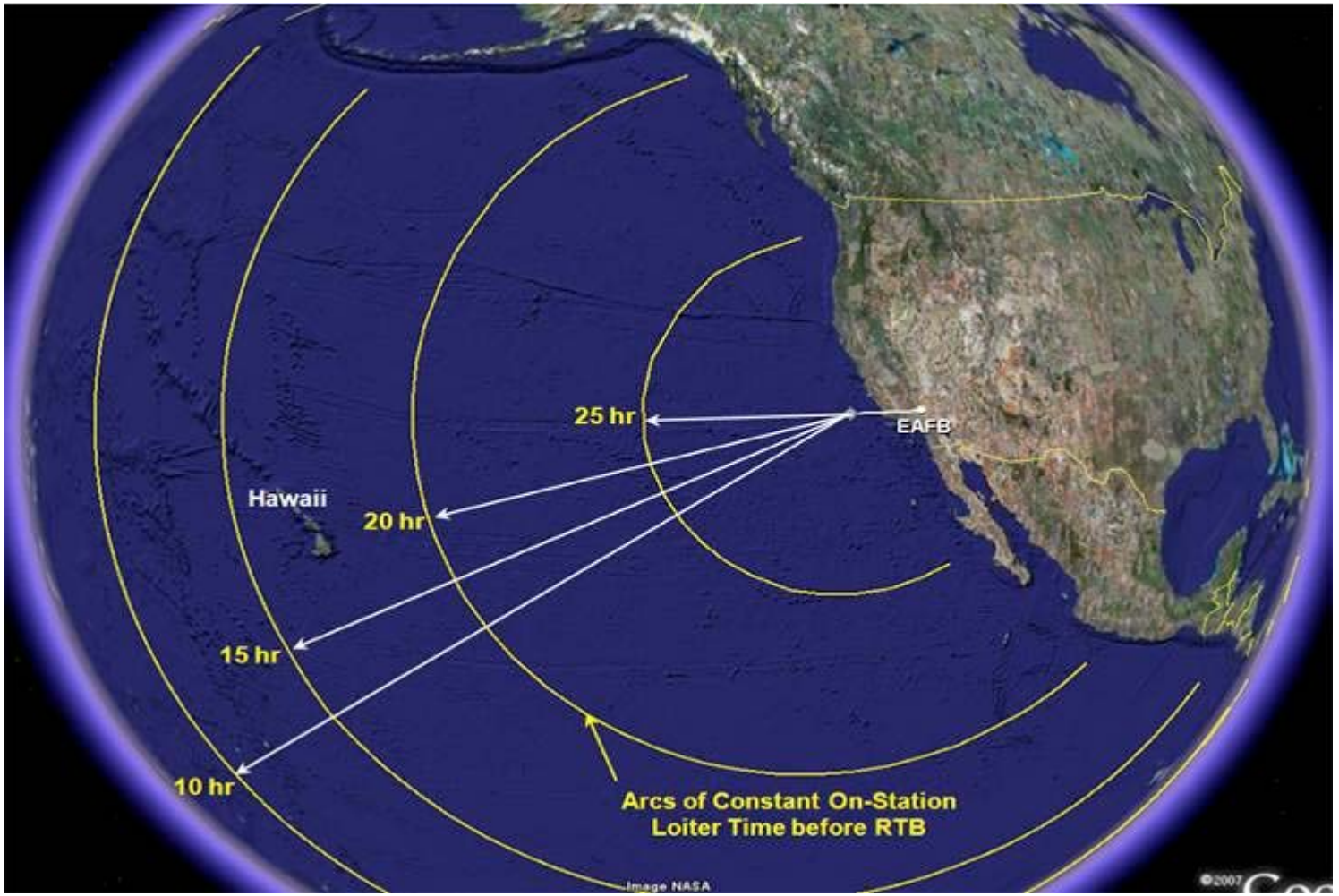
NASA GRIP Program

GRIP DC-8 Range from FLL

Loiter Capability from DFRC

East Pac Loiter Capability



NASA Hurricane Research Science Team

ROSES 08 (Science Team)

Scott Braun	NASA GSFC
Shu-Hua Chen	U. of California, Davis
William Cotton	Colorado State U.
Michael Goodman	NASA MSFC
Robert Hart	Florida State U.
Gerald Heymsfield	NASA GSFC
Robert Houze	U. of Washington
Svetla Hristova-Veleva	NASA JPL
Haiyan Jiang	U. of Utah (to FIU)
Tiruvalam Krishnamurti	Florida State U.
Greg McFarquhar	U. of Illinois
John Molinari	U. of Albany
Michael Montgomery	Naval Postgrad School
Elizabeth Ritchie	U. of Arizona
Robert Rogers	NOAA/AOML
Nick Shay	U of Miami
Eric Smith	NASA GSFC
Christopher Thorncroft	U. of Albany
Bin Wang	U. of Hawaii
Edward Zipser	U. of Utah

ROSES 09 (Field/Instrument Team)

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Paul Bui	NASA ARC
Stephen Durden	NASA JPL
Jeffrey Halverson	UMBC/JCET
Andrew Heymsfield	NCAR
Gerald Heymsfield	NASA GSFC
Syed Ismail	NASA LARC
Michael Kavaya	NASA LARC
Bjorn Lambrigtsen	NASA JPL

Summary of GRIP Science Objectives

(…any resemblance to those of IFEX and PREDICT is purely coincidental…)

- Genesis: Distinguish the role of the larger-scale environment vs. meso-convective processes near the putative developing center.

- Rapid Intensification: Relative role of environmental vs. inner core processes? Is RI predictable?

- Test-bed: Evaluate candidate technologies for remote sensing from aircraft and from satellites. Wind lidar, high frequency passive microwave, dual-frequency radars, Global Hawk itself.

Genesis

- Where, in the Atlantic, do we have the best chance of finding disturbances that have “reasonable chances” of becoming tropical depressions/tropical cyclones?

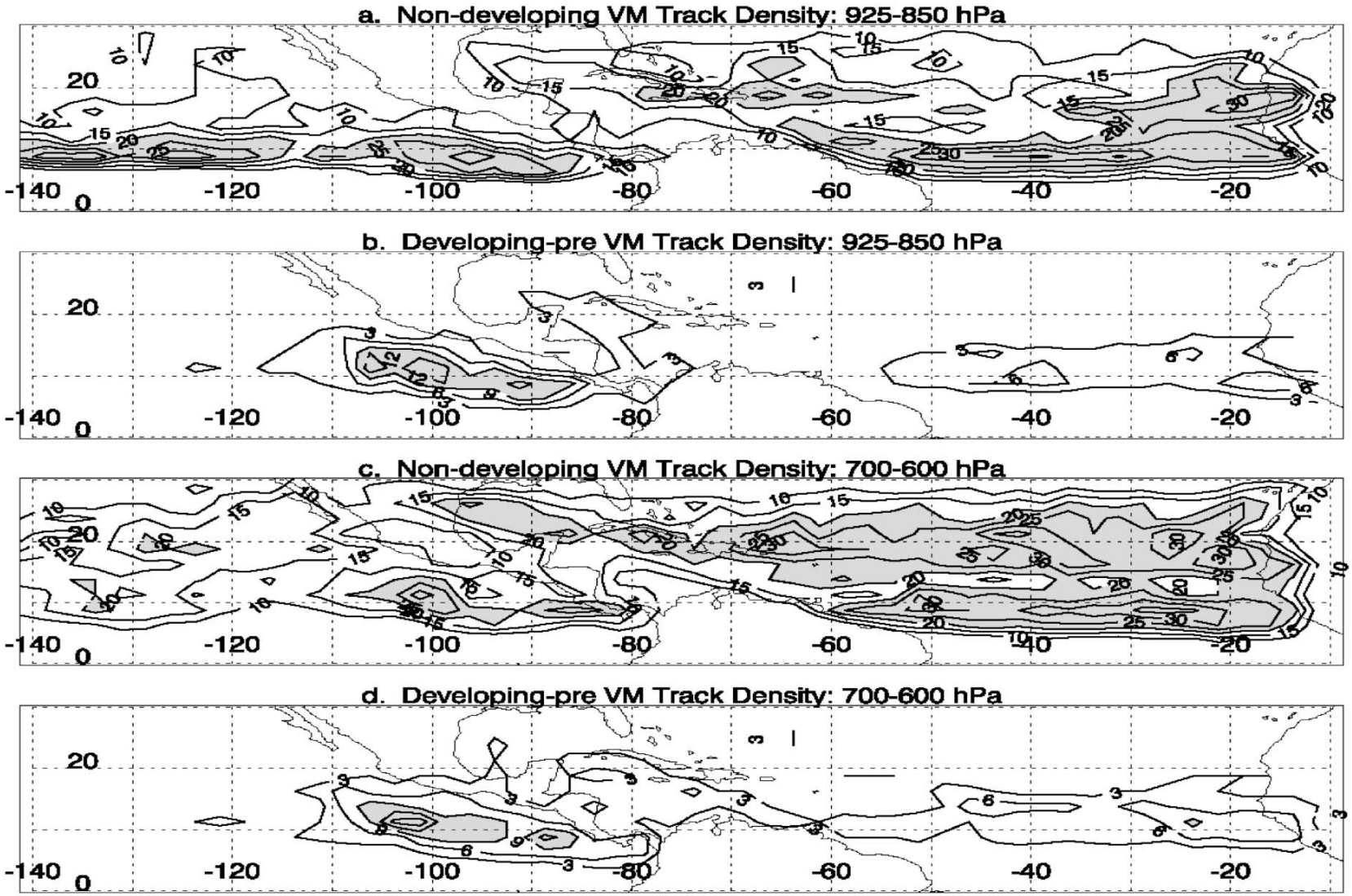


Figure 4.5. The number of VM tracks passing through each 2.5 degree box (track density) for June–October, 1998–2001. For parts a and c the contours are every 5, starting at 10, shaded above 20. For parts b and d the contours are every 3, starting at 3, shaded above 9.

(Courtesy Brandon Kerns)

Illustrating the challenge of sampling genesis cases

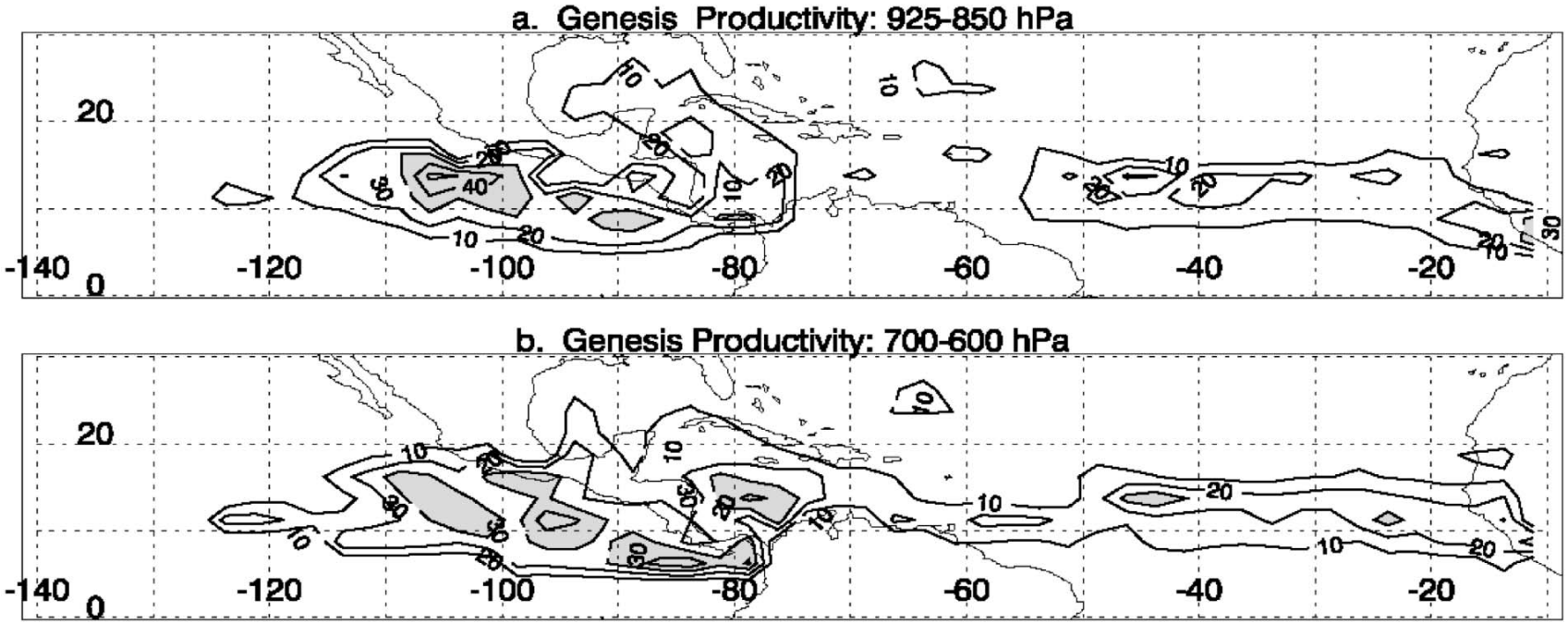


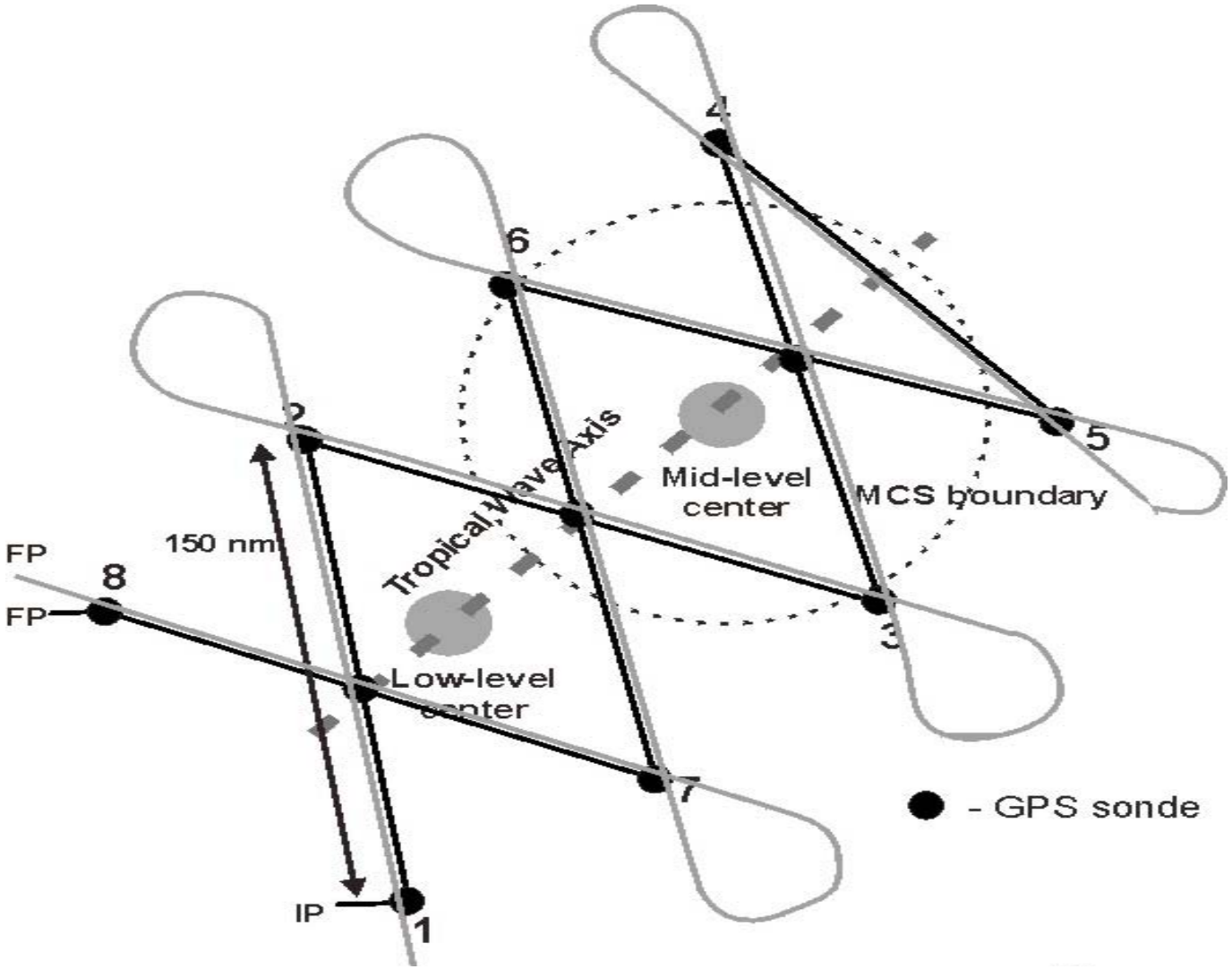
Figure 4.6. The percentage of all non-tropical cyclone VM tracks (non-developing + developing-pre) that eventually become tropical cyclones. The calculation is done for each 2.5 degree box for June-October, 1998–2001. Values are only plotted for boxes for which the total number of non-tropical cyclone VM tracks is at least ten. Contours are every 10%, and values above 30% are shaded.

(Courtesy Brandon Kerns)

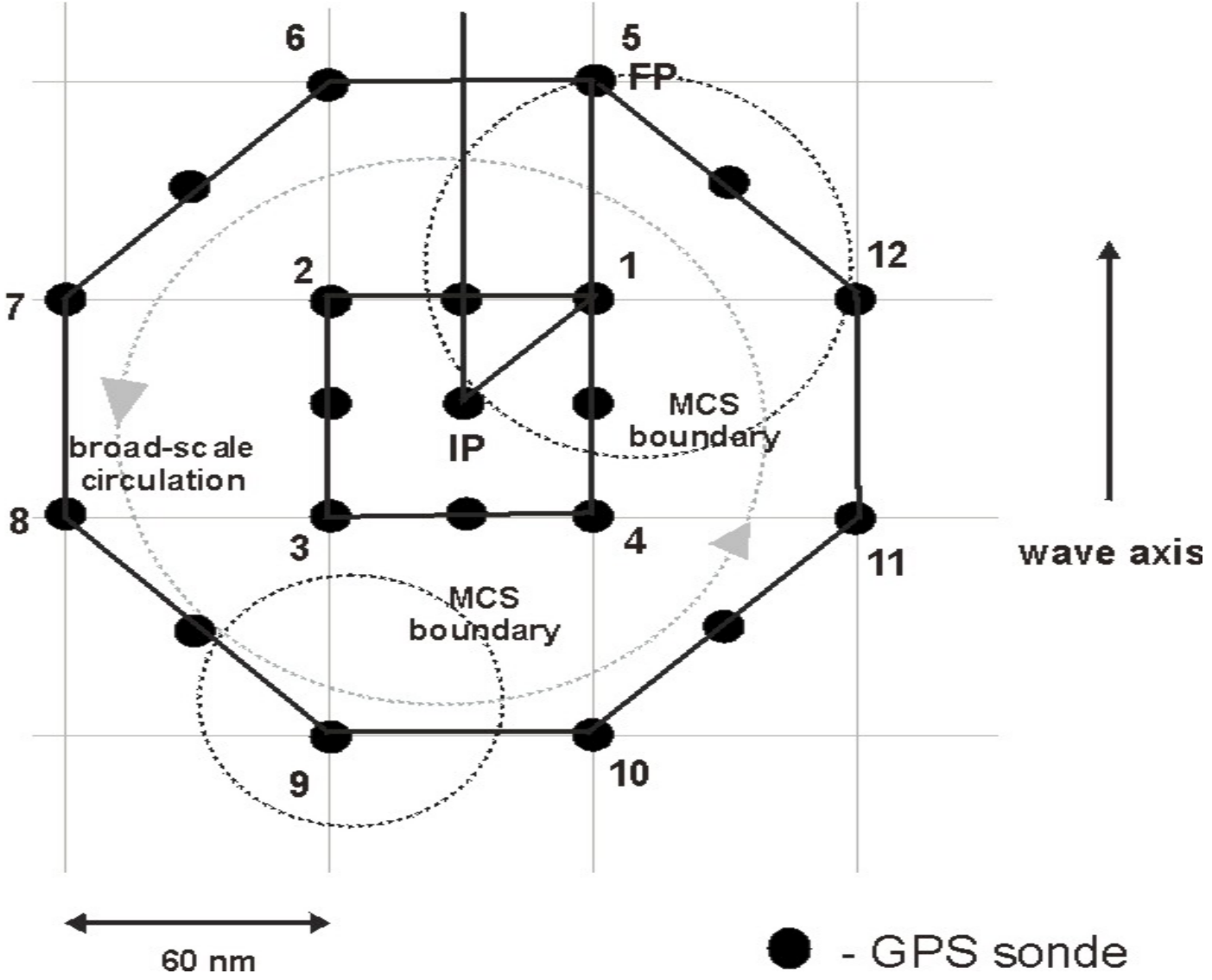
Flight Strategy

- **Central question:** What flight strategy gives the best chance of obtaining databases that can distinguish the *reasons* for development vs. failure to develop?
- **Central answer:** Monitoring of large-scale environment (annulus from r_1 - r_2) up to twice daily, while also obtaining critical information on meso-convective events near the possibly-developing central core.

Diamond Pattern - often suggested before any clear center has formed



One possible flight pattern (of many) for sampling both environment and inner convective region



Issues for discussion by GRIP, IFEX, and PREDICT

- In any given flight, what is the optimum annulus of observations intended to determine “environment”?
- What is optimum tradeoff between areal coverage of environment, frequency of flights, and sampling near disturbance center (or pouch)?
- What is optimum tradeoff between multiple aircraft at any given time and minimizing time between aircraft sorties? (This may be most important when deciding how much radar coverage of the inner core is needed at any given time.)

NASA GRIP Aircraft

NASA DC-8

DC-8 Interior

DC-8 Communications

REVEAL - Research Environment for Vehicle-Embedded Analysis on Linux

- Real-time aircraft position and data plotted on Google Earth
- X-Chat capability with science team members

Instrument Inter-communications

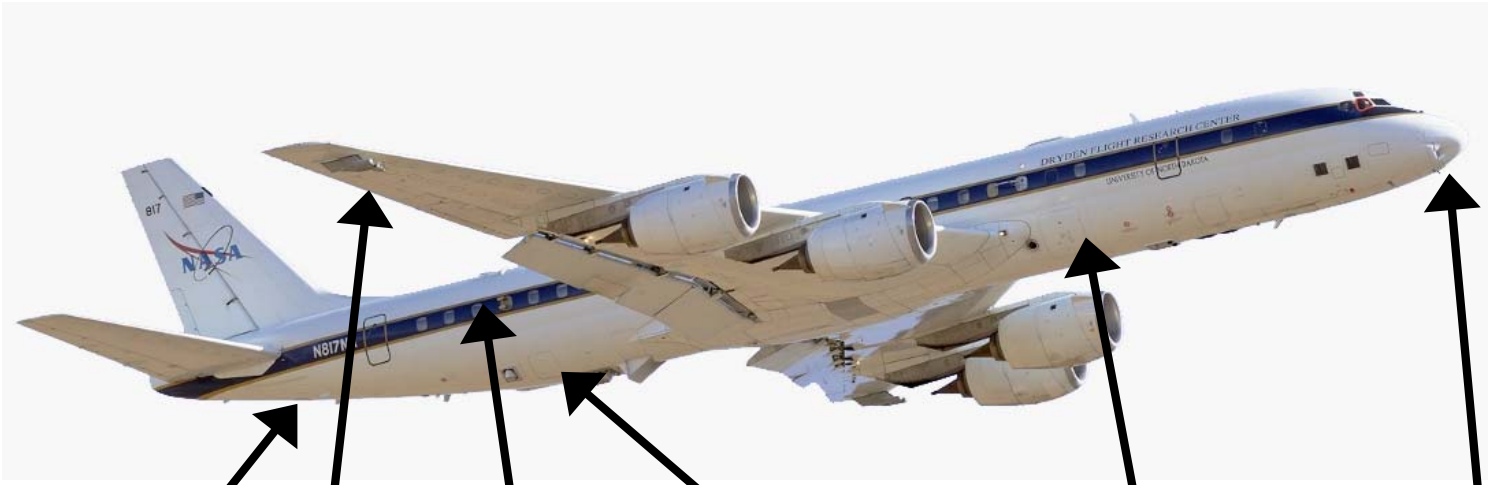
- Gigabit ethernet data system
- High Res. LCD displays

IRIDIUM and INMARSAT Satcom

- 9600 bps IRIDIUM
- 432kbps INMARSAT

Digital forward and Nadir video system

GRIP DC-8 Payload



Dropsondes
(Vertical Profiles of Temp, Press, Humidity and Winds)

CAPS, CVI, PIP
(Cloud Particle Size distributions, Precip Rate, Rain & Ice water content)

LASE
Lidar Atmospheric Sensing Experiment
(H2Ov, Aerosol profiles and Cloud distributions)

DAWN
Doppler Aerosol Wind Lidar
(Vertical Profiles of Vectored Horizontal Winds)

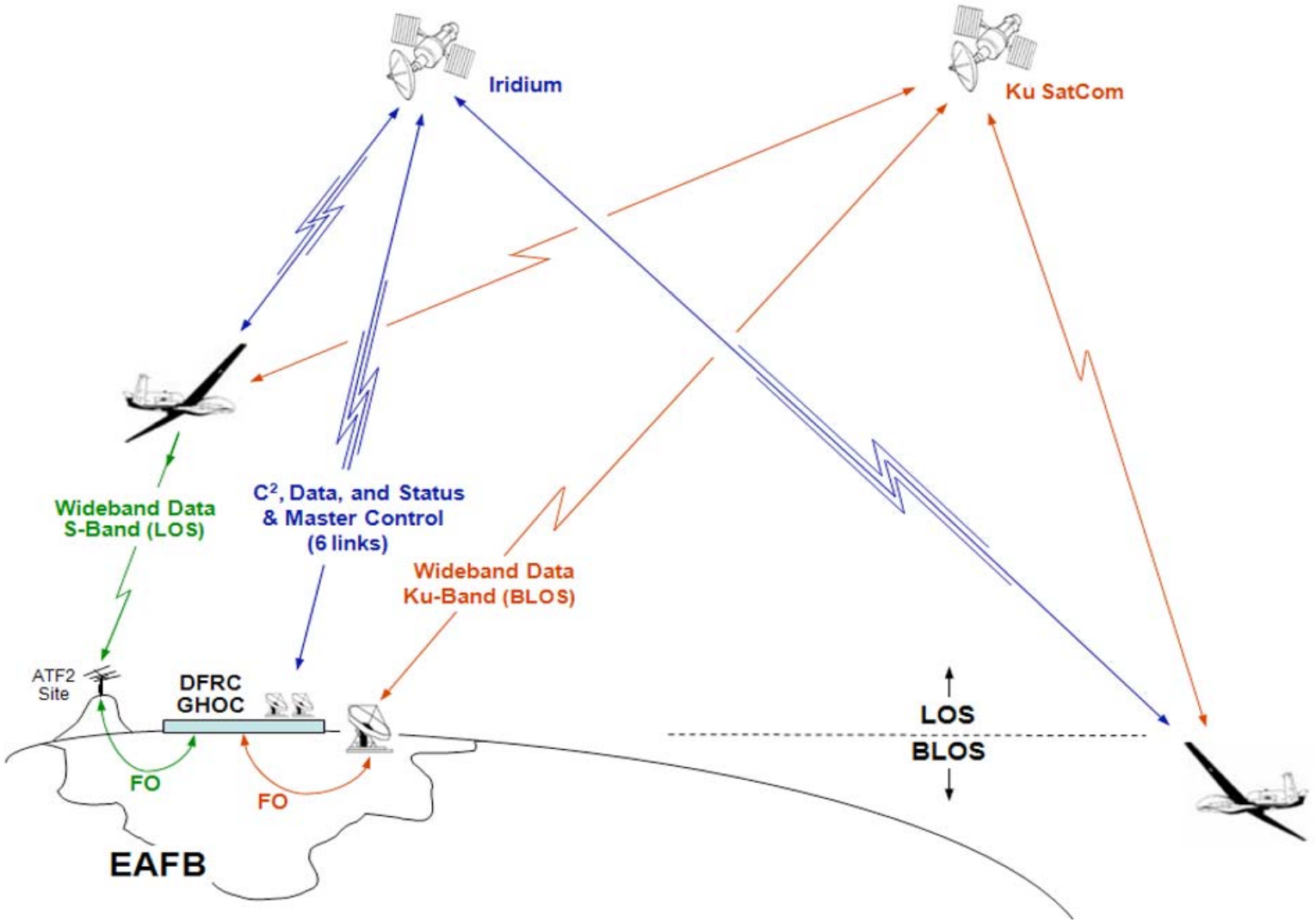
APR-2
Airborne Precipitation Radar Dual Frequency
(Vertical Structure Rain Reflectivity and Cross Winds)

MMS
Meteorological Measurement System
(Insitu Press, Temp, 3D Winds and Turbulence)

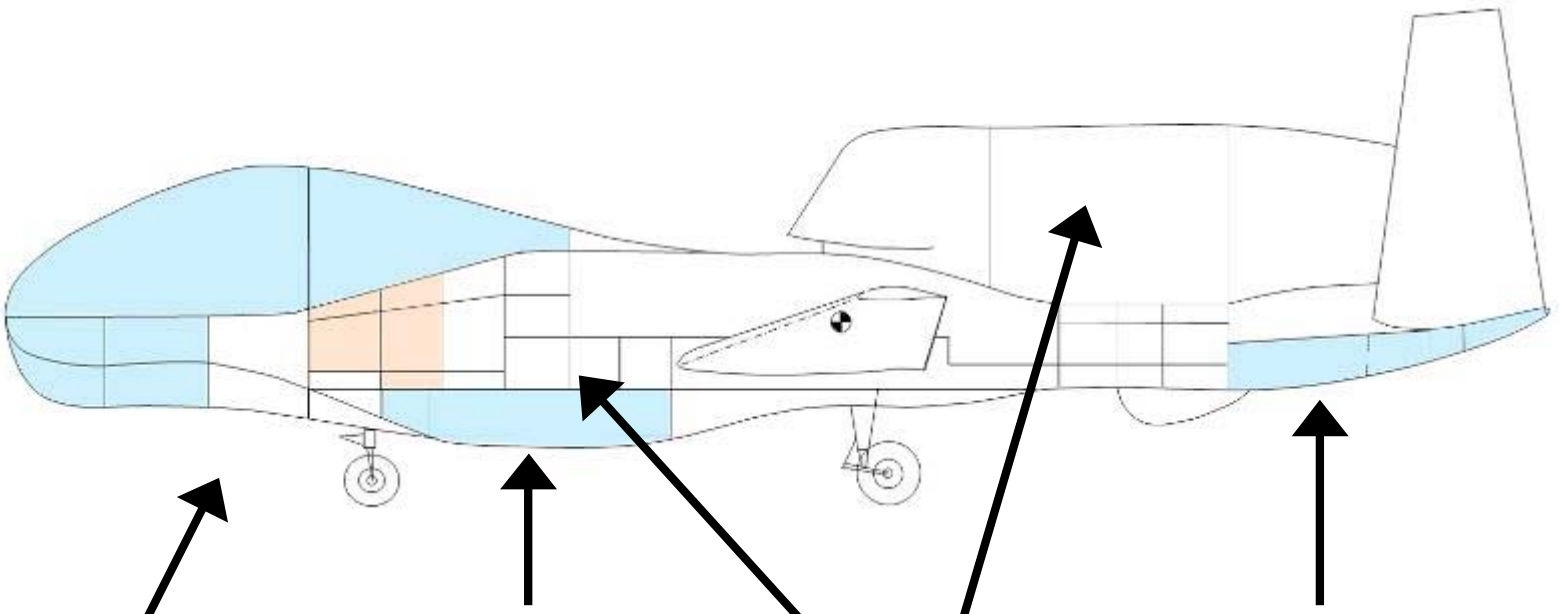
NASA Global Hawk 10/23/09

GHOC Flight Operations Room

GH UAS Communications



GRIP GH Payload



HAMSR
High Altitude MMIC Sounding Radiometer (Temp, H2Ov, Cloud liquid & ice distribution)

HIWRAP
High Altitude Imaging Wind and Rain Profiler (Horizontal wind vectors and ocean surface winds)

LIP
Lightning Instrument Package (Lightning and Electrical Storm observation)

Driftsondes
High Altitude Lightweight Dropsonde (Vertical profiles of temp, humidity, pressure & winds)

Pre-GRIP

April/May 2010

- Two test flights; 1 local in DFRC range and 1 24hr flight.

Test of Certificate of Authorization (COA) and Flight Information Regions (FIR) Process

- GH flight to the Gulf of Mexico, possibly Atlantic

Instruments on board

- HAMSR
- HIWRAP
- GH Wx Instruments
- LIP?

GH UAS Wx Hazard Mods

Install HD Camera in Aircraft Nose

- Low-Light / Visual / IR

Install Wx Severe Storm Instruments

- Storm-scope for lightening detection
- Data Link NexRad?

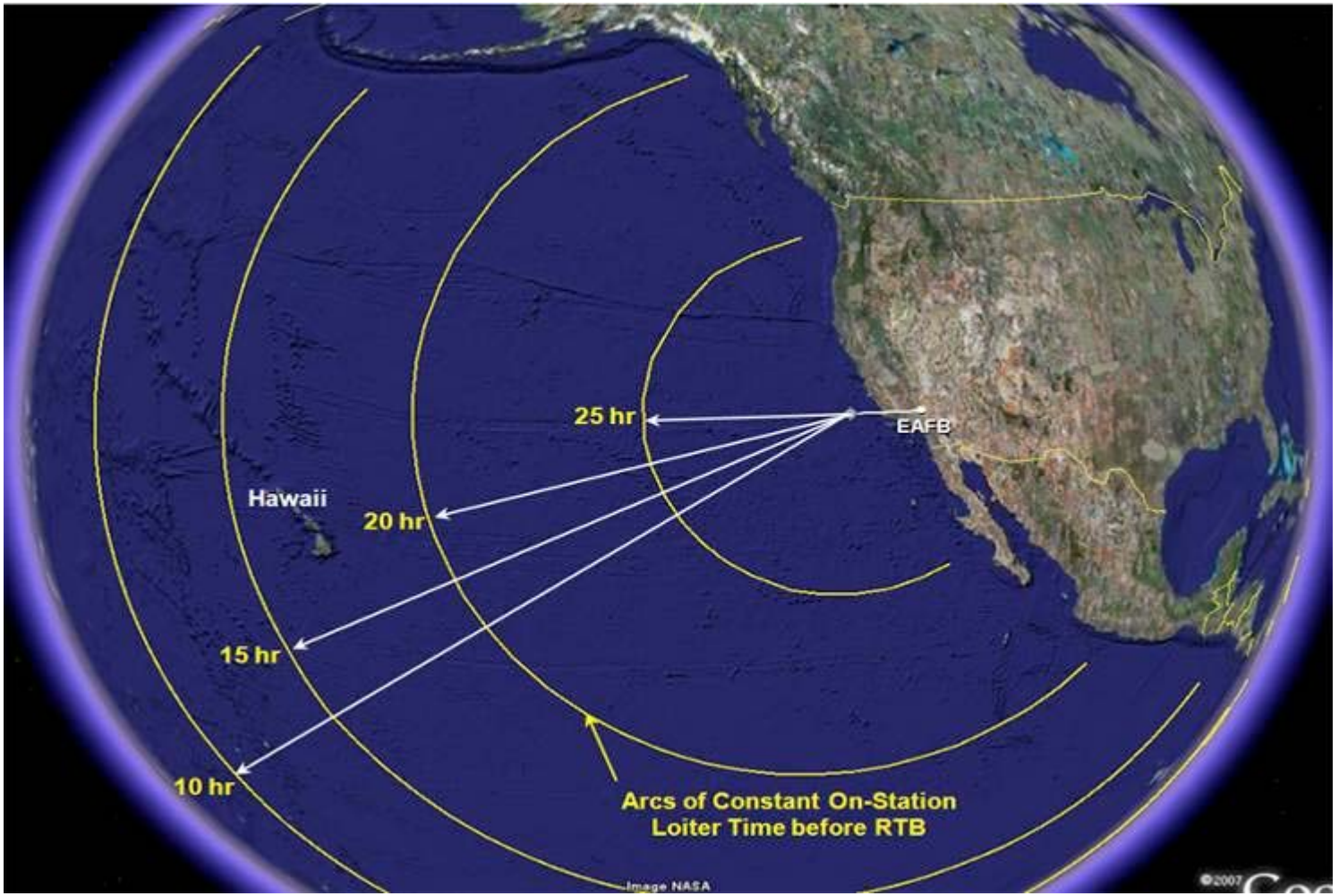
Install Turbulence Package

- Turbulence Sensor w/ Display

GRIP DC-8 Range from FLL

Loiter Capability from DFRC

East Pac Loiter Capability



GRIP Aircraft Platforms

Questions?

GRIP-IFEX-PREDICT DRY RUN

SEPTEMBER 2009

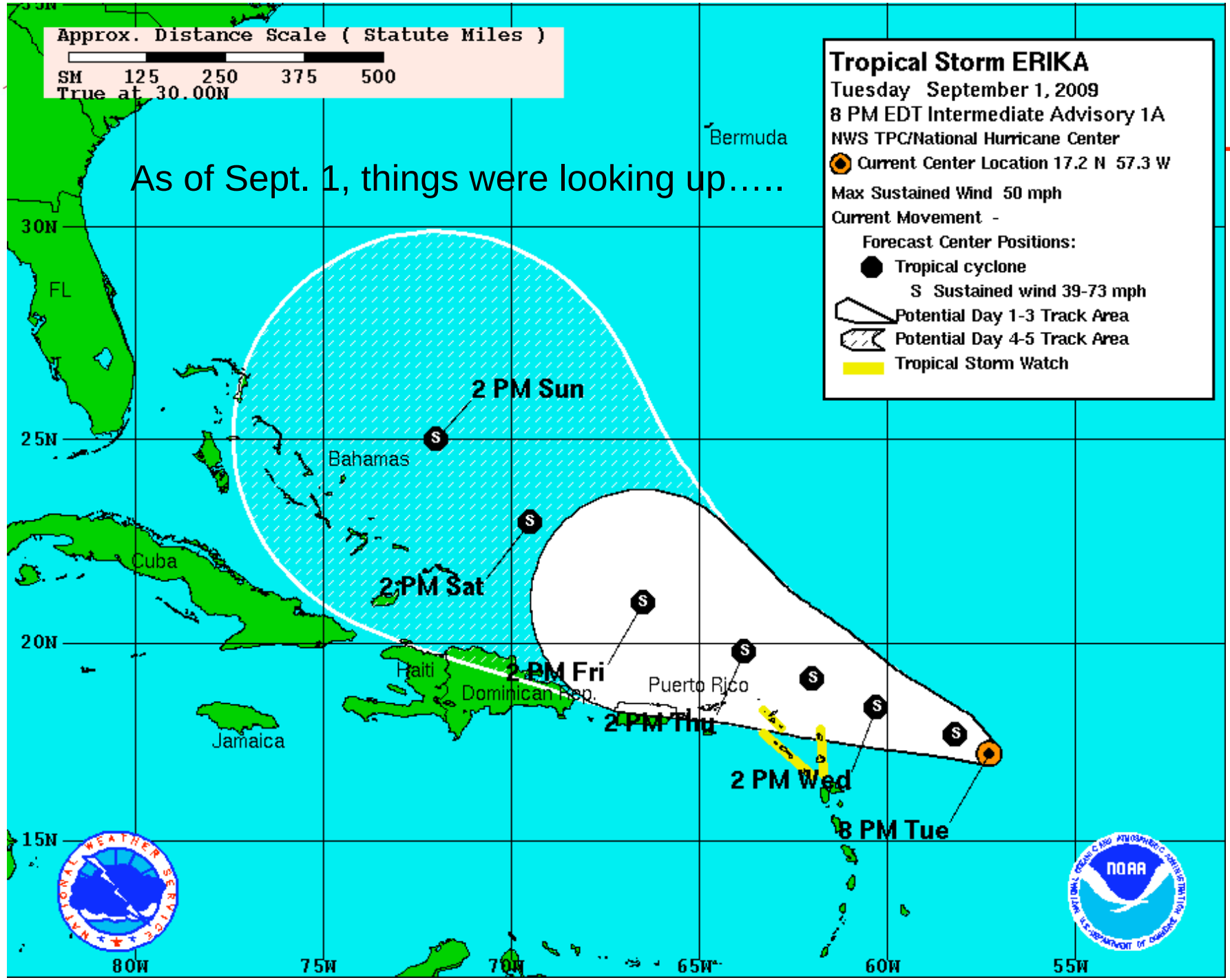
A few "lessons learned"

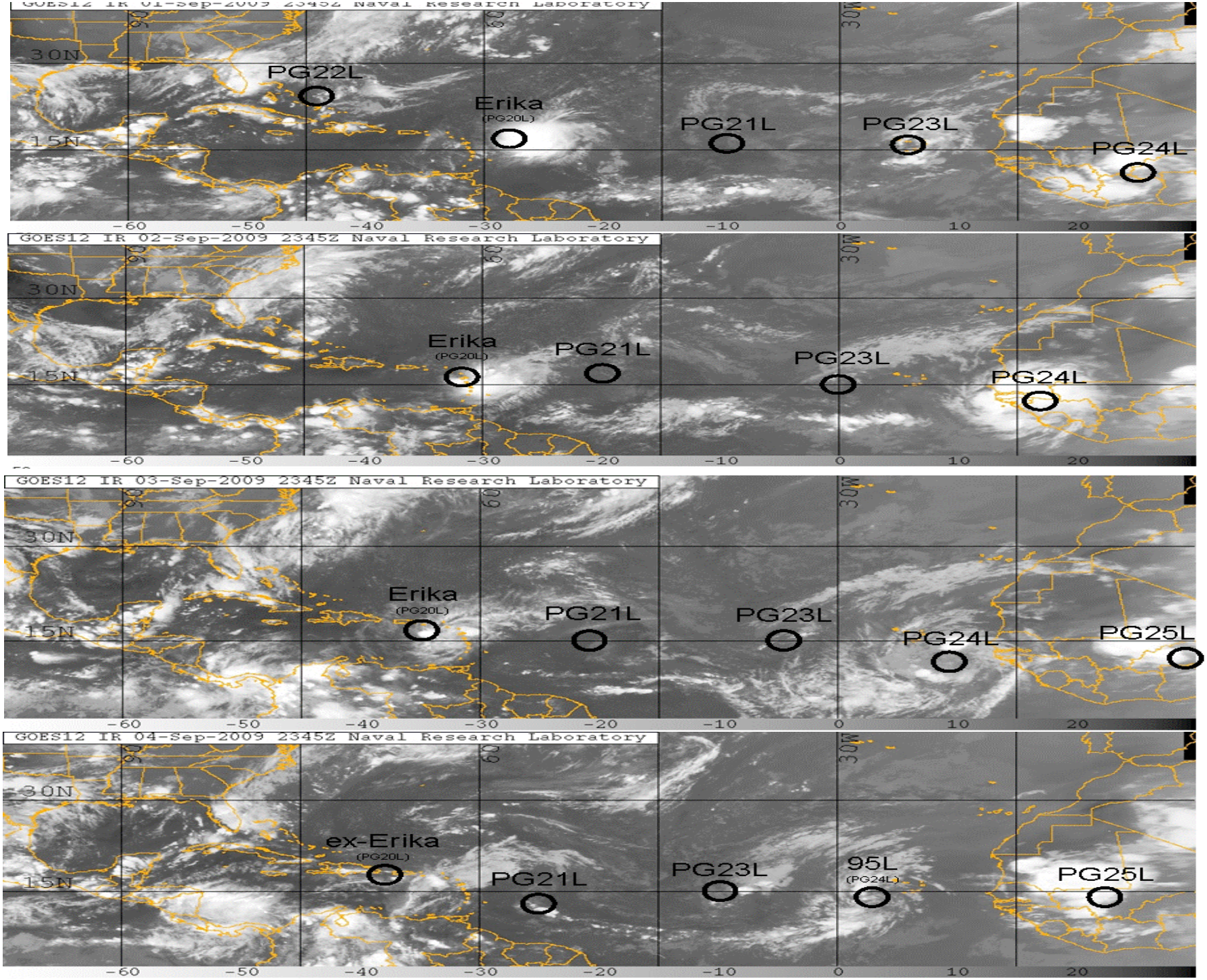
Ed Zipser and Gerry Heymsfield
(but any participant is welcome to chime in)

GRIP Dry Run Virtual Flight Hours

Probably contains some errors and omissions -- sorry about that.

Aircraft	Flights	Flight Hours
Global Hawk	8	231
Gulfstream-V	7	70
NASA DC-8	8	60
NOAA P3-42	4	30
NOAA P3-43	5	39


Approx. Distance Scale (Statute Miles)
SM 125 250 375 500
True at 30.00N
Tropical Storm ERIKA
Tuesday September 1, 2009
8 PM EDT Intermediate Advisory 1A
NWS TPC/National Hurricane Center
Current Center Location 17.2 N 57.3 W
Max Sustained Wind 50 mph
Current Movement -
Forecast Center Positions:
Tropical cyclone
S Sustained wind 39-73 mph
Potential Day 1-3 Track Area
Potential Day 4-5 Track Area
Tropical Storm Watch
As of Sept. 1, things were looking up…..
Bermuda
30N
FL
25N
Bahamas
2 PM Sun
Cuba
2 PM Sat
20N
Haiti
Dominican Rep.
2 PM Fri
Puerto Rico
2 PM Thu
Jamaica
2 PM Wed
8 PM Tue
15N
80W
75W
70W
65W
60W
55W
NOAA


GOES12 IR 01-Sep-2009 2345Z Naval Research Laboratory
30N
15N
PG22L
Erika
(PG20L)
PG21L
PG23L
PG24L
-60
-50
-40
-30
-20
-10
0
10
20
GOES12 IR 02-Sep-2009 2345Z Naval Research Laboratory
30N
15N
Erika
(PG20L)
PG21L
PG23L
PG24L
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-30
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-10
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GOES12 IR 03-Sep-2009 2345Z Naval Research Laboratory
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Erika
(PG20L)
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PG23L
PG24L
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GOES12 IR 04-Sep-2009 2345Z Naval Research Laboratory
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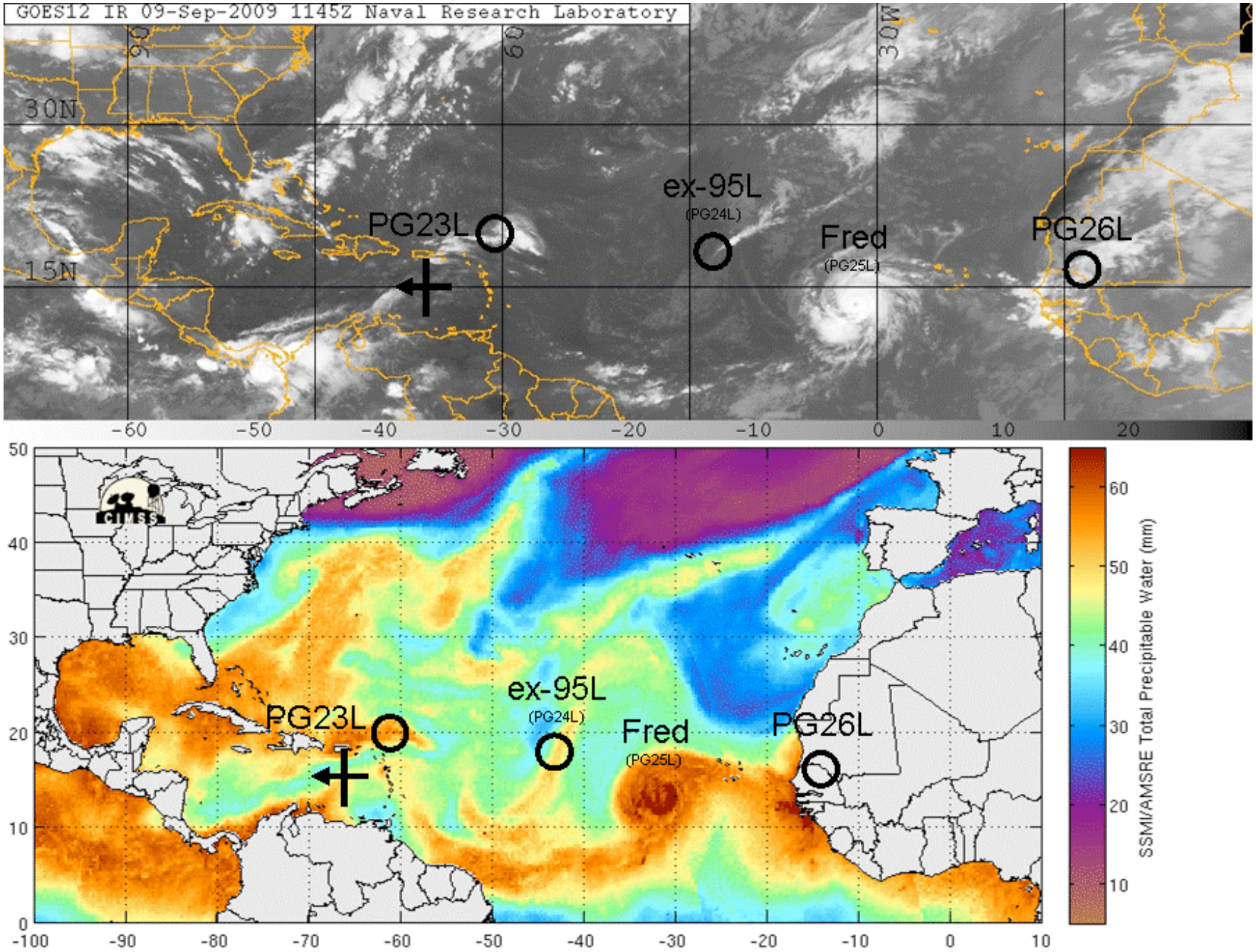
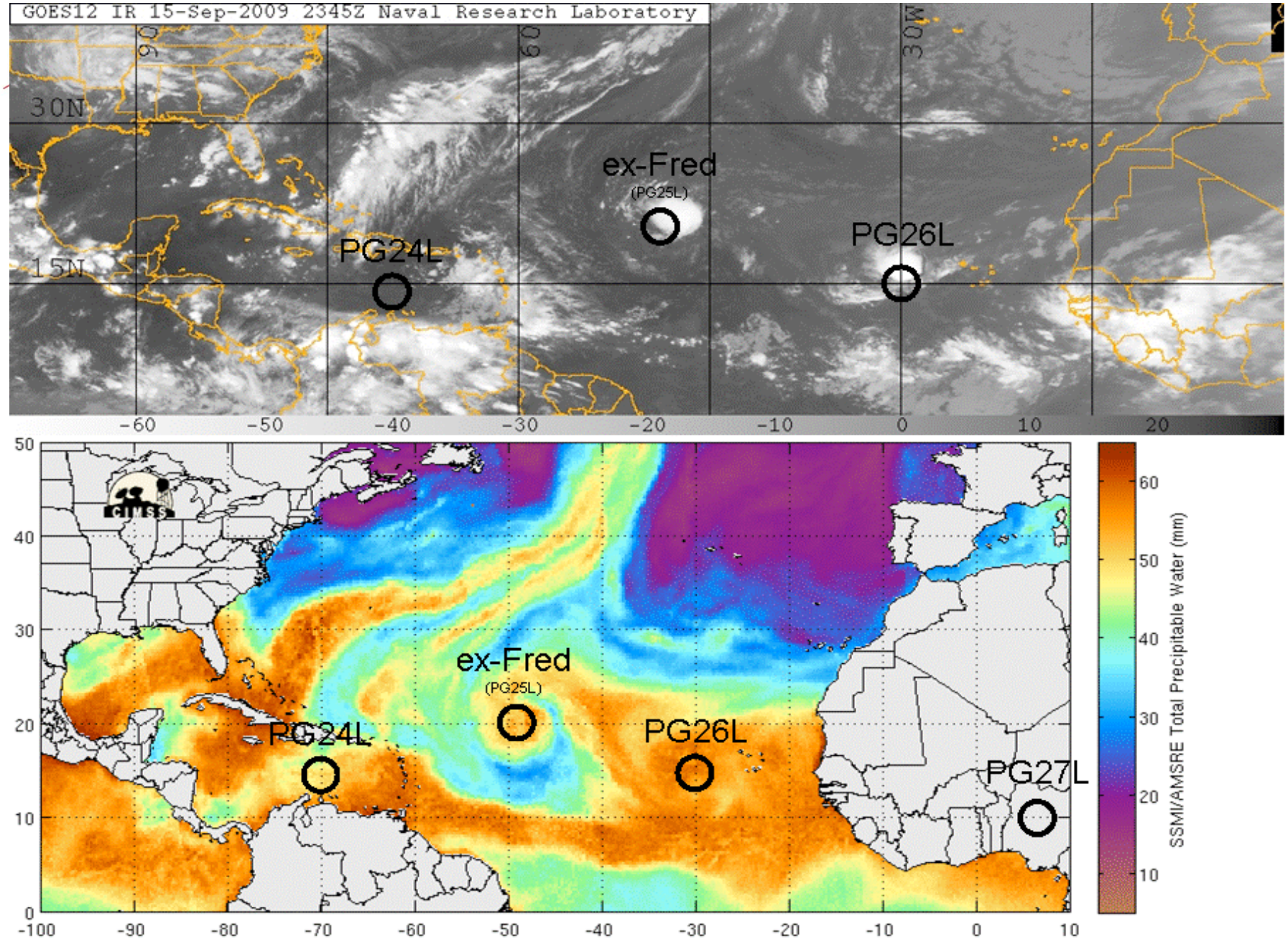
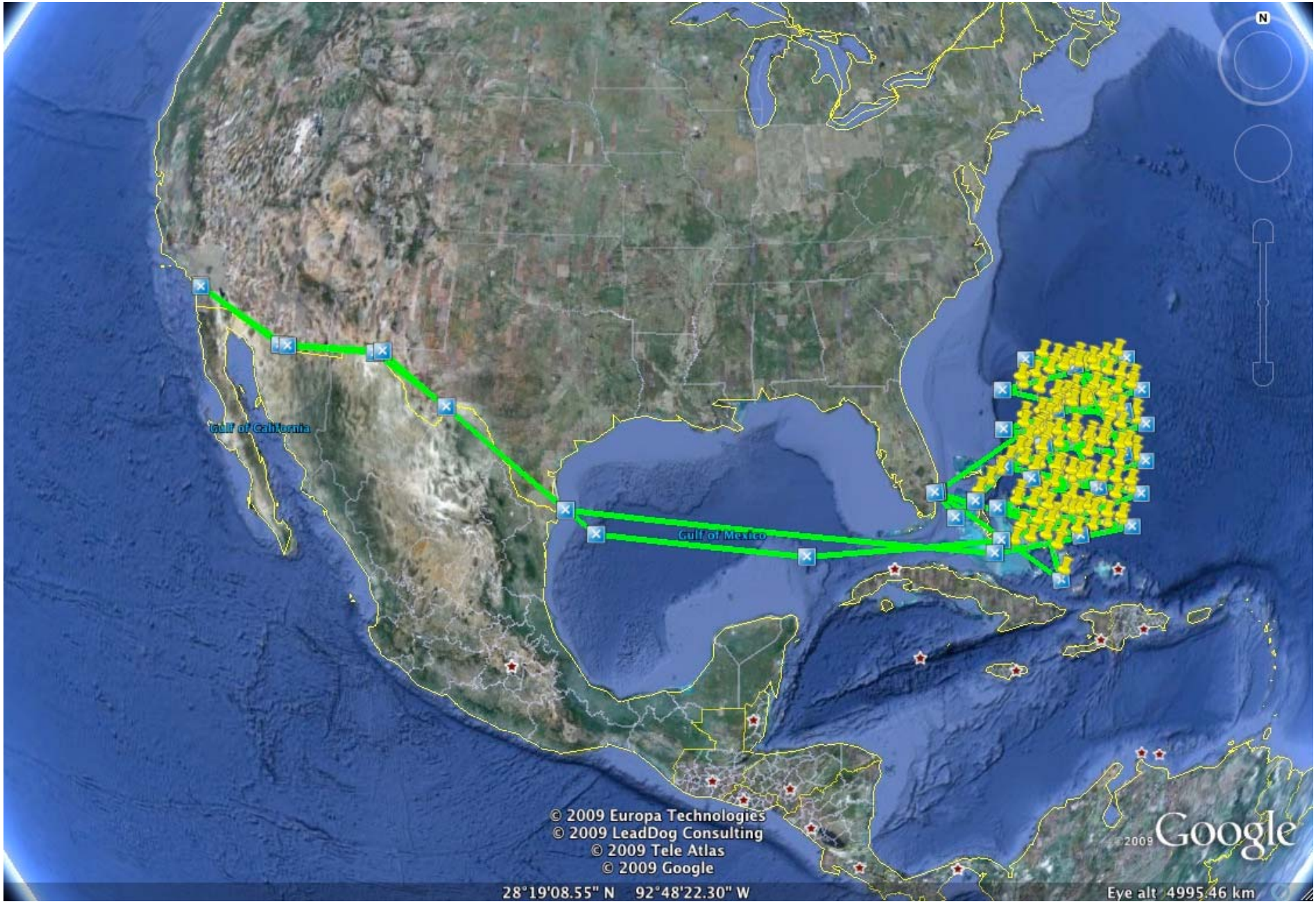
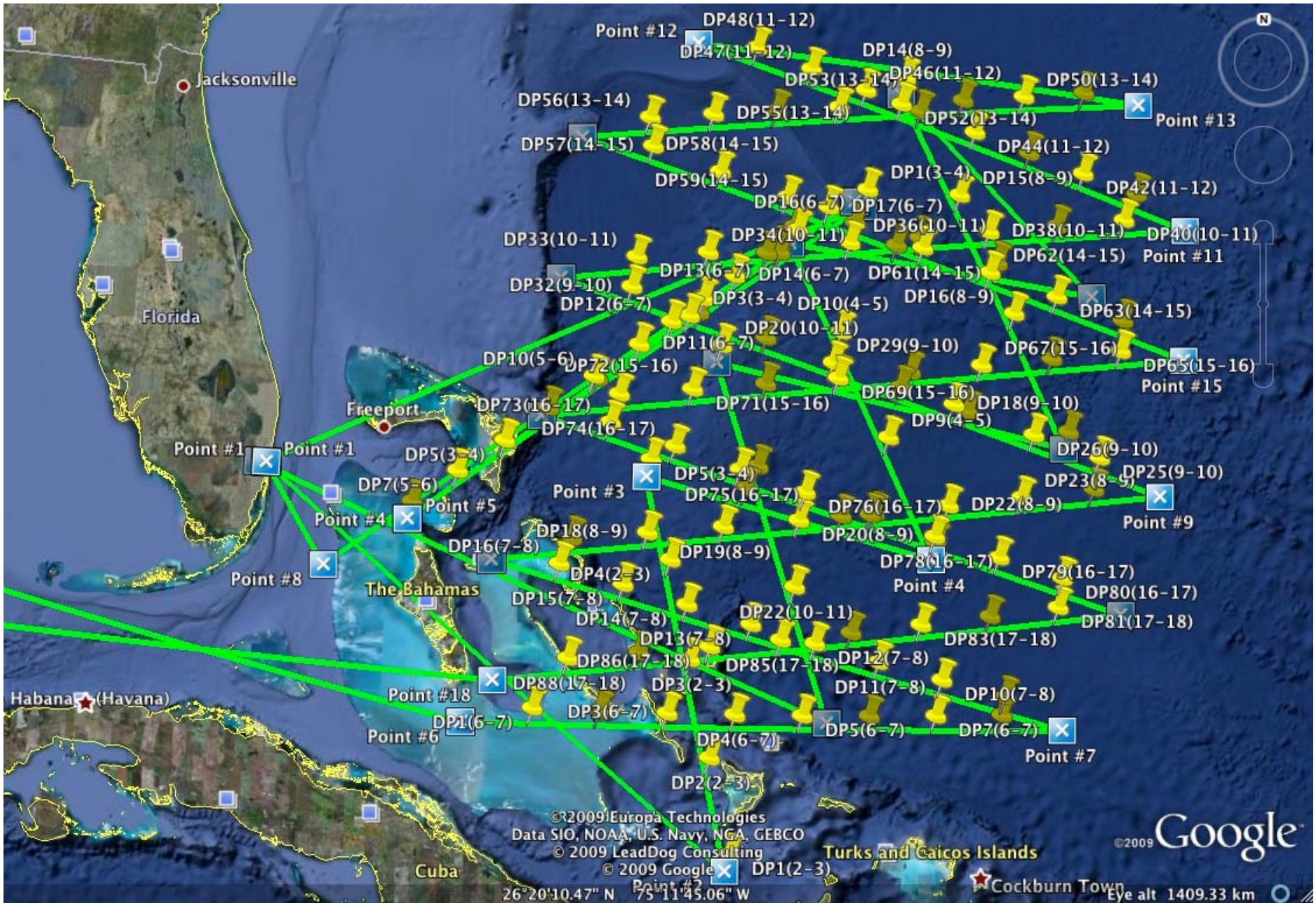


But by Sept. 10, after one flight into the dying Erica, PG23L was all there was…



On Sept 16, only the baroclinic system near the Bahamas and ex-Fred are within range….PG26L?


N
Gulf of California
Gulf of Mexico
© 2009 Europa Technologies
© 2009 LeadDog Consulting
© 2009 Tele Atlas
© 2009 Google
2009 Google
28°19'08.55" N 92°48'22.30" W
Eye alt 4995.46 km


Jacksonville
Florida
Freeport
The Bahamas
Habana (Havana)
Cuba
Turks and Caicos Islands
Cockburn Town
Point #1
Point #2
Point #3
Point #4
Point #5
Point #6
Point #7
Point #8
Point #9
Point #11
Point #12
Point #13
Point #15
Point #18
DP48(11-12)
DP47(11-12)
DP14(8-9)
DP46(11-12)
DP53(13-14)
DP50(13-14)
DP56(13-14)
DP55(13-14)
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DP15(8-9)
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DP14(7-8)
DP22(10-11)
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DP3(6-7)
DP1(6-7)
DP5(6-7)
DP7(6-7)
DP4(6-7)
DP2(2-3)
DP1(2-3)
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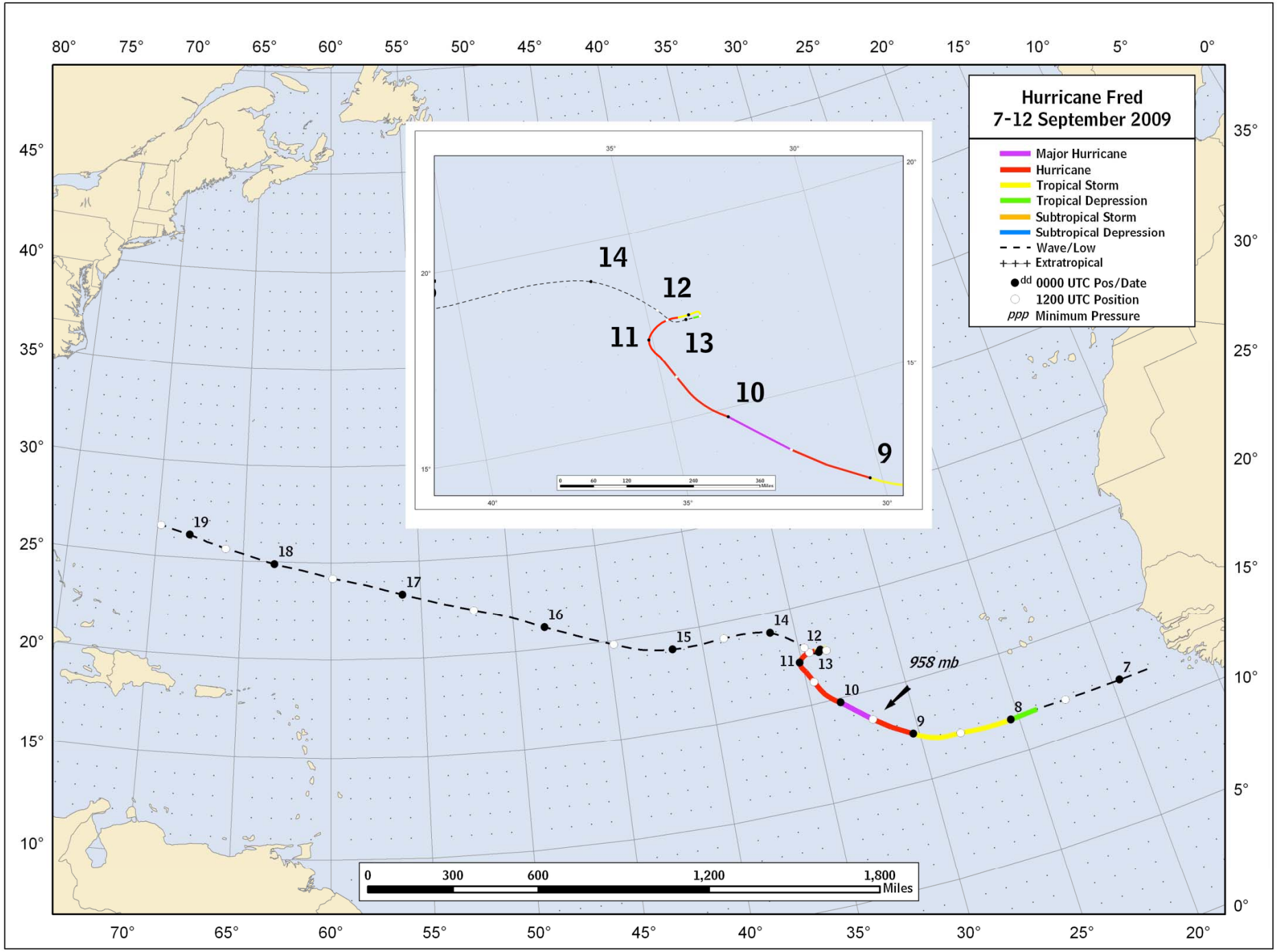
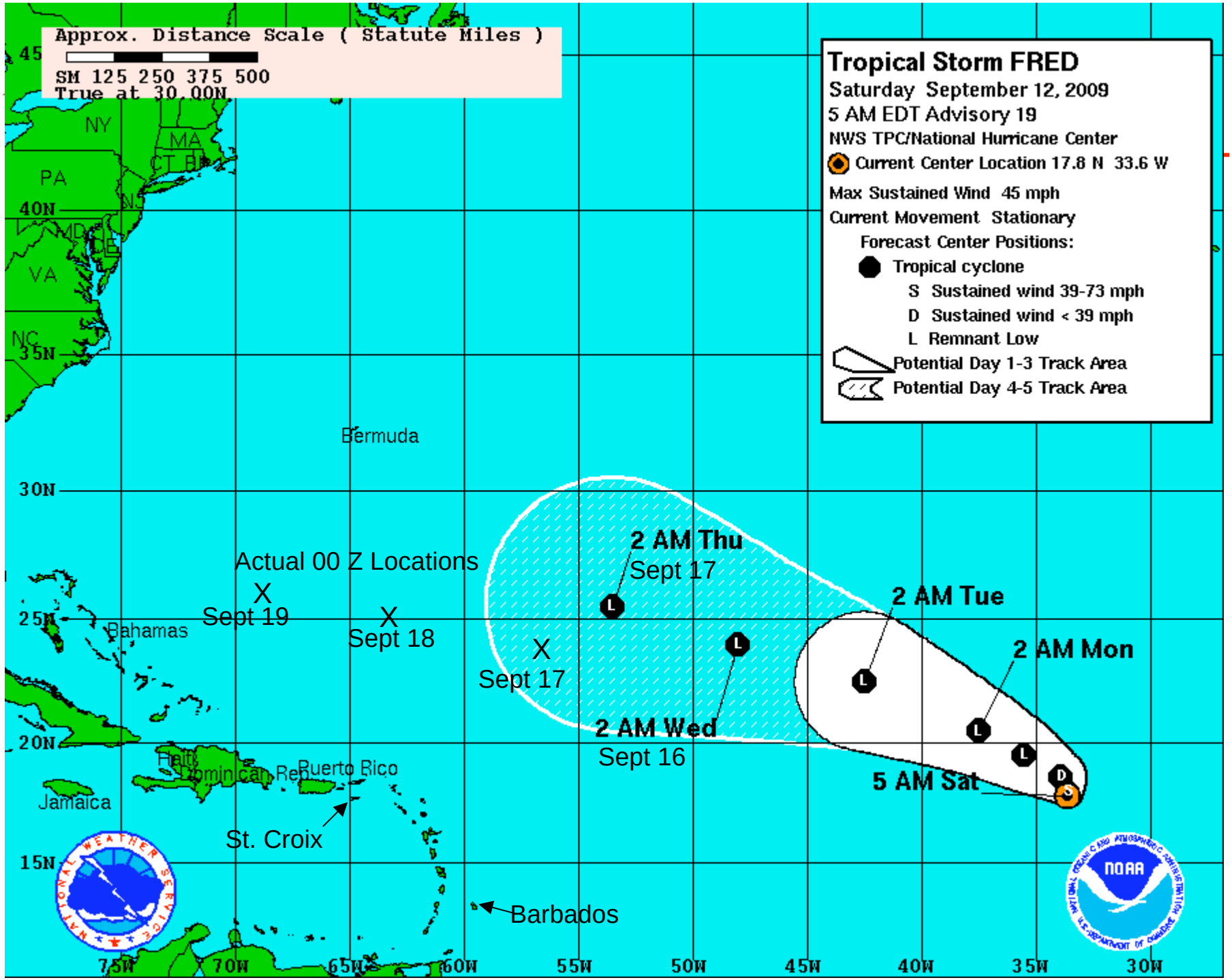
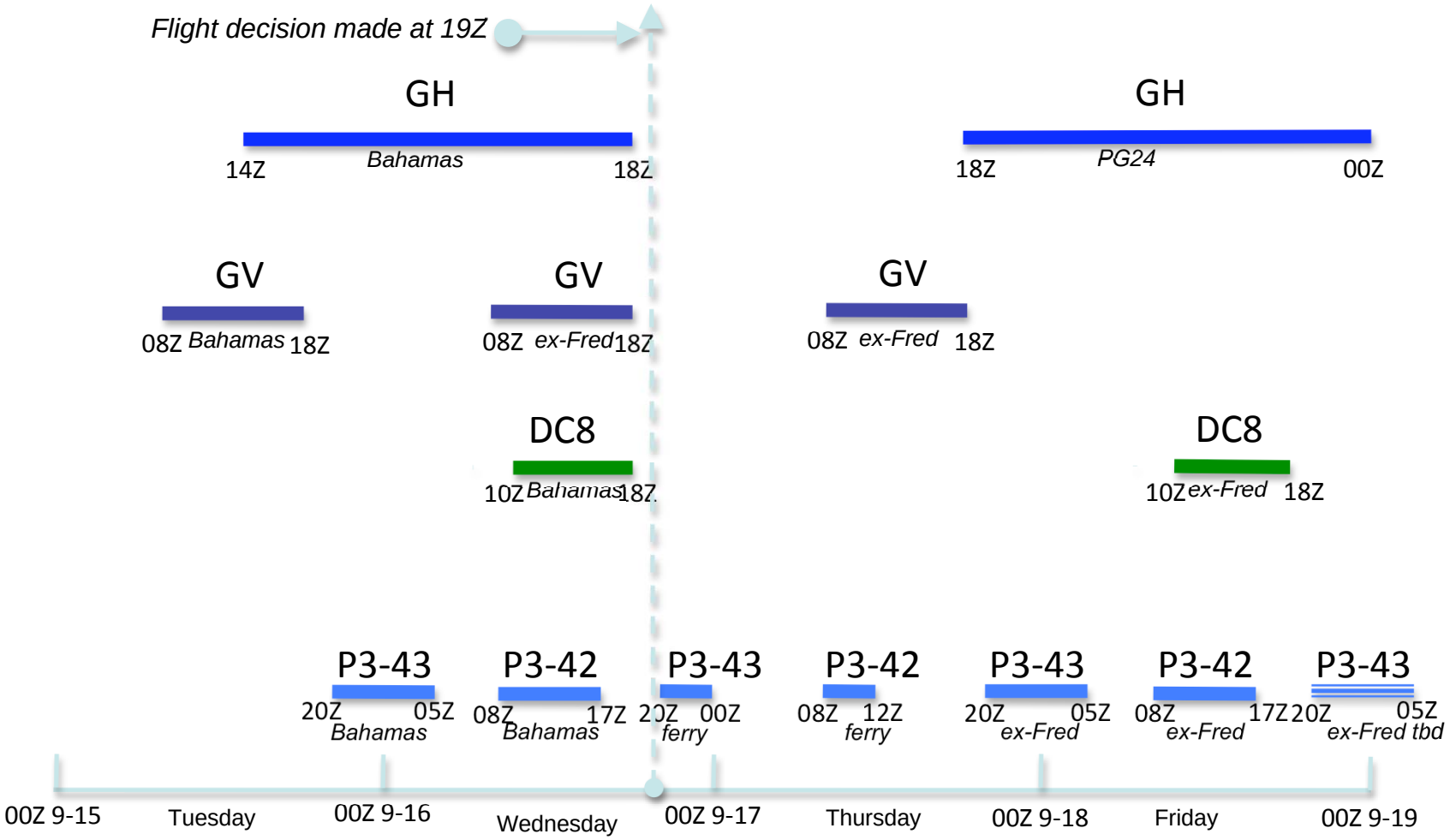
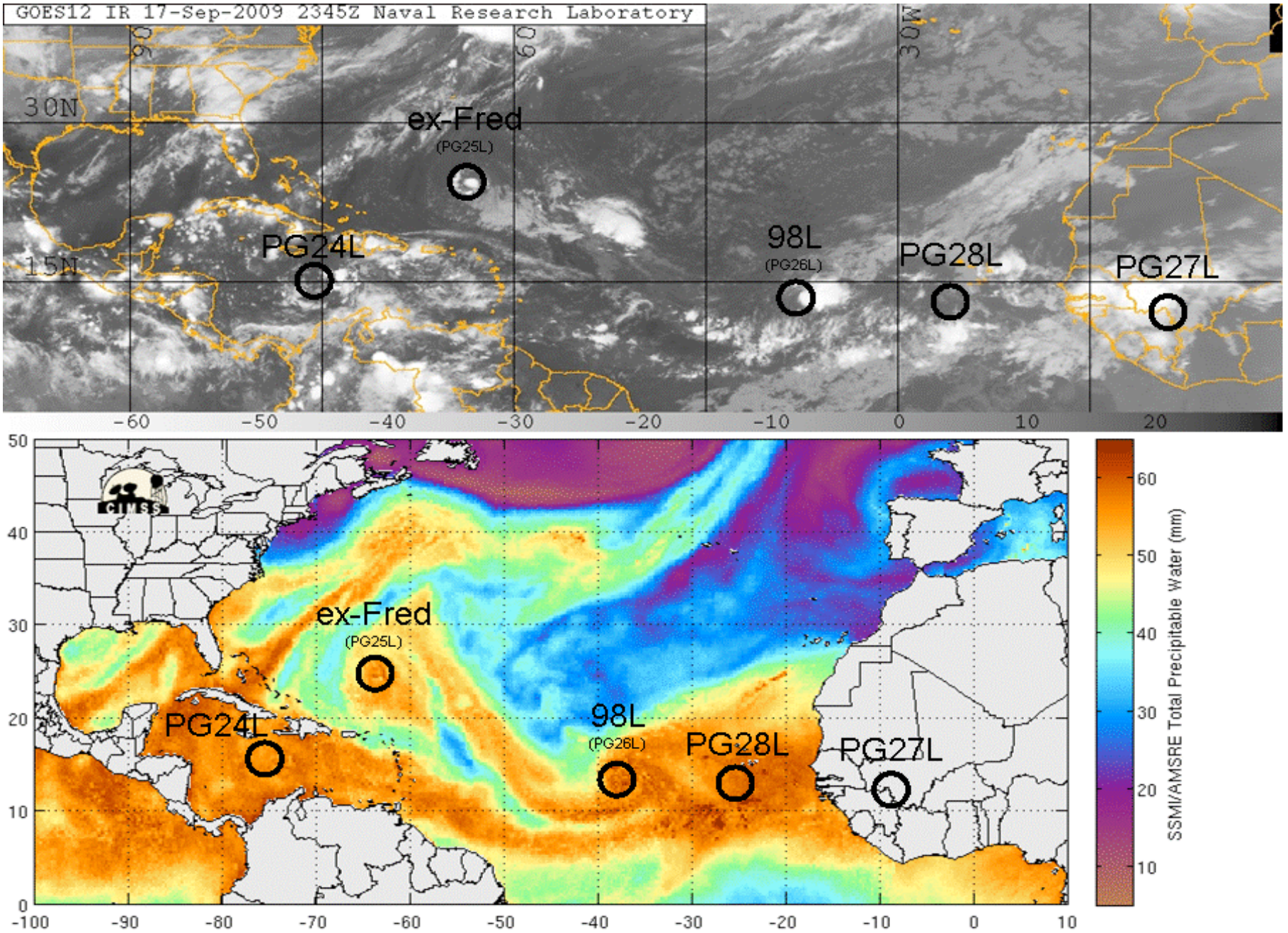
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2009 LeadDog Consulting
© 2009 Google
©2009 Google
26°20'10.47" N 75°11'45.06" W
Eye alt 1409.33 km
N


Hurricane Fred
7-12 September 2009
Major Hurricane
Hurricane
Tropical Storm
Tropical Depression
Subtropical Storm
Subtropical Depression
Wave/Low
Extratropical
dd 0000 UTC Pos/Date
1200 UTC Position
ppp Minimum Pressure
958 mb
0 300 600 1,200 1,800 Miles


Approx. Distance Scale (Statute Miles)
SM 125 250 375 500
True at 30.00N
Tropical Storm FRED
Saturday September 12, 2009
5 AM EDT Advisory 19
NWS TPC/National Hurricane Center
Current Center Location 17.8 N 33.6 W
Max Sustained Wind 45 mph
Current Movement Stationary
Forecast Center Positions:
Tropical cyclone
S Sustained wind 39-73 mph
D Sustained wind < 39 mph
L Remnant Low
Potential Day 1-3 Track Area
Potential Day 4-5 Track Area
NY
MA
CT
RI
PA
NJ
MD
DE
VA
NC
40N
35N
30N
25N
20N
15N
75W
70W
65W
60W
55W
50W
45W
40W
35W
30W
Bermuda
Bahamas
Haiti
Dominican Rep.
Puerto Rico
Jamaica
St. Croix
Barbados
Actual 00 Z Locations
X
Sept 19
X
Sept 18
X
Sept 17
2 AM Thu
Sept 17
2 AM Wed
Sept 16
2 AM Tue
2 AM Mon
5 AM Sat
NOAA

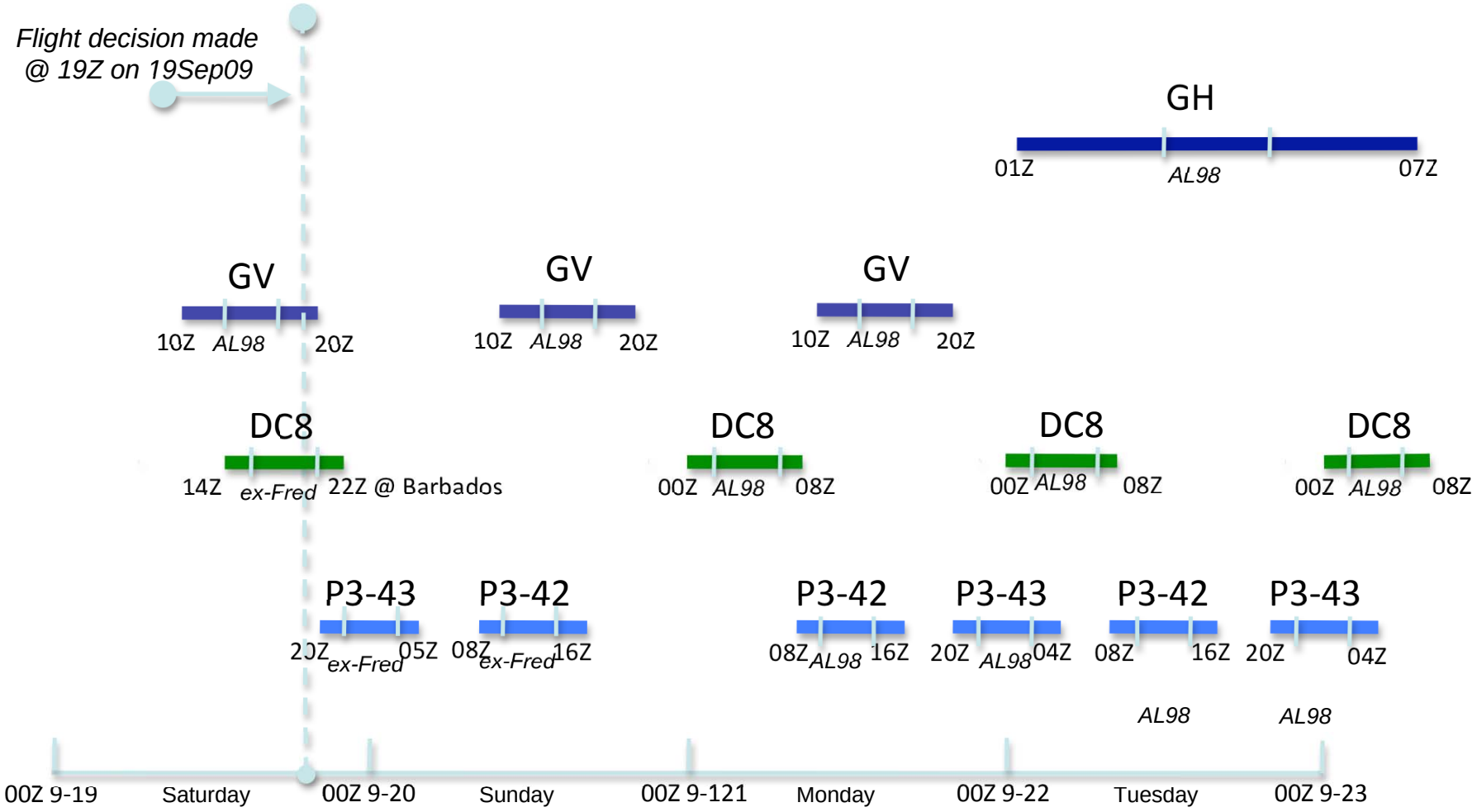
GRIP Dry Run All Aircraft Schedule
15-19 September 2009
Version: 16Sep09

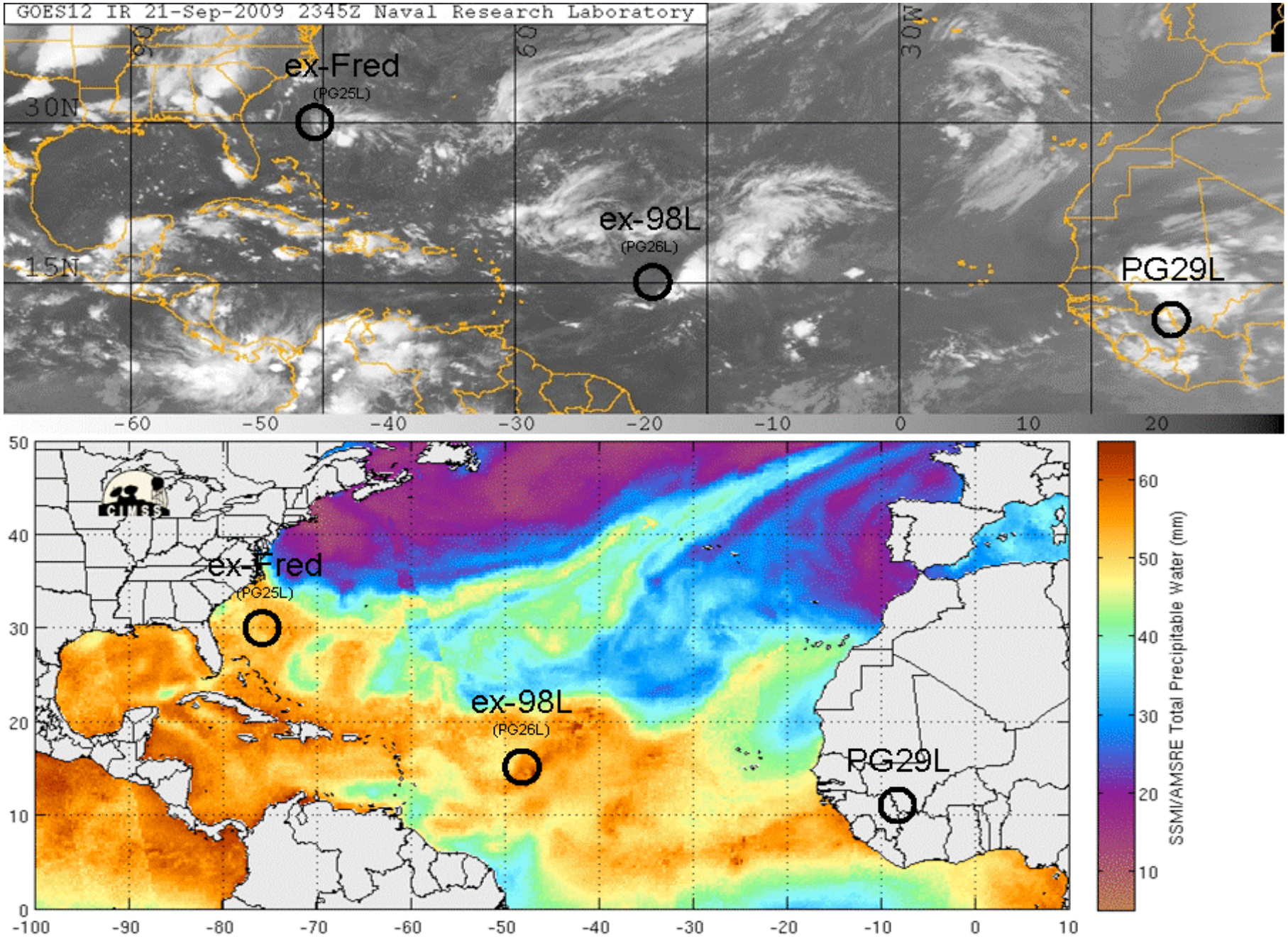




Sept 18: We are losing interest in ex-Fred; and PG26 (now 98L) is barely within reach

GRIP Dry Run All Aircraft Schedule
19-23 September 2009
Version: 19Sep09





Sept 22: Somehow, ex-Fred still lives, but ex-98L (ex-PG26) looks hopeless. What to do?

What happened next?

- AL98 never moved within easy range, and never became “interesting”. It was the only target, so we flew it for several days anyway.
- No new potential development areas moved into range for any aircraft.
- Without any viable targets in the Atlantic basin, the dry run team decided to task the Global Hawk to investigate several systems in the EASTPAC, including 2 flights into Nora

A few “lessons learned” from the Dry Run

- PREDICT, IFEX, and NASA PIs had excellent collaboration, working out flight plans to maximize temporal coverage. *Daily communication essential!*
- Geographical separation tolerable with *good internet, web tools, and telephone communication!*
- In good years or bad years, once a suitable target appears, jump on it. Prepare for back-to-back flights for about 3 days. Double-crewing likely for scientists and forecasters, not just for aircraft people.
- Suitcase flights for the DC-8 should be in the arsenal, but be aware that once committed, other opportunities can be lost.
- The worst enemy of a good plan is a better plan.
- Think outside the box: East Pacific? Mexico base?


NASA


NASA


NASA