NCAR

Scientific Overview for MLB ANC Demonstration

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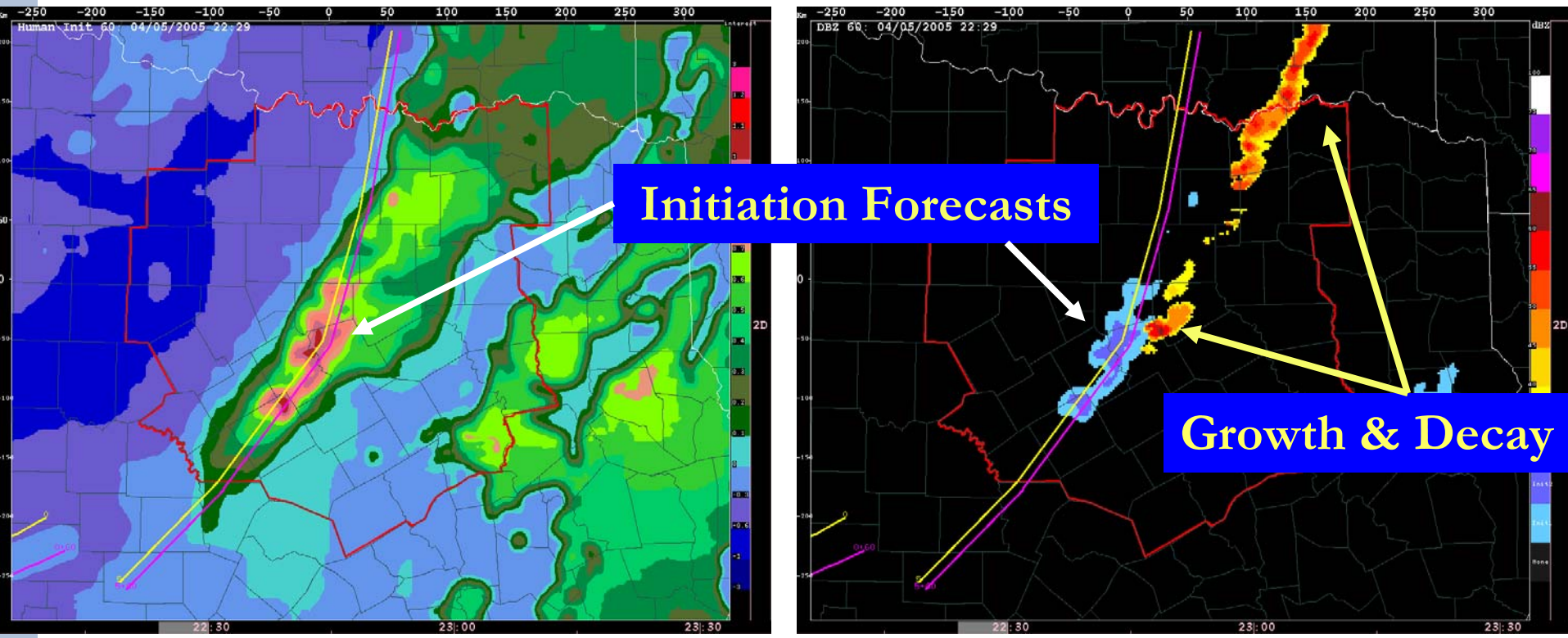
NCAR-RAL

National Center for Atmospheric Research

Training Topics

- Overview / Human Interaction
- AWIPS ANC Products
- Fuzzy Logic and MLB CF Regime
- Performance Considerations
- Lightning Topics

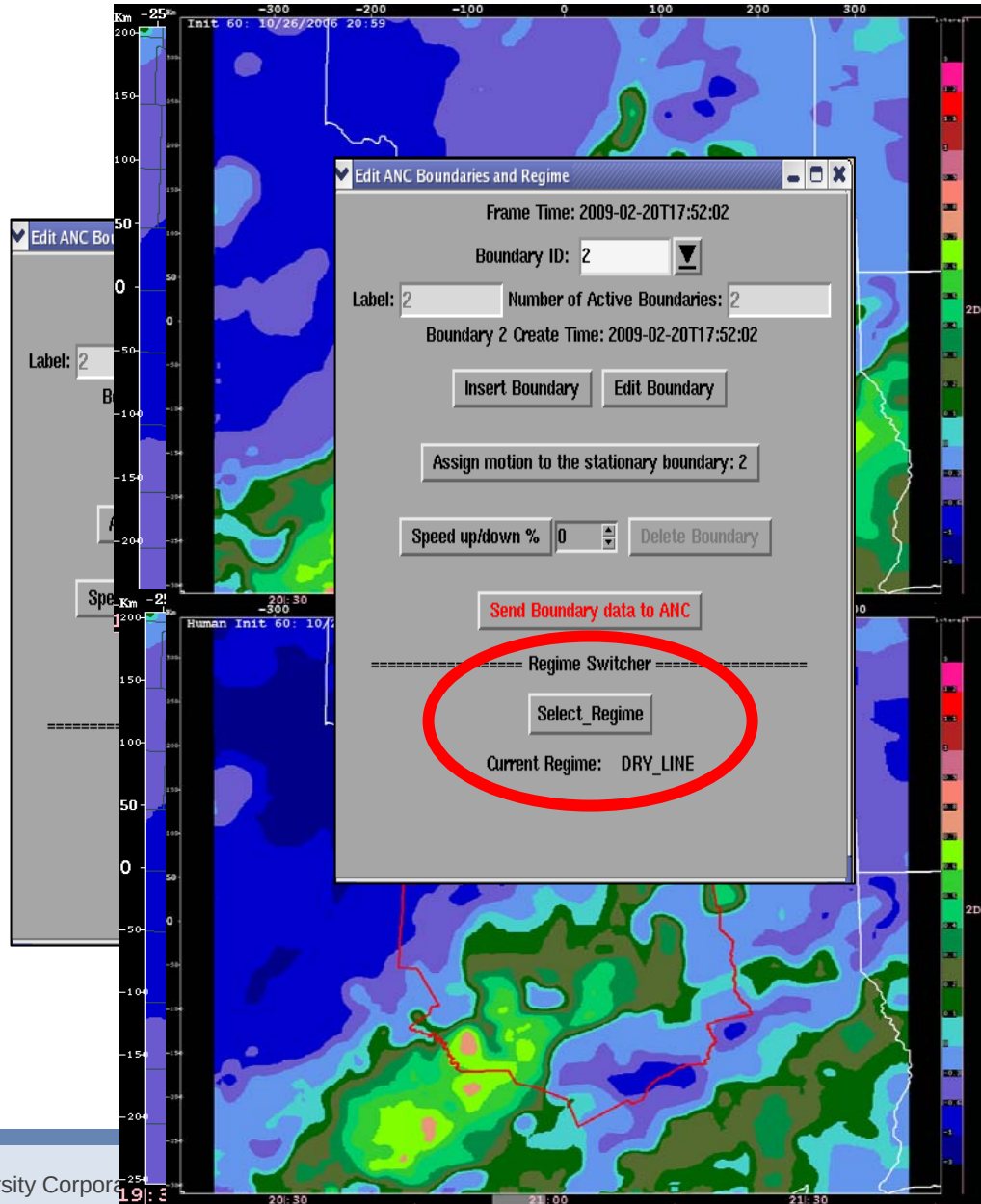
NCAR Auto-Nowcaster



- Routine (5mins) short-term (0-1hour) forecasts of thunderstorm initiation, growth and decay.
- Uses fuzzy logic to combine observations, NWP and forecaster input to generate nowcasts.

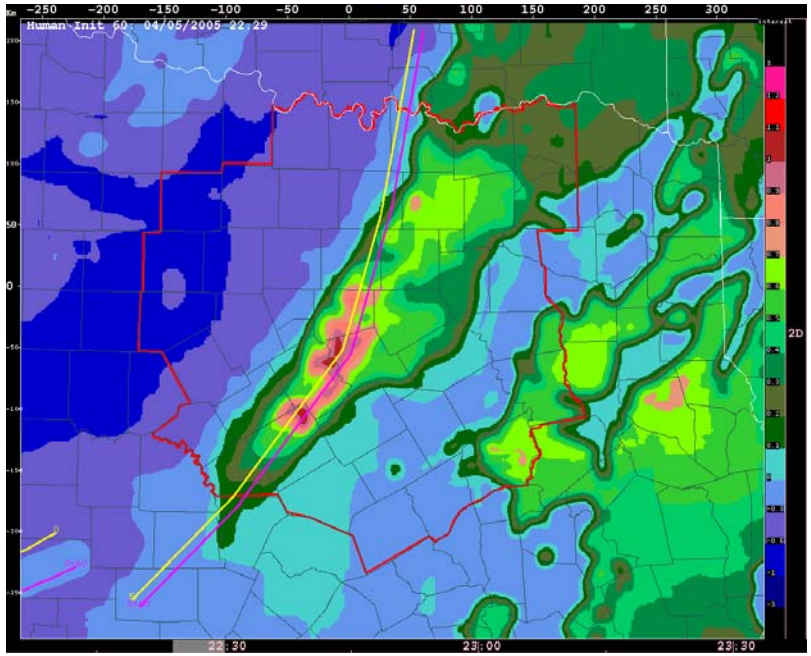
Interaction

- Boundary Entry
- Polygon Entry
- Init Field Nudging
- Regime Selection



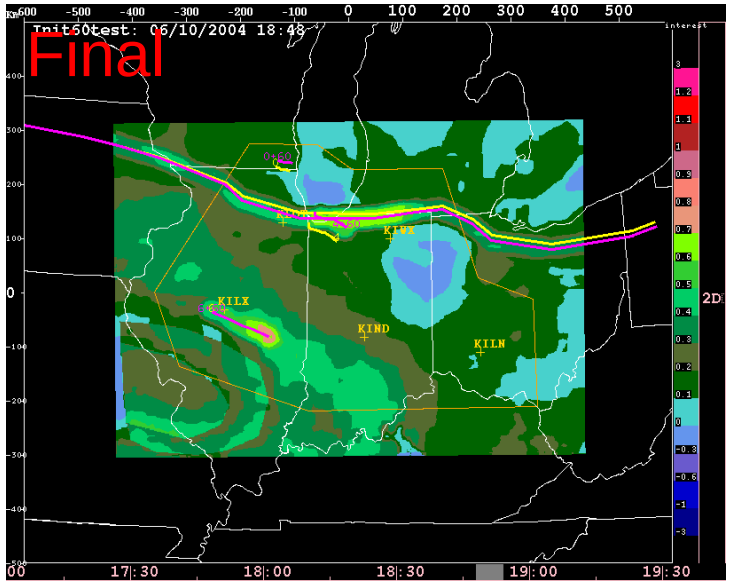
HumanInit60 Field (Initiation Final)

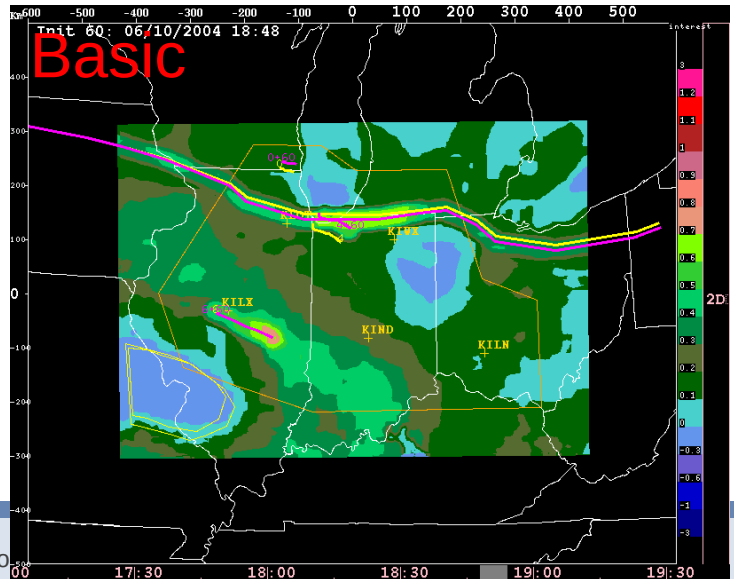
- Fuzzy logic output for likelihood for initiation at 60min.
- Warmer colors indicate higher likelihoods
- Values of .7 and higher (salmon/red) interpreted as threshold for storm initiation at 60mins.



CronusInit60 (Initiation Basic)

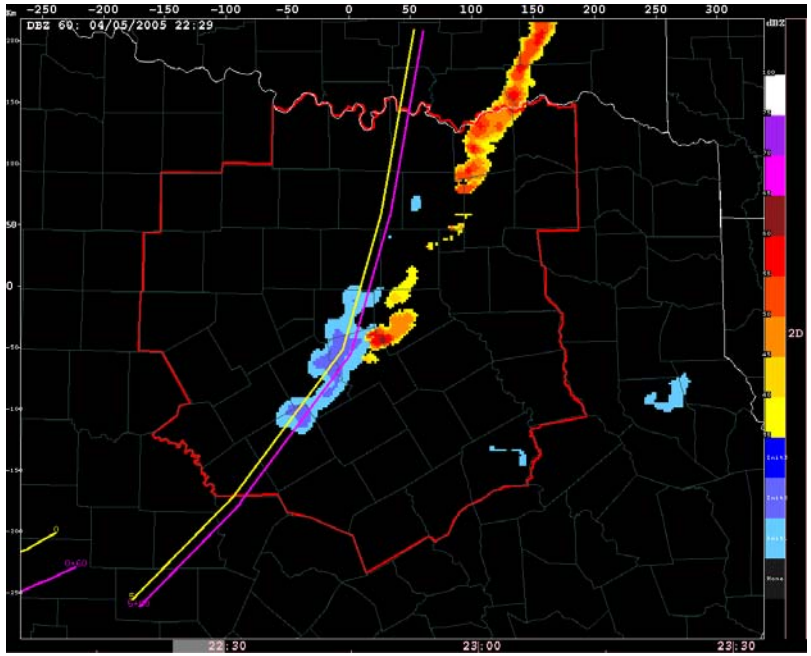
- Differs from HumanInit60
- No Nudging or Polygons used
- Boundary Predictor Fields still included
- Shows the Init60 field before human edits for comparison





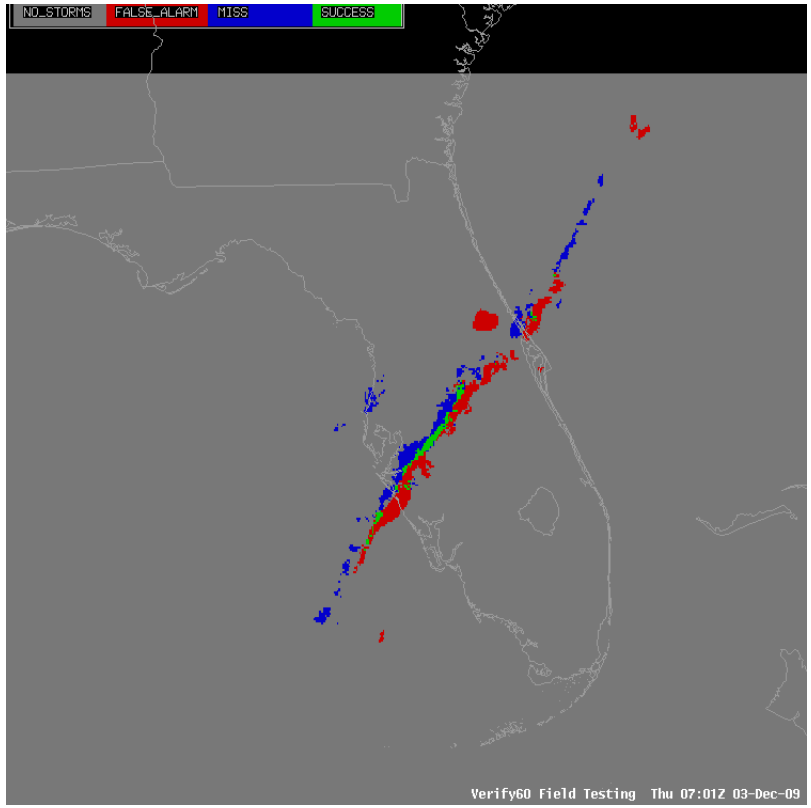
Gandi60 Field (Nowcast Final)

- Combined Growth/Decay and Initiation likelihood field
- Blue colors are arbitrary thresholds of initiation likelihood
- Warm colors are Growth/Decay of existing echoes.
- Existing echoes been filtered to remove stratoform precipitation



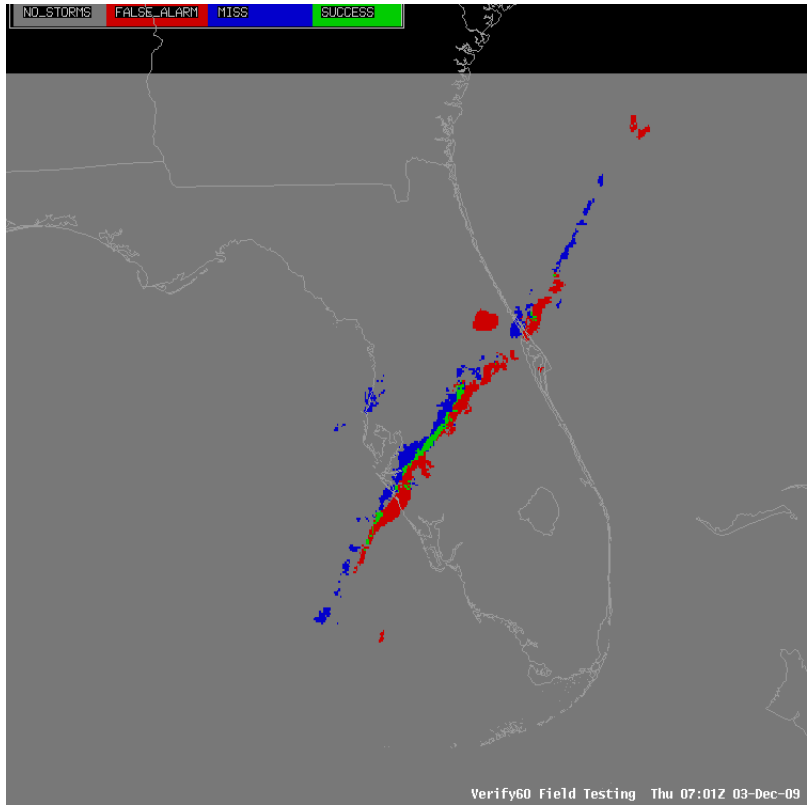
Verify60

- Shows the T-60min forecast valid NOW.
- Green are Hits (good forecasts)
- Blue are missed forecast areas
- Red are incorrect forecast areas



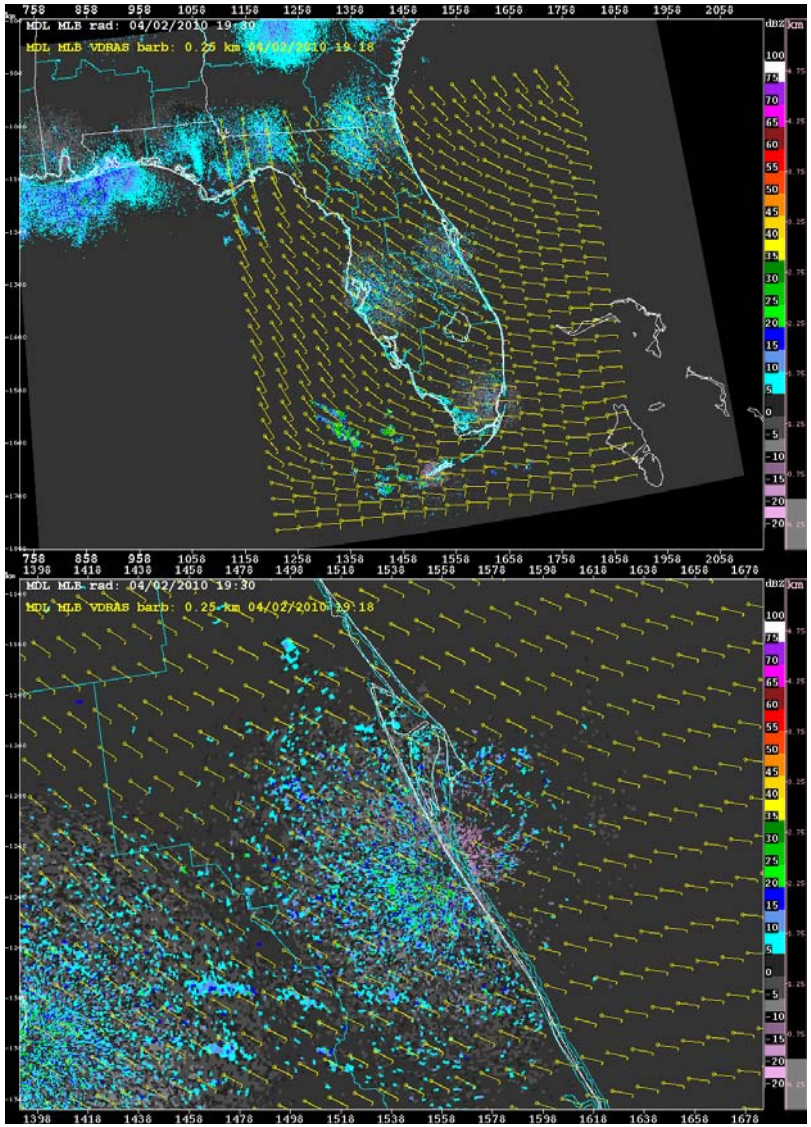
VerifyNH60

- NH stands for No-Human
- Validation field for forecasts not including any human interaction
- No Boundaries, Nudges, or Polygons.



Adjoint Sfc Wind

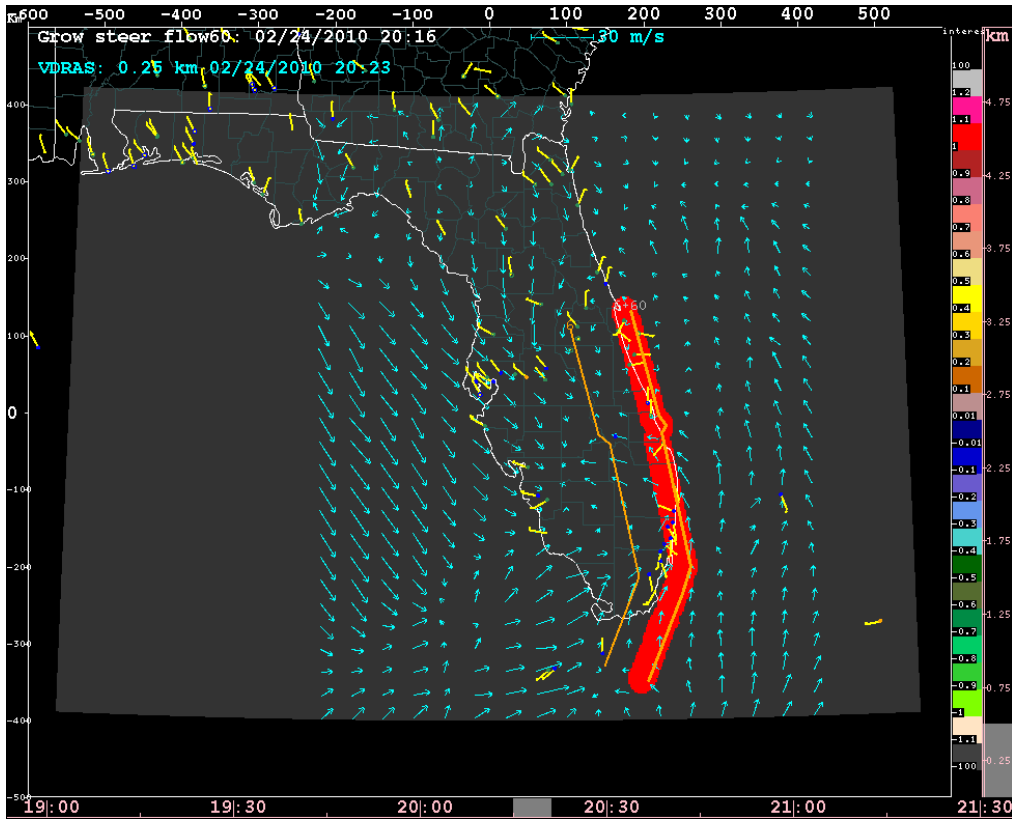
- Wind barbs for 250m from VDRAS
- Derived from background model field and radar data assimilation
- Other layers available



VDRAS – Variational Doppler Radar Assimilation System

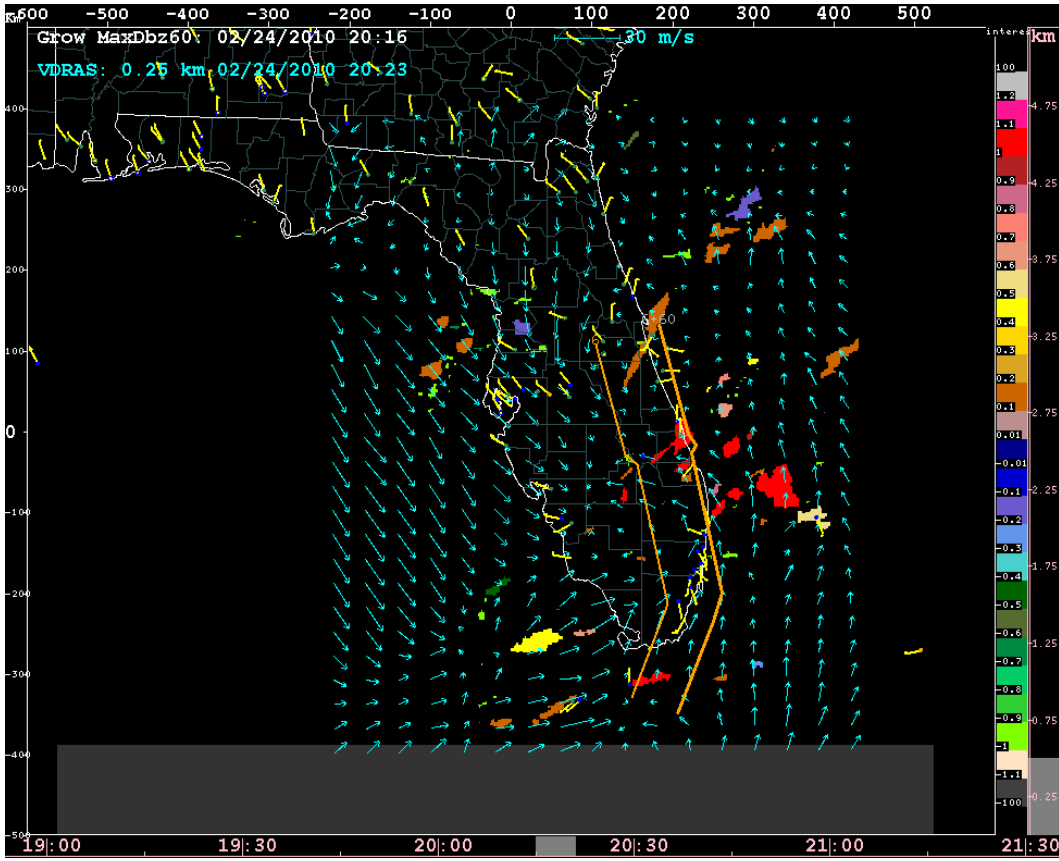
Grow60 – Steering Flow

- Steering Flow relative to human entered boundary
- Used to determine whether storms will stay anchored on boundary



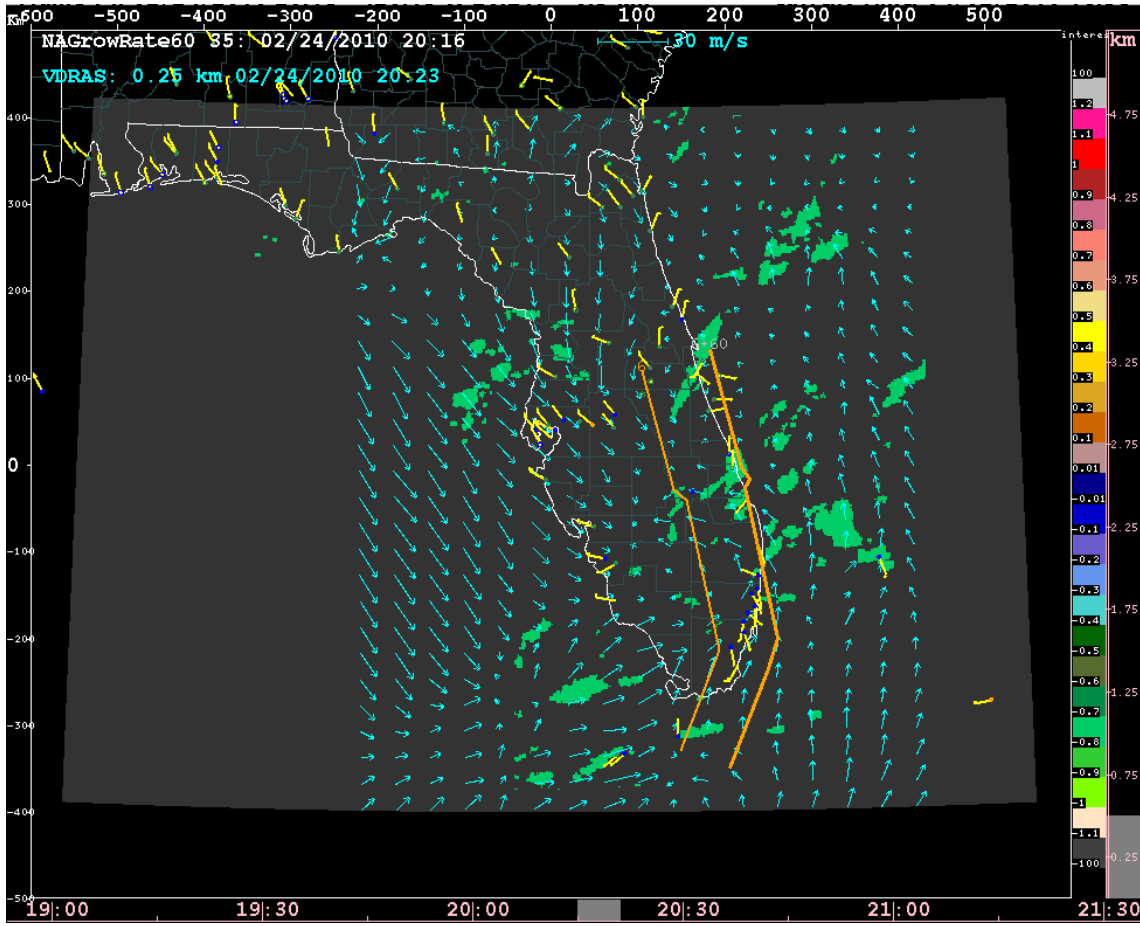
Grow60 MaxDbz

- Maximum observed reflectivity extrapolated 60mins



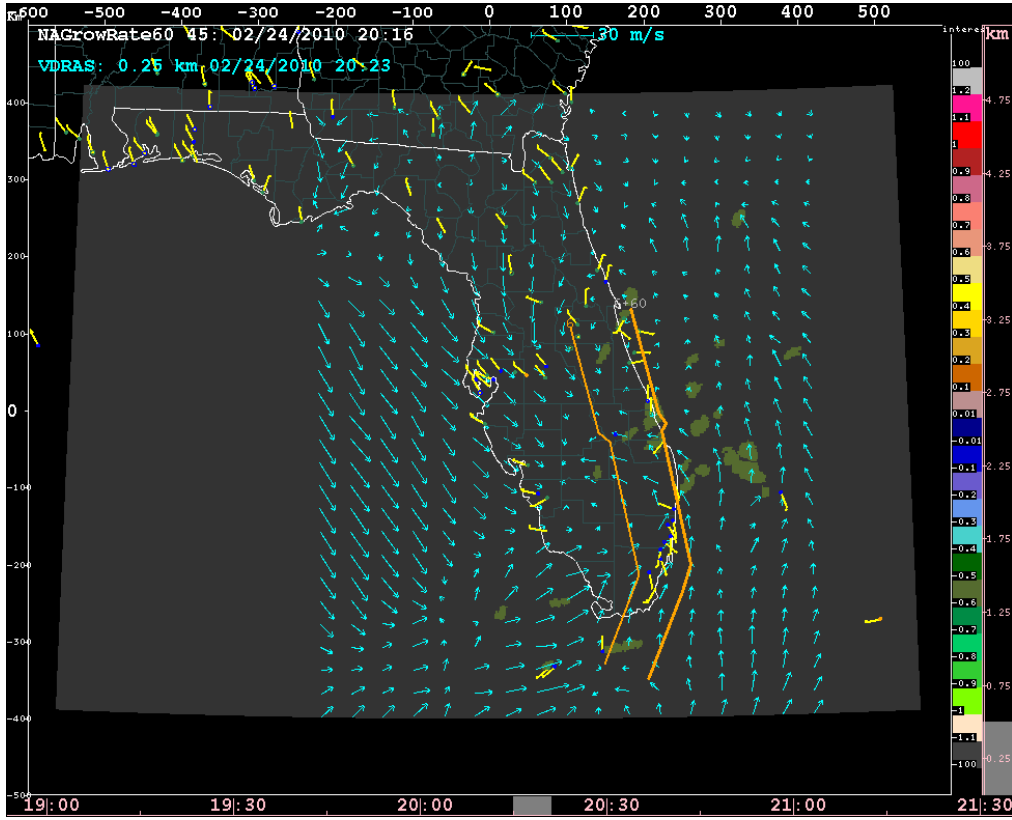
Grow60 - 35dbz GrowthRate

- Normalized Area Growth Rate for 35dbz echos (advected)



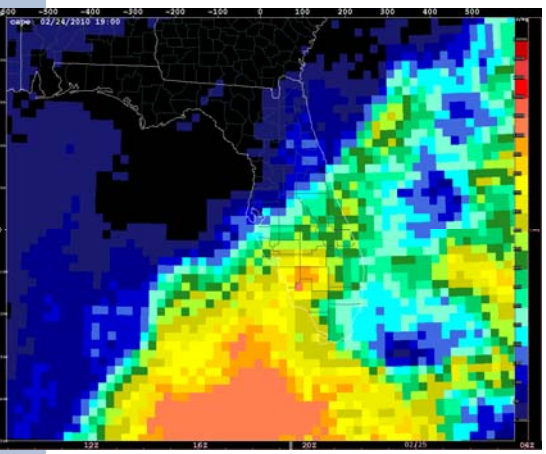
Grow60 – 45dbz GrowthRate

- Normalized Growth Rate for 45dbz echos (advected)

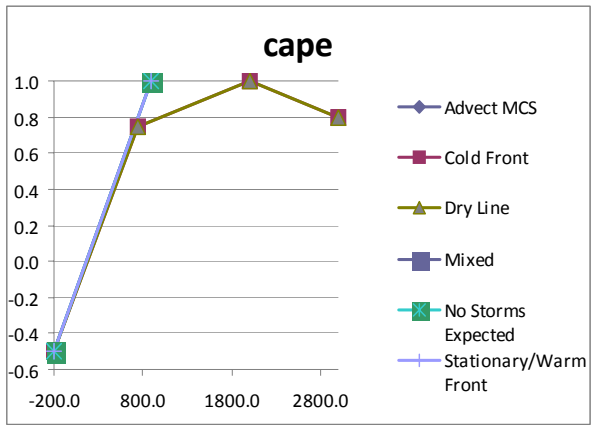


Fuzzy Logic

- Fuzzy Logic ingests predictor fields and applies a membership function to the field values to produce individual interest maps.



X



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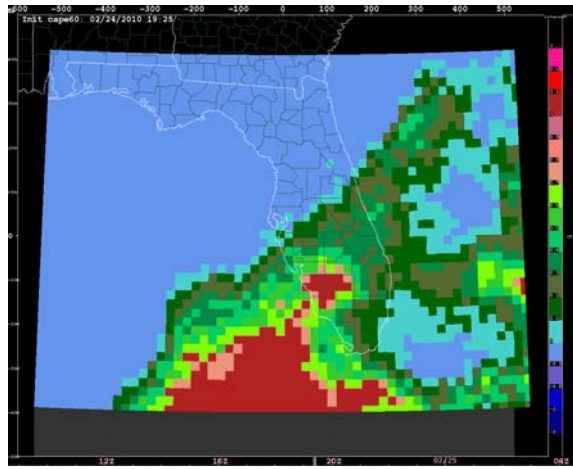
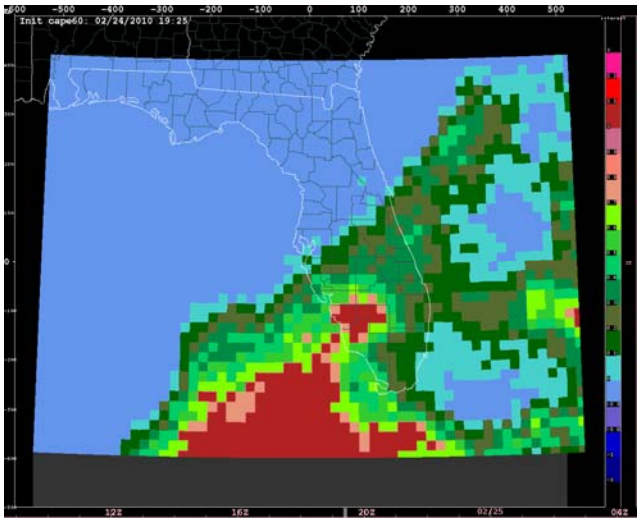


Fuzzy Logic

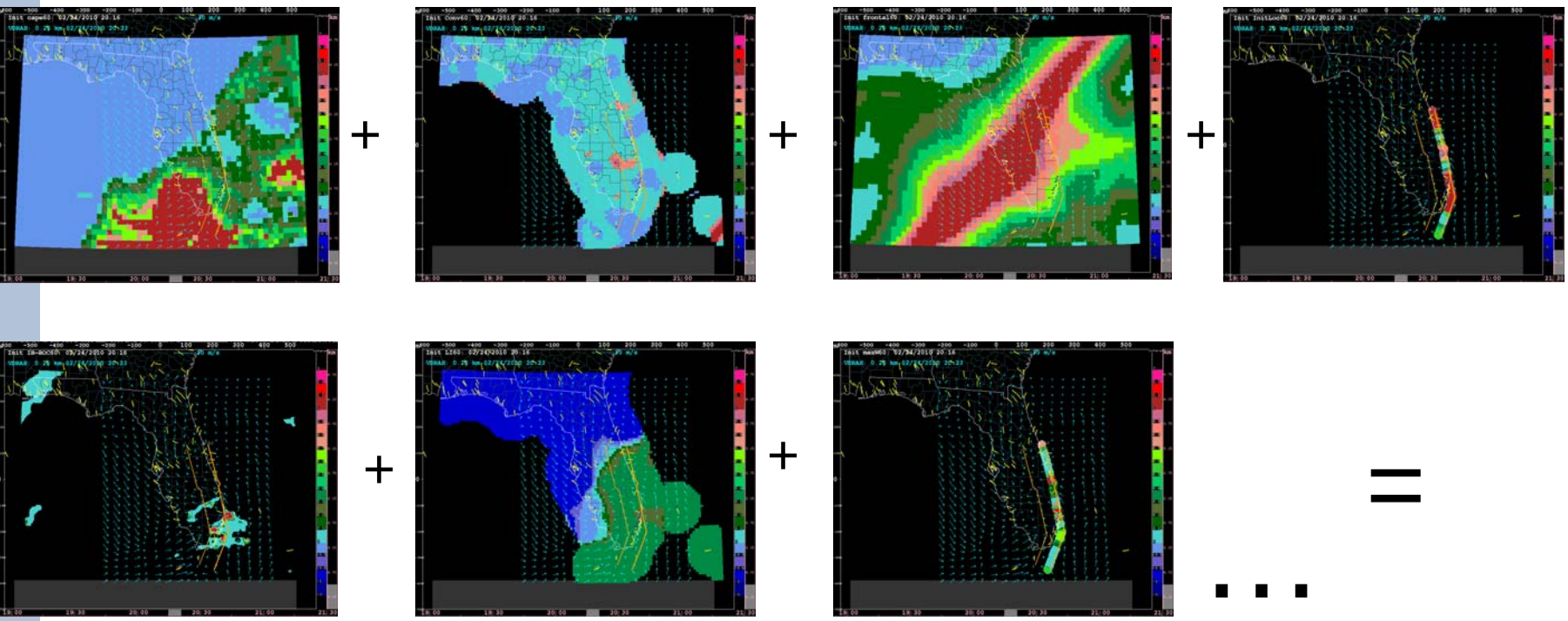
- Each Interest map is then multiplied by a weight



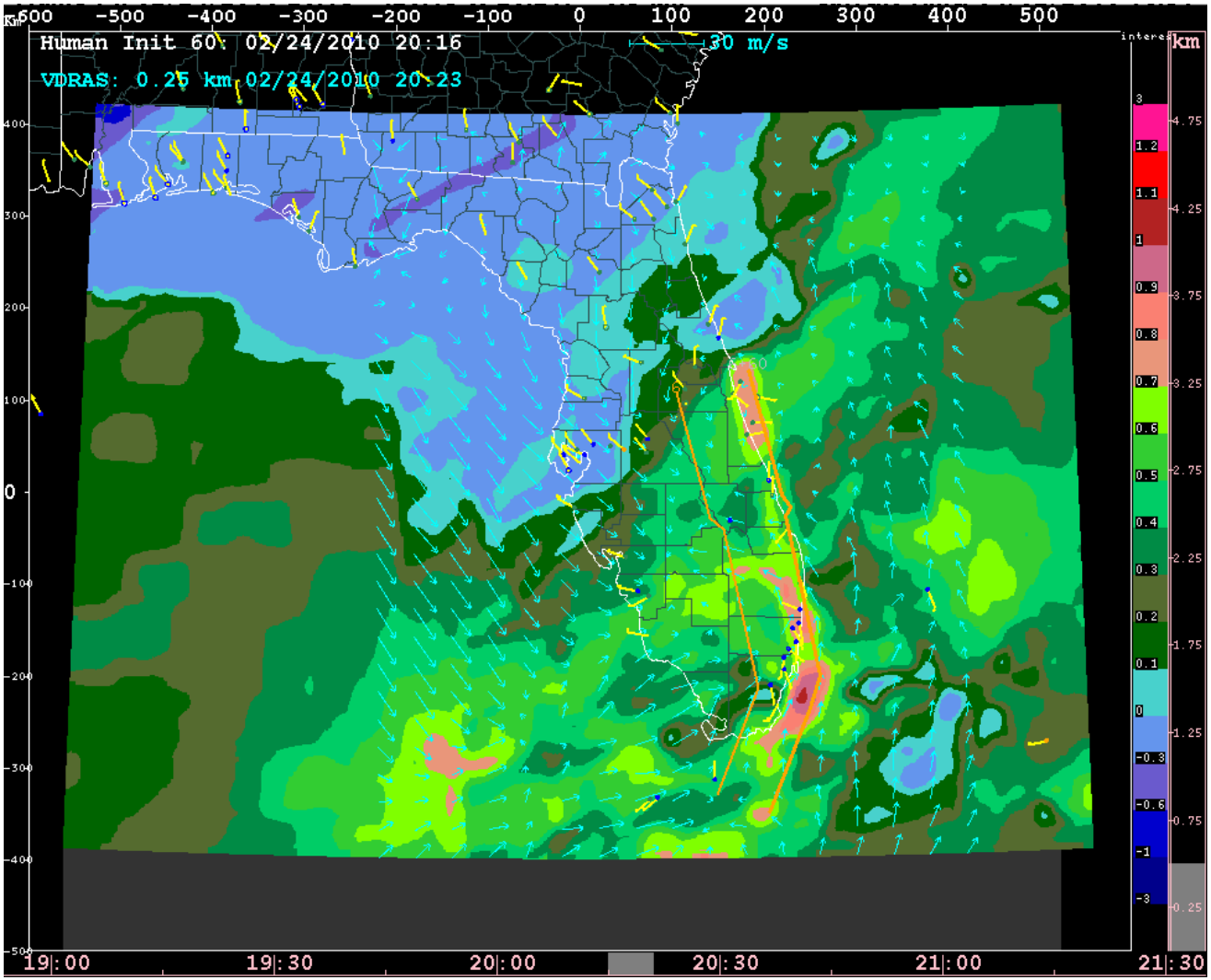
X 0.20

Fuzzy Logic

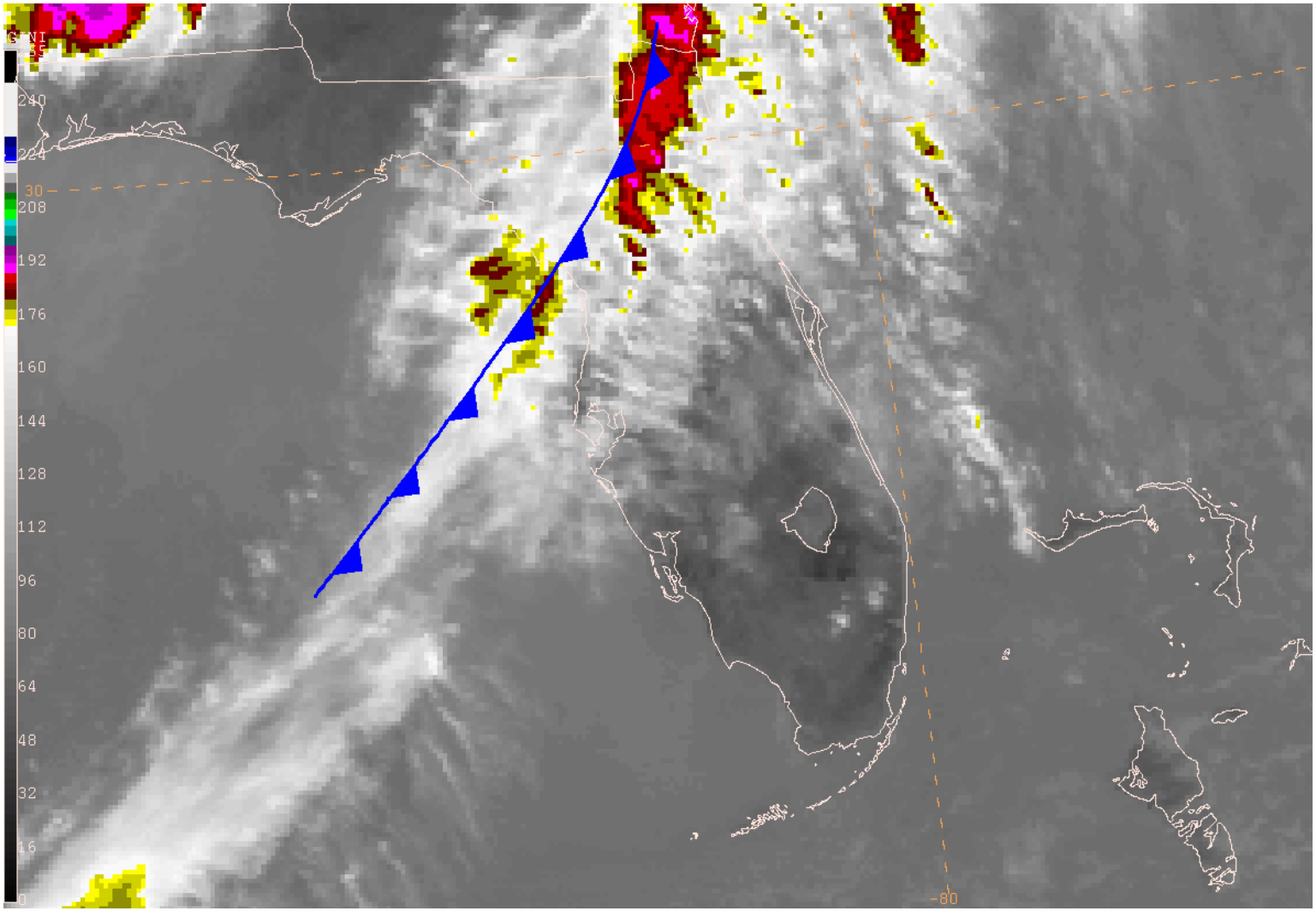
- All the weighted interest maps are then summed to produce the Init60 field



Init60

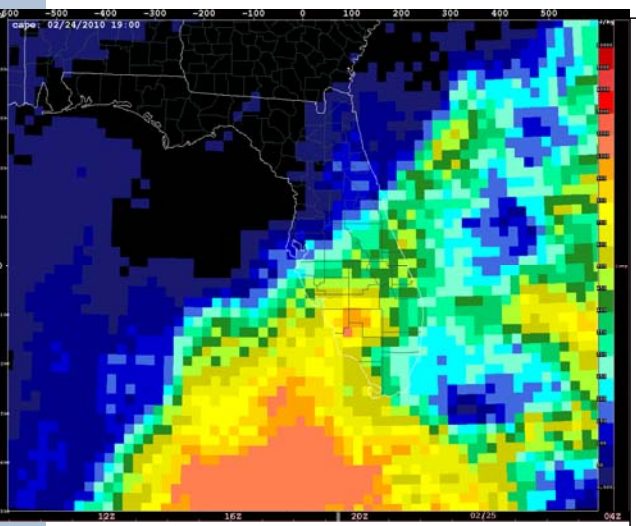


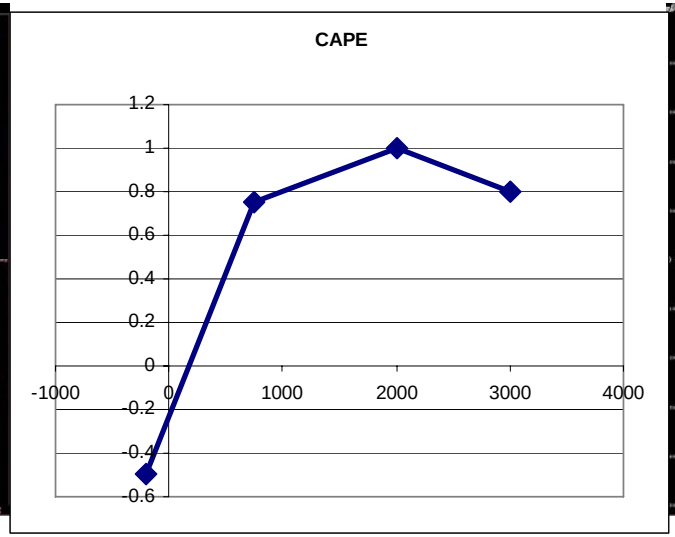
Cold Front Regime

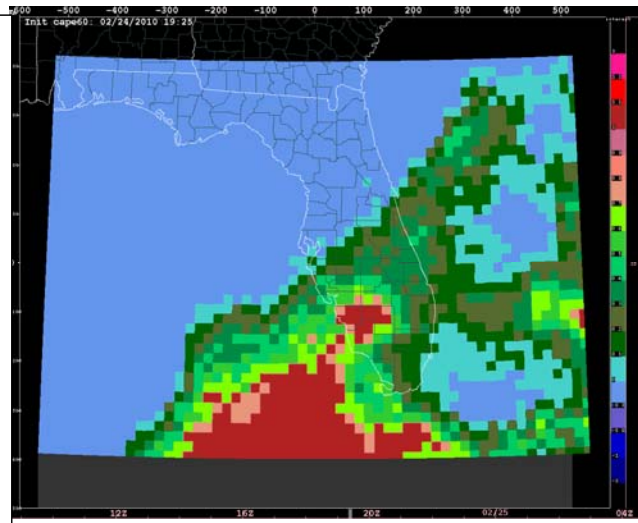


Cold Front Predictors

- Cape – RUC Most Unstable Cape 975mb-500mb.

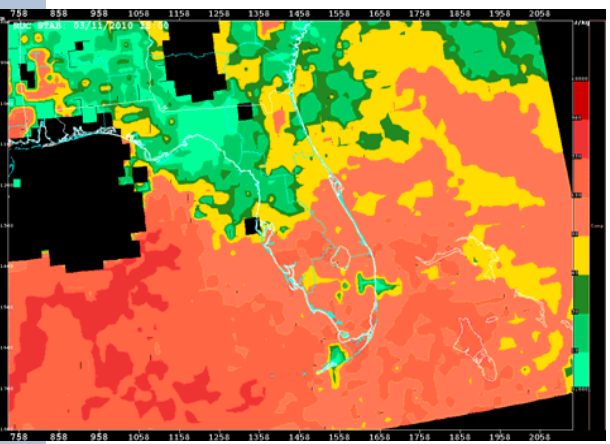


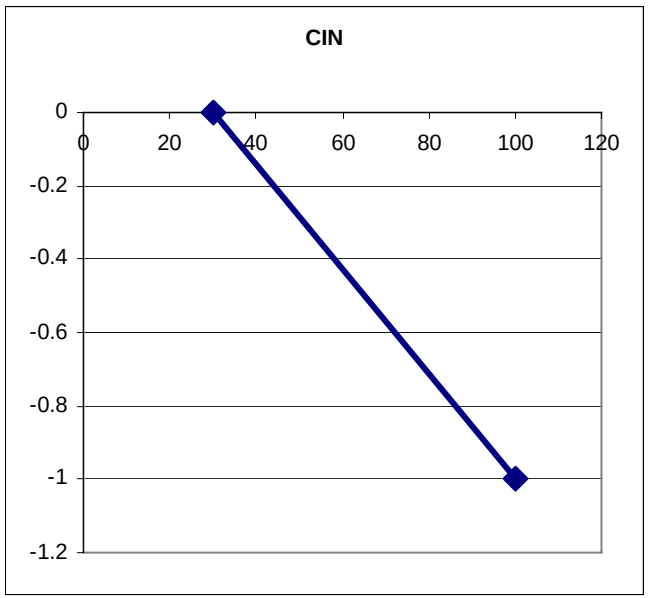


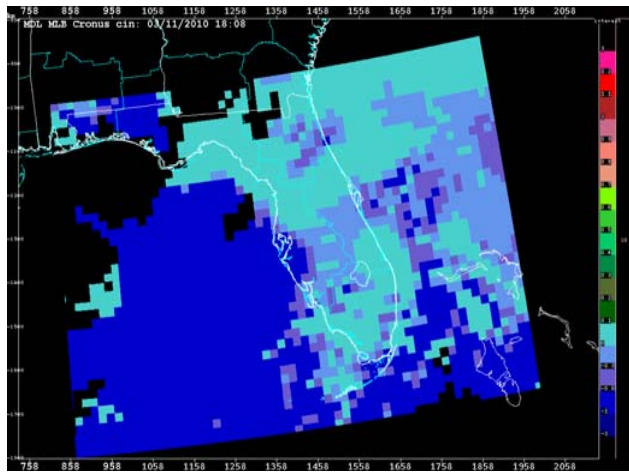


Cold Front Predictors

- CIN – Mean CIN between 975mb-900mb

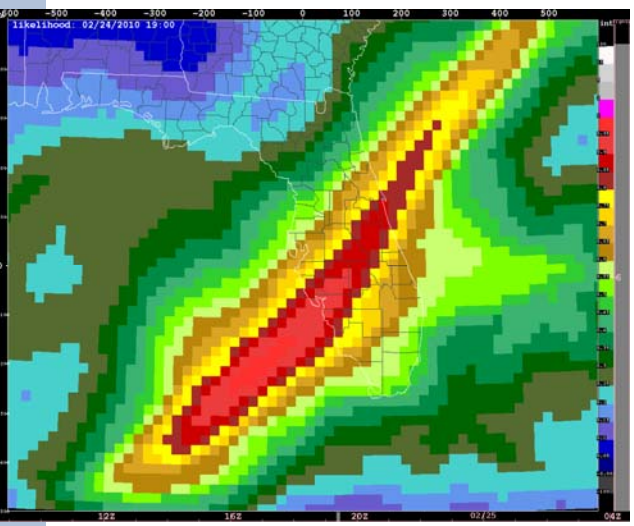


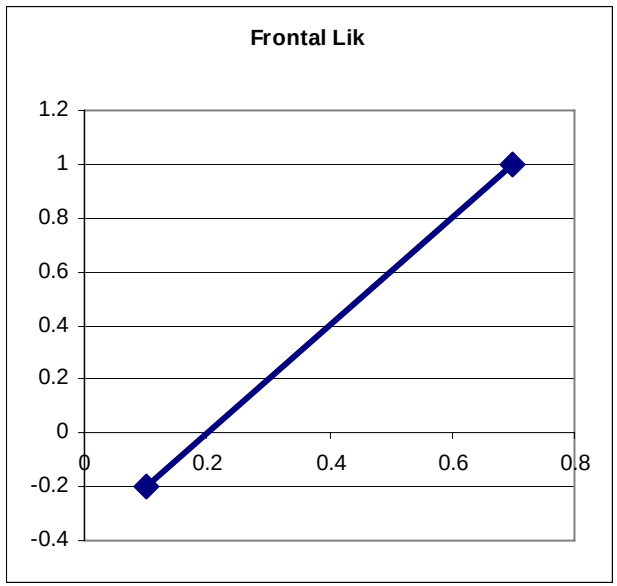


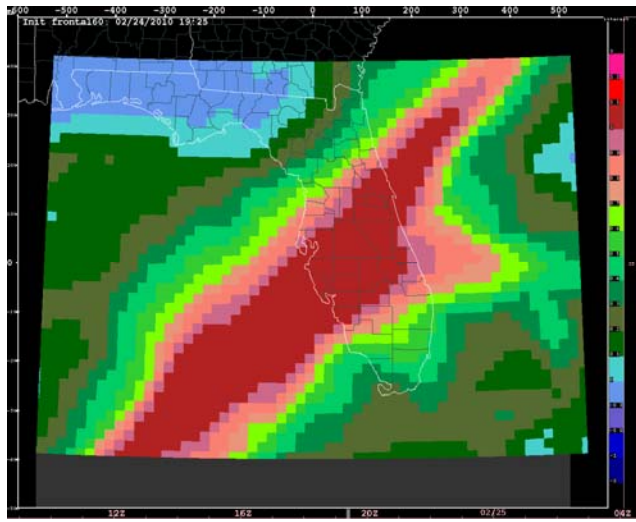


Cold Front Predictors

- Frontal Likelihood – Fuzzy logic field that uses RUC convergence, vorticity, and theta-e gradients to identify broad frontal zones.

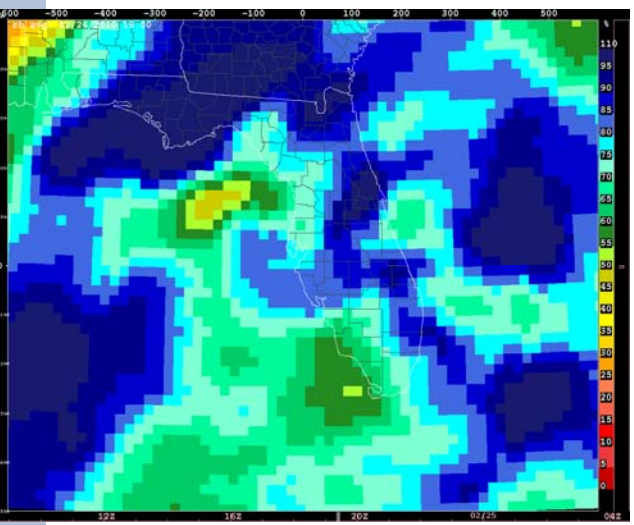


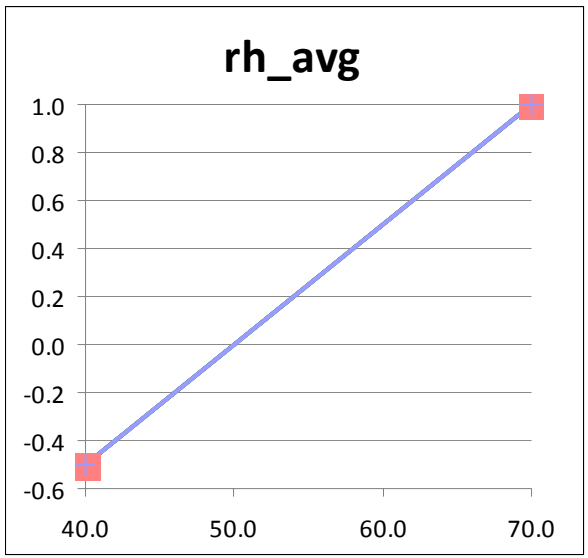


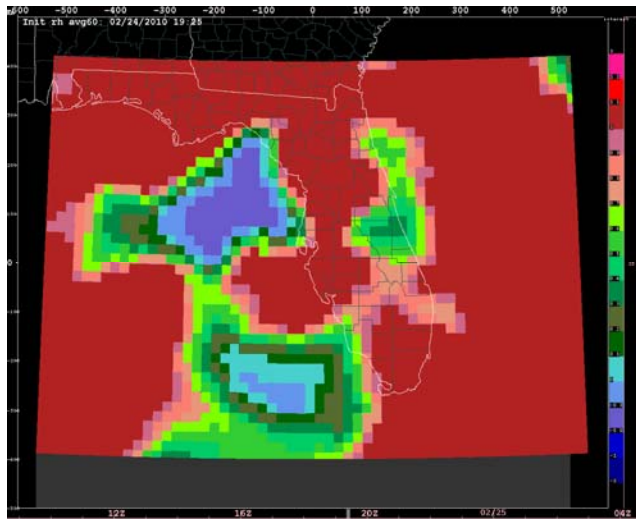


Cold Front Predictors

- Relative Humidity – Layer average between 875mb-625mb. Intended to assess mid-level moisture.

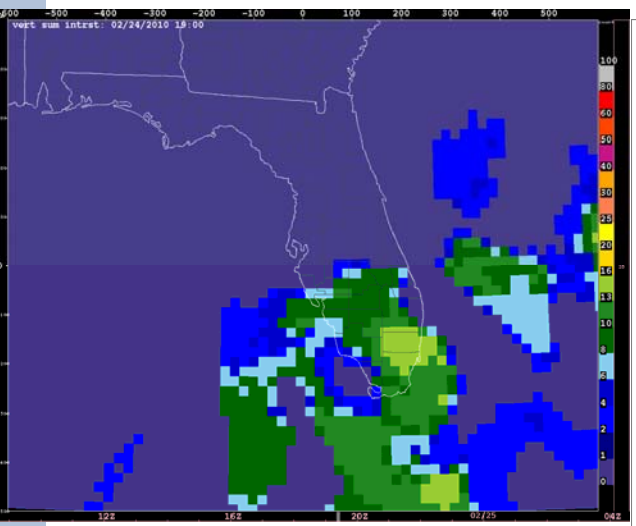


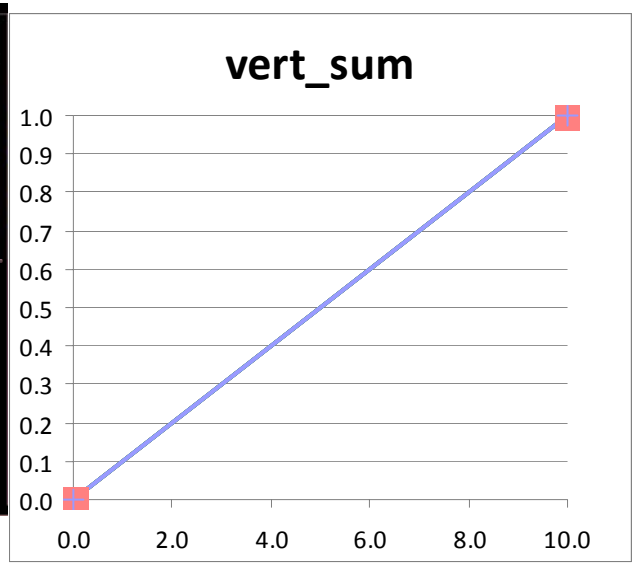


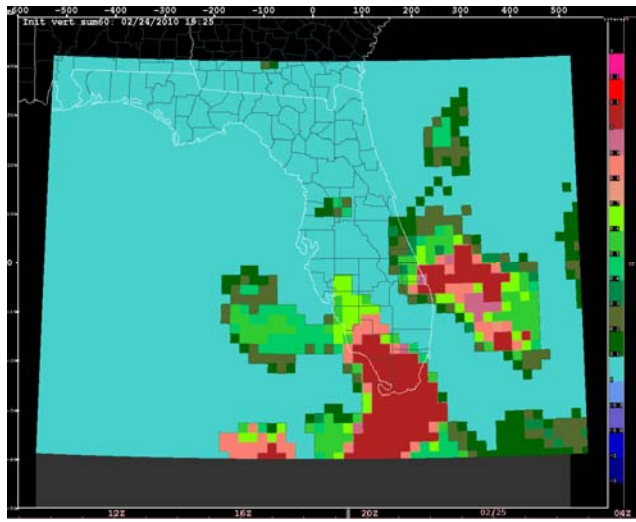


Cold Front Predictors

- VertSumInterest – A field derived from the RUC that looks for contiguous unstable layers. Interest is weighted based on CIN and wind shear.

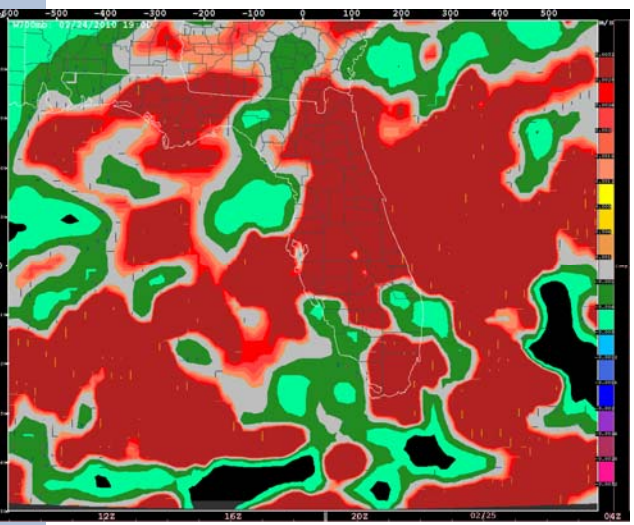


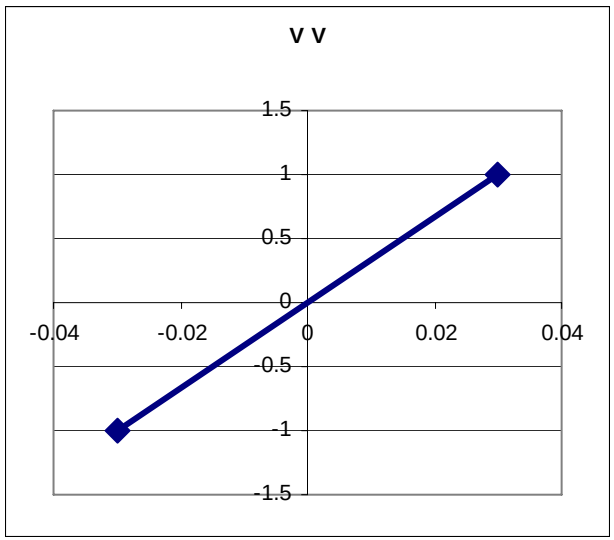


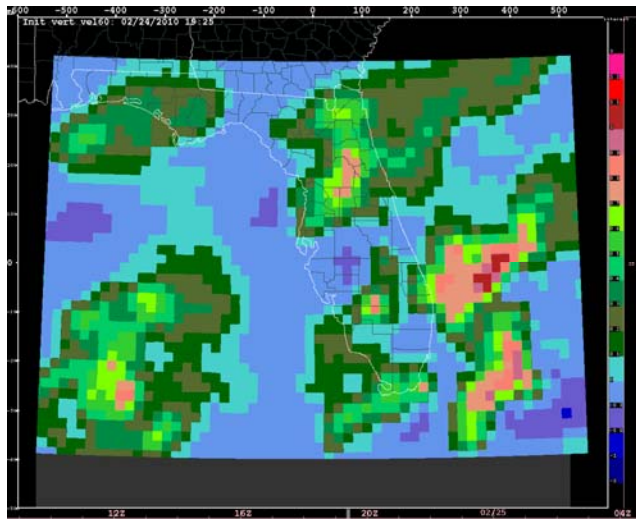


Cold Front Predictors

- Vertical Velocity – RUC 700mb Vertical Velocity.

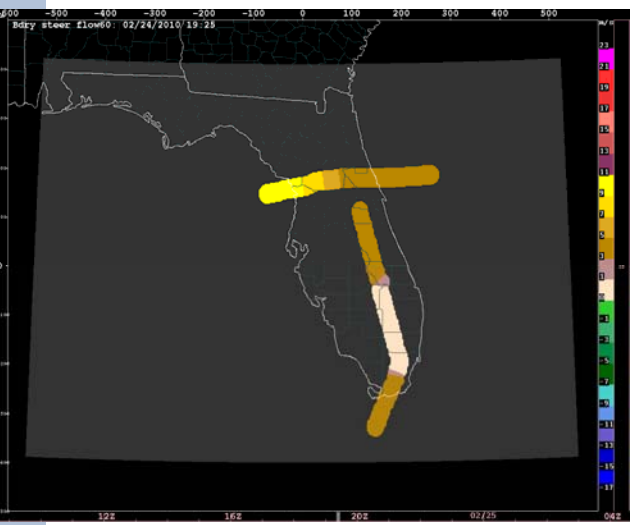


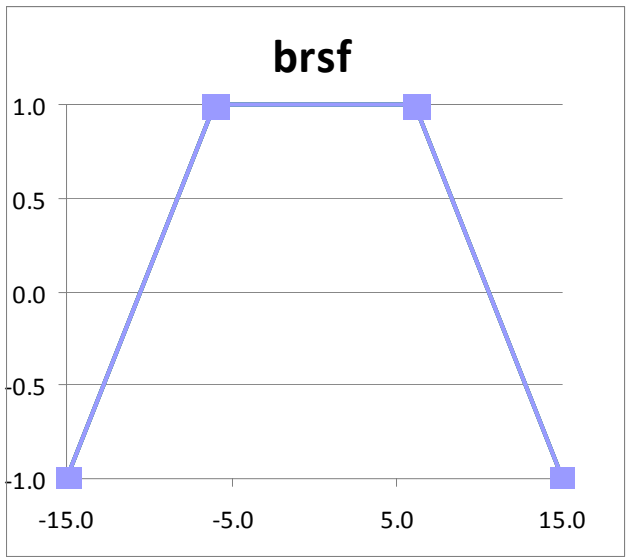


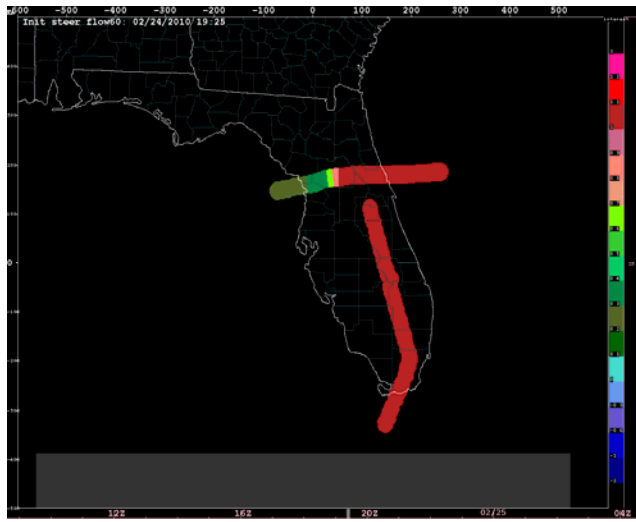


Cold Front Predictors

- Boundary Relative Steering Flow – This field assesses the likelihood of storms to remain close to boundary (if they form)

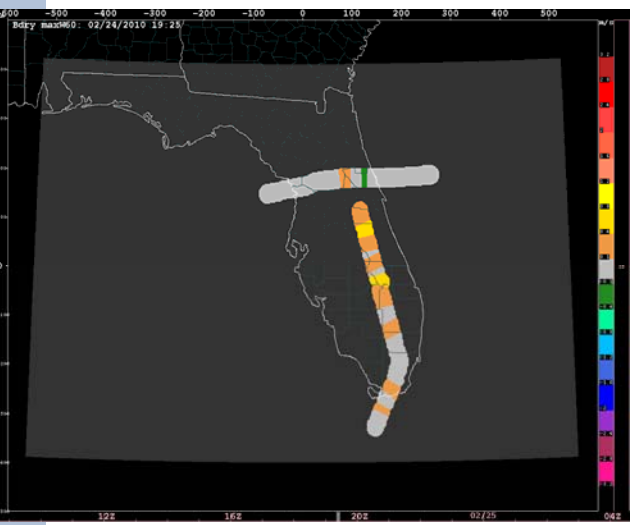


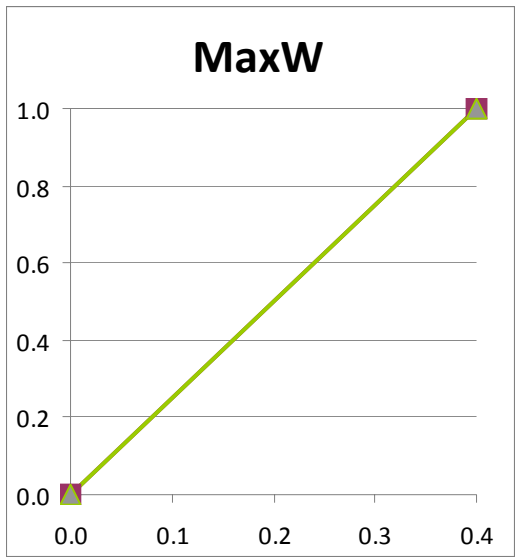


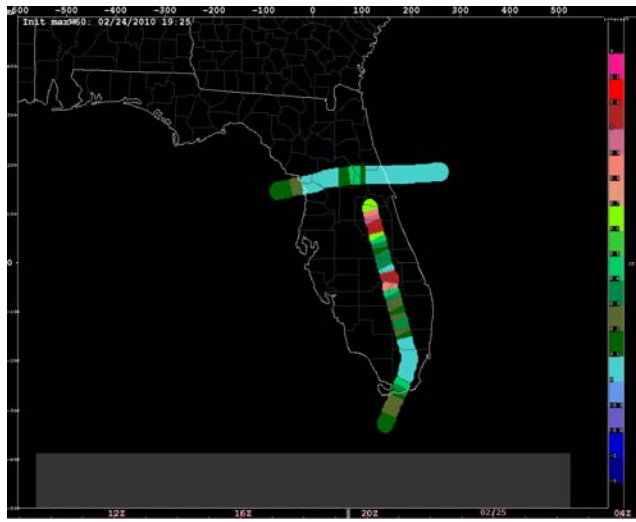


Cold Front Predictors

- Max W – Upward motion along human entered boundary computed from VDRAS winds.

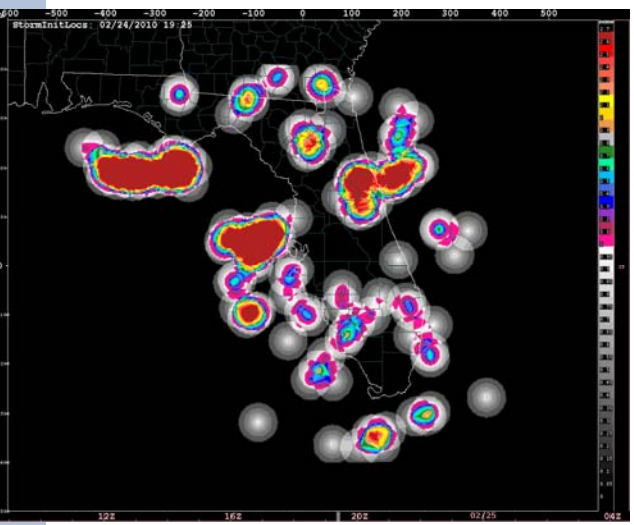


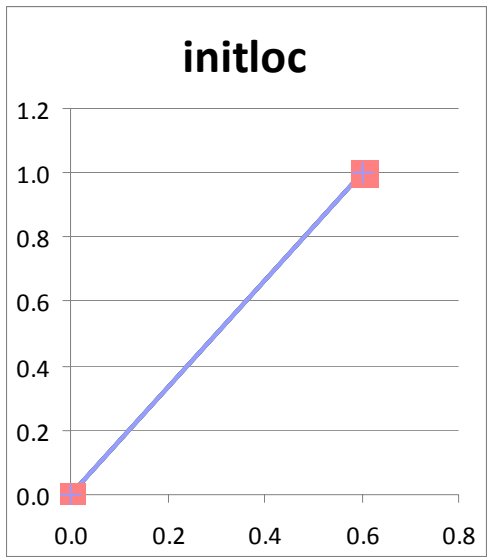


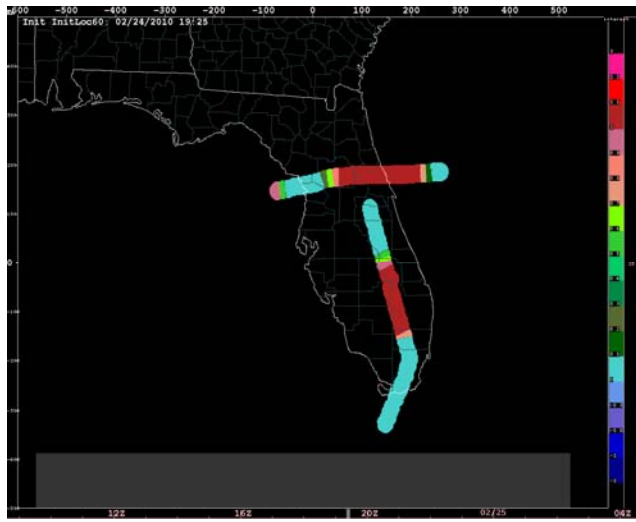


Cold Front Predictors

- Init Locations – Identifies areas along human boundaries close to storms that have initiated that are conducive for additional initiation.

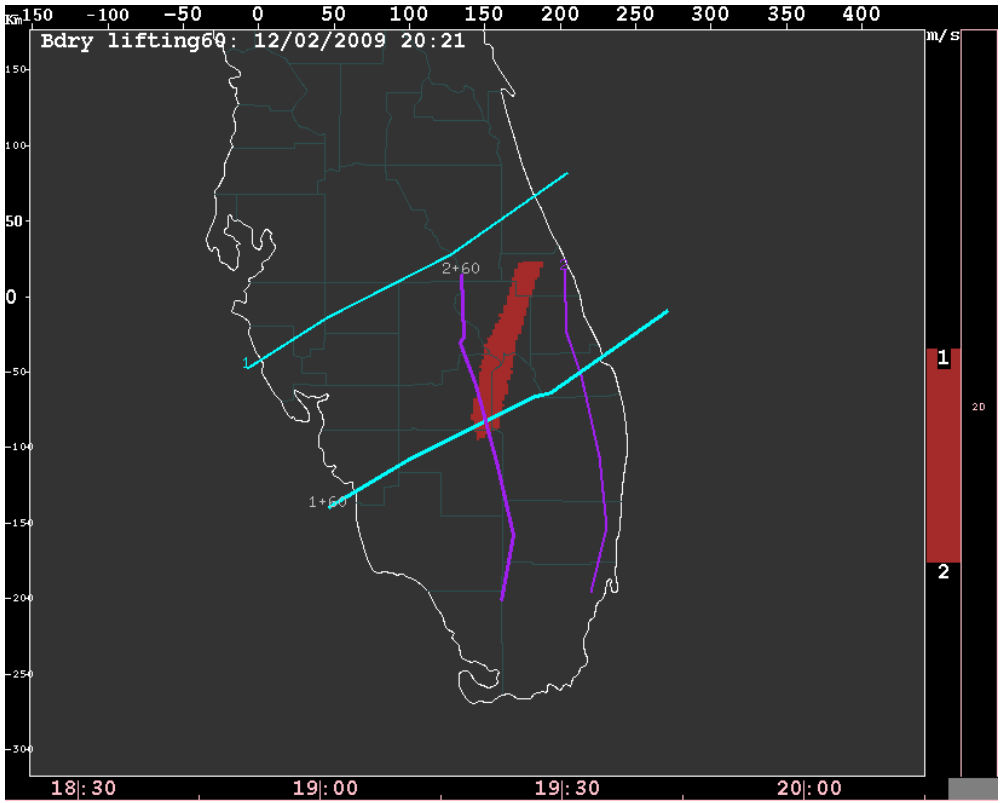






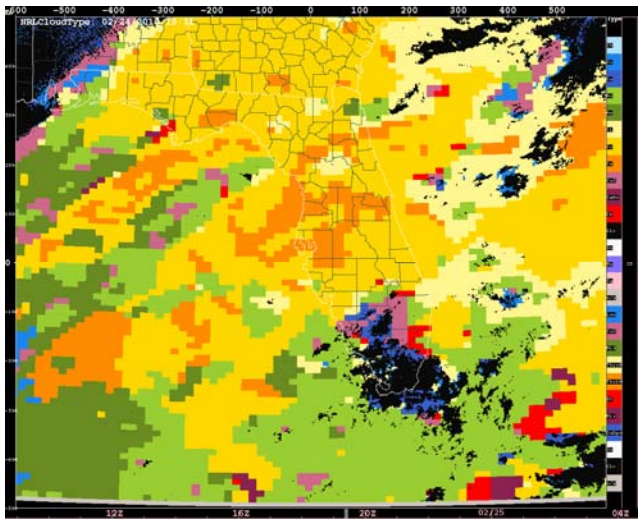
Cold Front Predictors

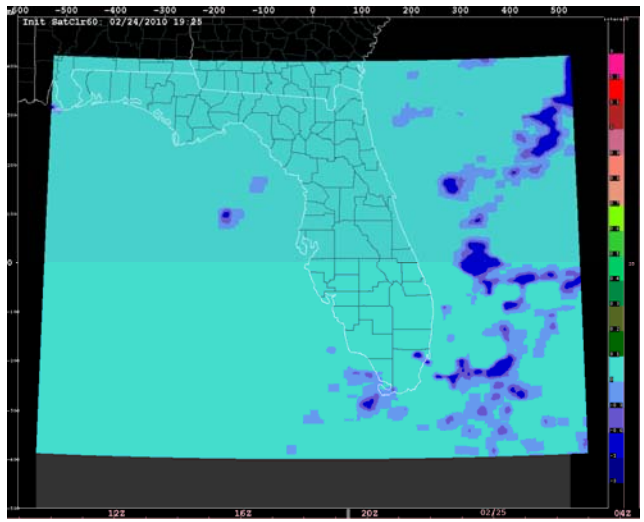
- Boundary Collisions – Identifies areas of interest that are swept out by two intersecting boundaries.



Cold Front Predictors

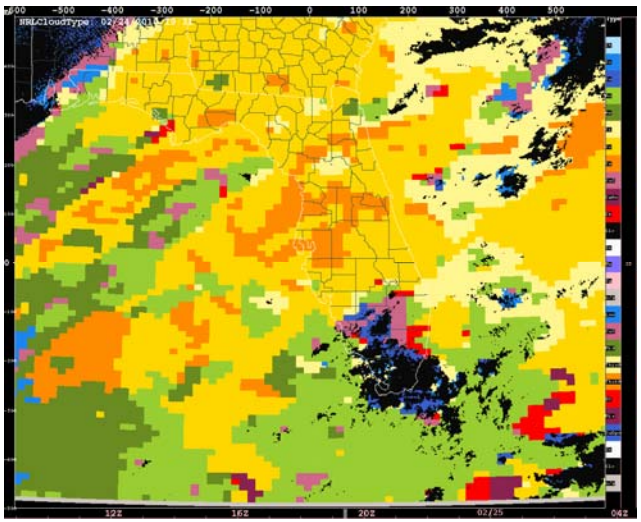
- Satellite Clear – Adds large negative interest to areas detected as having no cloud present. No positive interest from this field.

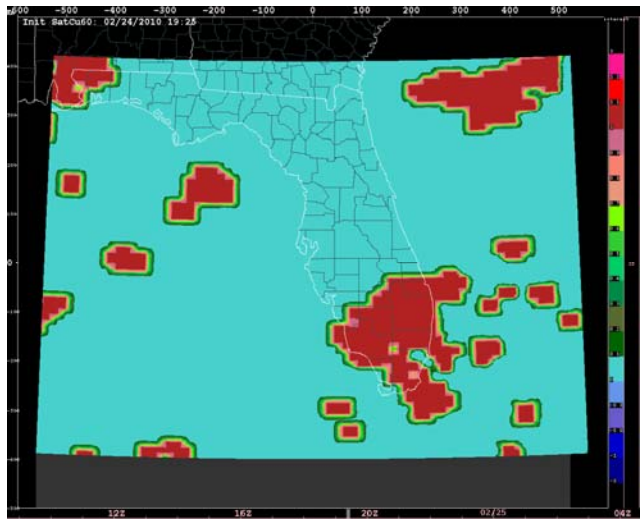




Cold Front Predictors

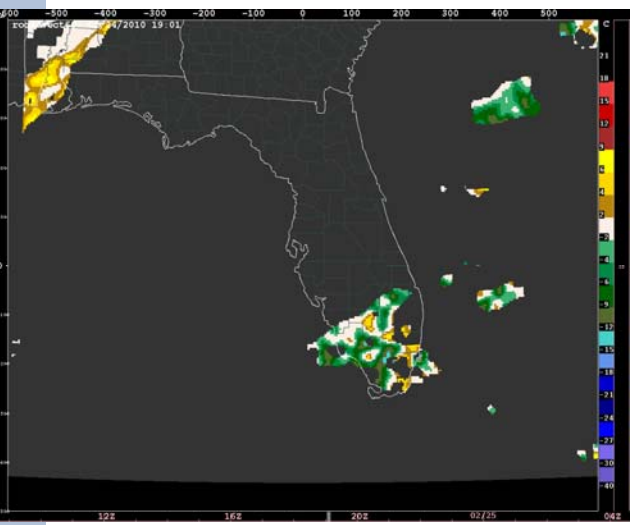
- Satellite Cu – Satellite detection of Cu and CuCongestus. Only positive interest from this field.

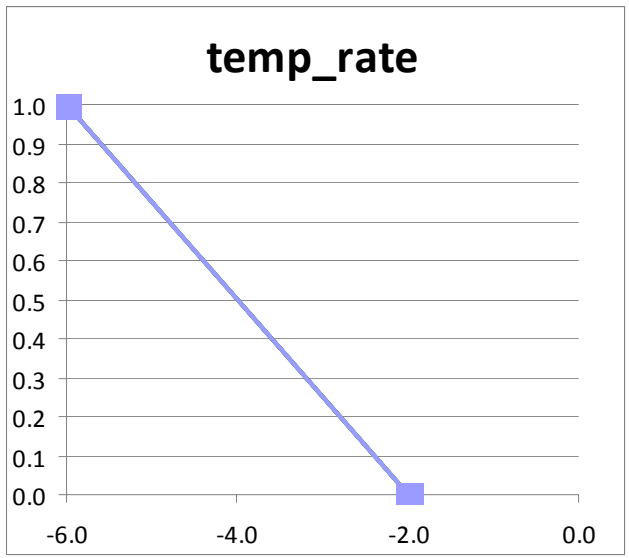


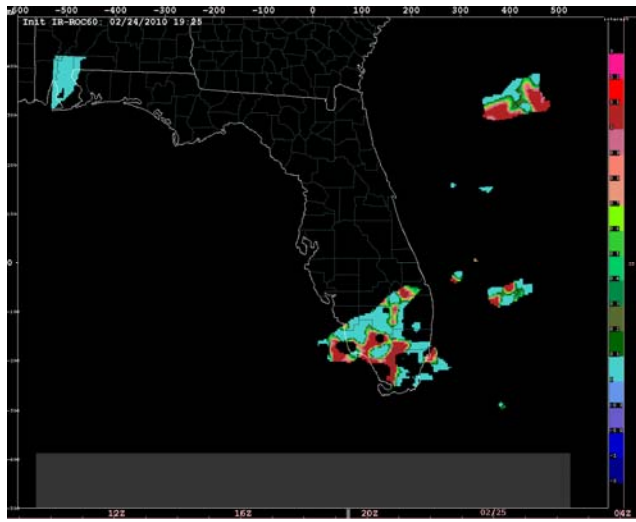


Cold Front Predictors

- IR-ROC – Infrared cloud top temperature rate of change, masked to Cu/CuCongestus detection areas.

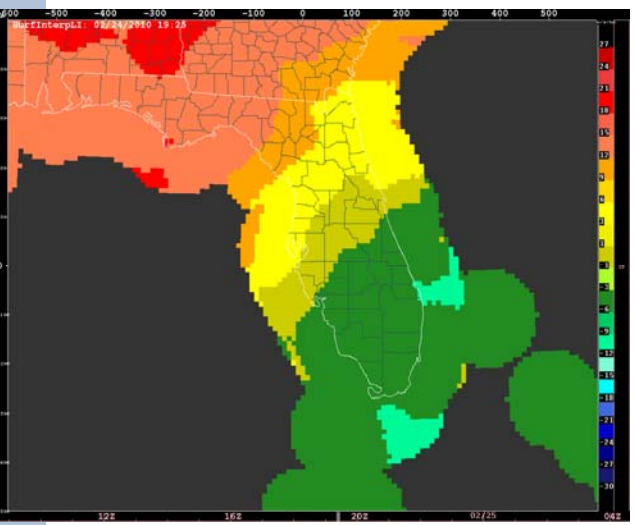


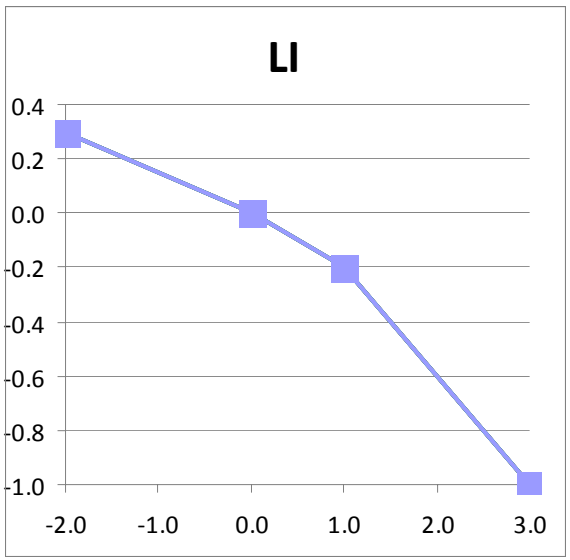


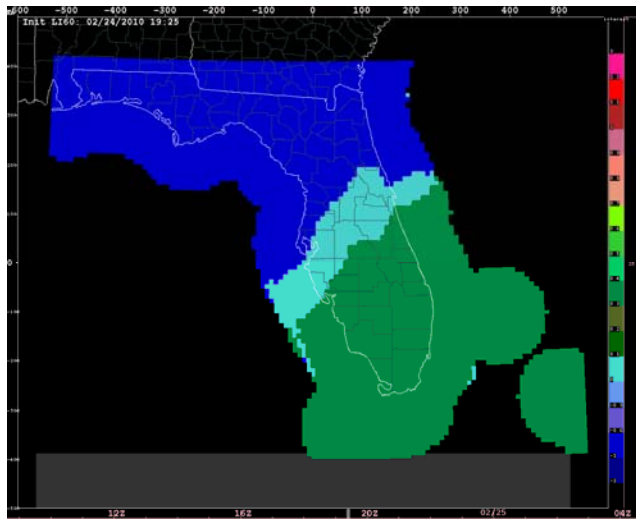


Cold Front Predictors

- Lifted Index – Computed from current sfc obs and RUC soundings.

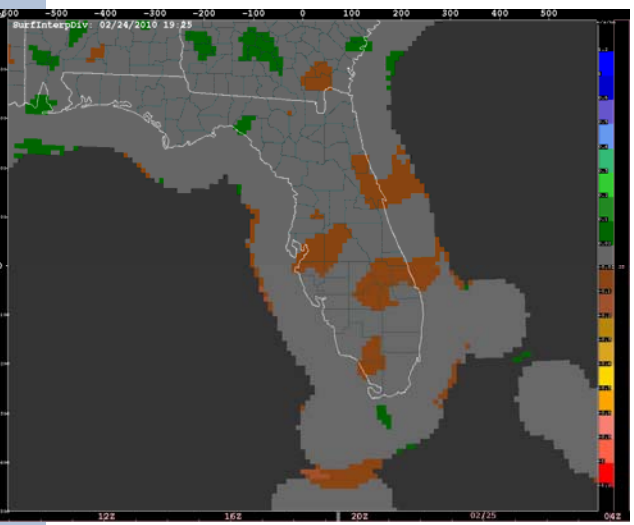


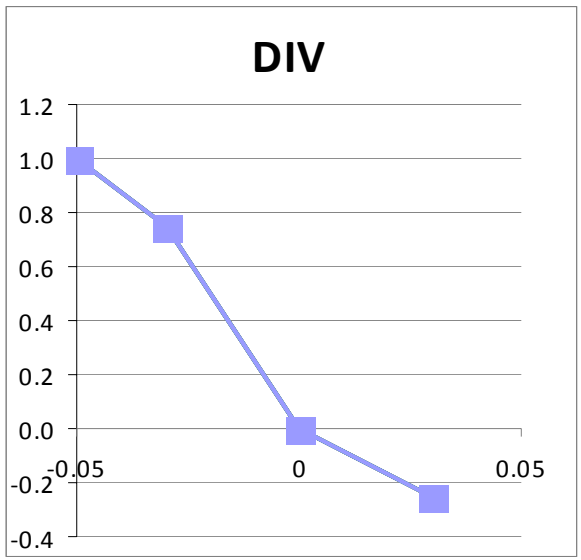


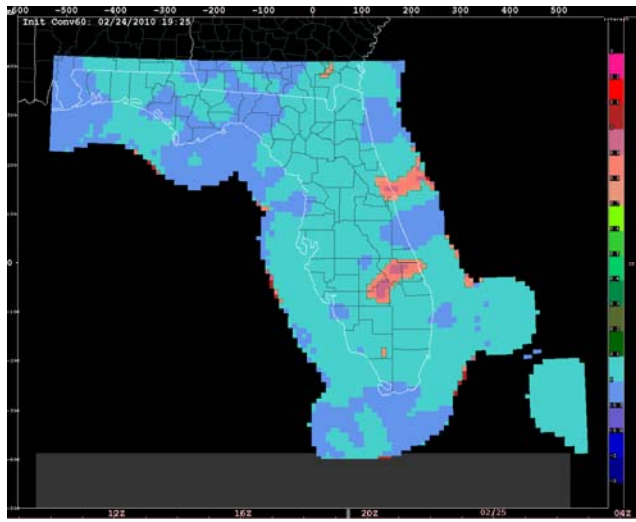


Cold Front Predictors

- Sfc Convergence – Objectively analyzed sfc mass convergence using standard metars and other mesonet obs.







Cold Front Regime Predictor Weights

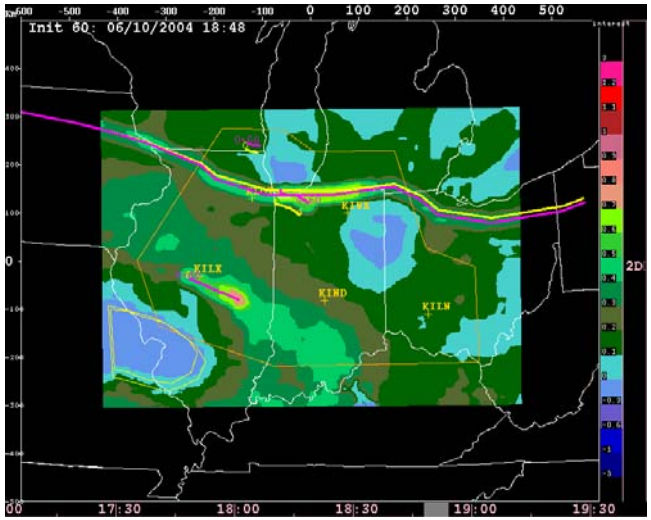
- Highest possible init interest without human entered boundary is 1.29
- Highest interest with boundary is 1.77

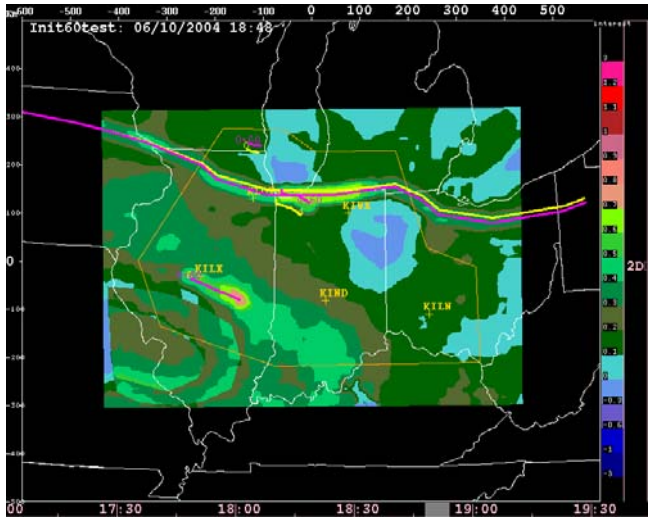
FL-CF	wgt	H	NH
CAPE	0.2	0.2	0.2
Frontal Likelihood	0.2	0.2	0.2
VertSum	0.14	0.14	0.14
RH	0.14	0.14	0.14
CIN	0.18	0	0
VV	0.12	0.12	0.12
Boundary Shear*	0.14	0.14	0
Max W*	0.14	0.14	0
InitLocations*	0.08	0.08	0
Bdry Collision*	0.12	0.12	0
Sat Clear	0.4	0	0
Sat Cu	0.14	0.14	0.14
IR-ROC	0.14	0.14	0.14
Lifted Index	0.2	0.06	0.06
Convergence	0.15	0.15	0.15
Total Interest Possible		1.77	1.29

Performance Considerations and Expectations

- 7 predictor fields are dependant on RUC data
- 4 predictors are associated with human entered boundaries
- 3 predictor fields are based on the NRL Cloud Classification algorithm
- Missing any of the 3 datasets above will compromise the ANC's ability to produce good nowcasts for initiation

Human Added Value

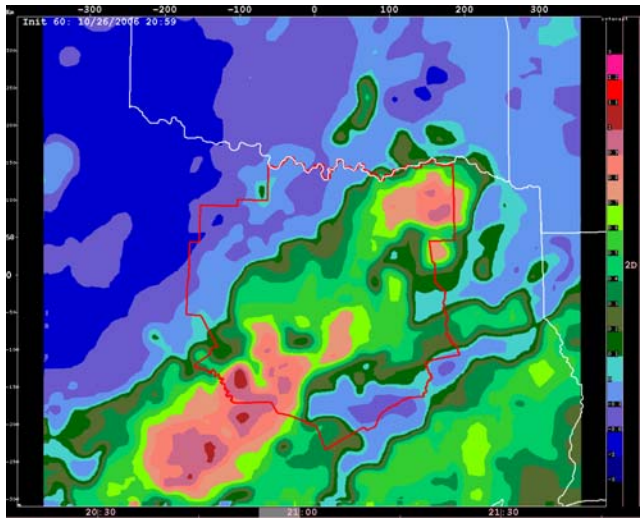


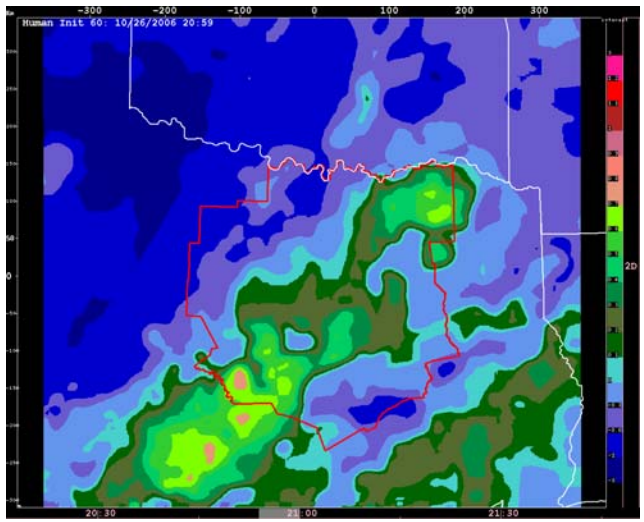


- Since the Initiation and Nowcast fields are products for external users, the nudge and polygons can compensate for missing or bad data

Which to use?

- Nudging can be used when the shape of the field is ok, but values are too low or too high
- Polygons are best for addressing localized deficiencies in the Initiation field





Performance Considerations and Expectations

- Forecasters should not expect to see initiation areas entirely overlap existing convection.
- Gandi60 product shows the complete nowcast and verify60 shows the T-60min forecast validation.

Performance Considerations and Expectations

- The ANC traditionally does well with convection forced along convergence boundaries
- Unfortunately, not all convection is so well behaved.

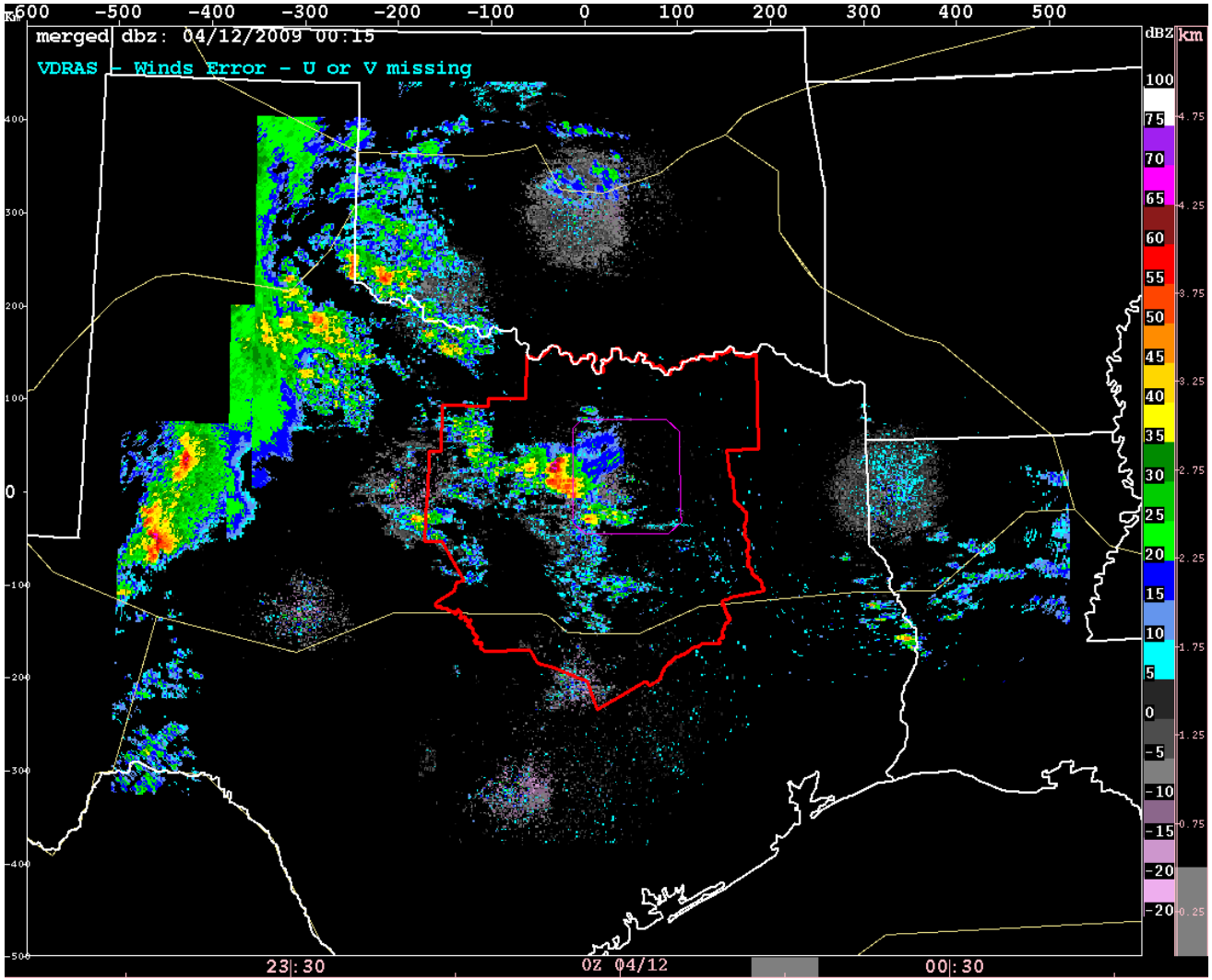
Elevated Convection

- Elevated convection presents challenges
- Displaced from sfc boundary locations
- Often unclear Cu signatures, sometimes obscurred by higher cloud
- Large CIN often present in near sfc parcels
- Cape may be marginal compared to sfc based scenarios

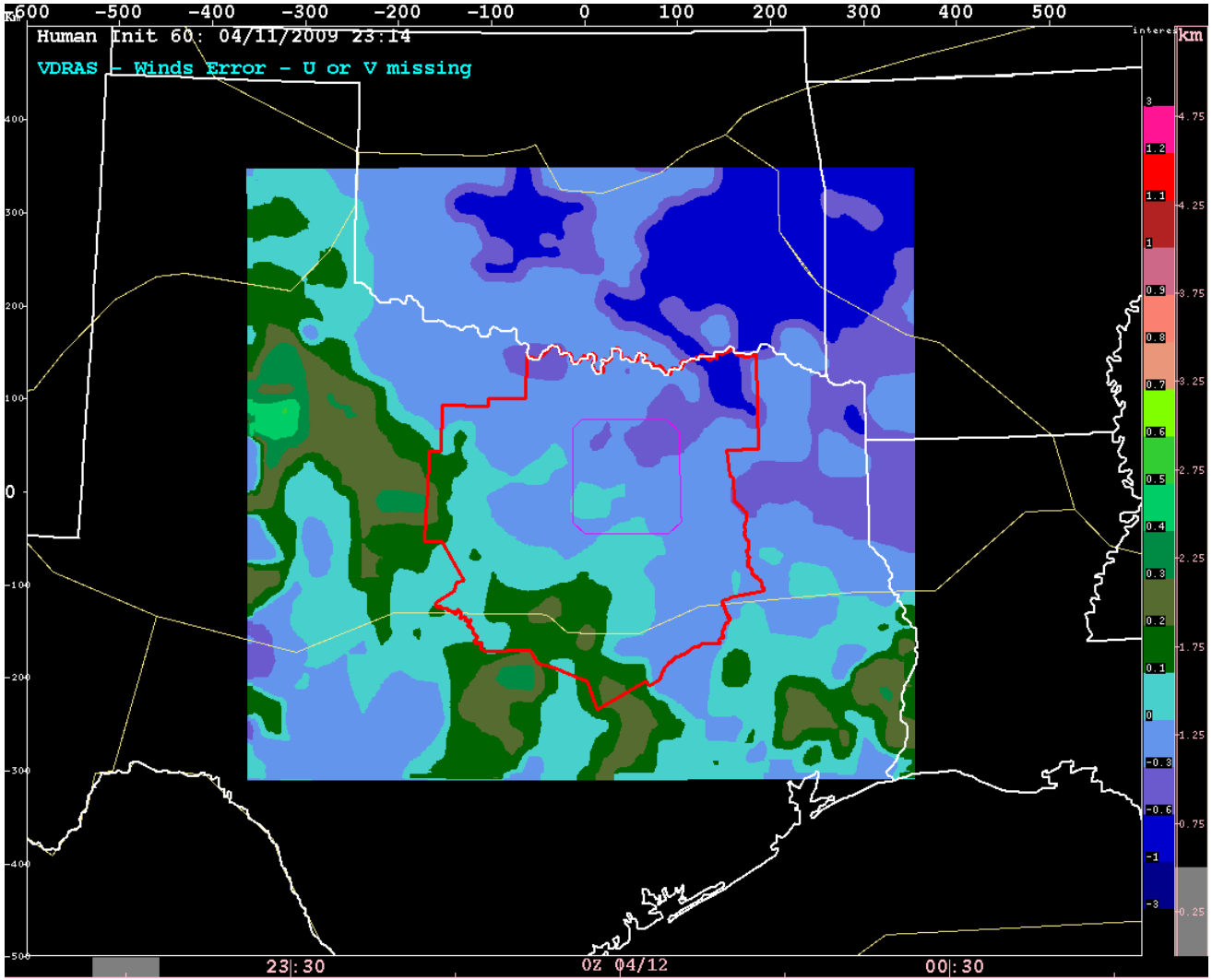
Nocturnal Convection

- Satellite cloud detection algorithms not as effective.
- Instability less than daytime, lower interest.
- Near sfc CIN often high.
- Parcels may or may not be surface based
- Contributing features (eg, low level jet) not accounted for in ANC regimes.

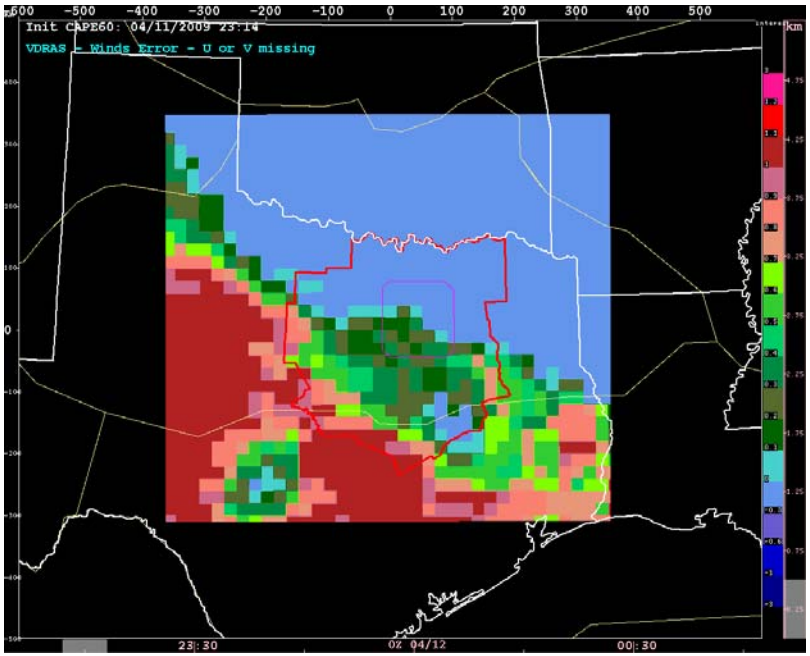
Elevated Example



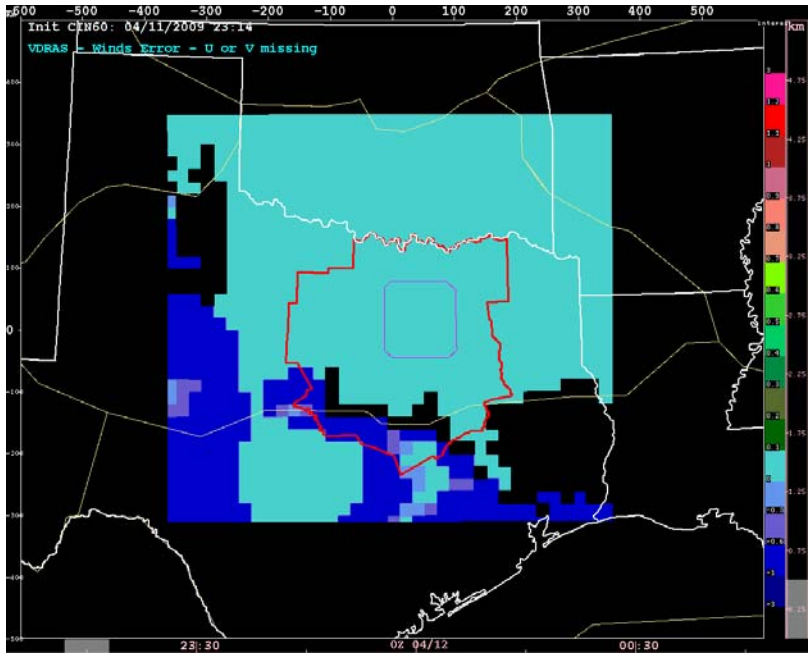
Init60



CAPE/CIN Interest

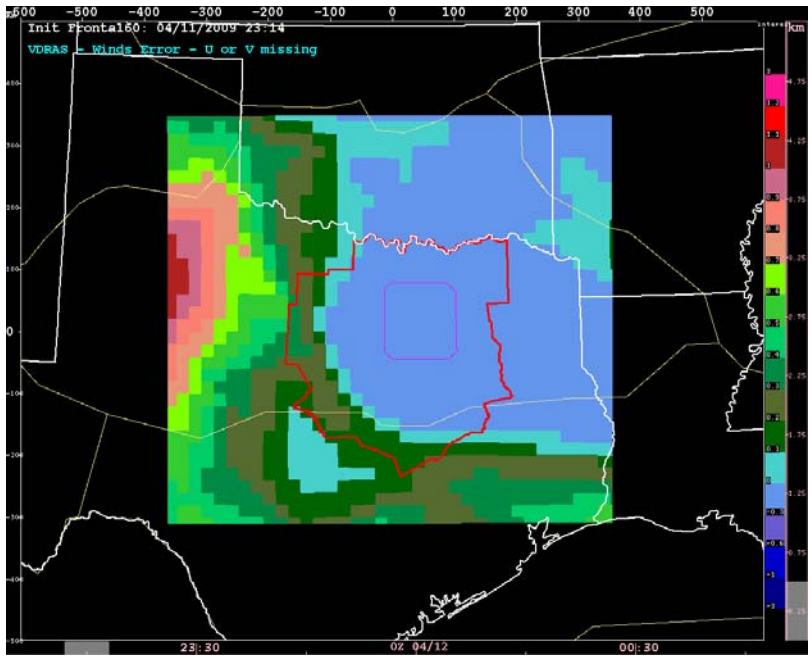


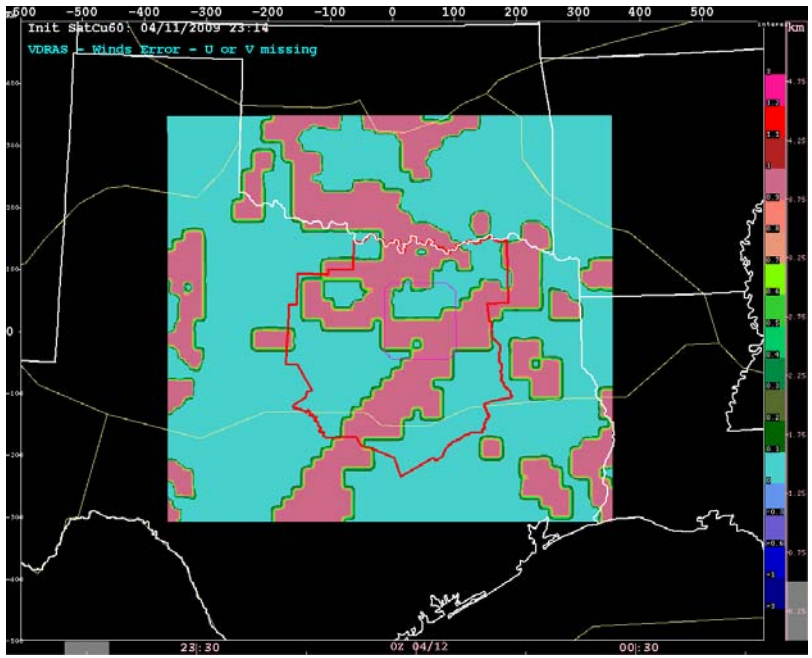
CAPE (MU H9-H7)



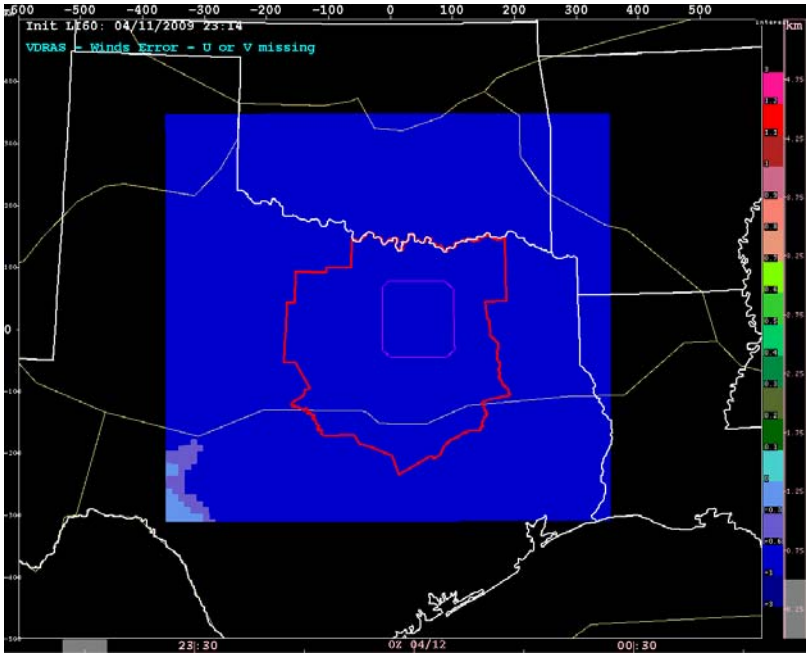
CIN (Mean 975-900mb)

Frontal Likelihood and SatCu

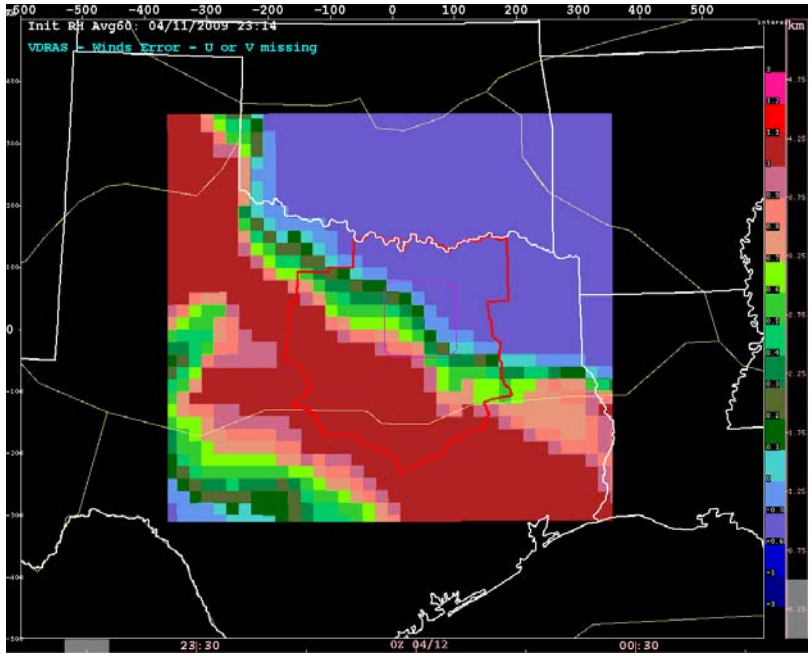




LI and RH

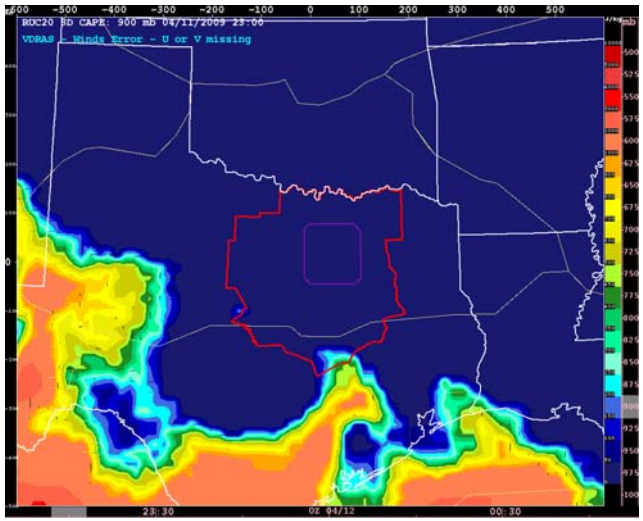


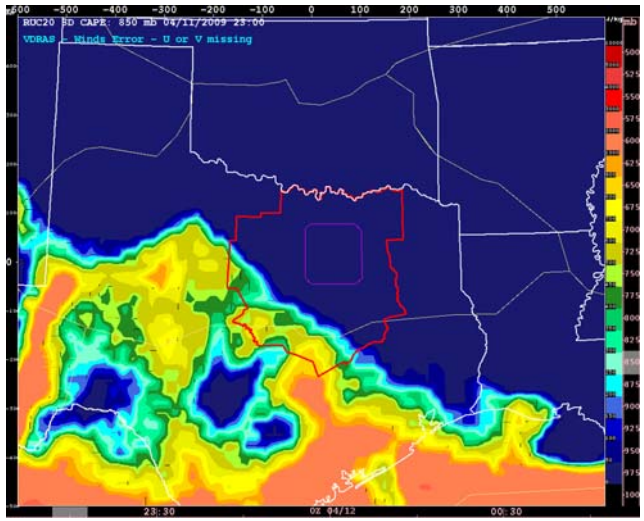
SFC Obs Based w/ RUC profile

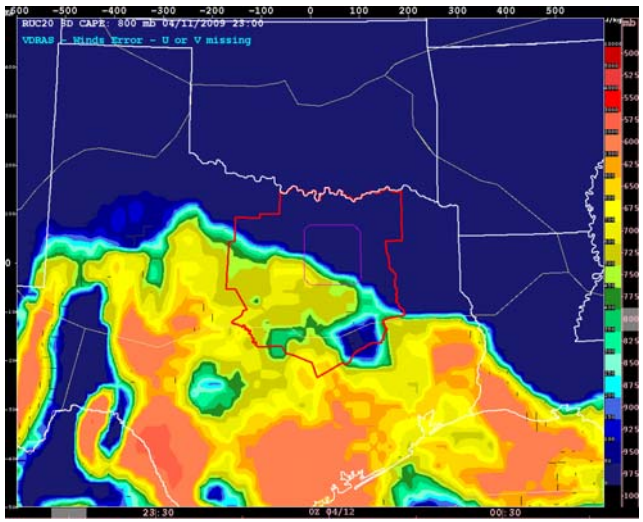


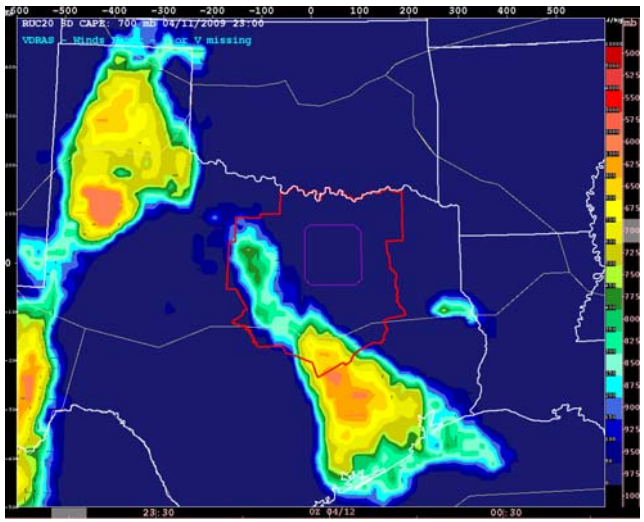
Mean 875-625

Vertical Distribution of CAPE

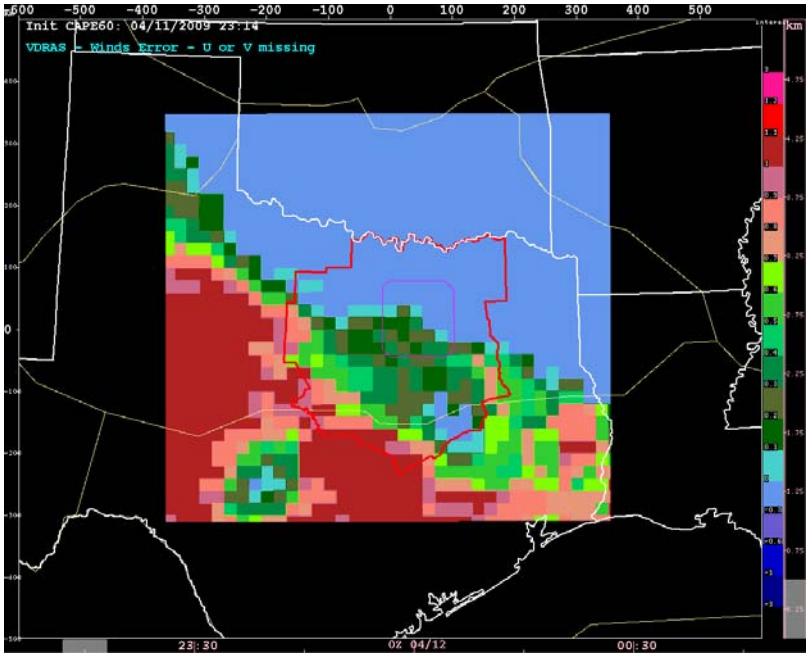


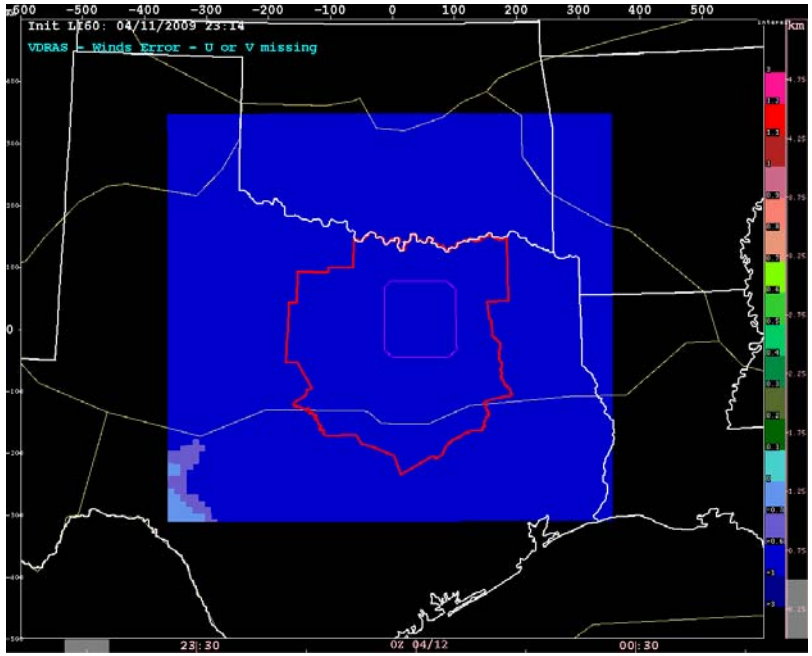




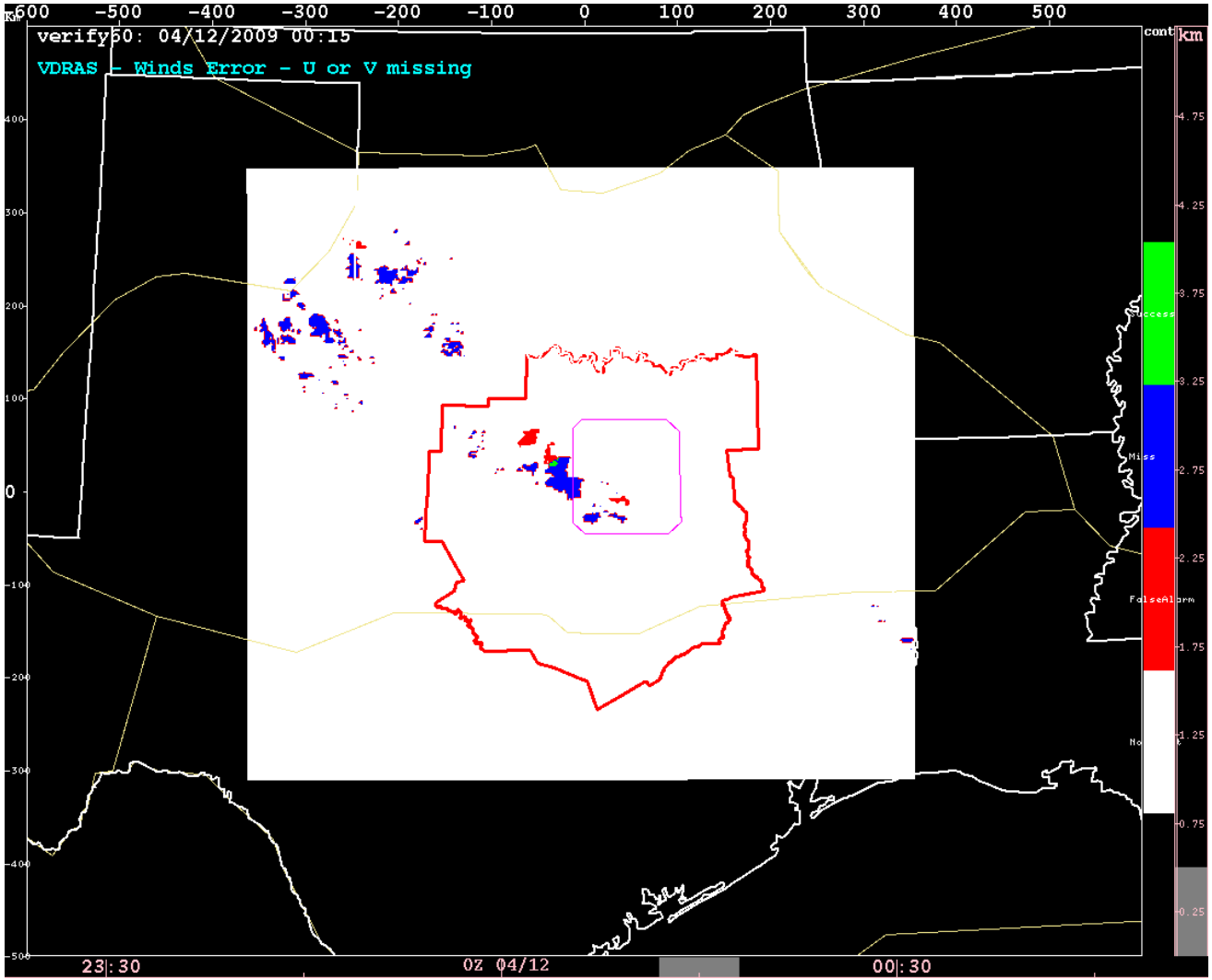


LI negated CAPE interest

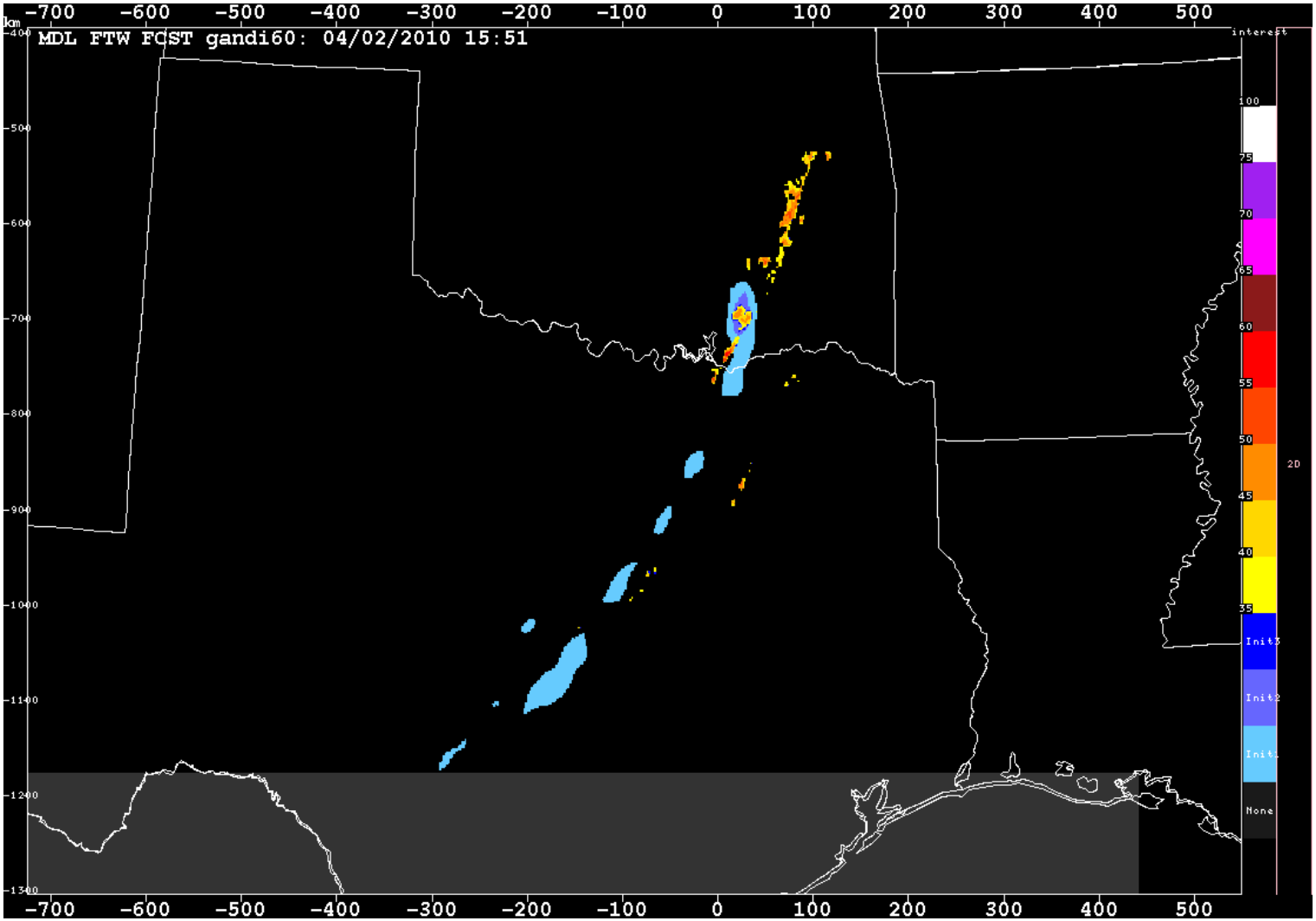




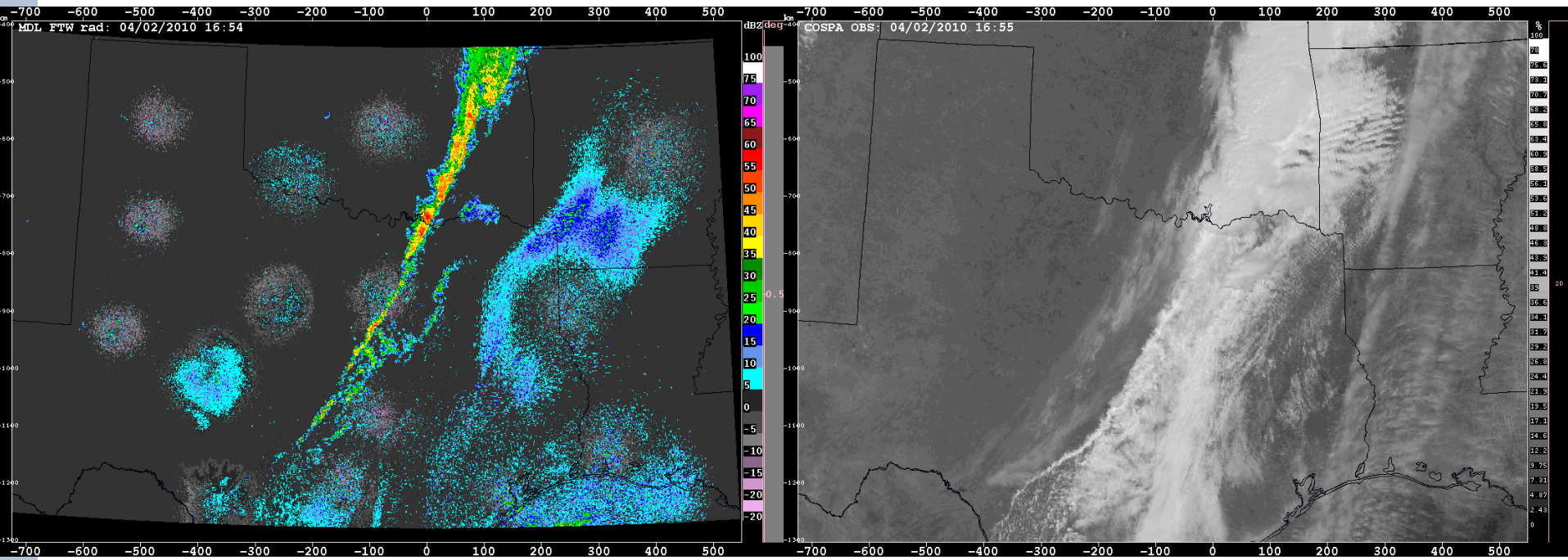
Both predictor fields are weighted 0.20



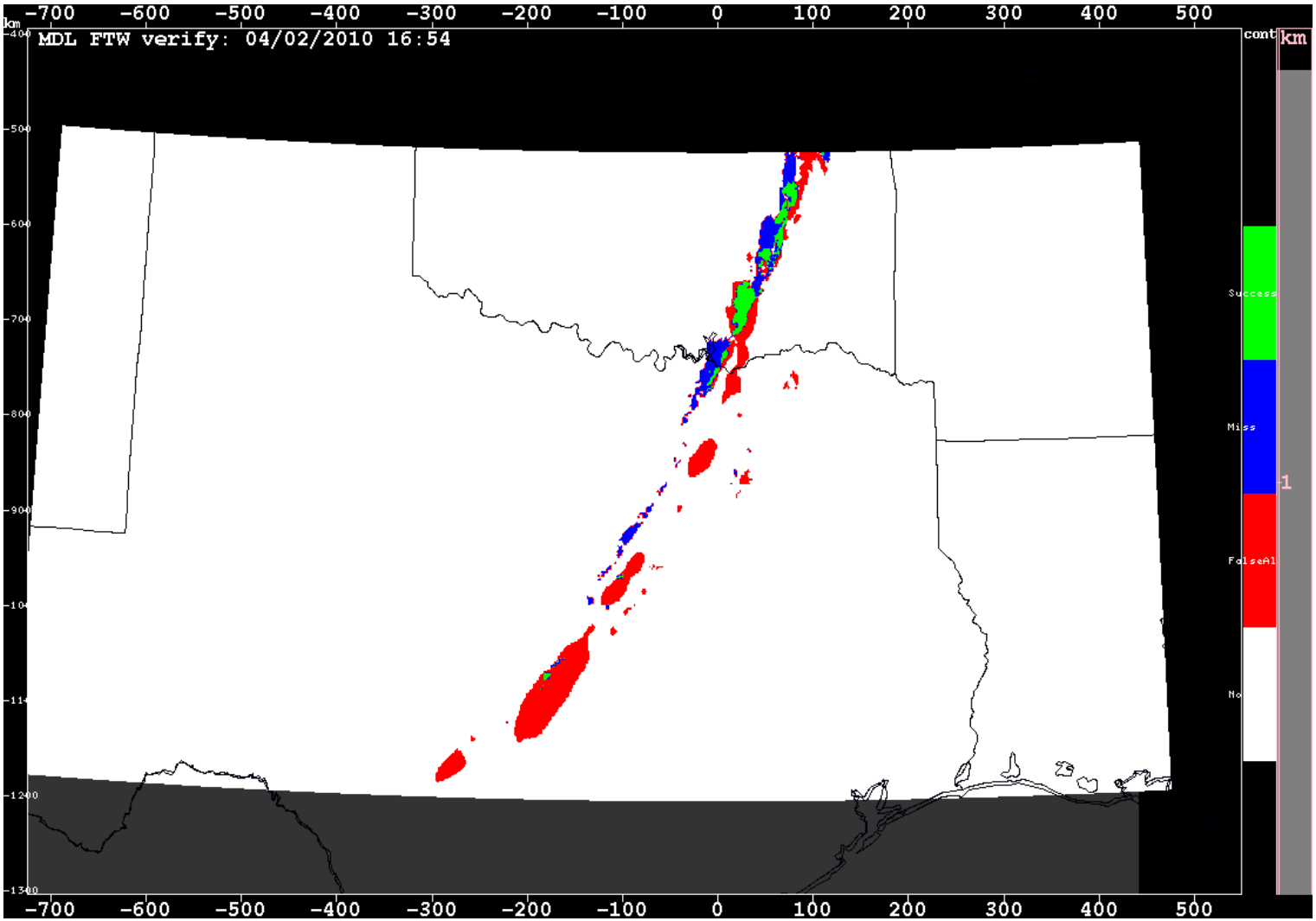
Is this a Good Forecast?



Given what was observed?



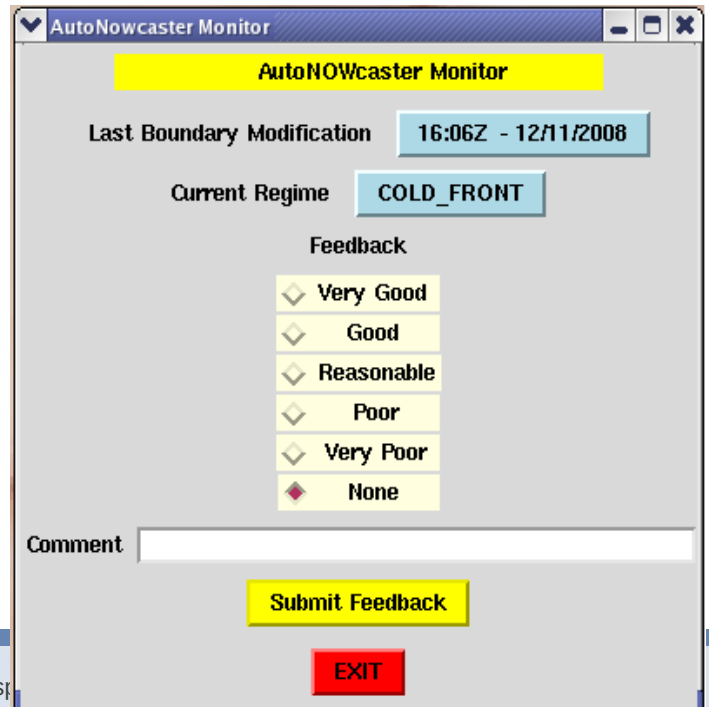
Good Qualitatively or Statistically?



We Want Your Feedback!

- If the forecast is good, tell us! Everyone loves a compliment!
- If the forecast is bad, tell us! You won't hurt my feelings!
- If you have quick questions, use the comment box!

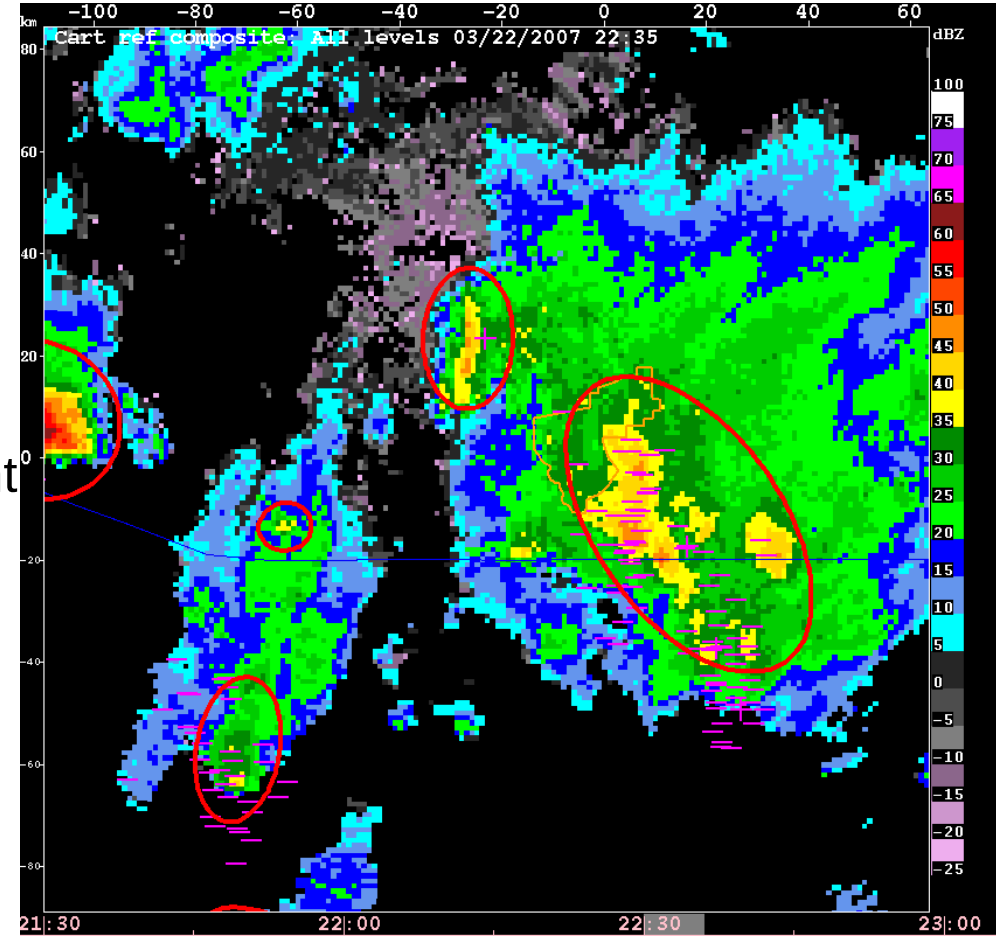
Feedback comments will often get a rapid response via email or a phone call to the WFO!



WSMR Lightning Potential

NCAR

- Utilizes local WSR-88D radar data to monitor reflectivity above the freezing level
  - 30 dBZ echo vol. above -10C
  - Volume Growth Rate
  - Max. reflectivity
  - Echo Top
- Outputs elliptical markers to highlight storms capable of producing CG lightning in very near term
- Lead times typically in the 5 to 15 minute range
- 80% POD, 18% FAR

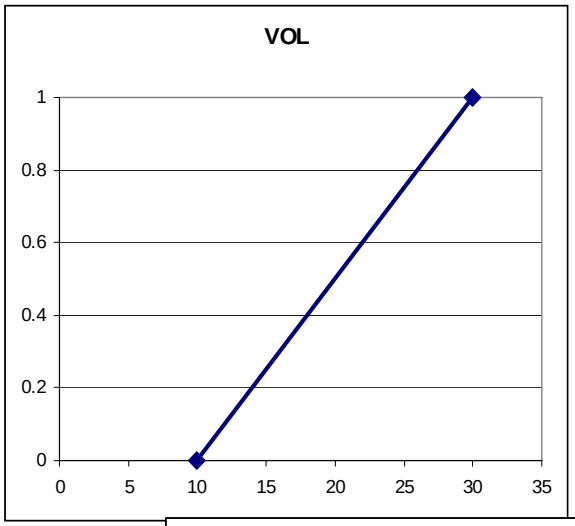


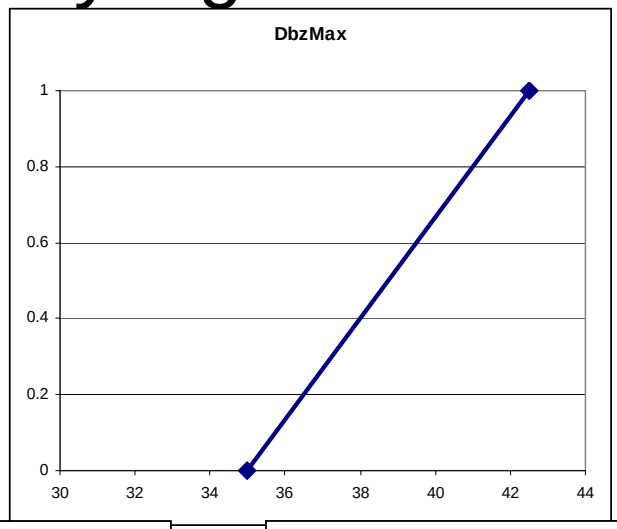
Saxon et al. 2002, 2008

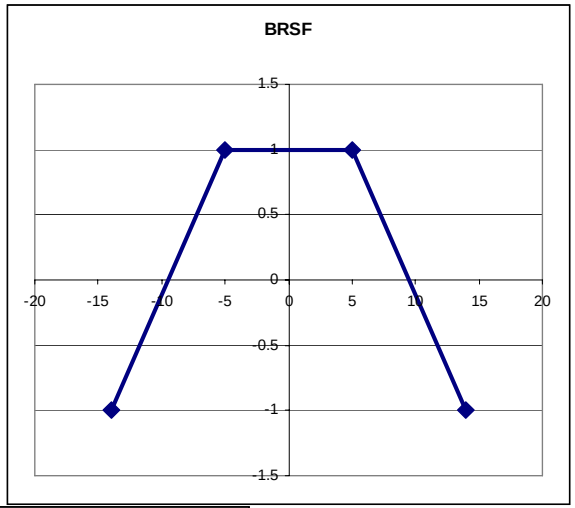
Lightning Potential Product

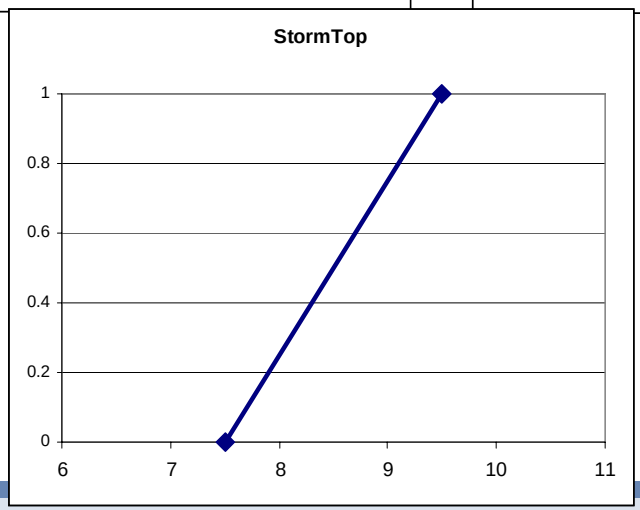
WSMR Lightning Potential

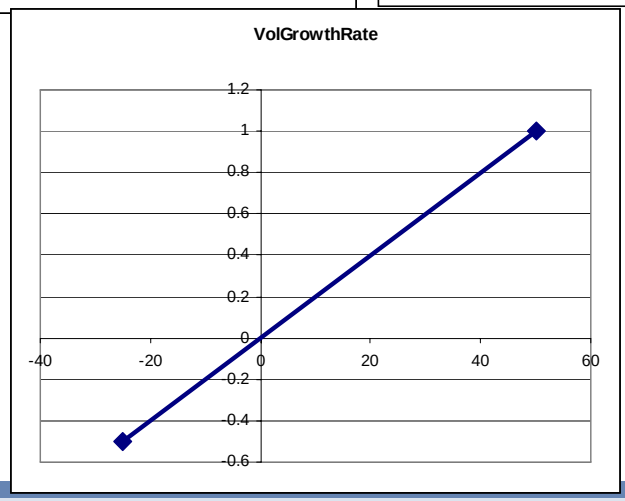
- Product is fuzzy logic based



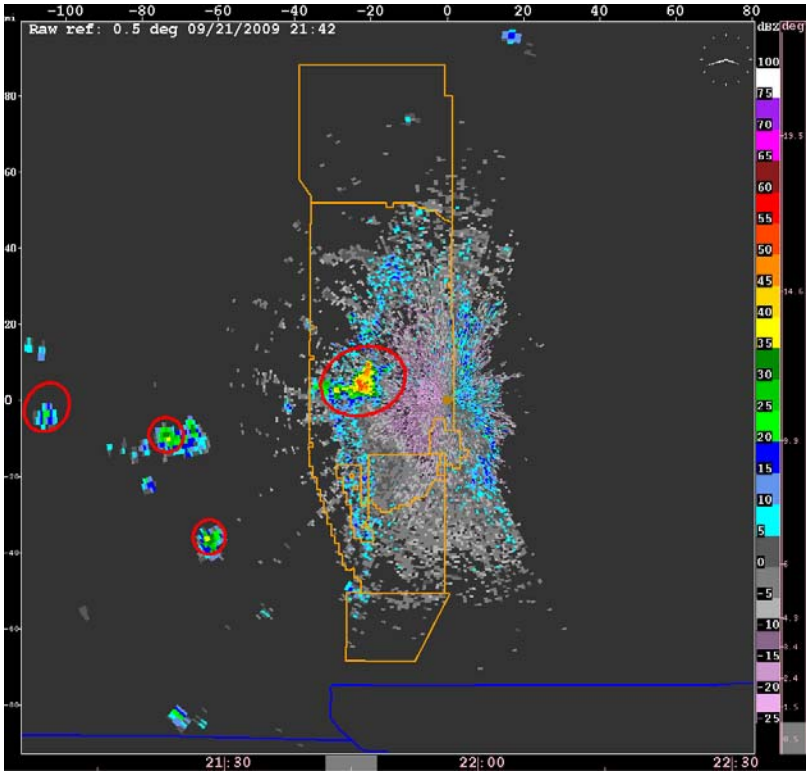




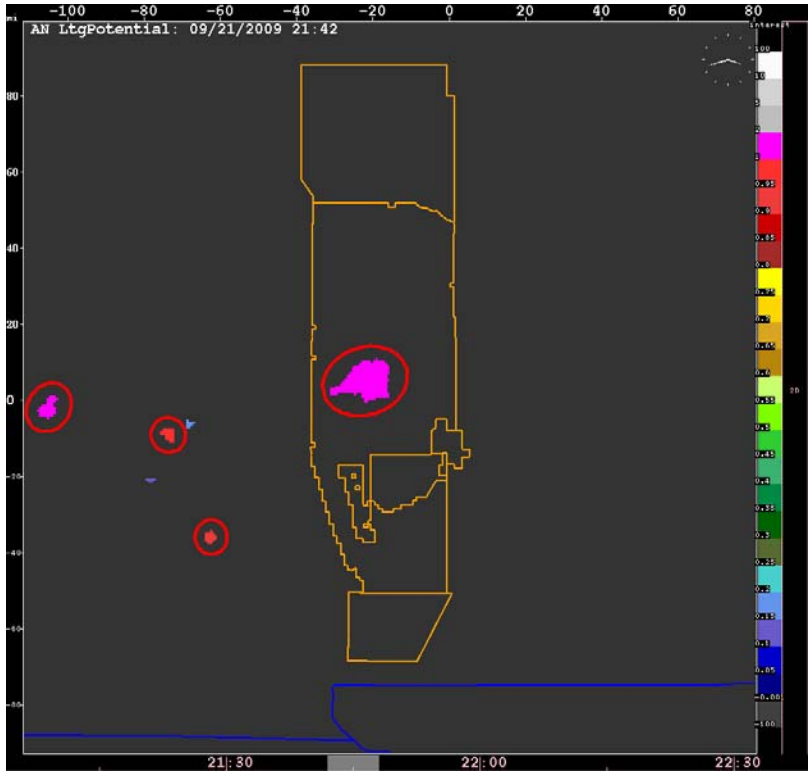




Example

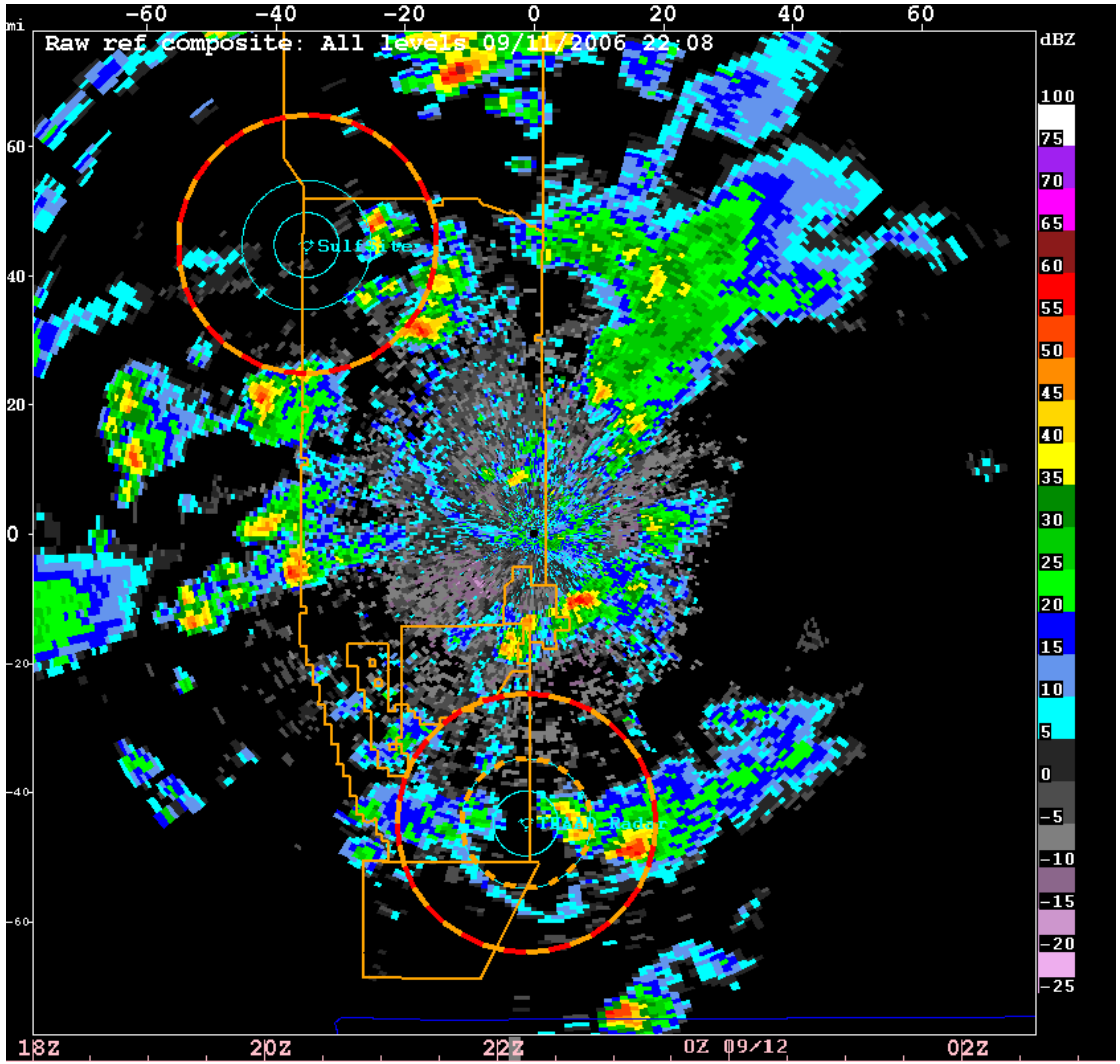


Reflectivity



LtgPotential Likelihood

Lightning Alert Circles: Example



LMA Data Investigation for G/D

In Progress…

- 2D Sources
- 2D Sources Rate of Change
- Flashes
- Flash Rate of Change

Yet to examined…

- Flash Extent
- Max Flash Height Rate of Change

Wrapping Up!

- The ANC produces Nowcasts for convection with inputs from YOU!
- ANC output should be view as products for an end user, not as a tool for NWS forecasters
- Fuzzy Logic is a great techinique, but it is only as strong as the predictors that go in
- We are counting on feedback from the WFO to help us make the ANC better
- Lightning Potential Algorithm will be transferred to MDL for inclusion in the MLB demonstration

Questions / Follow Up Discussion