NASA TC Research—Applications of the Global Hawk

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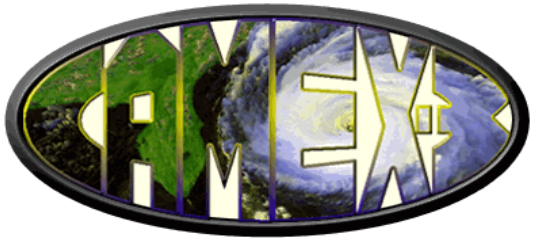
Images from the 2012 HS3 deployment

Today's Presentation

- 2010 Genesis and Rapid Intensification Processes (GRIP) experiment
  - The first use of Global Hawk over hurricanes
- Hurricane and Severe Storm Sentinel (HS3)
  - The first remote deployment of the GH
  - Environmental measurements during Nadine
  - Changes for 2013-2014
- Challenges and lessons learned

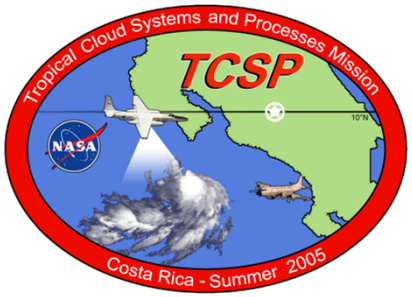
NASA Hurricane Field Experiments

1998



2001

2005



2006

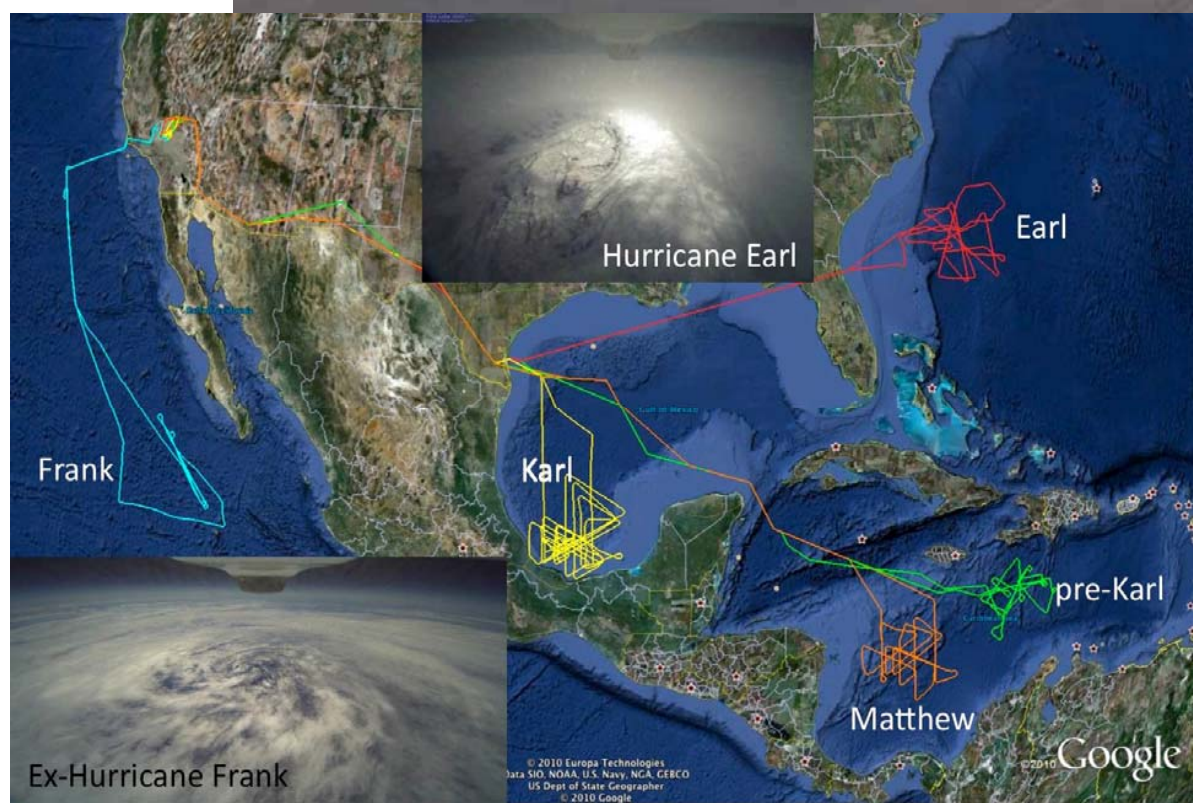
2010

- NASA sponsored field campaigns have helped us develop a better understanding of many hurricane properties including inner core dynamics, rapid intensification and genesis

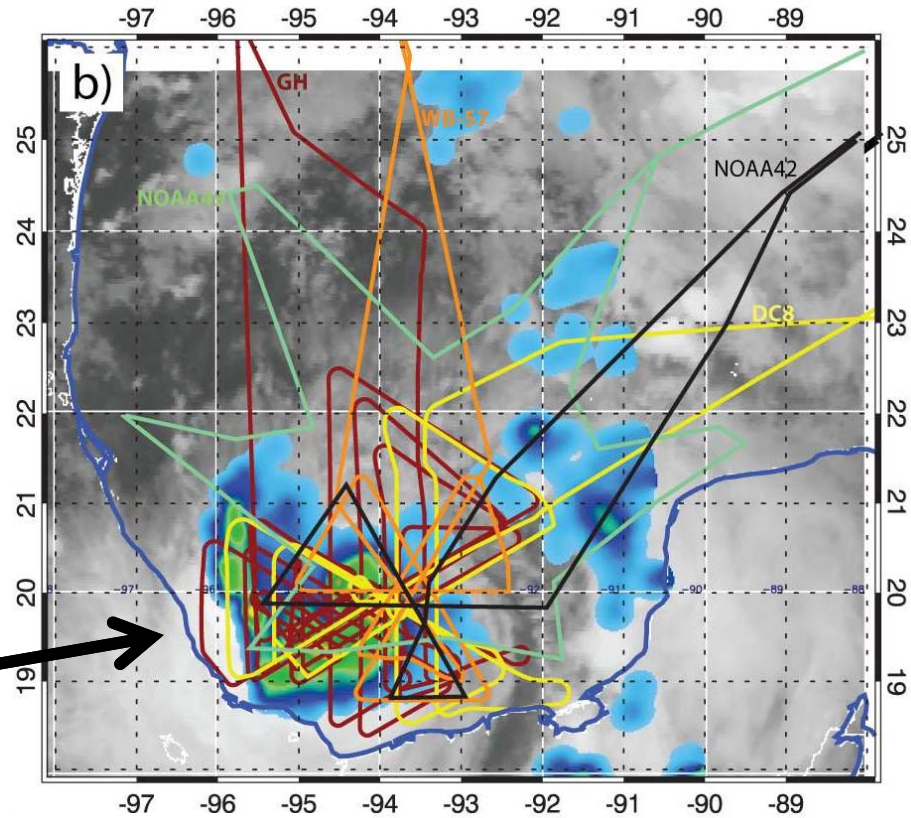
- We do field experiments to accomplish:
- - calibration/validation of satellite sensors
- - evaluation of new sensor concepts
- - process studies

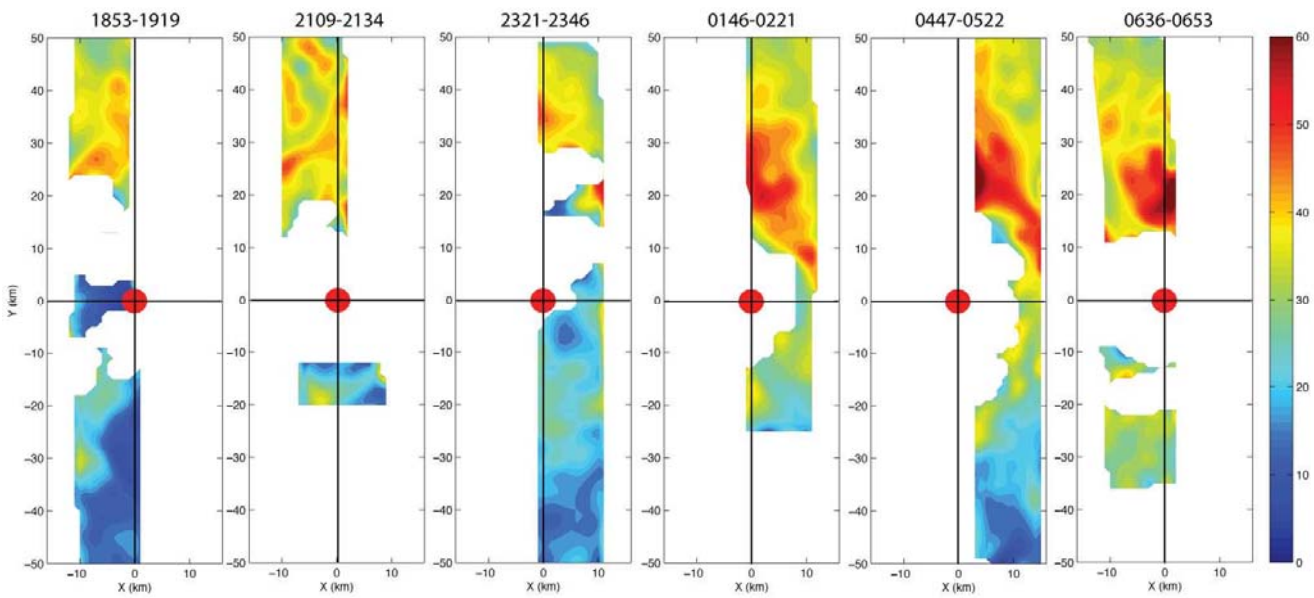
- First ever flights of the Global Hawk over a hurricane; used two satellite quality instruments developed by NASA

- 14 hours over Hurricane Karl during RI, 20 crossings of the eye



Record 5 aircraft in Karl at one time:
NASA DC-8, GH, WB-57; NOAA P-3, G-IV.
Air Force C-130 present at other times.





HIWRAP wind speeds at 3 km MSL during six north-to-south crossings of the eye

Hurricane and Severe Storm Sentinel (HS3)

A NASA Earth Venture 1 (EV-1) Selected Campaign

PI: Scott A. Braun (GSFC)

Science Goal:

To understand hurricane genesis and intensification.

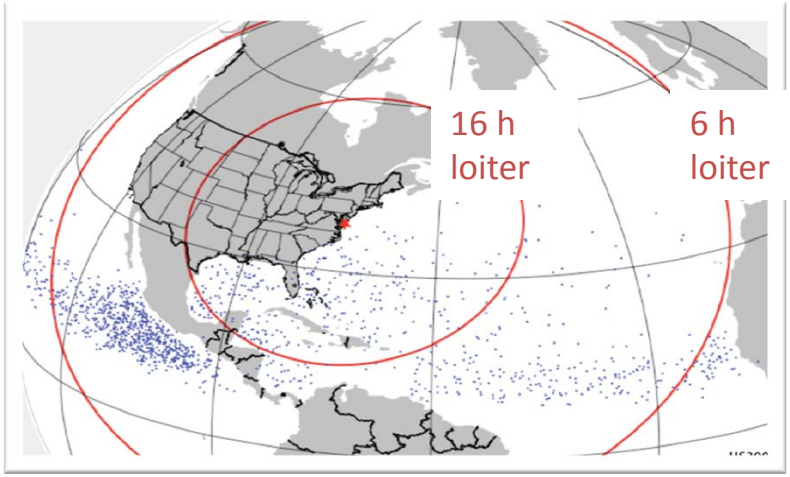
Key Science Questions:

- How do hurricanes form?
- What causes rapid intensity changes?
- What is the role of deep convective cores in intensification?
- What's the role of the Saharan Air Layer?

Deployment Details:

- Deployments in hurricane seasons of 2012-2014
- Based at NASA's Wallops Flight Facility in Virginia
- 275 science flight hours (~10-11 26-hour flights) per deployment

Genesis Locations and Loiter Times



Two Global Hawk (GH) aircraft

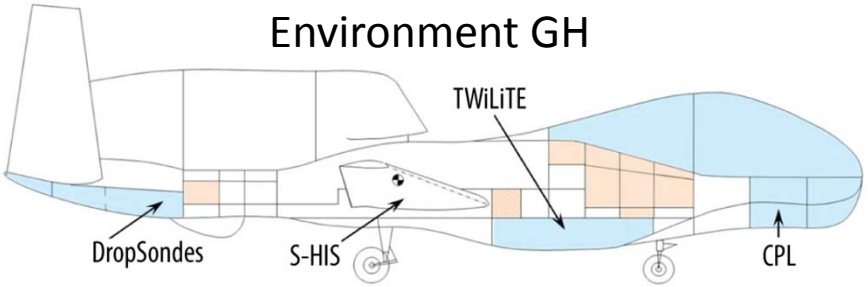
Environment GH instrumentation

- CPL (cloud & aerosol lidar)
- Scanning HIS (T, RH)
- Dropsondes (wind, T, RH)
- TWiLiTE (direct detection wind lidar)

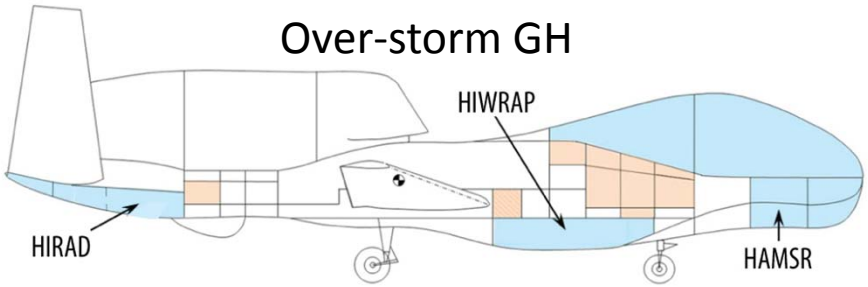
Over-storm GH instrumentation

- HIWRAP (3-D preip. + 3D winds + sfc winds)
- HIRAD (sfc winds and rain)
- HAMSR (T, RH, hydrometeor profiles)

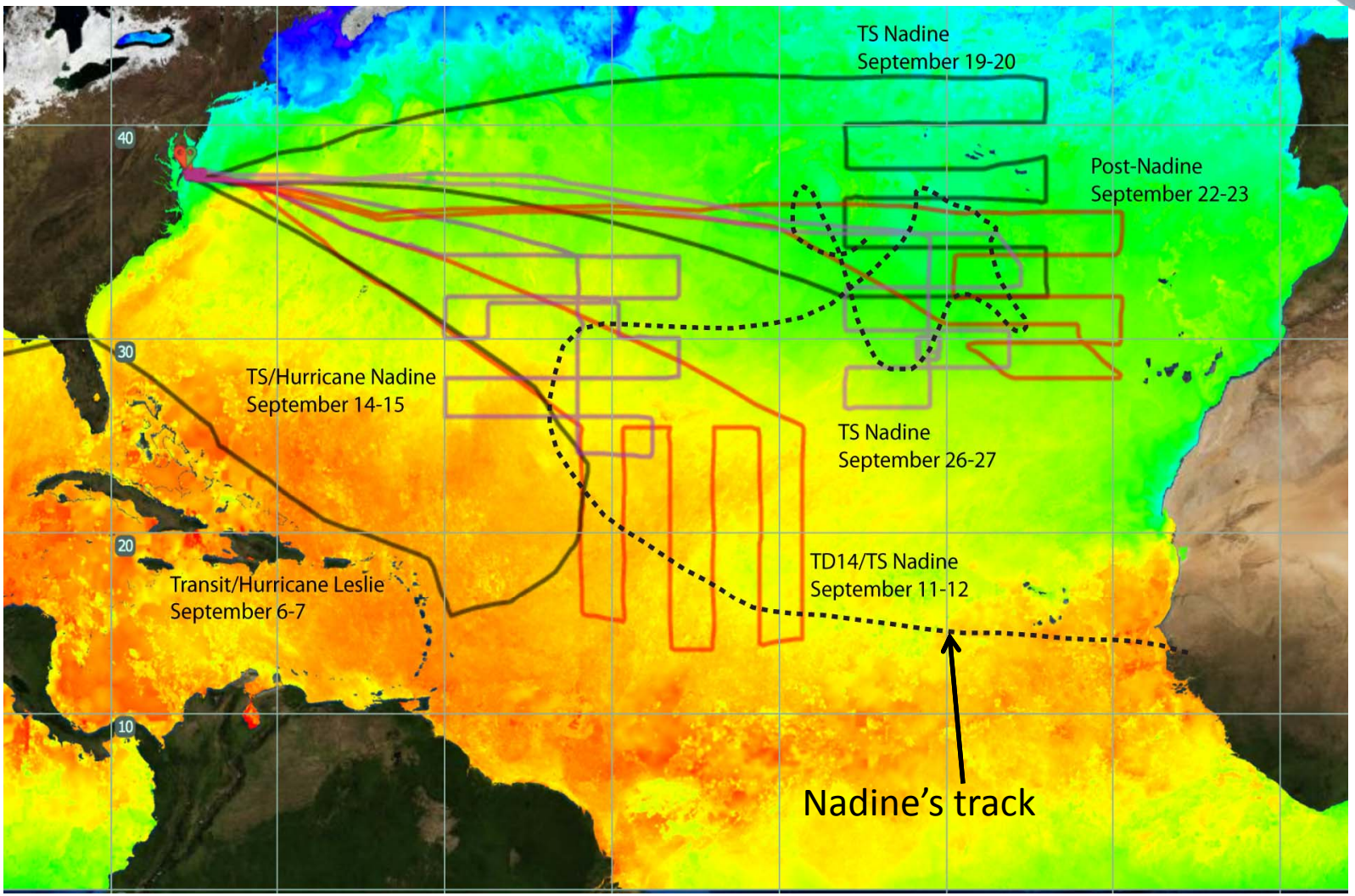
Environment GH



Over-storm GH



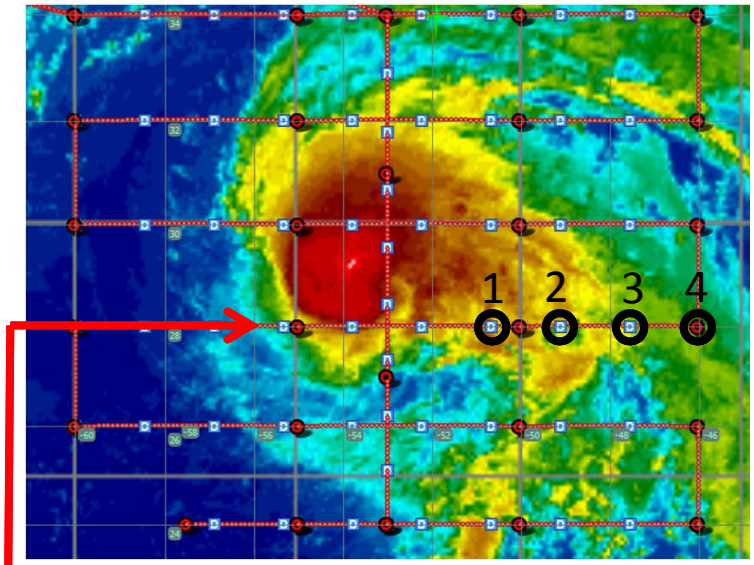
HS3 2012 Deployment

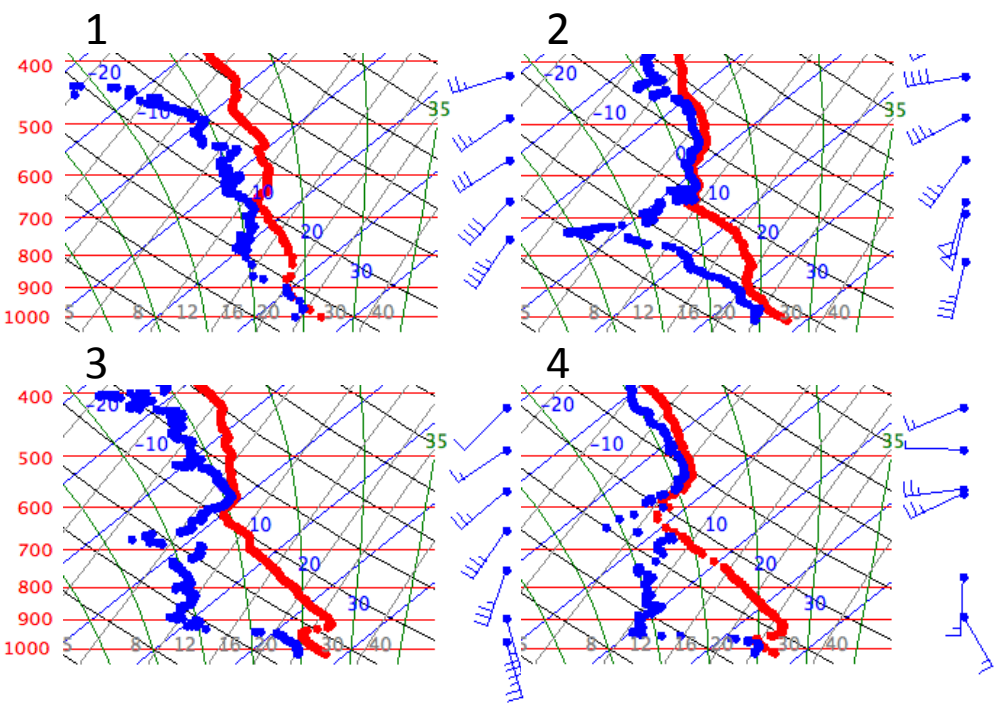


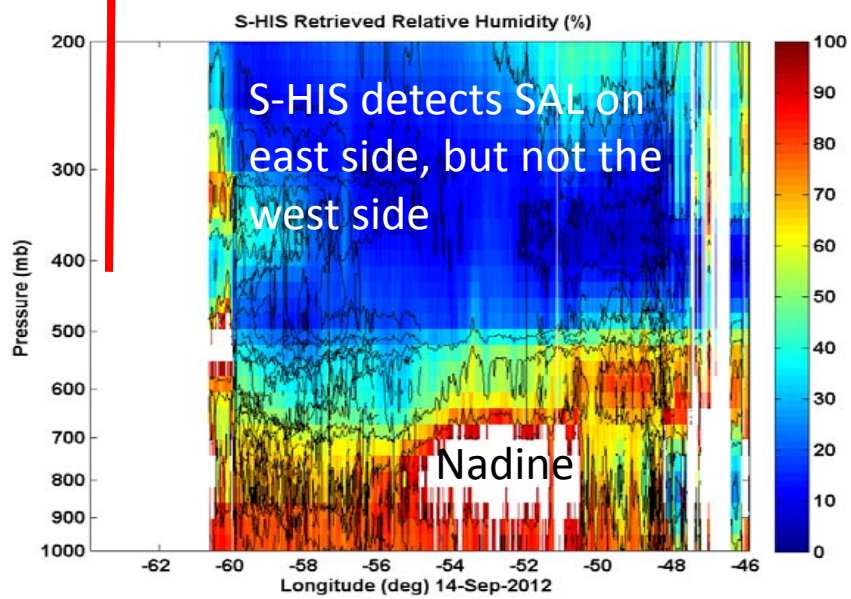
Only AV-6 (the environmental GH) was used in 2012

Intensification of Nadine to Cat 1 Sept 14-15, 2012

- During flight, Nadine became a Cat 1 hurricane
- Goal was to examine storm evolution in an environment with strong vertical wind shear and dry air
- SAL air detected on the northern and eastern sides of Nadine. No clear evidence for direct interaction.

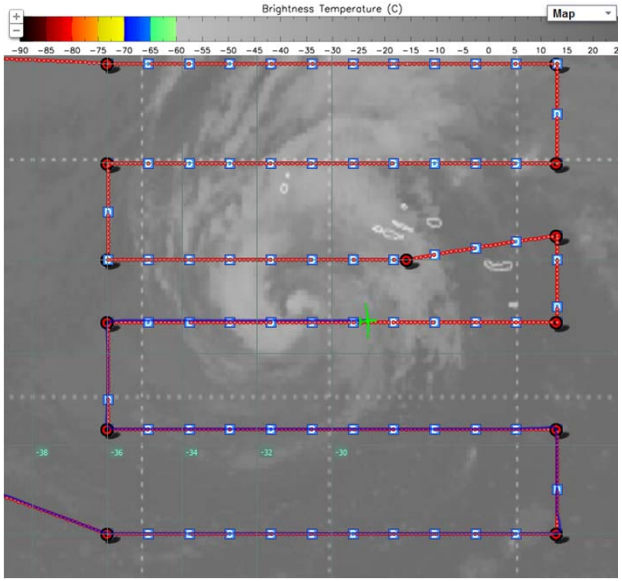


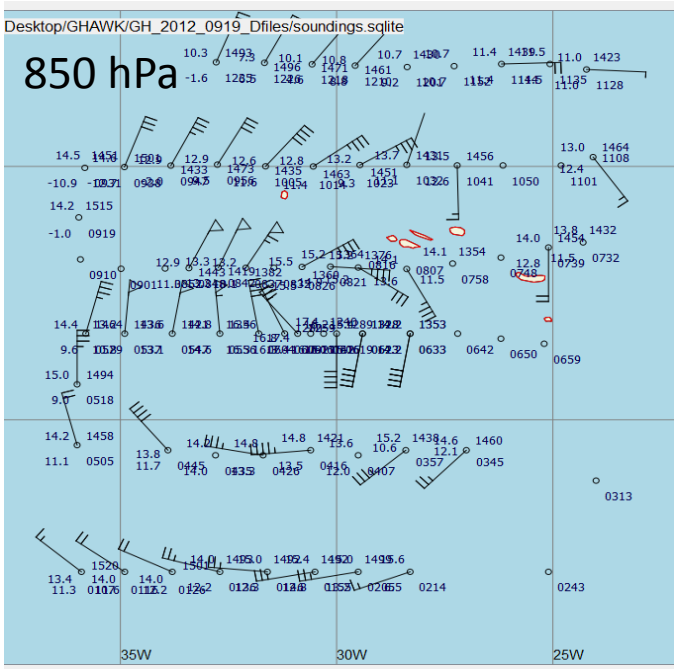


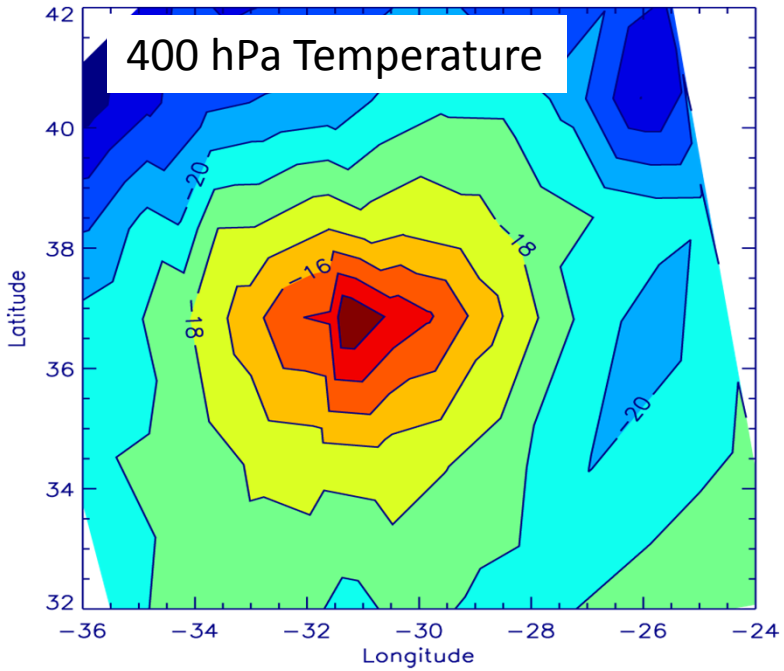


Nadine Survives Despite Adverse Conditions (Sept 19-20)

- Despite strong vertical shear and dry air, Nadine survives
- Dropsondes reveal warm core structure near center through most of the troposphere
- NHC uses HS3 observations to maintain Nadine as a tropical storm

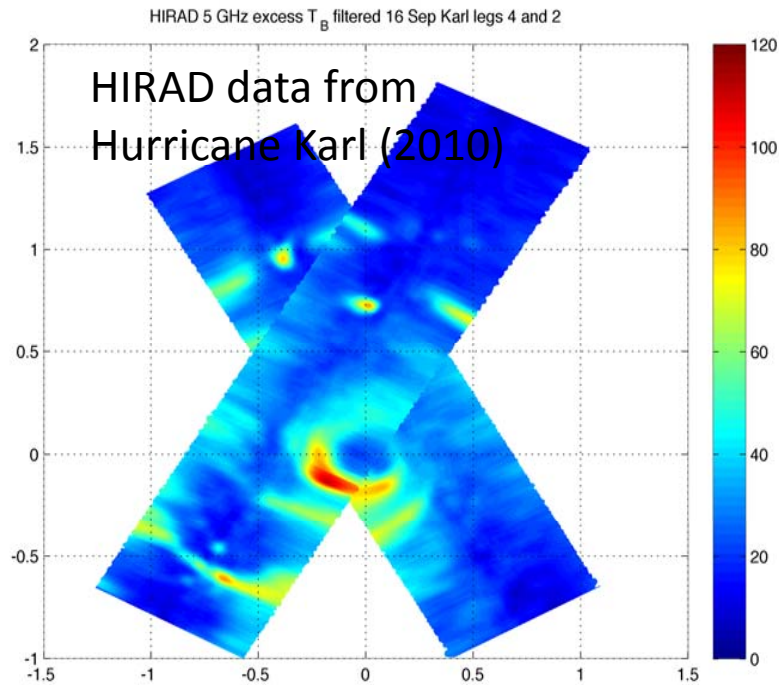


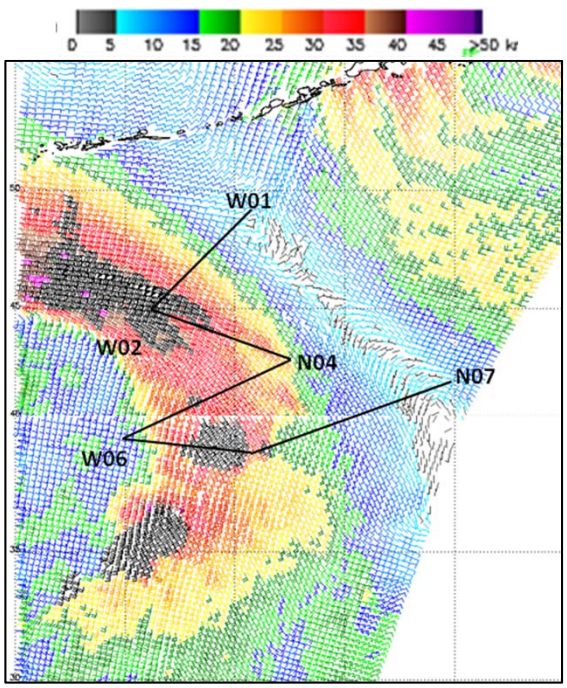


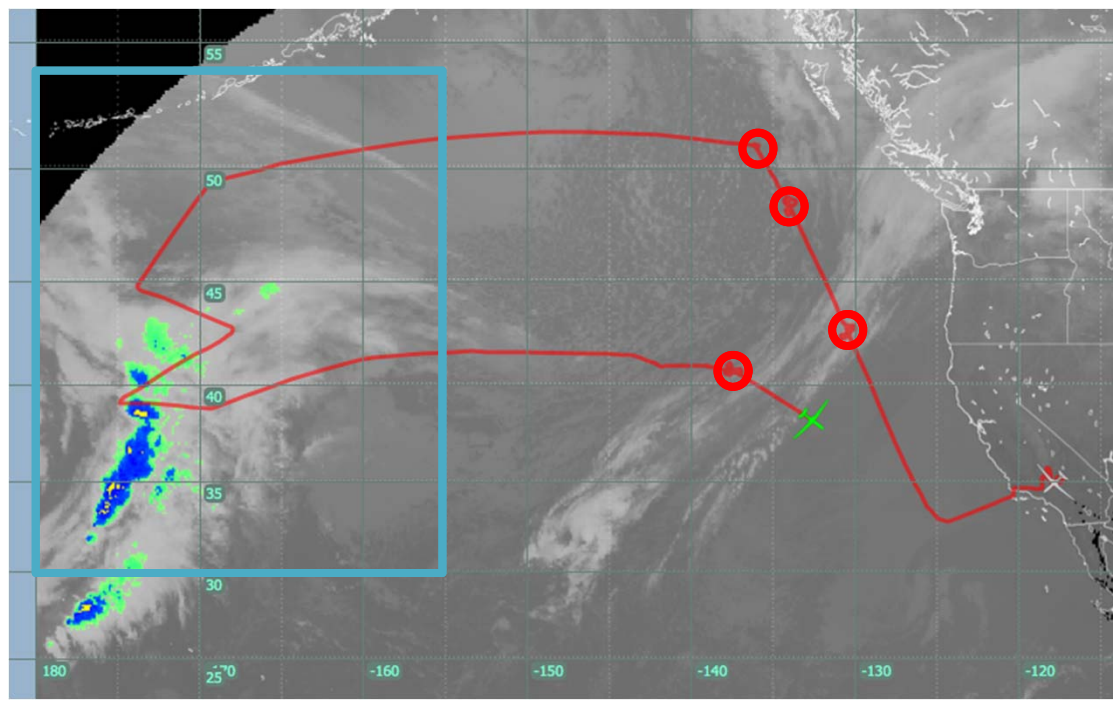


V-1 Prep for 2013-2014

- AV-1 did not make the 2012 deployment due to aircraft issues
- Test flight in Pacific on Nov. 5-6
- In addition to HAMSR and HIWRAP, flying HIRAD for the first time

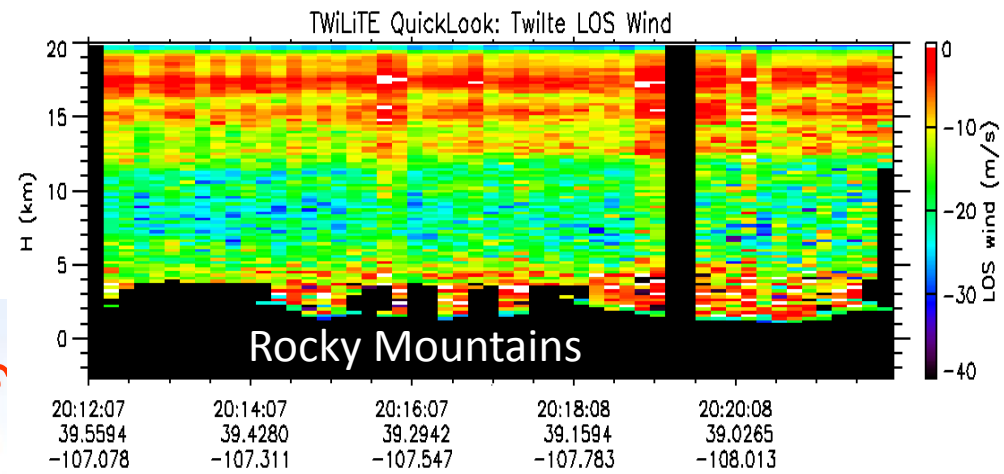


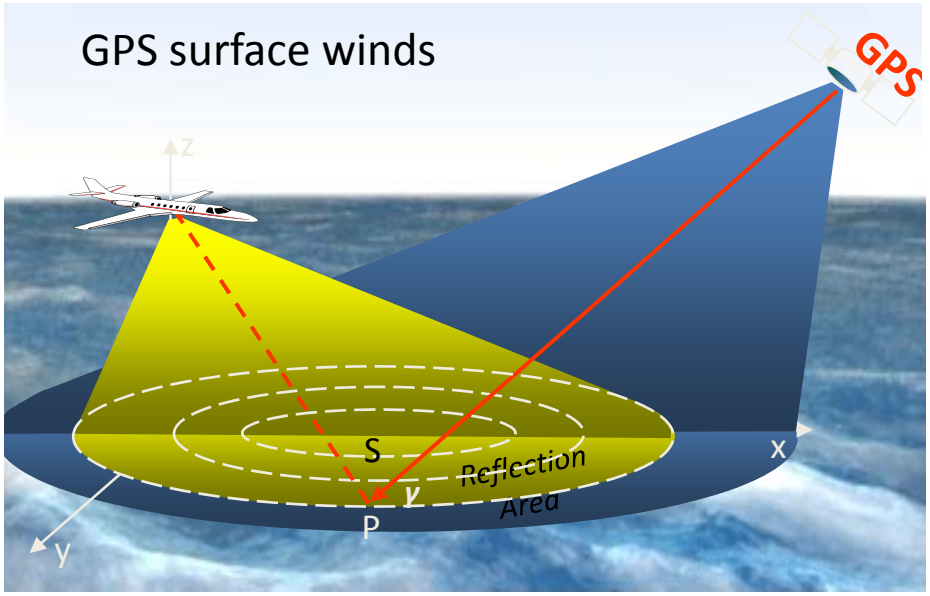


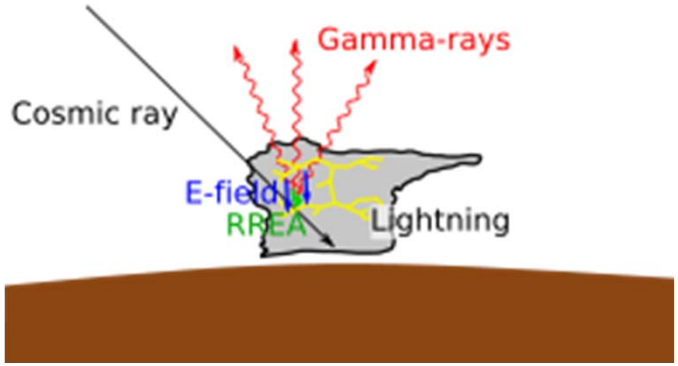


Possible Additions for 2013-2014

- TWiLiTE wind lidar
- Yankee Environmental Systems dropsonde
- GPS surface wind sensors
- Gamma ray detector







Key Challenges To GH Operations

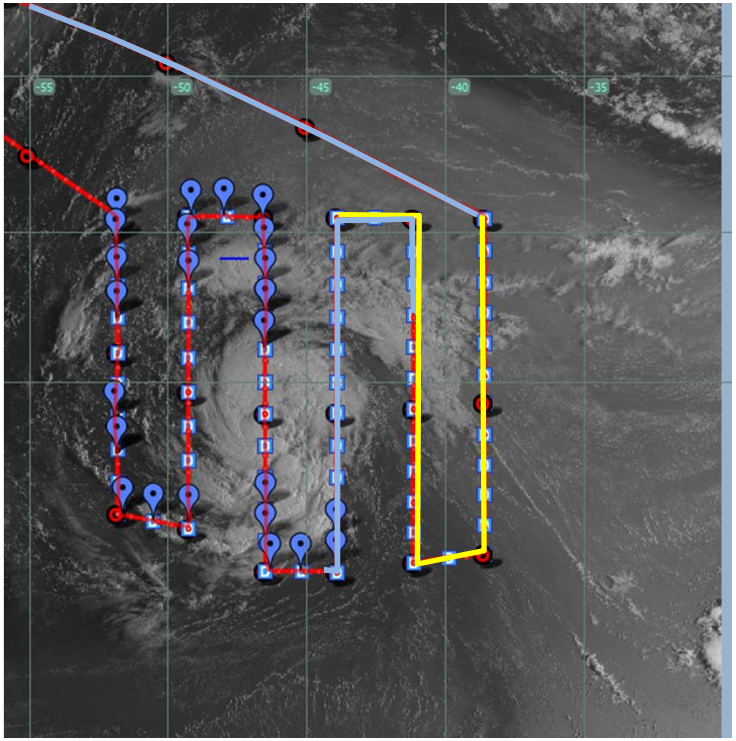
- FAA requires flight-plan review 1 ***business*** day before flight
- Dropsondes significantly limit flexibility in flight planning or adjustments in flight because of FAA requirements
- Chase aircraft might be required
- Hazard (turbulence) avoidance poses challenges, esp. in W. Pac.

Extra Slides

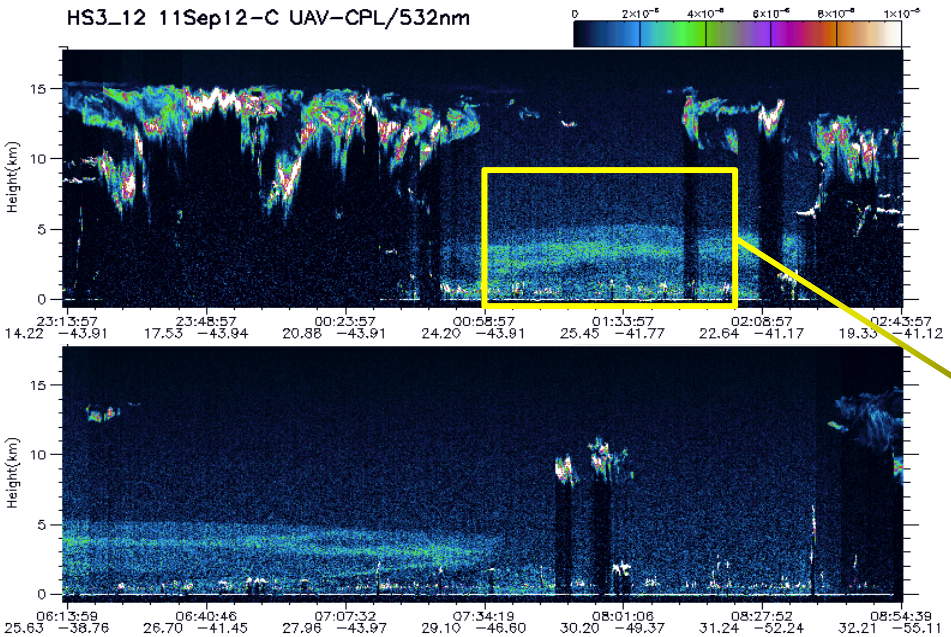
Dropsonde Observations

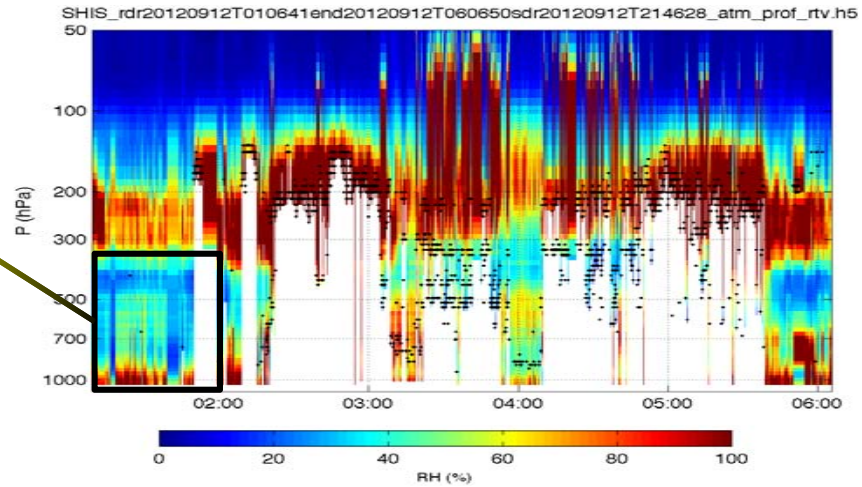
Flight	Target	Sondes	Comments
5-6 Sep 2012	Leslie	30	Transit, Limited Ku
11-12 Sep	Nadine	34	System fault -– parachute cap anomaly; RF noise issue emerges in flight
14-15 Sep	Nadine	70	RFI continues
19-20 Sep	Nadine	76	RFI continues
22-23 Sep	Nadine	58	RFI continues
26-27 Sep	Nadine	75	RFI improves
6 Oct	NPP underflight	0 (24 planned)	Sensor failure prevented drops
Total Sondes		343	

The Formation of Nadine (Sept 11-12)



- During flight, storm became Tropical Depression 14 and then Tropical Storm Nadine
- Goal was to examine interaction of Nadine with the Saharan Air Layer
- Instruments detected SAL air only on northern and eastern sides of Nadine. No evidence for direct interaction.





HS3 Data

- Real-time products were available through the Mission Tools Suite (mts.nasa.gov)
- Research products will be made available after QC/processing, likely up to 6-9 months
- For complete information on HS3, go to

  http://espo.nasa.gov/missions/hs3/