

Hurricane Precipitation and Rainband Structure Improvements with a realtime Weather Research and Forecast (WRF-ARW) Model

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Verification and Graphics

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Project Collaborators

- Brent Shaw, John McGinley, John Smart, Jennifer Mahoney (NOAA FSL)
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- Paul Ruscher, Pete Bogenschutz (FSU)
- Bernard Meisner (NWS SRH)
- David Lambert (UNF)

WRF(ARW)-LAPS Model

- Result of NOAA CSI Project (team effort)
- LAPS- realtime local data diabatic “Hot Start”
- First quasi-operational WRF in the country (March 2003) [WRF v 1.3]
 - Only three weak tropical cyclones in 2003
 - Showed skill with structure, wind, precipitation
- Updated in July 2004 to WRF v 2.02
 - “A couple of Florida Storms”
 - Significant skill

WRF ARW Lessons Learned

- It is an excellent model “out of the box”
 - Kinematics are “outstanding”
 - Convective Rainfall is very good
 - Tropical Performance (you judge)
 - Version 1.3 had persistent cold inland bias
 - Visibility was also excellent (forecasters)
- Still needs PBL and LAPS Assimilation work
 - Particularly Radar and Satellite Clouds
 - Improved SST input (Where? Coupling?)
 - WRF v2 YSI PBL and NOAH LSM are much improved
 - GFS or ETA LBCs ???

Caveat Emptor

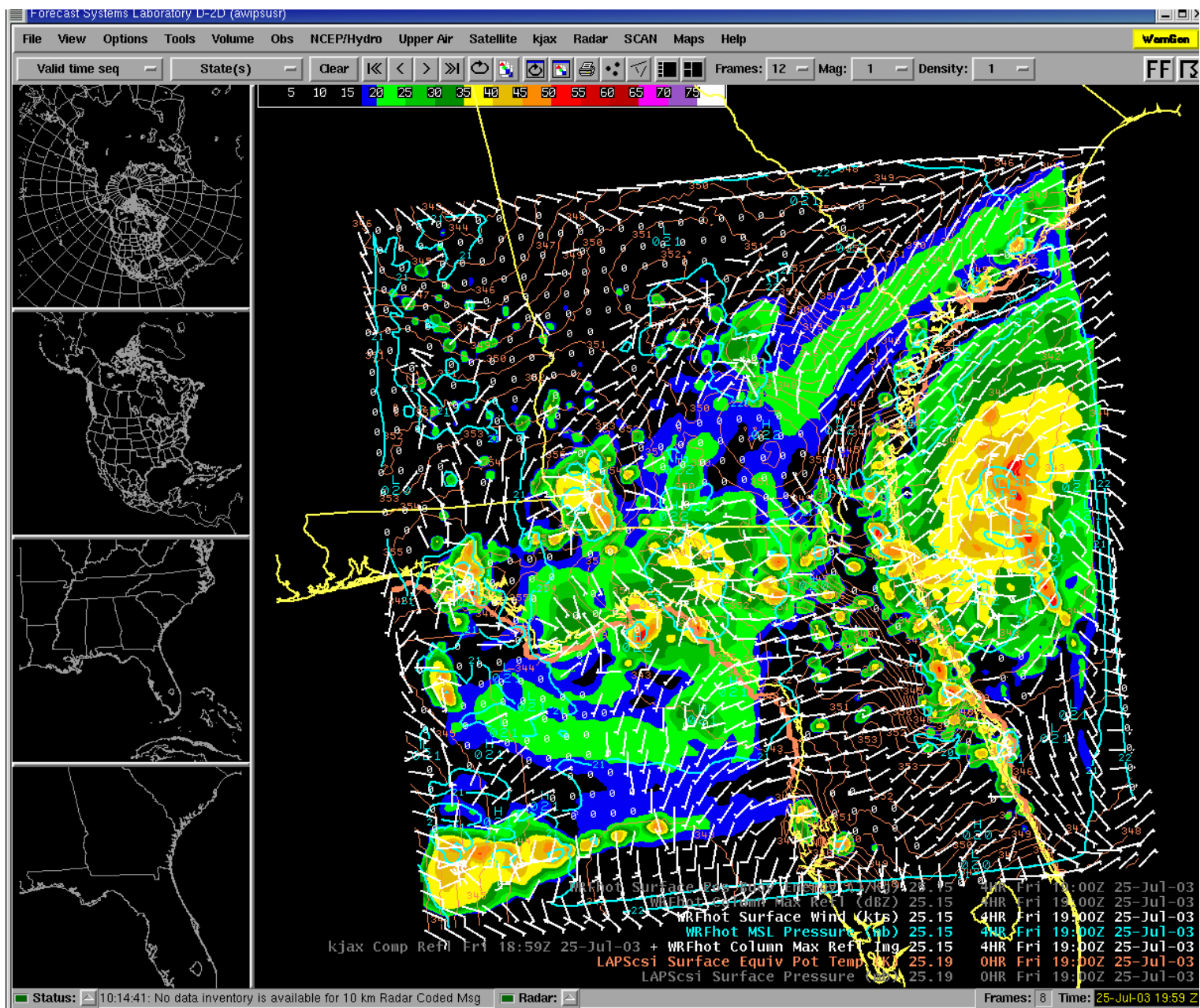
- Strong opinions are MINE even if they are wrong...not my collaborators!
- Florida weather is unique (NCEP take note please...)
- I have a strong bias toward forecasting
- Models have prognostics, not forecasts.
- A forecast is when someone signs their name at the bottom of a prediction...

Tropical Results from 2003

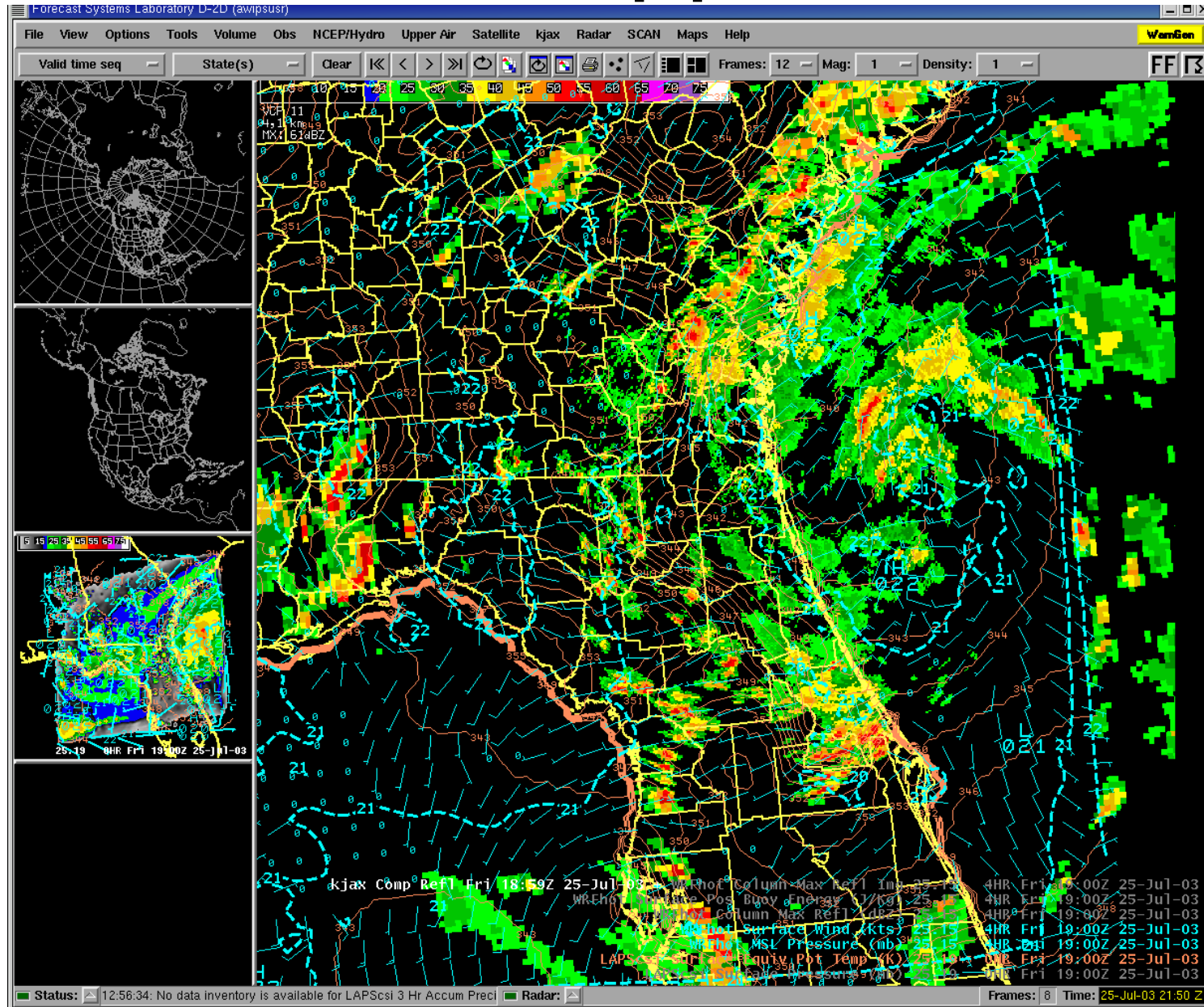
{ 3 weak storms in domain }

- T.D. #7 forecast **only** by WRF ARW Model
 - Location and winds well forecast (track?)
 - Surprising skill with TD structure
- T. S. Henri
 - Detailed analysis...ETA/GFS rain overforecast
 - Seems to suffer from ETA LBCs...extraction?
- T. S. Kyle
 - most data lost to Archive problem
 - Model did well by forecaster assessment

Model Forecast TD #7

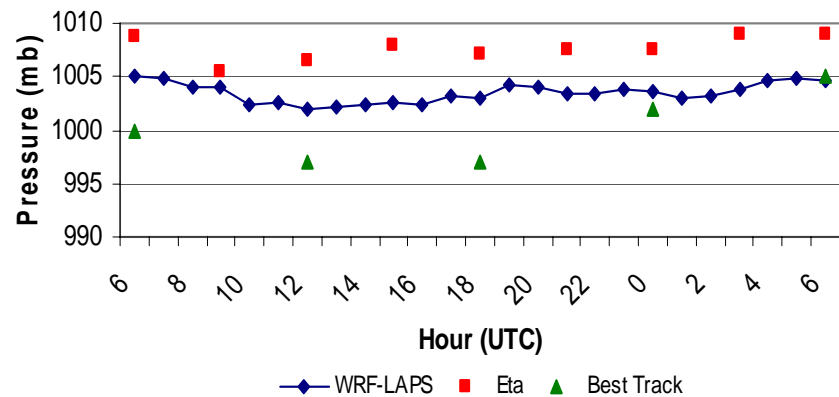


TD #7 on Doppler Radar

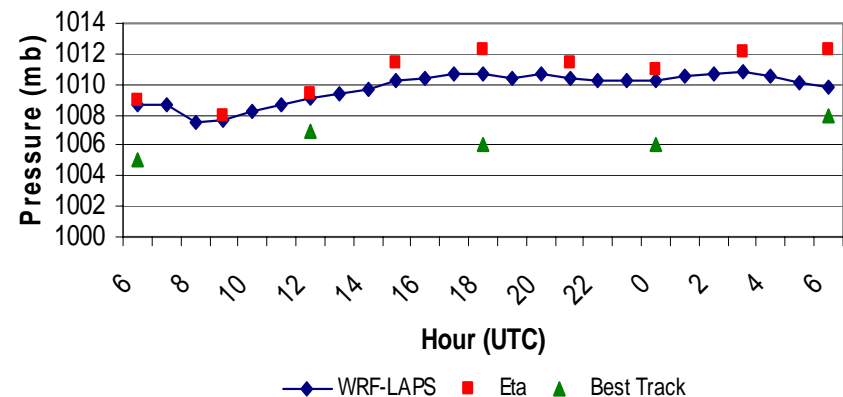


Tropical Storm Henri (2003)

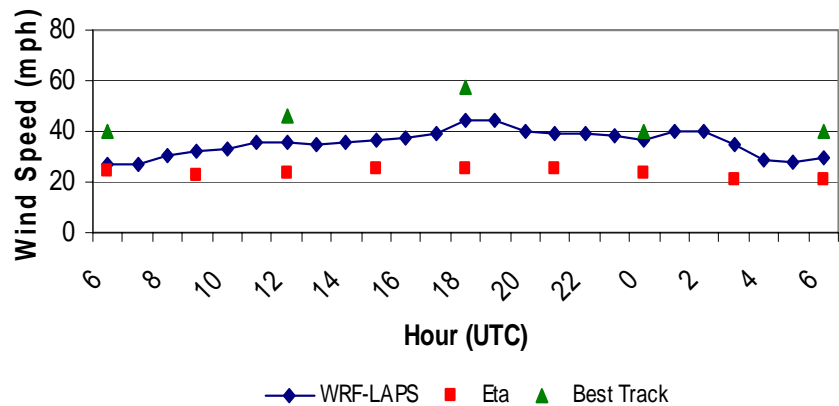
September 5, 2003
24 Hour Minimum Pressure Forecast



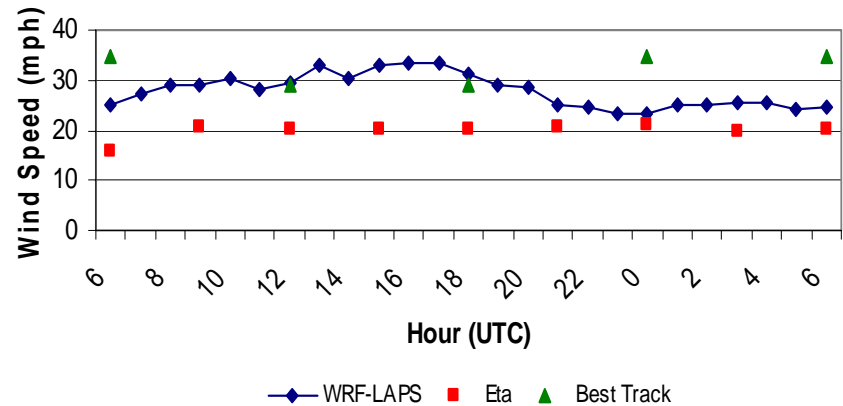
September 6, 2003
24 Hour Minimum Pressure Forecast



September 5, 2003
24 Hour Maximum Wind Speed Forecast



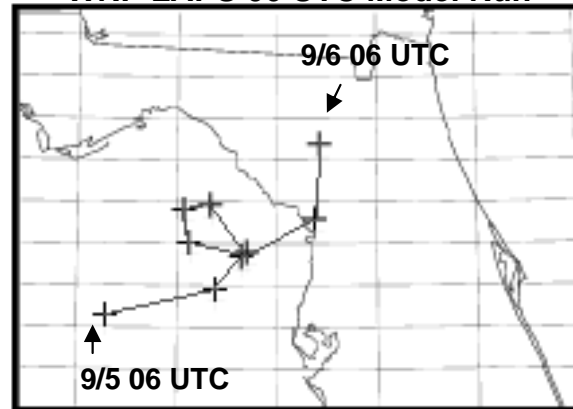
September 6, 2003
24 Hour Maximum Wind Speed Forecast



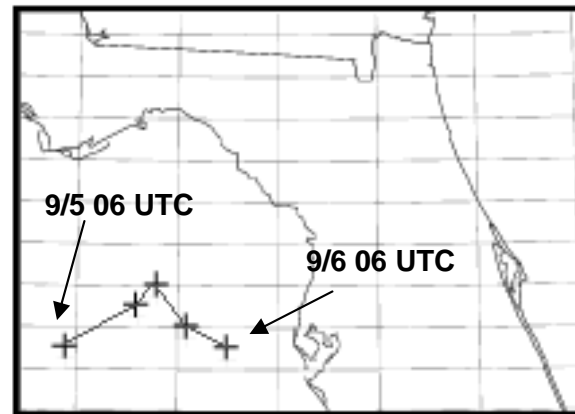
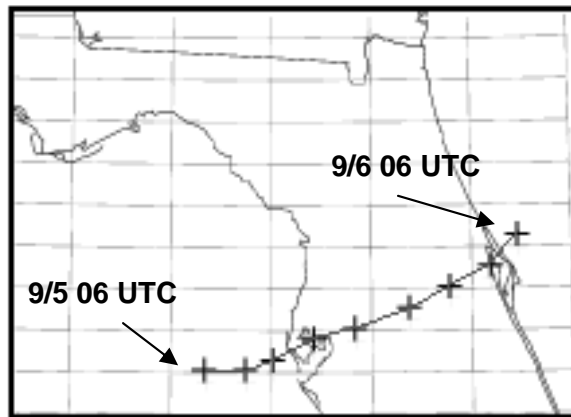
T. S. Henri

Sept 5th, 2003 Track Forecast

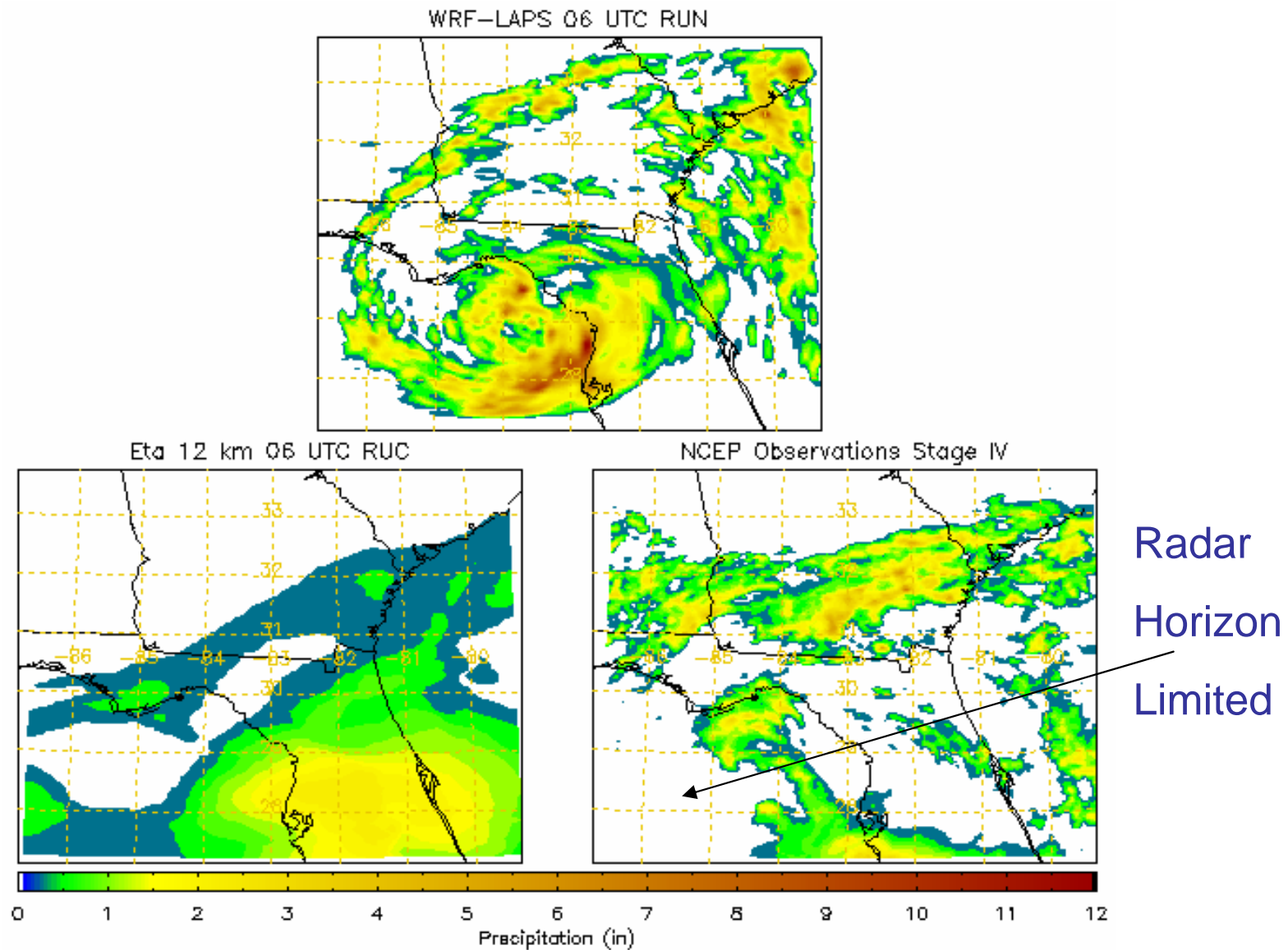
WRF-LAPS 06 UTC Model Run



Eta 12 km



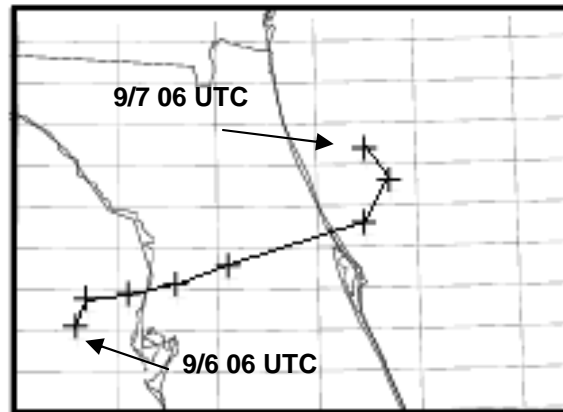
T. S. Henri Sept 5th, 2003



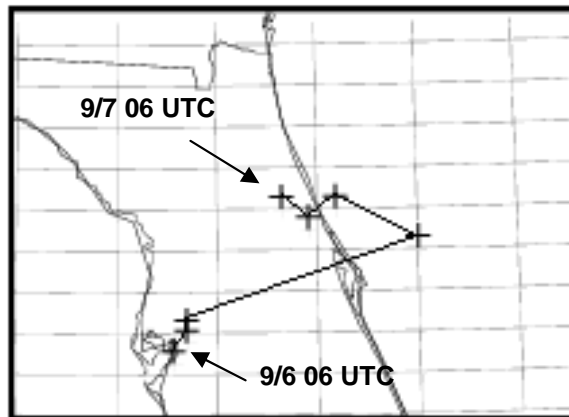
T. S. Henri

Sept 6th, 2003 Track Forecast.

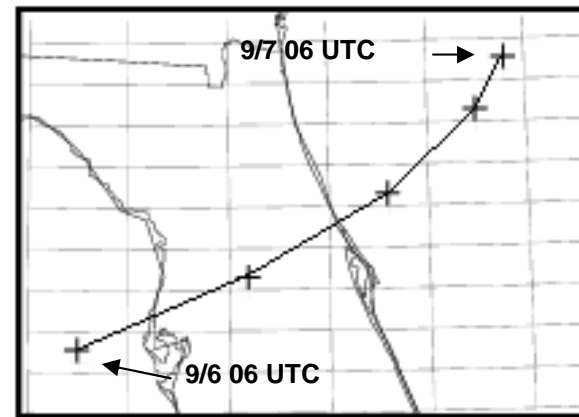
WRF-LAPS 06 UTC Model Run



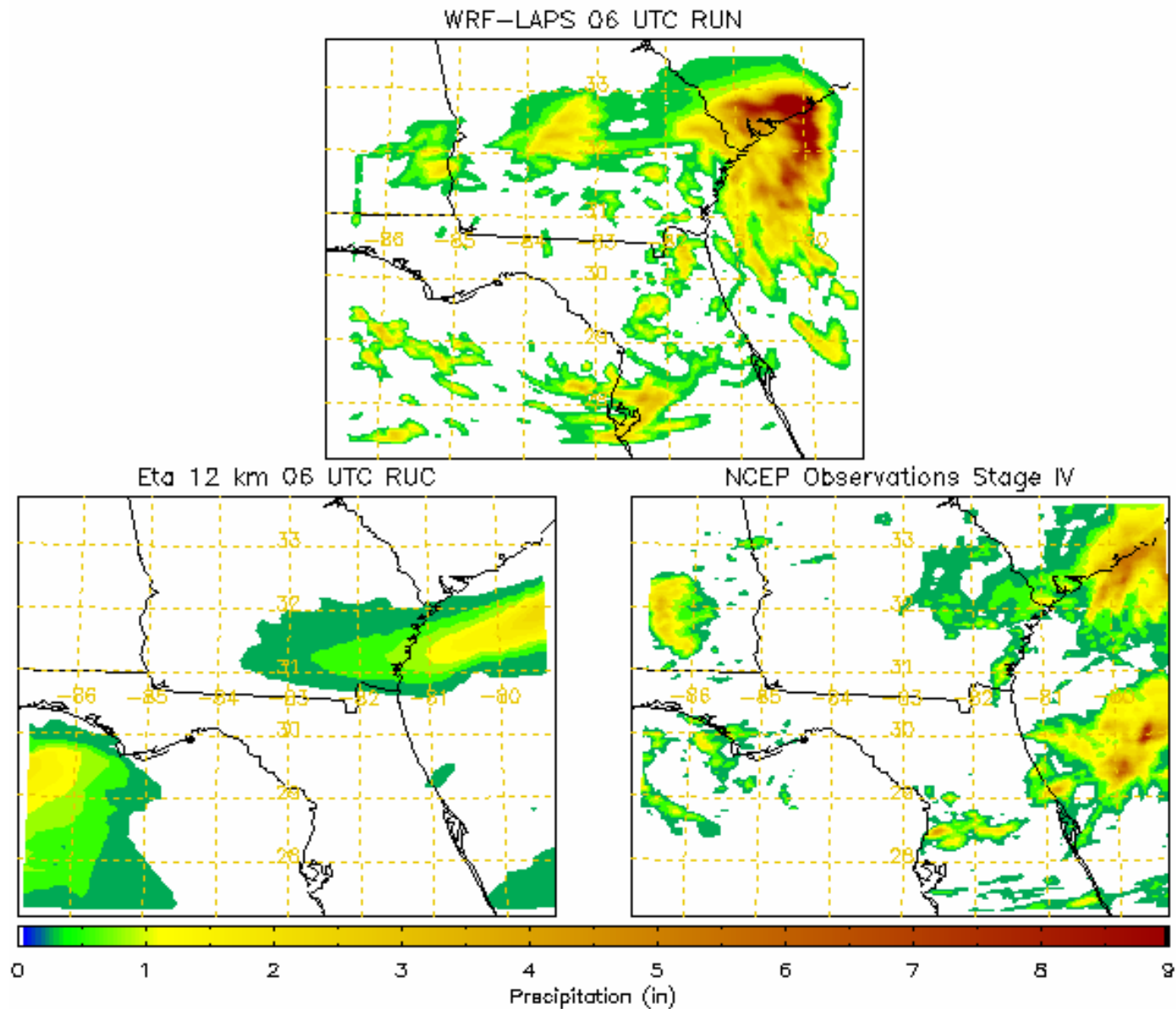
Eta 12 km



NHC Best Track



T. S. Henri Sept 6th, 2003



Response(s) to Yesterday

- WRF early versions had cold land bias that impacts forecasts...we need to be careful extrapolating WRF 2003 to current version.
- M-Y PBL mixes too deep/fast...YSI (!)
- ARM 25% time penalty (terrain)...Florida?
- RUC 13 km with GPS-IPWV (today)
- Grib1 smaller files...AWIPS LDAD
- WRF convective false alarms...thresholding?
- WRF captures deepening and heavy rain (!!!)

2004 Results

WRF Version 2.02

WRF Version 2.02

- Installed July 20th, 2004 at JAX WFO
- New physics options:
 - NOAH LSM
 - YSU PBL
 - Grell-Devenyi ensemble cumulus scheme
- An AWIPS problem destroyed many of the forecasts after they were issued. However, ten days worth of full forecasts were salvaged from late August, 2004, just in time for the spectacular hurricane season.

2004 Limited Tropical Results

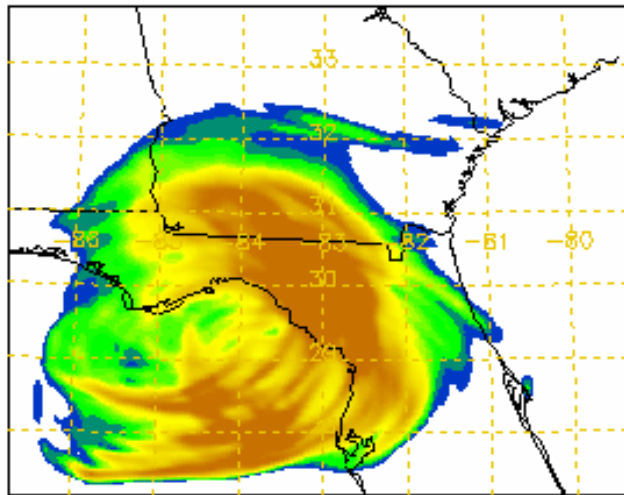
- Limited domain WRF Model covering North and Central Florida, South Georgia...Laps Hot Start, data rich domain
- T. S. Bonnie and Hurricane Charlie lost due to AWIPS file structure changes
- Pete put a lot of effort in converting scales and graphic formats to create these images
- Model produces pseudo-radar reflectivity as a function of rain rate...visually appealing to forecasters

Hurricane Frances

Accumulated Precipitation

September 5, 2004

WRF-LAPS 06 UTC RUN



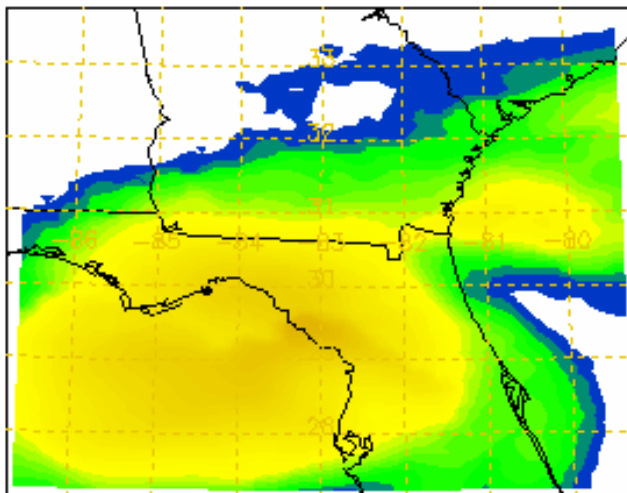
WRF Stats:

Bias: 0.83

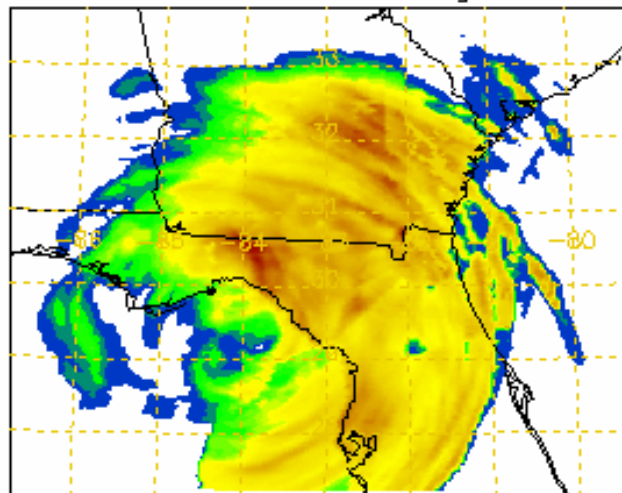
MAE: 0.81

ETS: 0.51

Eta 12 km 06 UTC RUN



NCEP Observations Stage IV

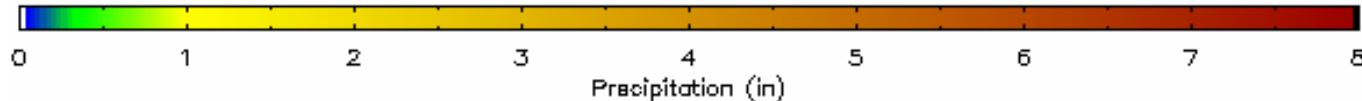


Eta Stats:

Bias: 1.53

MAE: 0.85

ETS: 0.38

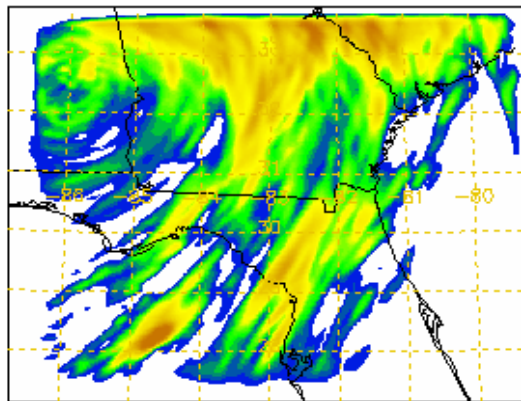


Hurricane Frances

Accumulated Precipitation

September 6, 2004

WRF-LAPS 06 UTC RUN



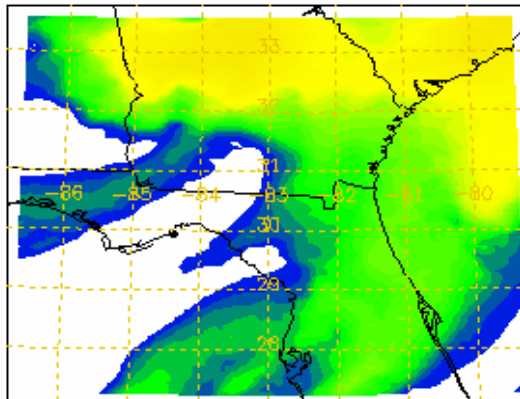
WRF Stats:

Bias: 0.93

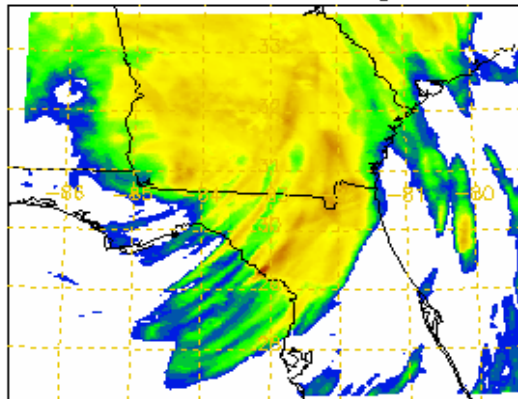
MAE: 0.70

ETS: 0.60

Eta 12 km 06 UTC RUN



NCEP Observations Stage IV



Eta Stats:

Bias: 1.20

MAE: 0.80

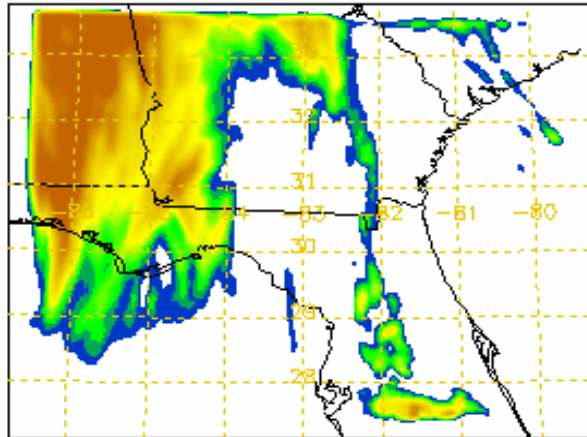
ETS: 0.42



Hurricane Ivan

Accumulated Precipitation

WRF-LAPS 06 UTC RUN



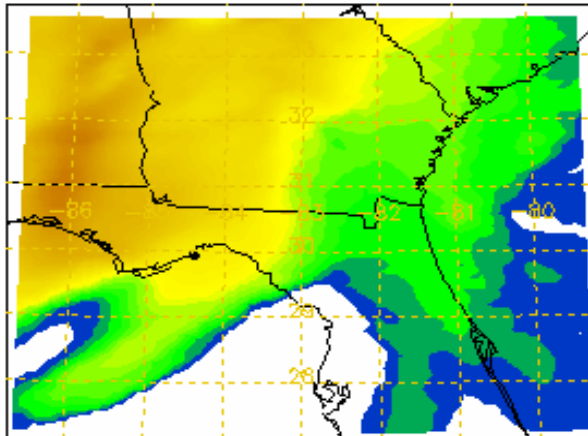
WRF Stats:

Bias: 0.87

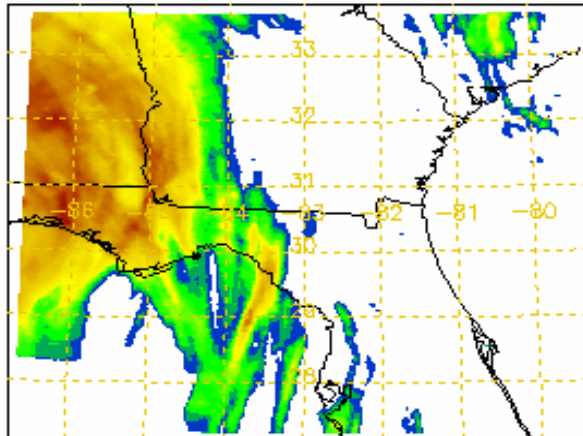
MAE: 0.45

ETS: 0.52

Eta 12 km 06 UTC RUN



NCEP Observations Stage IV



Eta Stats:

Bias: 2.16

MAE: 0.59

ETS: 0.26

0 1 2 3 4 5 6 7 8
Precipitation (in)

Future Projects

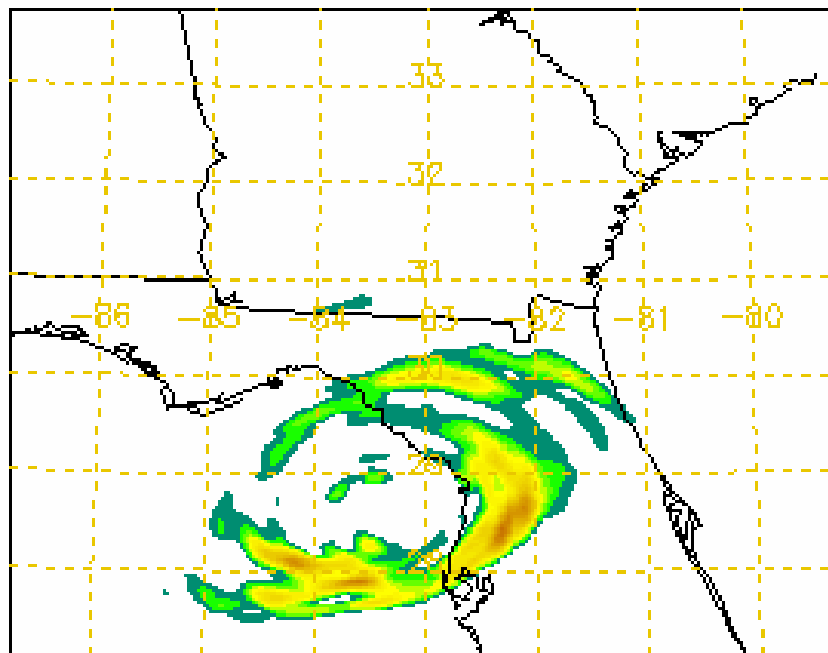
- Verification of wind
 - Hurricane wind verification (We have a problem...)
 - RWIS ingest (sonic anemometry Yulee to Stuart)
- Local Modeling Projects (New UNF P5 Cluster!)
 - Extend WRF model forecasts out to 48-72 hours
 - Expand the size of the model domain (Keys to NC)
 - Use WRF wind forecasts for St. John's River Estuary model
 - Export the WRF model to other Florida/SE WFOs, and other University researchers (primarily Florida)
 - Investigate WRF Hurricane outflow/outer rainband problem with Krishnamurti (Warm core or Flow problem?)
 - Hire a Post-Doc to help? Dependent on funding...any help?

Hurricane Frances

Hourly Precipitation Loop

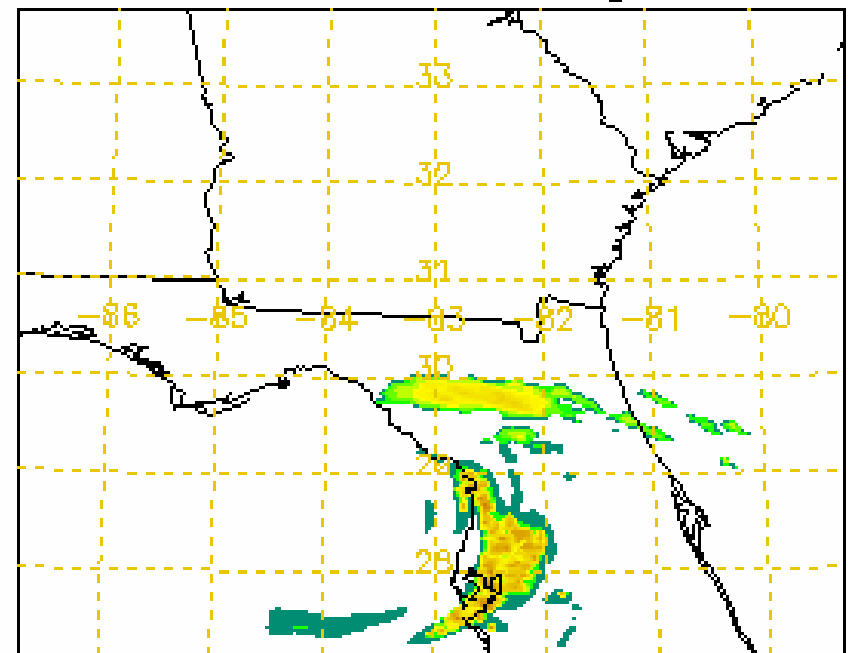
WRF Model

WRF-LAPS 06 UTC RUN



NCEP Stage 4

NCEP Observations Stage IV



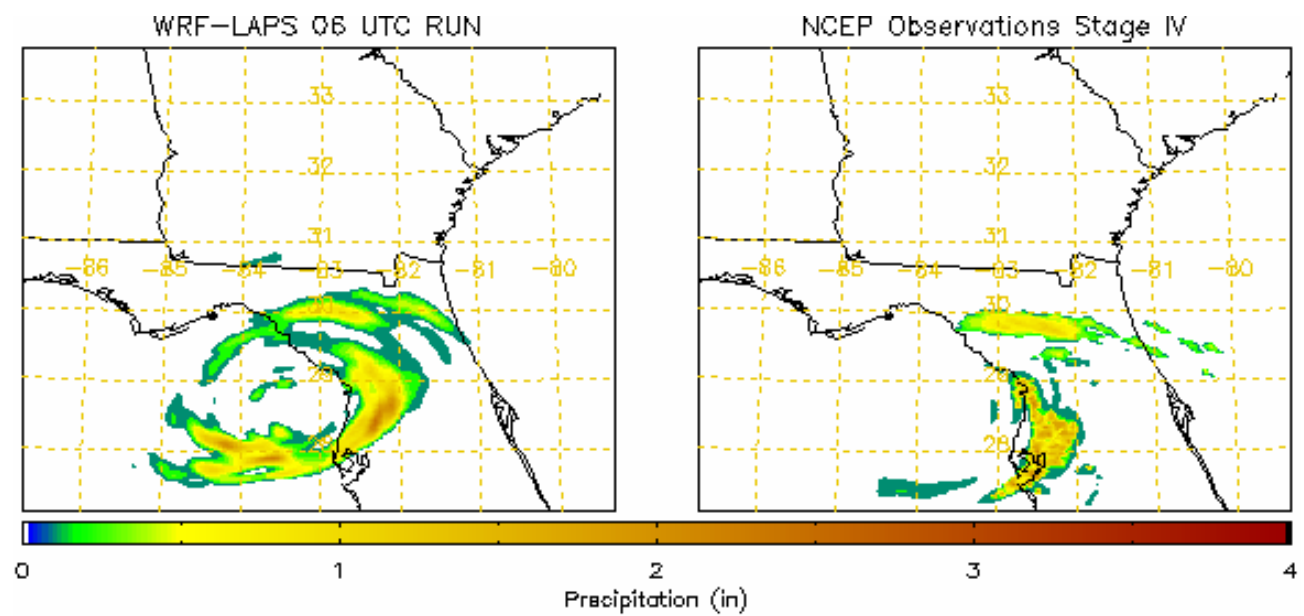
0 1 2 3 4
Precipitation (in)

Hourly loop

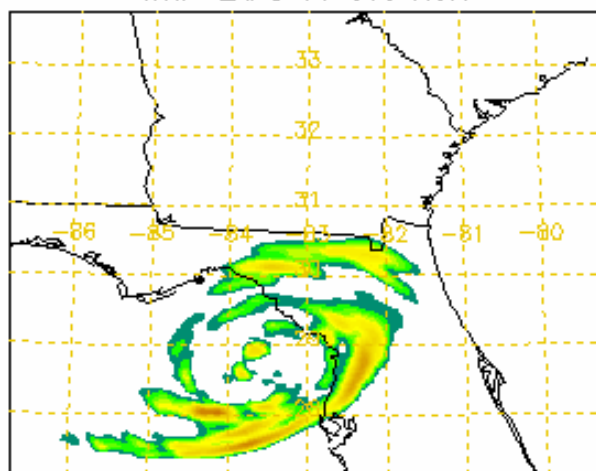
Watch for structure of bands

Rain mass rotates around storm

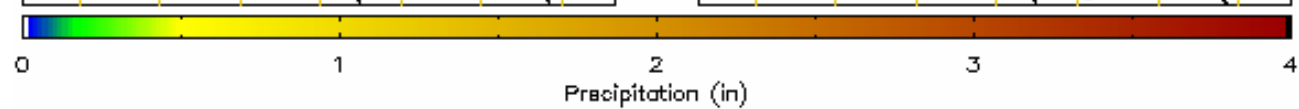
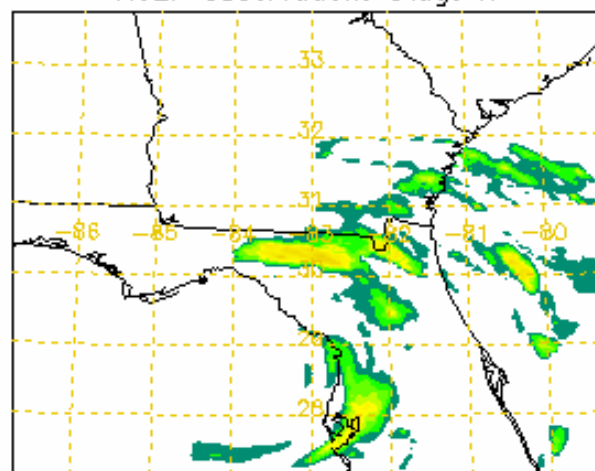
Outer banding is too weak



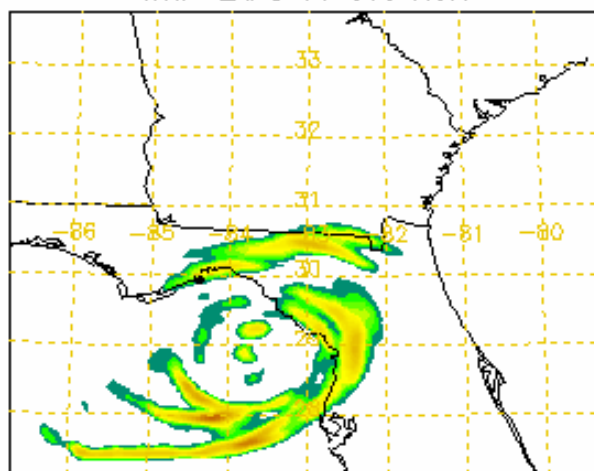
WRF-LAPS 06 UTC RUN



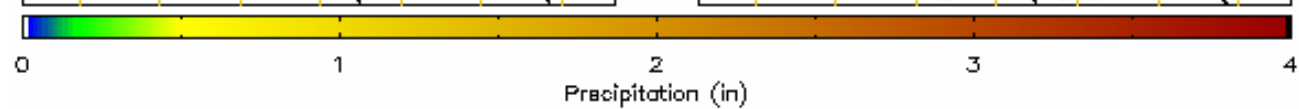
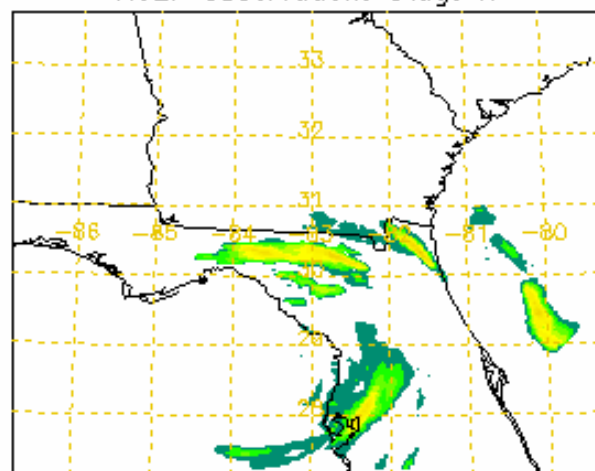
NCEP Observations Stage IV

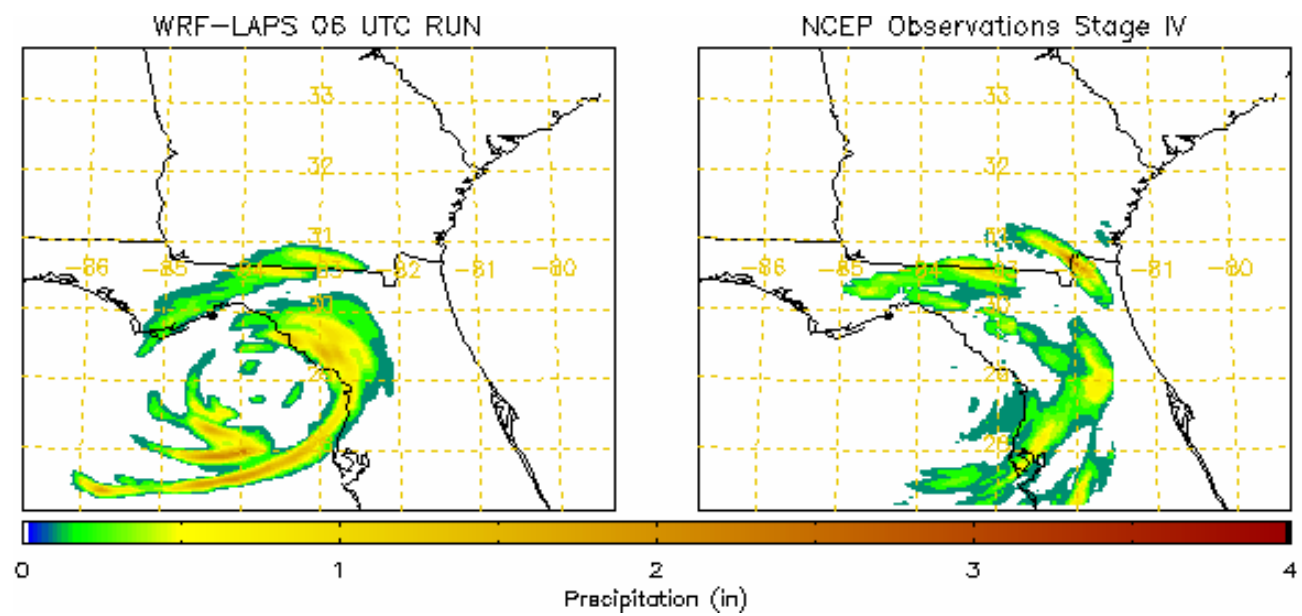


WRF-LAPS 06 UTC RUN

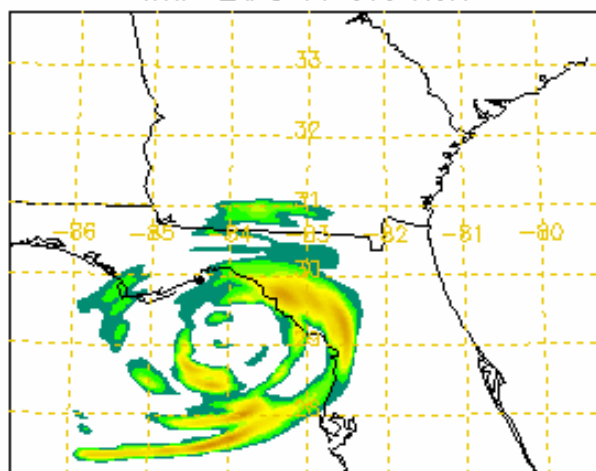


NCEP Observations Stage IV

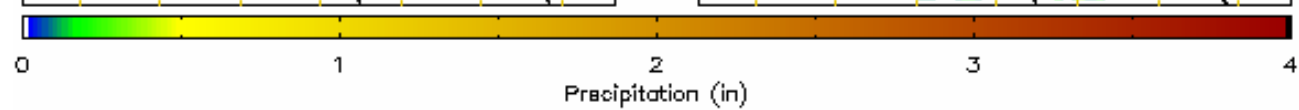
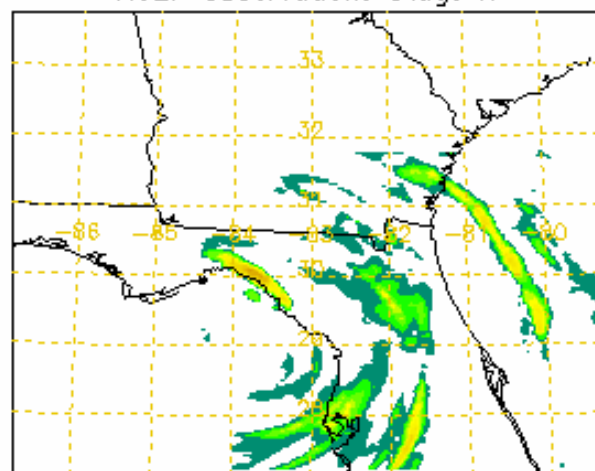




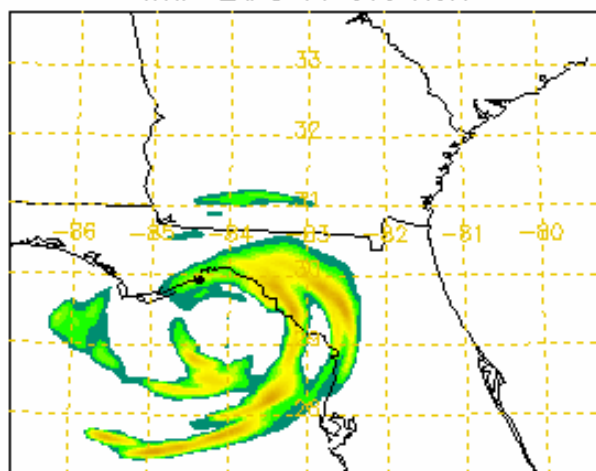
WRF-LAPS 06 UTC RUN



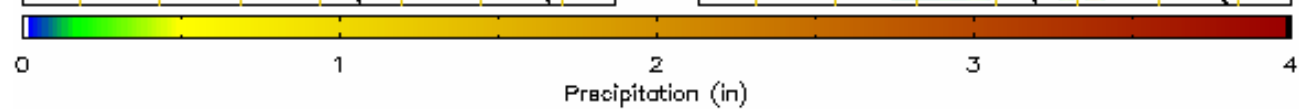
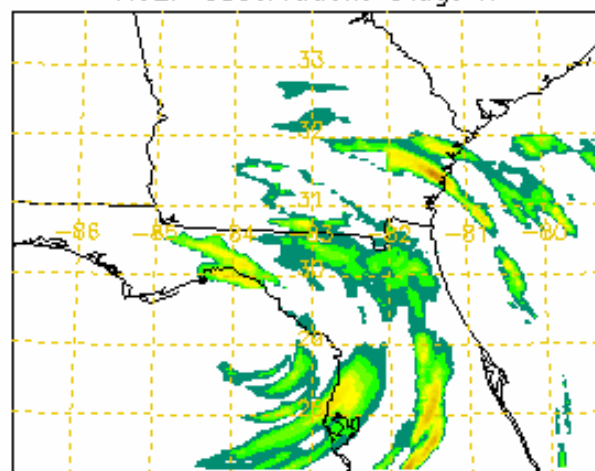
NCEP Observations Stage IV

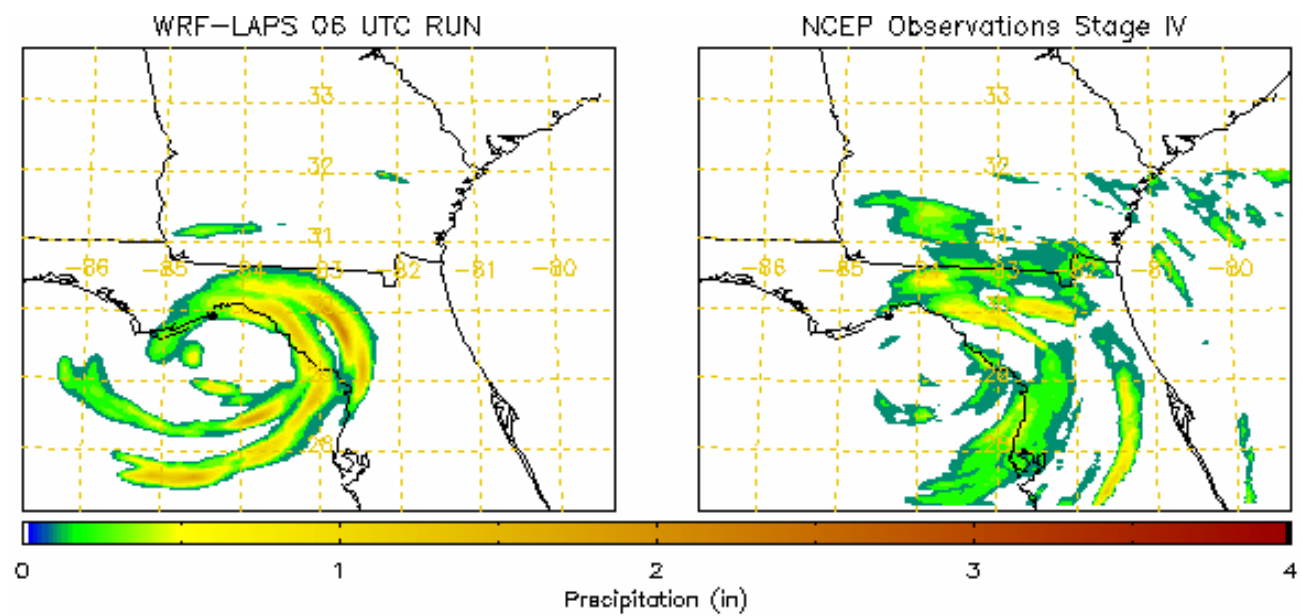


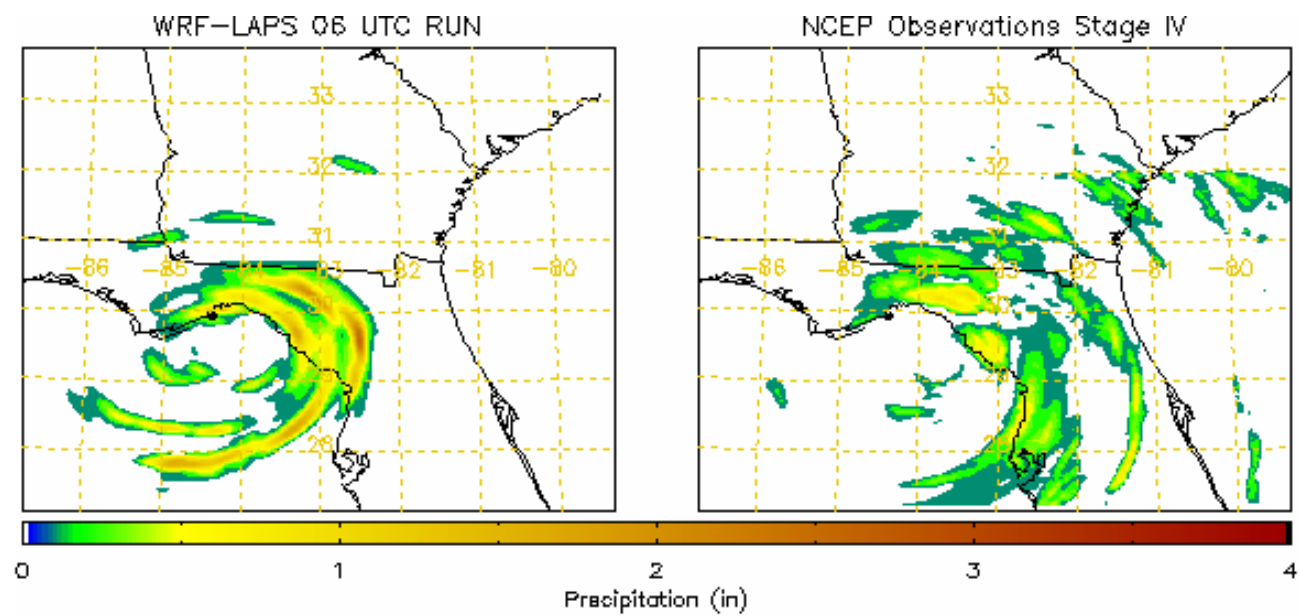
WRF-LAPS 06 UTC RUN



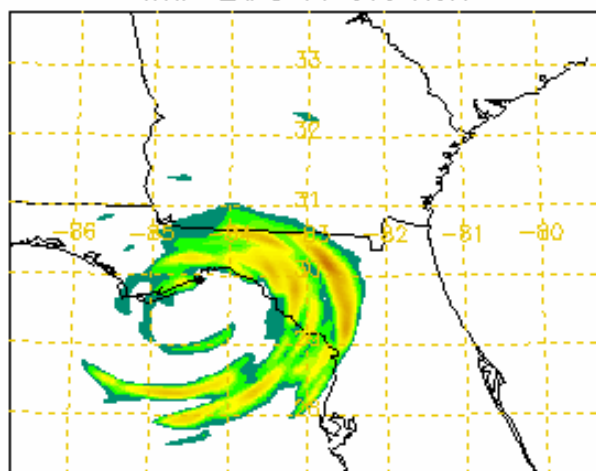
NCEP Observations Stage IV



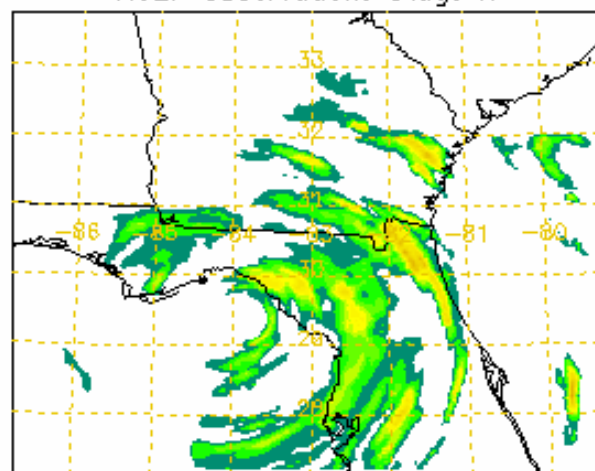


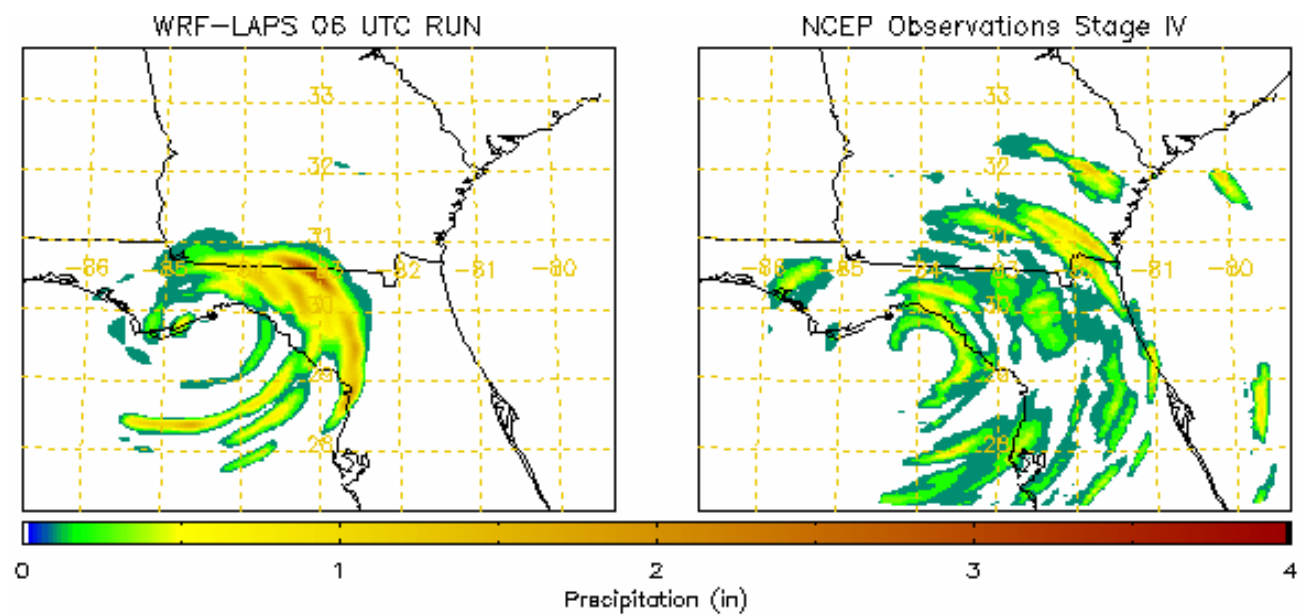


WRF-LAPS 06 UTC RUN

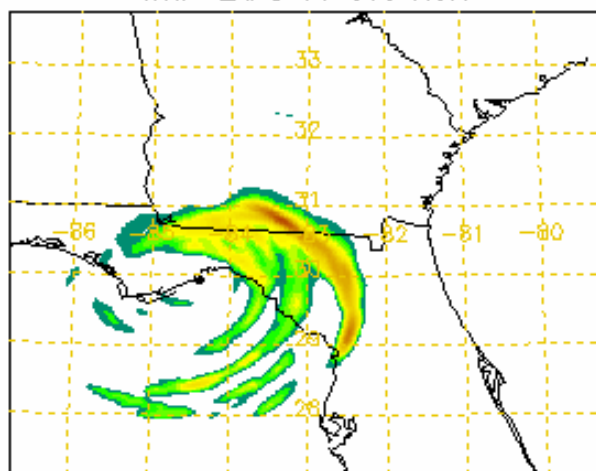


NCEP Observations Stage IV

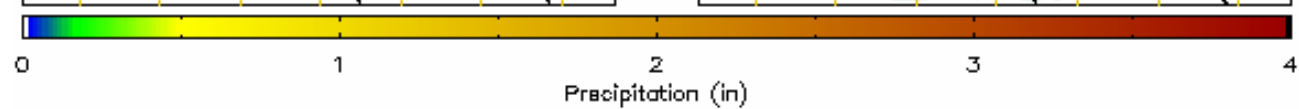
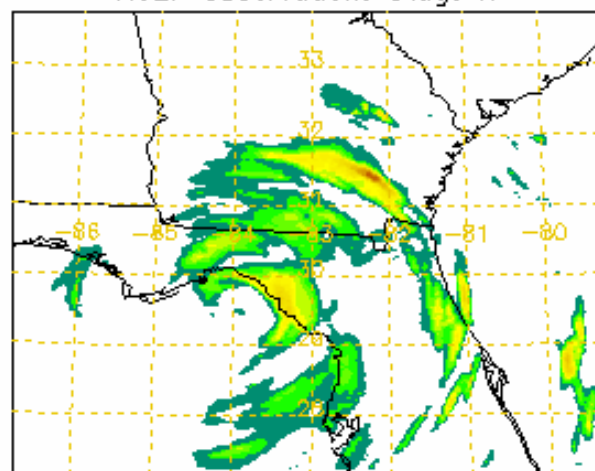


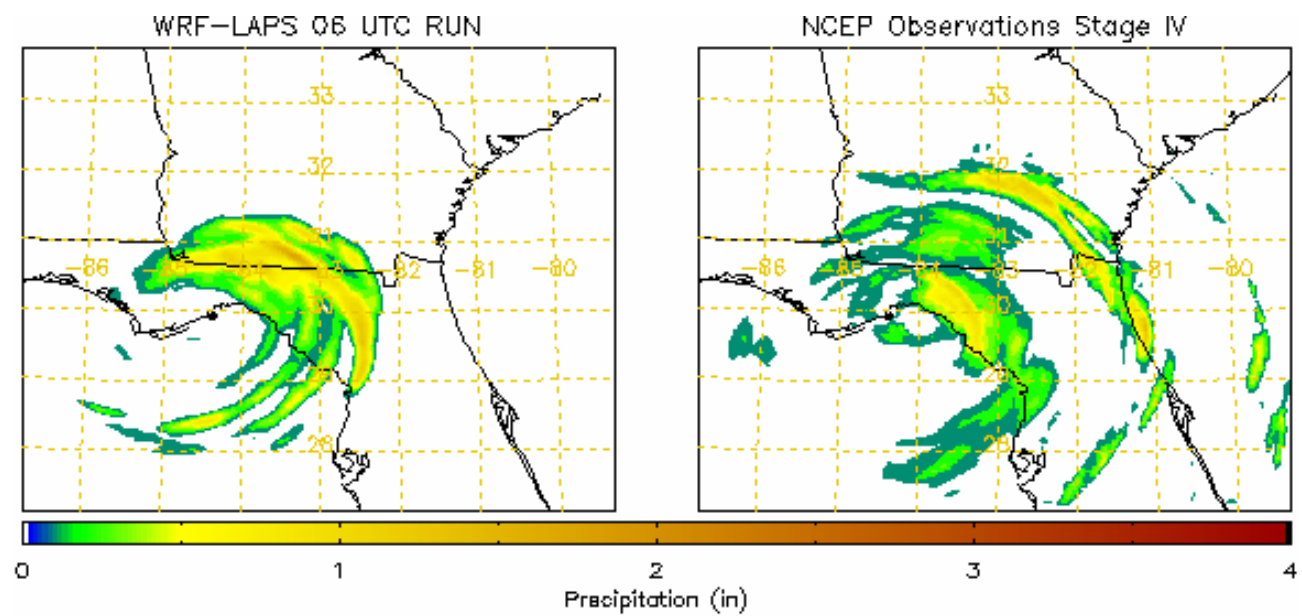


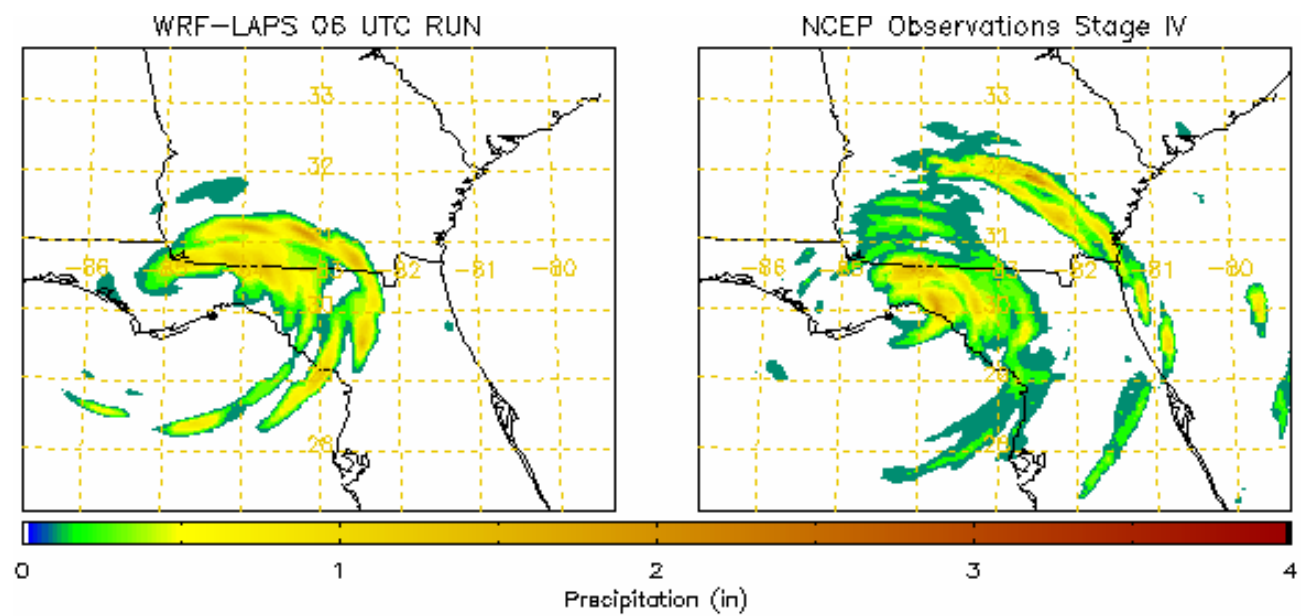
WRF-LAPS 06 UTC RUN

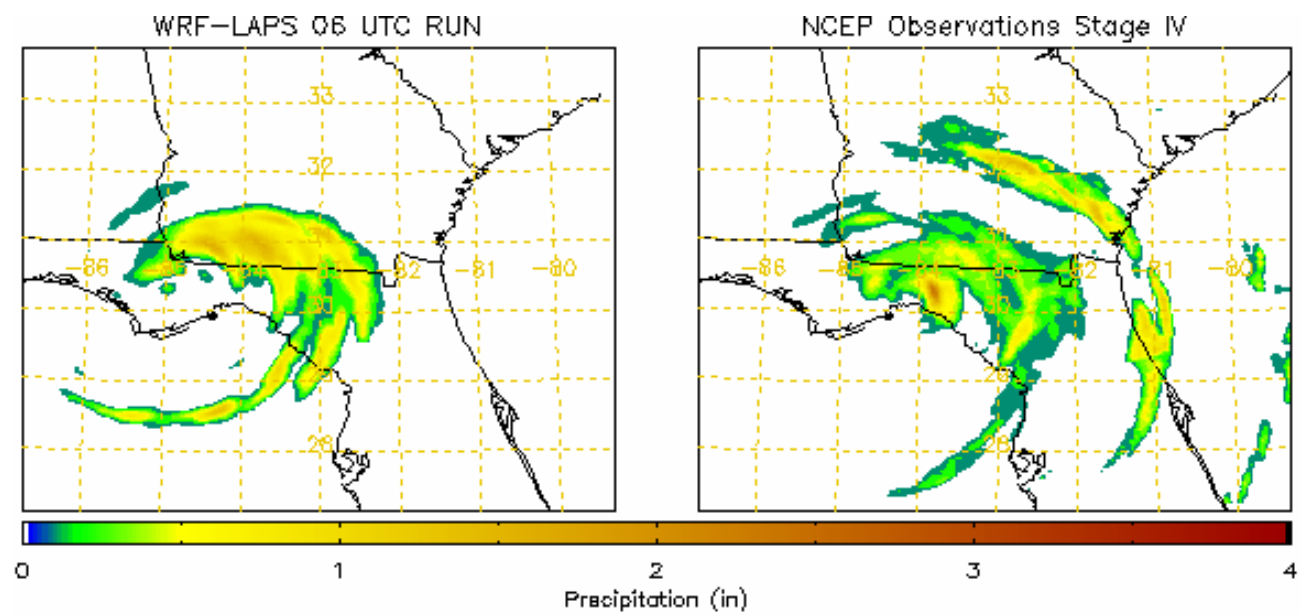


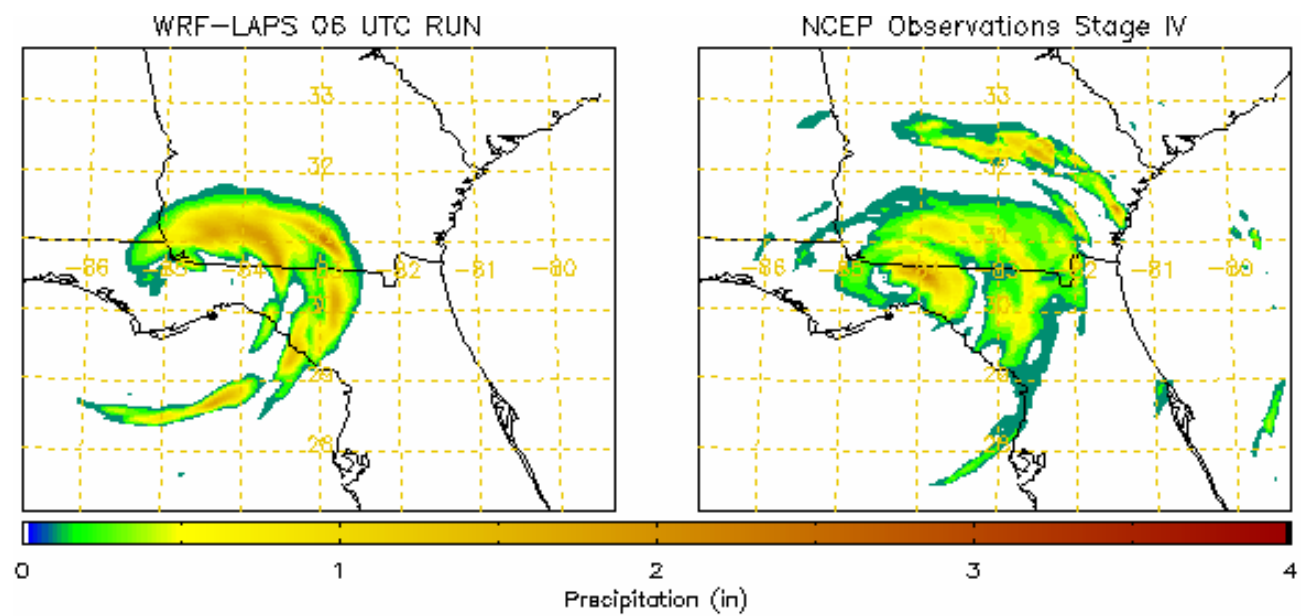
NCEP Observations Stage IV

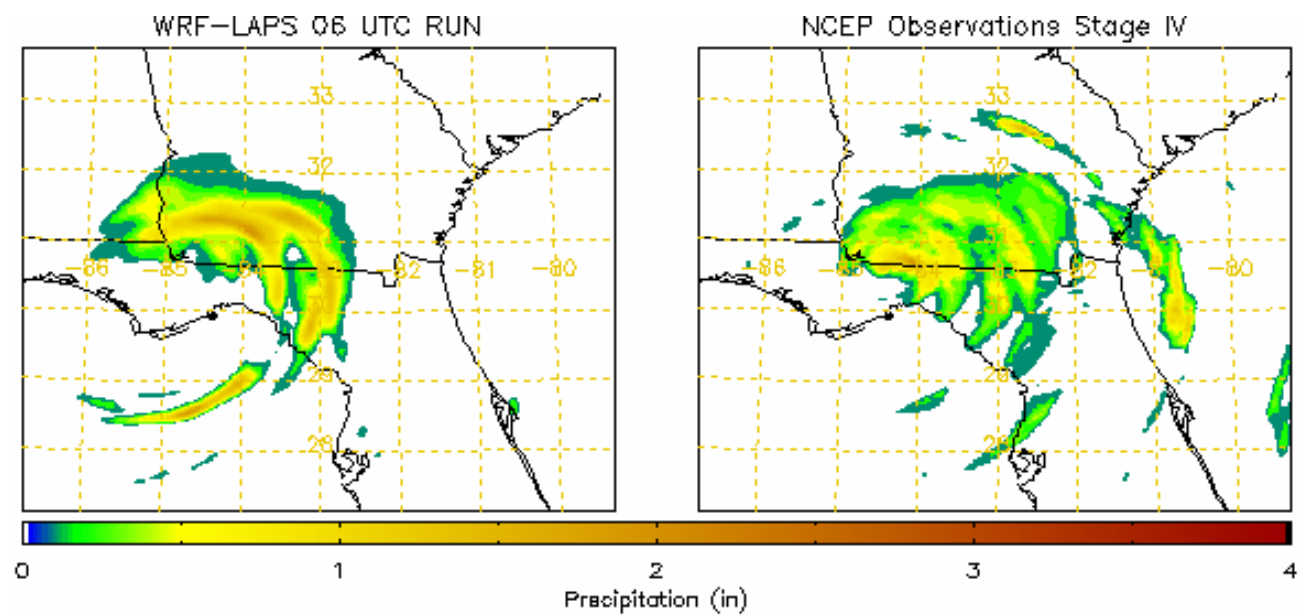












Summary:

WRF ARW Model has Tropical Cyclone promise (configure?)

Need larger domain (SE) 2005 version and to investigate 2004 storms more closely...

Is there funding out there?