# An Analysis of Developing and Non-developing Disturbances from PREDICT

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Goal:

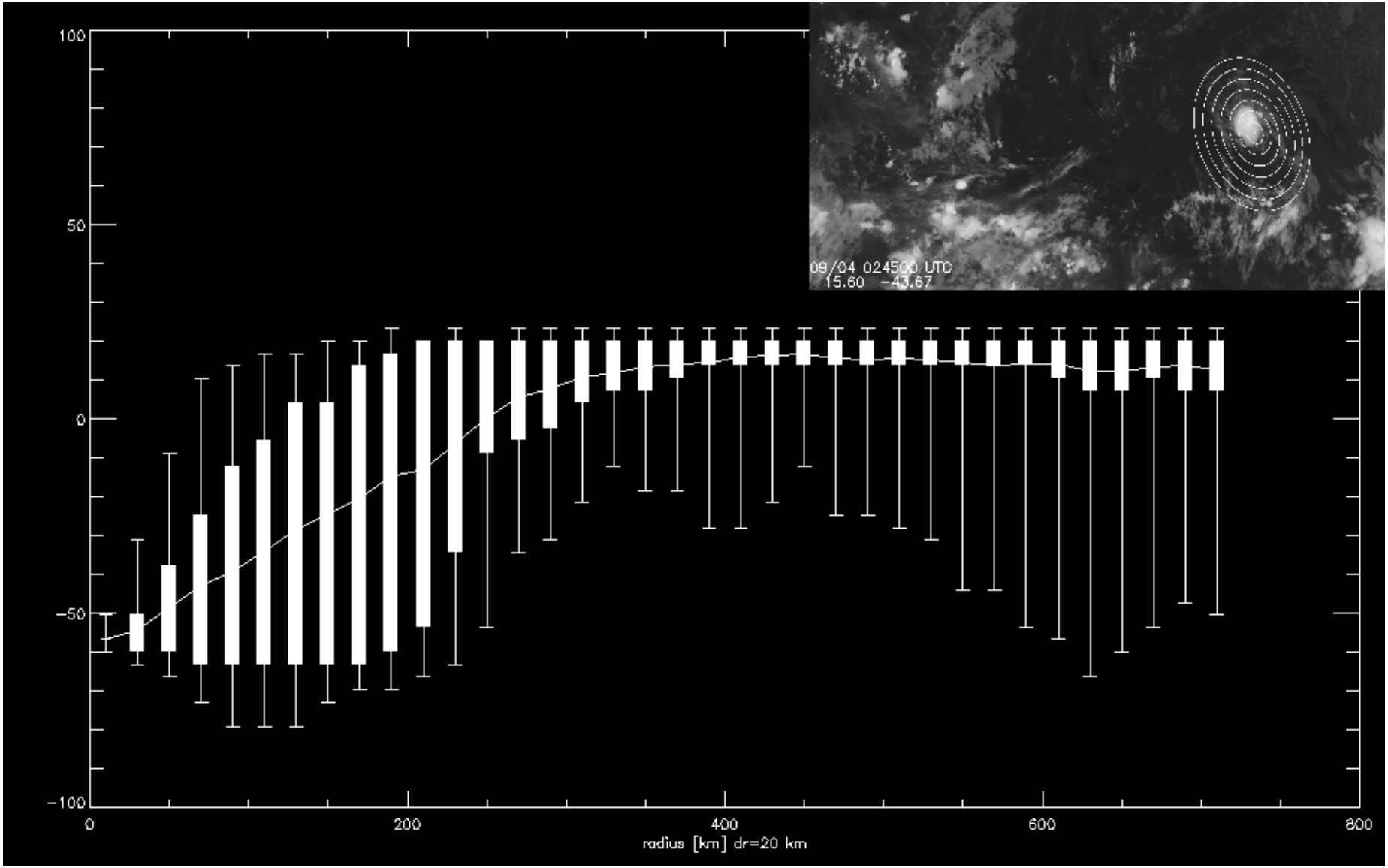
Compare the evolutions of Gaston, Karl and Matthew and figure out what prevented Gaston from redeveloping, what delayed the formation of Karl and what led to the relatively rapid formation of Matthew.


NCAR

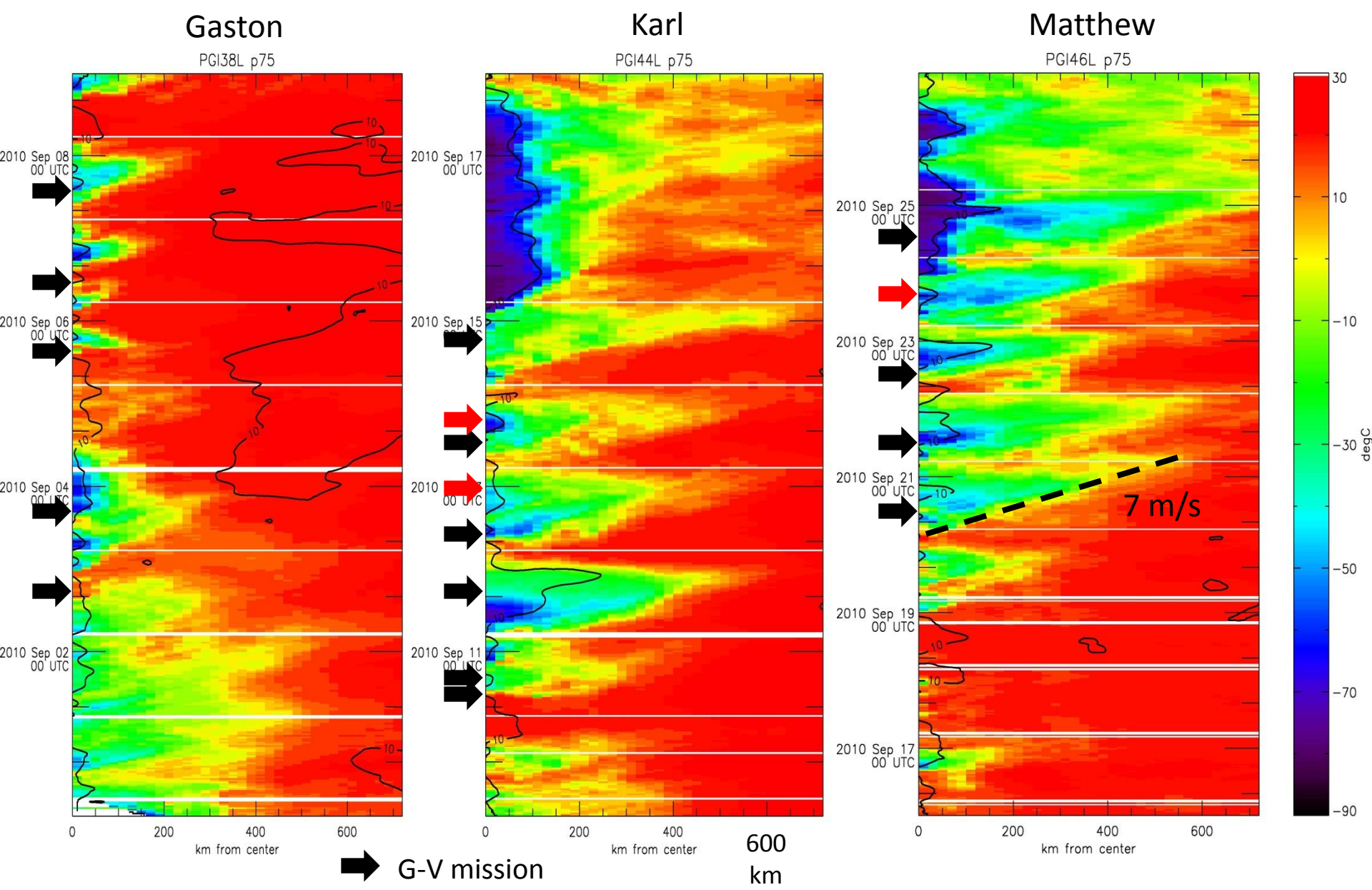
# Analysis

- Time-space analysis of geostationary satellite data
- Analysis of dropsonde data:
  - Circulation strength at different altitudes
  - Vertical shear and relative flow profiles (with environmental shear from operational analyses)
  - Vortex tilt (mis-alignment of circulation centers at different levels)
  - Spatial distributions of moisture (relative humidity and saturation fraction)
  - Vertical velocity (e.g. divergence profiles)
- Utilize well resolved temporal evolution (on scale of ~200 km) to discern important differences among cases

# PDF Analysis of GOES IR Data



# Time-Radius Plots of GOES IR Data

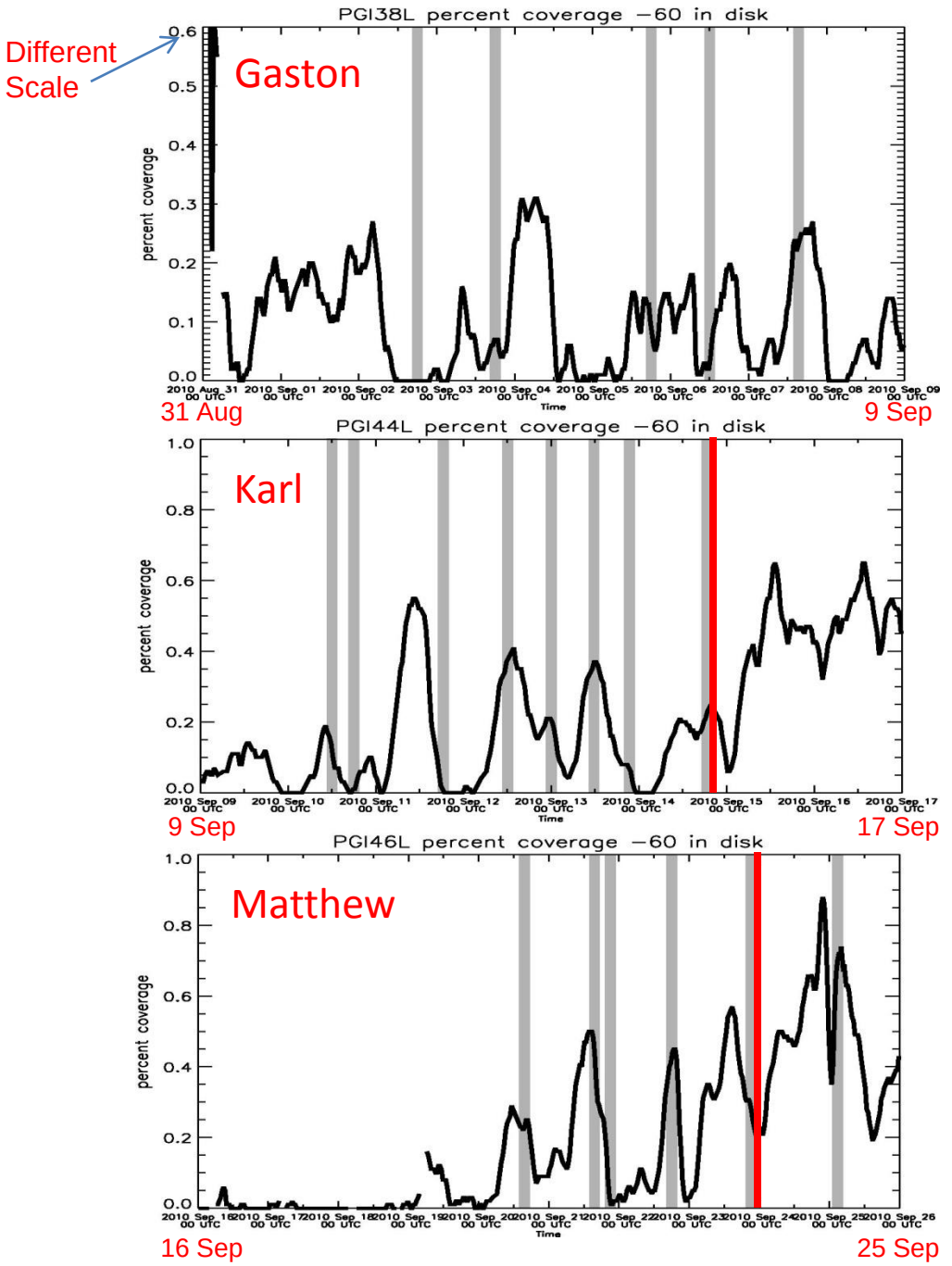


# Intermittency of Convection

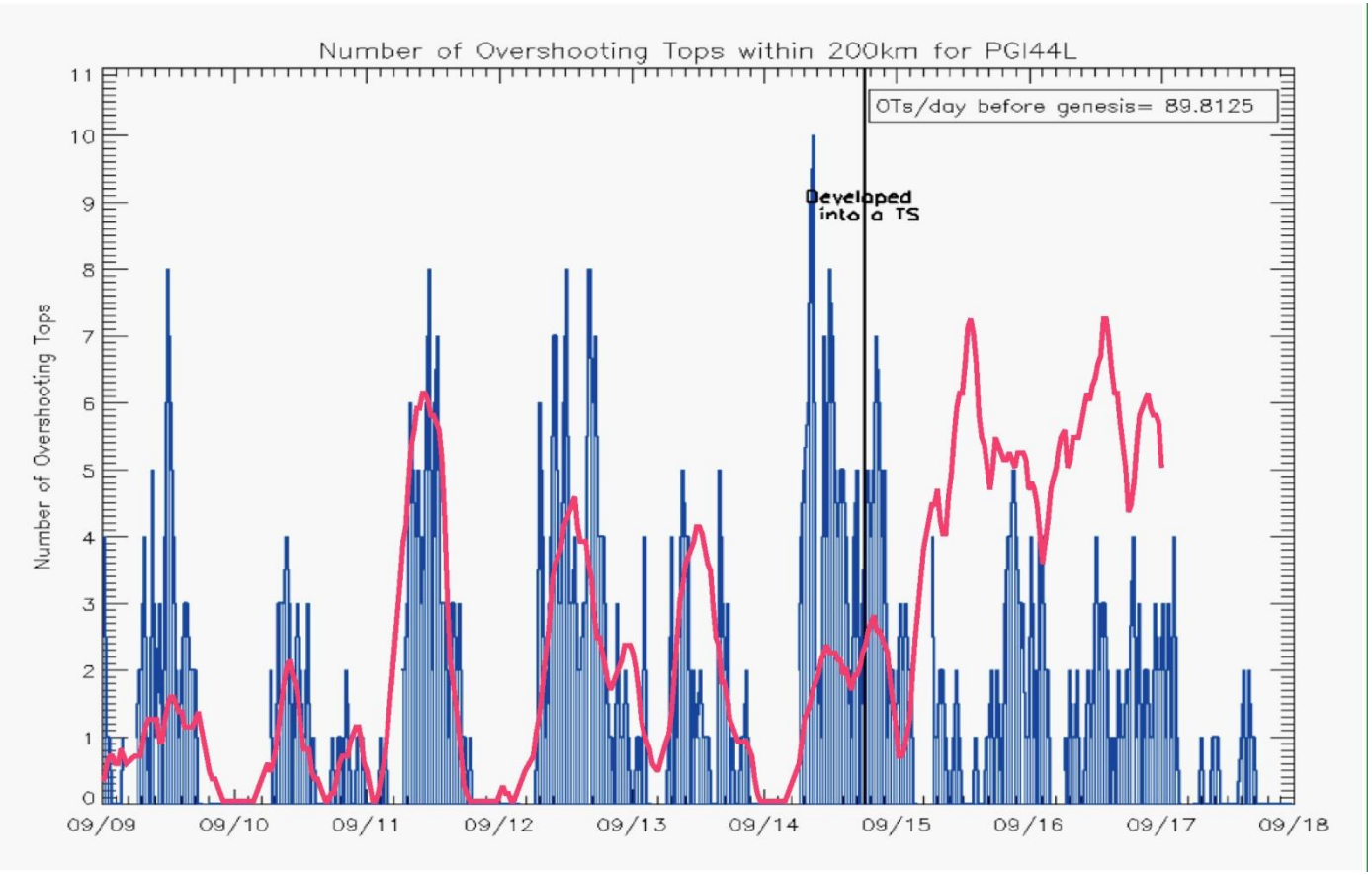
Time series of percent coverage of -60C cloud tops within 2-degrees of pouch center

Gray bars are flights

Area coverage of cold cloud in Gaston roughly half of that in Karl and Matthew

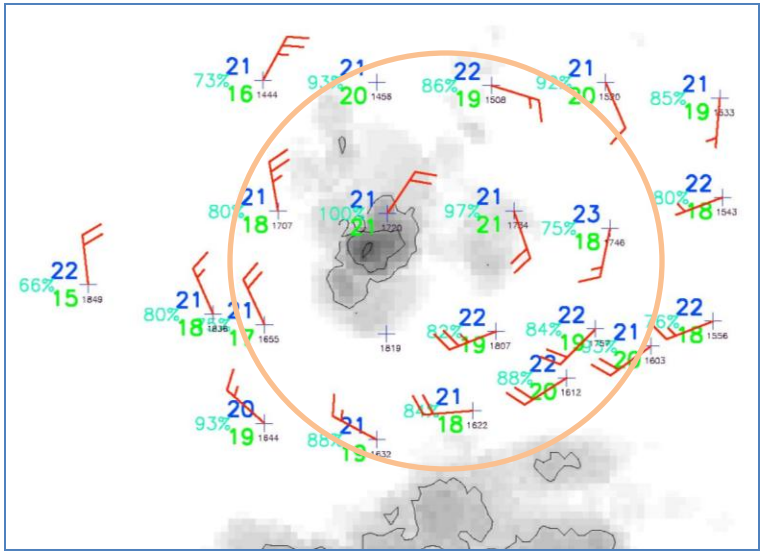


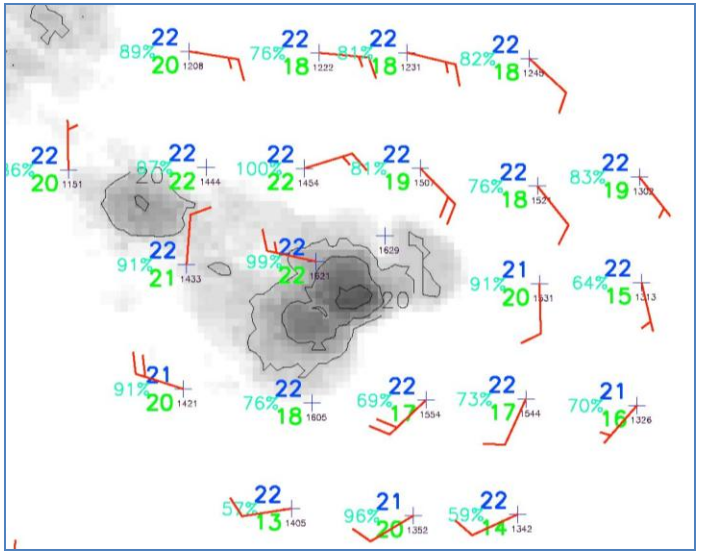
# Comparison of Cold Cloud and Overshooting Tops



# Dropsondes at 925 mb and Occurrence of CTT < -60C

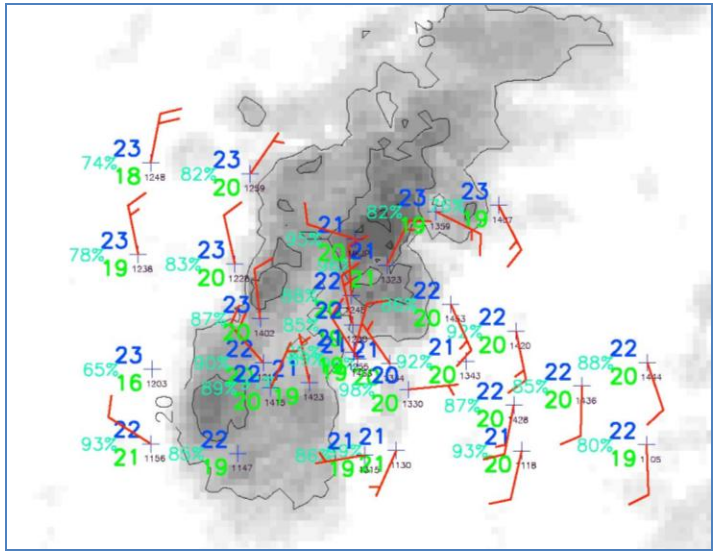
Gaston
09/03

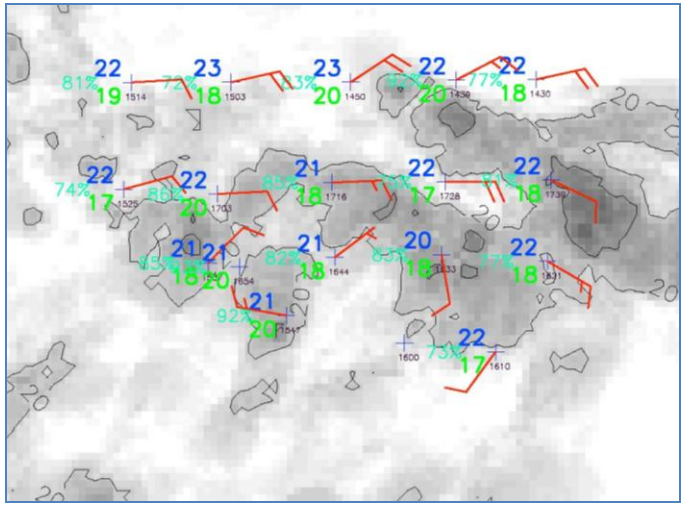




Gaston
09/06

Karl
09/13

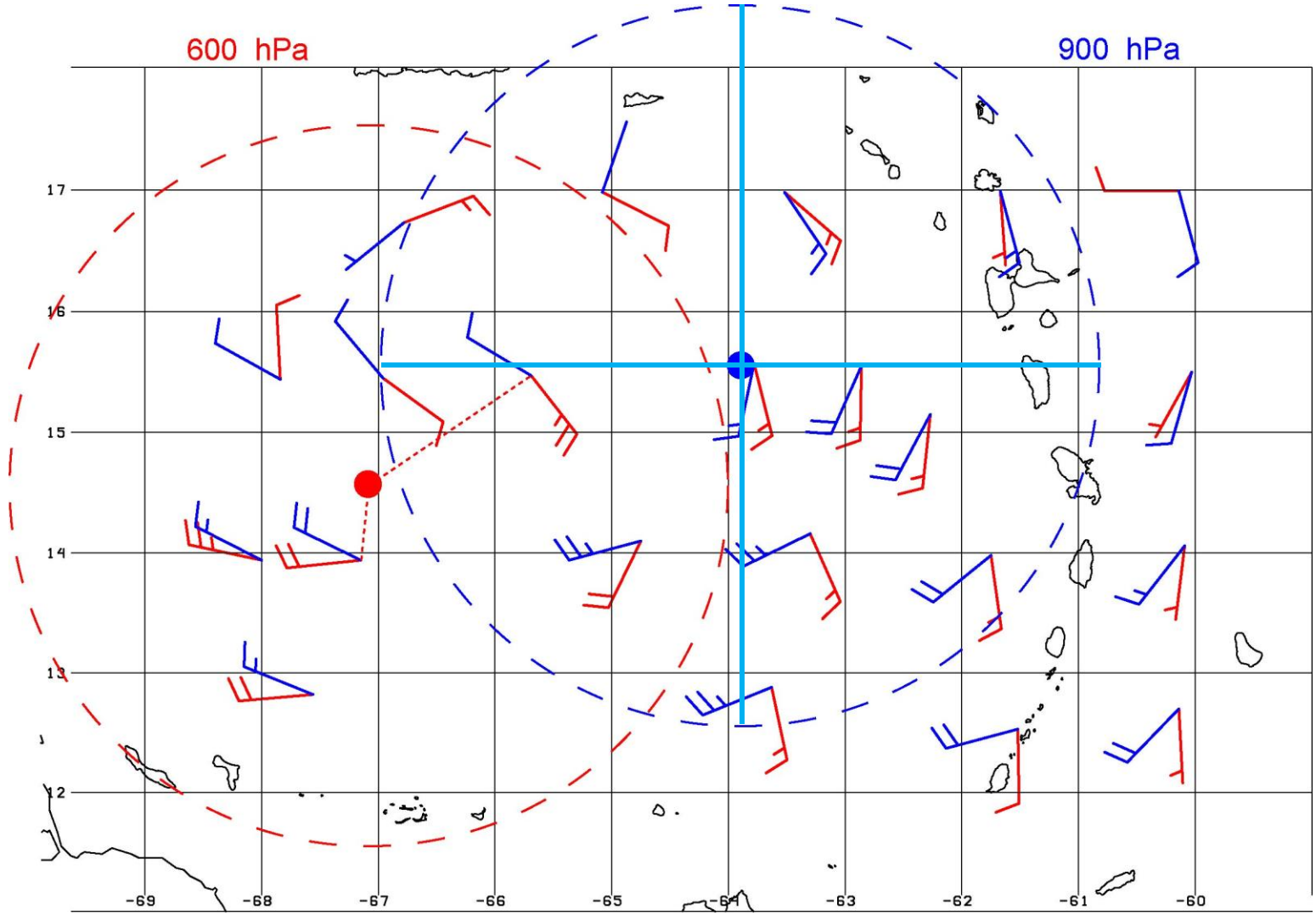




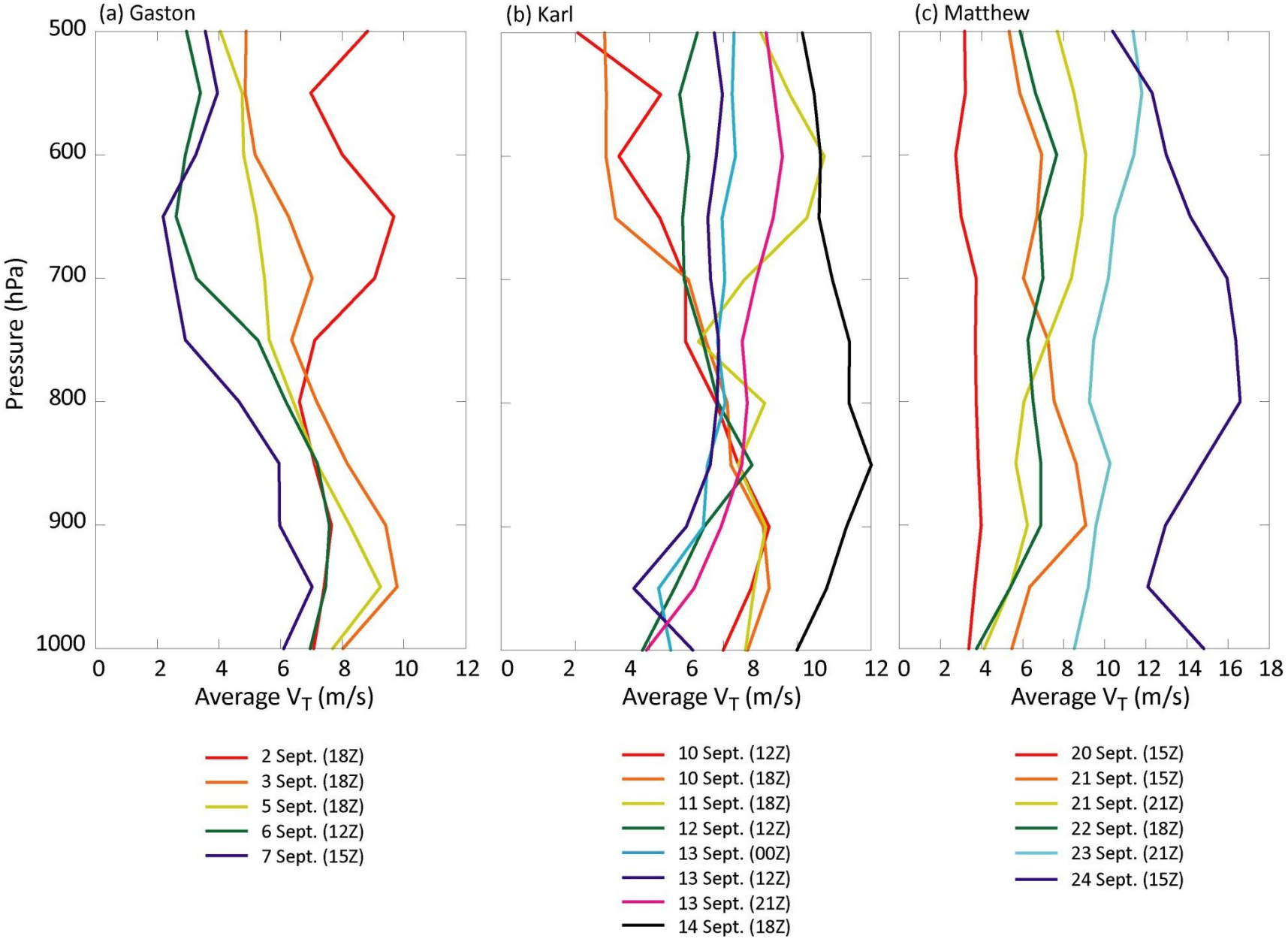
Matthew
09/22

# Circulation Centers

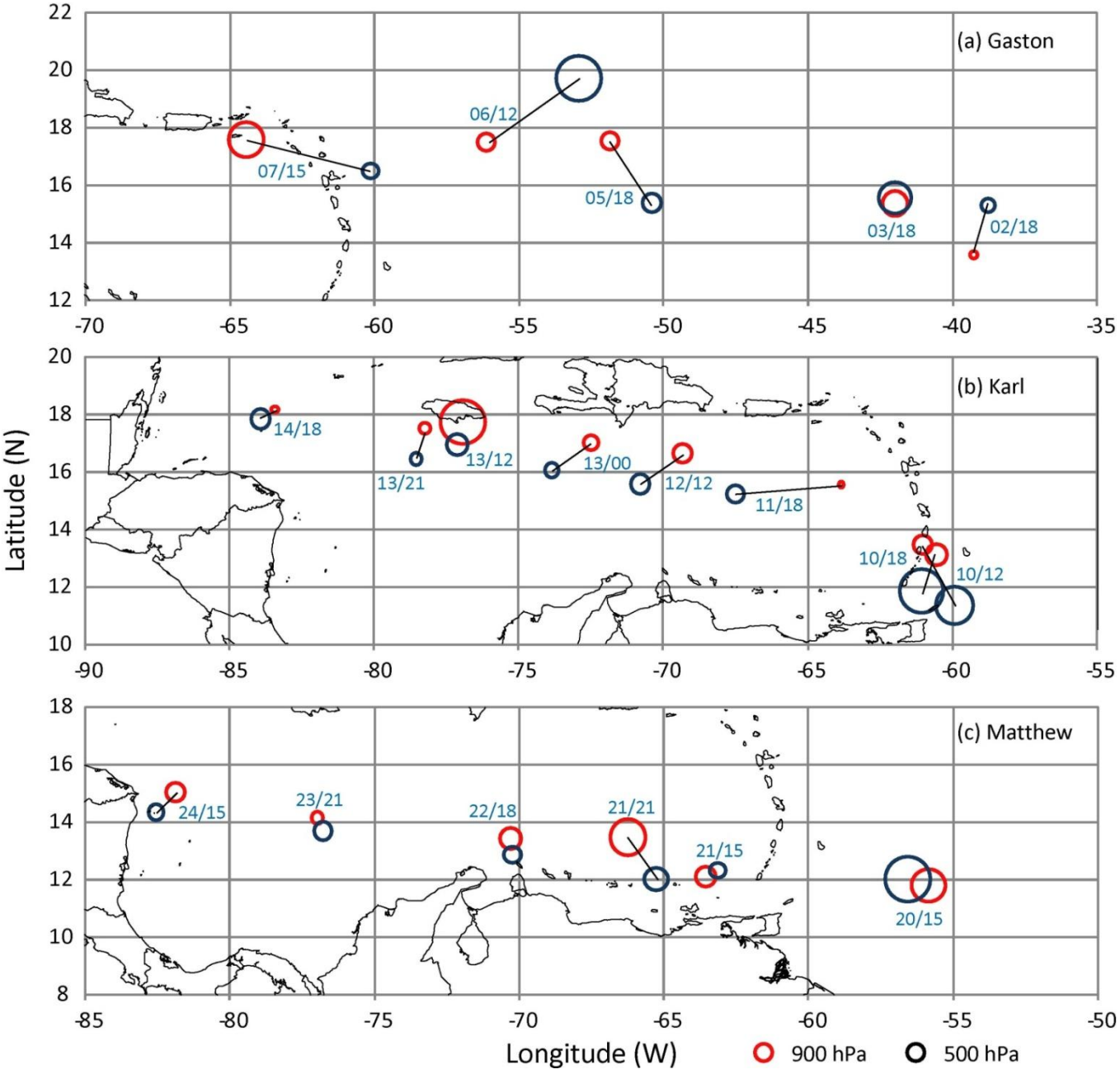
18 UTC 11 September



# Vortex Strength vs. Pressure (height) and Time

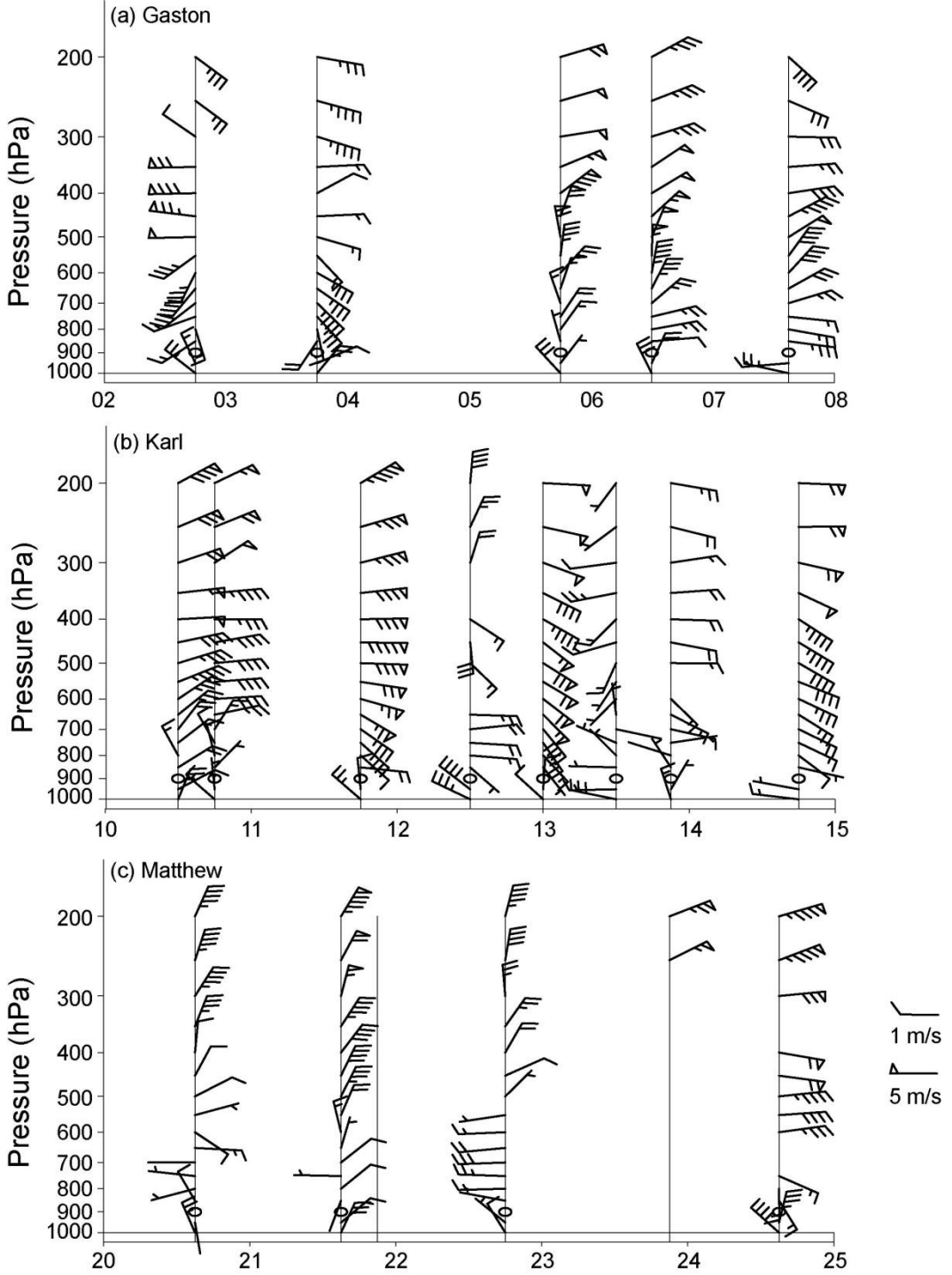


# Relative Positions of Circulation Centers at 500 and 900 hPa

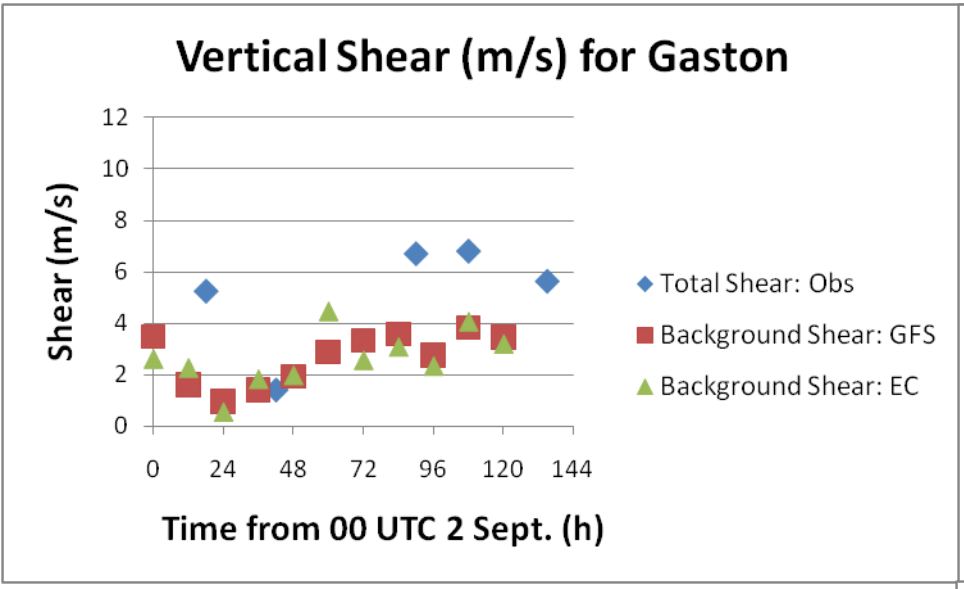


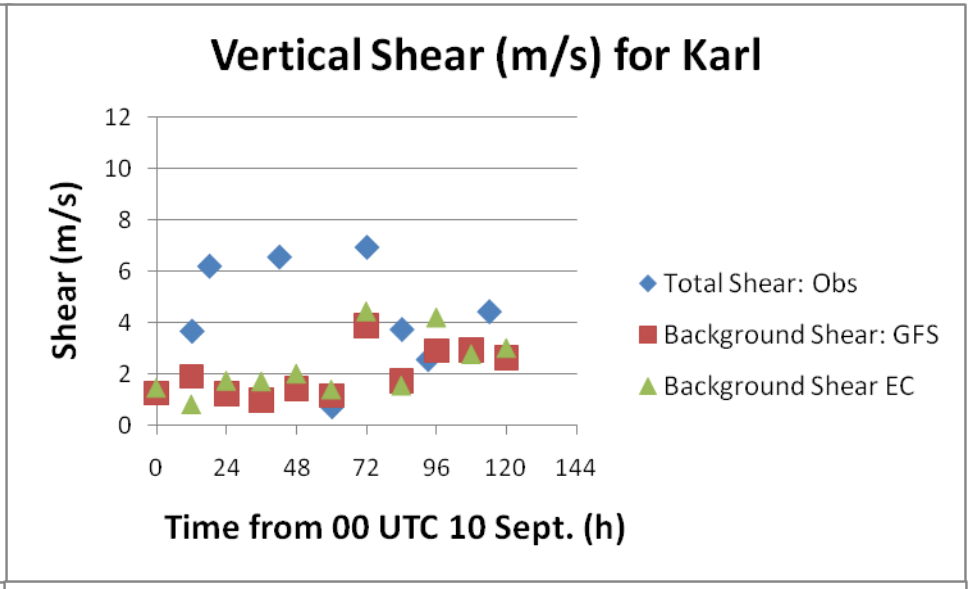
# Relative Flow

- Relative to 900 hPa center
- Strong relative flow in mid-troposphere for both Gaston and Karl
- Weak relative flow for Matthew (up to about 400 hPa) prior to genesis



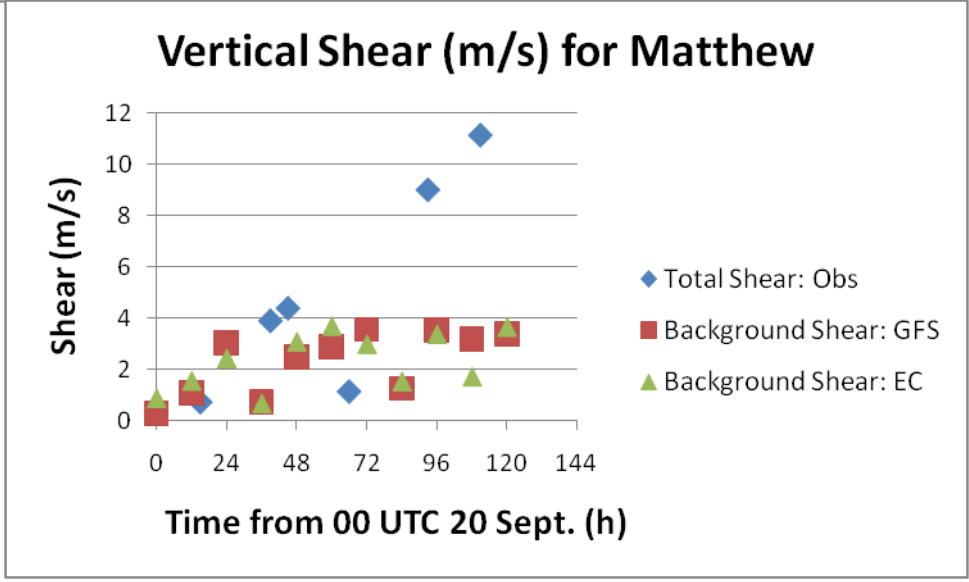
# Background vs. Total Shear



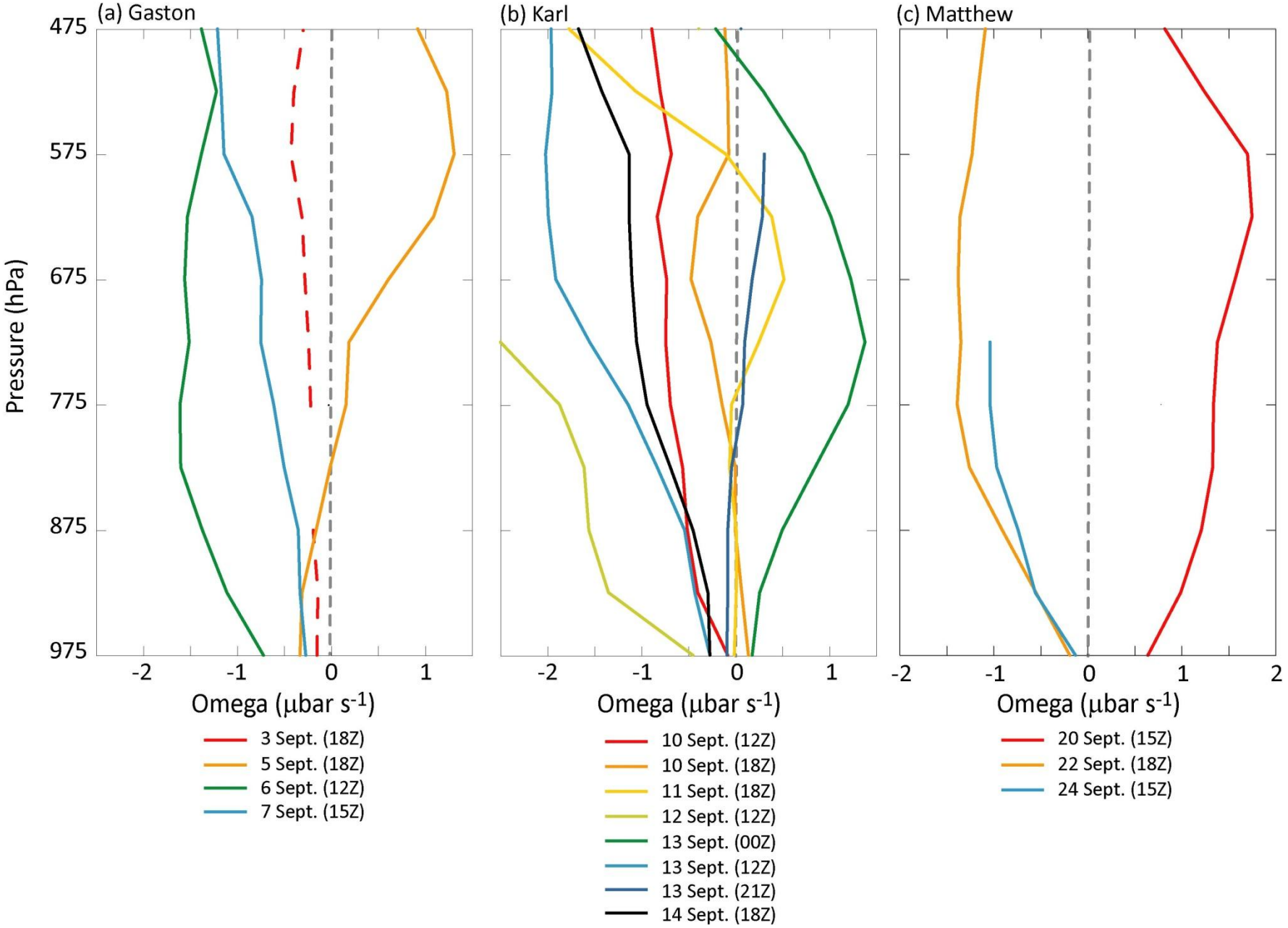



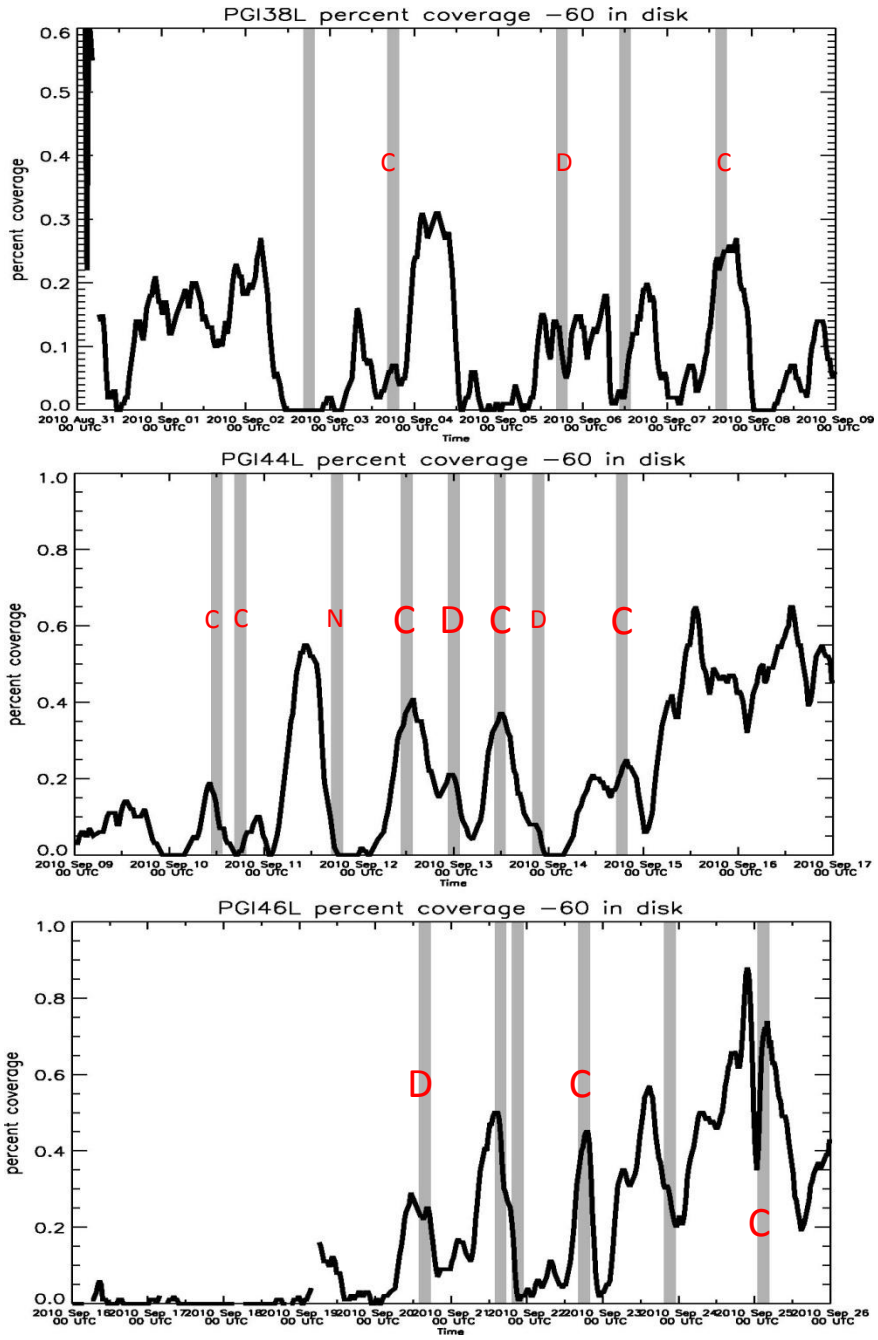

GFS and EC: “storm” removed (Davis et al. 2008, MWR), 925-500 hPa

OBS: 925-500 hPa shear from sondes averaged within 3 degrees of circulation center at 700 hPa.



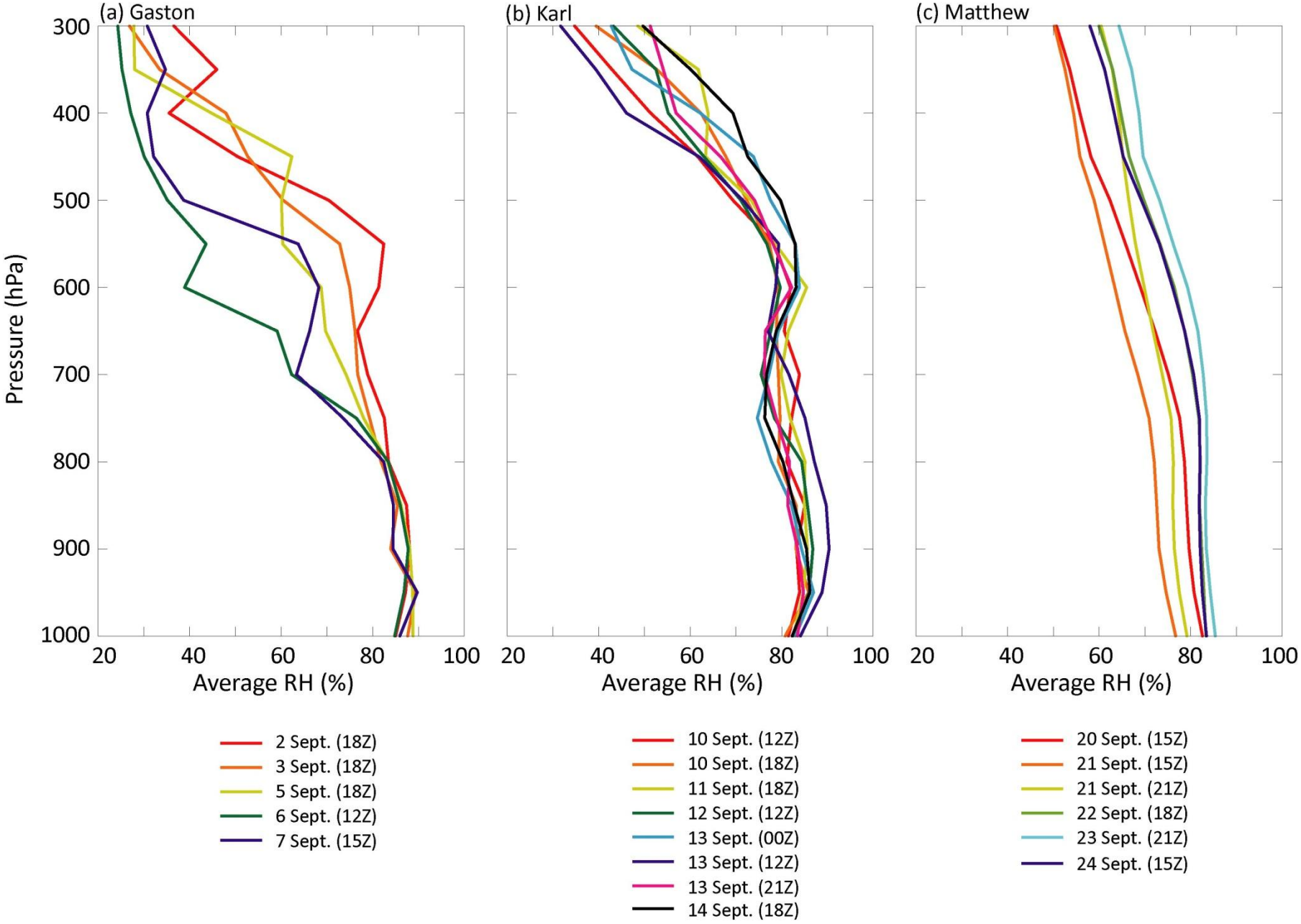
# Profiles of Vertical Motion within 3-Degree Radius






- D, C refer to divergence or convergence below 800 hPa
- Div. favored past convective peak
- Conv. Favored at or prior to convective peak

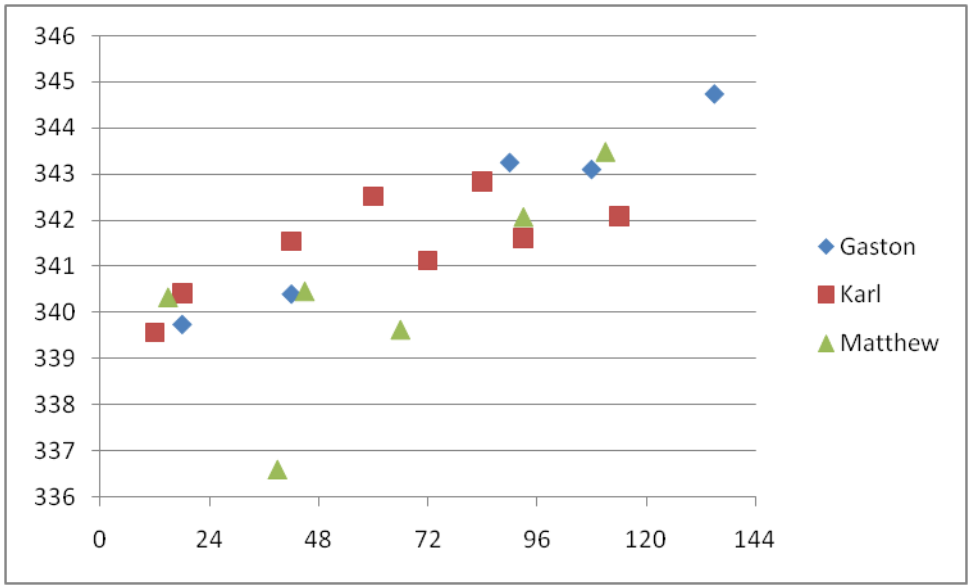
# Relative Humidity Profiles

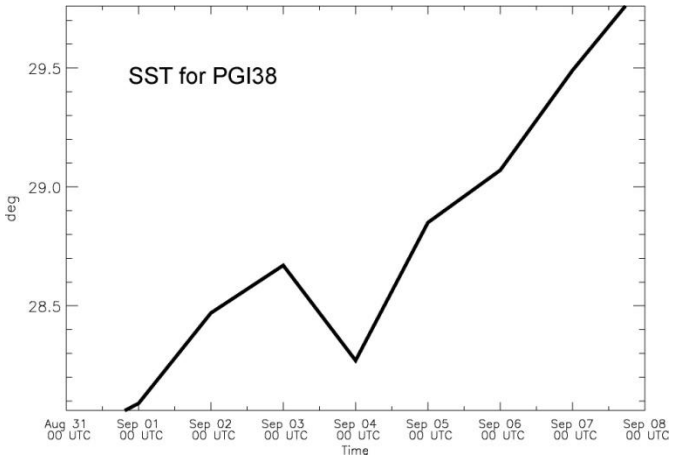


# SST, Moist Static Energy (MSE) and $\theta_v$

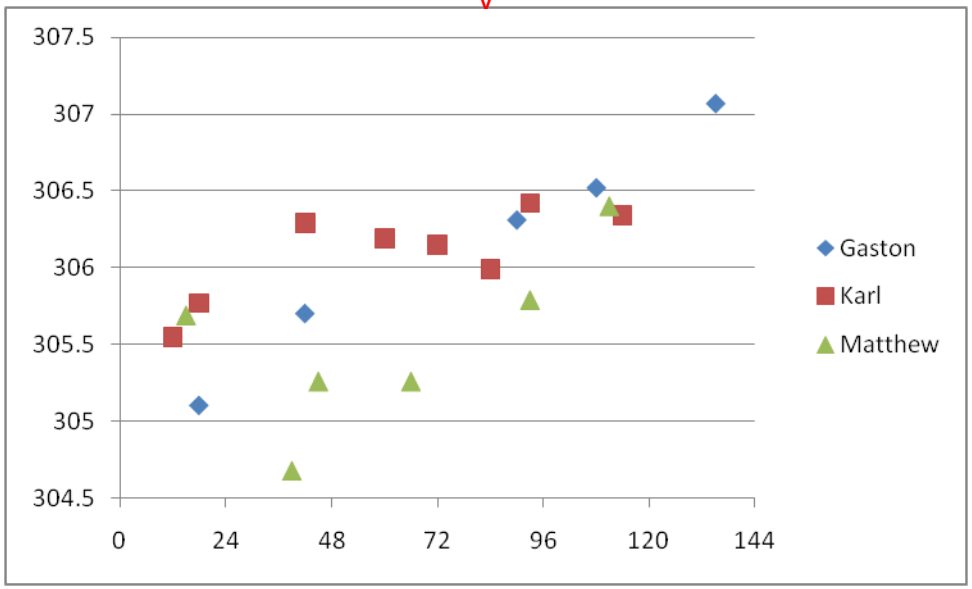
Boundary-layer and lower-troposphere MSE and $\theta_v$ both increase, especially in Gaston. Gaston responds to increase in SST

900 hPa MSE vs. time



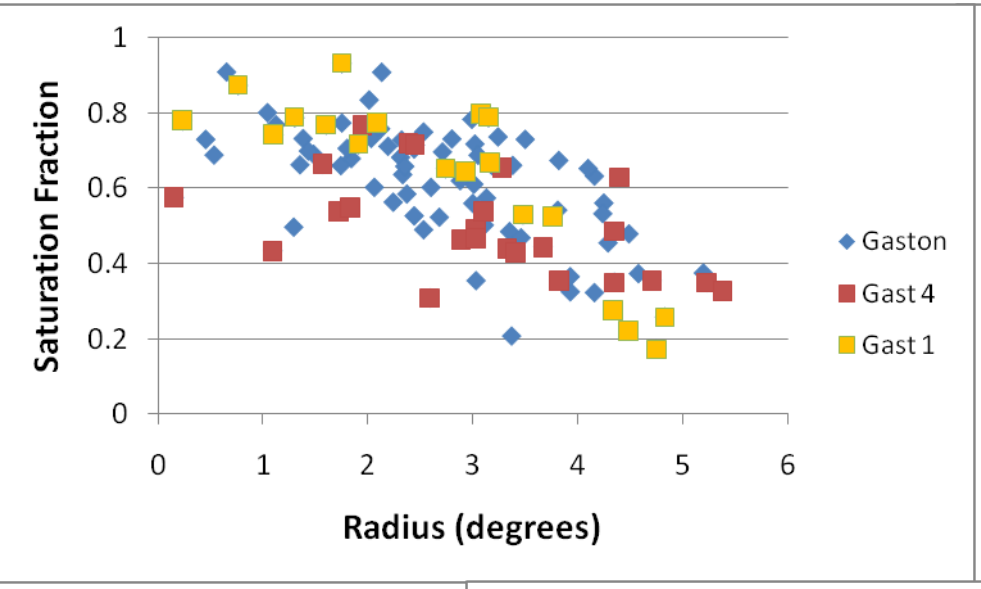



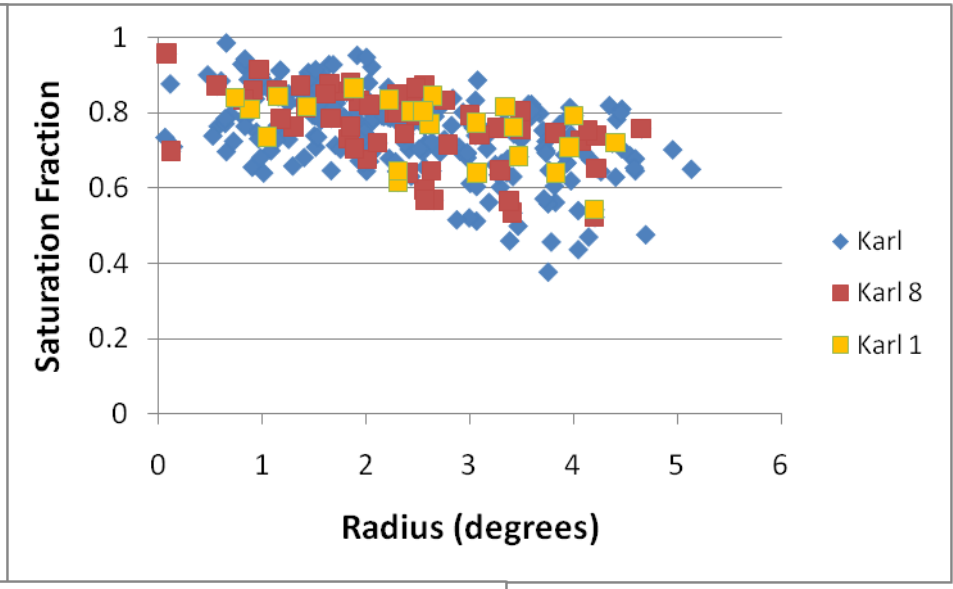

900 hPa $\theta_v$ vs. time

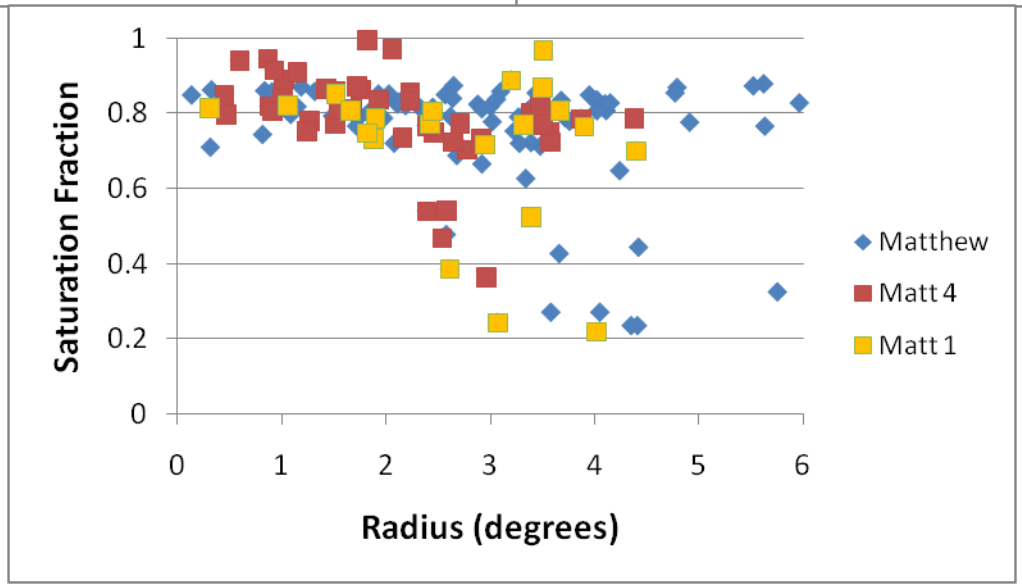


# Radial Profiles of Saturation Fraction

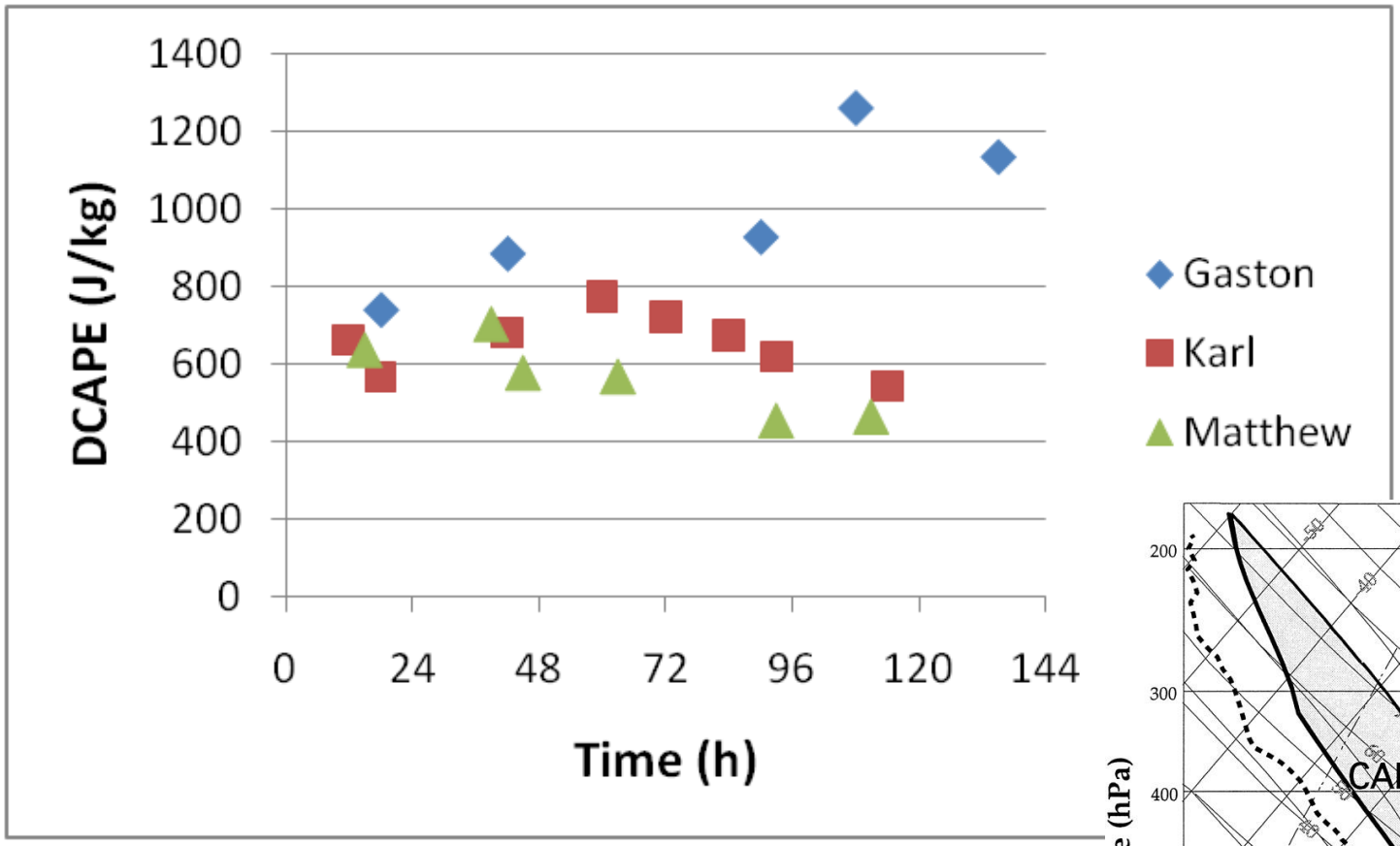
(800-400 hPa)

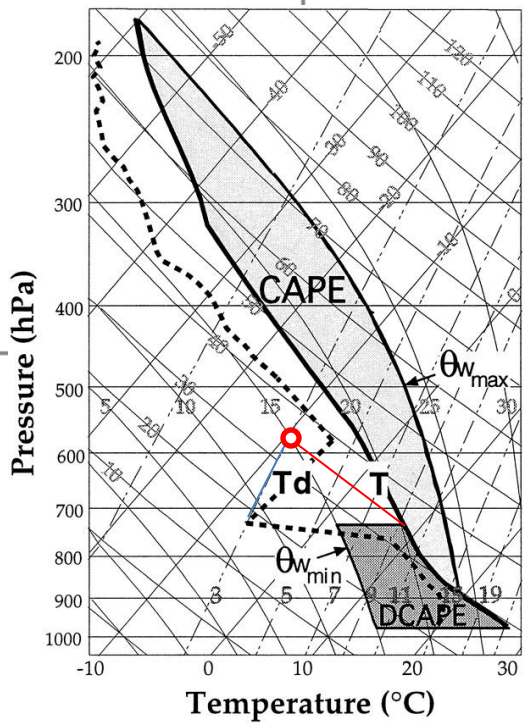


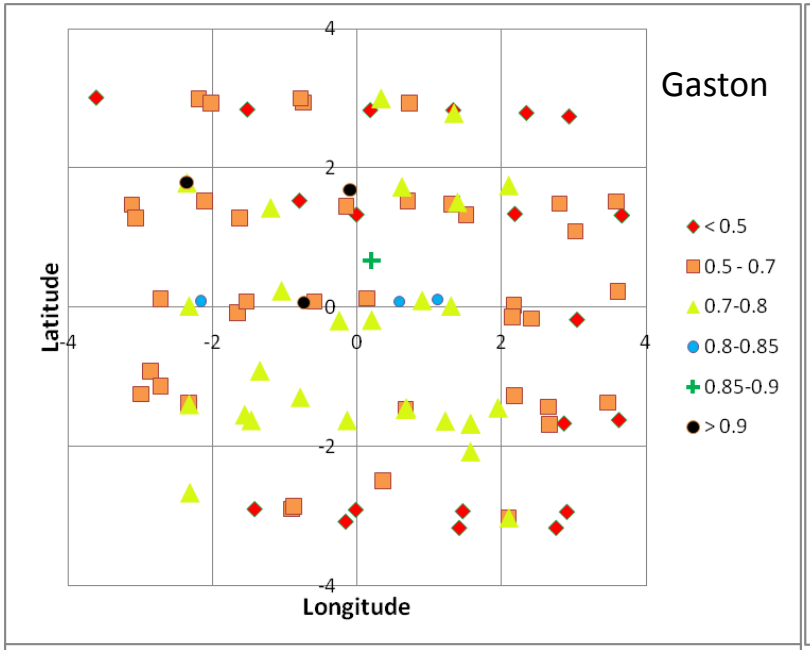



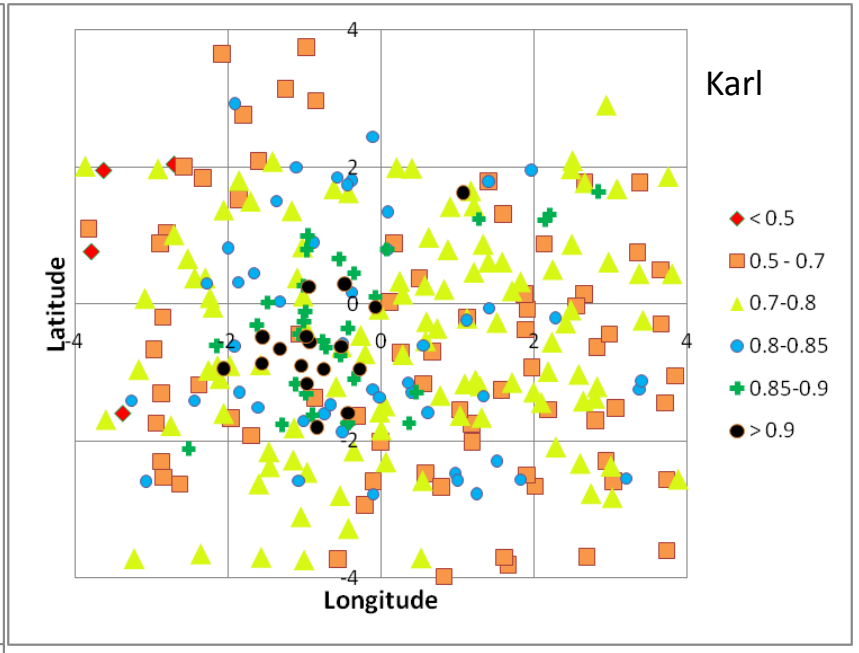
# Downdraft CAPE

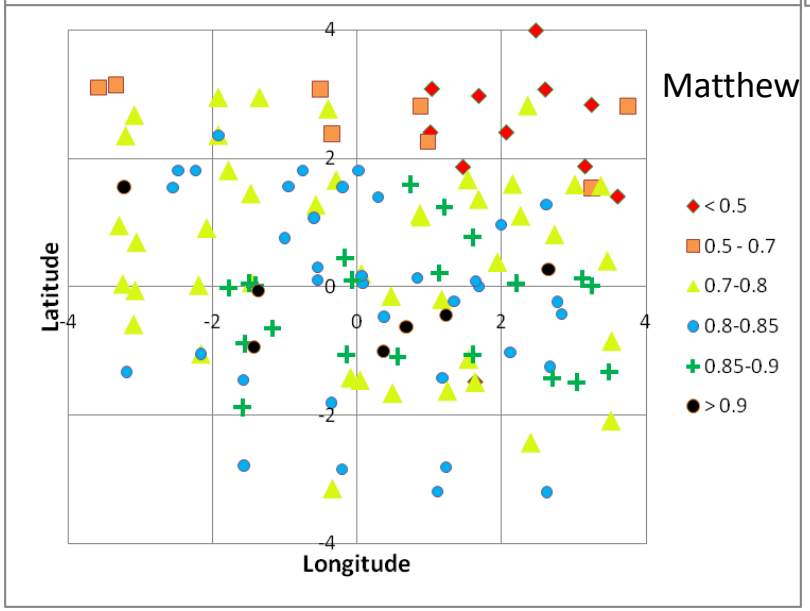


# Spatial Distribution of Saturation Fraction



# Putting it Together (or trying)

- Gaston
  - Surrounded by dry air
  - Cooler ocean surface, initially
  - Substantial relative flow (shear) developed, led to misalignment and weakening from the top downward
  - Convection was limited, unable to moisten column
  - Dry air infiltrated in middle troposphere
  - Downdraft potential increased; outflows observed
  - Boundary layer MSE (and Tv) increased with SST; Probably not enough convection to lower boundary-layer MSE.
  - Gaston ended where Karl began (vertical structure), but drier

# Putting it Together (or trying)

- Karl
  - Relatively moist (but not near saturation) over large area
  - Convection appears to have significant role in mis-alignment and subsequent alignment
  - Quasi-persistent region of near saturation on downshear side
  - Vortex gradually aligned.

# Putting it Together (or trying)

- Matthew
  - Moist environment became even more moist
  - Vortex nearly aligned at all times
  - Weakest shear and relative flow (early)
  - Convection near pouch center from the start
  - Fastest to develop
  - RI short-circuited by increase shear

# Some General Thoughts

- Convection pulsates, not close to steady
- Each pulse potentially intensifies system
- Lull between pulses allows weakening; question is whether negative influences between pulses undo the spinup during pulses
- Negative influence is greater when relative flow is larger (shear); able to destroy moist column
- Alignment eliminates relative flow; still need continued convection for genesis
- All cases retain downdraft potential up until genesis (and beyond); greater in Gaston, but is this a distinguishing characteristic?