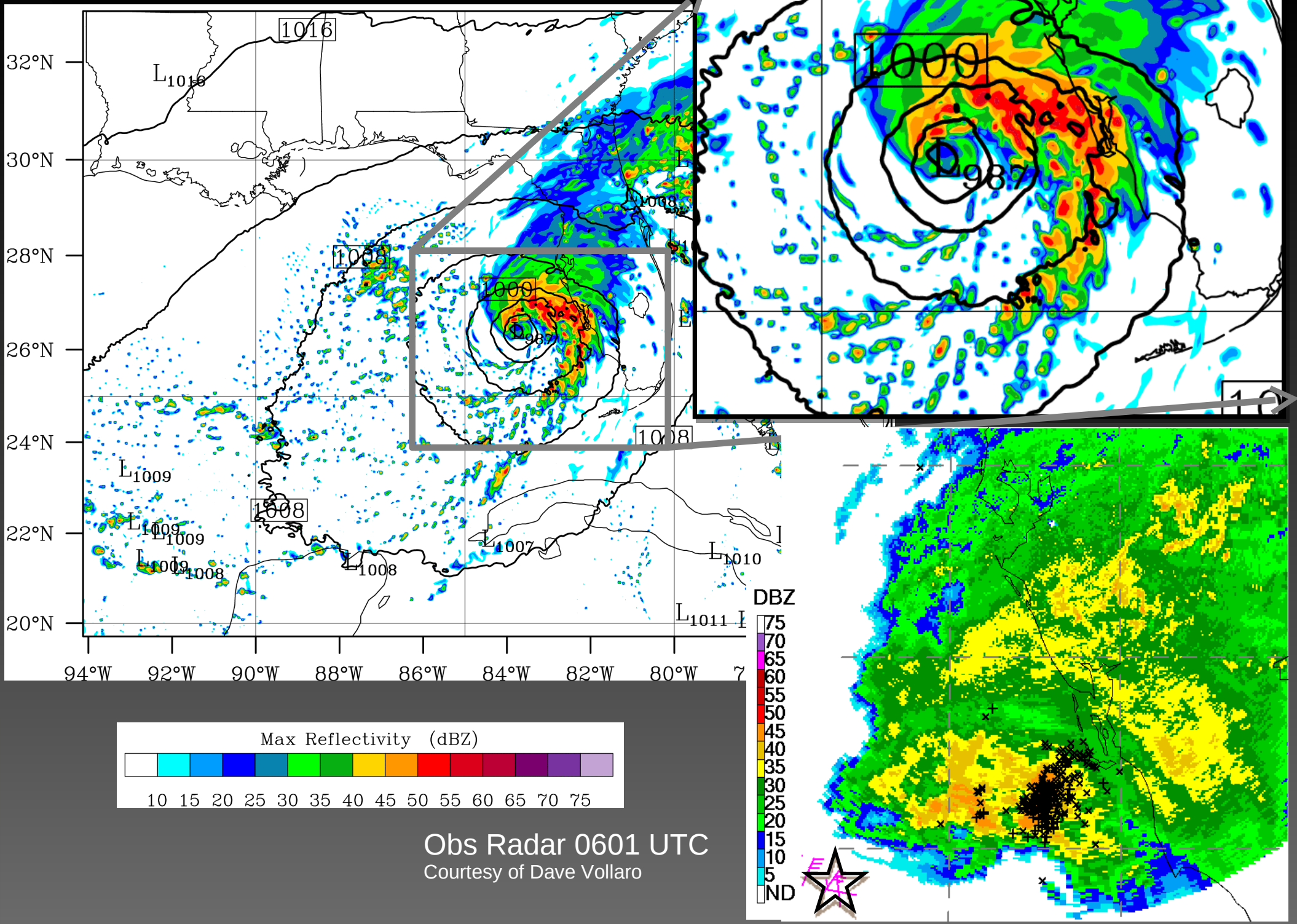
Convective Signature

- 0741 UTC observed radar imagery from Tampa
- Convective Cell NE of second center 20 min late
- Simulation lags observation

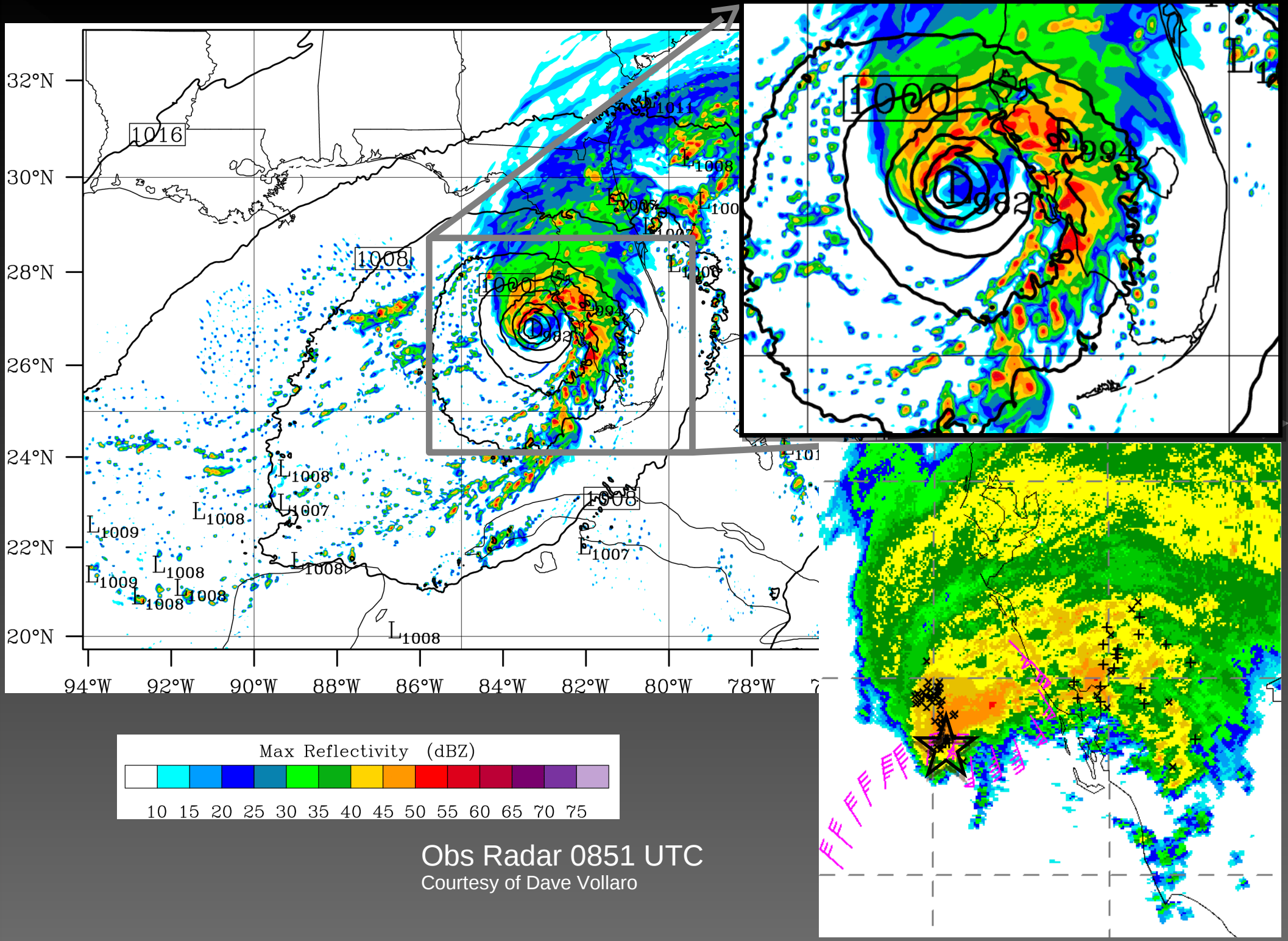


Molinari and Vollaro 2010



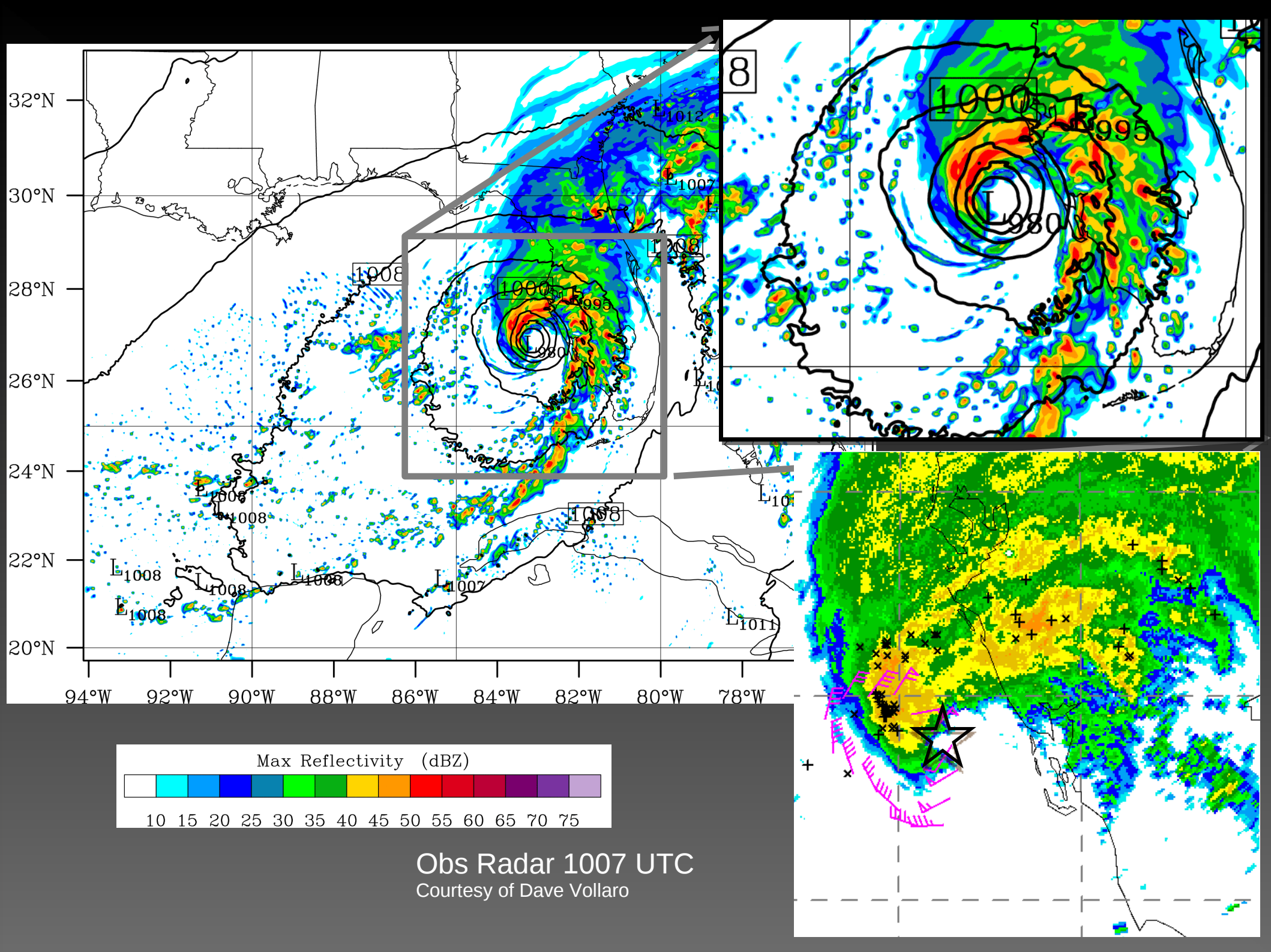
Obs Radar 0601 UTC

Courtesy of Dave Vollaro



Obs Radar 0851 UTC

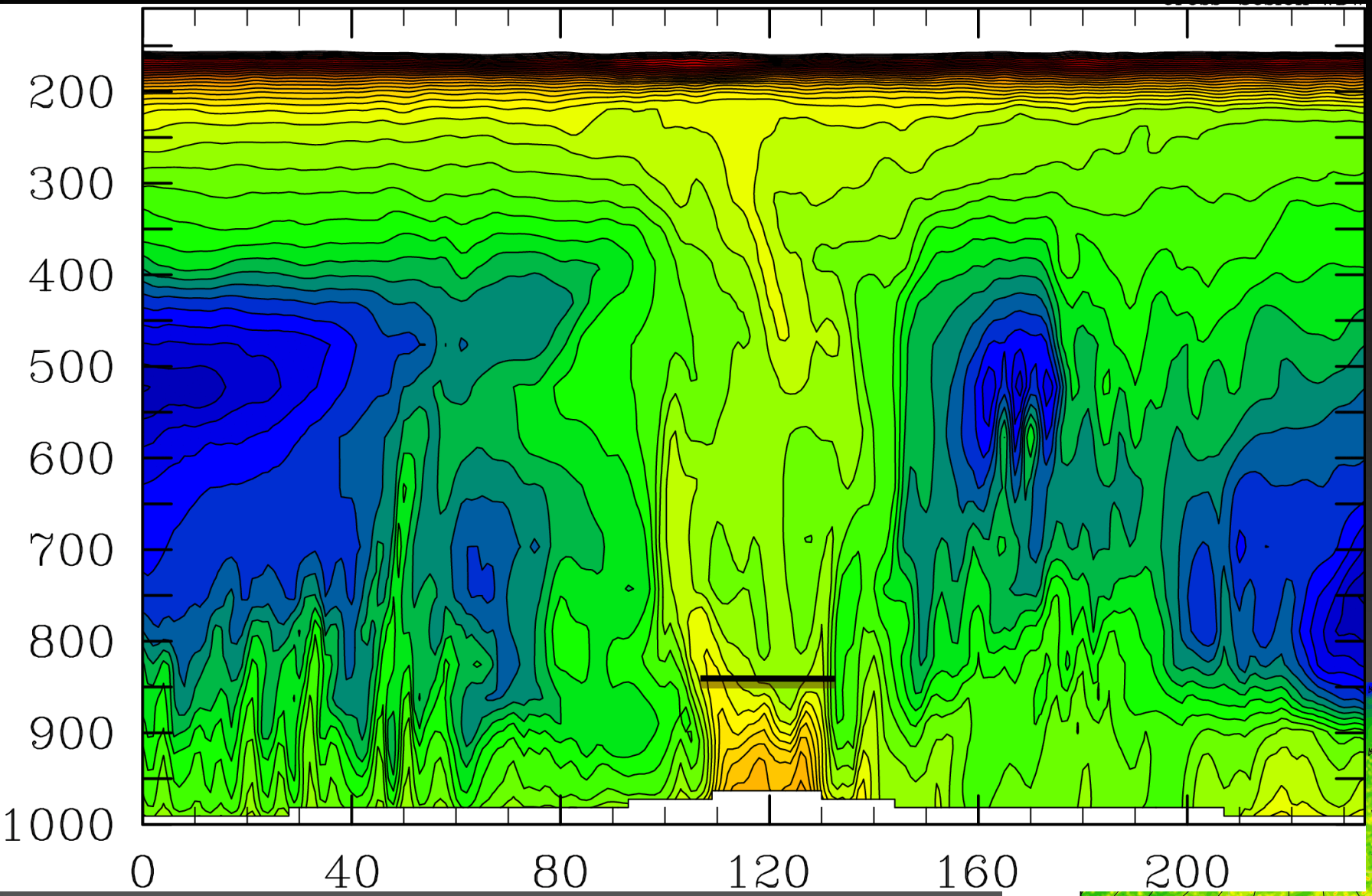
Courtesy of Dave Vollaro

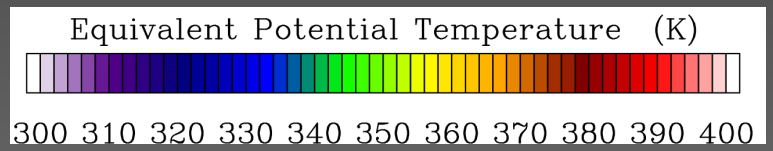


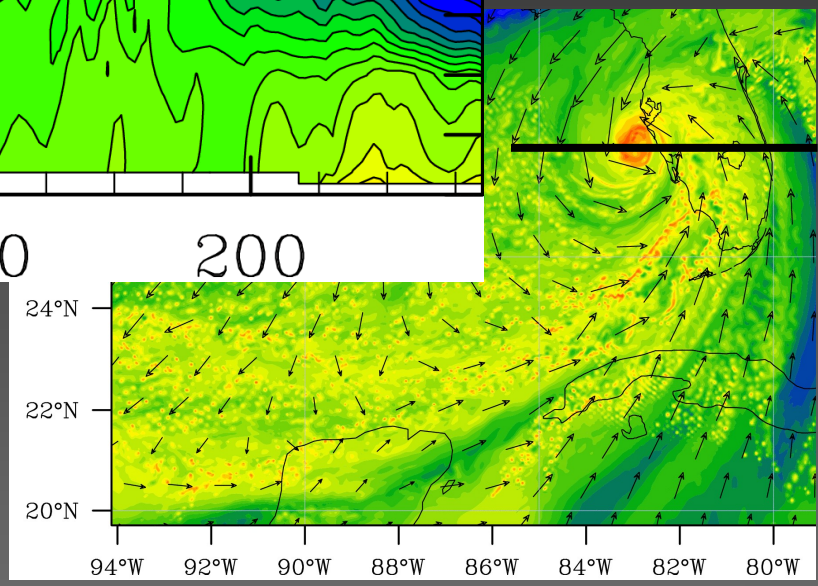
Obs Radar 1007 UTC

Courtesy of Dave Vollaro

θ_e
1100 UTC







850 hPa θ_e

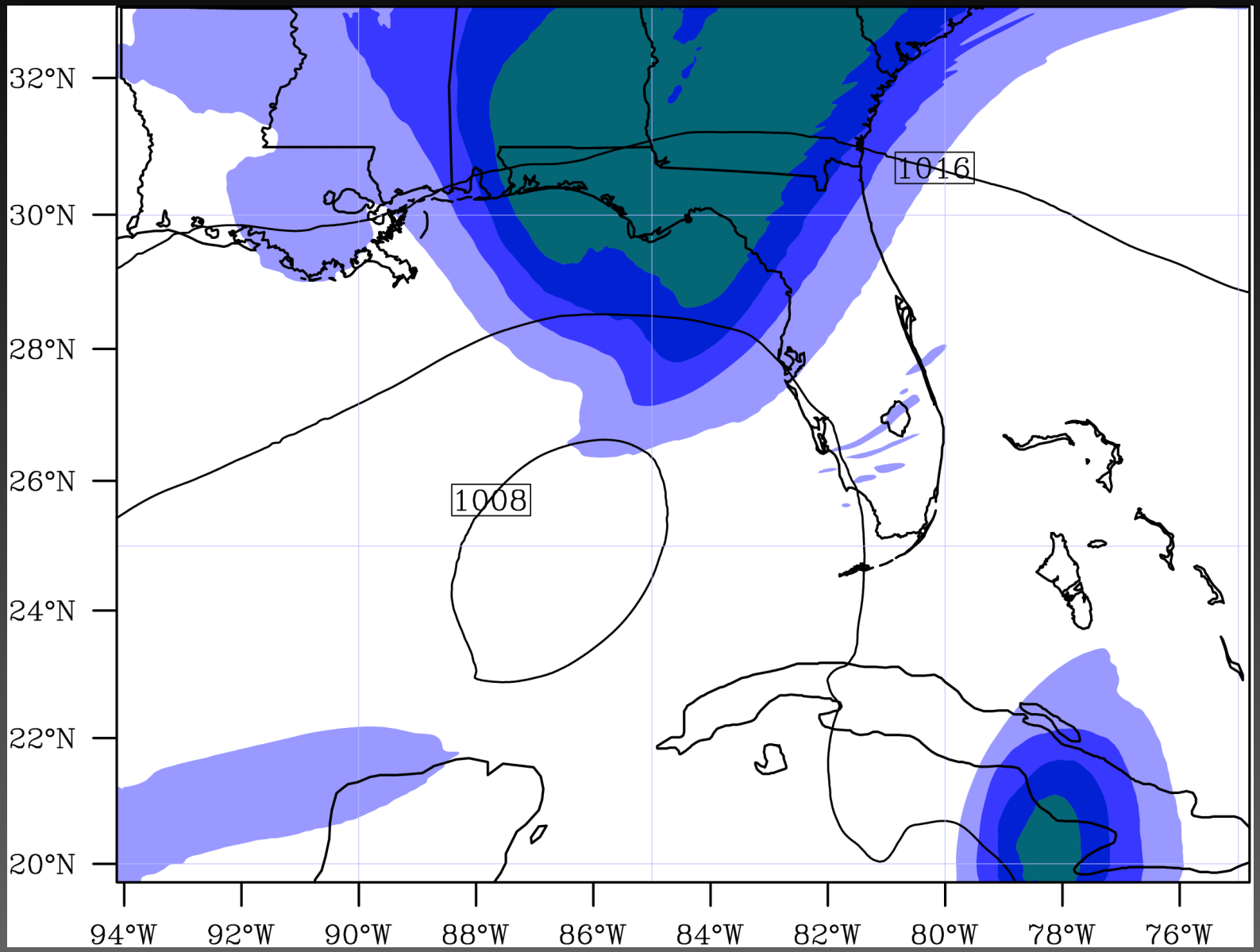
MSLP

	Observed (Molinari et al 2006)	Model
0600 UTC	994 (615)	987
0700 UTC		985
0800 UTC		984
0900 UTC	972 (844)	982
1000 UTC	980 (1009)	980
1100 UTC	983 (1132)	978
1200 UTC		979
1300 UTC		981

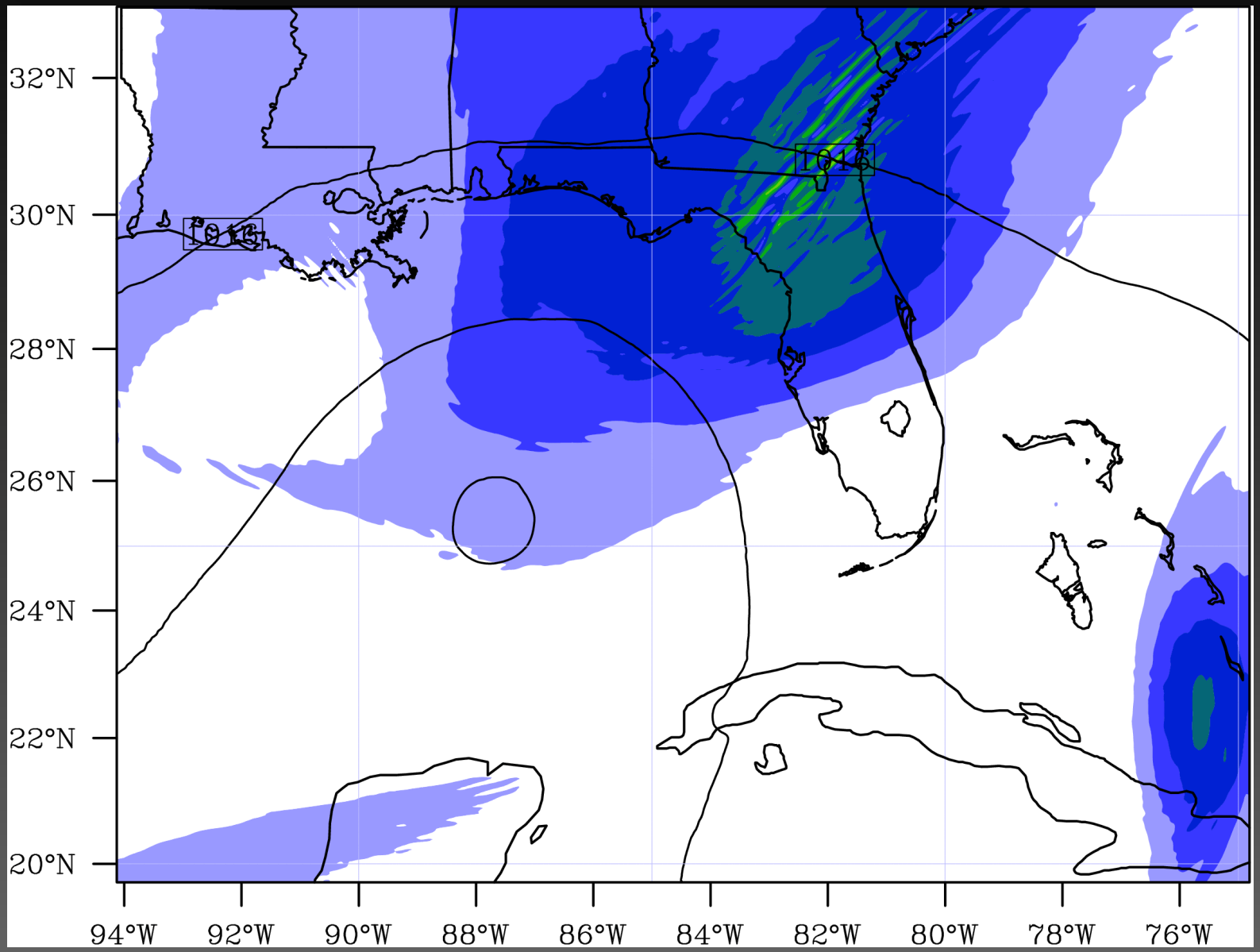
Trial Simulation

- Removed all diabatic heating to capture trough evolution
- No latent heating, Convective scheme
  - Microphysics, PBL, Surface Fluxes, Radiation (SW, LW)

200 hPa PV 0000UTC



200 hPa PV 1200UTC



Conclusions

- Well simulated aspects of Gabrielle
  - Overall track and intensity are well simulated
  - Convective orientation with respect to the center during intensification
- Not so well simulated aspects of Gabrielle
  - Upper level trough is not far enough East
  - As a result track begins to degrade 1200 UTC - 1800UTC
  - May represent over-prediction of

Conclusions

- When all diabatic heating is removed, the upper level trough continues to propagate eastward without weakening

- But without convection, it propagates too fast

What Now?

- Run model with 1km grid
  - Simulate long-lasting convective cells between 0500 and 0900 UTC
- Evaluate Helicity in the model
- Further experiments with parameterizations
  - Microphysics
  - PBL