

# TS Karen Debrief

October 3rd-5<sup>th</sup>, 2013

Flight ops re-cap: 4 Total flight missions  
~32 Total flight hours; ~80 GPSsondes; ~36 AXBTs

October 7, 2013

# Agenda

- Missions Overview (Reasor/Rogers/Cione)
- TDR Observations and Discussion (Gamache)
- TDR Impacts on operational HWRF (Vijay)

# Missions Overview

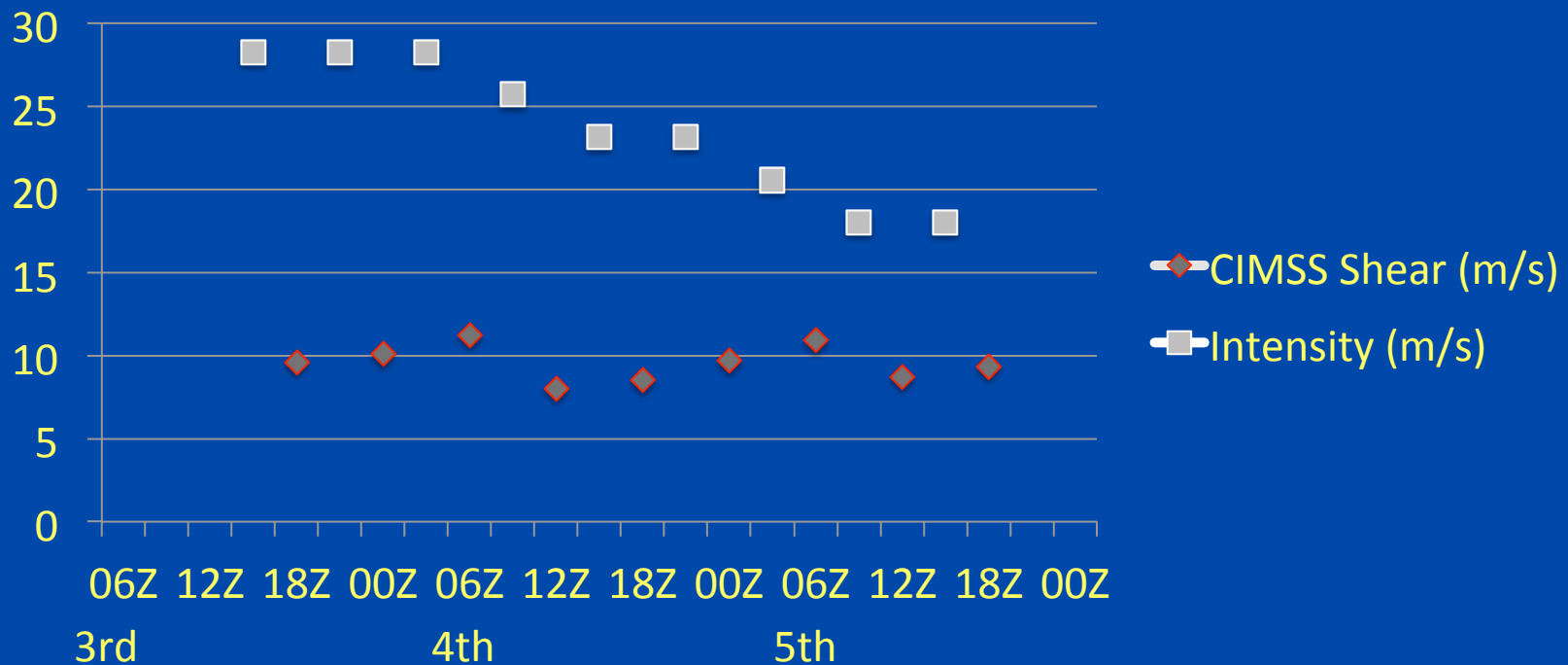
**Purpose:** Collect P-3 TDR data for assimilation into the operational HWRF model

**Target:** TS Karen on 3-5 Oct in the Gulf of Mexico

**Background:** At 8AM on 2 Oct, NHC gave an area of low pressure in the NW Caribbean a 40% (50%) chance of development in 48 h (5 days). The low moved north of the Yucatan and was declared a TS at 9AM on 3 Oct.

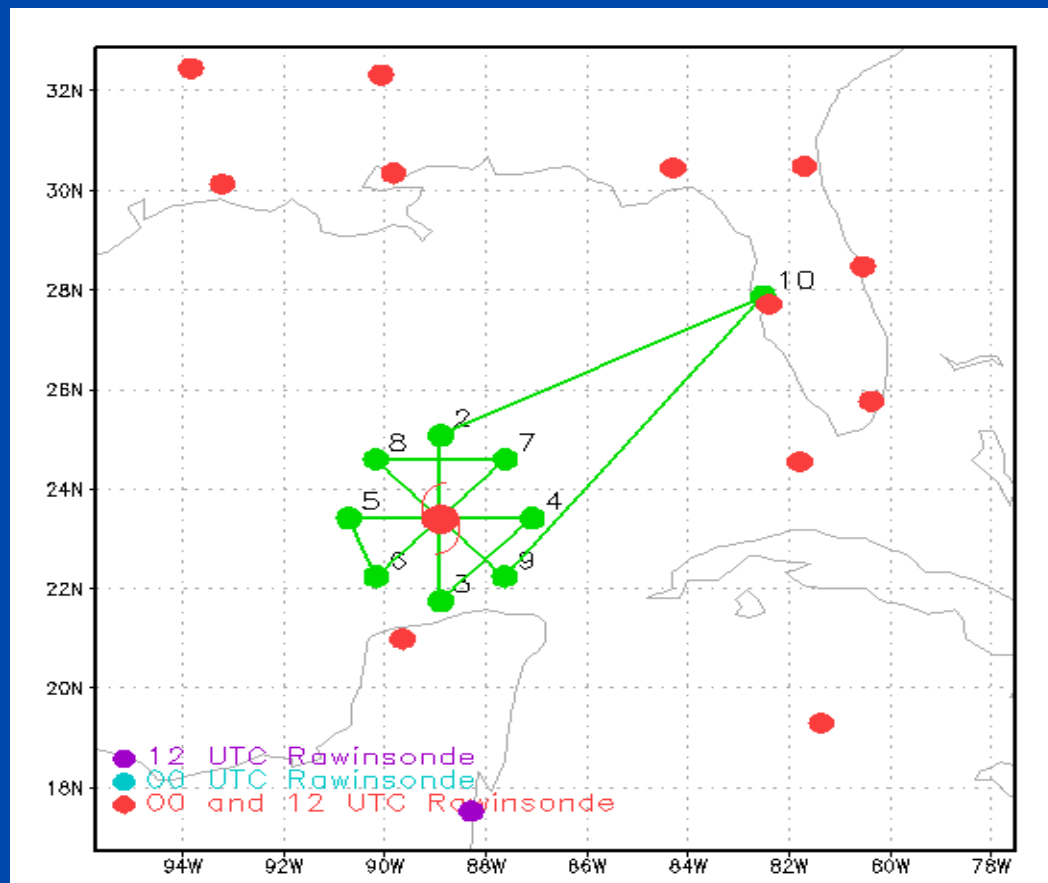
# Missions Highlights

- Scientifically interesting case of intensification from Disturbance to TS under sustained moderate (south)westerly vertical wind shear.

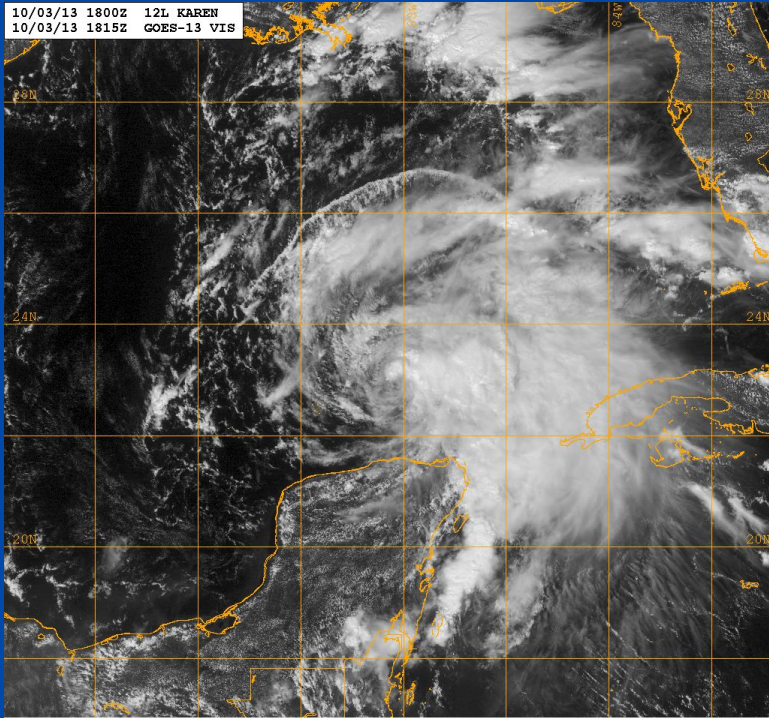


# Missions Overview

3 Oct: N42 (2PM) rotated figure-4 pattern

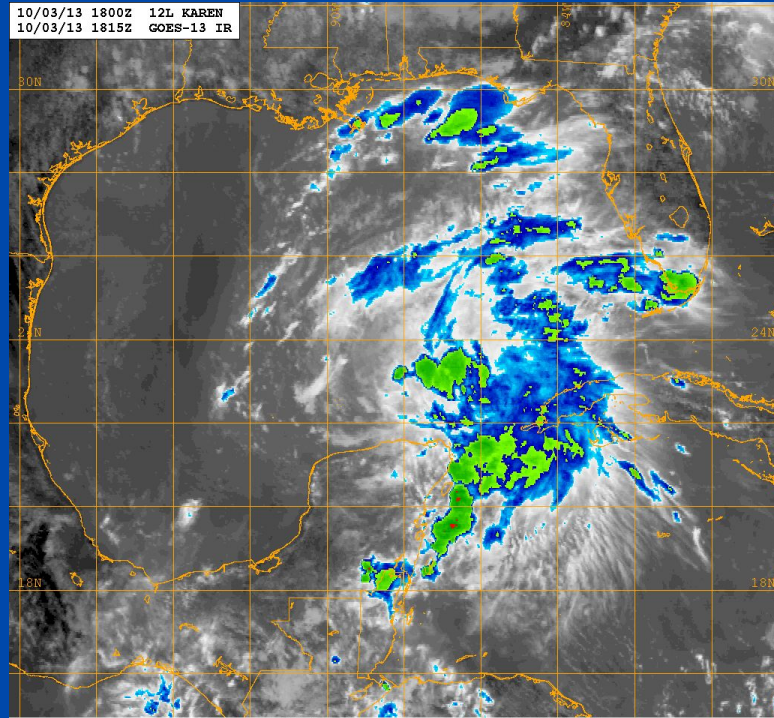


10/03/13 1800Z 12L KAREN  
10/03/13 1815Z GOES-13 VIS

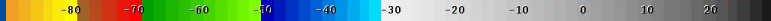


Naval Research Lab [http://www.nrlmry.navy.mil/sat\\_products.html](http://www.nrlmry.navy.mil/sat_products.html)  
<-- Visible ( Sun elevation at center is 61 degrees) -->

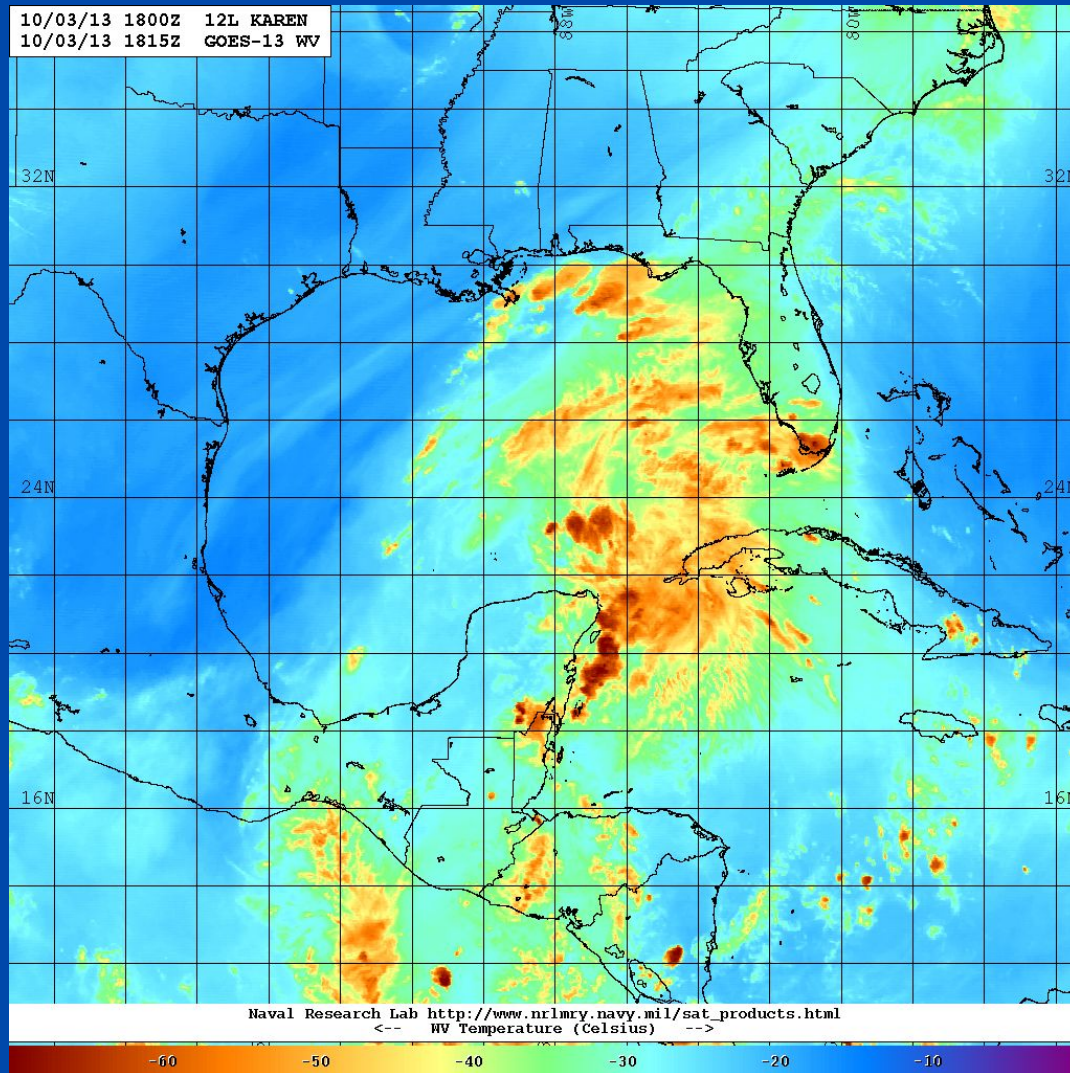
10/03/13 1800Z 12L KAREN  
10/03/13 1815Z GOES-13 IR



Naval Research Lab [http://www.nrlmry.navy.mil/sat\\_products.html](http://www.nrlmry.navy.mil/sat_products.html)  
<-- IR Temperature (Celsius) -->

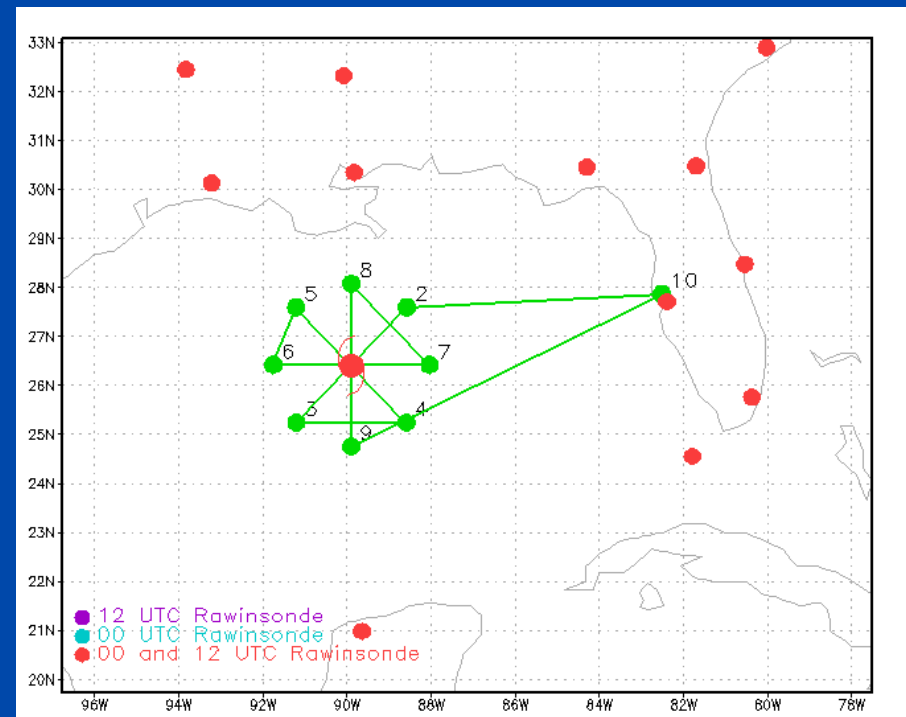
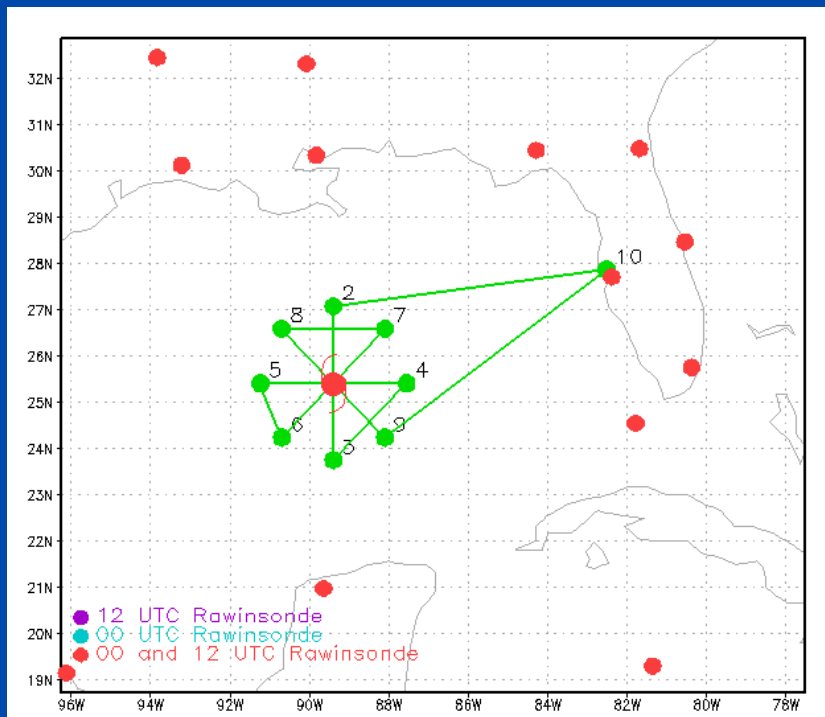


10/03/13 1800Z 12L KAREN  
10/03/13 1815Z GOES-13 WV

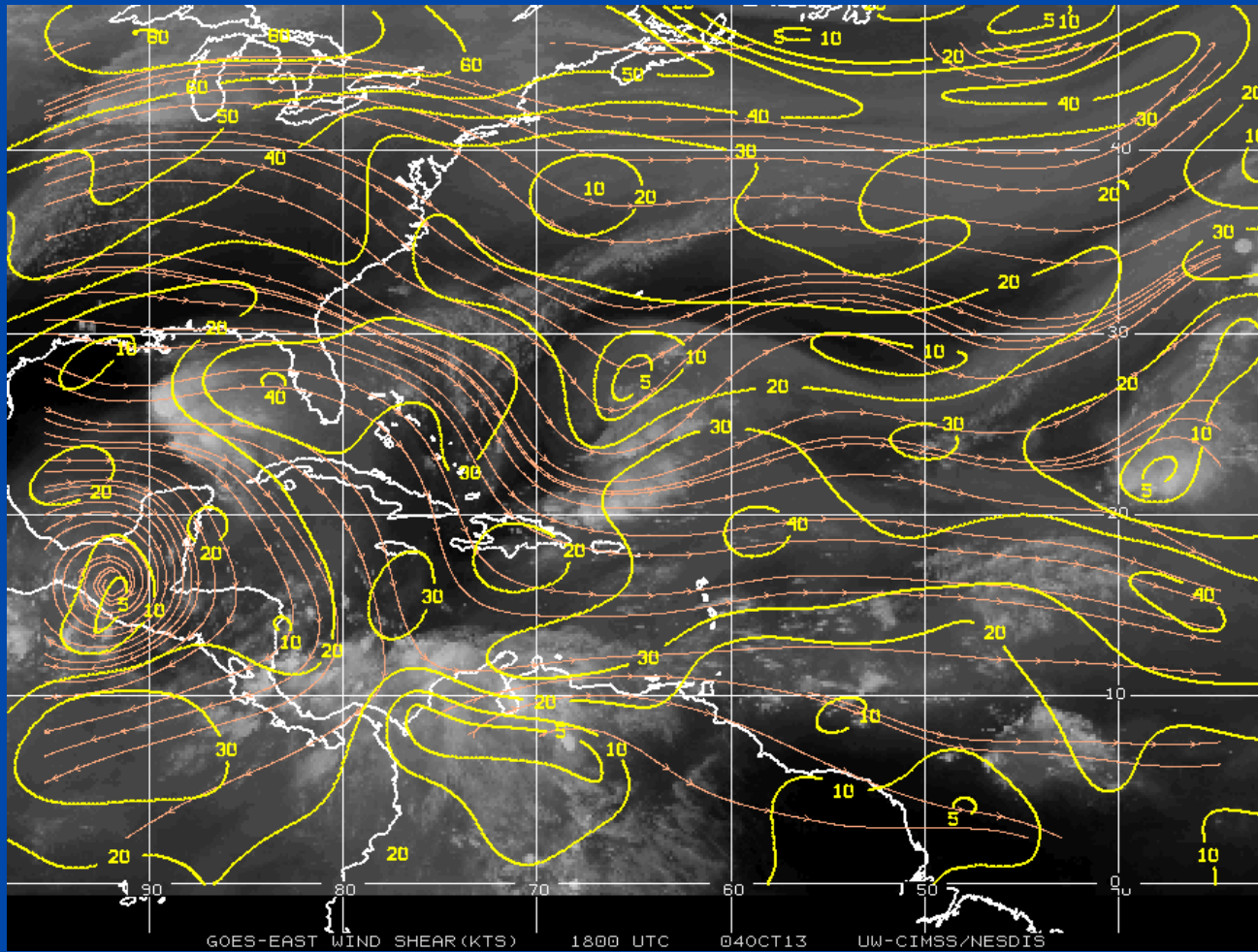


# Missions Overview

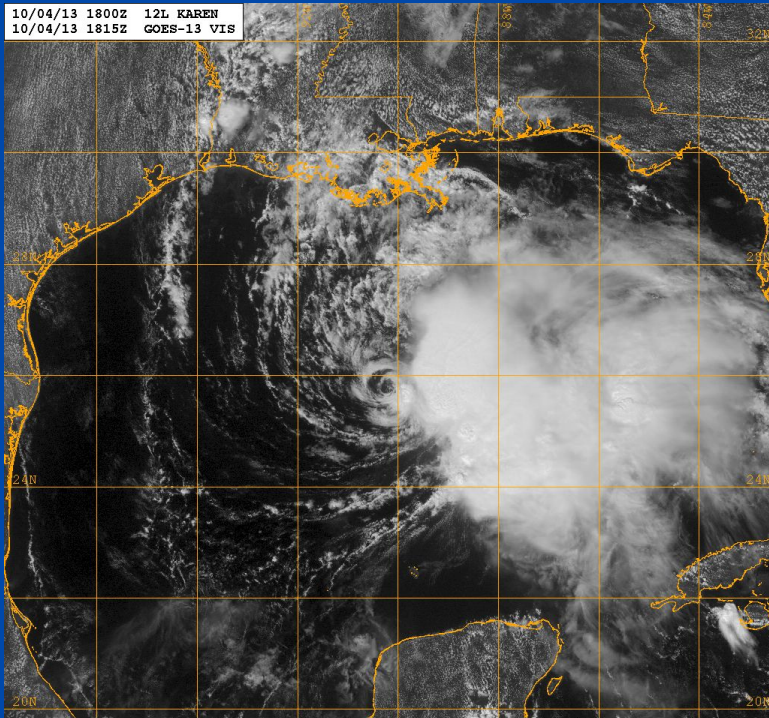
**4 Oct: N43 (2AM) rotated figure-4 pattern; N42 (2PM) rotated figure-4 pattern**





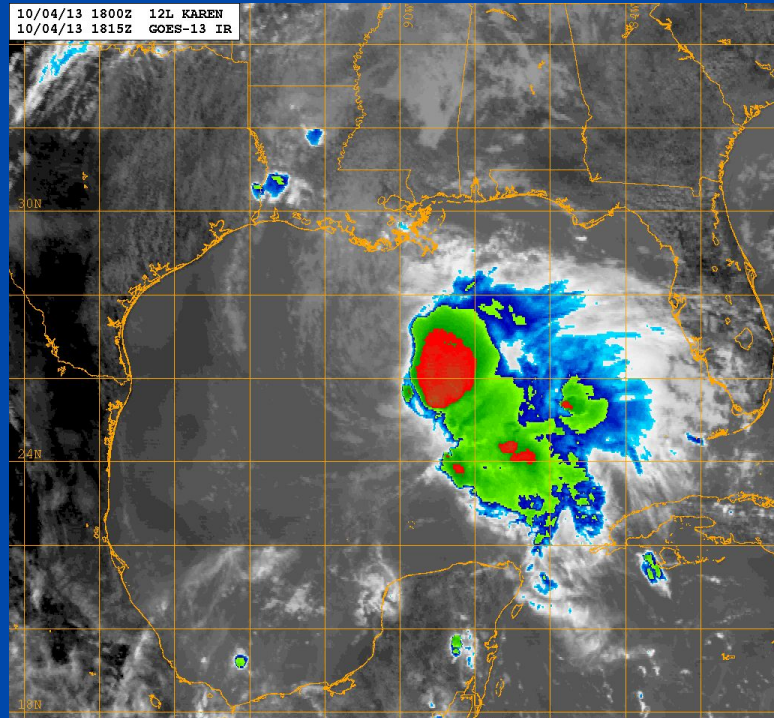


10/04/13 1800Z 12L KAREN  
10/04/13 1815Z GOES-13 VIS

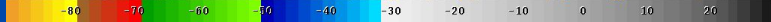


Naval Research Lab [http://www.nrlmry.navy.mil/sat\\_products.html](http://www.nrlmry.navy.mil/sat_products.html)  
← Visible ( Sun elevation at center is 48 degrees) →

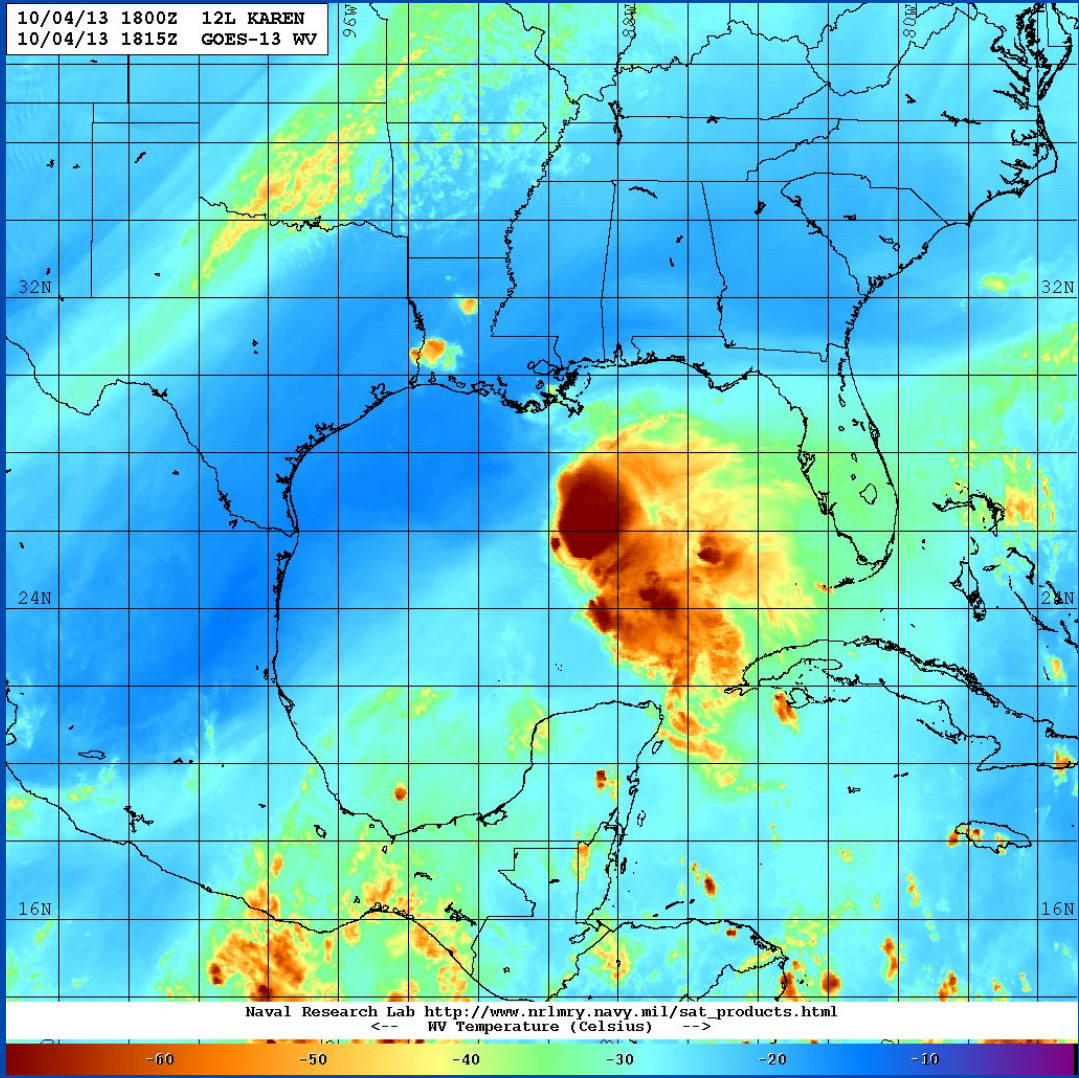
10/04/13 1800Z 12L KAREN  
10/04/13 1815Z GOES-13 IR



Naval Research Lab [http://www.nrlmry.navy.mil/sat\\_products.html](http://www.nrlmry.navy.mil/sat_products.html)  
← IR Temperature (Celsius) →



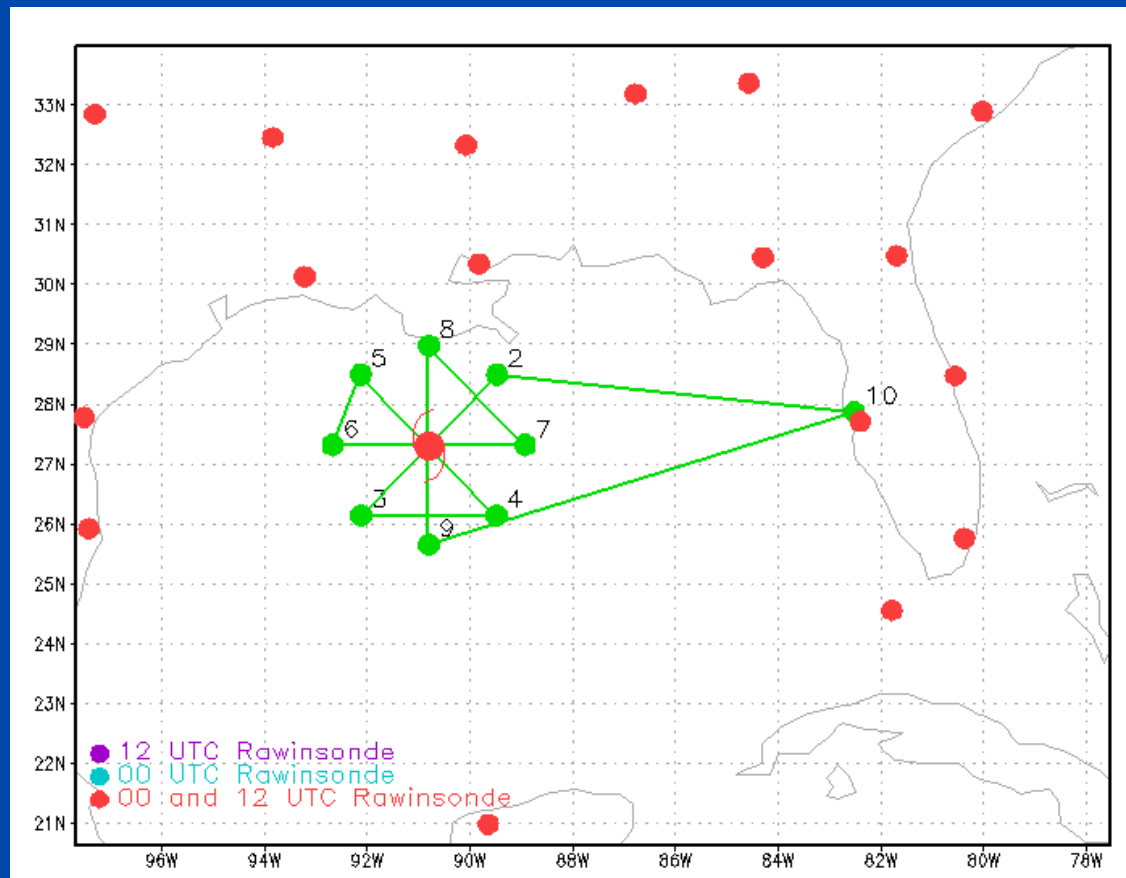
10/04/13 1800Z 12L KAREN  
10/04/13 1815Z GOES-13 WV



Naval Research Lab [http://www.nrlmry.navy.mil/sat\\_products.html](http://www.nrlmry.navy.mil/sat_products.html)  
← WV Temperature (Celsius) →

# Missions Overview

5 Oct: N43 (2AM) rotated figure-4 pattern

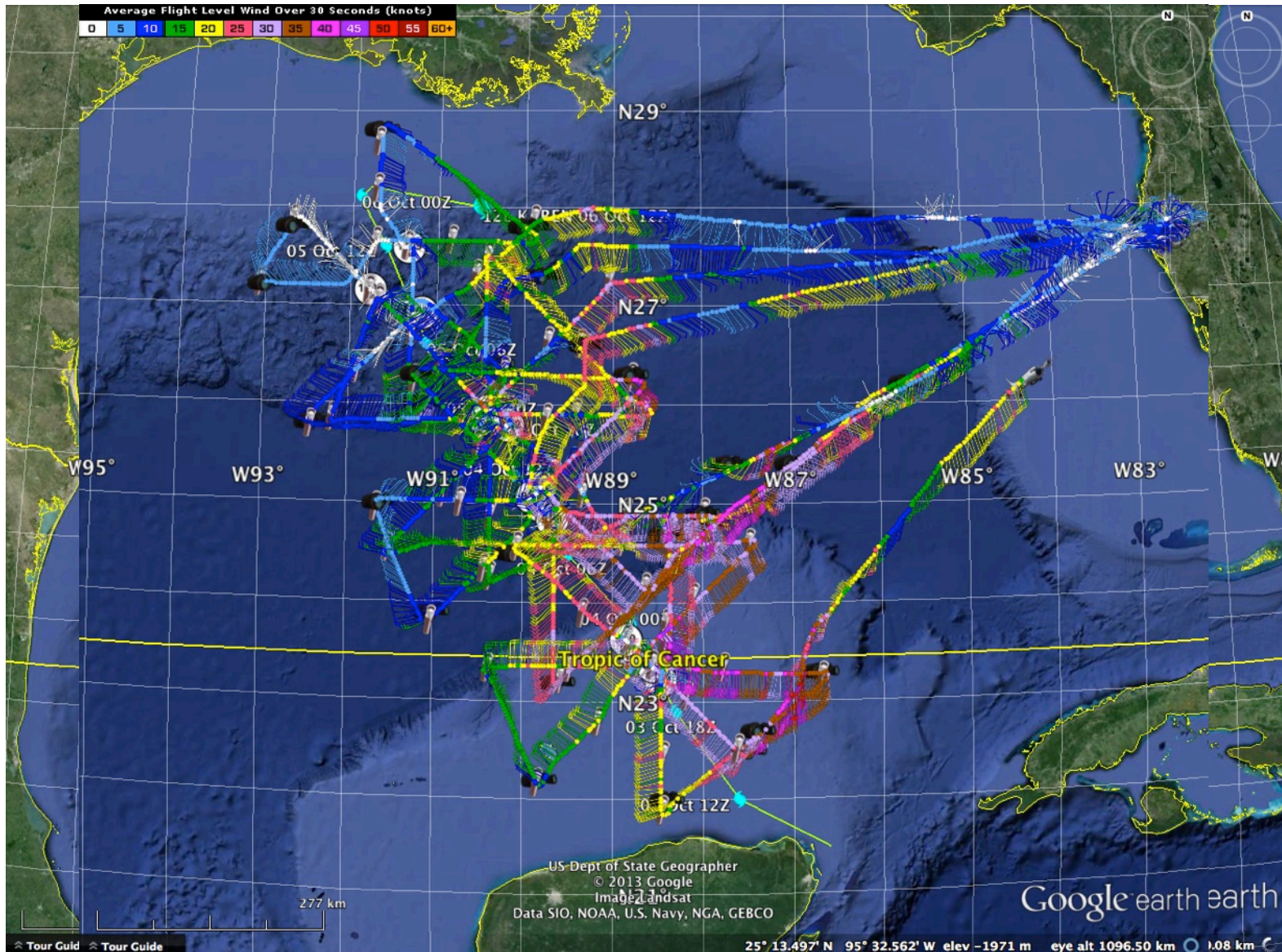


# Missions Highlights

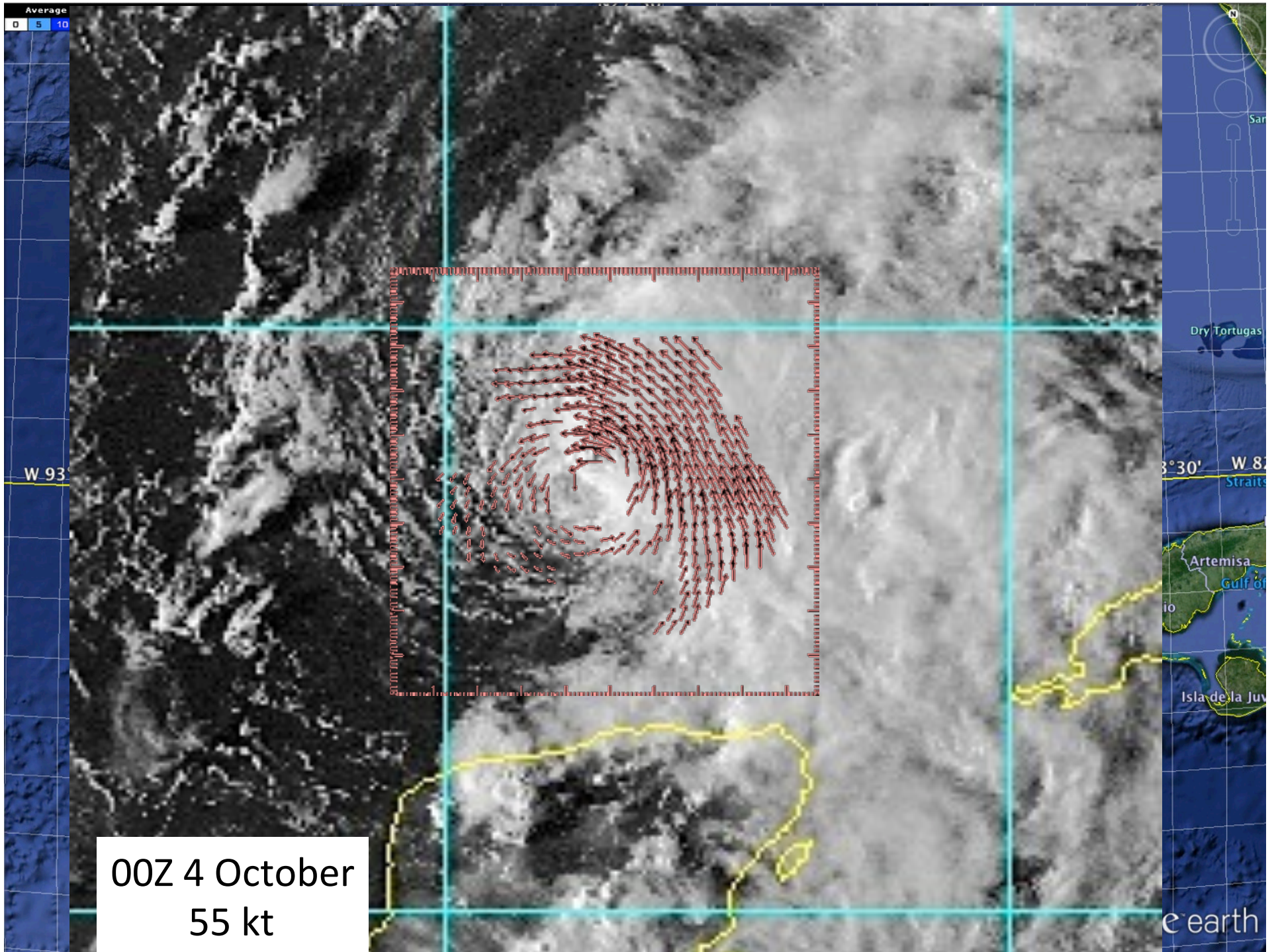
## NOAA flights referenced in NHC discussions:

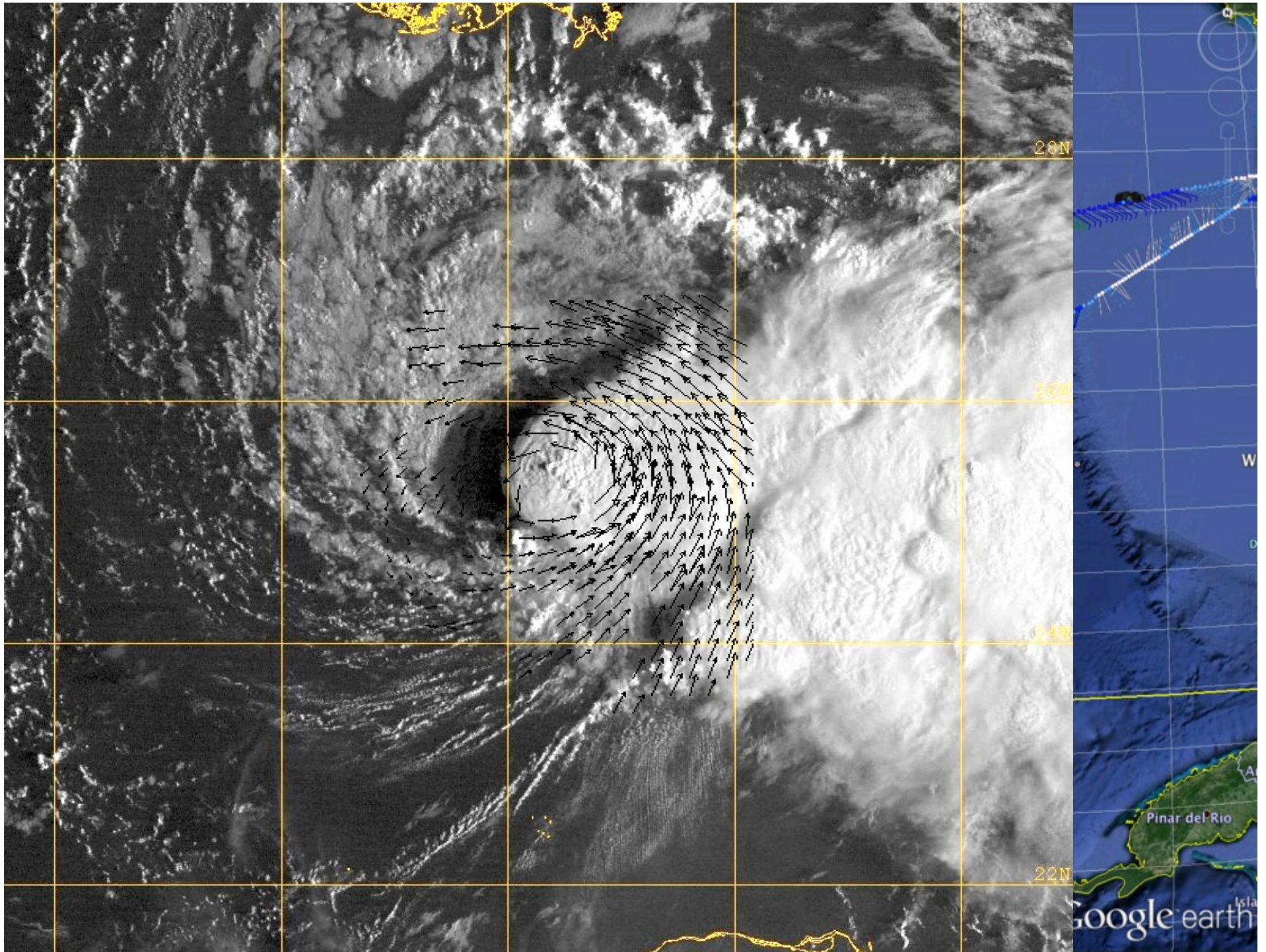
- 3 Oct (5PM): THE NOAA HURRICANE HUNTERS JUST MEASURED A CENTRAL PRESSURE OF 999 MB...AND FLIGHT-LEVEL AND SFMR WINDS FROM BOTH THE NOAA AND AIR FORCE RESERVE AIRCRAFT SUPPORT MAINTAINING THE INITIAL INTENSITY AT 55 KT.
- 3 Oct (11PM): THERE HAS BEEN AN EXCELLENT COVERAGE BY BOTH AIR FORCE AND NOAA HURRICANE HUNTER PLANES DURING THE PAST SEVERAL HOURS.
- 4 Oct (5AM): REPORTS FROM AIR FORCE RESERVE AND NOAA HURRICANE HUNTER AIRCRAFT INDICATE THAT THE CENTRAL PRESSURE HAS RISEN TO 1002 MB...AND THAT BOTH THE FLIGHT-LEVEL AND SFMR WINDS HAVE DECREASED.
- 4 Oct (5PM): IN PARTICULAR THE GFS IS WEAKER WITH ITS FORECAST OF KAREN AFTER DATA FROM THE NOAA GULFSTREAM-IV JET...WHICH SHOWED 200-MB WINDS WEST OF KAREN STRONGER THAN PREVIOUSLY ANALYZED...WERE INCORPORATED INTO THE 12Z ANALYSIS.
- 4 Oct (5PM): THE 12Z HWRF RUN SHOWED CONSIDERABLY LESS INTENSIFICATION WITH KAREN COMPARED TO PREVIOUS RUNS AFTER ASSIMILATING DATA FROM THE FROM THE NOAA P-3 TAIL DOPPLER RADAR. THIS MARKS THE FIRST TIME DOPPLER RADAR DATA HAVE BEEN ASSIMILATED INTO AN OPERATIONAL HURRICANE MODEL IN REAL TIME.

# Tropical Storm Karen

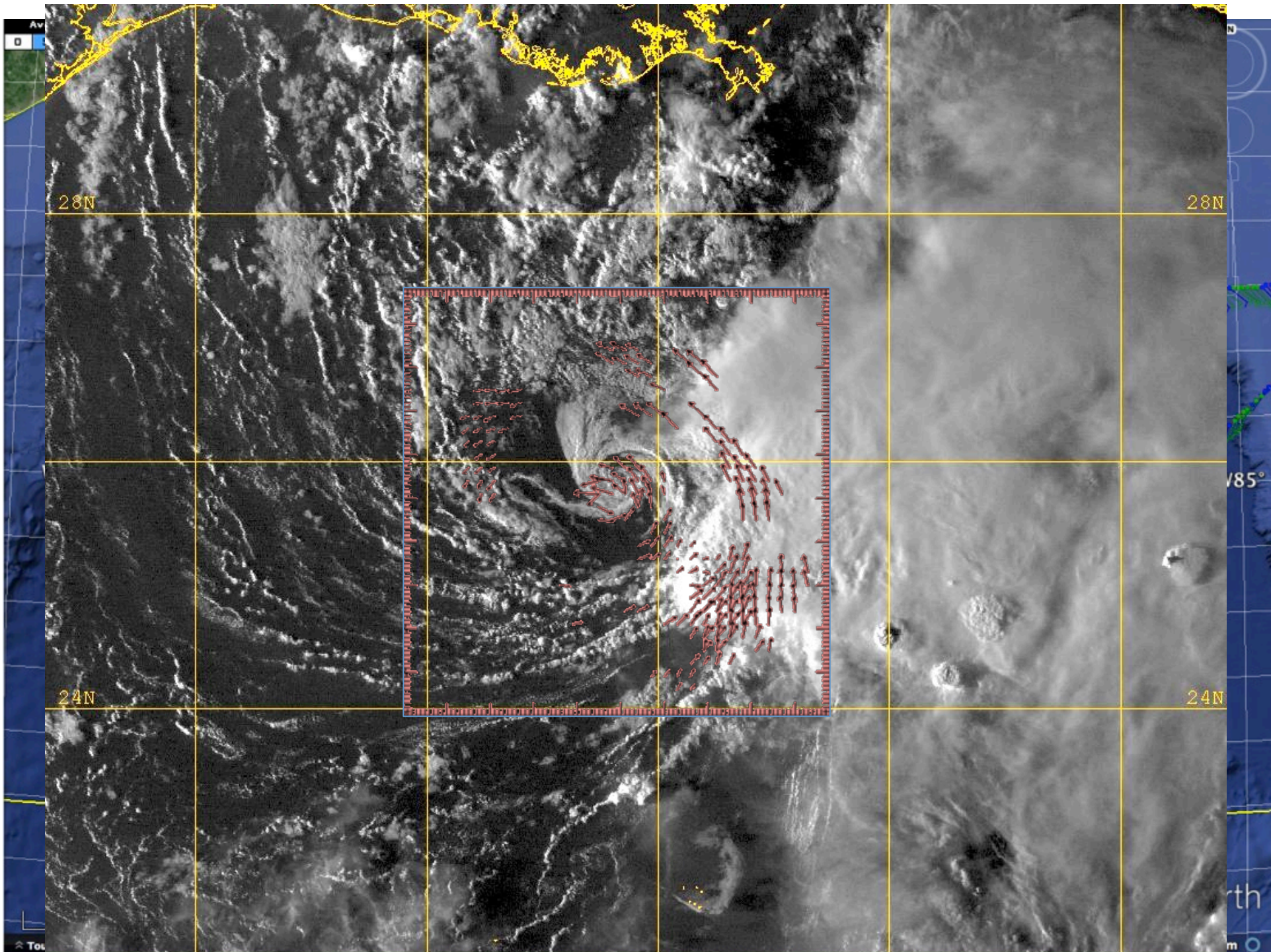


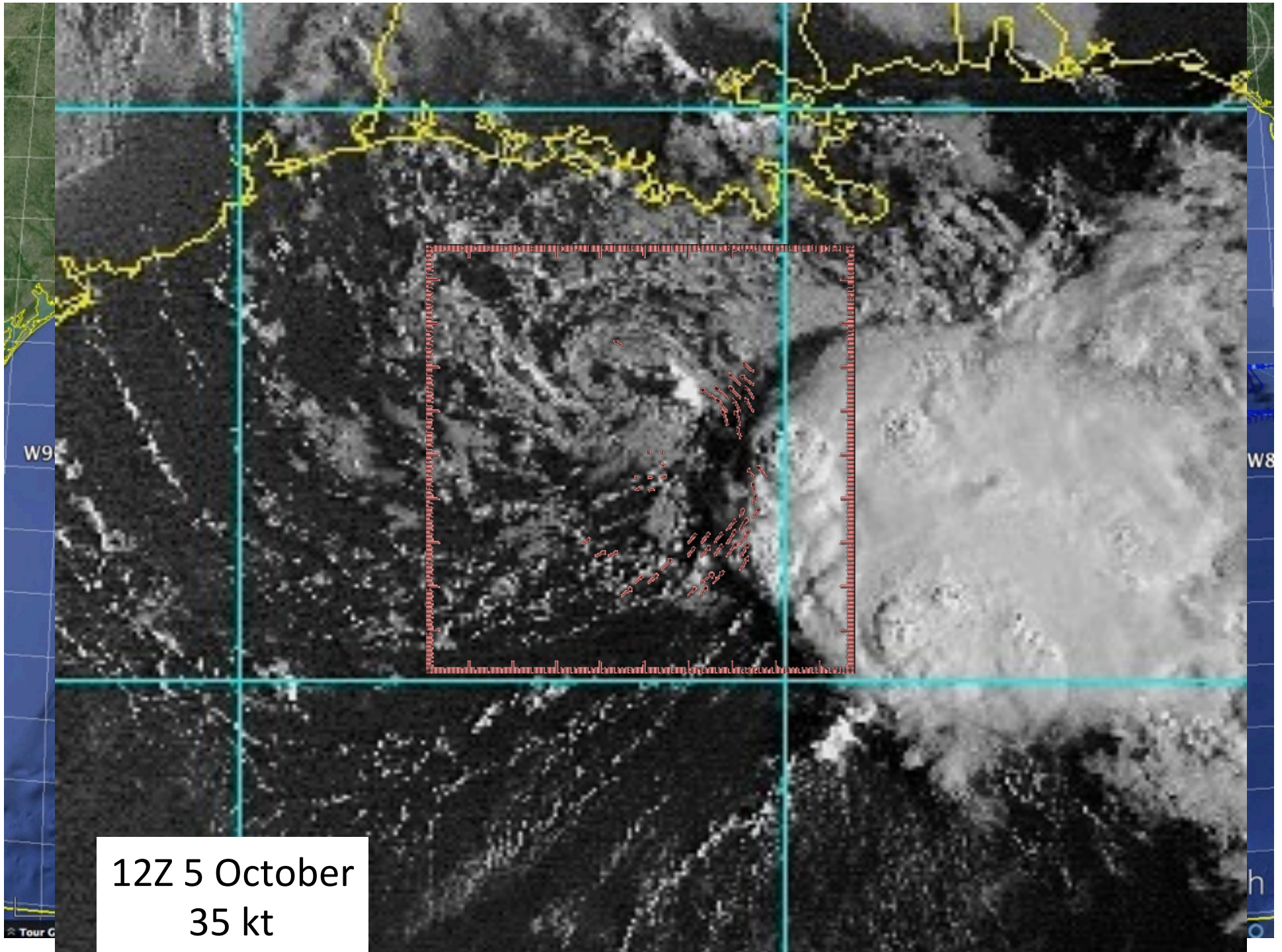
4 P-3 and 1 G-IV mission







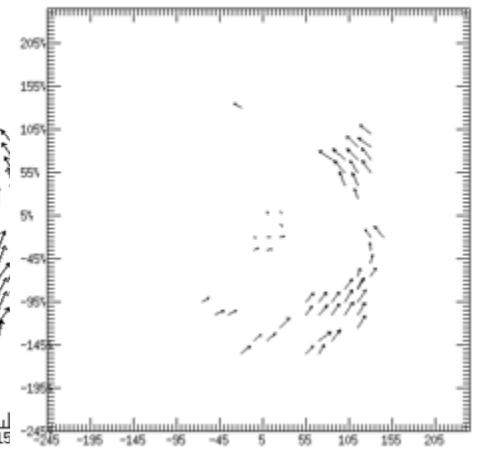
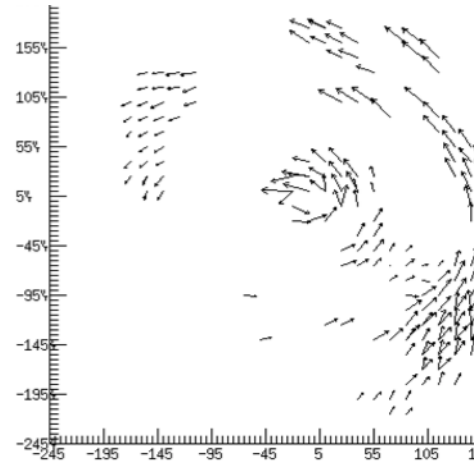
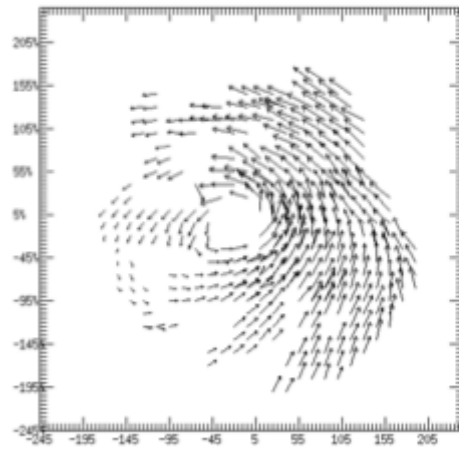
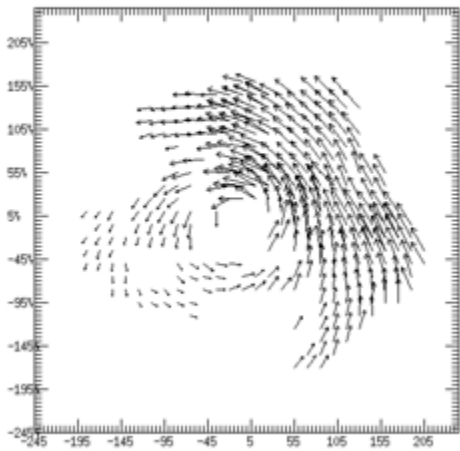




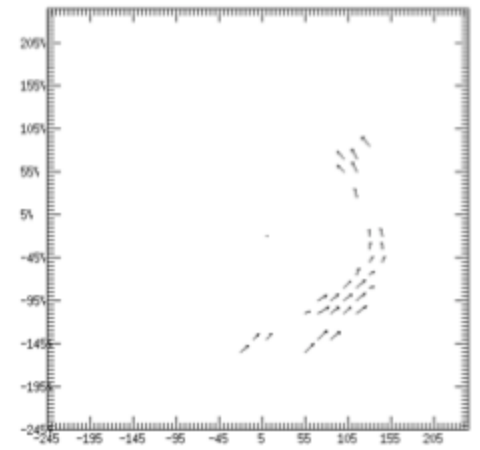
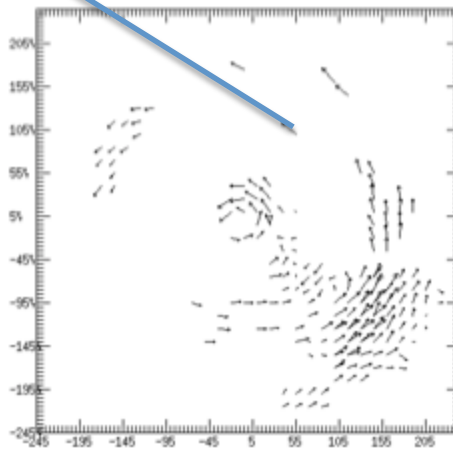
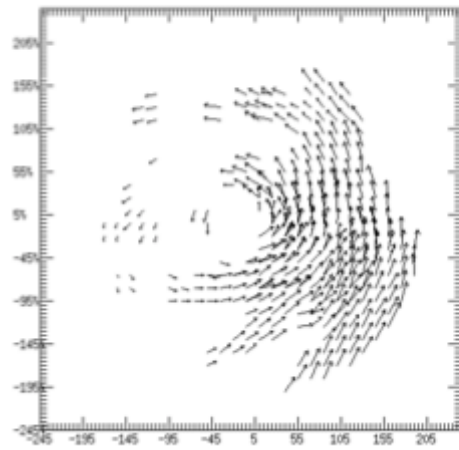
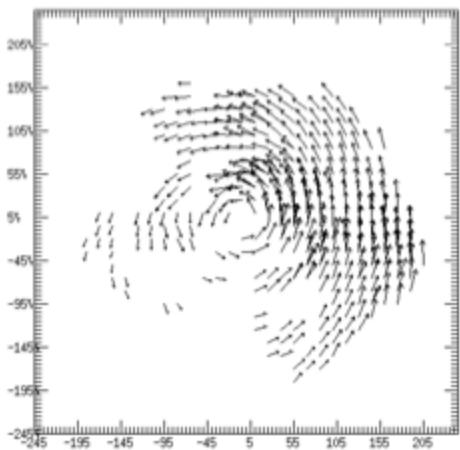
12Z 5 October  
35 kt

# Doppler winds

1-km altitude



3-km altitude



20131003H1

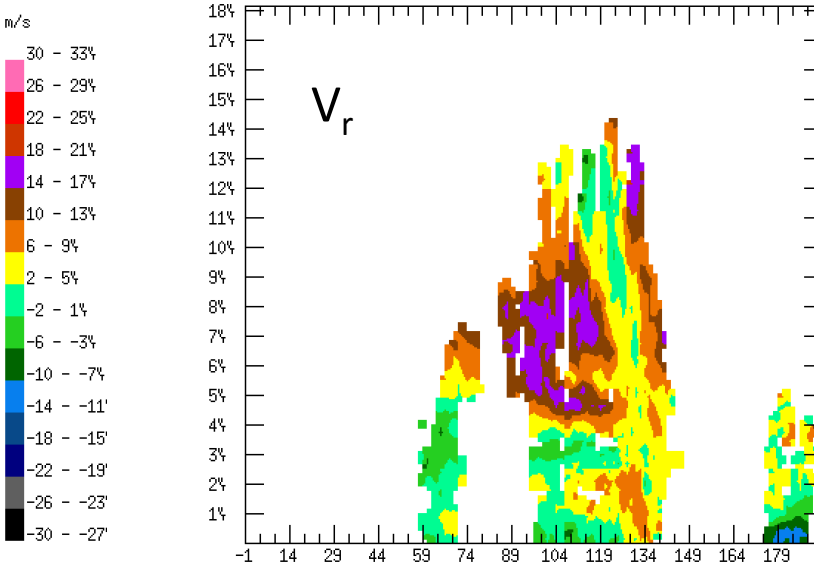
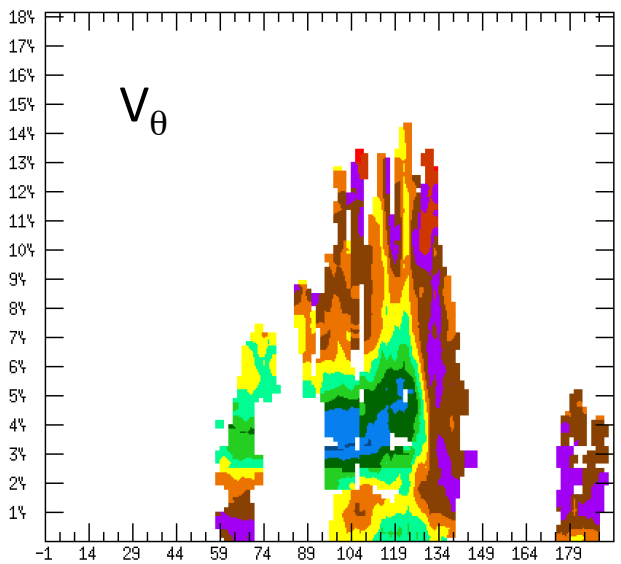
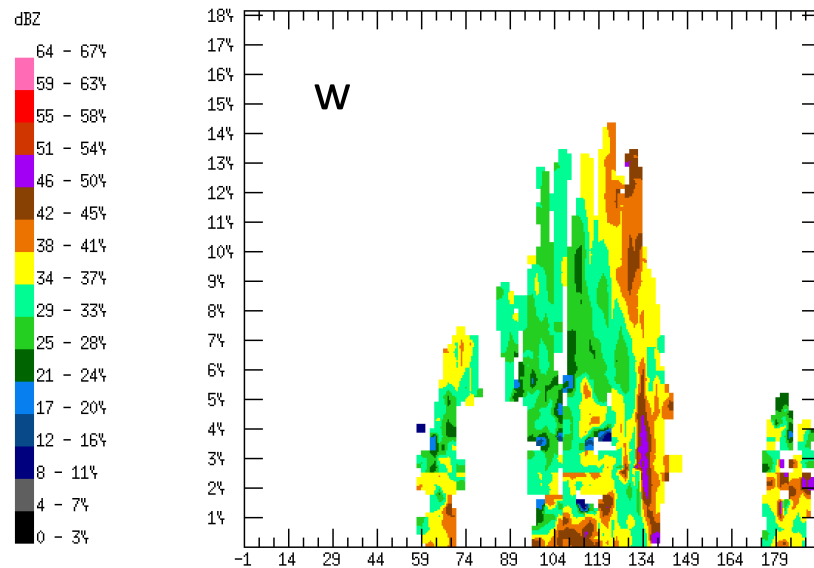
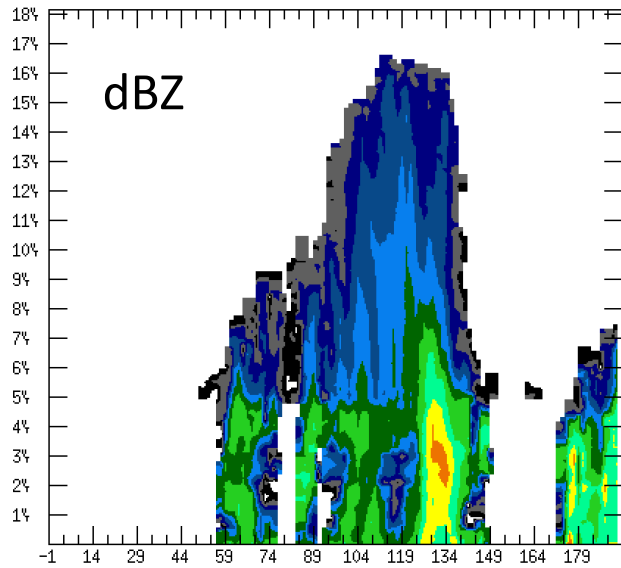
20131004I1

20131004H1

20131005I1

# Doppler winds

20131004H1



P3 Quality-Controlled Doppler  
Observations in TS Karen (2013)  
Successes, Failures  
and the Way Ahead

John Gamache  
7 October 2013

# P3 Airborne Doppler Collection during TS Karen

- 20131003H1-20131005I1
  - All data transferred successfully from AOC to NCO
  - Job files made at home for 20131003H1 and 20131004H1
  - Job files made on aircraft for 20131004I1 and 20131005I1 and checked by Gamache at home
  - 20131003H1—no data assimilated by operational HWRF due to “clerical error” by Gamache—wrong storm number
  - 20131004I1—data assimilated in 2013100412, but not in 2013011406
  - 20131004H1—data assimilated in 2013100418 and 2013100500
  - 20131005I1—data (although very meager) assimilated in 2013100506 and 2013100512

# Clerical Error

- I entered 13 instead of 12, incorrectly reading the number on an NHC storm discussion for Karen
- Short term remedy
  - if someone on ground enters storm and flight id it is checked by someone on the aircraft—a quick report file could be made for person on aircraft to check
  - Person on ground checks job file or similar report that is sent from aircraft as quality-control/analysis job is started

# Data Timing—00, 06, 12 or 18

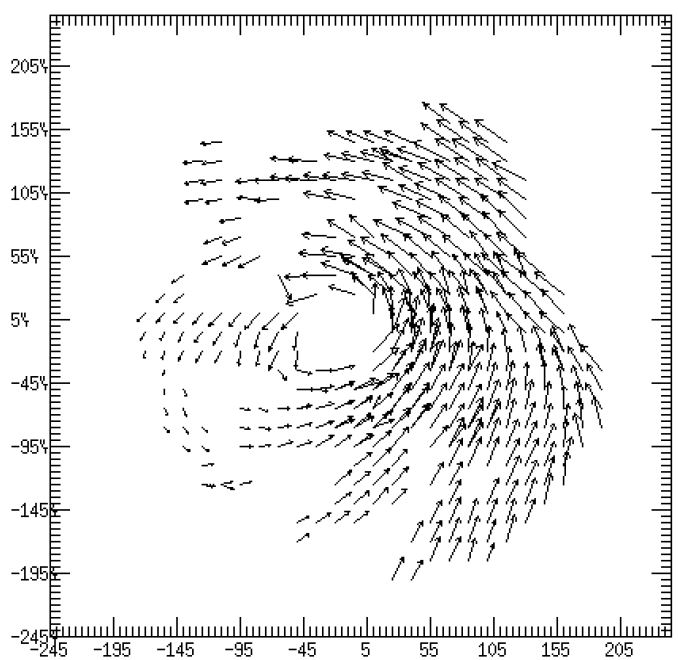
- 2 AM or 2 PM takeoff designed to put some data into 18 (06) instead of all in 00 (12)UTC model run—will, lead to some loss of data for real-time assimilation—more or less depending upon timing
- Example
  - Data collected from 0719-0845 in second flight (20131004I1). Some delay in beginning processing—first data appears to have been sent from AOC to NCO at 0958—too late for any of it to be assimilated---I had originally believed the deadline was 1000, but found out later it was 923. All data from 0719-0900 lost for real-time assimilation.



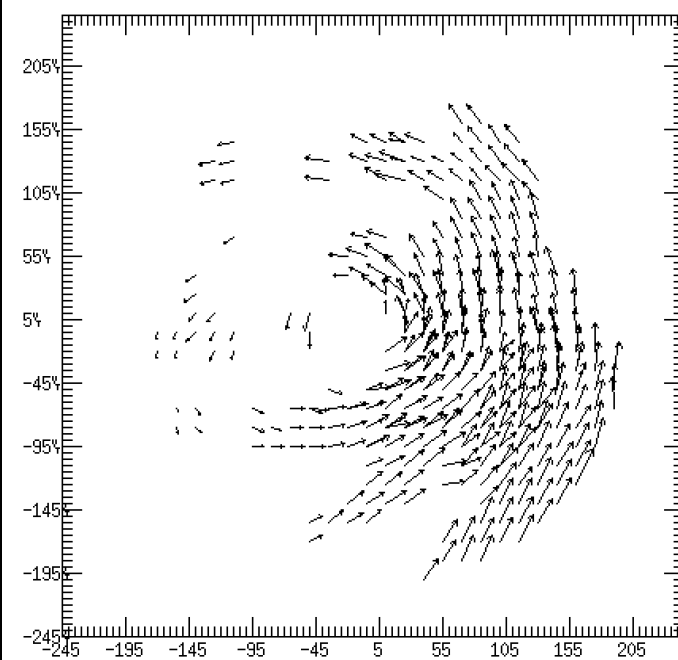
# Data Timing “Solution”

- For third flight (20131004H1), data collected from 1928-2024 UTC processed without downwind leg
- Processing finished before 2100 UTC and transmitted to AOC
- All data transmitted to NCO by 2111 UTC
- Data from 2024-2100 UTC lost for real-time assimilation (in downwind leg and first portion of pass 2)

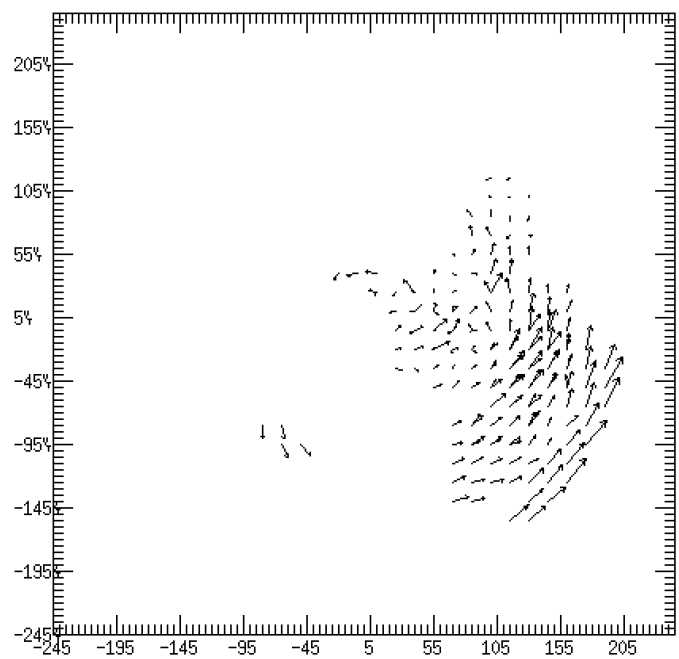
# 20131004I1 (Flight 02)



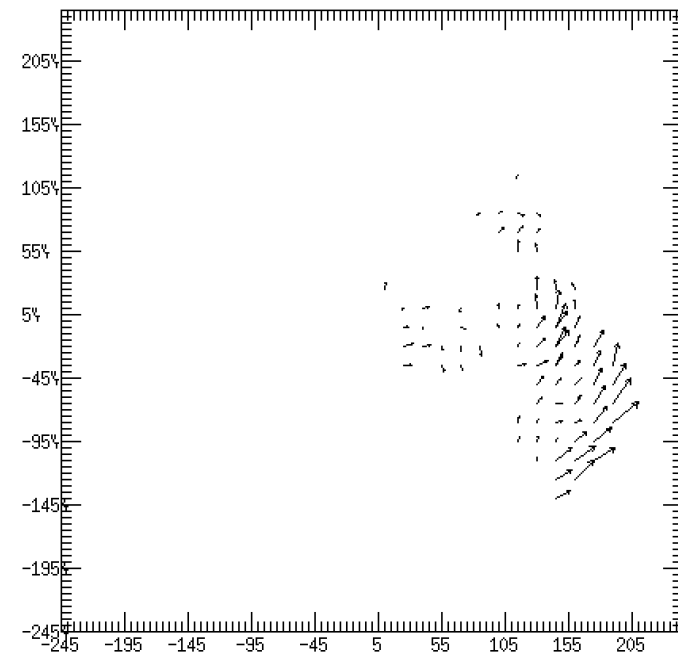
1 km



3 km

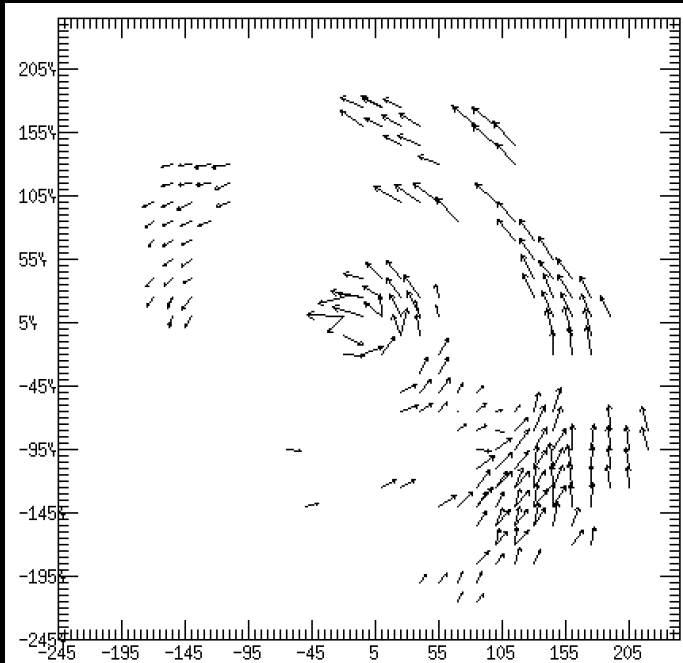


6 km

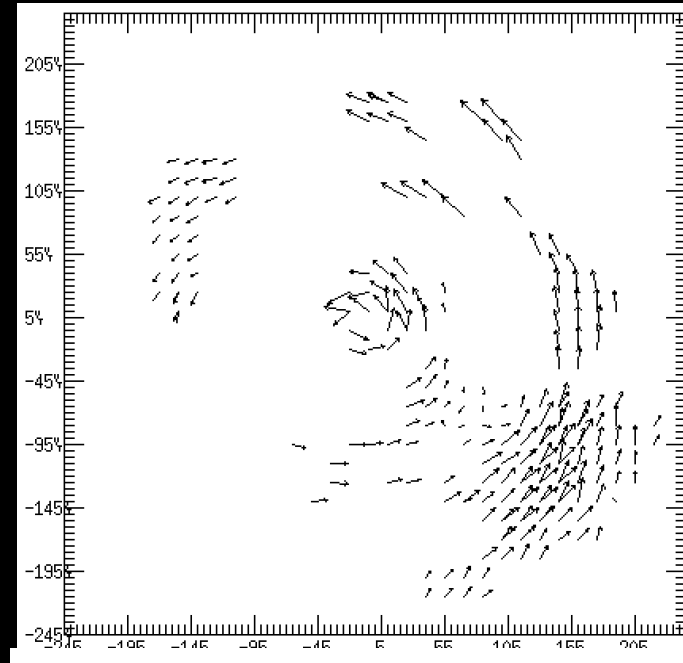


8 km

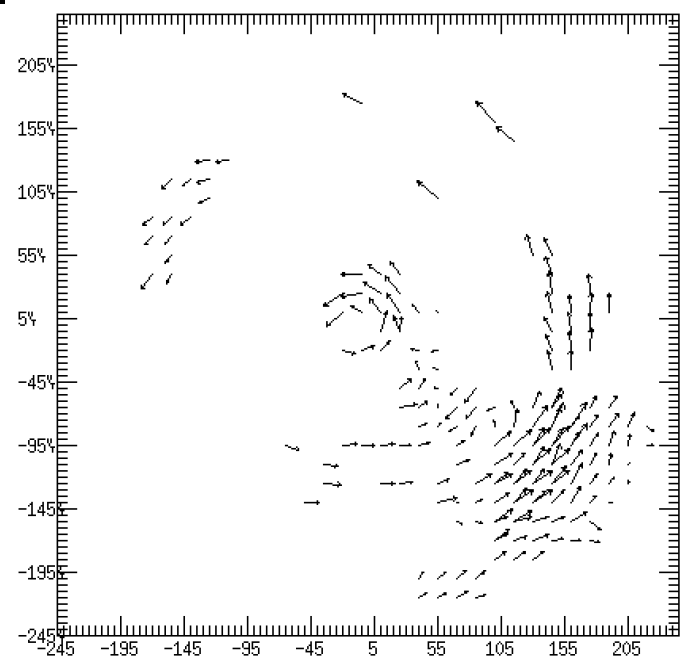
# 20131004H1 Flight 03



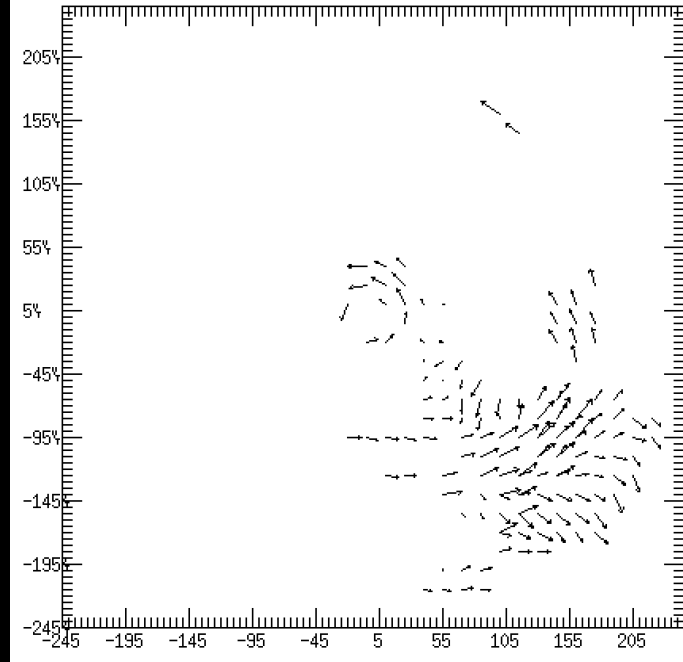
1 km



2 km

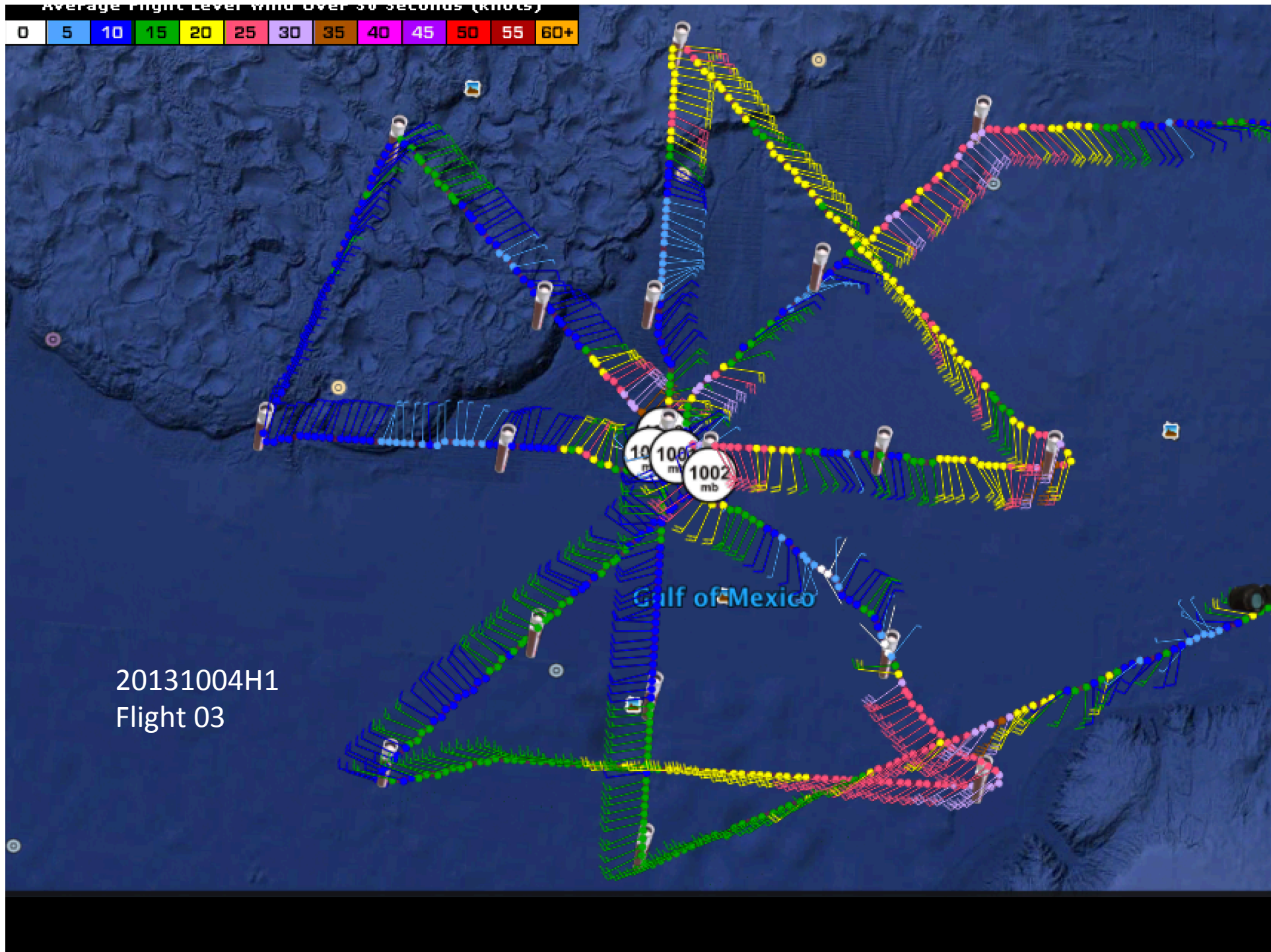


3 km

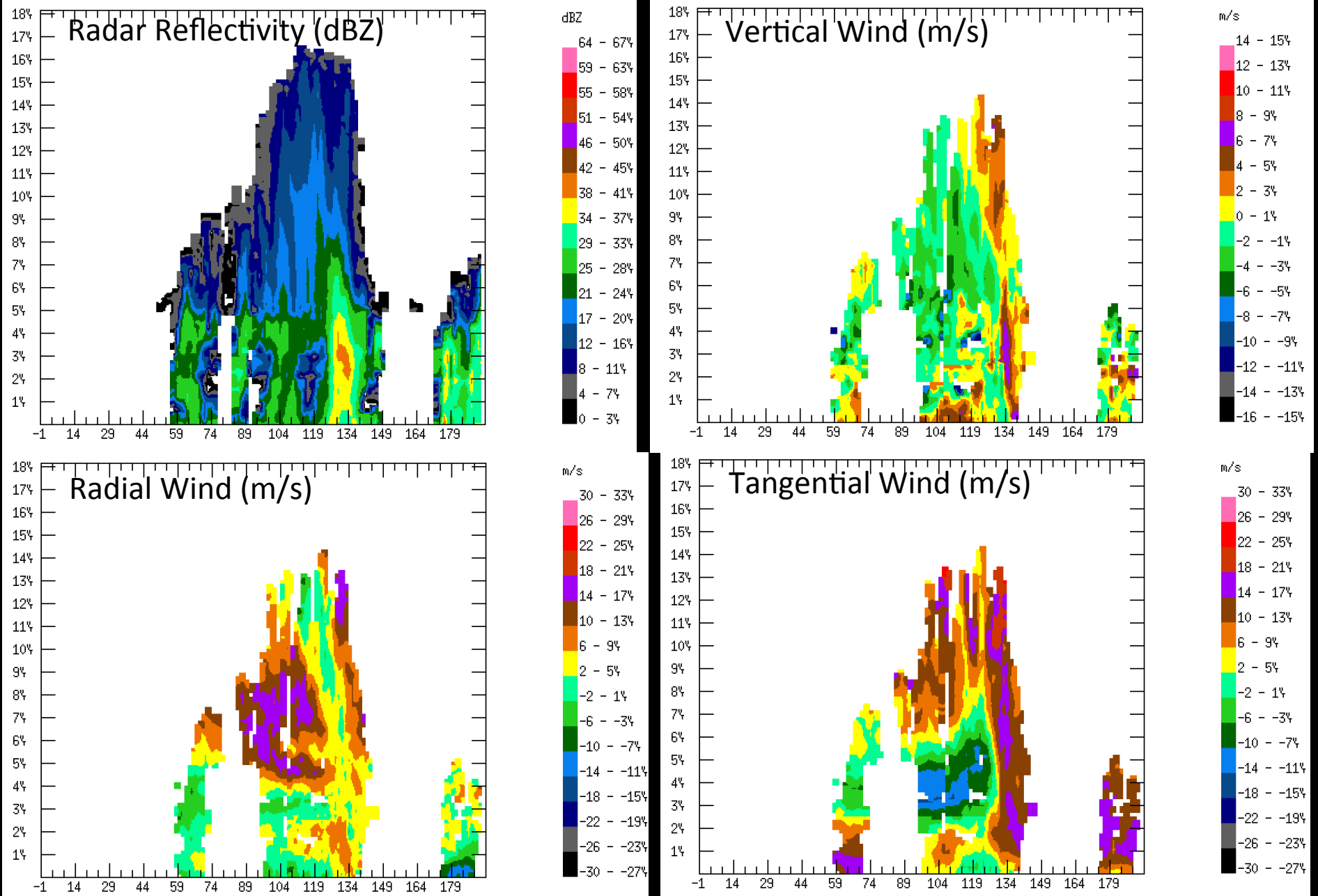


4 km

Average Flight Level Wind Over 30 Seconds (knots)



# Cross-section extending from storm center toward azimuth 135 (20131004H1—flight 03)



# Takeaway points

- Further care will be taken to avoid clerical errors resulting in loss of real-time data—both human and software
- We will attempt to time our Doppler processing to lose as little real-time data to the change of analysis cycle challenge
- In weak systems, Doppler data can help determine degree of complexity and/or disorganization

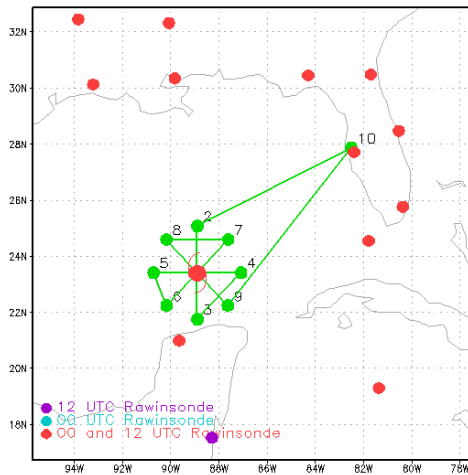
# Operational HWRF TDR Data Assimilation for TS Karen

**NHC Forecast Discussion on October 4, 5 PM:**

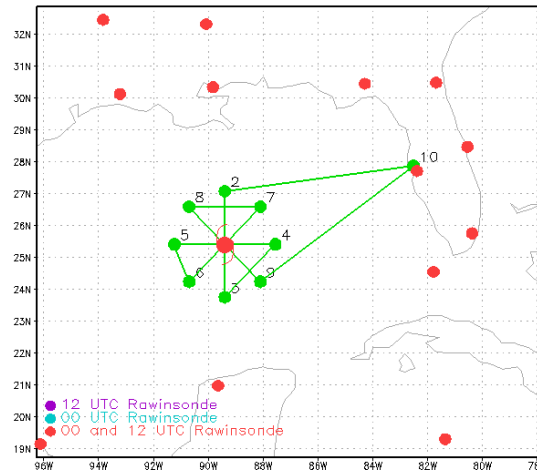
- **THE 12Z HWRF RUN SHOWED CONSIDERABLY LESS INTENSIFICATION WITH KAREN COMPARED TO PREVIOUS RUNS AFTER ASSIMILATING DATA FROM THE FROM THE NOAA P-3 TAIL DOPPLER RADAR. THIS MARKS THE FIRST TIME DOPPLER RADAR DATA HAVE BEEN ASSIMILATED INTO AN OPERATIONAL HURRICANE MODEL IN REAL TIME.**

# P3 TDR Flight Patterns for TS Karen

Thursday 10/03 1400L



Friday 10/04 0200L

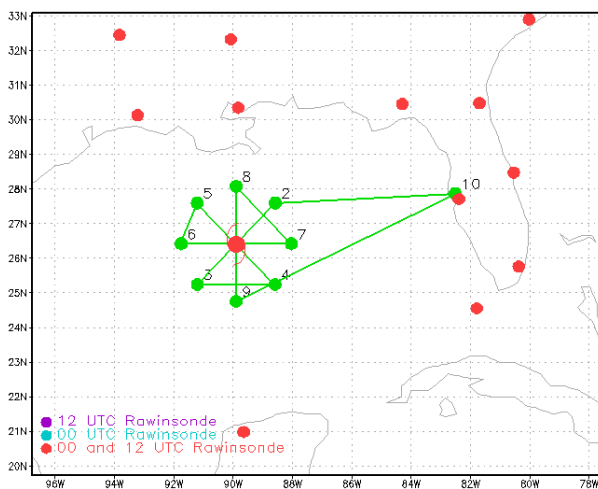


Five back-to-back missions planned.

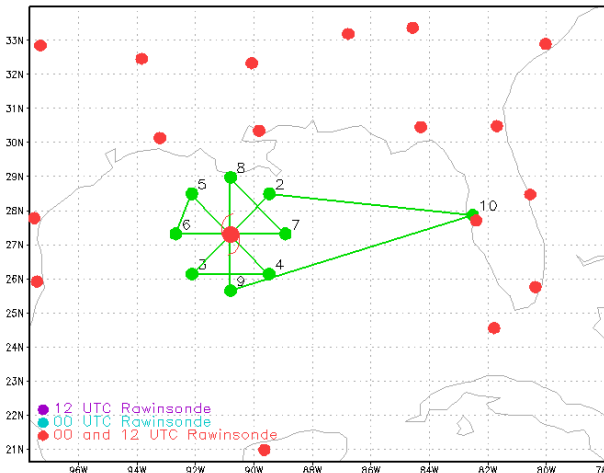
Data to NCEP first reached for 12Z cycle on Friday (10/04).

Saturday 10/05 1400L was canceled.

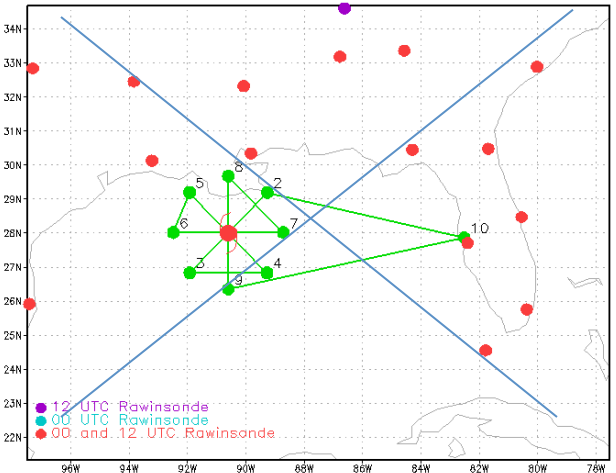
Friday 10/04 1400L



Saturday 10/05 0200L

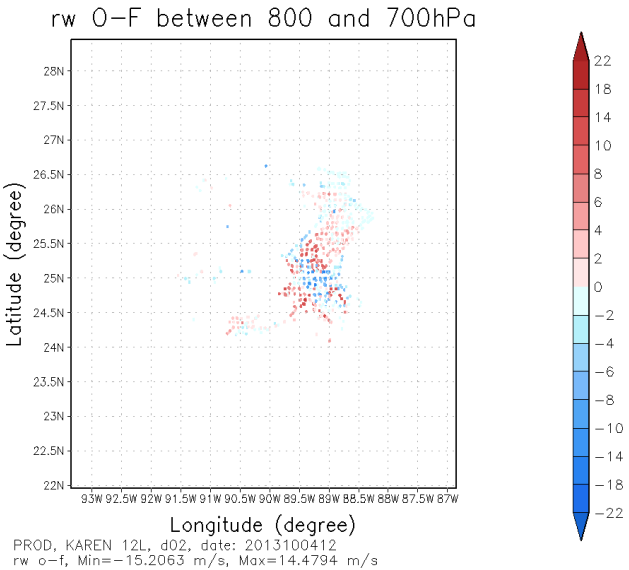
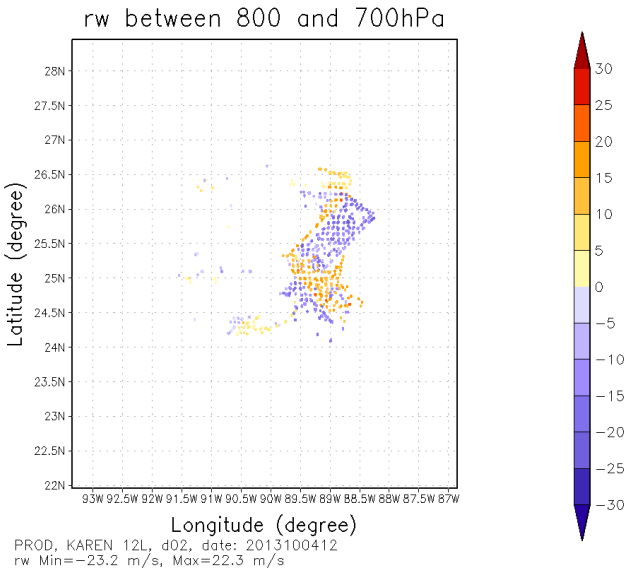
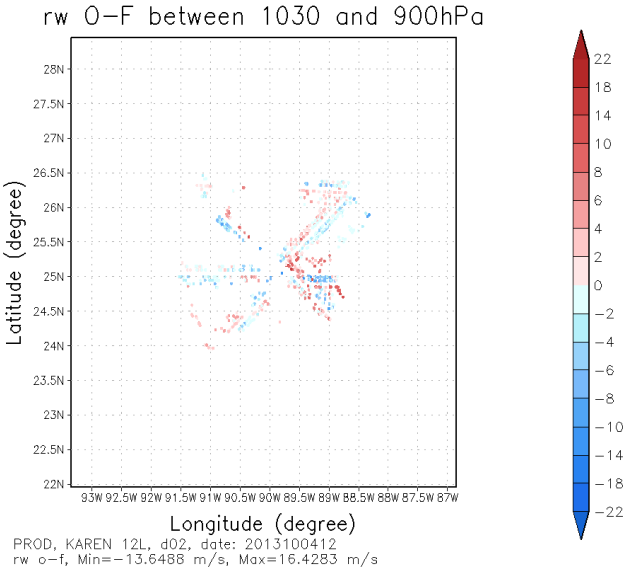
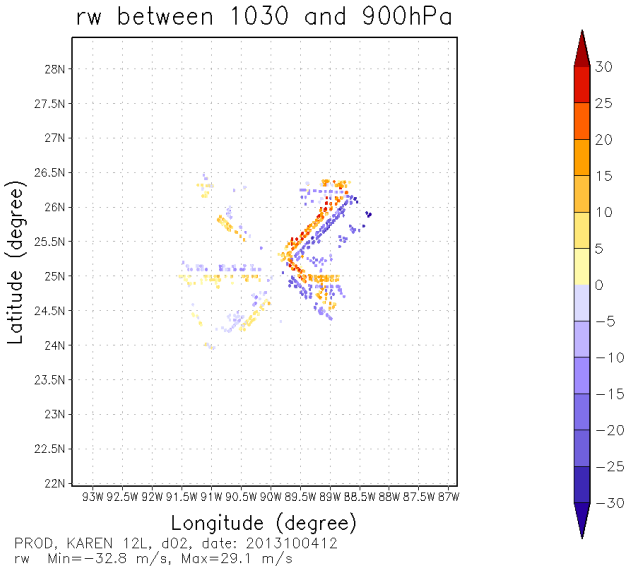


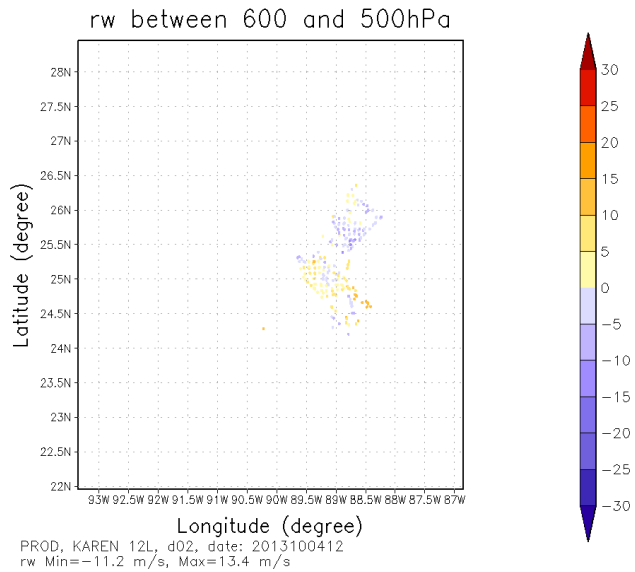
Saturday 10/05 1400L



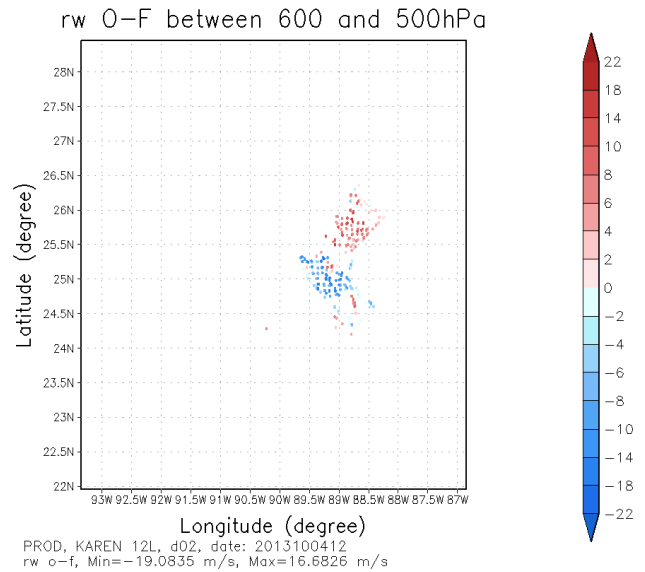


# TDR radial velocity data assimilated for 12Z 10/04

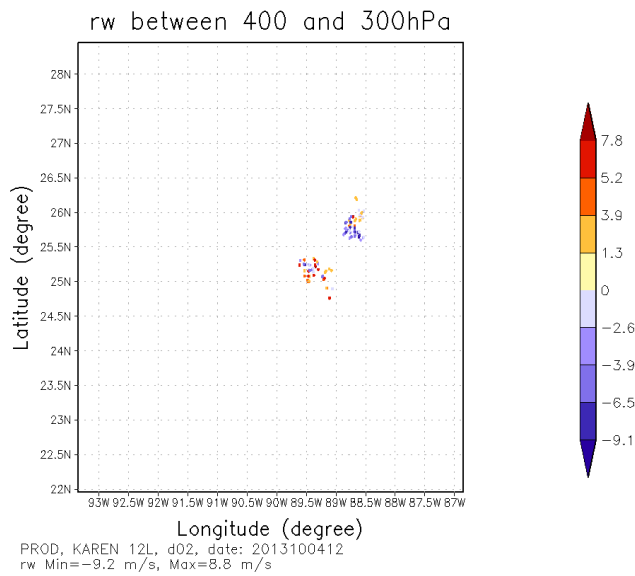




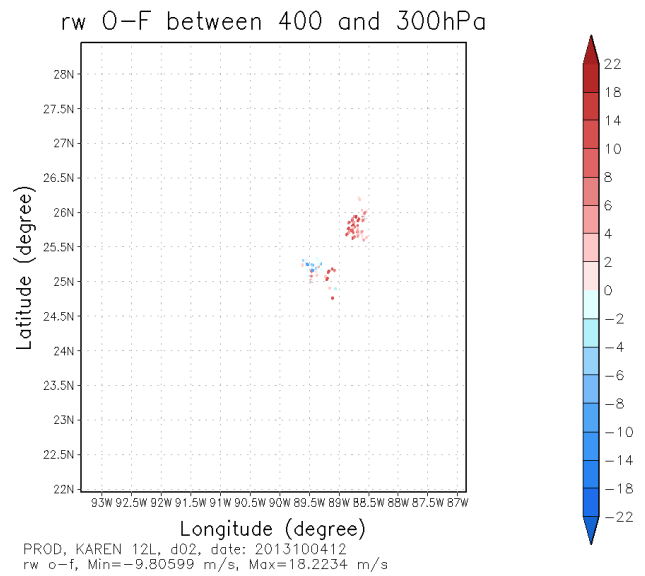
GRADS: COLA/IGES



GRADS: COLA/IGES



GRADS: COLA/IGES

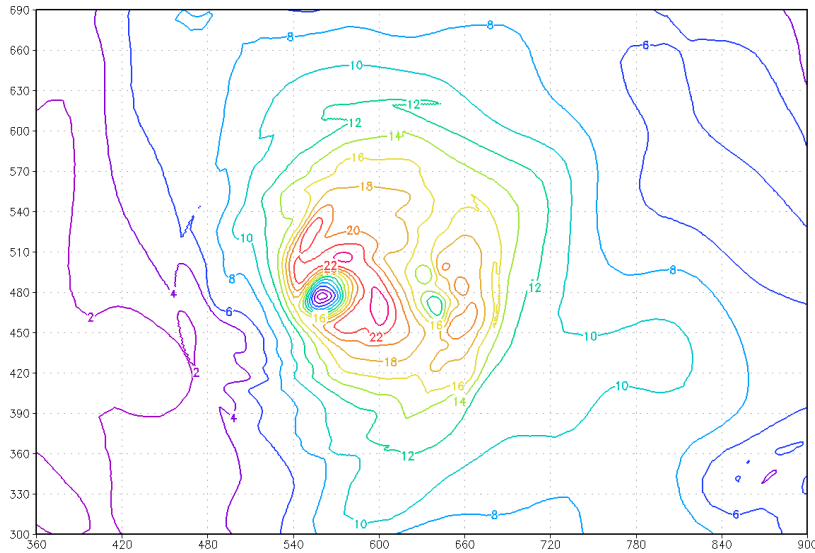


GRADS: COLA/IGES

# First model level wind speed

## 12Z 10/04

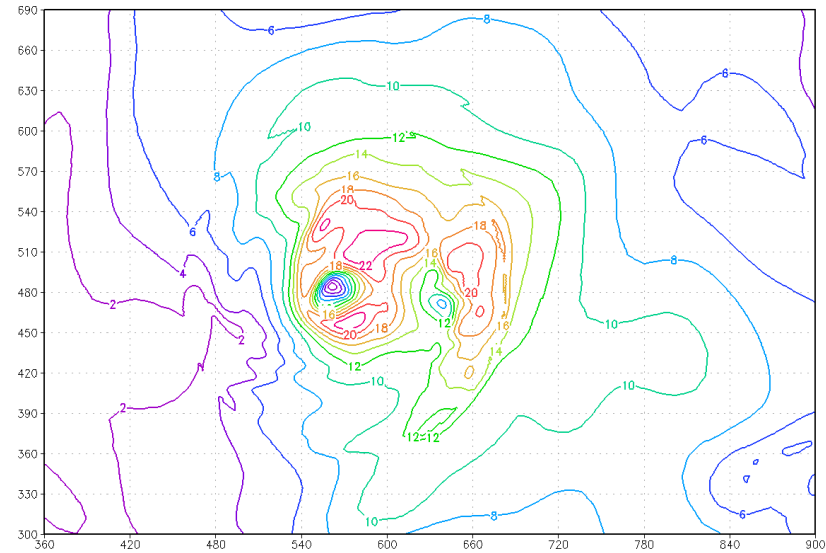
First guess



GRADS: COLA/IGES

2013-10-04-17:14

Analysis

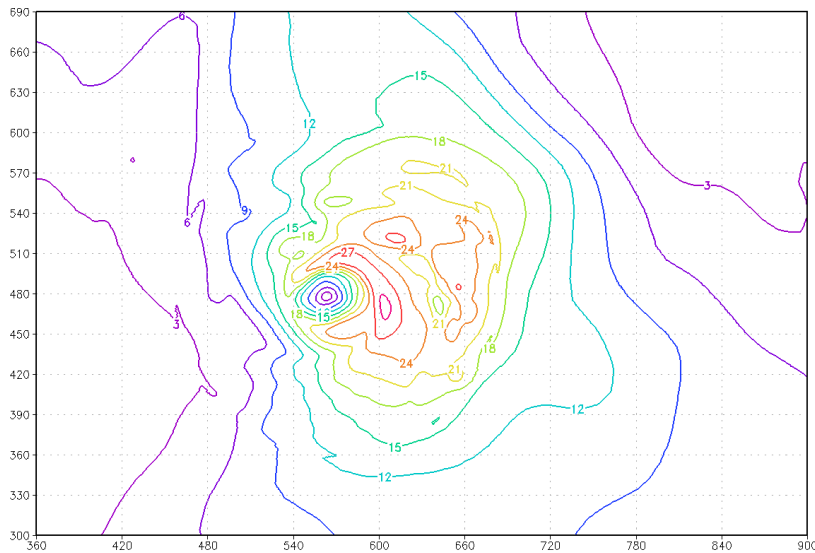


GRADS: COLA/IGES

2013-10-04-17:24

# Wind speed at 11<sup>th</sup> model level (~ 850 hPa) **12Z 10/04**

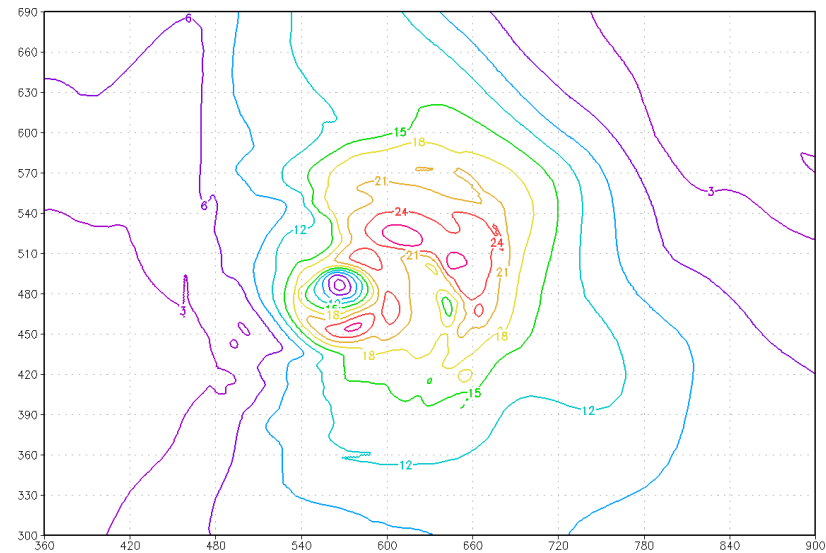
First guess



GrADS: COLA/IGES

2013-10-04-17:32

Analysis

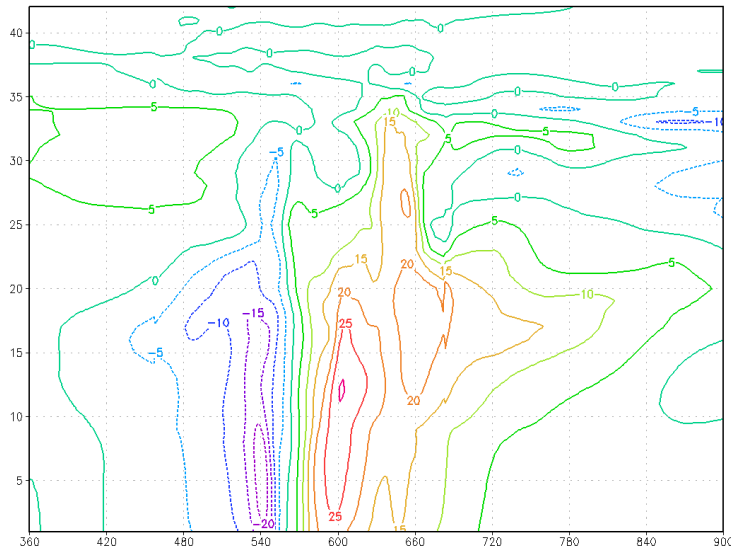


GrADS: COLA/IGES

2013-10-04-17:33

# E-W cross section V 12Z 10/04

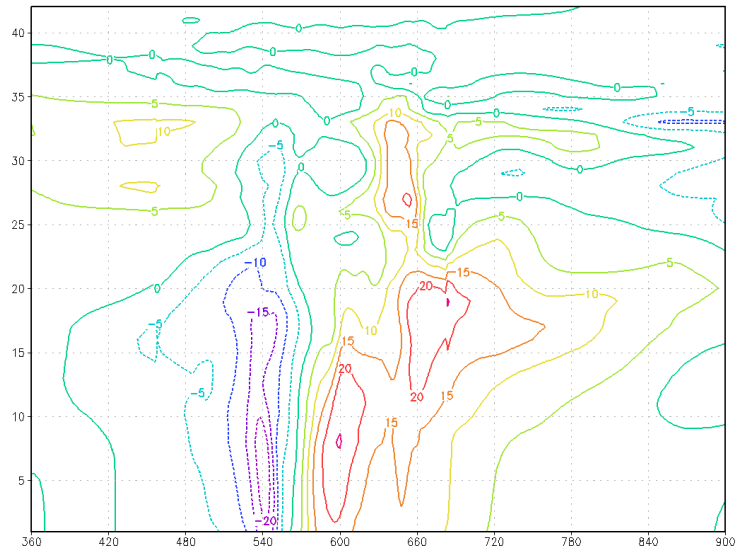
First guess



GRADS: COLA/IGES

2013-10-04-17:35

Analysis



GRADS: COLA/IGES

2013-10-04-17:35

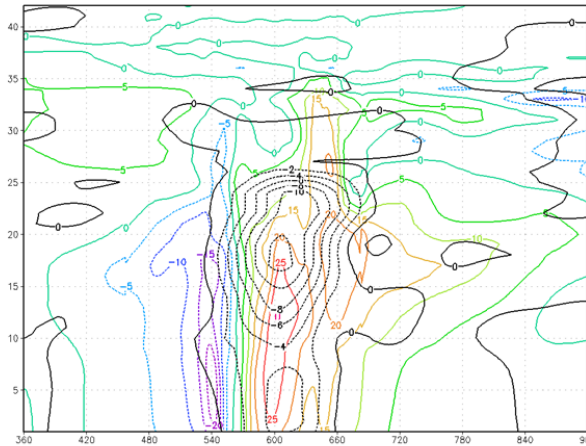
# E-W cross section first guess v (color) v, t and q increment (black)

12Z 10/04

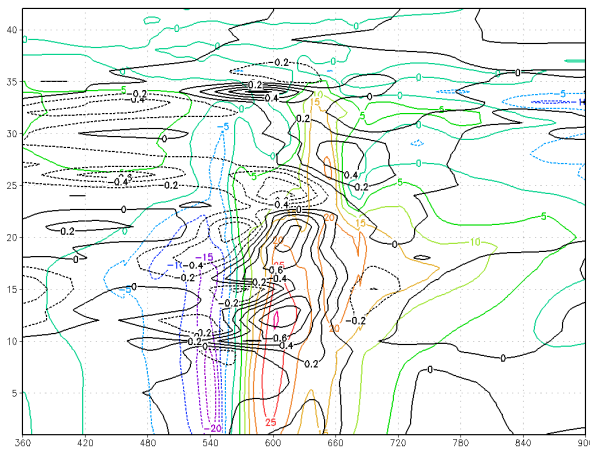
west

east

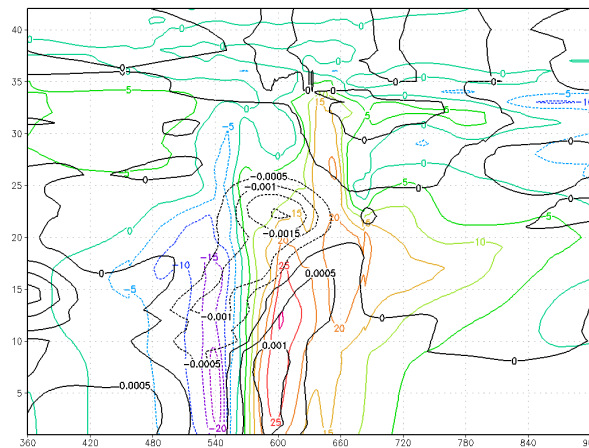
v



t



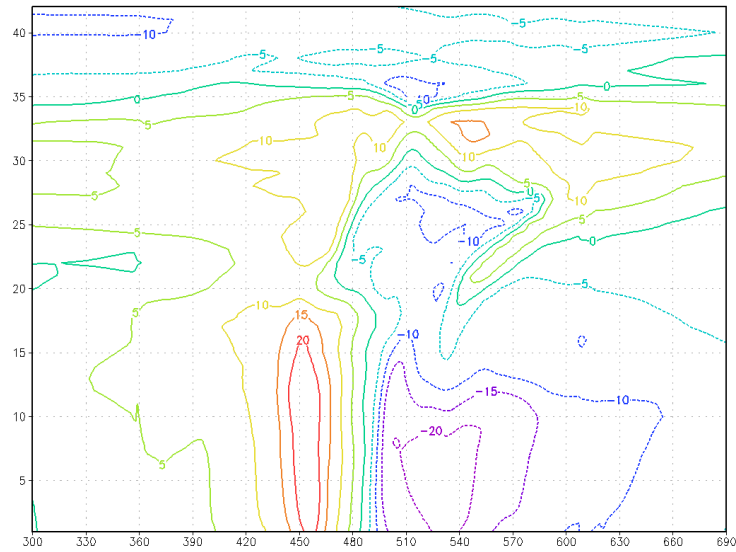
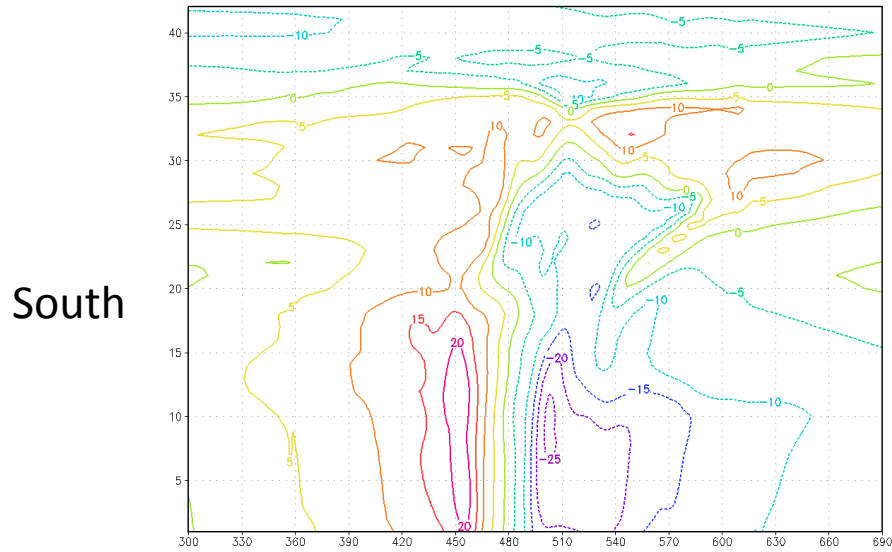
q



# N-S cross section u

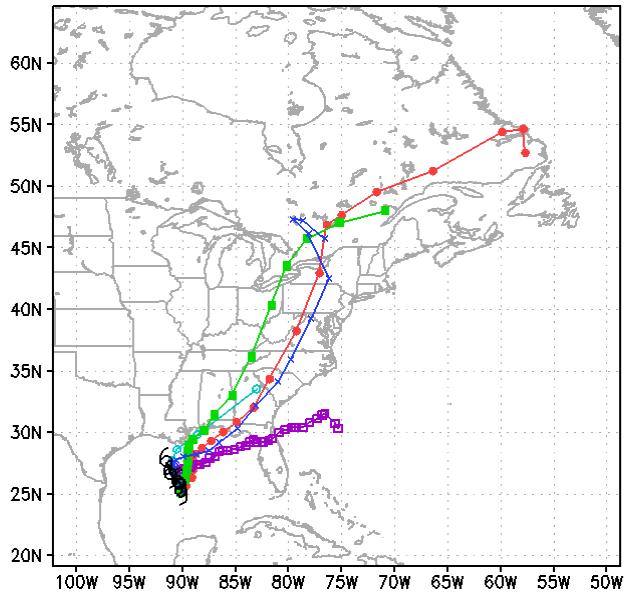
First guess

Analysis



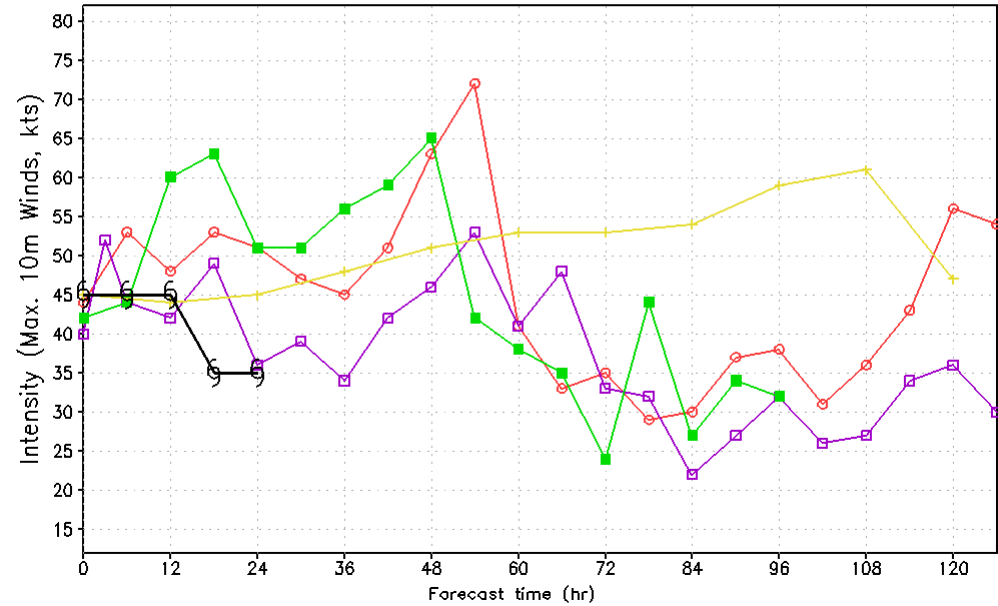
HNTD 2013 Baseline: TC Tracks  
 Storm: KAREN (12L) valid 2013100412

- OFCL: NHC Official
- HWRf: 2013 Oper.
- ▲— AVNO: Oper. GFS
- HNTD: FY13 no TDR testing
- GFDL: GFDL Oper.
- BEST: Best Track

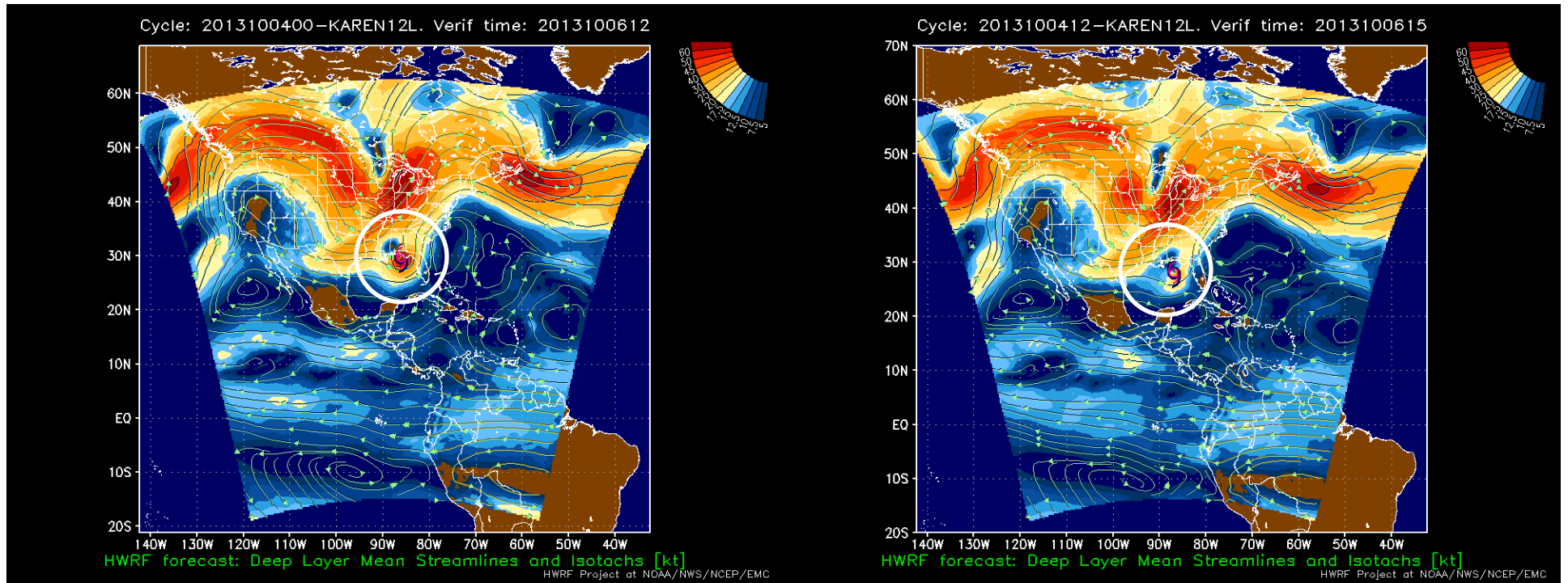


HNTD 2013 Baseline: TC Intensity Vmax  
 Storm: KAREN (12L) valid 2013100412

- HNTD: FY13 no TDR testing
- HWRf: 2013 Oper.
- ▲— SHF5: SHIFOR 5-day
- GFDN: GFDN model
- GFDL: GFDL Oper.
- BEST: Best Track

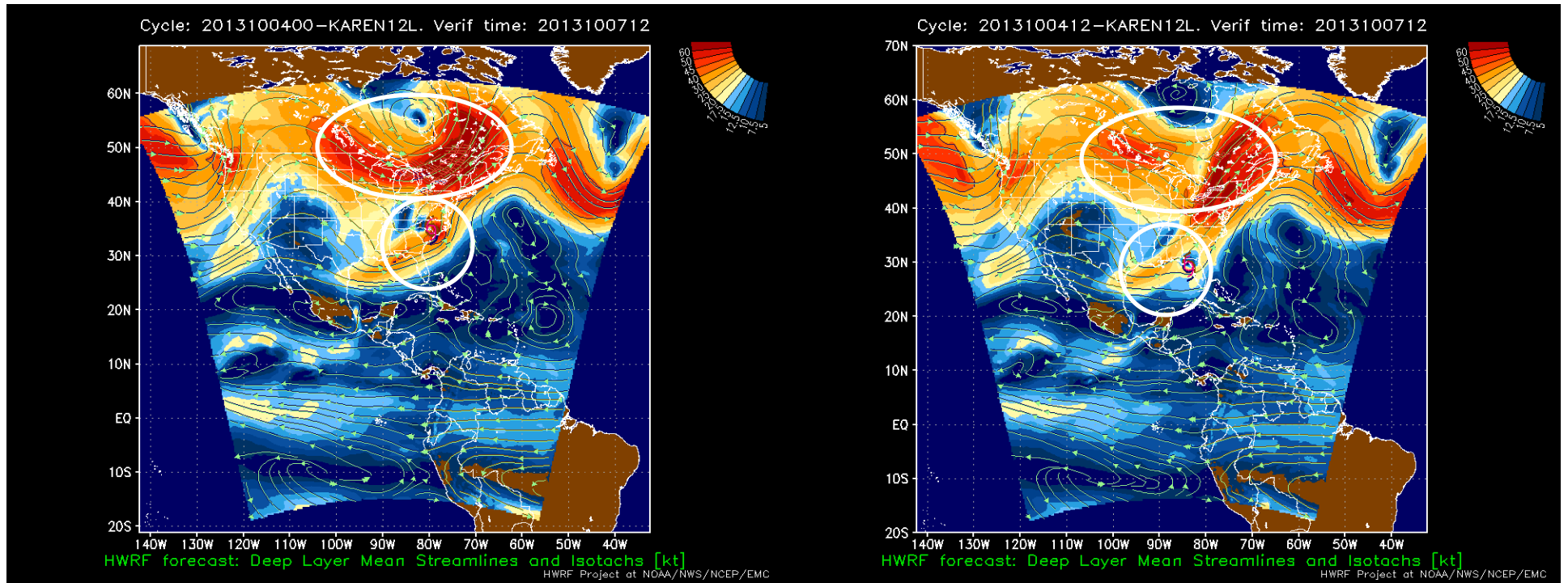






Valid at 12z06:

- Storm intensity at 00Z04 showed strong intensity at the interaction with the trough, while the storm intensity at 12z04 became very weak valid at the same time 12z06.
- Large-scale trough at 12z14 cycle seems to be weaker than that in 00z14 cycles?



Valid at 12z07:

- the storm initialized at 00z04 still maintained strength, the trough was significantly stronger than that in the cycle initialized at 12z14. Looks like the strong intensity of the 00z14 storm allowed it to interact more efficiently with the trough and being pulled north. In contrast, the 12z14 storm was too weak to be carried out by the trough to the north.
- Also the trough is too weak as compared to the previous cycles. So the 12z14 storm was not pulled to the north strongly.

# Preliminary thoughts

- TDR data assimilation weakened the storm through reduced winds and by bringing in the cold dry air associated with the mid-latitude trough;
- Large scale flow in HWRF showed very different behaviors between 12z14 and 00z14 cycle (valid at the same time). The midlatitude trough in 00z14 cycle was stronger that tended to advect the storm to the north more efficiently. This caused slow translational speed of the 12z14 storm and so could not move north.

# Lessons learned during NOAA P3 TDR Missions for TS Karen

- Did not receive data for first three cycles (Thursday 18Z/Friday 00Z/Friday 06Z)
  - Wrong storm id (13L instead of 12L), fixed for 12Z
- Successful assimilation of TDR data for Friday 12Z cycle (and all subsequent cycles)
  - No issues noted by NCO in operational runs
  - Data is delivered to both /dcom and /dcomdev directories
  - HWRF jobs point to /dcomdev instead of /dcom
  - Some latency in generating final bufr files (may not be an issue)
  - RFC submitted to point to /dcom for future missions
- Data arrival at NCEP has improved for Friday 18Z cycle (first set of data arrived before HWRF GSI jobs were submitted)
  - Only partial data was received.
  - Too early for 18Z/06Z, too late for 12Z/00Z
  - Should consider alternate take-off timings to obtain better data coverage for assimilation purpose
- Real-time data analysis and model initial analysis and forecast evaluation is essential
  - Preliminary analysis showed improved intensity forecasts, better vortex- large-scale interactions
  - Subtle impacts on steering flow noted in the real-time experiments.
  - Non-TDR real-time runs helped assess the impact of TDR data assimilation for NHC forecasters.