Investigating the ‘G’ and ‘RI’ Using Numerical Modeling and a Host of In Situ GRIP Data Sets

Henry Fuelberg

Dan Halperin

Brad Reinhart

Robert Hart

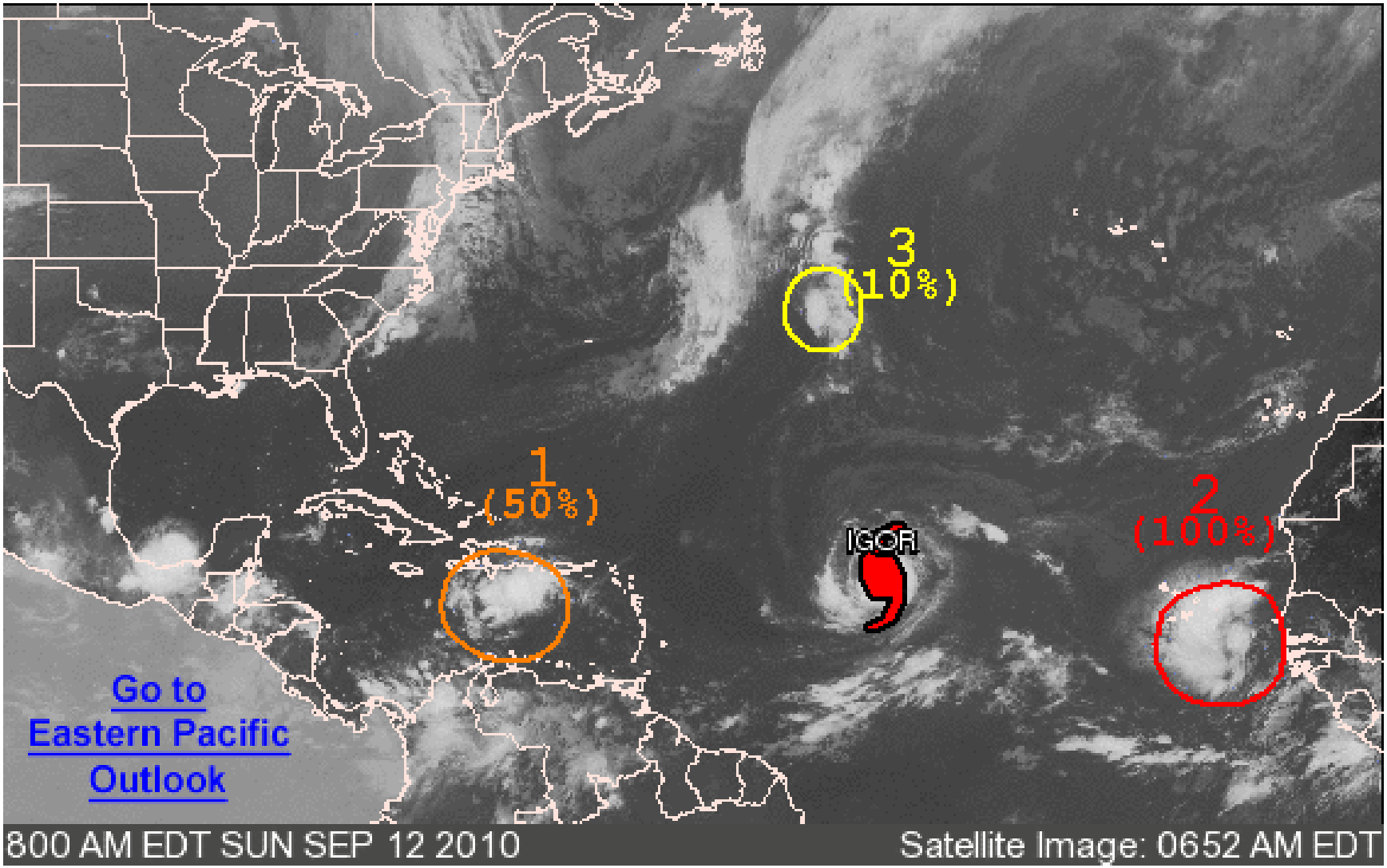
Florida State University

We Thank Our Collaborators

- Richard Pasch---NHC
- Andy Heymsfield & Aaron Bansemer – Microphysics
- Richard Blakeslee and Douglas Mach – LIP
- Steve Durden and Simone Tanelli – APR-2
- Gerry Heymsfield – HIWRAP
- Bjorn Lambrigtsen - HAMSR

Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida

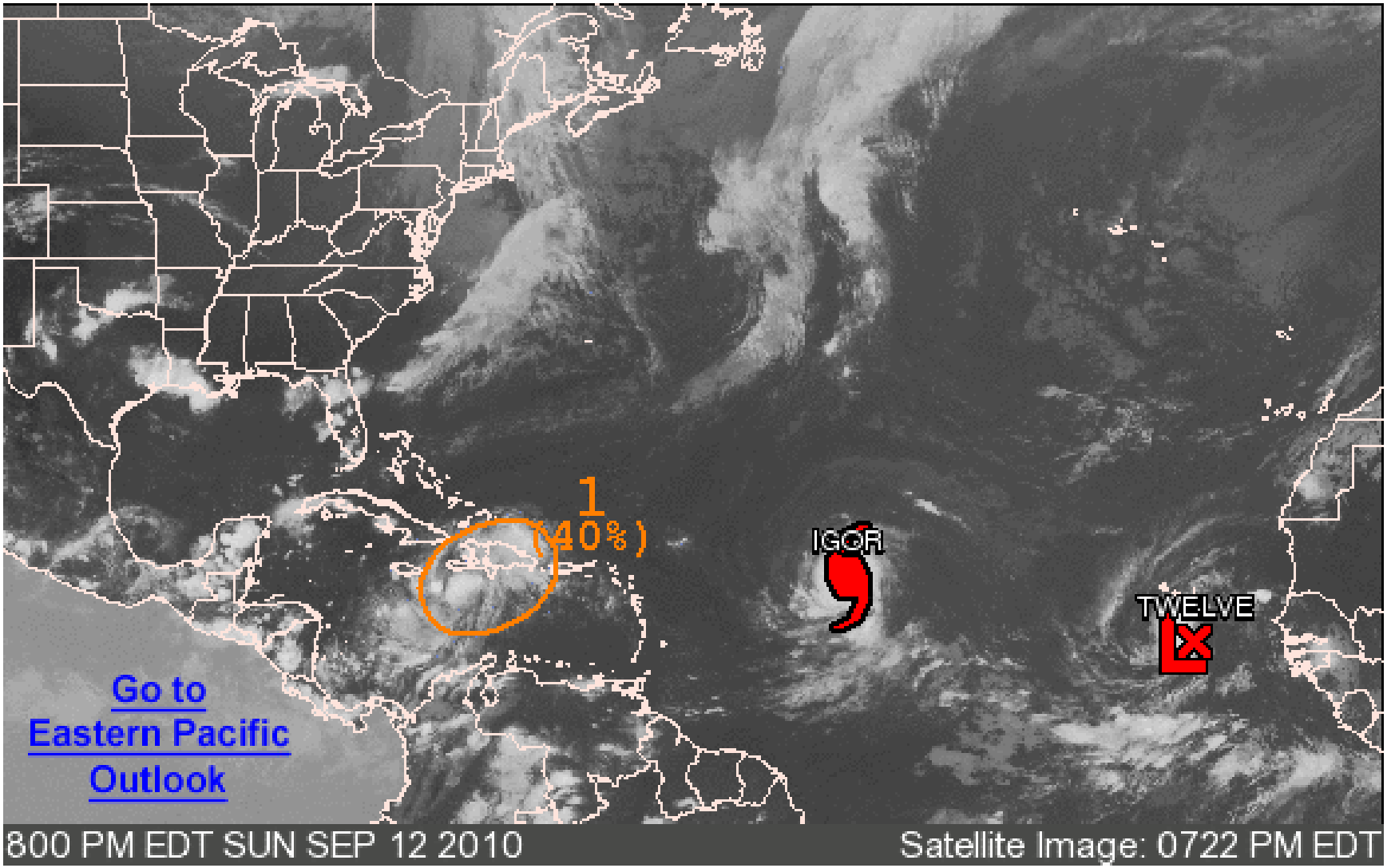


Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30% Medium 30-50% High >50%

Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida

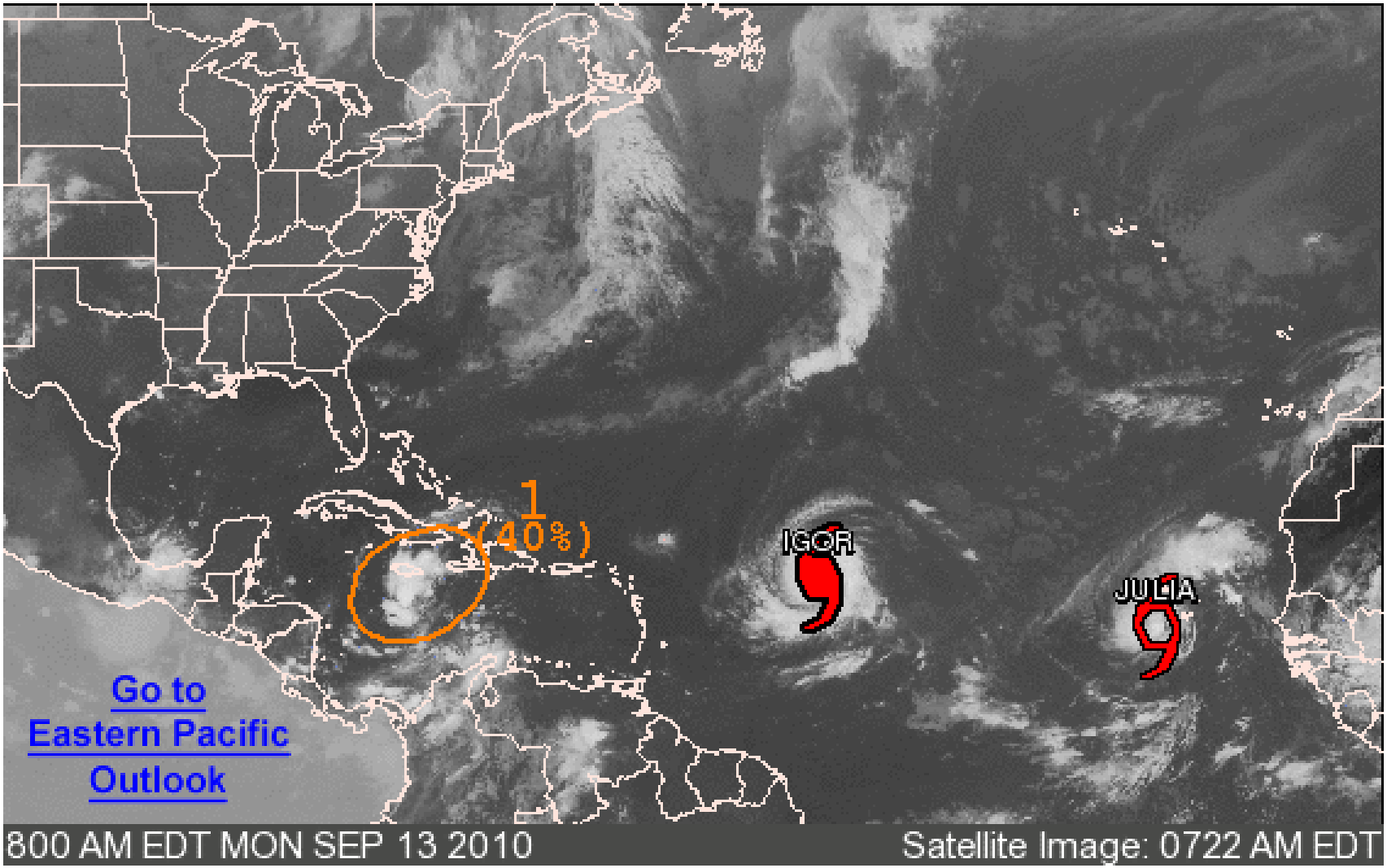


Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30% Medium 30-50% High >50%

Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida

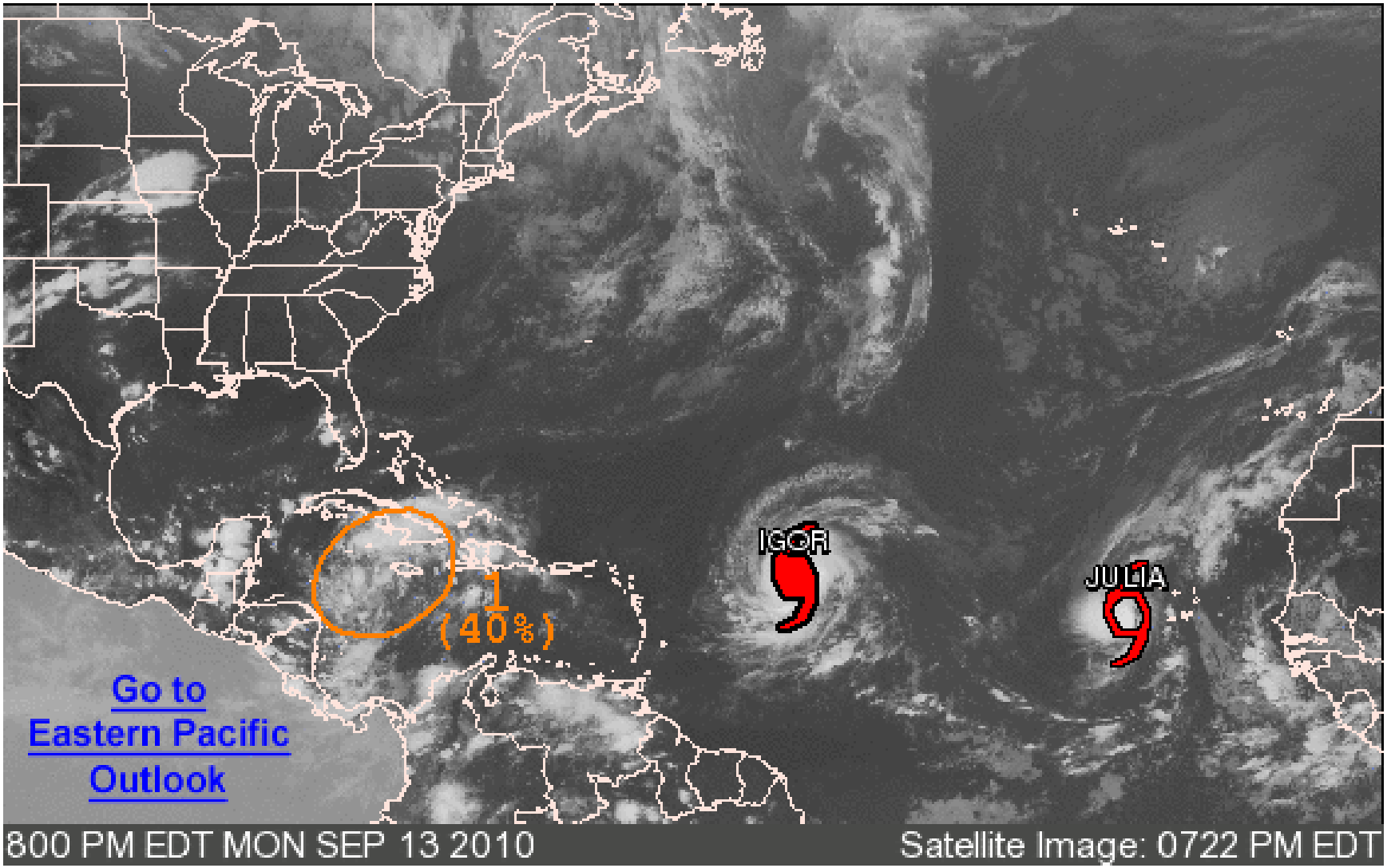


Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30% Medium 30-50% High >50%

Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida

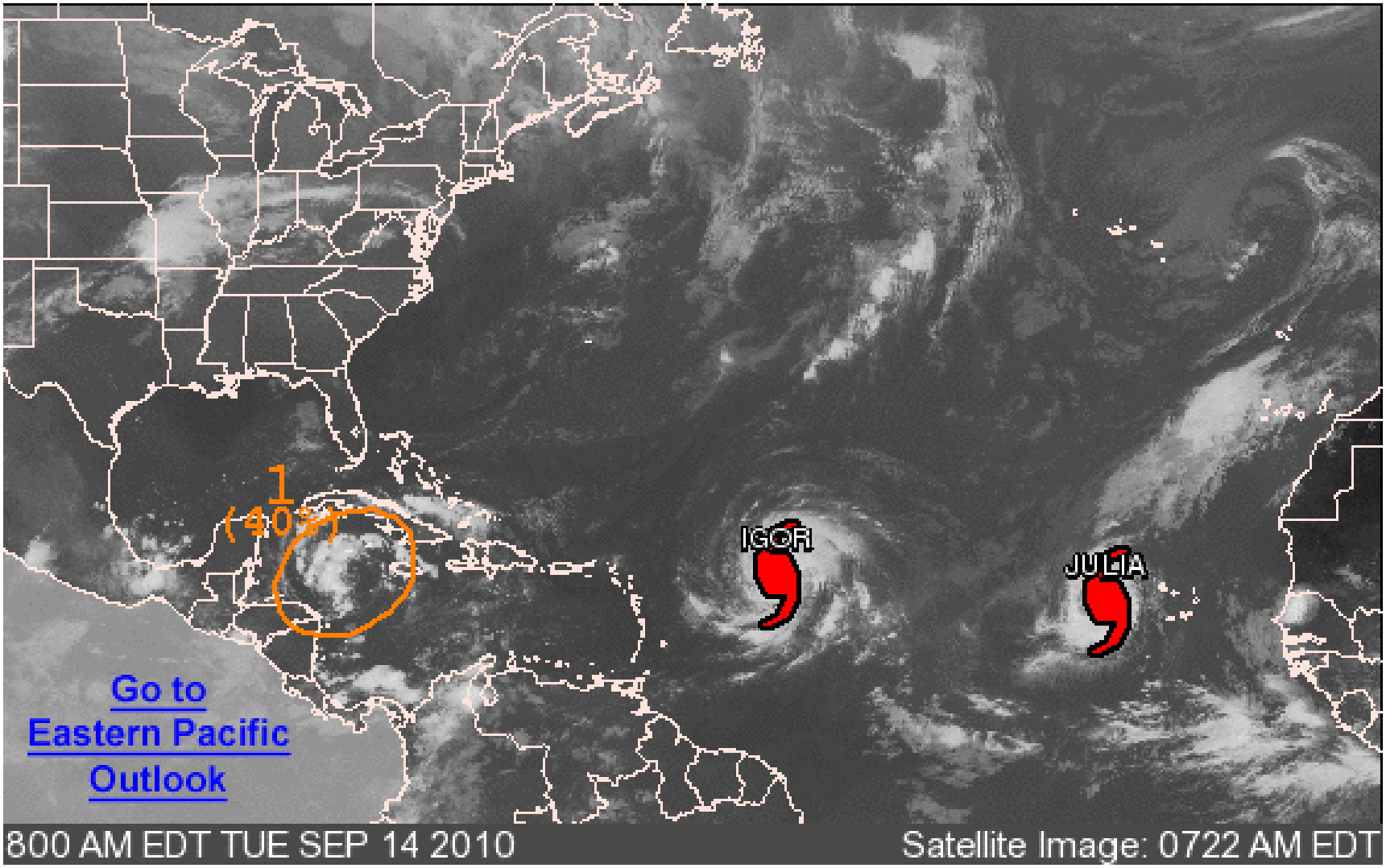


Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30% Medium 30-50% High >50%

Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida

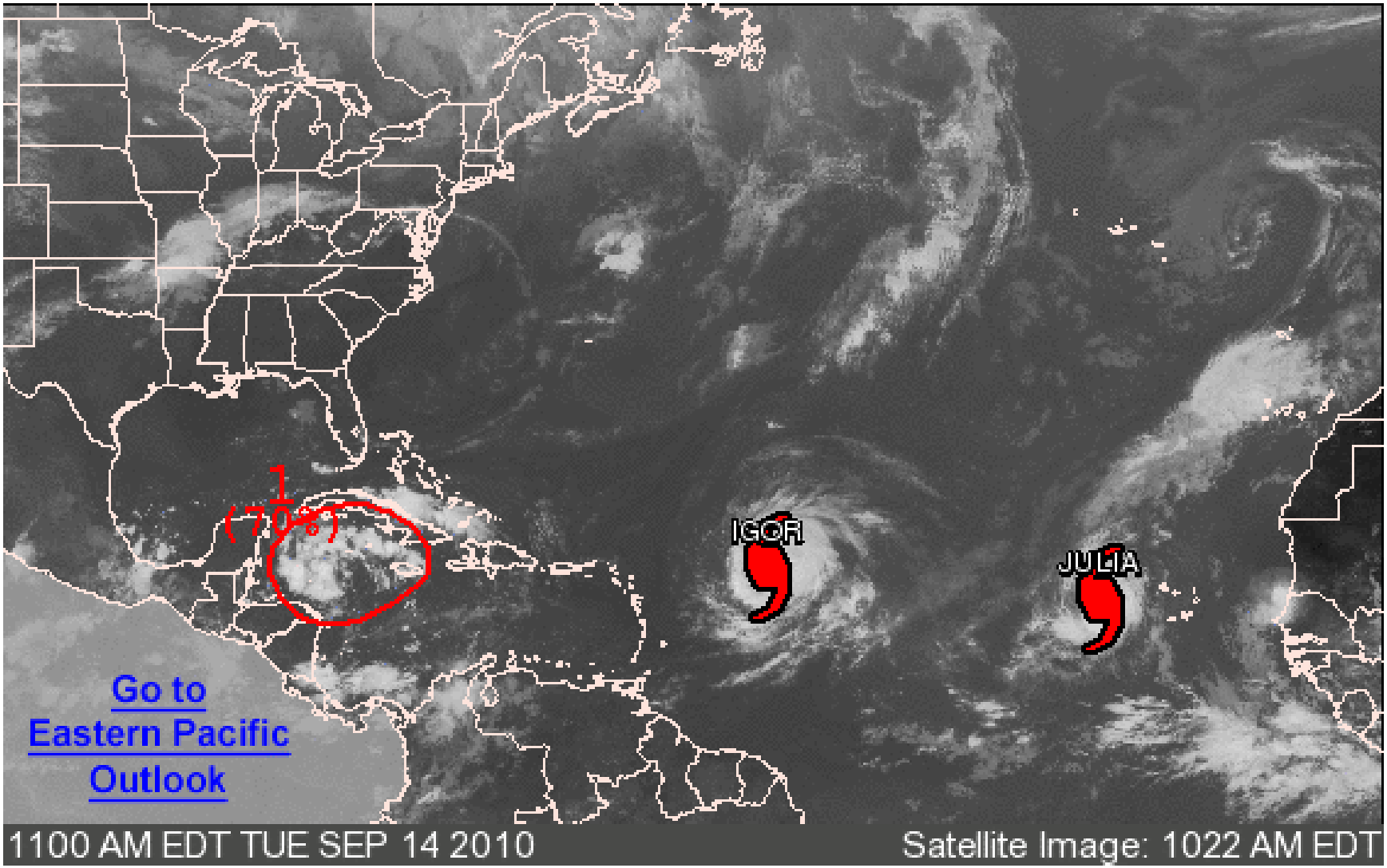


Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30% Medium 30-50% High >50%

Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



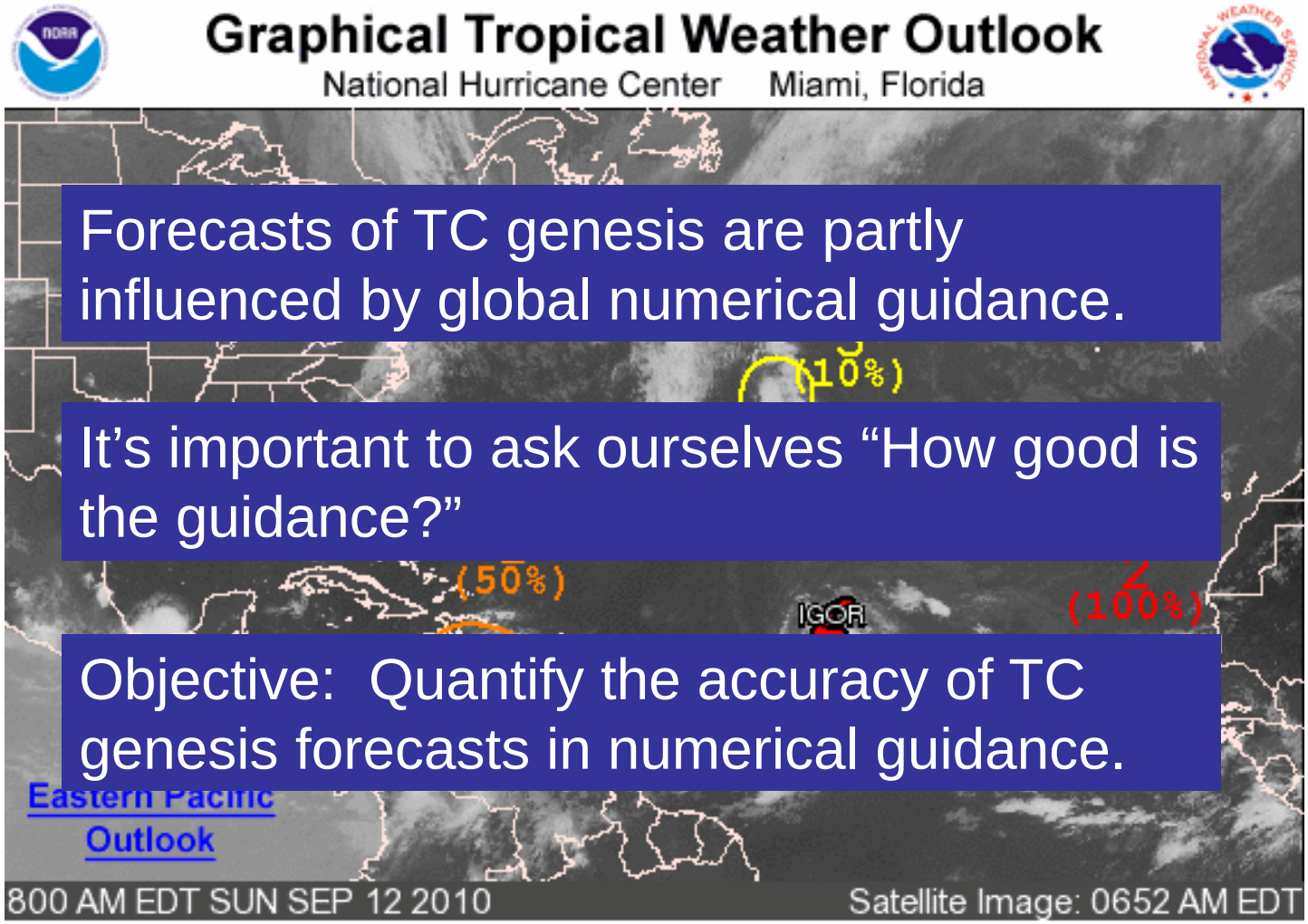
Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30% Medium 30-50% High >50%

Genesis Forecast for Karl

- NHC tracked the disturbance that became Karl in its Graphical Tropical Weather Outlook—but did not increase the probability of genesis until the last few hours.
- But…..none of the models we studied (CMC, GFS, NOGAPS) predicted the genesis of Karl.
- The models did show an elongated area of low pressure near the genesis time.
  - But, the low was too weak to be classified as a TC.

Motivation



Forecasts of TC genesis are partly influenced by global numerical guidance.

It's important to ask ourselves "How good is the guidance?"

Objective: Quantify the accuracy of TC genesis forecasts in numerical guidance.

Outlined areas denote current position of systems discussed in the Tropical Weather Outlook. Color indicates probability of tropical cyclone formation within 48 hours.

Low <30% Medium 30-50% High >50%

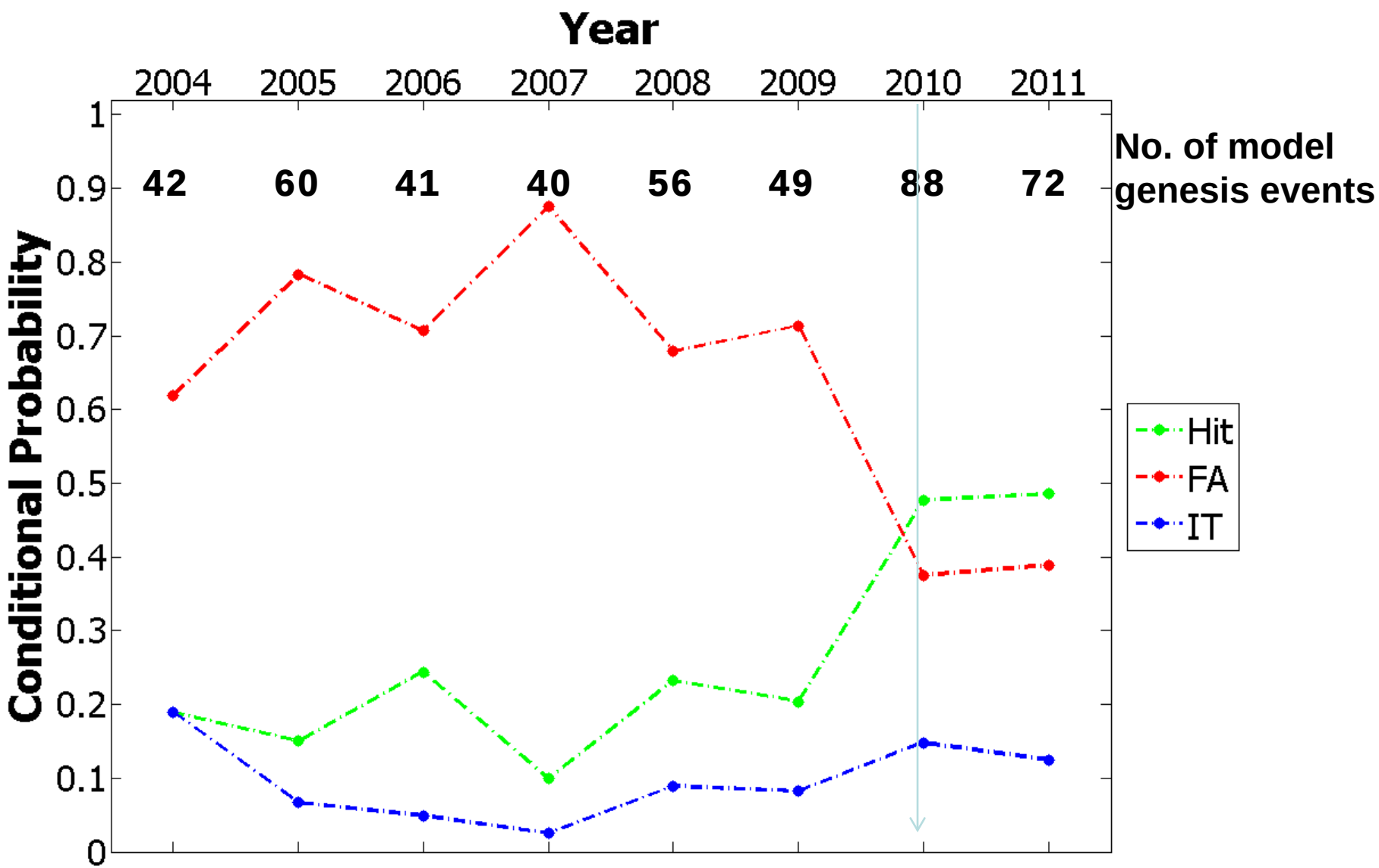
Data

- Model output archive available at FSU (2004-2011)
  - Canadian Meteorological Centre Global Environmental Multiscale Model (CMC)
  - National Centers for Environmental Prediction Global Forecast System (GFS)
  - Navy Operational Global Atmospheric Prediction System (NOGAPS)
  - United Kingdom Met Office Global Model (UKMET)
    - Data available for 2004-2009 only.
- Working to procure:
  - UKMET 2010-2011
  - ECMWF via TIGGE
- Analyzed genesis forecasts out to 96 h over the North Atlantic Basin.

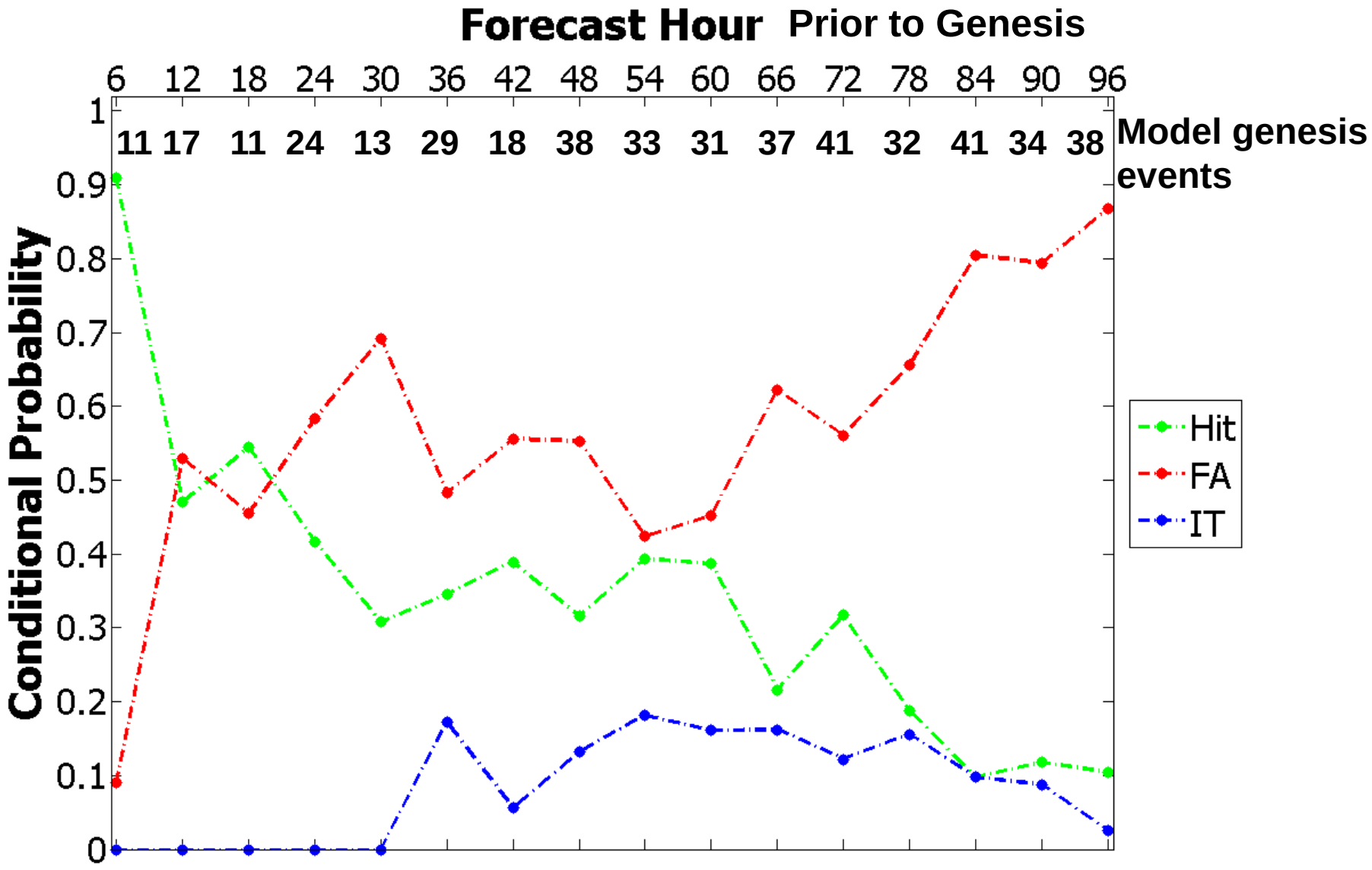
Methodology

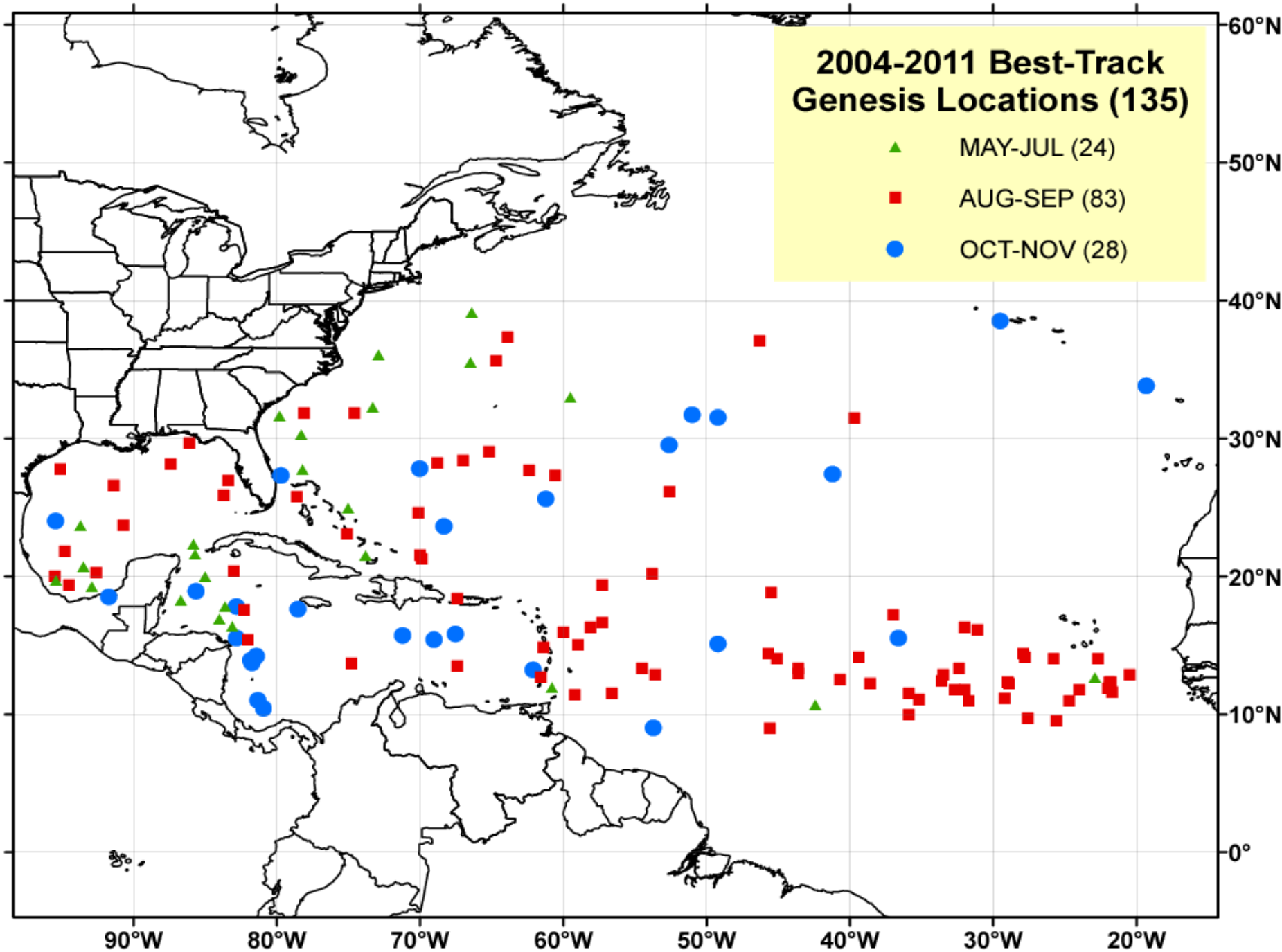
- Code was developed to identify, track, and classify all model-indicated TCs.
- Each model-indicated TC genesis event was classified as a hit, a false alarm, or an incorrect timing event (partial success).
- Classifications are based on comparisons with Best-Track entries.
- We define “Best-Track genesis” as the first entry in which a storm is designated a Tropical Depression or Tropical Storm.
- See Dan’s poster for more details

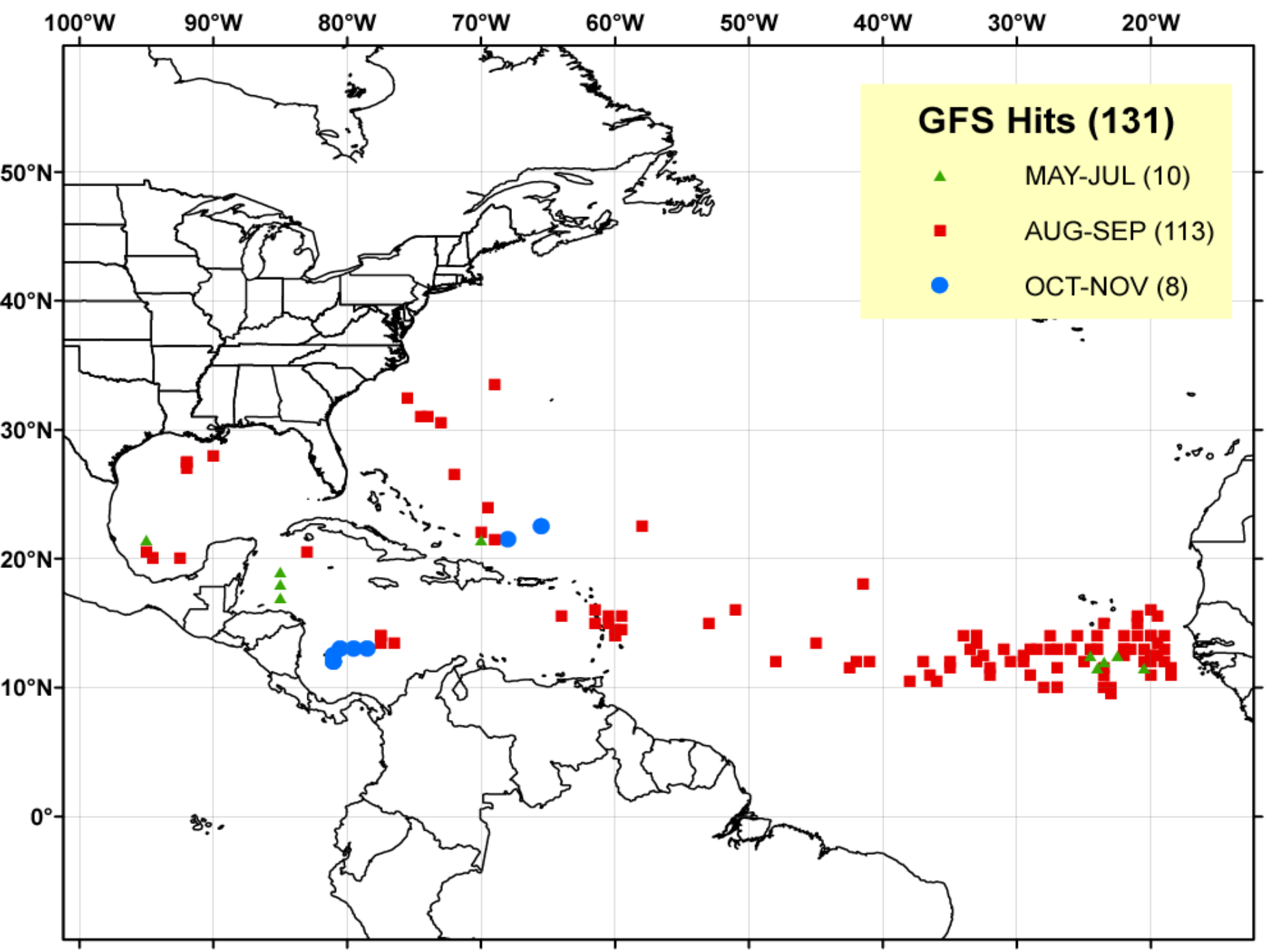
GFS Results by Year

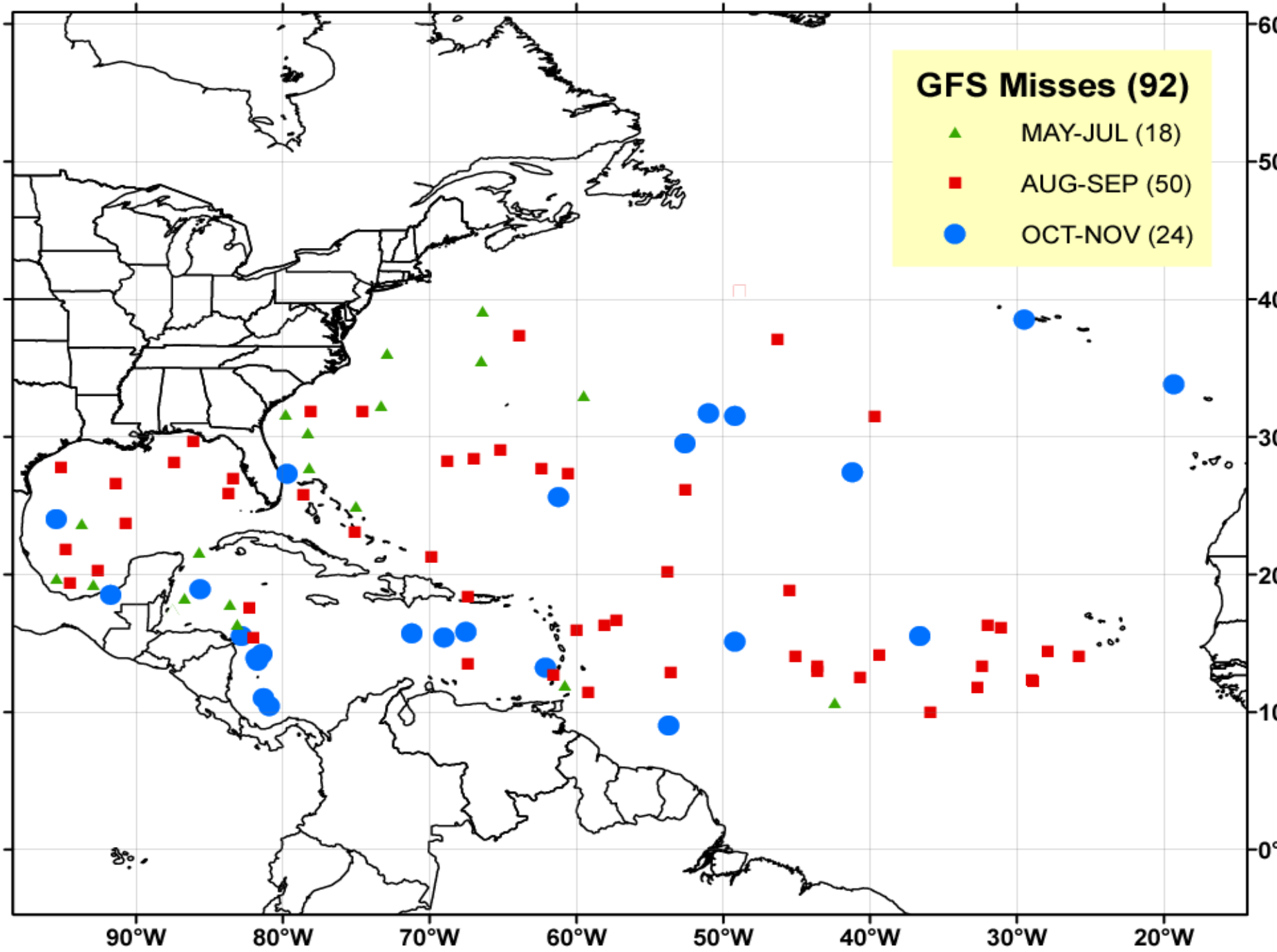


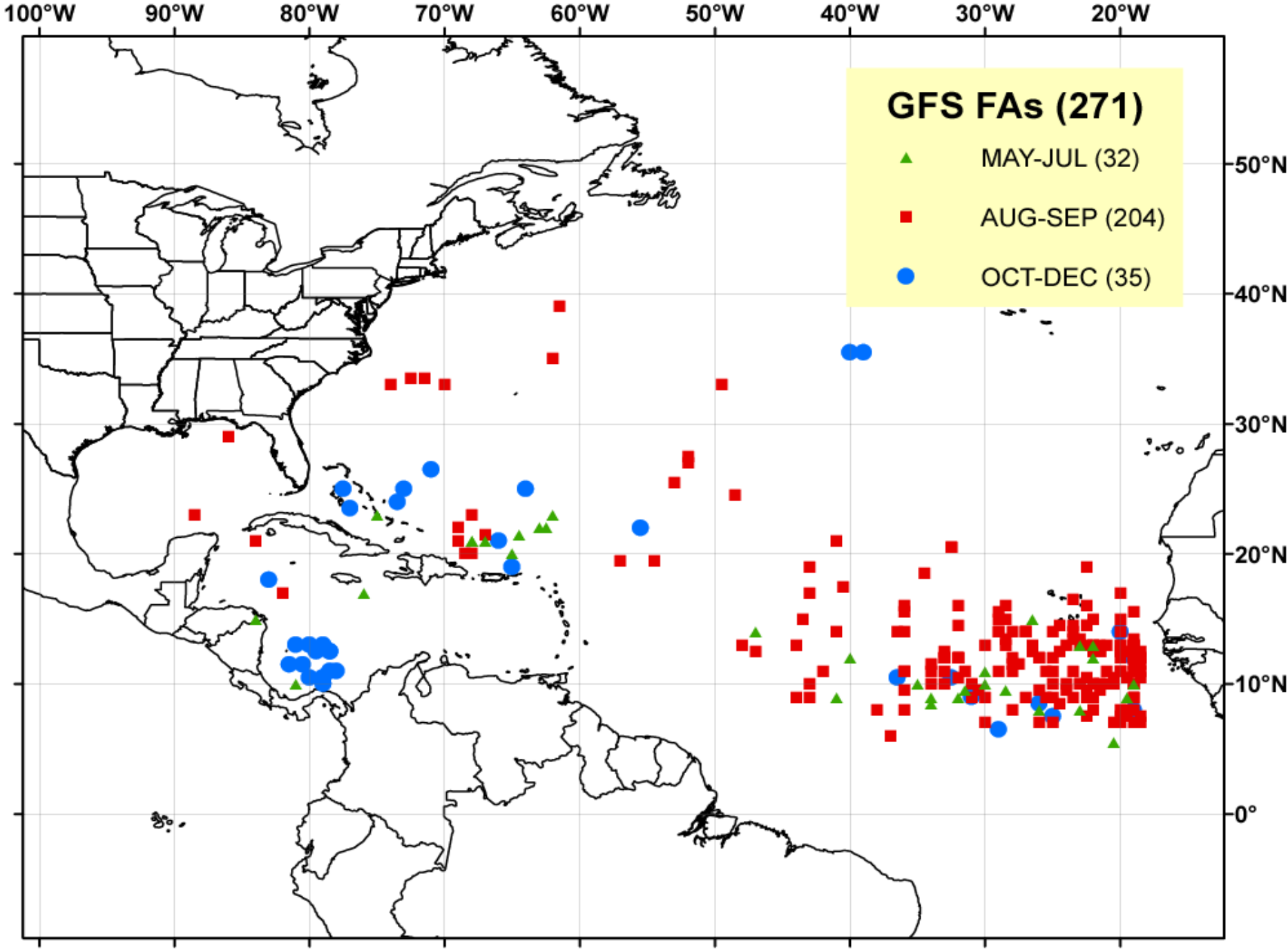
GFS Results by Forecast Hour

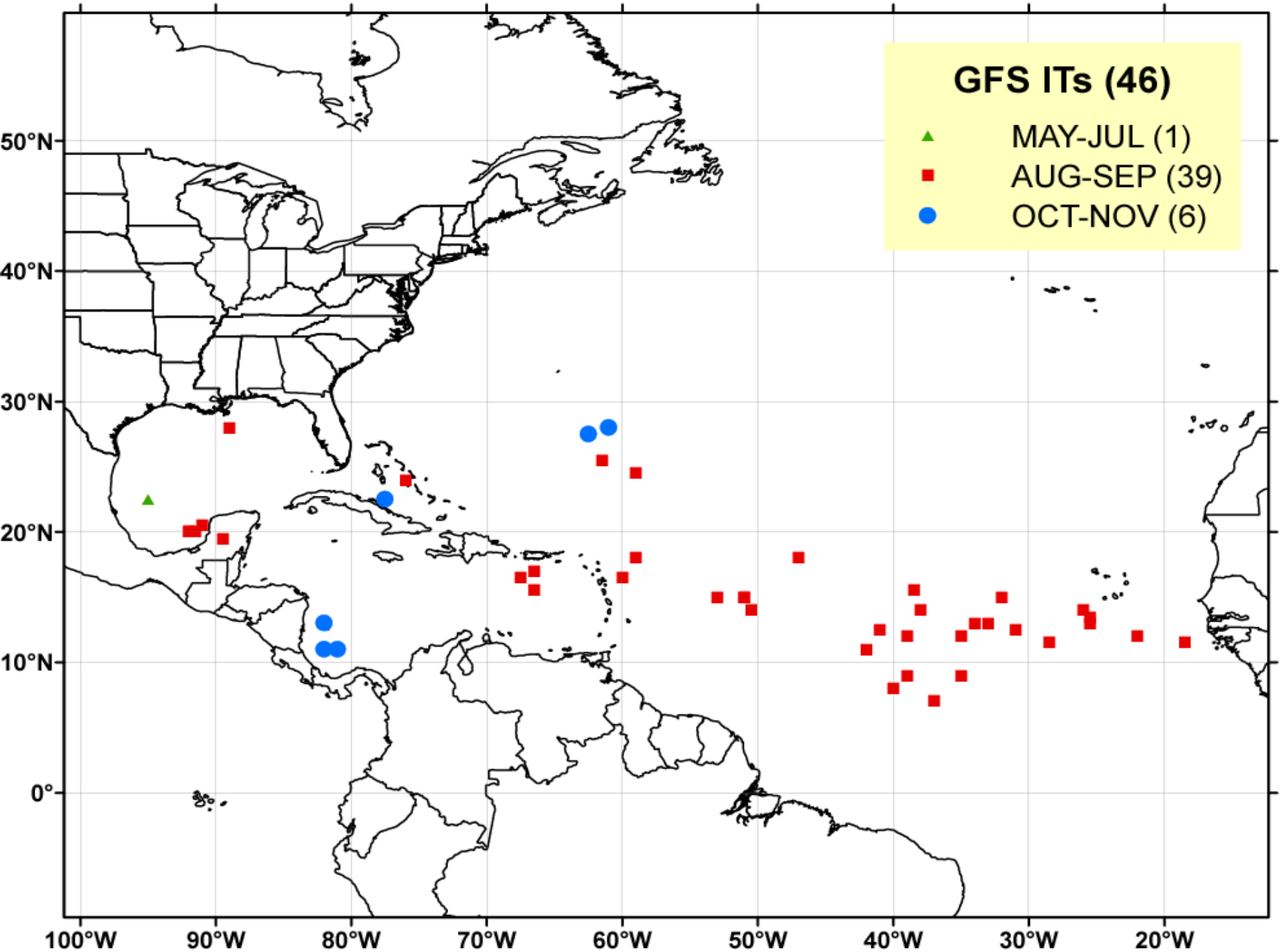



2004-2011 Best-Track
Genesis Locations (135)
MAY-JUL (24)
AUG-SEP (83)
OCT-NOV (28)
60°N
50°N
40°N
30°N
20°N
10°N
0°
90°W
80°W
70°W
60°W
50°W
40°W
30°W
20°W


GFS Hits (131)
MAY-JUL (10)
AUG-SEP (113)
OCT-NOV (8)
100°W
90°W
80°W
70°W
60°W
50°W
40°W
30°W
20°W
50°N
40°N
30°N
20°N
10°N
0°


GFS Misses (92)
MAY-JUL (18)
AUG-SEP (50)
OCT-NOV (24)
90°W
80°W
70°W
60°W
50°W
40°W
30°W
20°W


GFS FAs (271)
MAY-JUL (32)
AUG-SEP (204)
OCT-DEC (35)
100°W
90°W
80°W
70°W
60°W
50°W
40°W
30°W
20°W
50°N
40°N
30°N
20°N
10°N
0°


GFS ITs (46)
MAY-JUL (1)
AUG-SEP (39)
OCT-NOV (6)
50°N
40°N
30°N
20°N
10°N
0°
100°W
90°W
80°W
70°W
60°W
50°W
40°W
30°W
20°W

Next Step—Why don’t models do better?
What physical processes are they missing?
Results from GRIP and PREDICT will help provide answers.

Karl’s Genesis Difficult to Forecast

So Was Its Rapid Intensification

KARL 16 Sept 2010 03Z Advisory

INTENSITY IS KEPT AT 35 KNOTS. GIVEN THE OUTSTANDING STRUCTURE ON SATELLITE AND THE FAVORABLE ENVIRONMENT FOR INTENSIFICATION WHICH PREVAILS IN THE SOUTHERN GULF OF MEXICO...THE OFFICIAL FORECAST CALLS FOR RE-STRENGTHENING ONCE THE CIRCULATION MOVES BACK OVER WATER. KARL IS FORECAST TO REACH THE COAST OF THE STATE OF VERACRUZ WITHIN THE WATCH AREA AS A HURRICANE. HOWEVER...NONE OF THE GUIDANCE IS VERY AGGRESSIVE IN INTENSIFYING KARL.

	Forecast Time						
Wind Range (mph)	12 hour for 7 AM Thu	24 hour for 7 PM Thu	36 hour for 7 AM Fri	48 hour for 7 PM Fri	72 hour for 7 PM Sat	96 hour for 7 PM Sun	120 hour for 7 PM Mon
Dissipated	<1%	1%	2%	3%	36%	52%	NA
Tropical Depression (<39)	8%	9%	10%	8%	33%	20%	NA
Tropical Storm (39-73)	88%	79%	68%	59%	27%	22%	NA
Hurricane (all categories)	3%	11%	21%	31%	5%	6%	NA
-- Category 1 (74-95)	3%	11%	18%	25%	4%	5%	NA
-- Category 2 (96-110)	<1%	1%	3%	4%	1%	1%	NA
-- Category 3 (111-130)	<1%	<1%	1%	2%	<1%	<1%	NA
-- Category 4 (131-155)	<1%	<1%	<1%	<1%	<1%	<1%	NA
-- Category 5 (>155)	<1%	<1%	<1%	<1%	<1%	<1%	NA
Forecast Maximum Wind	50 mph	60 mph	65 mph	75 mph	30 mph	25 mph	NA

Forecast intensity at 9/18 00Z = 65 kt

Obs. peak intensity at 9/17 12Z = **110** kt

2% chance of this
Too much reliance on model results ?

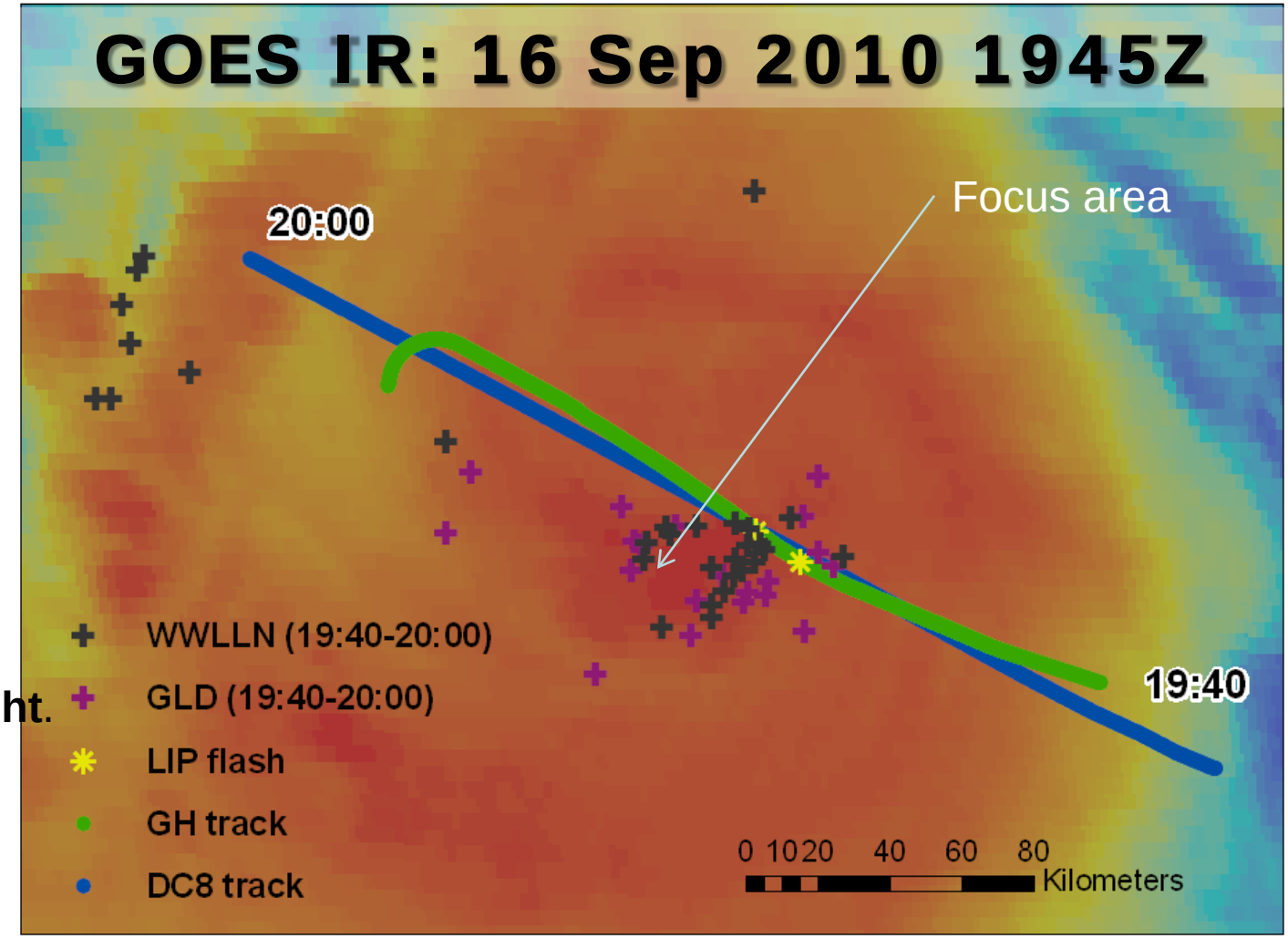
<u>Objective:</u> Utilize multiple GRIP datasets to compare the physical properties of electrified and non-electrified flight legs in rapidly intensifying hurricane (Karl 16 Sept 2010)

<u>GRIP datasets used in this study</u>

DC-8	Global Hawk
Airborne Precipitation Radar (APR-2)	Lightning Instrument Package (LIP)
Cloud microphysics probes (CDP, CAS, CIP, PIP)	High Altitude MMIC Sounding Radiometer (HAMSR)
Meteorological Measurement System (MMS)	High Altitude Imaging Wind & Rain Profiler (HIWRAP)

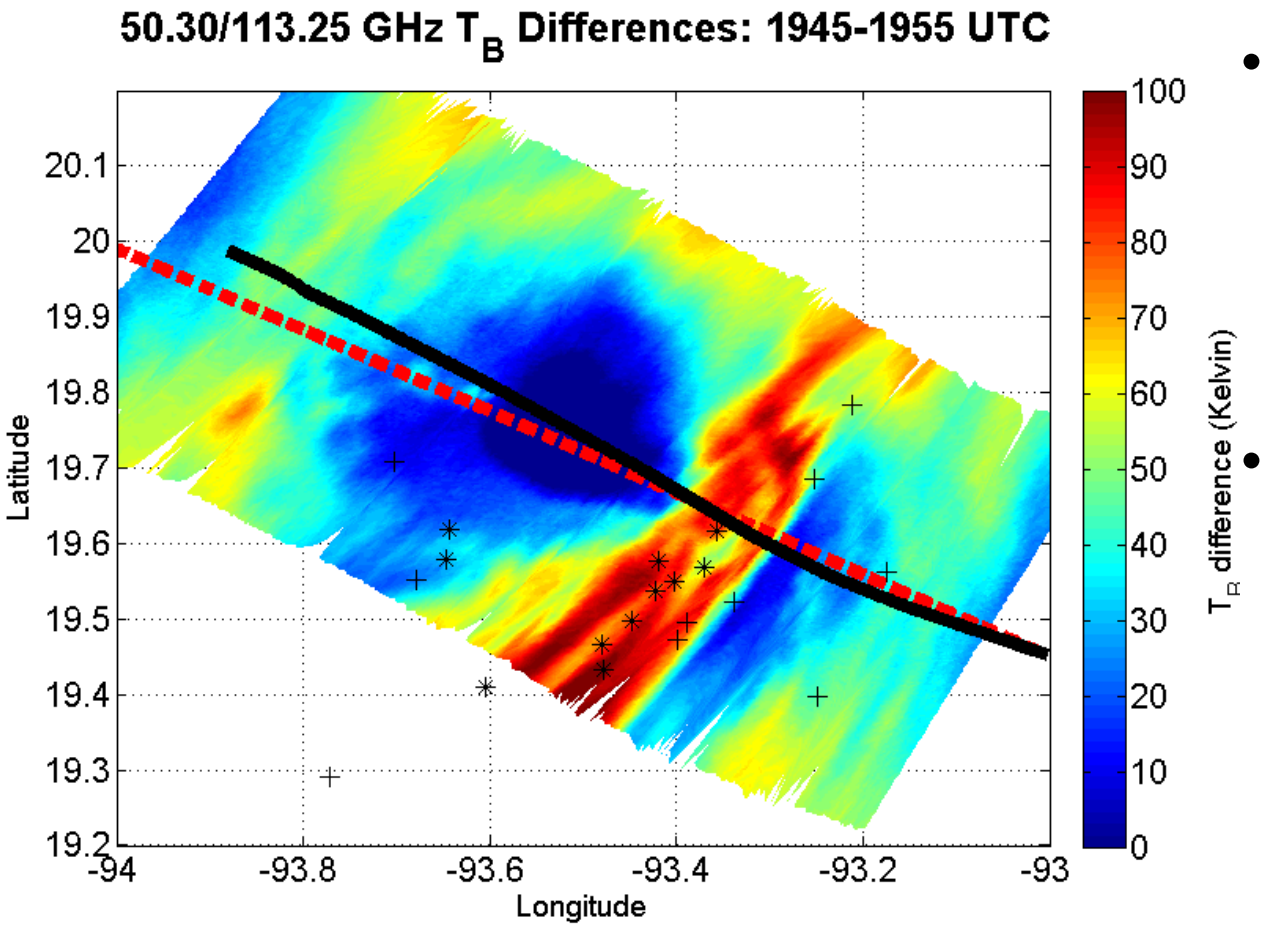
Examined five coordinated passes of GH and DC-8 through the eye – some electrified, some not

Electrified Case: Leg 2



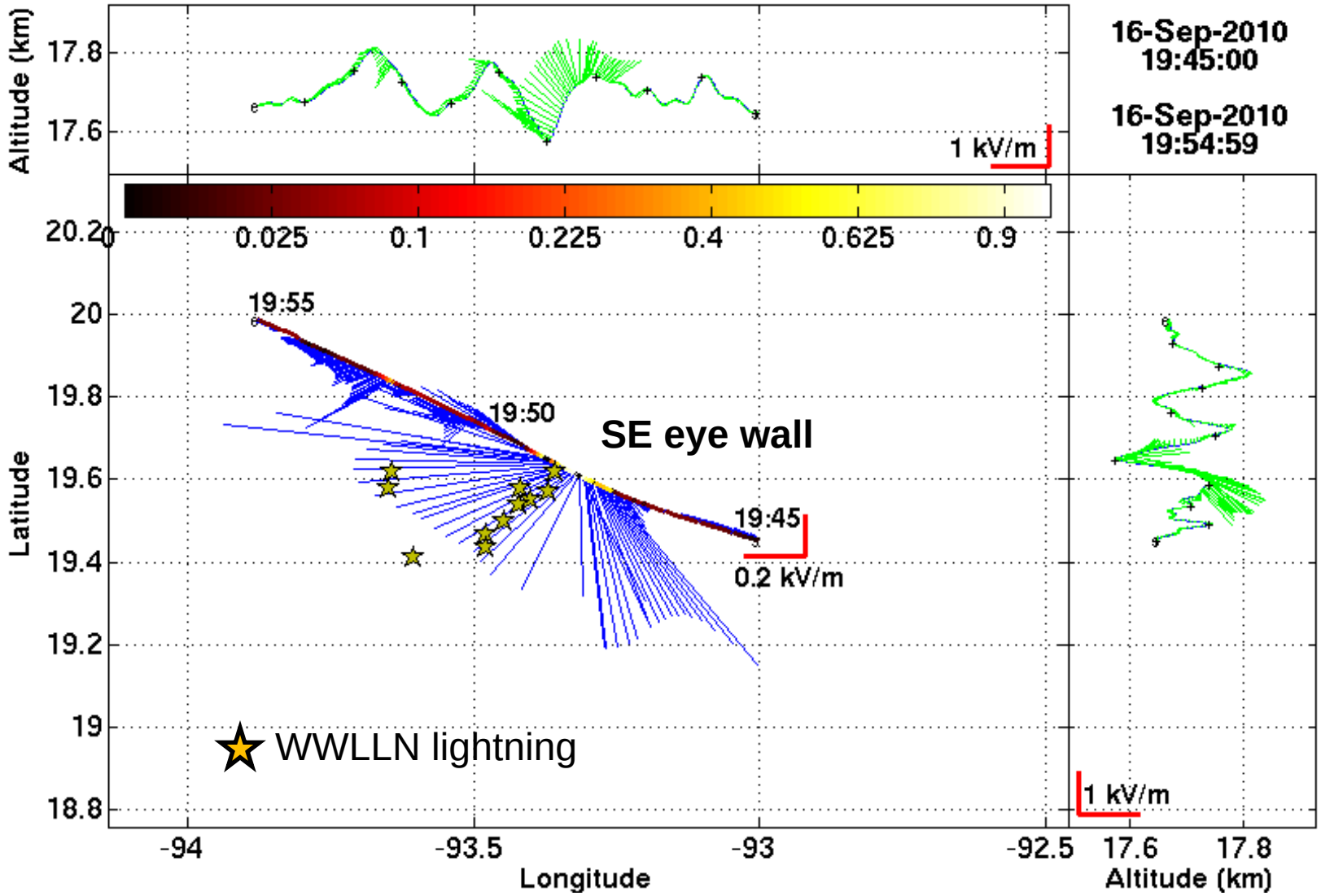
20 min light.

HAMSR Brightness Temps



- Higher frequency → more scattering by ice in deep convection → lower T_B
- Large 50.30/113.25 GHz T_B differences indicate regions of deep convection (Brown et al. 2007)

LIP Electric Field Measurements

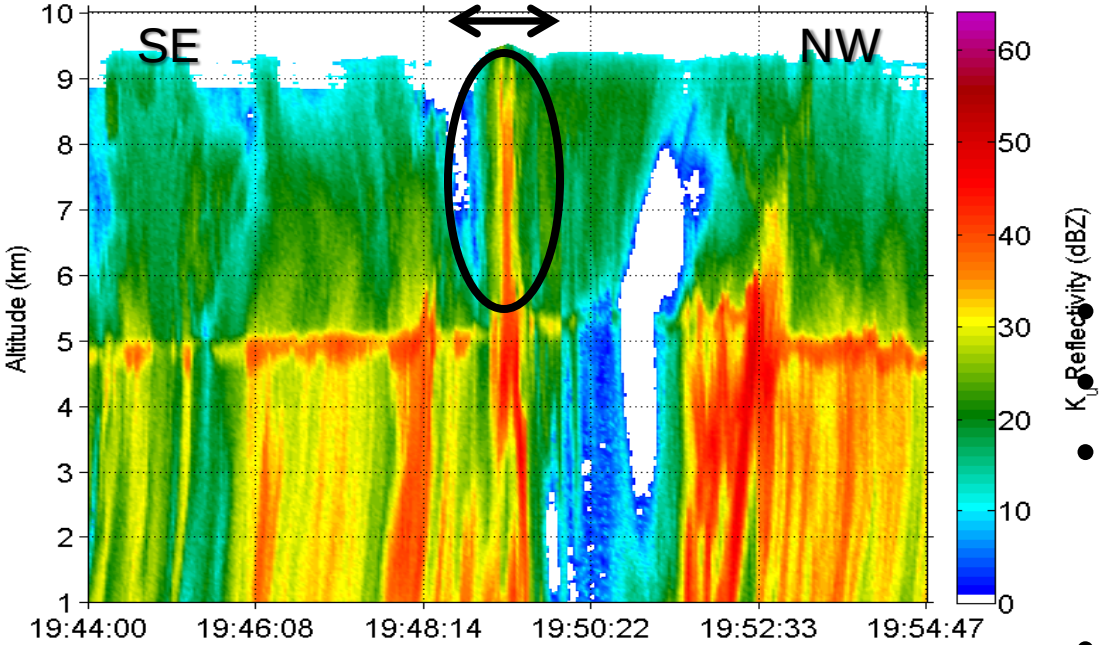


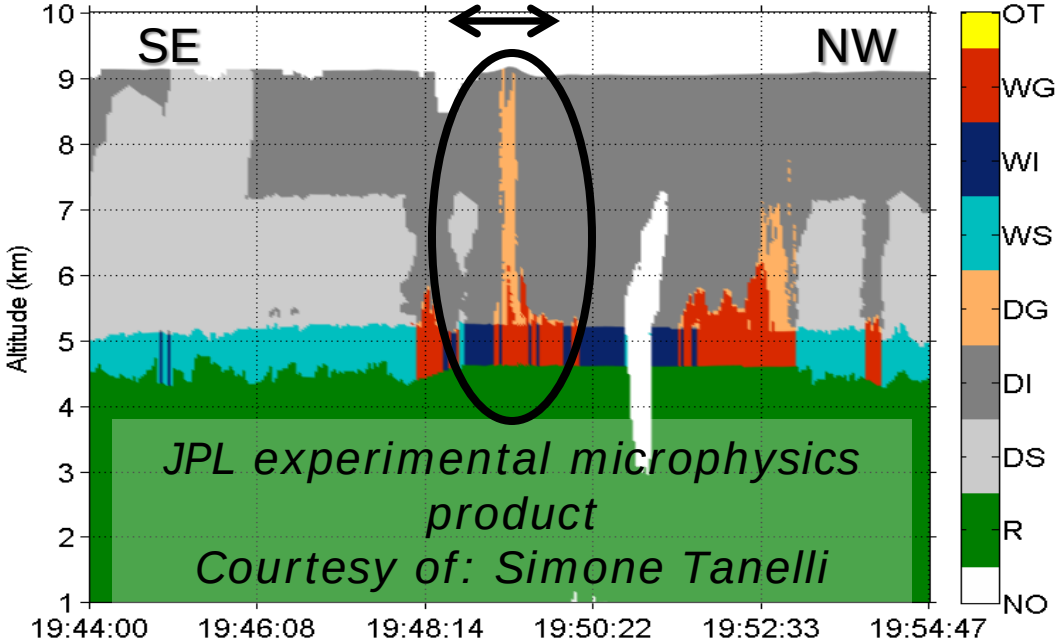
Non-Inductive Charging

Collisions between different sized ice particles in the presence of supercooled water

Deep mixed layers are best, associated with strong updrafts

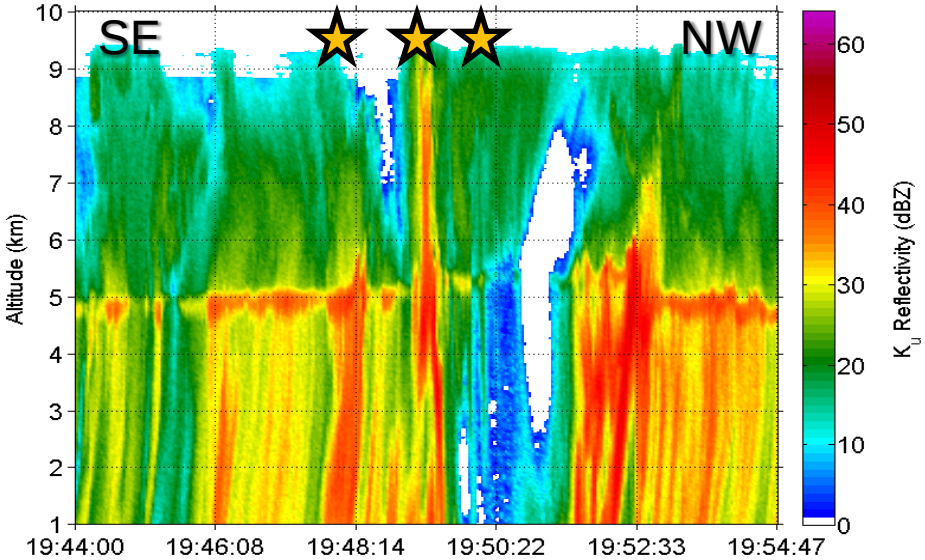
Let’s check it out

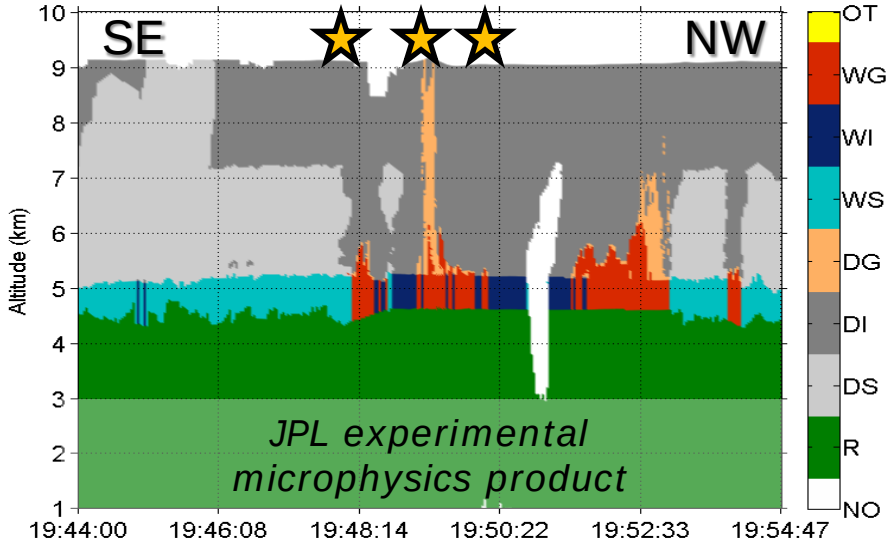




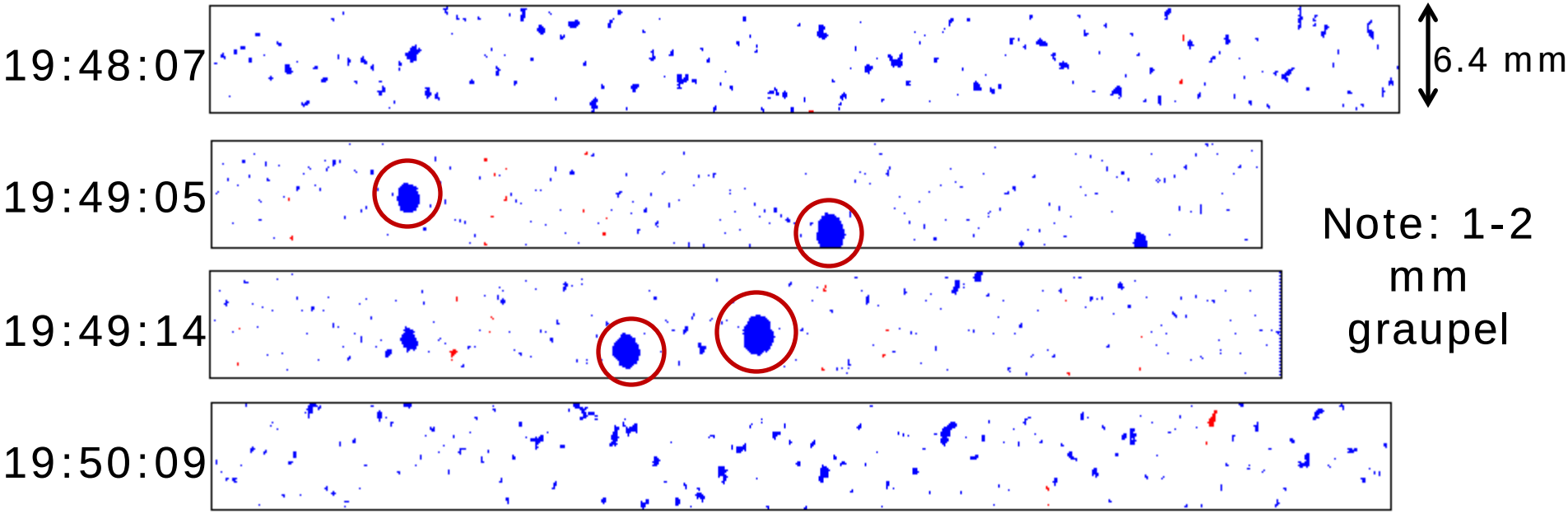
APR-2 Data

- Electrified region in SE eyewall (1949 UTC)
- Enhanced Kd reflectivity aloft
  - 39 dBZ at 7 km
- Strongest flight level updraft measured within this cell (20.19 m/s)
- Radar-derived microphysics product shows deep mixed phase region
  - Graupel extending upwards to 9 km

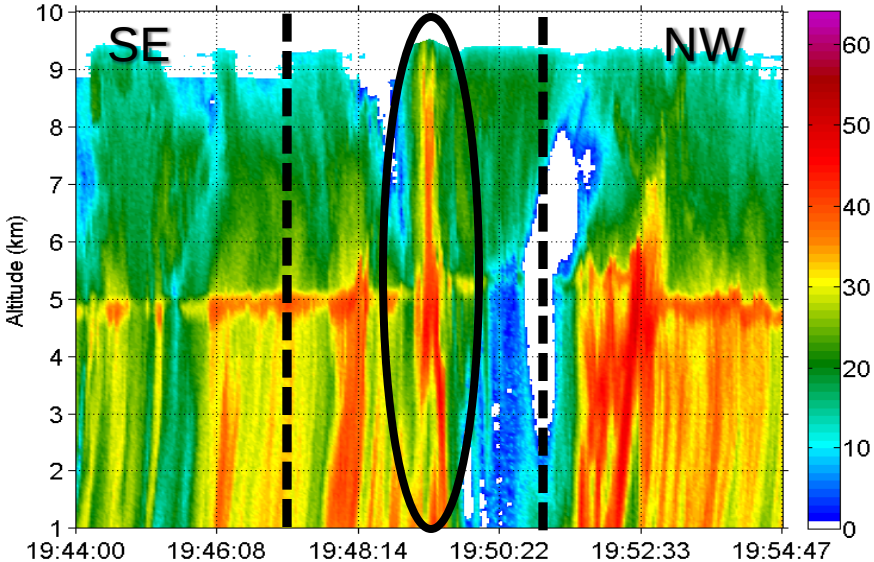


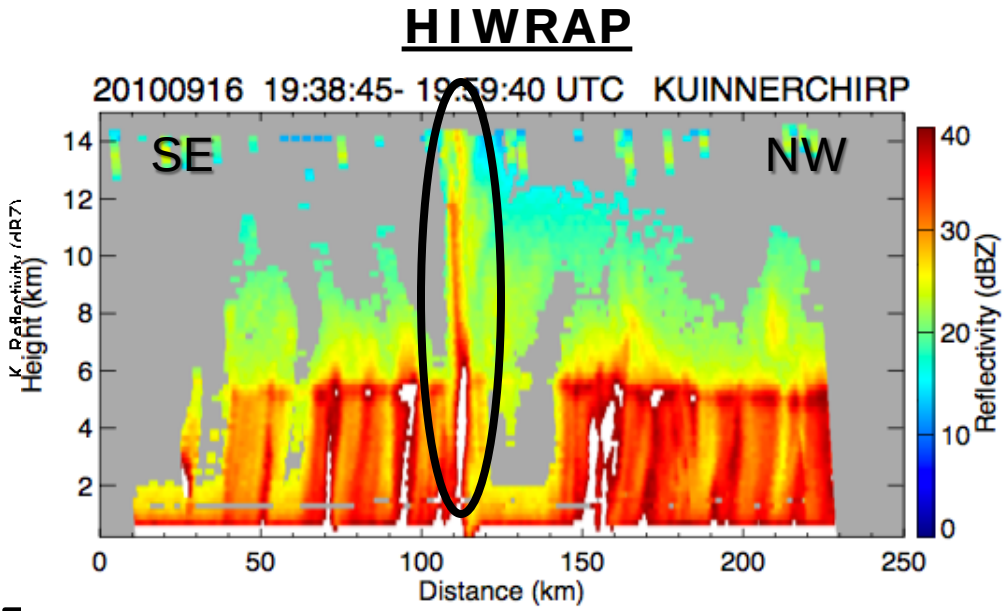


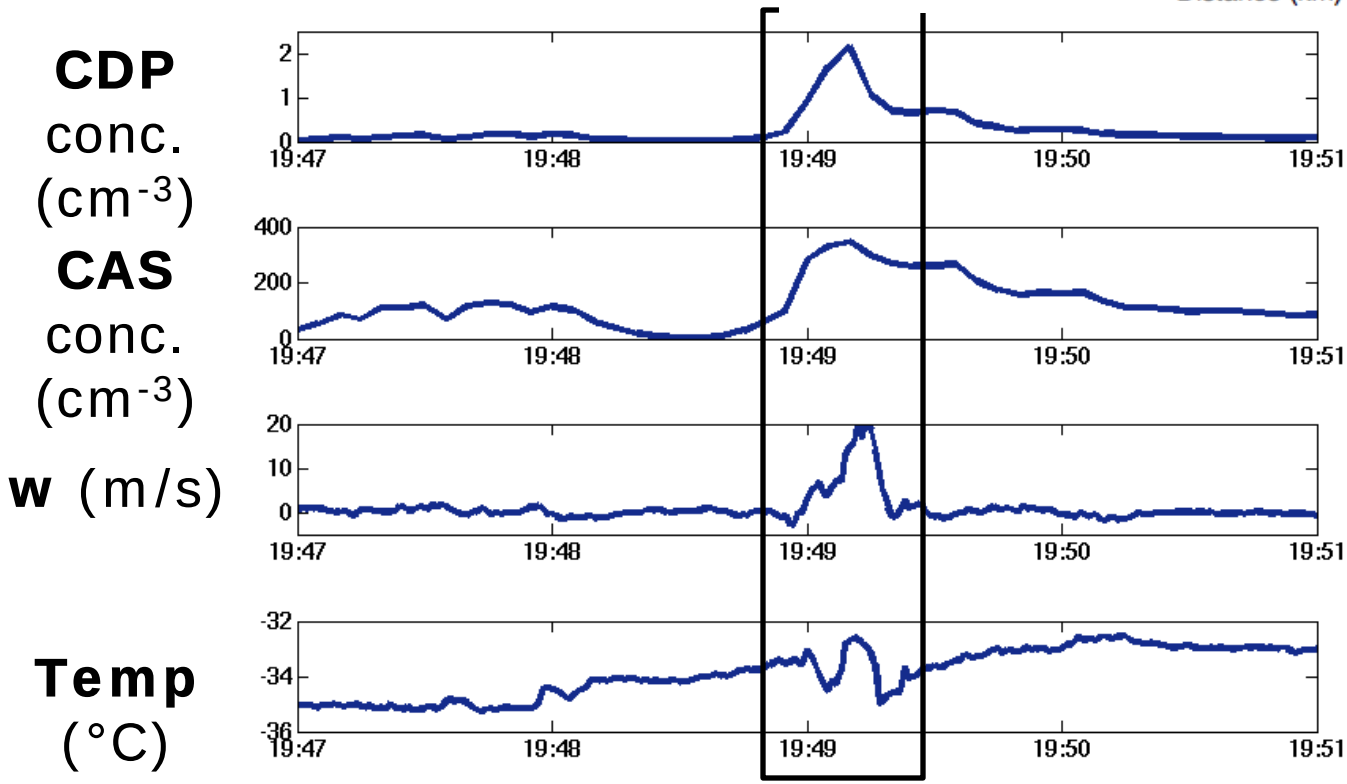
Precipitation Imaging Probe (PIP) – 100 to 6400 µm



Note: 1-2 mm graupel







Highest particle concentrations and vertical velocities sampled on 9/16/10

Combination of GRIP data sets provide a lot of information about storms occurring during Karl's RI

Come View the Posters for More Information