

NASA GRIP 2010

Overview of research flights

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on behalf of the Science Team

What did we do during hurricane season 2010?

- NSF/NCAR PREDICT (PRE-Depression Investigation of Cloud Systems of the Tropics)
- NASA GRIP (Genesis and Rapid Intensification Processes)
- NOAA IFEX (Intensity Forecasting Experiment)

GOALS: Remarkably Similar.....*Not a coincidence!*



Mission and Science Overview: Summary of GRIP Science Objectives



- **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.



Scientific Accomplishments

- Tropical cyclone genesis
 - Tropical Storm Gaston—null case for development
 - Hurricane Karl—unprecedented multiday coverage from first detection through genesis
- Rapid Intensification
 - Hurricane Earl—documentation of rapid intensification as well as weakening stage of a previously large Category 4 storm
 - Hurricane Karl—observations of rapid intensification from storm stage to Category 3 and landfall

Aircraft Hours in GRIP



Storm	GH	DC-8	WB-57	NOAA	NSF	AF
Frank	15.3	0	0	N	N	N
Earl	24.2	39.3	10.9	Y	Y	Y
Gaston	0	14.5	0	N	Y	N
Karl	48.5	40.2	17.5	Y	Y	Y
Matthew	25.1	17.8	0	Y	Y	Y
Other Sci	0	12.2	0	NA	NA	NA
Transit/test flights	8.6	14.9	0	NA	NA	NA
TOTAL	121.7	138.9	28.4			

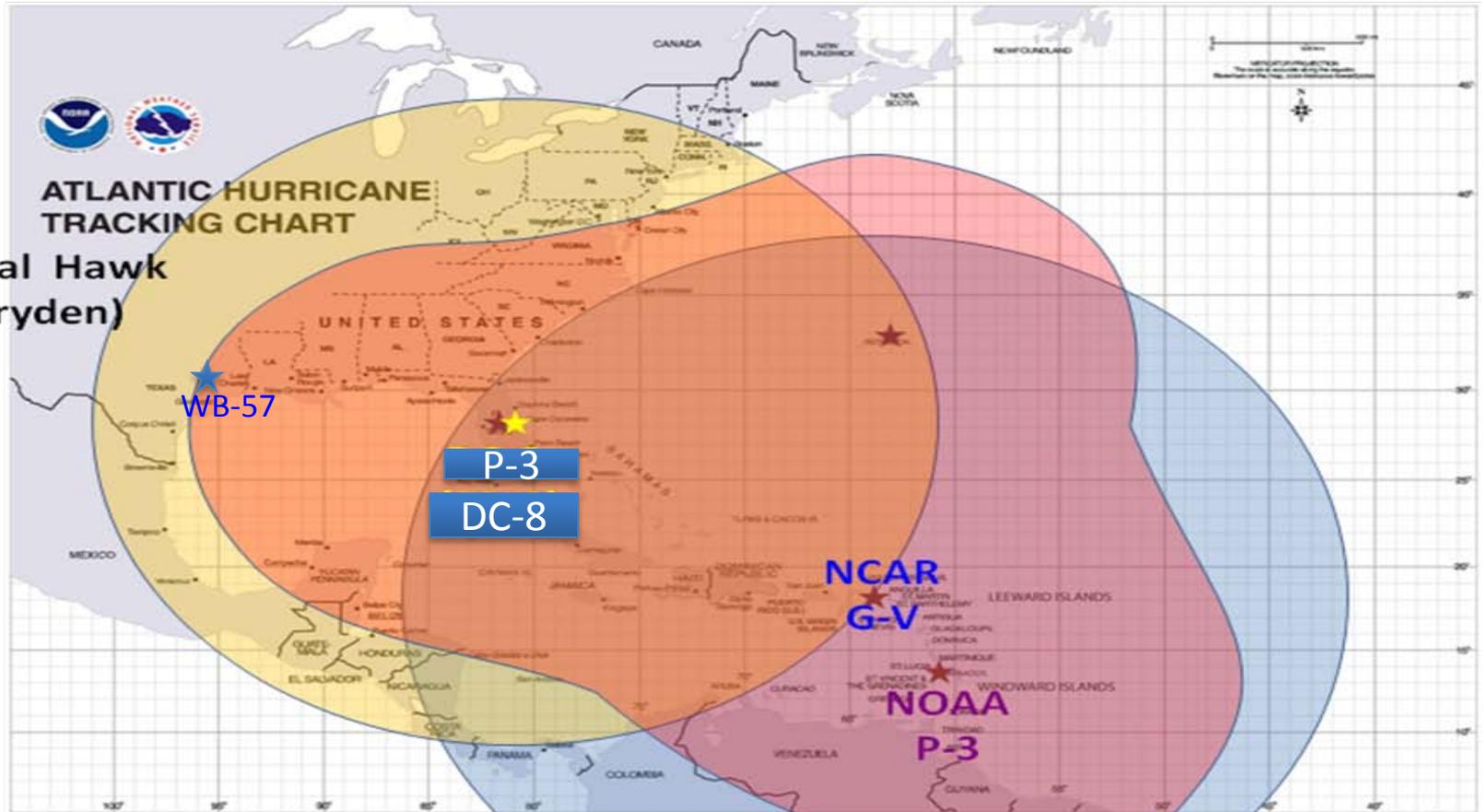


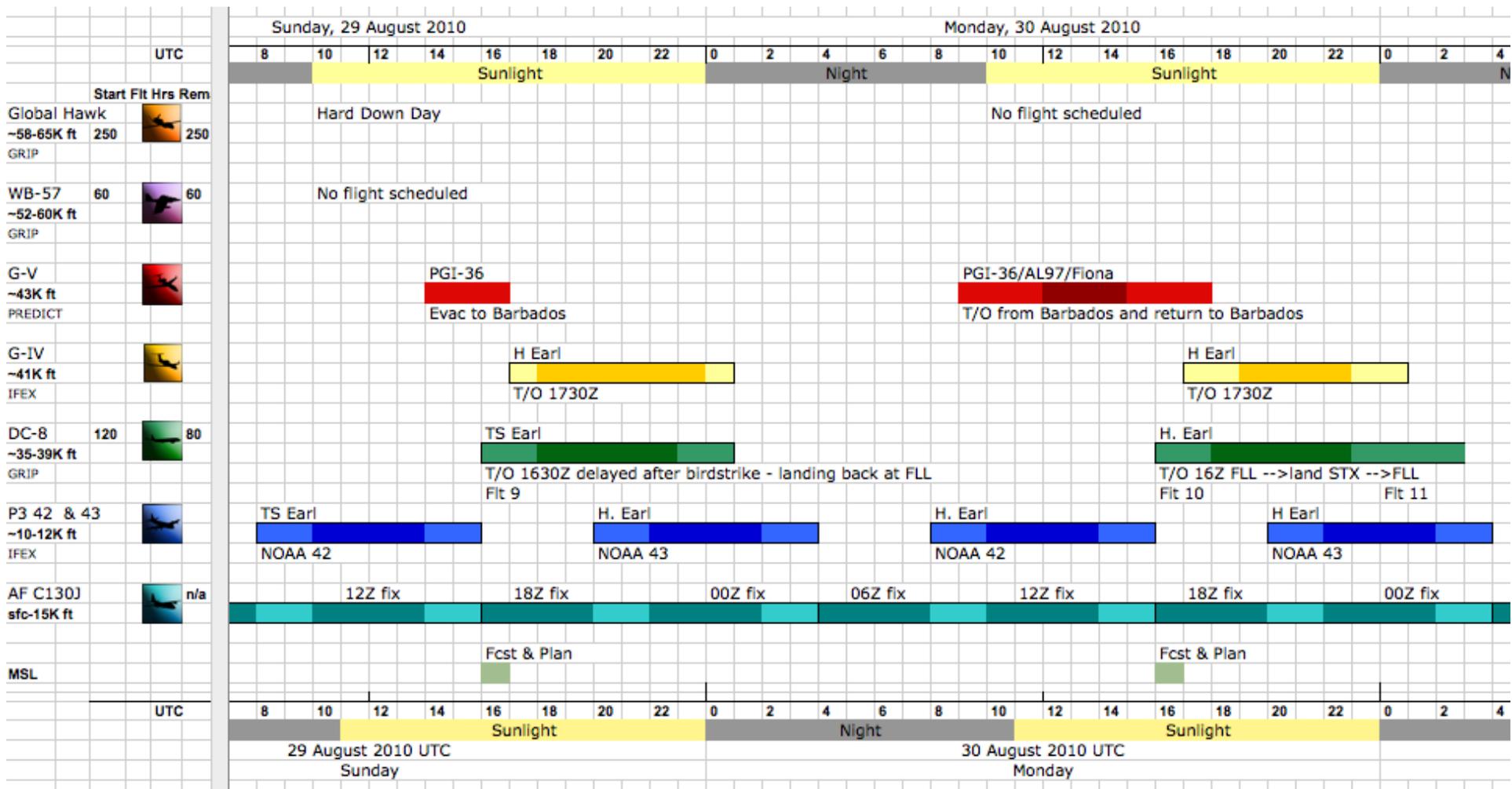
GRIP Hurricane Mission

Genesis and Rapid Intensification Processes



PREDICT/GRIP/IFEX Domains

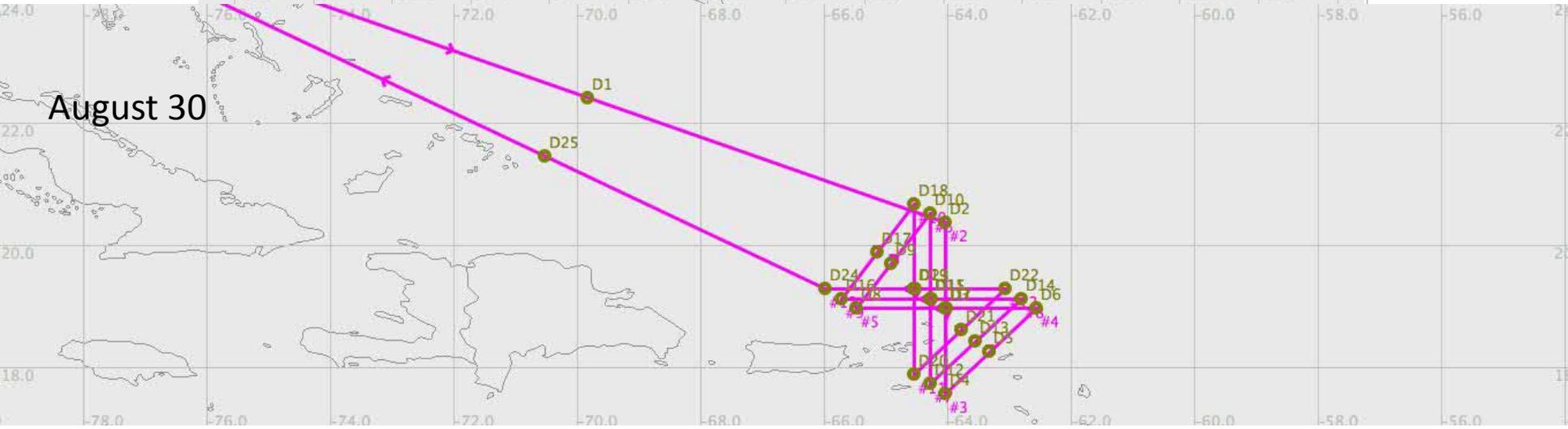
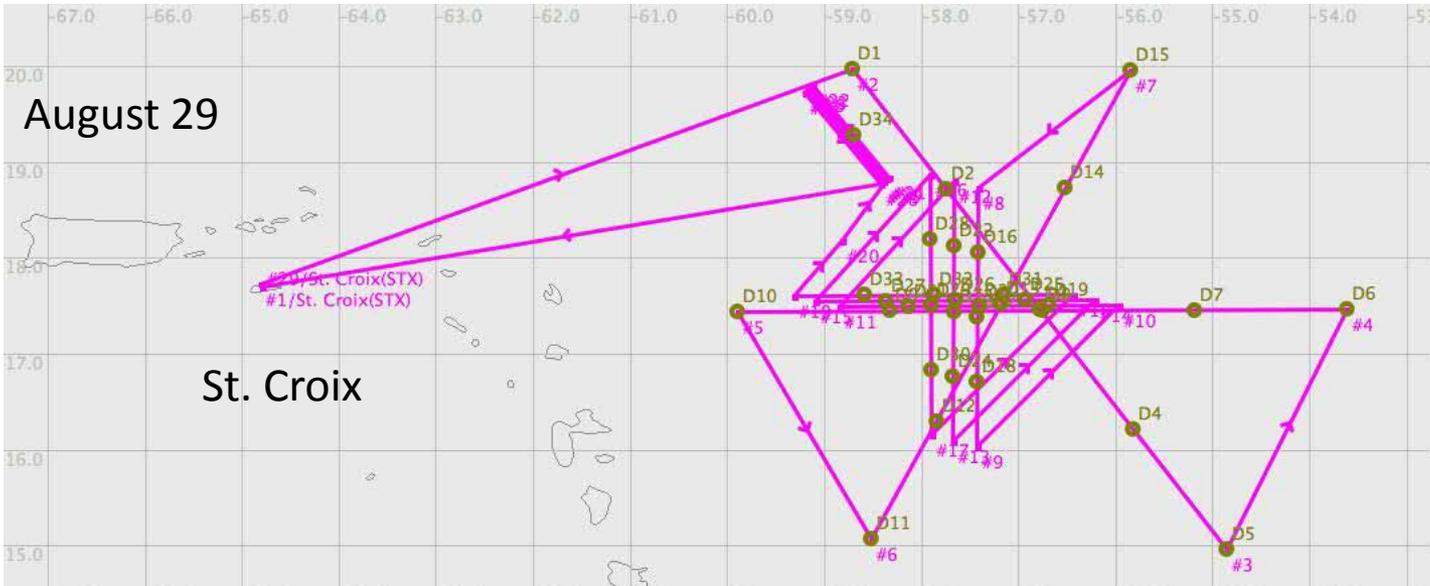


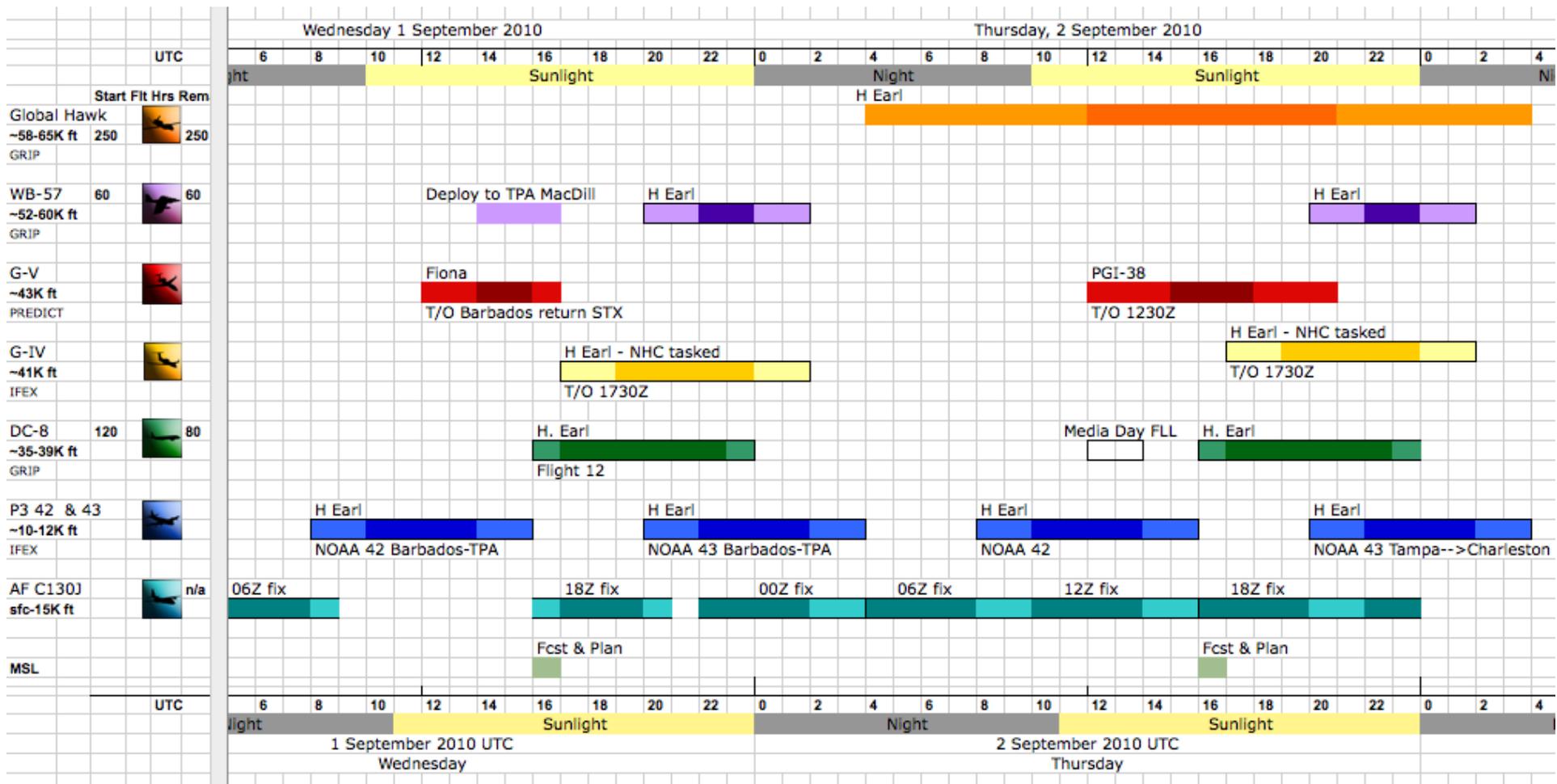


All flights into Earl during rapid intensification, 29-31 August 2010



Hurricane Earl Flights August 29-30

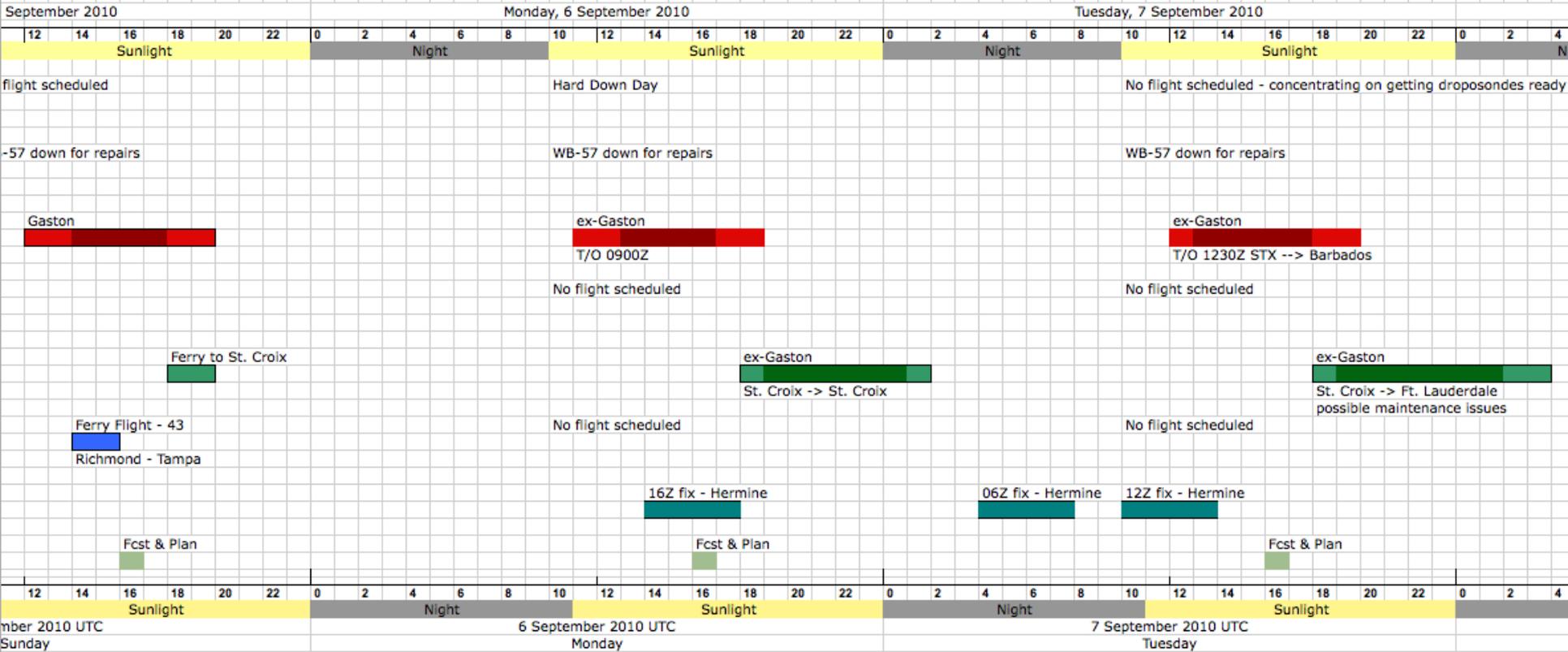




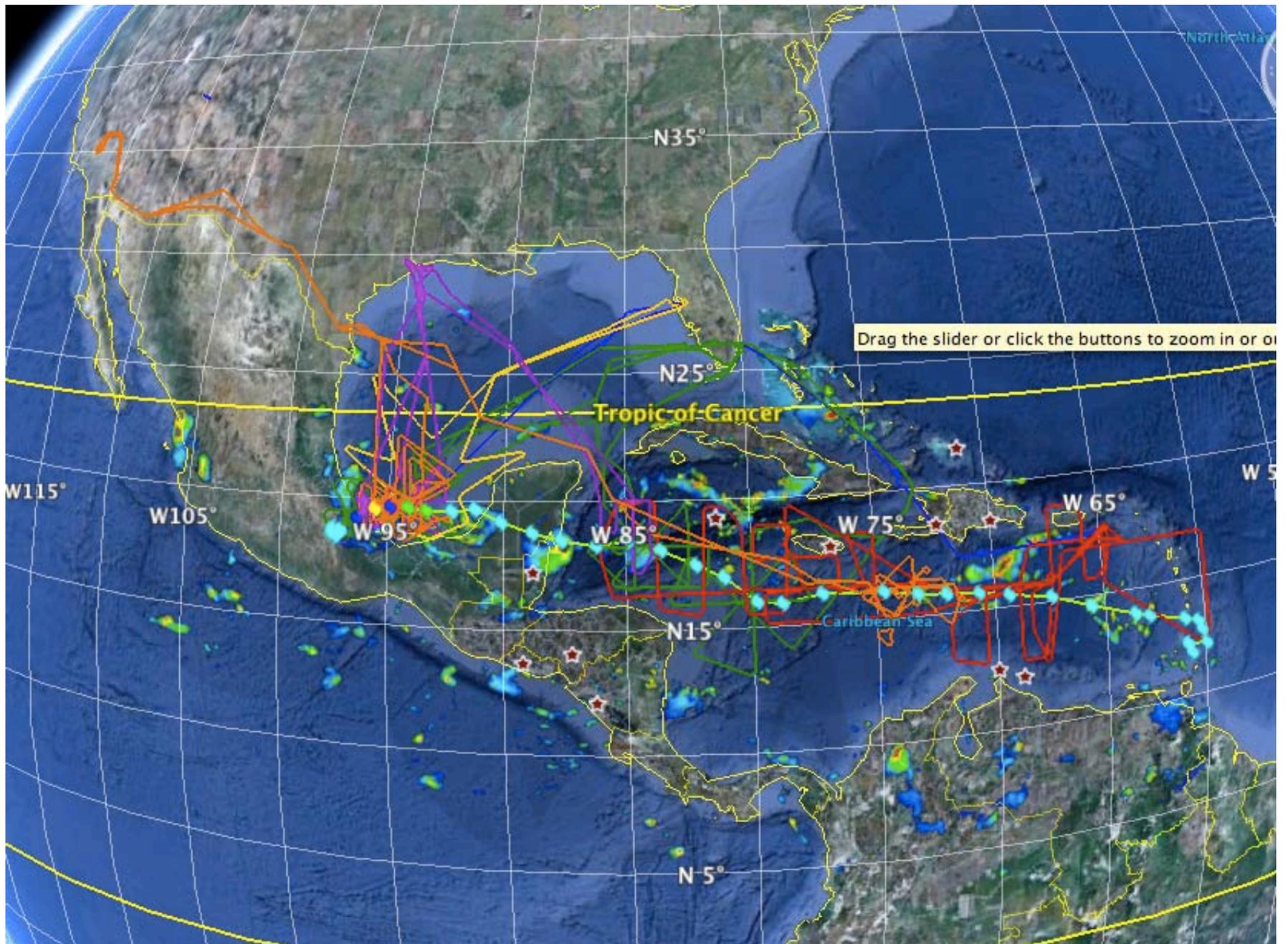
All flights into Hurricane Earl, 1-3 September 2010

GRIP-IFEX-PREDICT All Aircraft Flight Schedule

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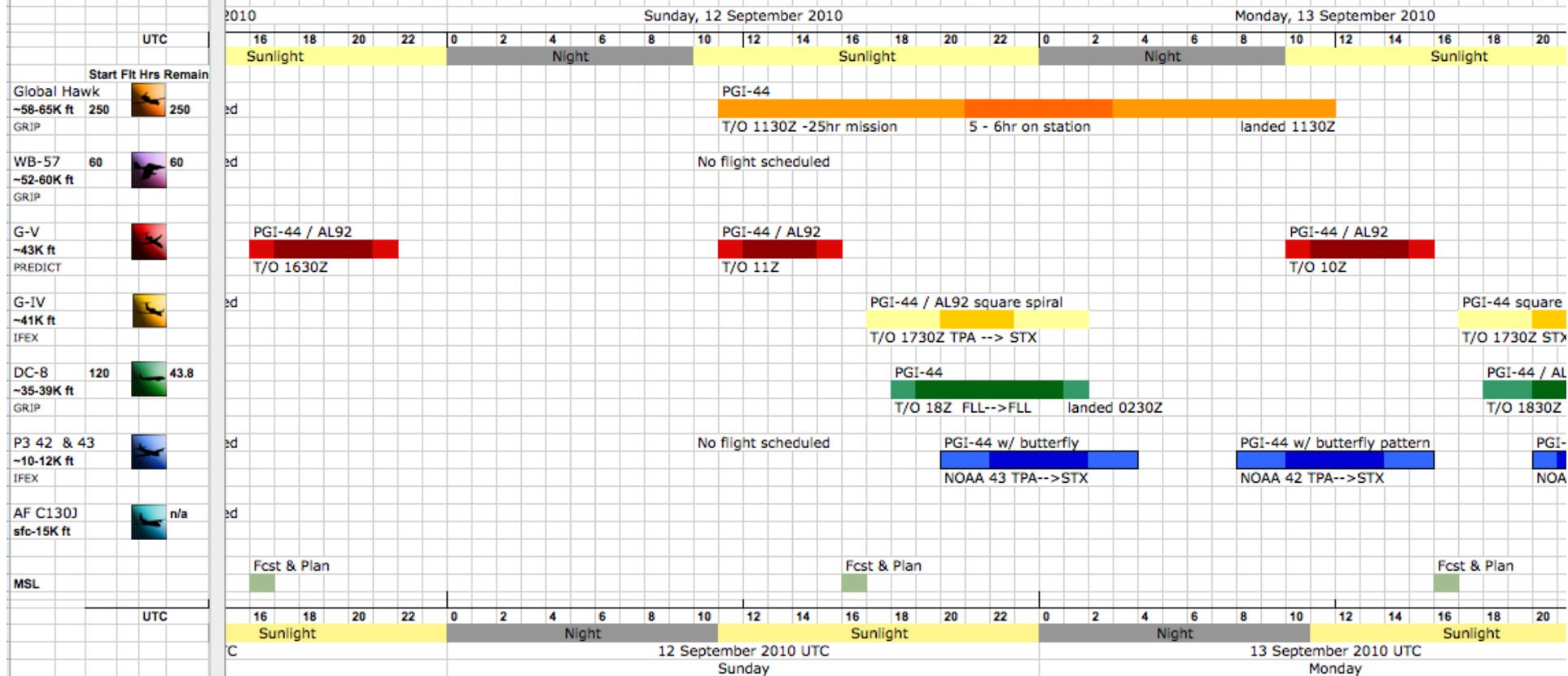
All flights into ex-Gaston, 5-7 September 2010



This made all the planning worthwhile! Karl 2010: All Flight tracks (almost) Sept 11-17 *Courtesy Scott Braun*

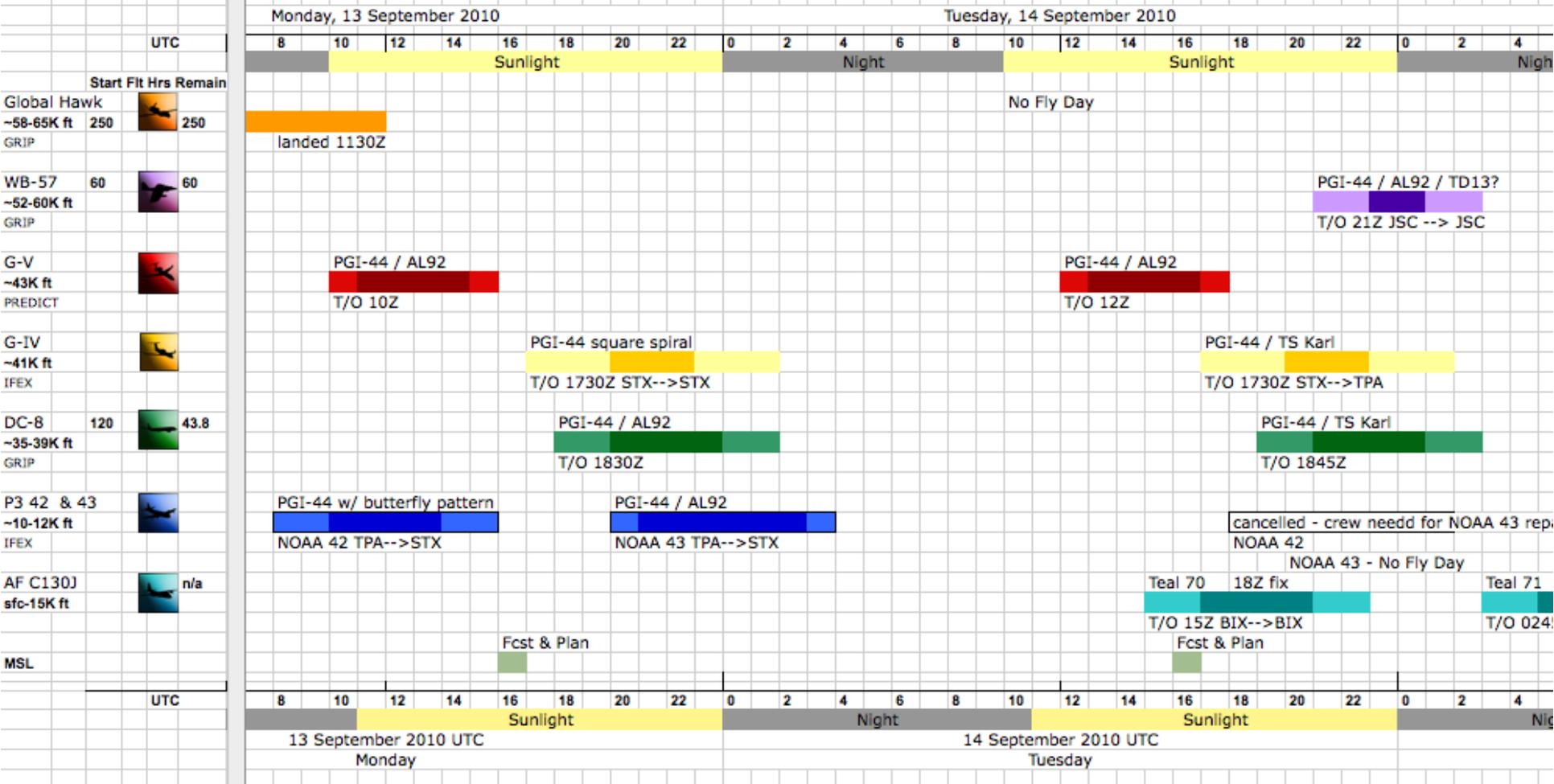
Flight Schedule

GRIP-IFEX-PREDICT All Aircraft Flight Schedule



All flights into pre-Karl, 11 – 13 September 2010

GRIP-IFEX-PREDICT All Aircraft Flight Schedule



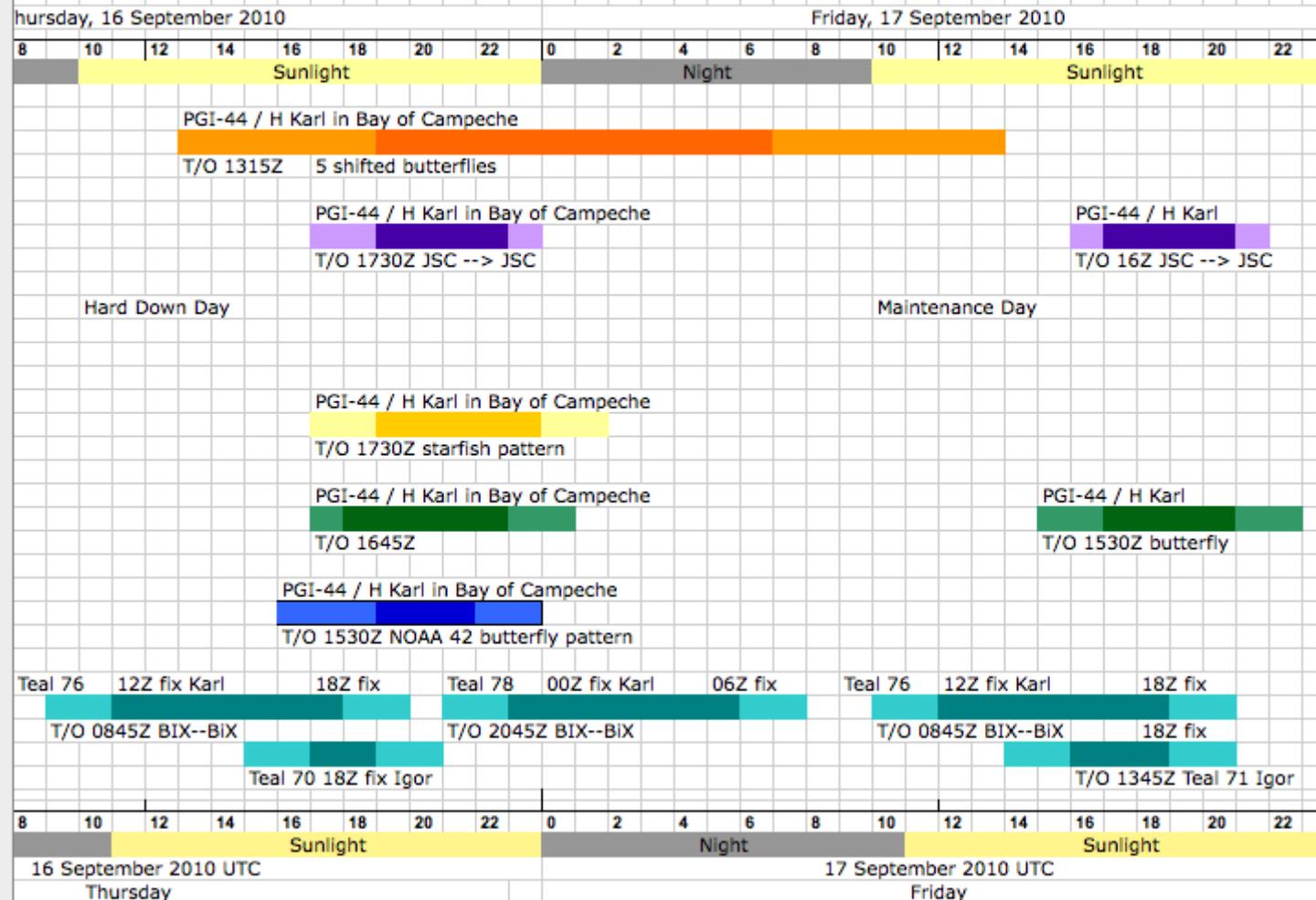
All flights into pre-Karl and TS Karl, 13 – 14 September 2010

GRIP-IFEX-

GRIP-IFEX-PREDICT All Aircraft Flight Schedule

GRIP-IFEX-PREDICT All Aircraft

UTC	0	2	4
	Nig		
Start Flt Hrs Remain			
Global Hawk ~58-65K ft GRIP	250		250
WB-57 ~52-60K ft GRIP	60		60
G-V ~43K ft PREDICT			
G-IV ~41K ft IFEX			
DC-8 ~35-39K ft GRIP	120		43.8
P3 42 & 43 ~10-12K ft IFEX			
AF C130J sfc-15K ft			n/a
MSL			
UTC	0	2	4
	N		

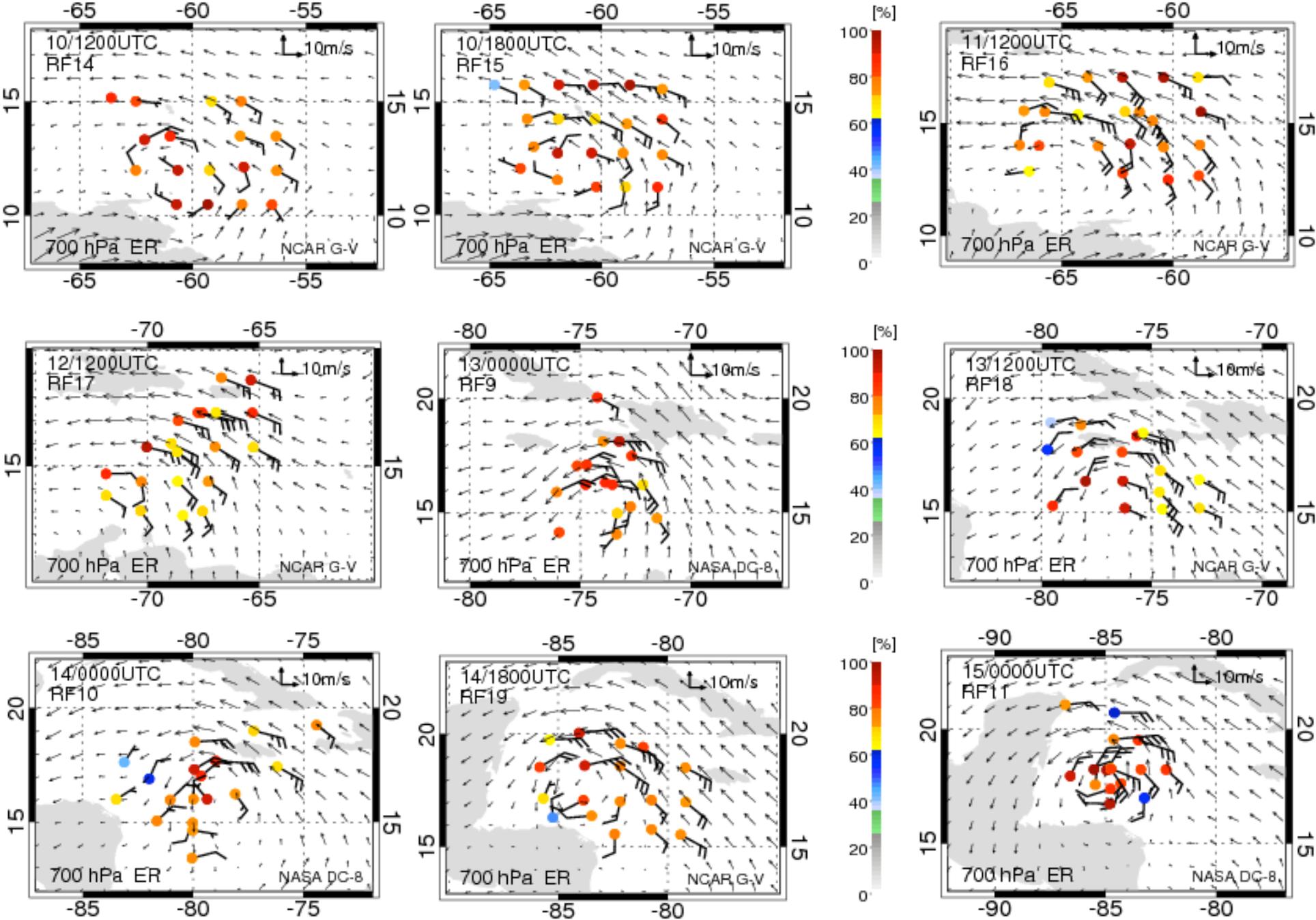


All flights into Hurricane Karl, 16 – 17 September 2010

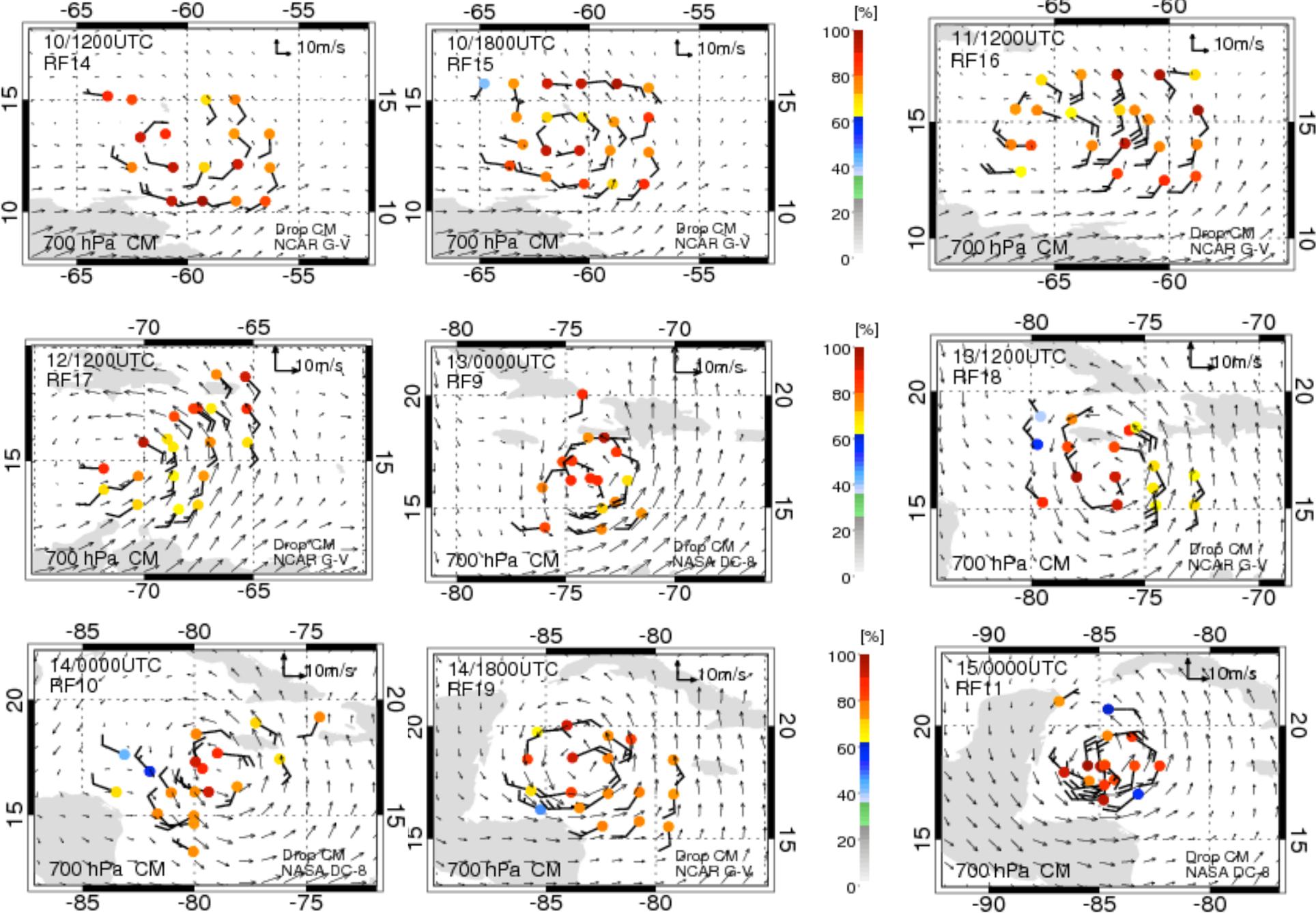
Major Science Questions: Why did Karl take so long to form?

What was the time evolution of inner core moistening? Did the convective bursts help?

STAY TUNED: WORK IS JUST GETTING STARTED



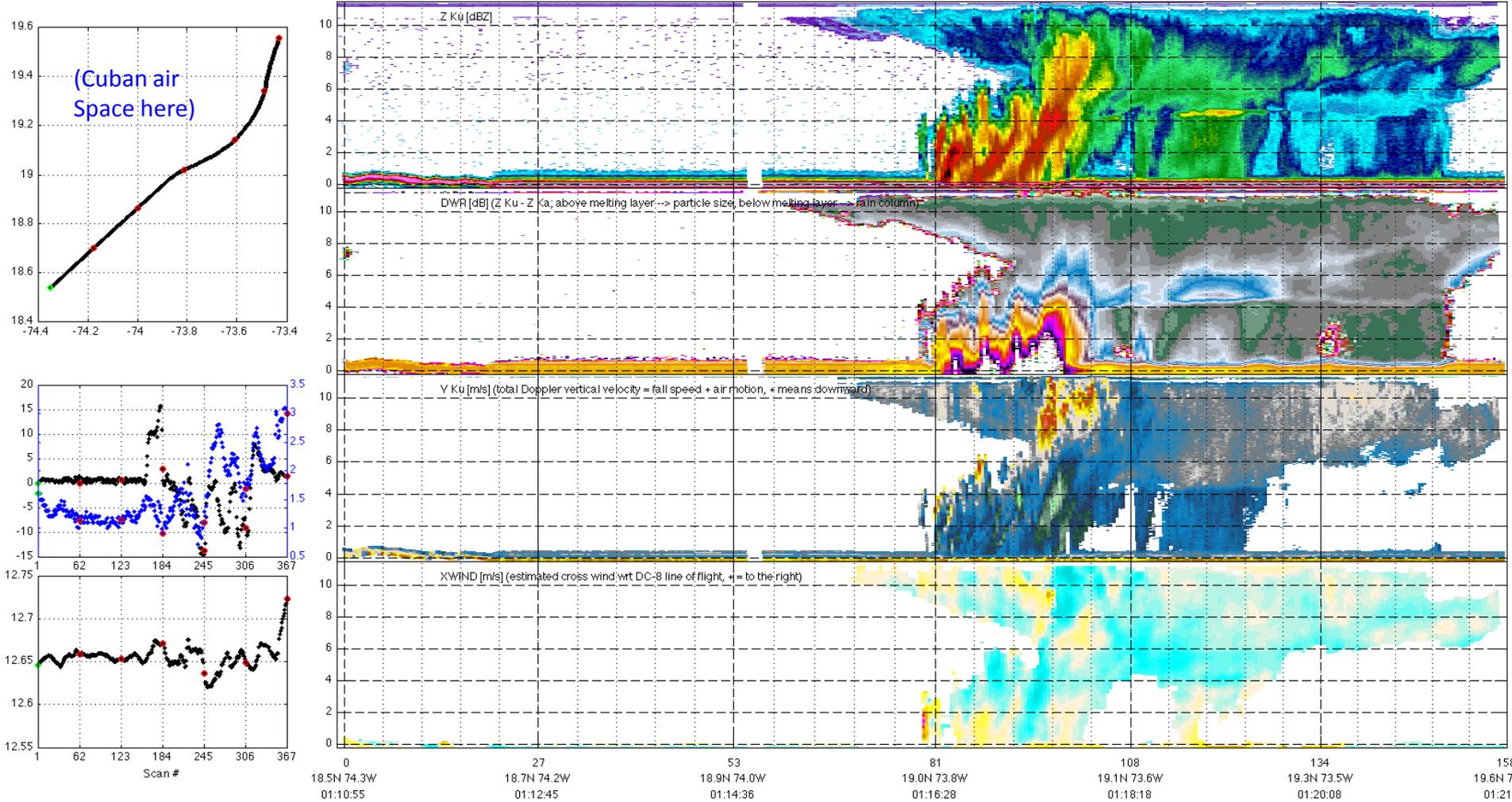
Courtesy Jon Zawislak

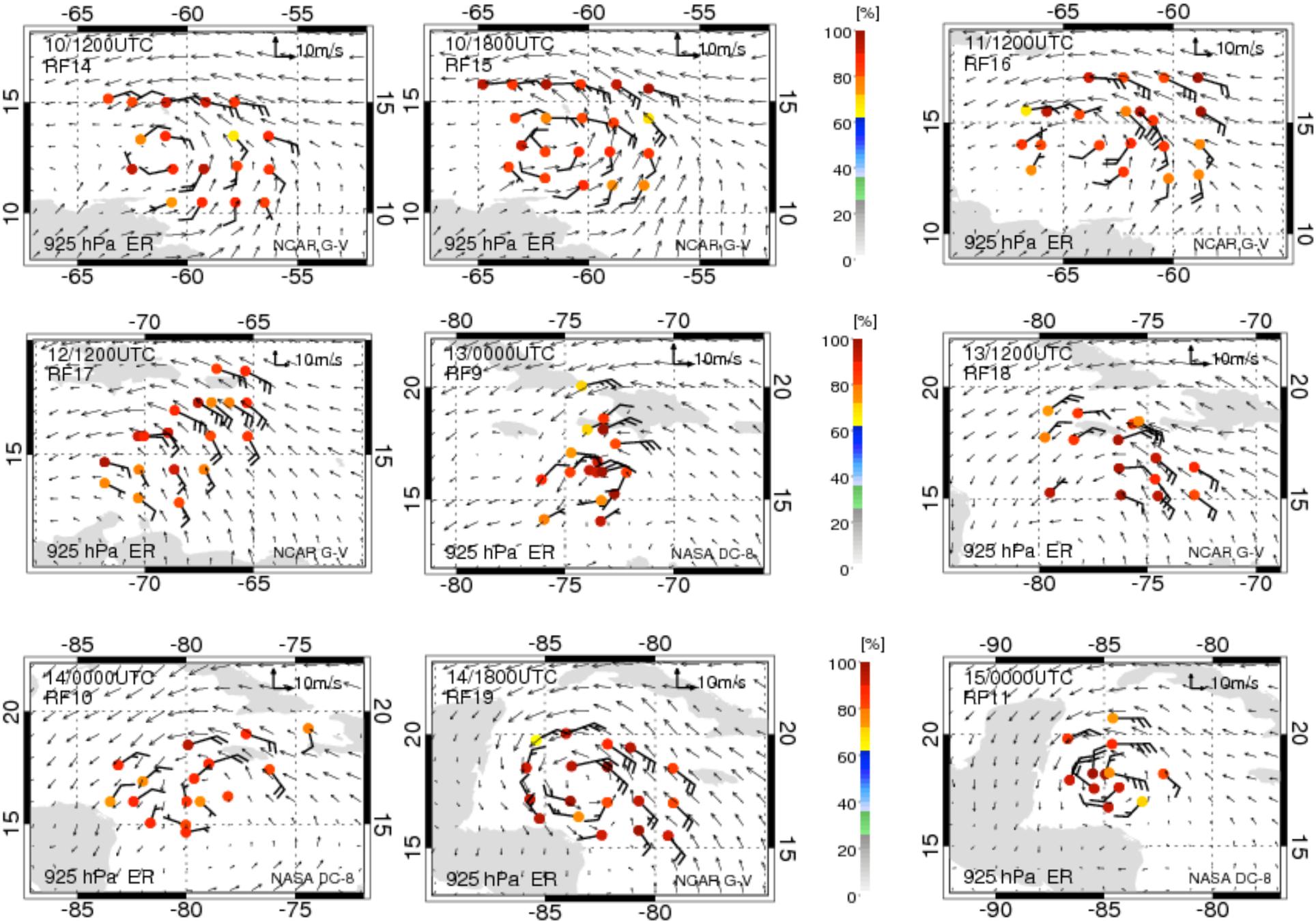


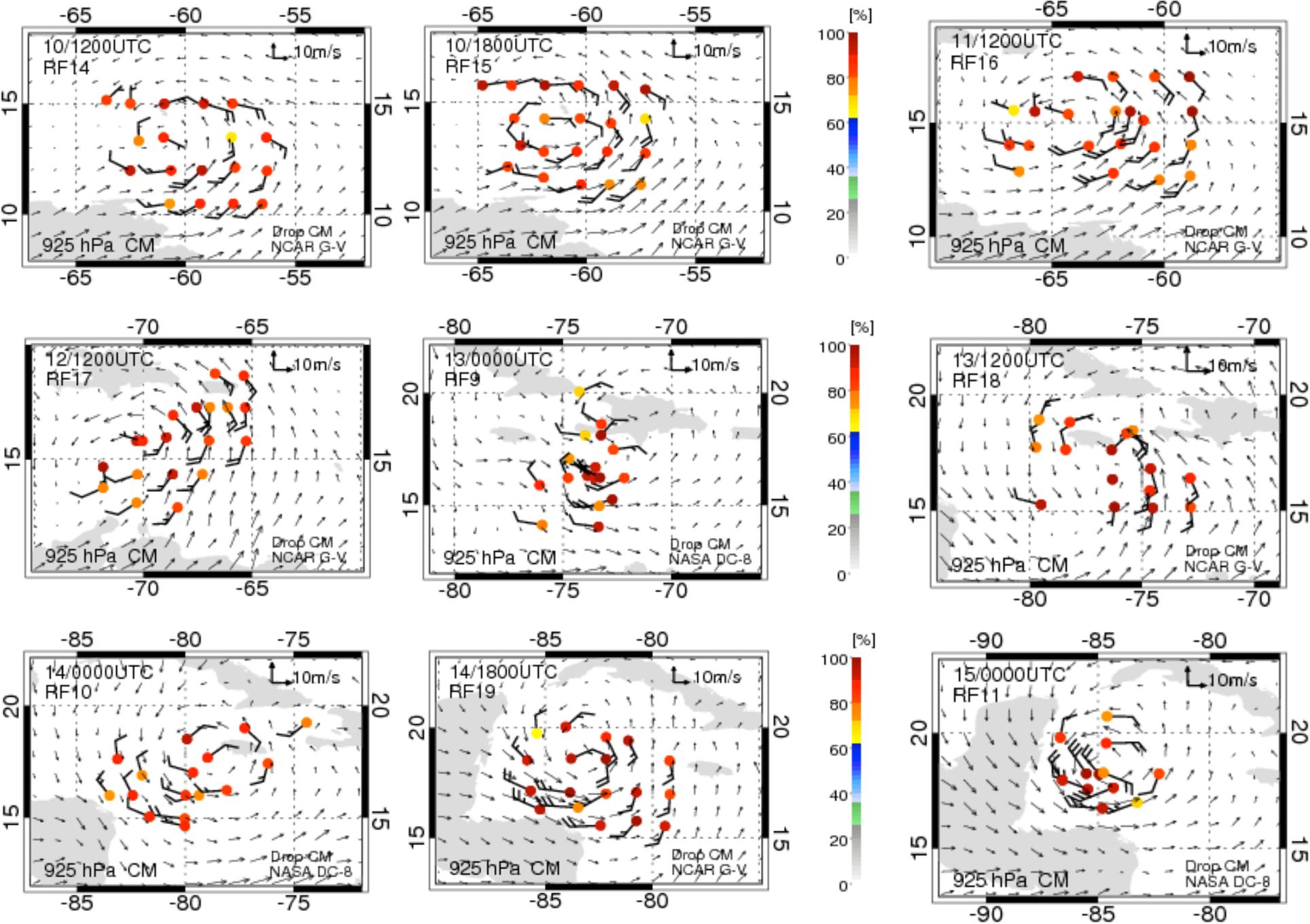
Courtesy Jon Zawislak

Example of great data obtained by APR-2 when the DC-8 pilot preferred penetration of an active thunderstorm/MCS complex over Haiti to entering Cuban air space

Courtesy Simone Tanelli and APR-2 team from JPL

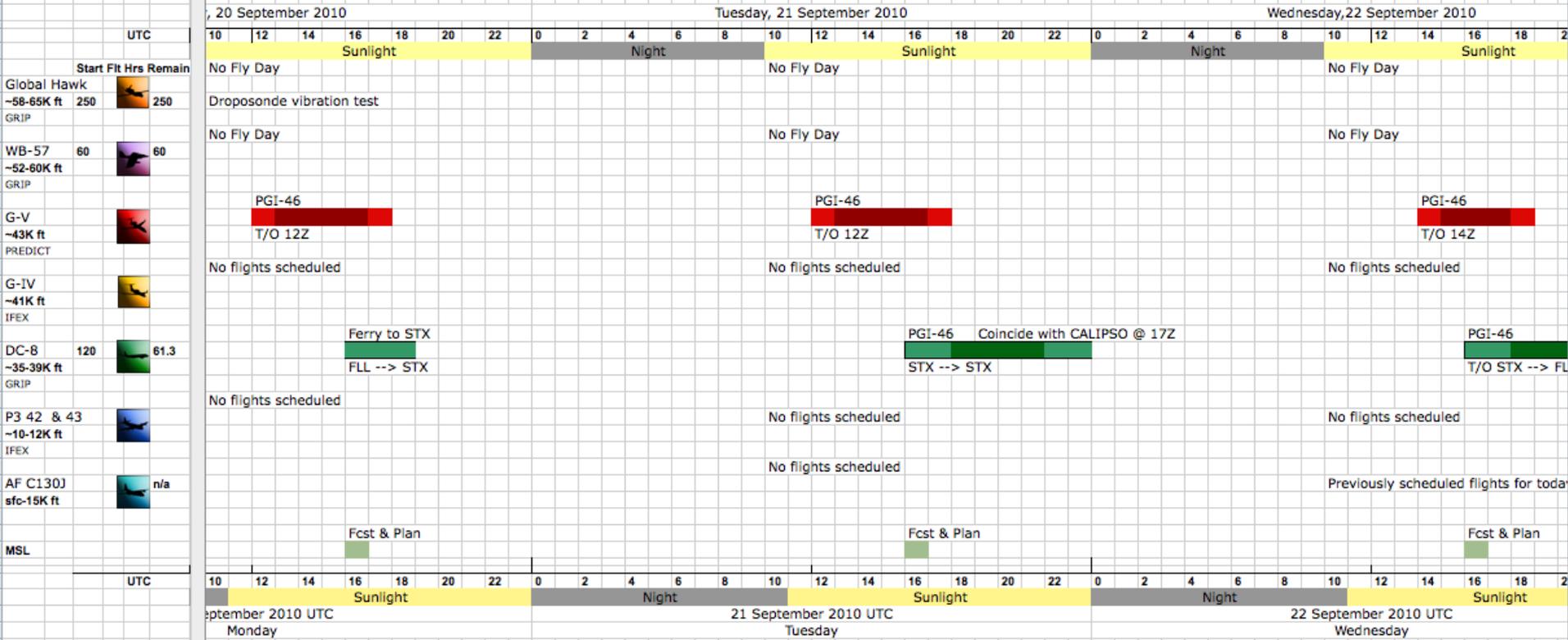






GRIP-IFEX-PREDICT All Aircraft Flight Schedule

GRIP-IFEX-PREDICT All

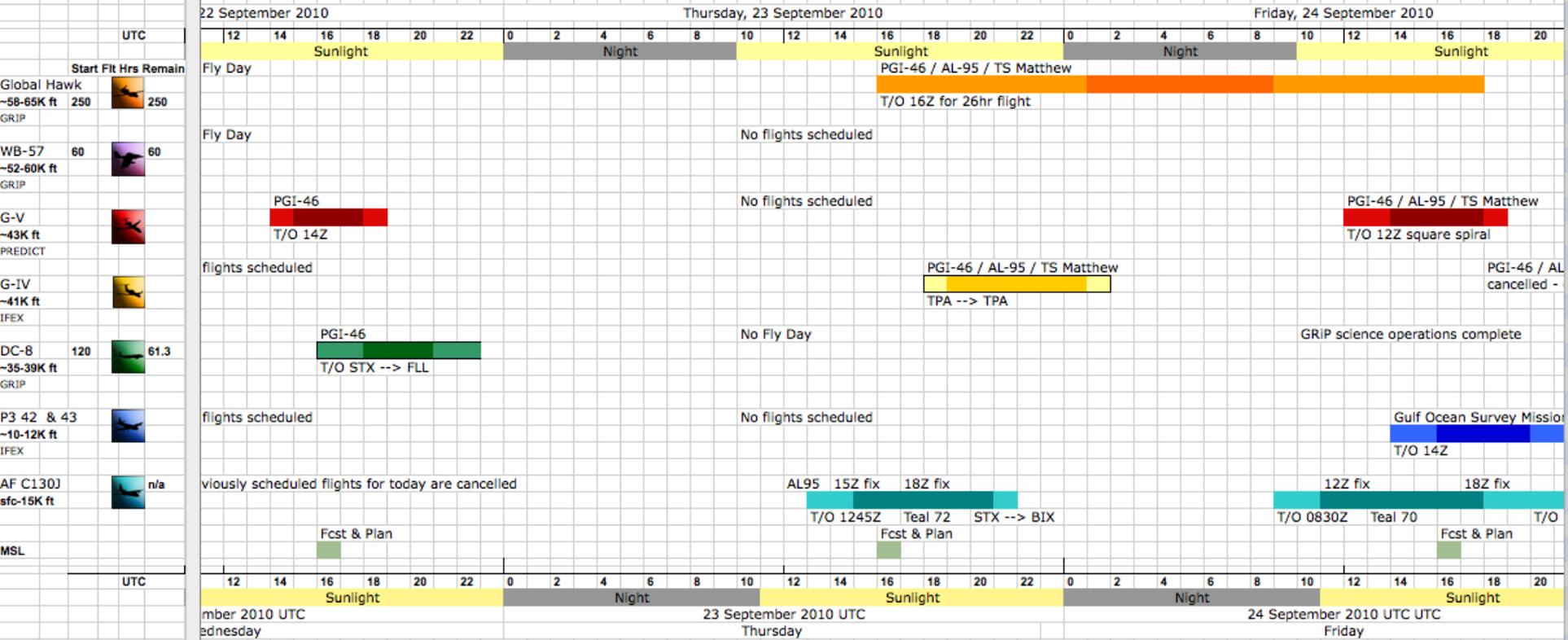


All flights into pre-Matthew, 20-22 September 2010

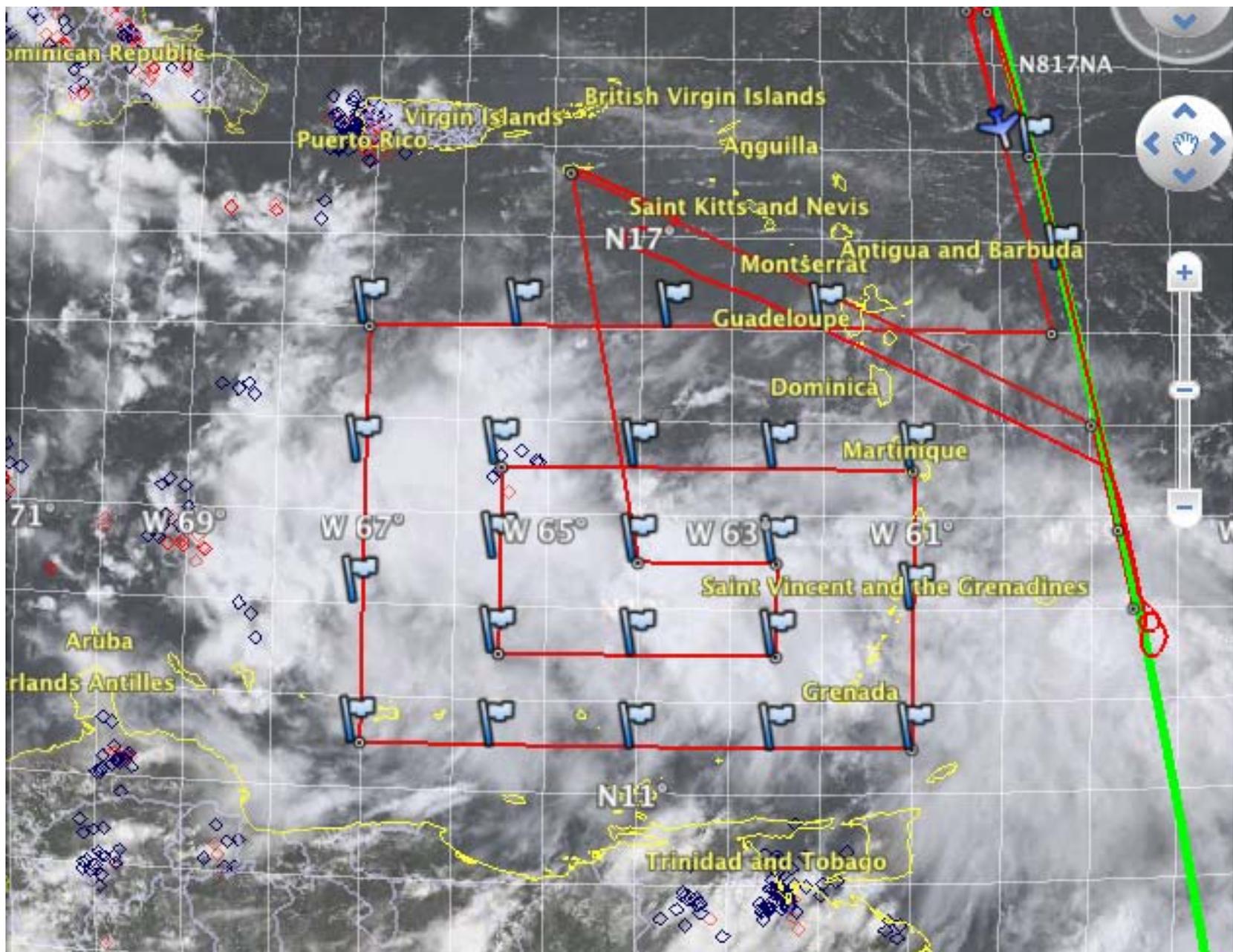
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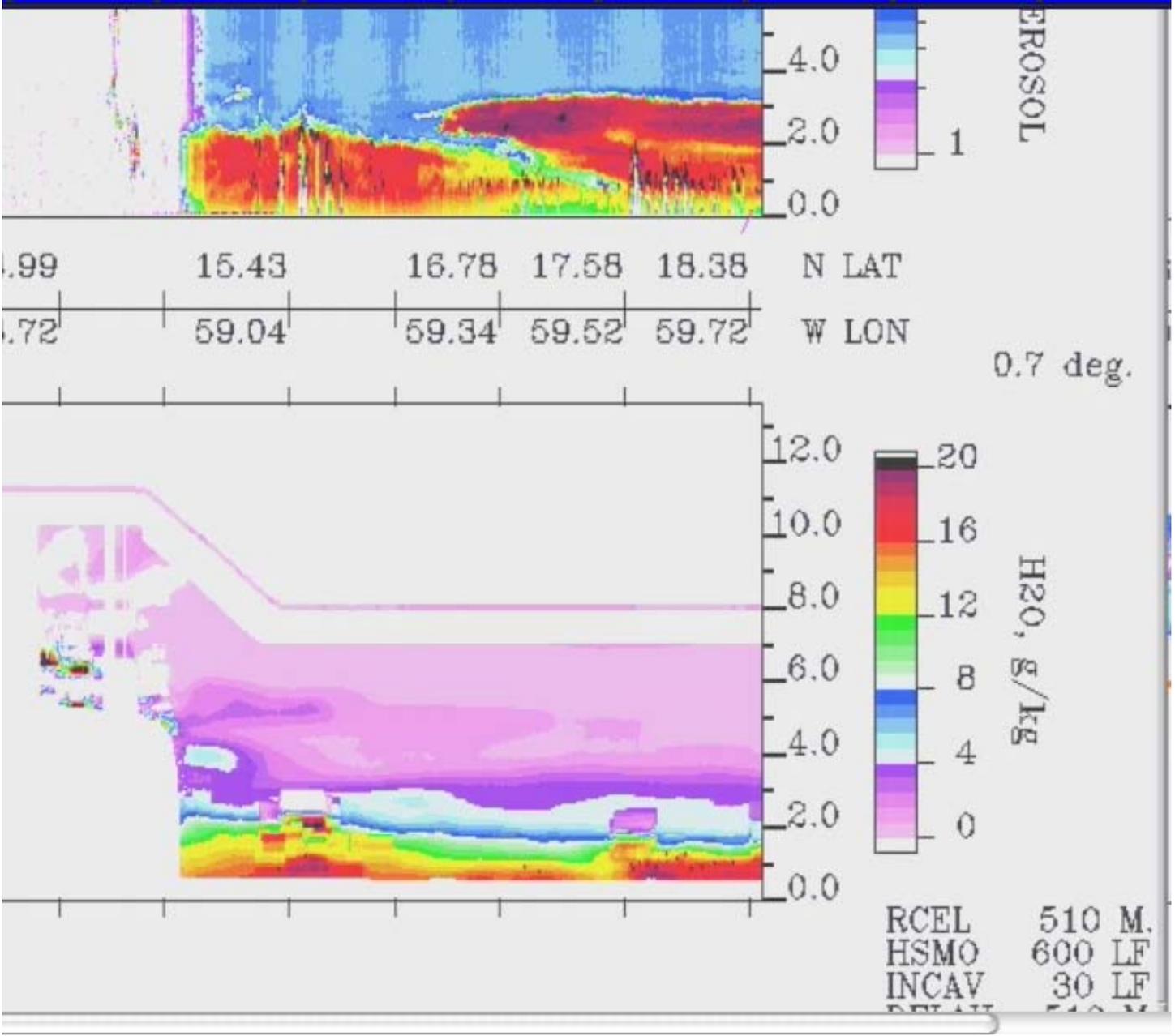
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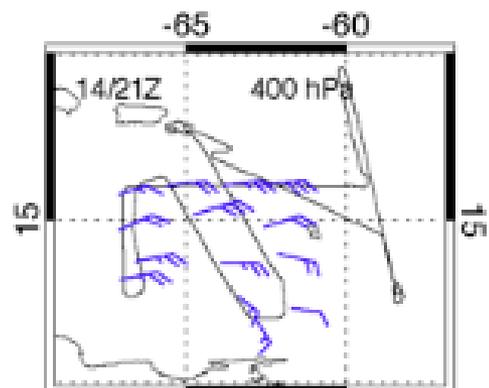
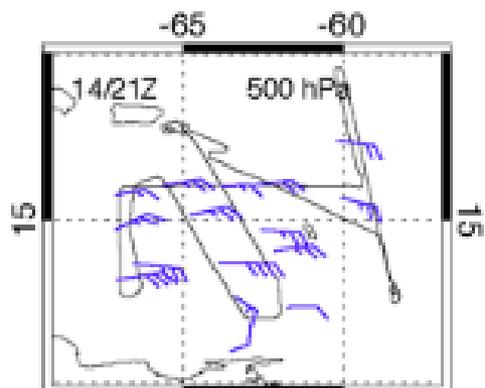
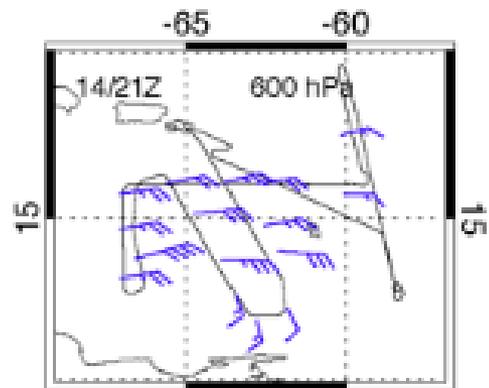
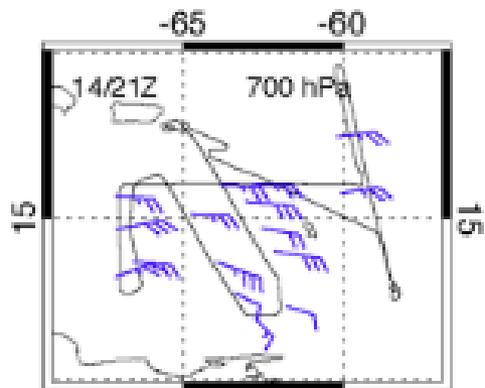
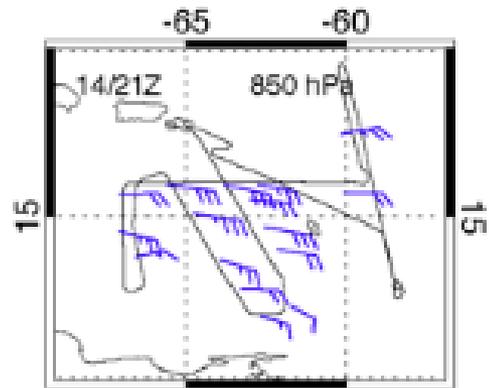
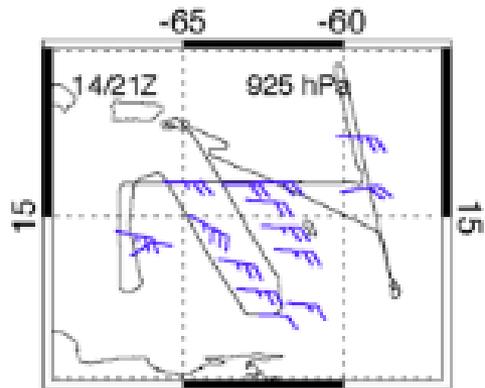
GRIP-IFEX-PREDICT All Aircraft Flight Schedule



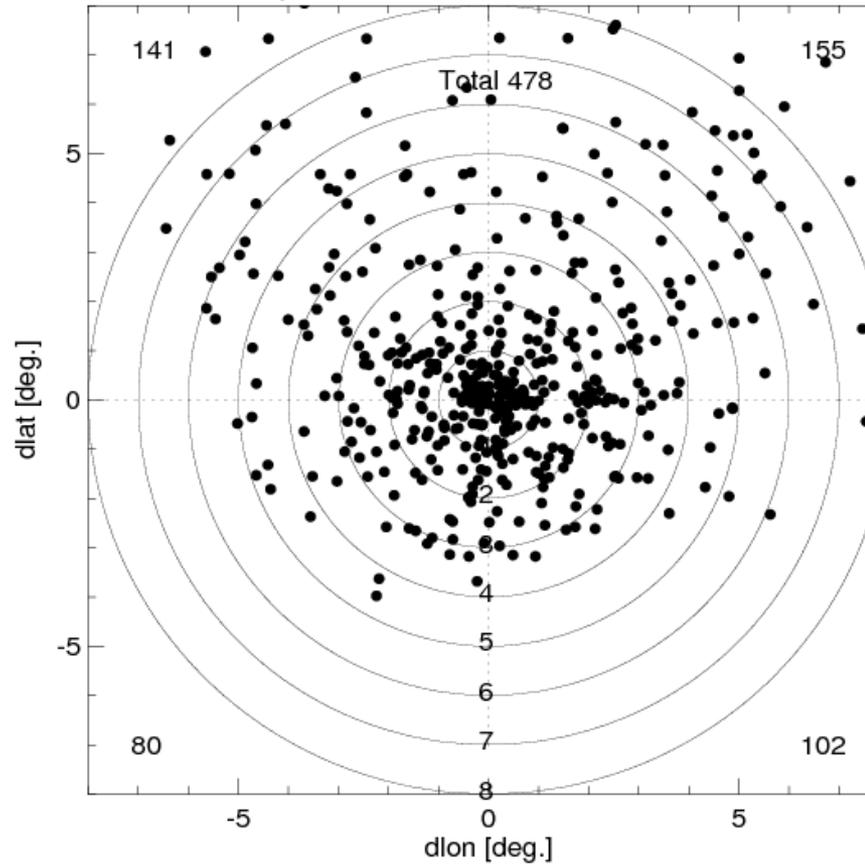
All flights into pre-Matthew and Matthew, 22-24 September 2010



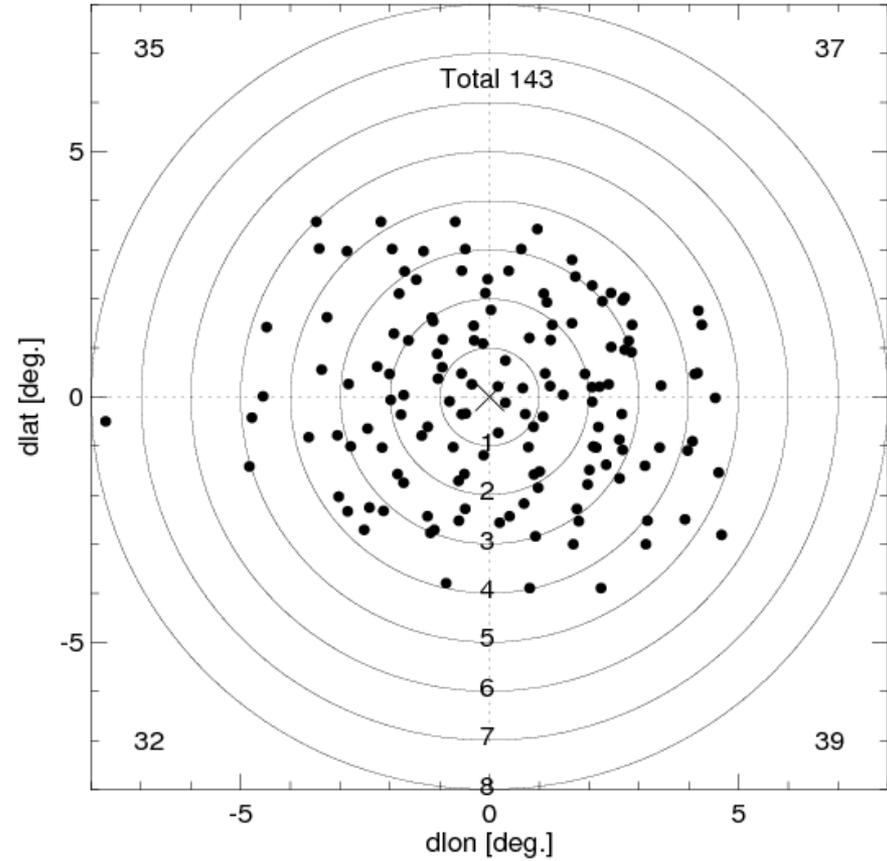




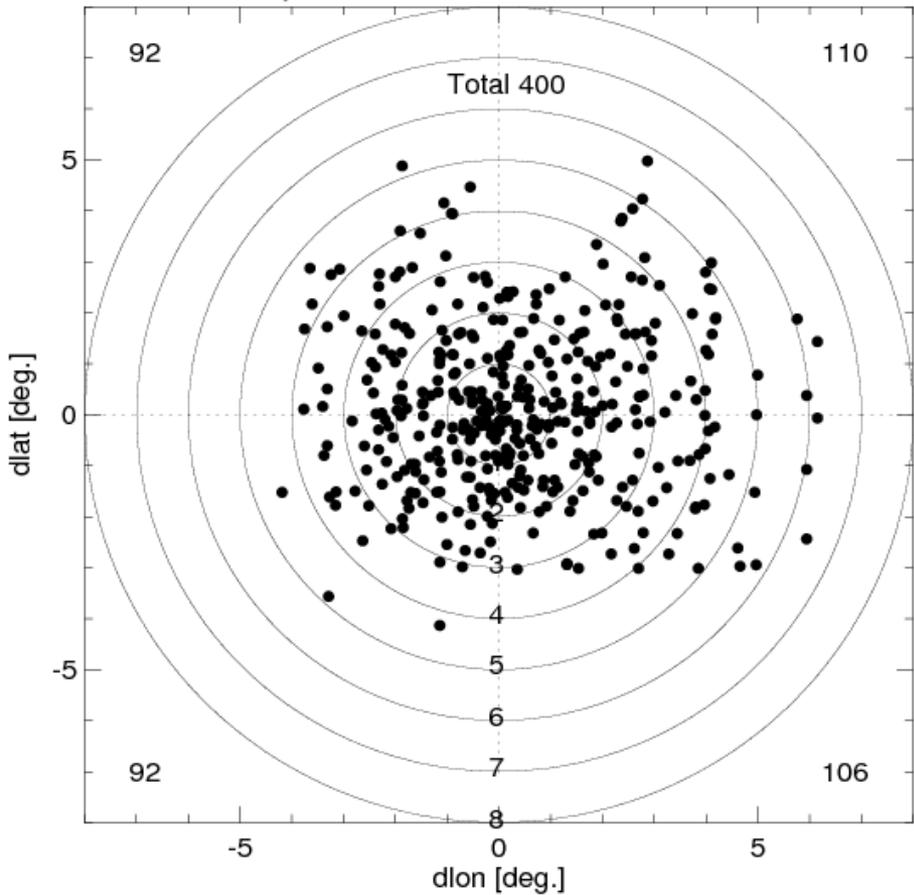
Earl Drop Locations Relative to 850 hPa VM



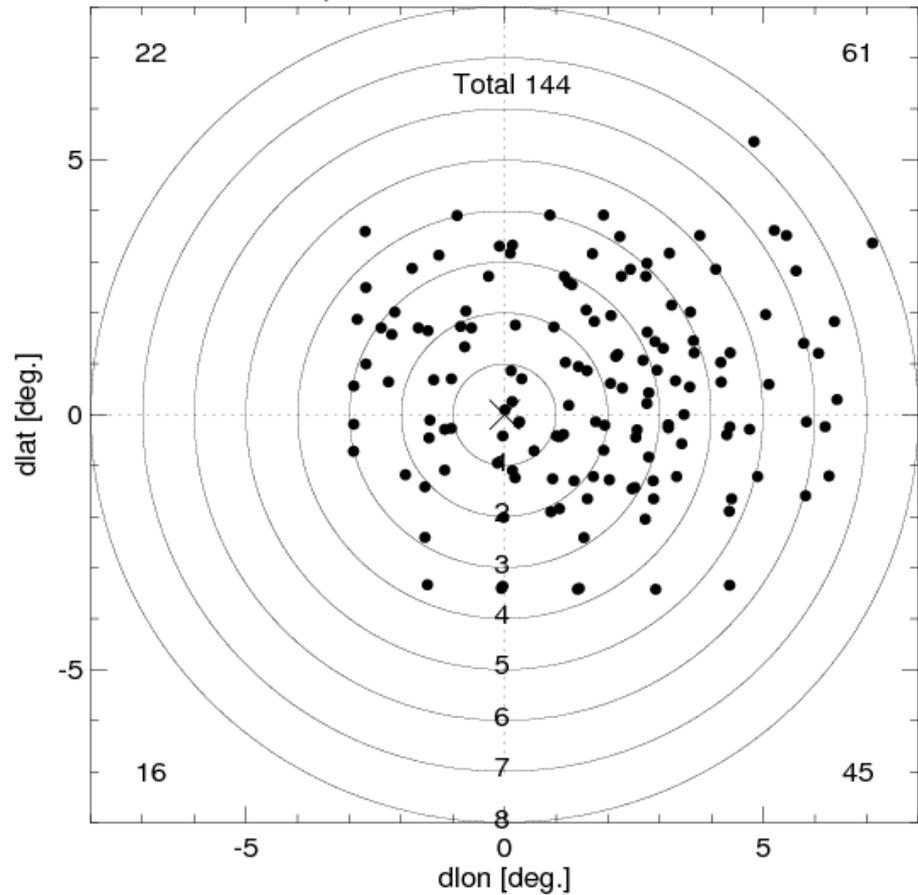
ex-Gaston Drop Locations Relative to 850 hPa VM



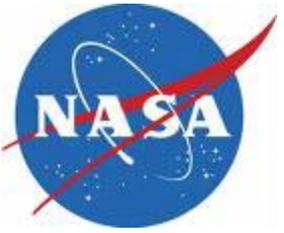
Karl Drop Locations Relative to 850 hPa VM



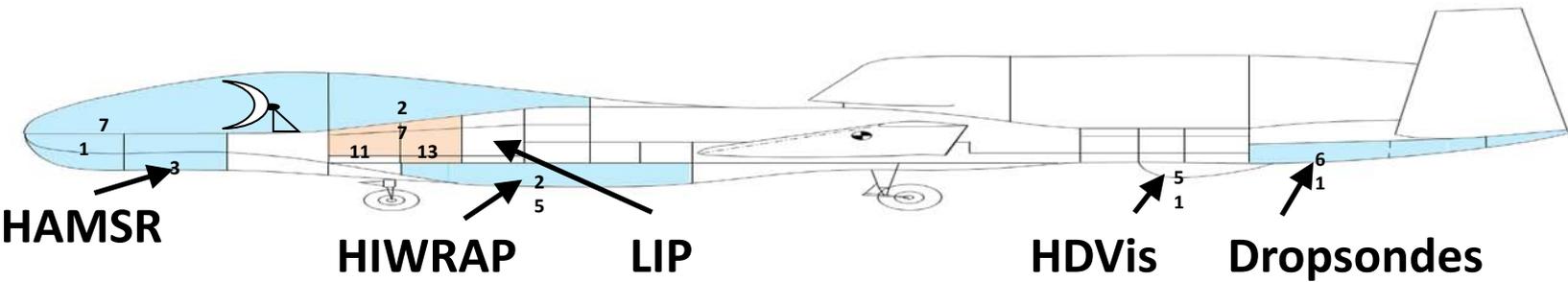
Matthew Drop Locations Relative to 850 hPa VM



Now it's time to get to work!



GLOBAL HAWK



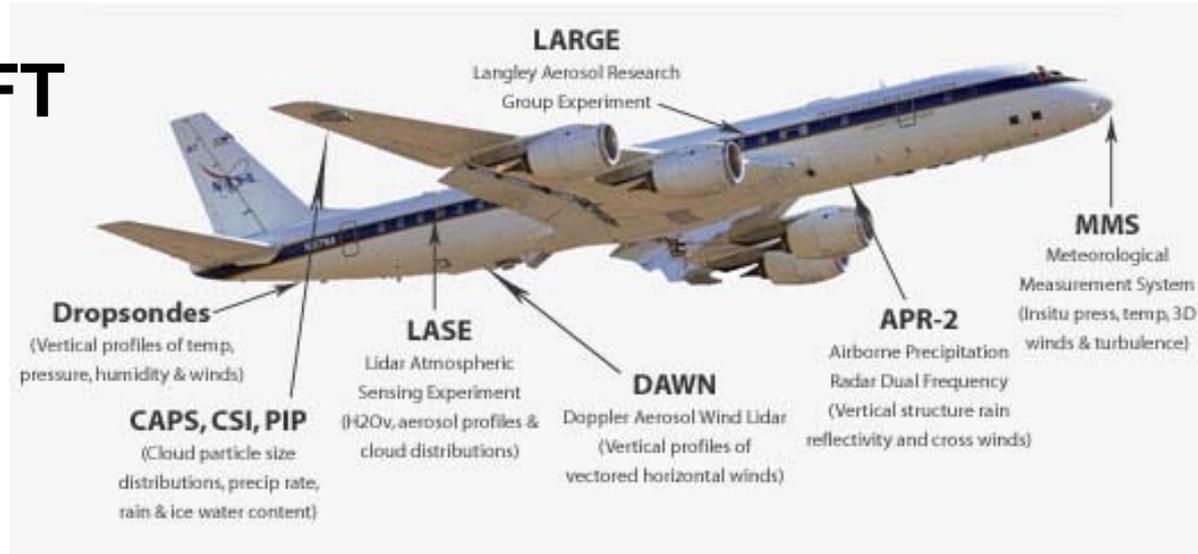


GRIP Hurricane Mission

Genesis and Rapid Intensification Processes



DC-8 AIRCRAFT



WB-57 AIRCRAFT

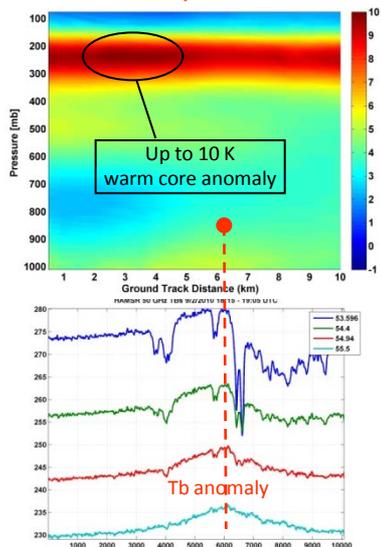


PREDICT planning meeting, Nov 2009 at HRD, together with IFEX and GRIP people

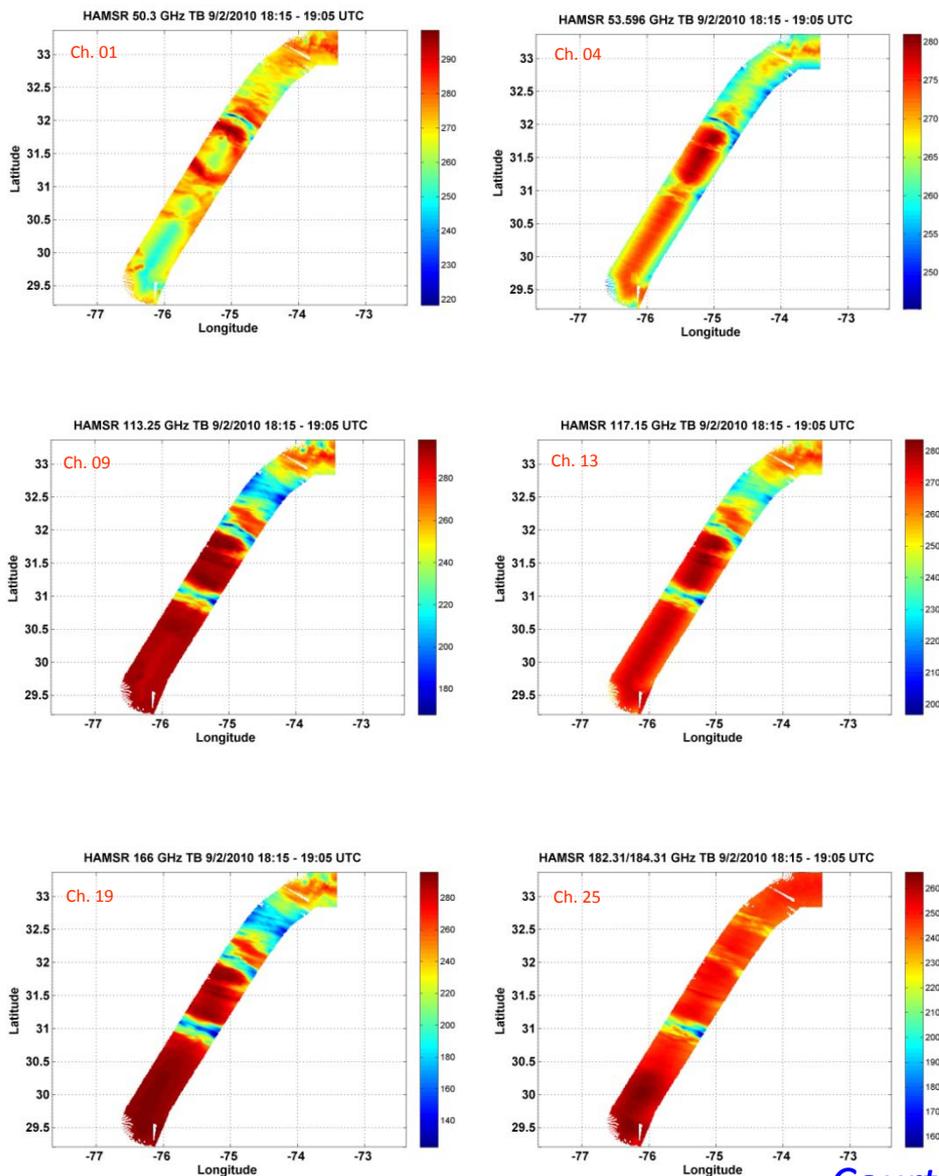
HAMSR @ Earl, 9/2/2010, 1815-1905 UTC

(All retrievals are preliminary)

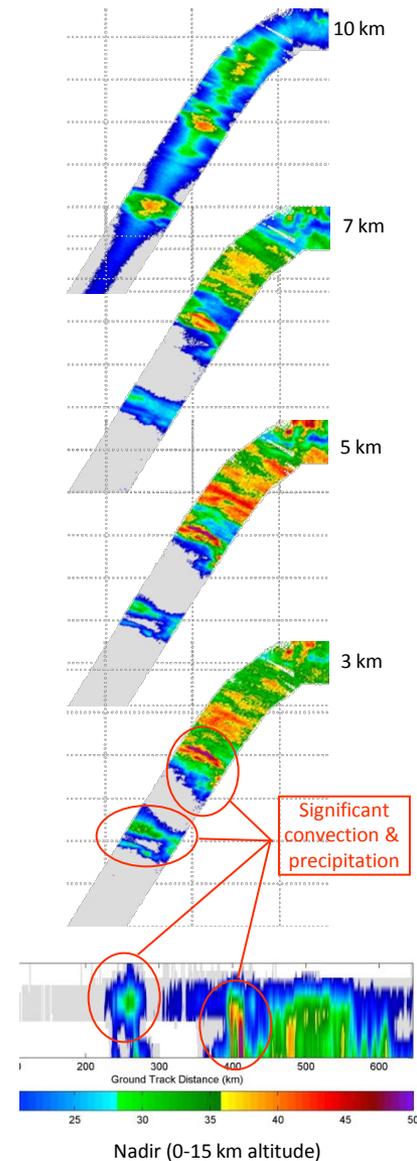
Temperature



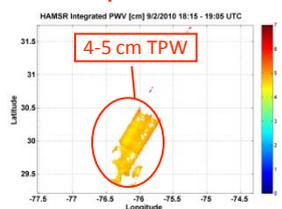
Brightness temperatures



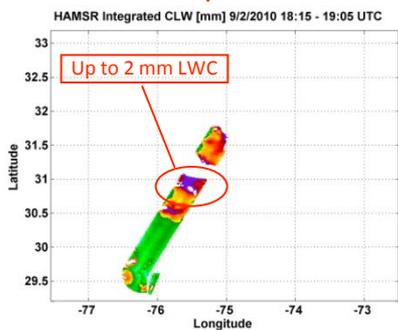
Reflectivity (experimental)



Precipitable water



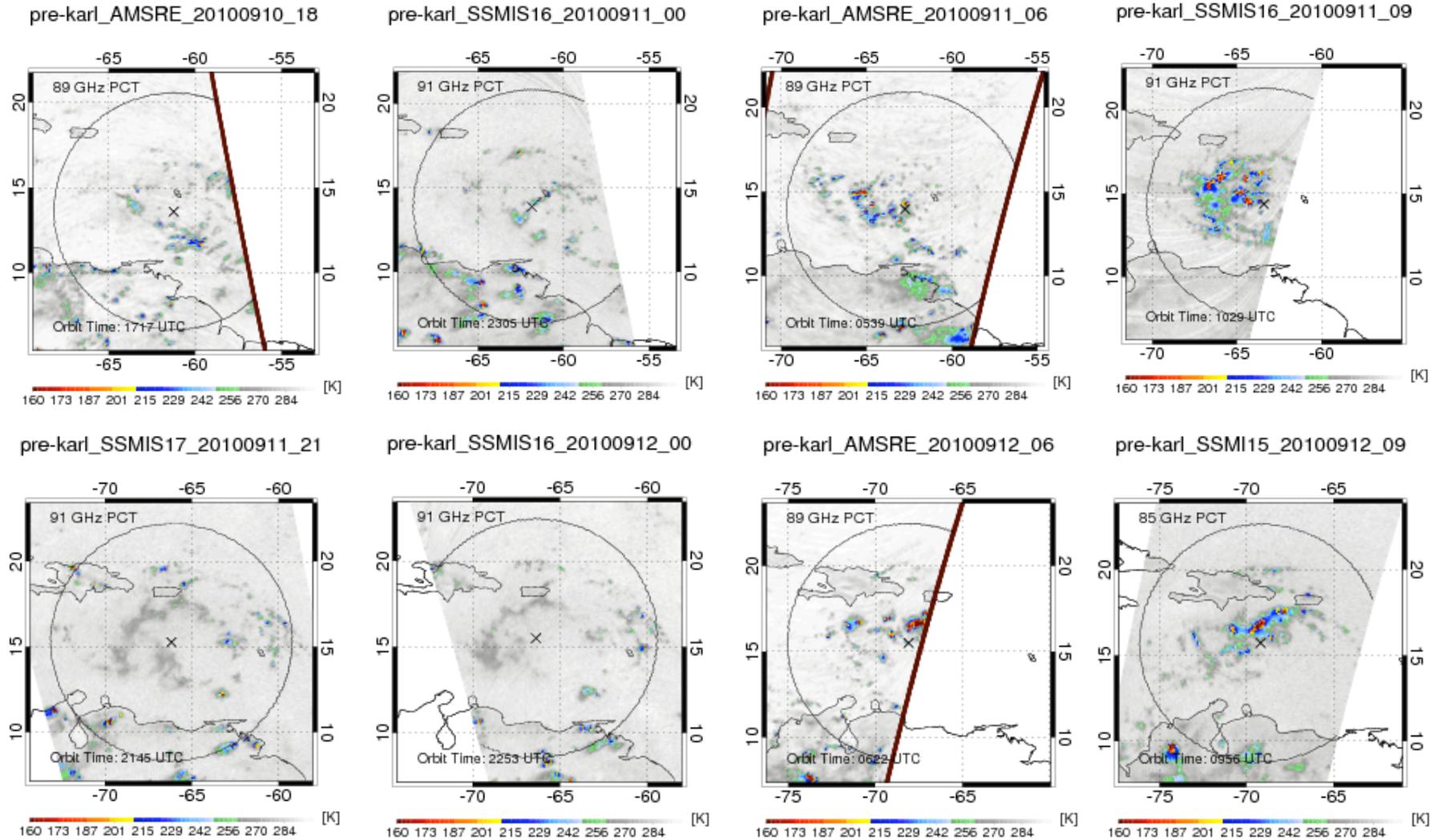
Cloud liquid water



Courtesy Bjorn Lambrigtsen

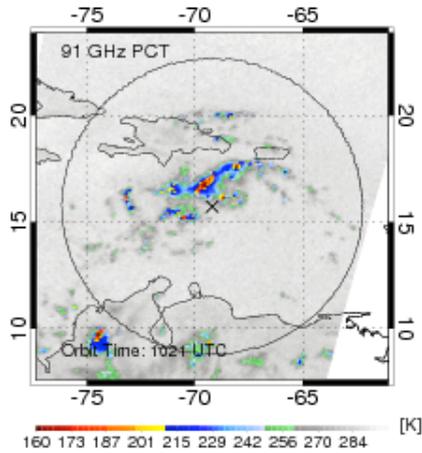
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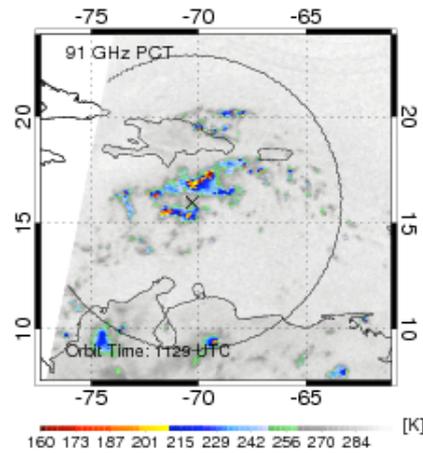


Courtesy Jon Zawislak

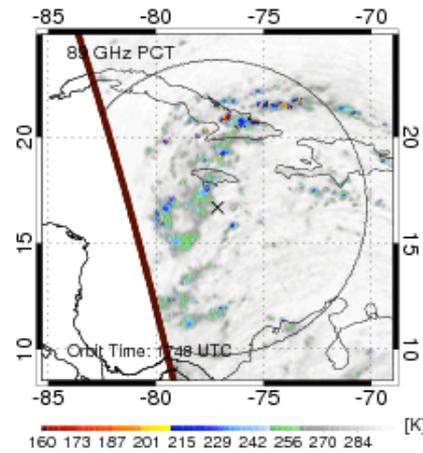
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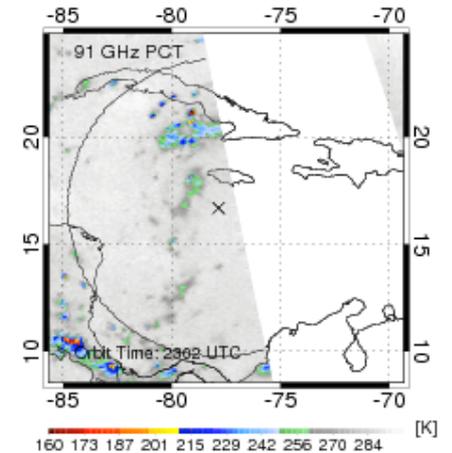
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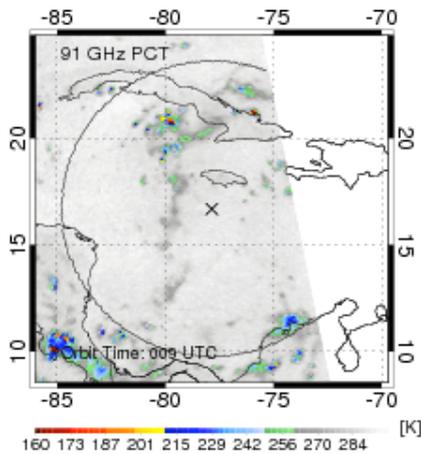
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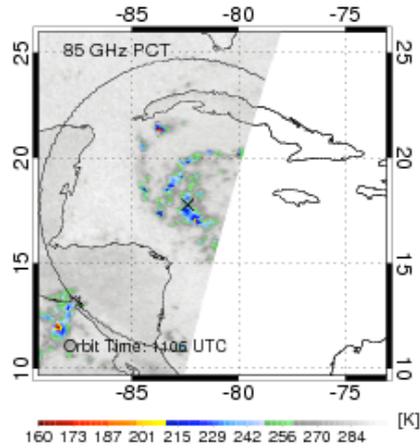
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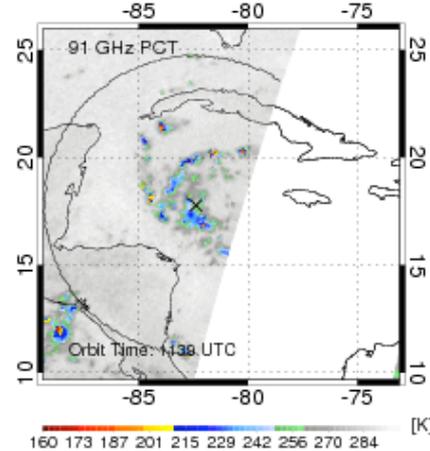
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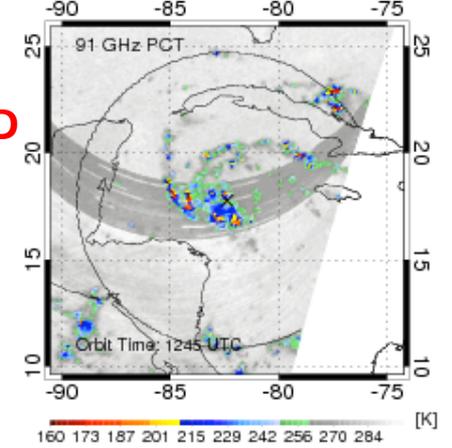
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pre-karl_SSMIS17_20100914_12



pre-karl_SSMIS16_20100914_12



Courtesy Jon Zawislak