



# Lessons Learned from GRIP That May Assist in Flight Planning For HS3

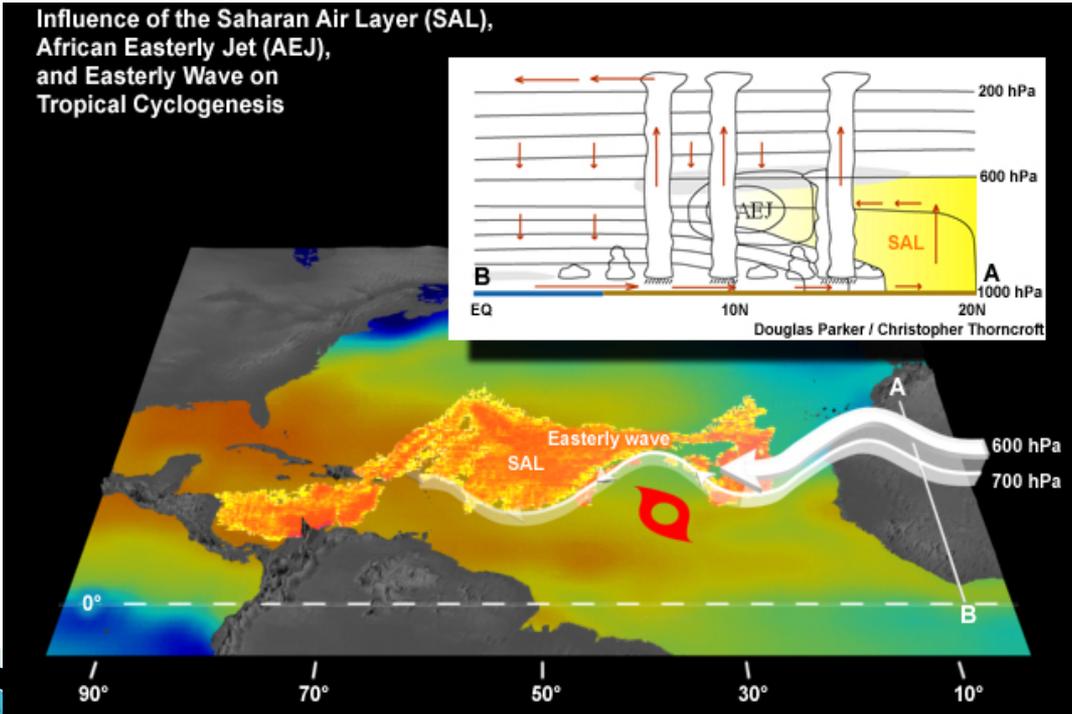


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# Science Questions—Environment

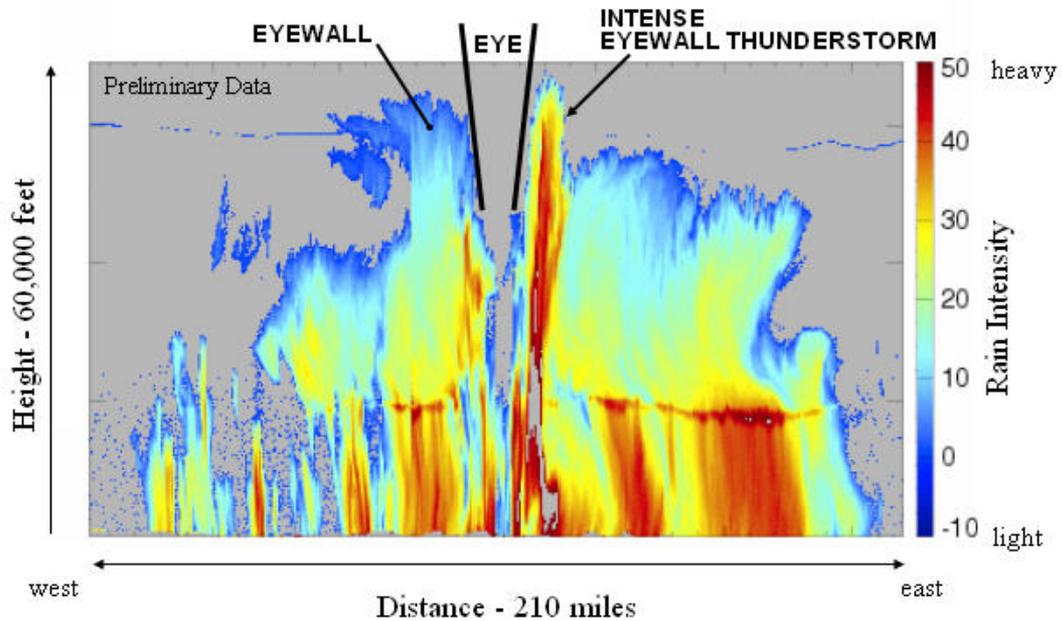
- ▶ What aspects of the environment most impact the ability of a tropical storm to form and intensify?
- ▶ Is the Saharan Air Layer positive or negative influence on storm formation and evolution? Both?





# Science Questions—Inner-core

- ▶ Are convective hot towers actively contributing to storm intensification beyond merely contributing to the total mass flux required for intensification?
- ▶ Do specific transformations of convective structure occur prior to genesis and rapid intensification?



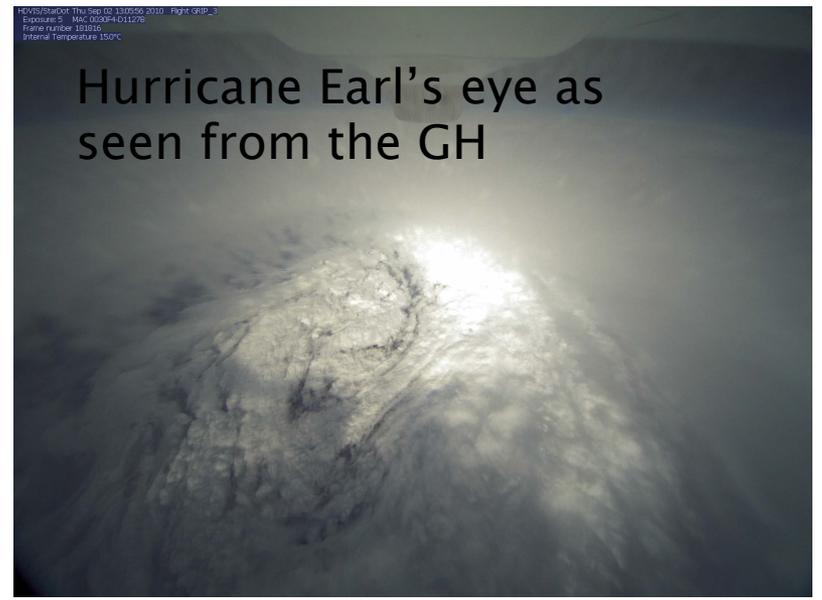
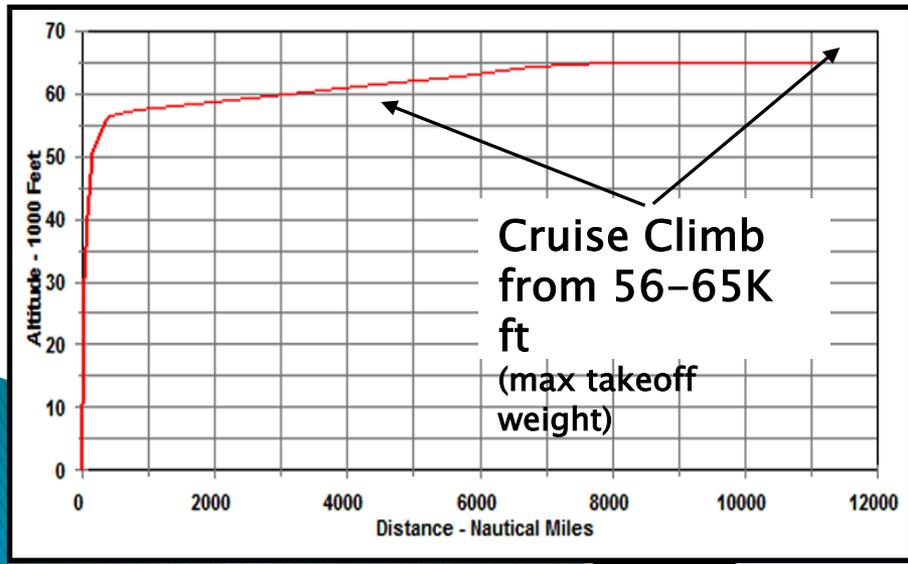
**Vertical slice showing rain structure across the entire storm - 1:30 - 2:00 AM CST July 17, 2005**



# NASA's Global Hawk Unmanned Airborne System



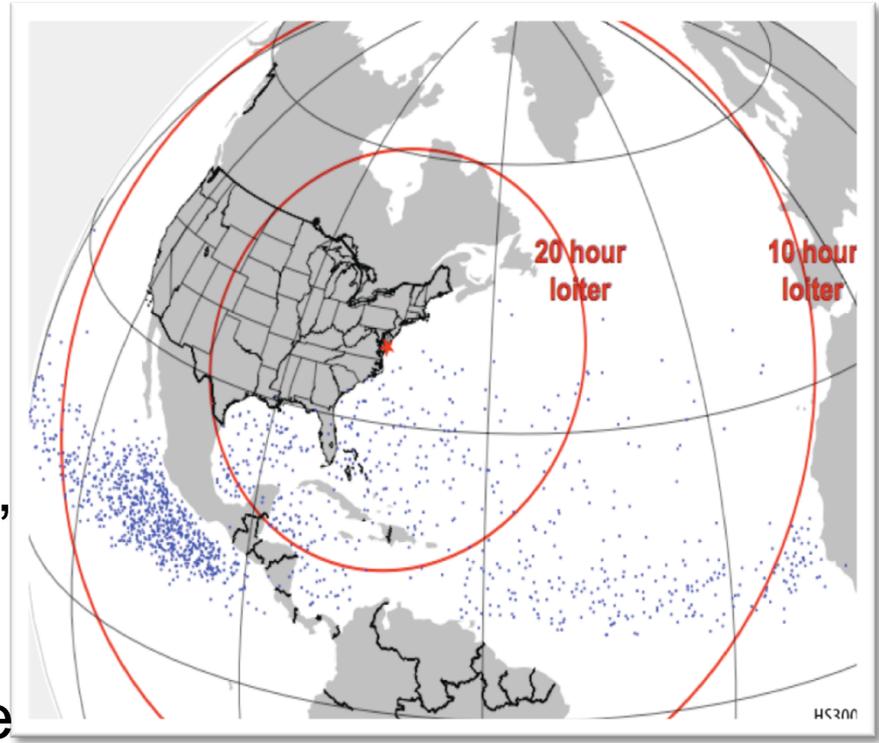
Endurance	> 30 hours
Range	>11,000 nmi
Service Ceiling	65,000 ft
Airspeed (55K+ ft)	335 KTAS
Payload	1,000-1,500 lb
Length	44 ft
Wingspan	116 ft



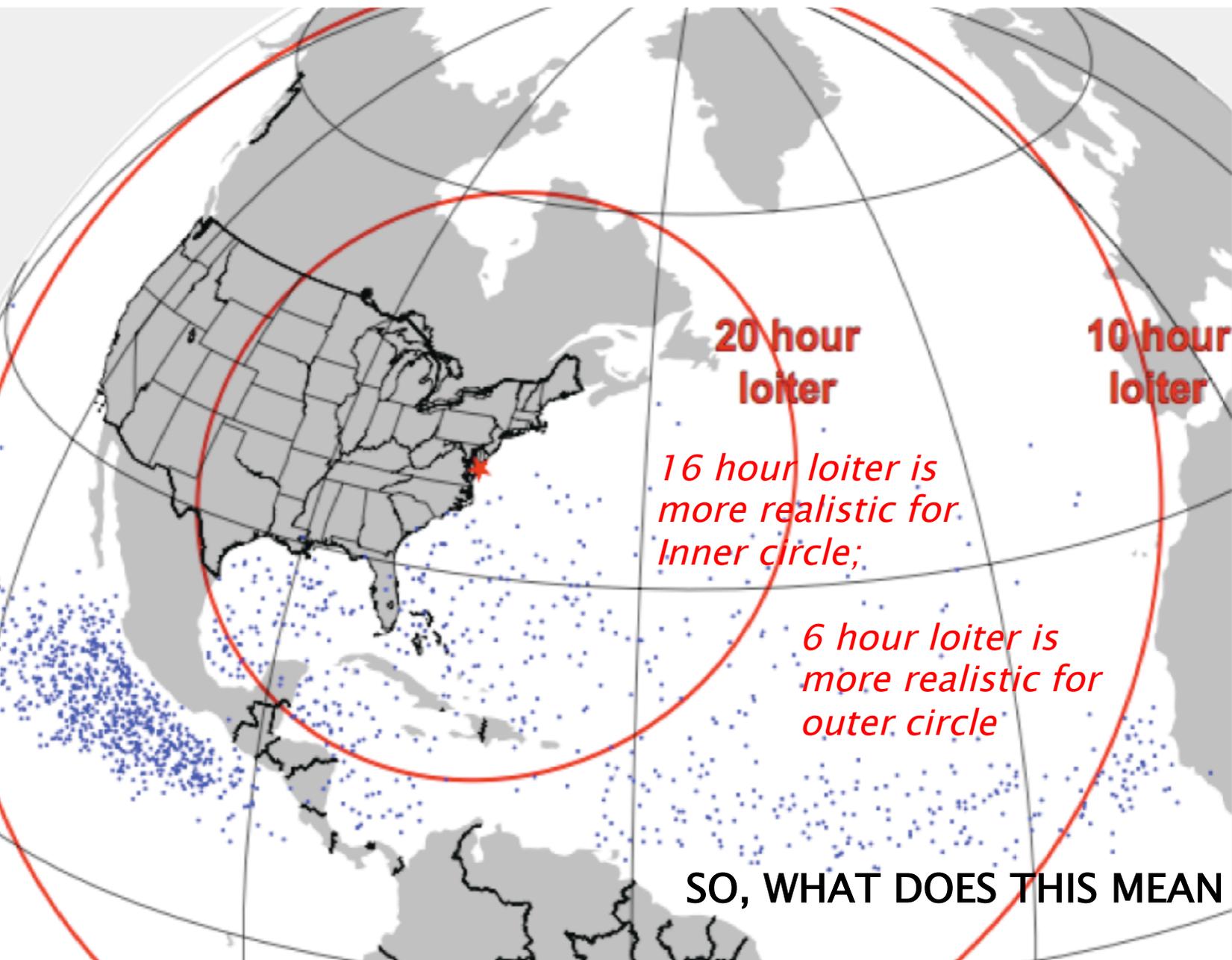


# HS3 Mission Overview

- Two aircraft, one equipped for the storm environment, one for over-storm flights
- Deployments of GHs from the East Coast, likely Wallops Flight Facility in VA
- One-month deployments in 2012, 2013, and 2014
- 3-year mission ensures adequate sampling of a wide variety of conditions



Dots indicate genesis locations. Range rings assume 30-h flights.



**20 hour loiterer**

**10 hour loiterer**

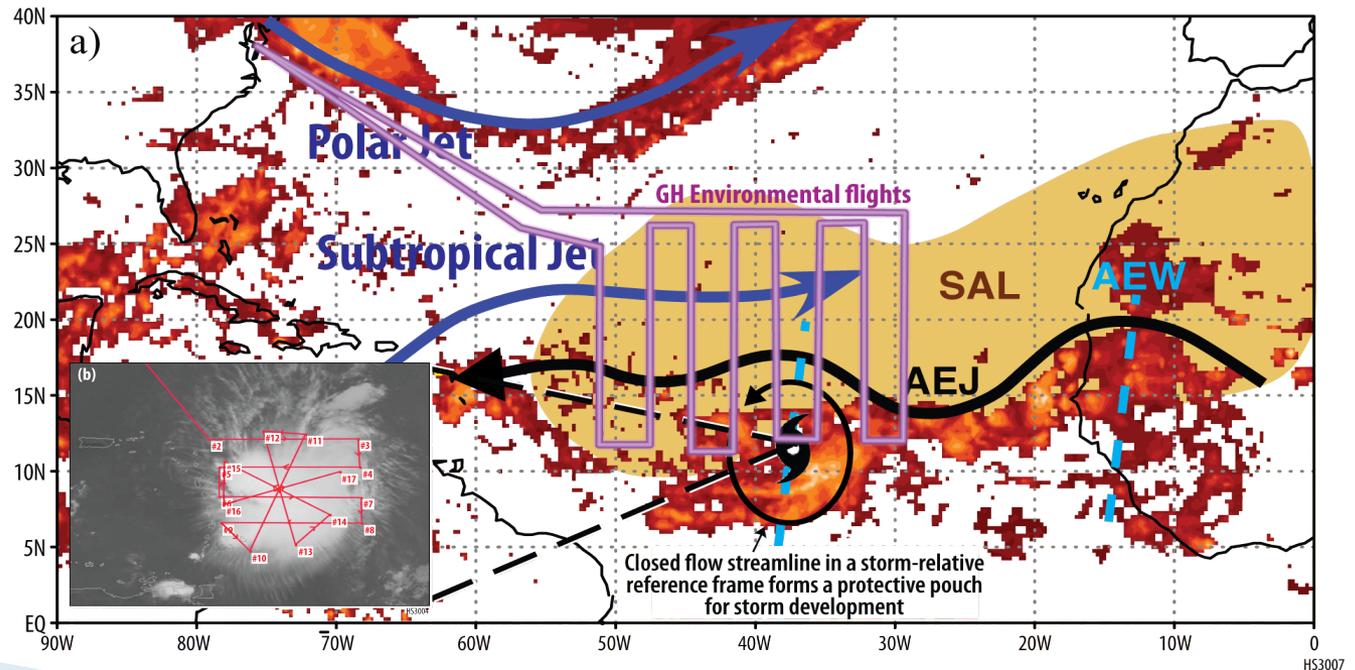
*16 hour loiterer is more realistic for Inner circle;*

*6 hour loiterer is more realistic for outer circle*

**SO, WHAT DOES THIS MEAN FOR HS3?**

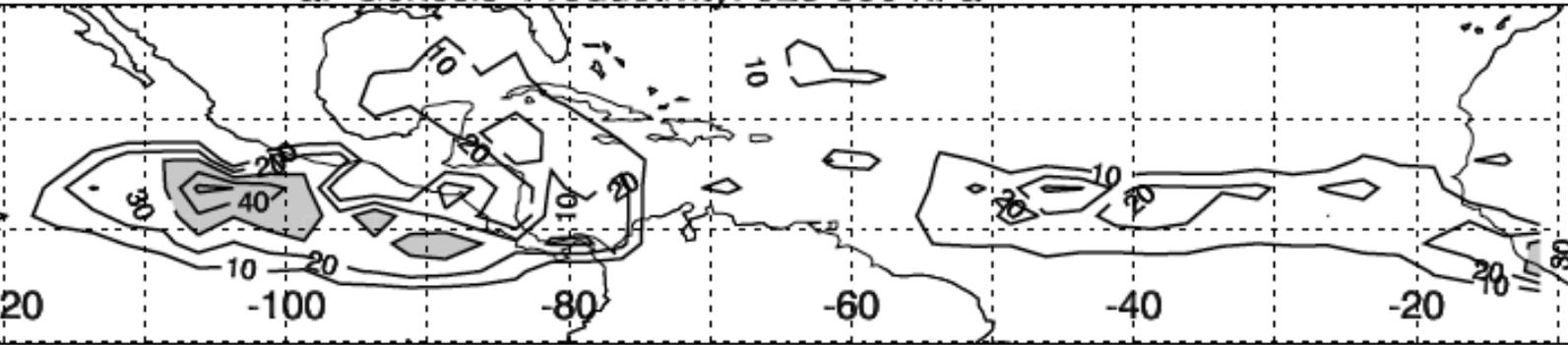
With apologies to Scott, who has already corrected some of the previously shown optimistic flight plans (e.g. this one for >32 hours), it is time to deal with reality and plan carefully for what we are able to do.

Let's start by reviewing the genesis situations from PGI (2010). The next slide places 2010 storm formations on Kerns et al. (2009)'s map of "genesis productivity" .....

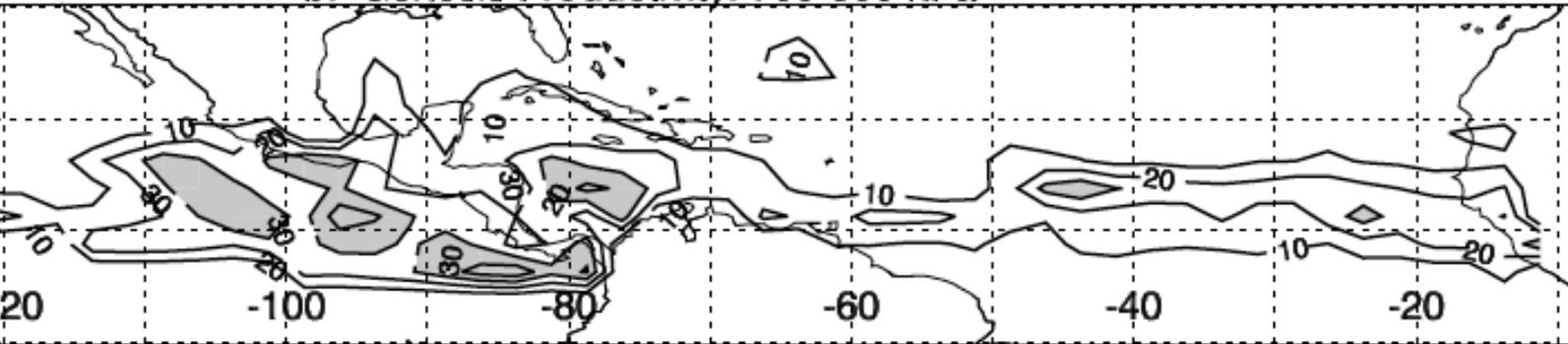


Orange shading is 24-h precipitation

a. Genesis Productivity: 925-850 hPa

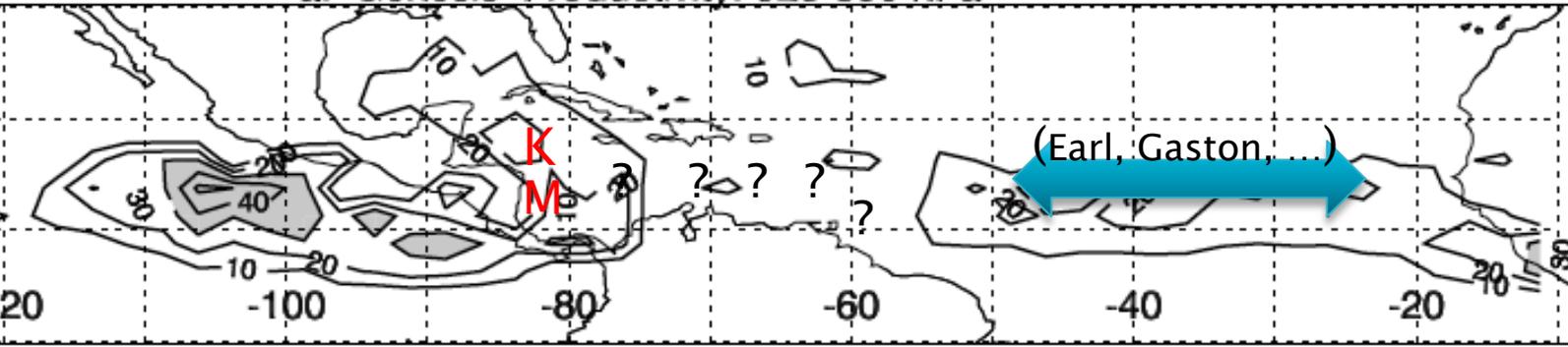


b. Genesis Productivity: 700-600 hPa

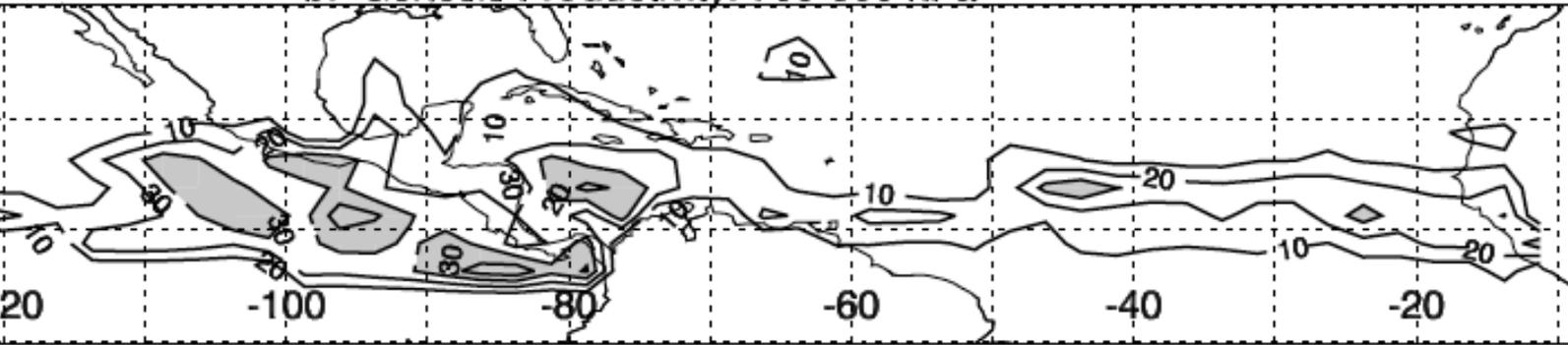


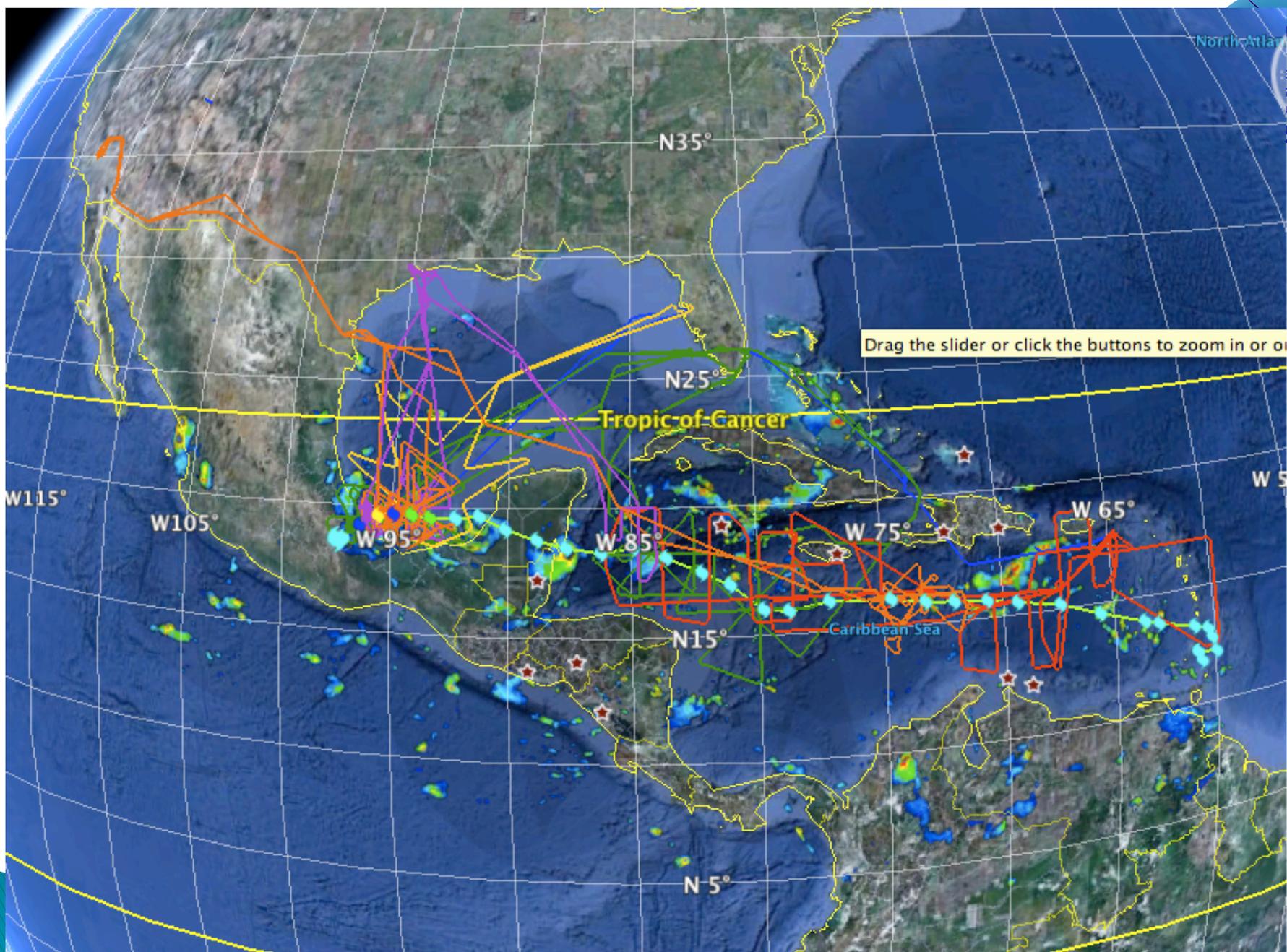
Kerns et al. (2009) defined genesis productivity as the ratio between density of *developing* vorticity maxima to density of *all* vorticity maxima. Sample size: About 600 low and 600 mid-level vort maxima between 1998-2001.

a. Genesis Productivity: 925-850 hPa



b. Genesis Productivity: 700-600 hPa





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

Courtesy Scott Braun



# Tentative recommendations:

- ▶ For genesis OR intensity change research, do repetitions of *any* flight pattern. (Otherwise we can't improve on what was done in 2010.)

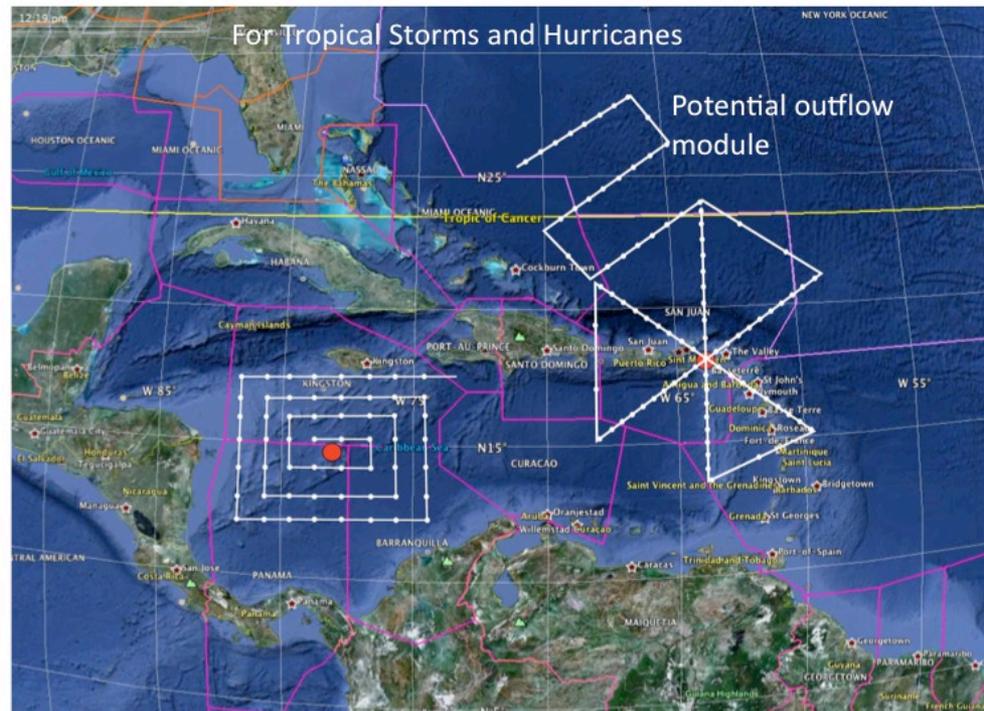


# Tentative recommendations:

- ▶ For genesis OR intensity change research, do repetitions of *any* flight pattern. (Otherwise we can't improve on what was done in 2010.)
- ▶ Guidelines: Ferry distance (2-way) =  $9^\circ$  lat. + flight pattern length =  $96^\circ$  lat. (16 hrs) is OK. Example: Can repeat butterfly with 6 radials to  $6^\circ$  lat. In all directions from center point at  $13^\circ$  N  $53^\circ$  W (covers  $7^\circ$  N –  $19^\circ$  N)

# Potential Flight Modules

## Environmental Global Hawk Flights



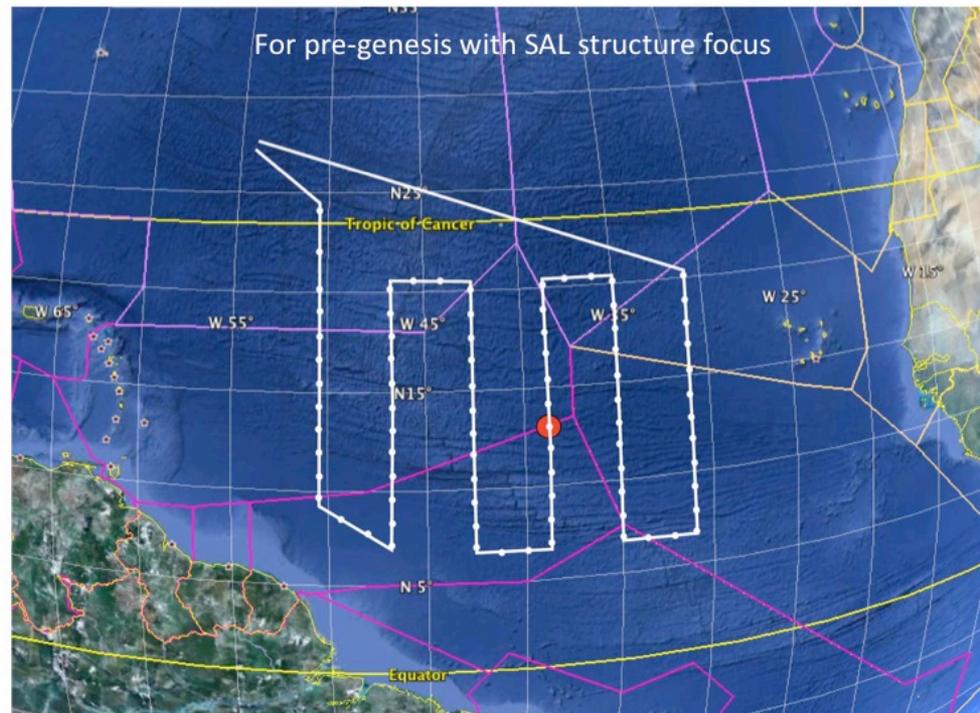


# Tentative recommendations:

- ▶ For genesis missions, anything in the MDR (east of 50 W) may have to stand on its own, without any follow-up data for 3 days.
- ▶ Guidelines: If science priorities call for long-legged N-S lawn mower pattern east of 50 W extending north into SAL *and* quite far south, this can be done, but cannot be repeated. (see example– this is ~ 32 hour mission, but can be easily shortened to 26 h.

# Potential Flight Modules

## Environmental Global Hawk Flights





# Tentative recommendations:

- ▶ For genesis OR intensity change research, do repetitions of *any* flight pattern. (Otherwise we can't improve on what was done in 2010.)
- ▶ For genesis missions, anything in the MDR (east of 50 W) may have to stand on its own, without any follow-up data for 3 days.
- ▶ For missions over named storms, we should strive for coordination with both NOAA P-3 and G-IV, for context, radar, microphysics, and time continuity during the data gap, pending the next GH mission.

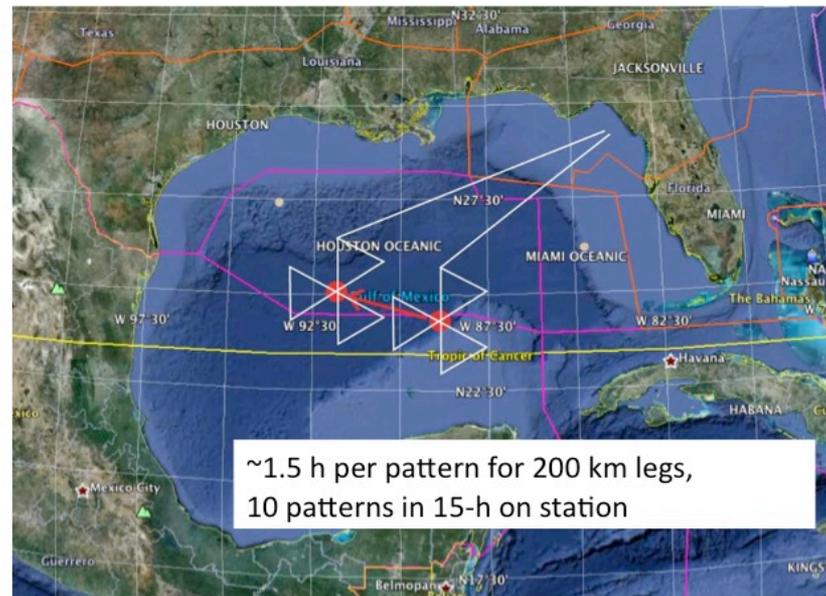


# Tentative recommendations:

- ▶ For missions over named storms, we should strive for coordination with both NOAA P-3 and G-IV, for context, radar, microphysics, and time continuity during the data gap, pending the next GH mission.
- ▶ Guidelines: GH takeoff time 17–18 UTC, for a storm in Gulf, W. Caribbean, or W. Atlantic could permit 4 hours coordination with BOTH NOAA P-3s, (from 22–02 UTC AND 10–14 UTC, landing 17–19 UTC. (Ferry must be < 9 hours total for GH, but this is OK if P-3 mission is from Tampa.)

# Potential Flight Modules

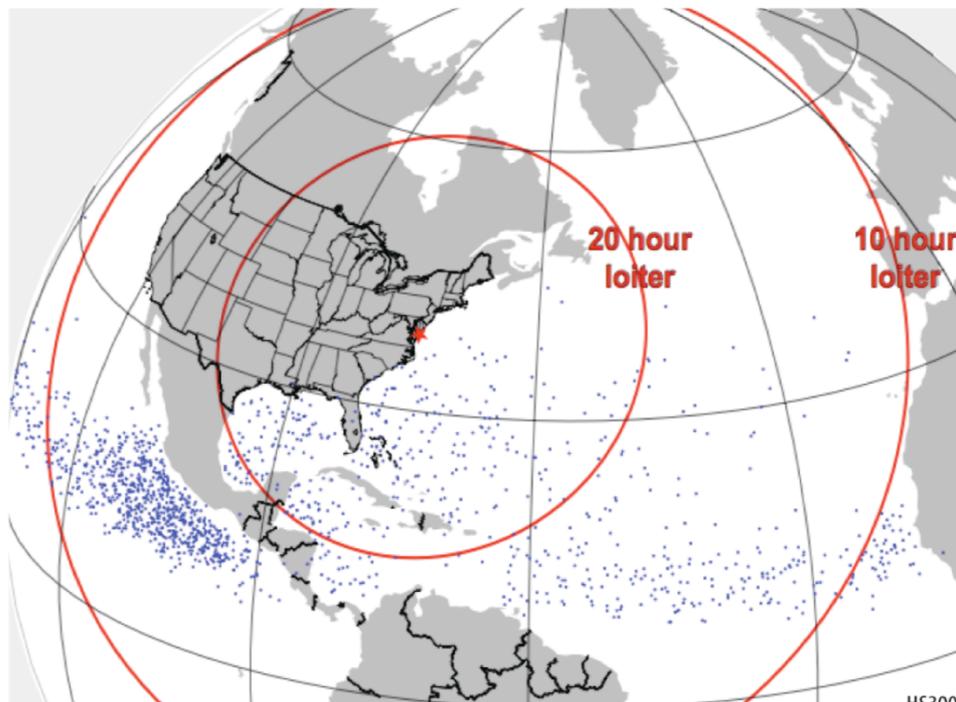
## Over-Storm Global Hawk Flights



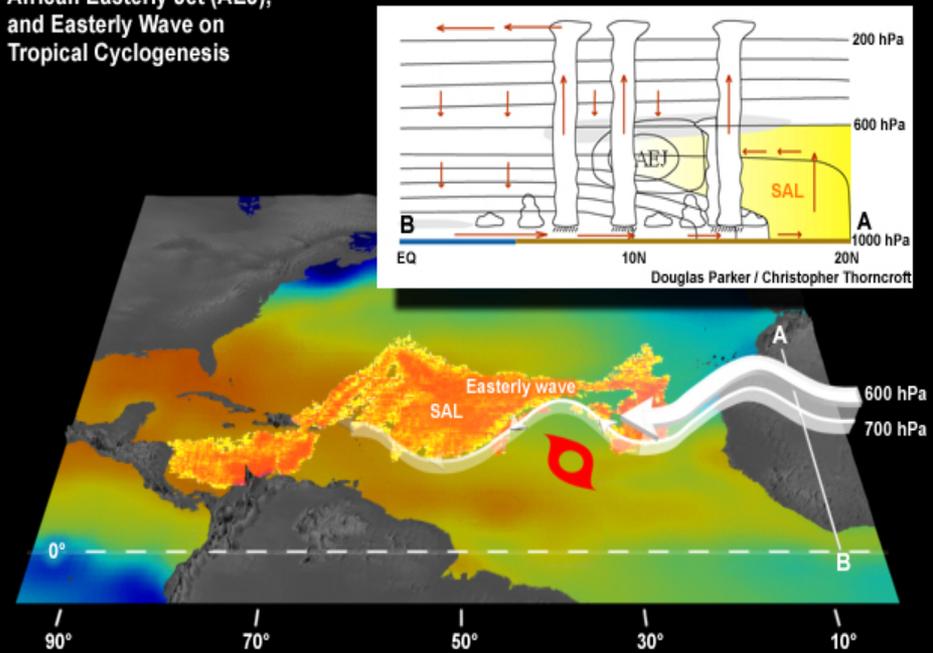
Red dot represents storm center moving westward. Crossing angles at headings of 180, 300, and 60 degrees. Leg lengths can be varied depending on how frequently we want to repeat the pattern.



Questions?  
Comments?  
Disagreements?



Influence of the Saharan Air Layer (SAL), African Easterly Jet (AEJ), and Easterly Wave on Tropical Cyclogenesis

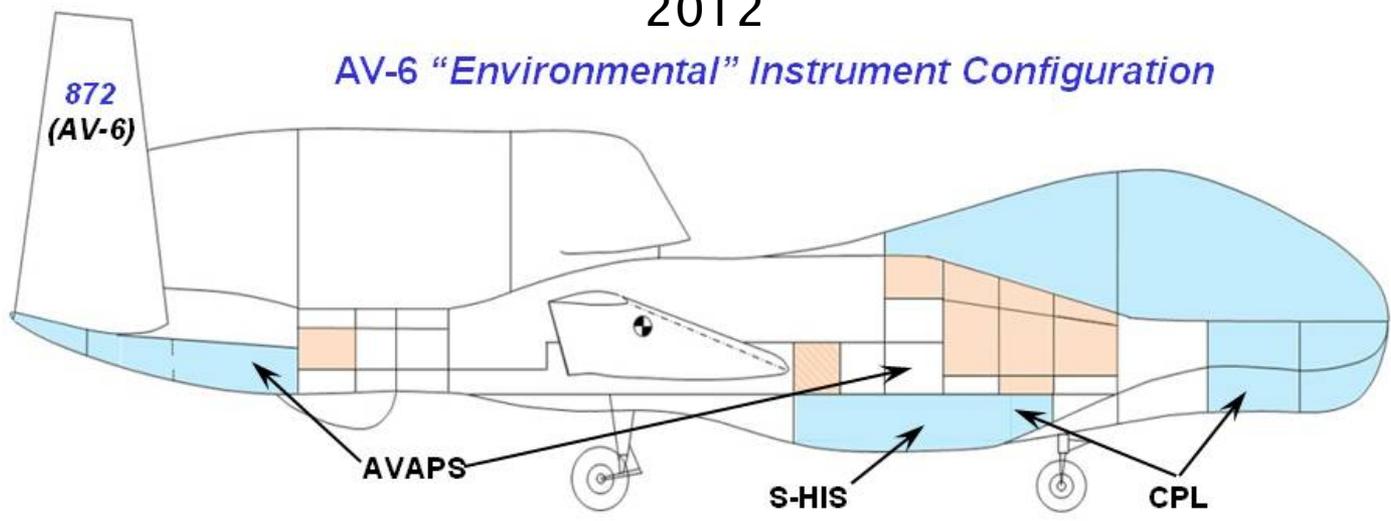




# Environmental Payload

2012

AV-6 "Environmental" Instrument Configuration



2013-2014

AV-6 "Environmental" Instrument Configuration

