NASA Global Hawk: Project Update and Future Plans

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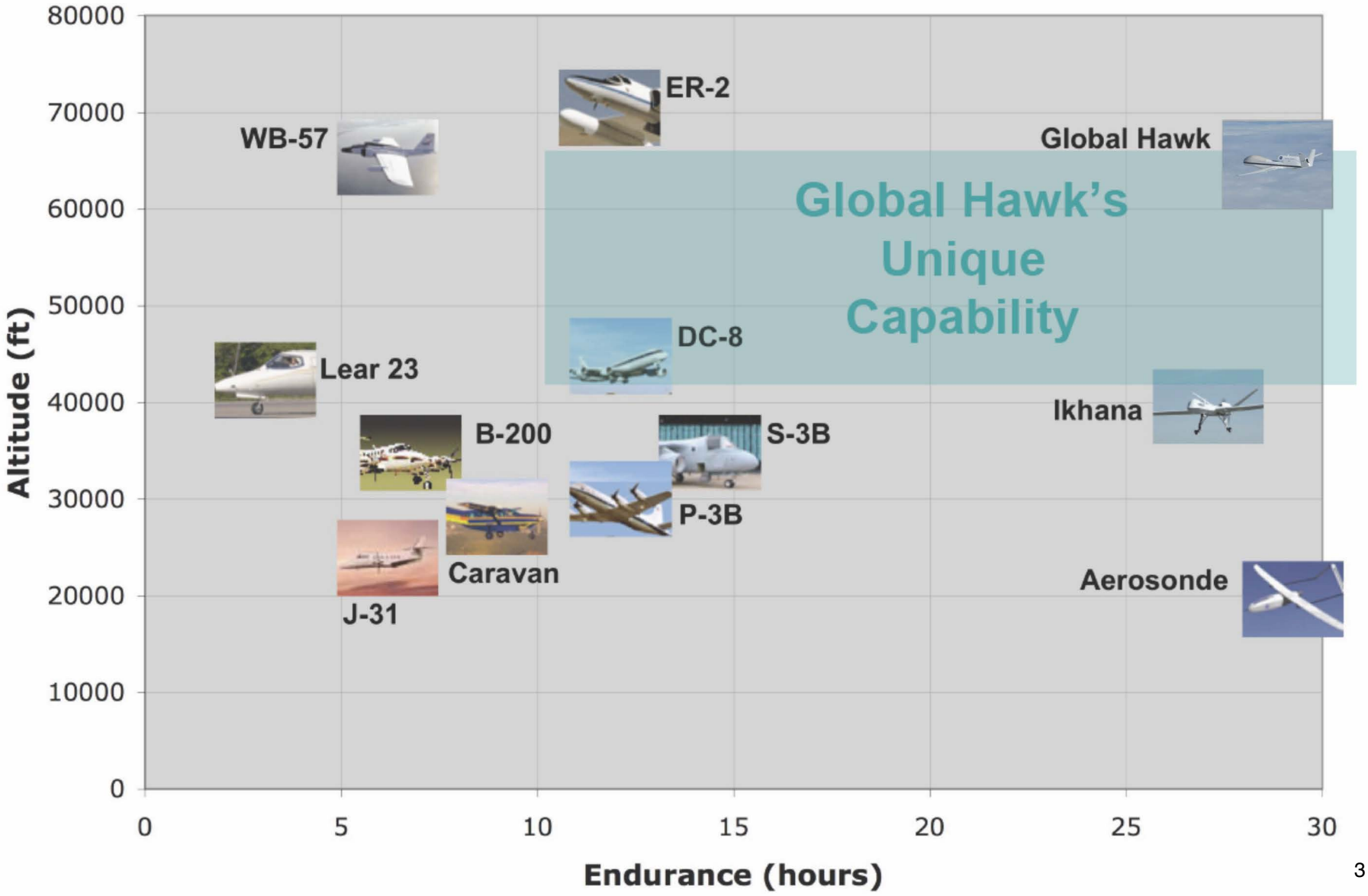
Edwards Air Force Base and NASA Dryden Flight Research Center

NASA Dryden Aircraft Fleet
(as of November 2008)

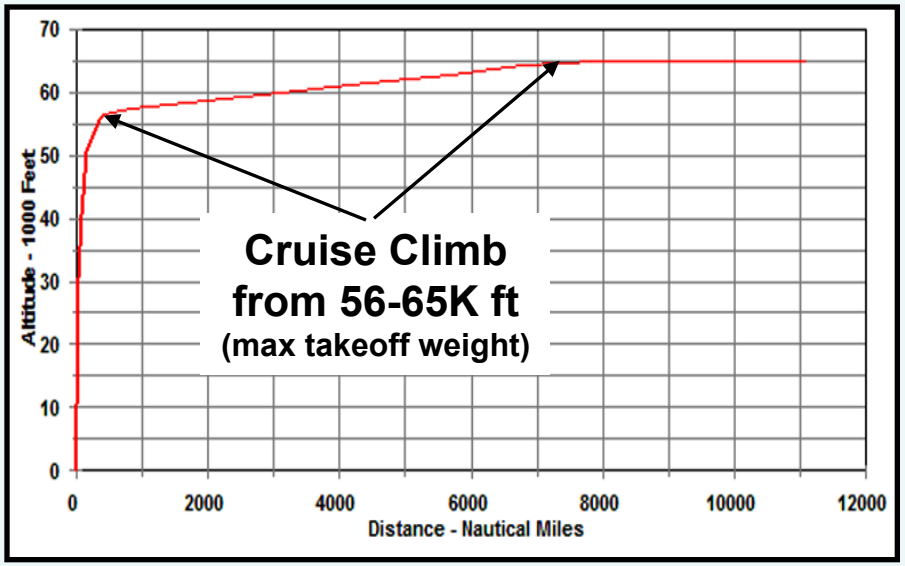
NASA's Airborne Science Program Aircraft Capabilities



NASA Global Hawk System

- **Two USAF Pre-Production Global Hawk aircraft were transferred to NASA in September 2007. (A third aircraft arrived in January 2010)**
- **A combined NASA/Northrop Grumman team is maintaining, modifying, and operating the UAS through a 5-year partnership. (2008-2013)**
- **The first flight of the NASA Global Hawk occurred on 23 October 2009. The flight lasted 4 hours and reached 61,400 ft with no anomalies noted.**

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



2010 NASA Global Hawk Flights Outside the EAFB Airspace

Flight Summary

- 9 Flights
- 190.5 Total Hours
- ~64,000 nmi

Certificates of Authorization

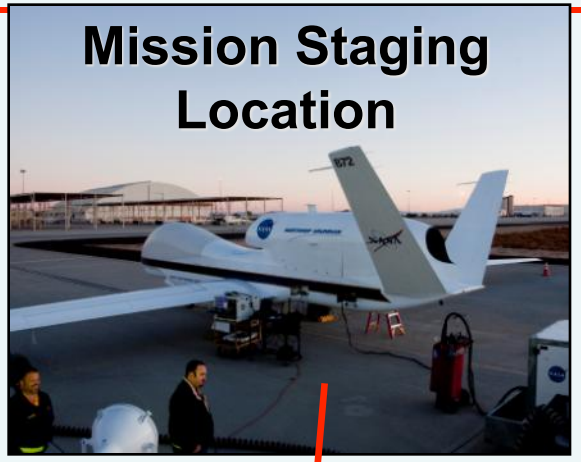
- Pacific-Alaska-Arctic
- Western Atlantic-Caribbean-Gulf of Mexico

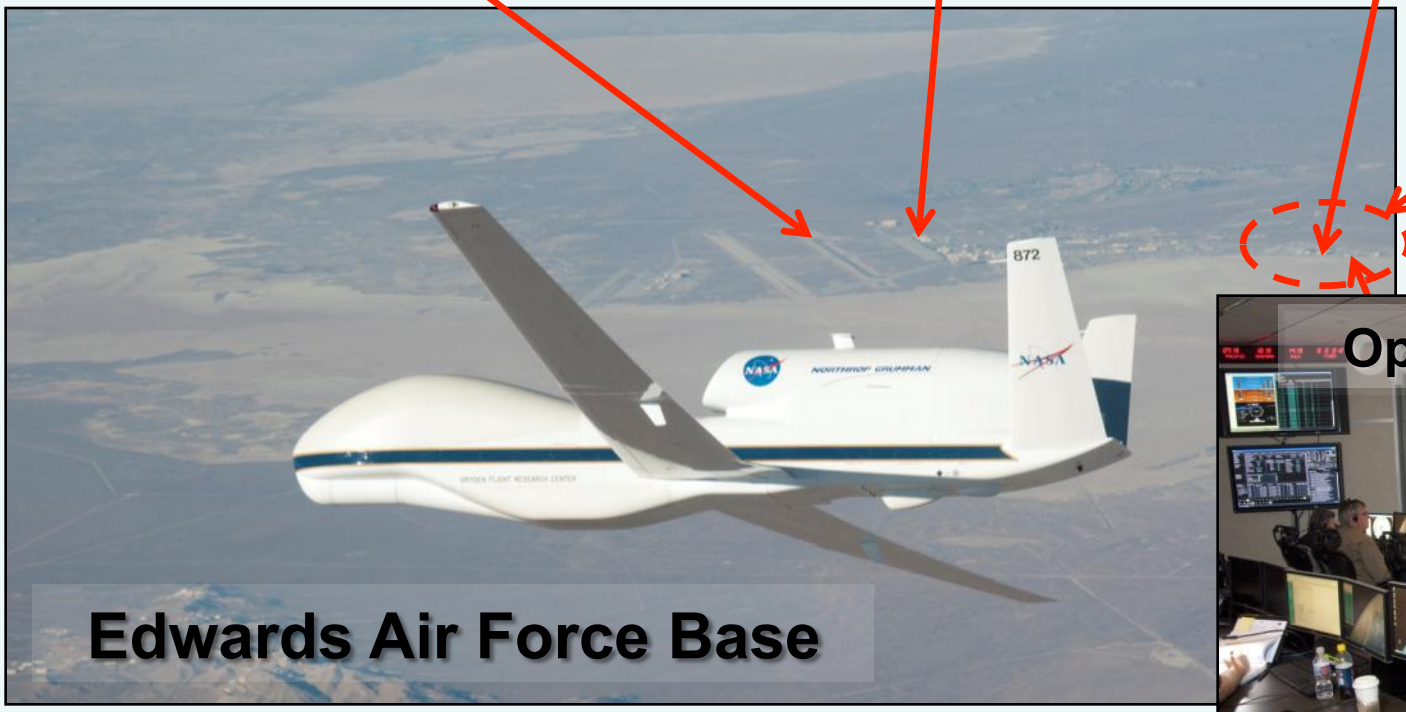
First Year Global Hawk Missions

	TN871 (AV-1)		TN872 (AV-6)		
Date	Flight Number	Duration, hr	Flight Number	Duration, hr	Flight Objective
10/23/09			0044	4.0	Return to flight for AV-6, Functional Check flight
10/29/09			0045	2.8	Completion of Functional Check Flight objectives
11/4/09			0046	1.4	Pilot Proficiency
11/9/09			0047	0.9	Pilot Proficiency
11/9/09			0048	1.2	Pilot Proficiency
3/3/10			0049	2.6	Checkout flight for Payload Support System
3/5/10			0050	9.2	Checkout flight for Payload Support System
3/11/10			0051	10.3	Checkout flight for Payload Support System
4/2/10			0052	6.3	GloPac Instrument check-out flight in the range
4/7/10			0053	14.1	GloPac Science Flight #1
4/13-14/10			0054	24.4	GloPac Science Flight #2
4/23-24/10			0055	28.6	GloPac Science Flight #3
4/30/10			0056	9.3	GloPac Science Flight #4
5/27/10	0068	4.1			Return to flight for AV-1, Functional Check flight
6/15/10	0069	0.7			Pilot Proficiency
6/15/10	0070	0.8			Pilot Proficiency
6/22/10	0071	0.8			Pilot Proficiency
6/22/10	0072	1.0			Pilot Proficiency
6/29/10	0073	4.3			Pilot Proficiency
8/15/10			0057	6.1	GRIP Instrument check-out flight in the range
8/24/10			0058	2.5	Dropsonde test flight
8/28/10			0059	15.3	GRIP Science Flight #1
9/1-2/2010			0060	24.2	GRIP Science Flight #2
9/12-13/2010			0061	24.3	GRIP Science Flight #3
9/16-17/2010			0062	25.2	GRIP Science Flight #4
9/23-24/2010			0063	25.1	GRIP Science Flight #5
10/13/10	0074	1.0			Pilot Proficiency
10/13/10	0075	1.7			Pilot Proficiency
10/21/10	0076	0.8			Pilot Proficiency
Totals	**9 flights**	**15.2**	**20 flights**	**237.8**	

First Year of Operations	**29 Flights**	**253 hours**

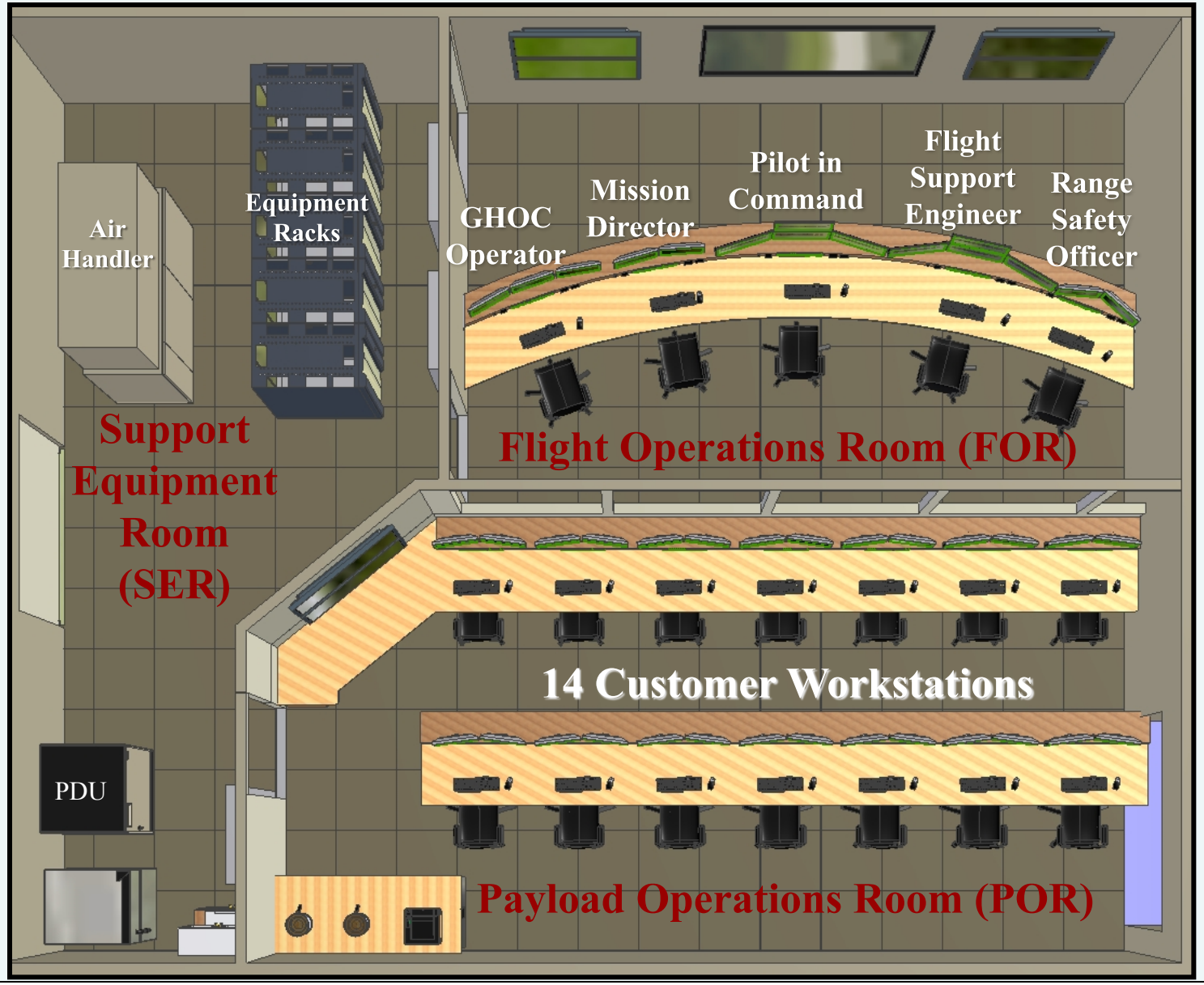
NASA Global Hawk Operations Overview





NASA Dryden Flight Research Center

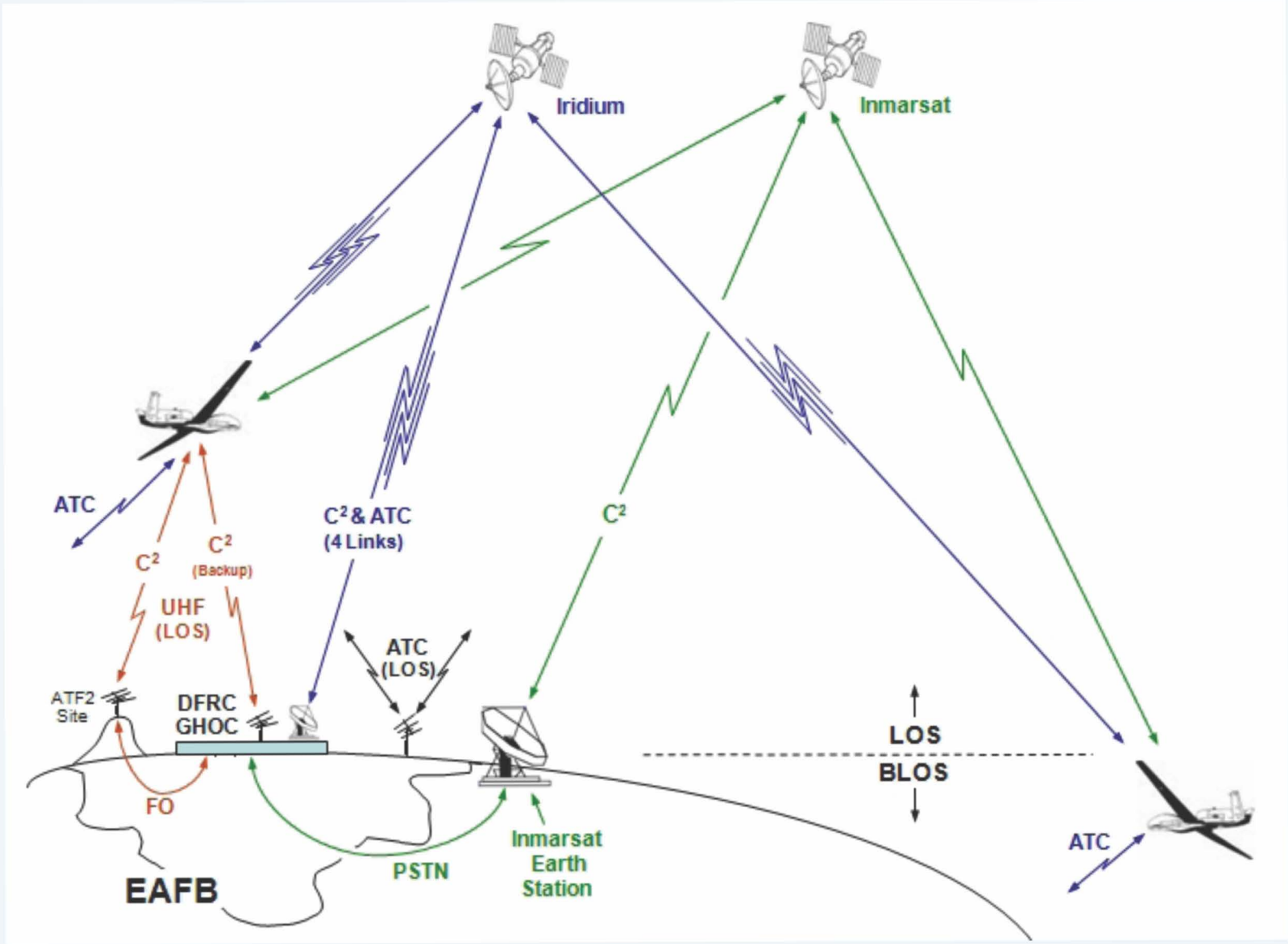
Global Hawk Operations Center (GHOC)



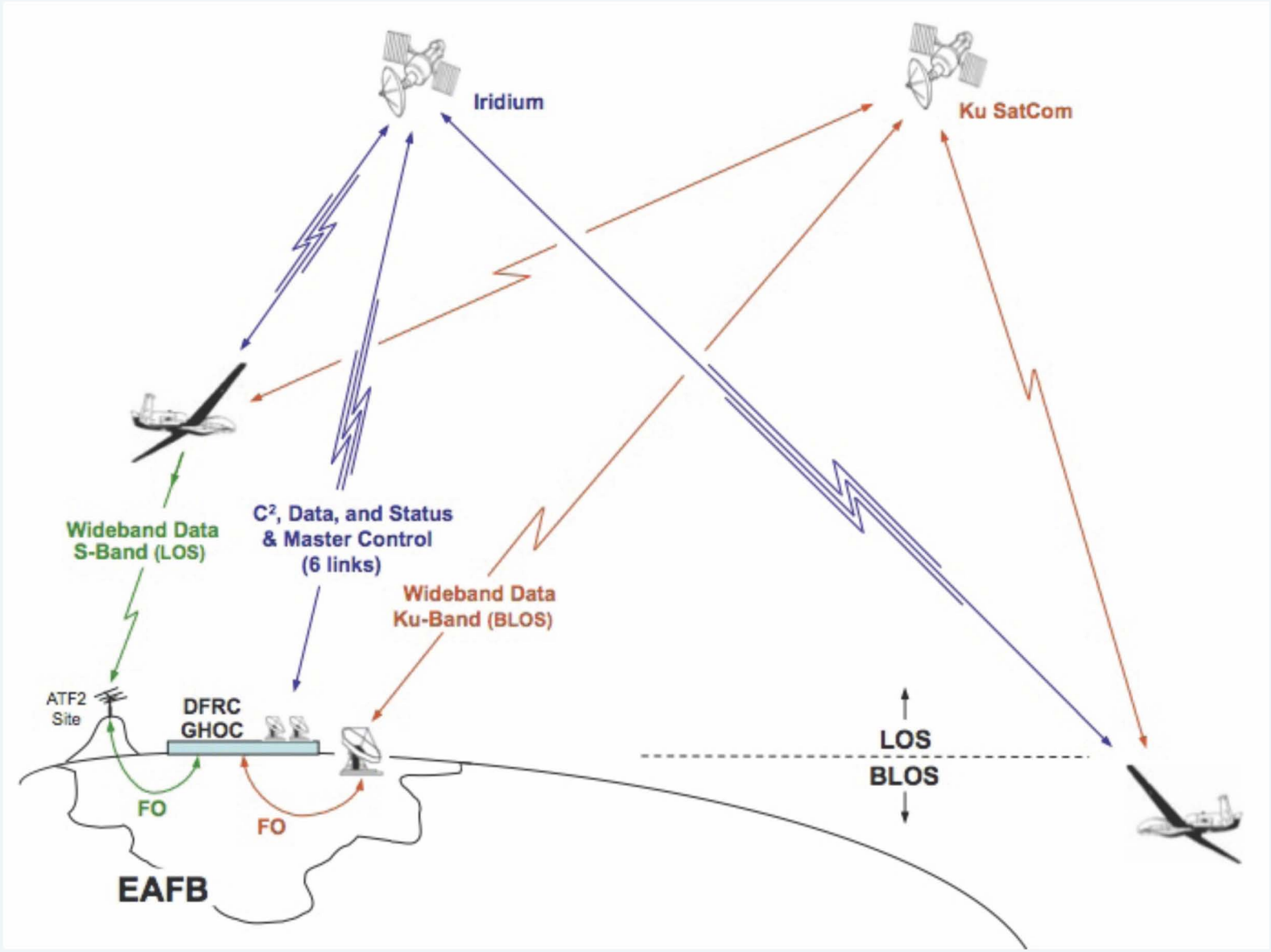
Facility Entrance

Global Hawk Operations Center (GHOC)

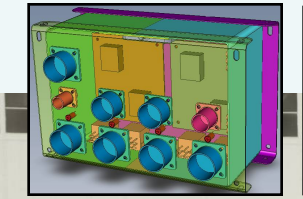
Flight Control and Air Traffic Control Communications Architecture



Payload Communications Architecture

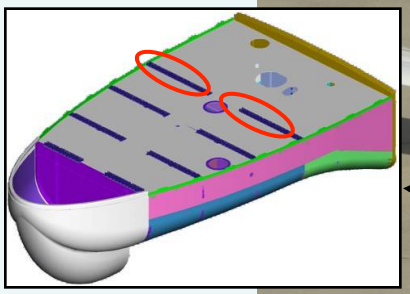


Payload Integration and Accommodations

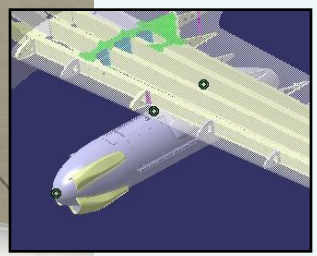


Experiment Interface Panel & Ethernet Switch (located throughout the aircraft providing power and communications)

Payload Integration Software T&E

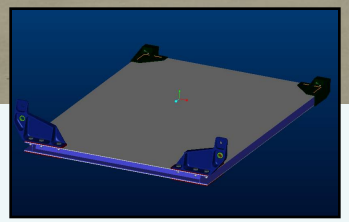


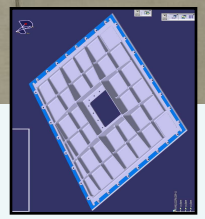
Mounting Rails



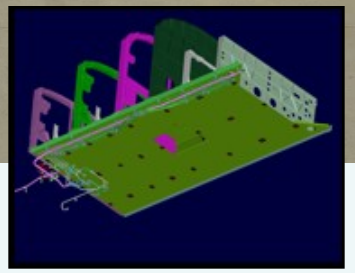
Wing Pods (future capability)

Bay Under the Nose





Pallets and Hatches



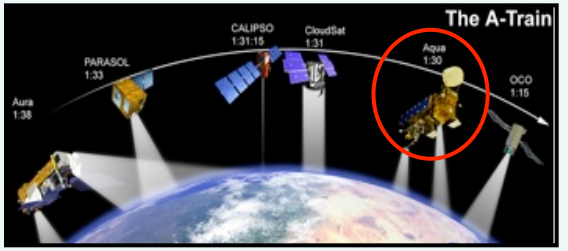
Mounting Hard Points

Global Hawk Pacific 2010 (GloPac)

First Global Hawk Science Mission (March-April 2010)

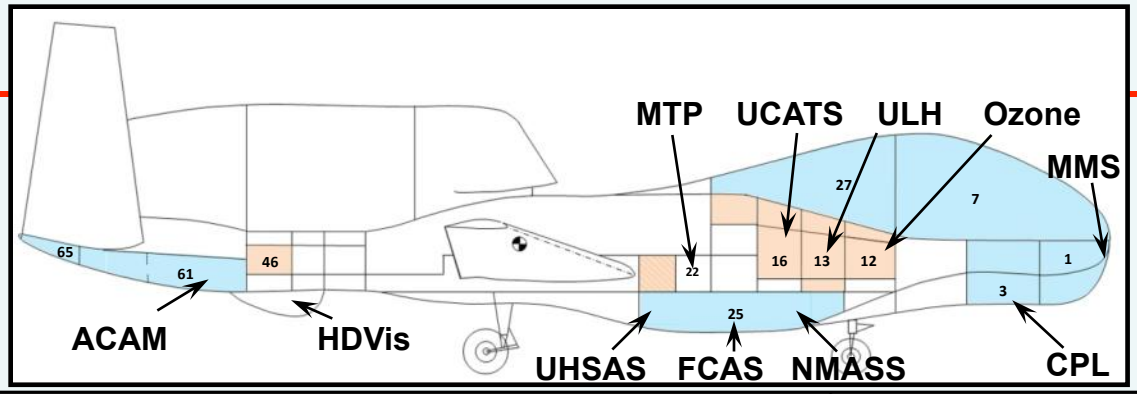
GloPac Objectives

- First demonstration of the Global Hawk unmanned aircraft system (UAS) for NASA and NOAA Earth science research and applications
  - Development of science-operation protocols & procedures
  - Long duration Pacific Ocean and Arctic flights
- Exploration of trace gases, aerosols, and dynamics of remote upper troposphere and lower stratosphere regions
  - Aura satellite instrument validation
  - Sample Arctic vortex fragments, and aerosol plumes



- Risk reduction for future Global Hawk missions
  - NASA GRIP hurricanes study (Aug-Sept 2010)
  - Earth Venture (EV-1) -- ATTREX and HS3

GloPac Instrument Overview

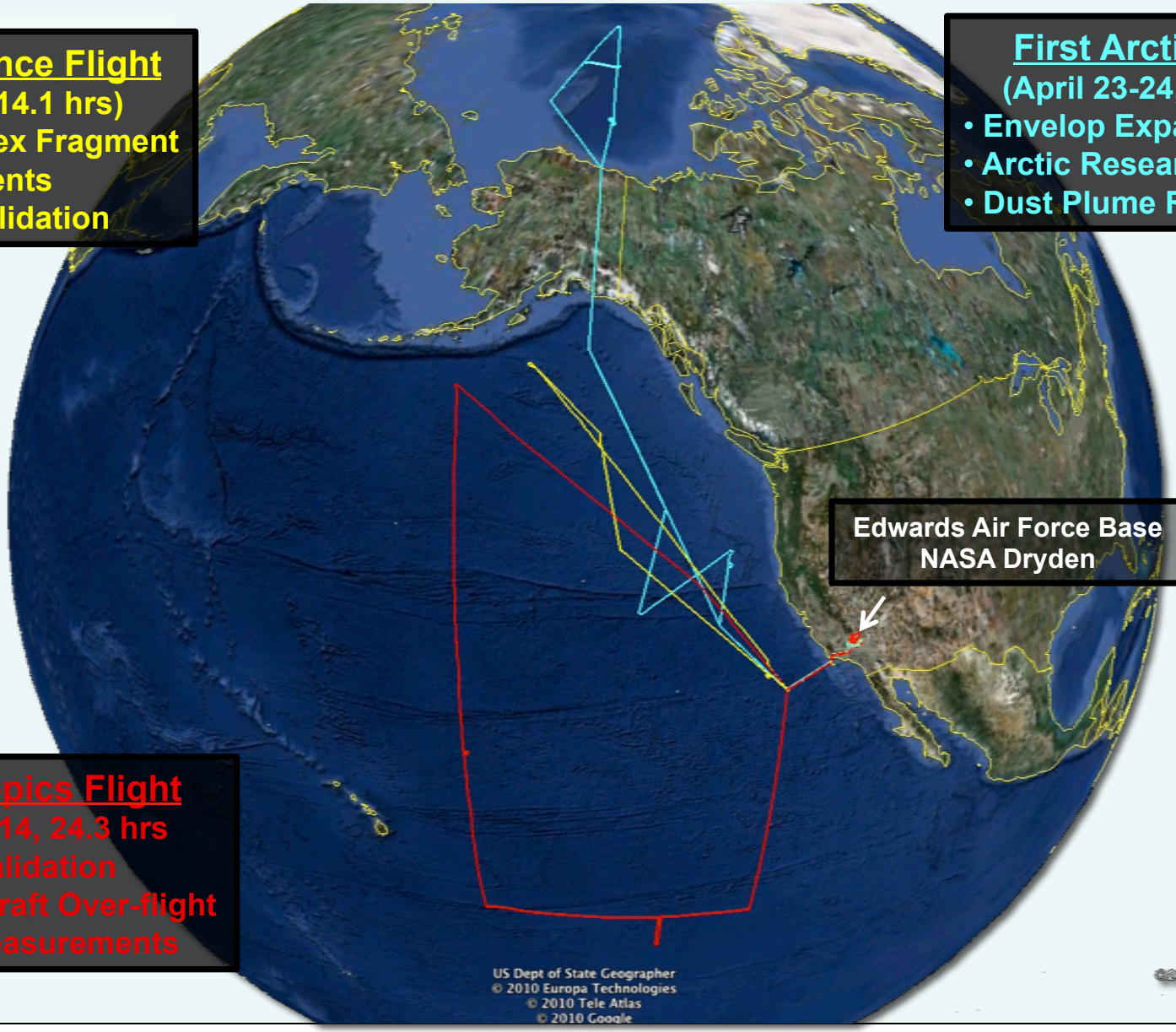


ACAM	Airborne Compact Atmospheric Mapper (GSFC)	Cross-track scanning spectrographs of NO2, O3, & aerosols.
CPL	Cloud Physics LIDAR (GSFC)	Backscatter LIDAR for hi-res profiling of clouds & aerosols.
FCAS	Focused Cavity Aerosol Spectrometer (U. of Denver)	Aerosol size and concentration measurements.
MMS	Meteorological Measurement System (ARC)	Science quality aircraft state variable measurements.
MTP	Microwave Temperature Profiler (JPL)	Passive microwave radiometer meas. of O2 thermal emissions.
HDVis	HiDef Video System (ARC)	Time-lapse nadir color digital imagery with georeferencing.
NMASS	Nuclei-mode Aerosol Size Spectrometer (U. of Denver)	Aerosol size and concentration measurements.
Ozone	UAS Ozone (NOAA)	Dual-beam UV photometer for accurate O3 measurements.
UCATS	UAS Chromatograph for Atmospheric Trace Species (NOAA)	Dual gas chromatographs for N2O, SF6, H2, CO, & CH4 meas.
UHSAS	Ultra-High Sensitivity Aerosol Spectrometer (Droplet Measurement Technologies)	Ultra-high sensitivity aerosol spectrometer.
ULH	UAS Laser Hygrometer (JPL)	In-situ hi-accuracy atmospheric water vapor measurements.

Global Hawk Pacific (GloPac) 2010 Flights

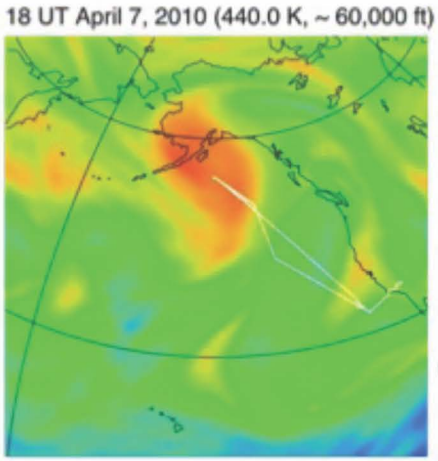
First Science Flight
(April 7, 14.1 hrs)
- Arctic Vortex Fragment Measurements
- Satellite Validation

First Arctic Flight
(April 23-24, 28.6 hrs)
- Envelop Expansion
- Arctic Research
- Dust Plume Rendezvous

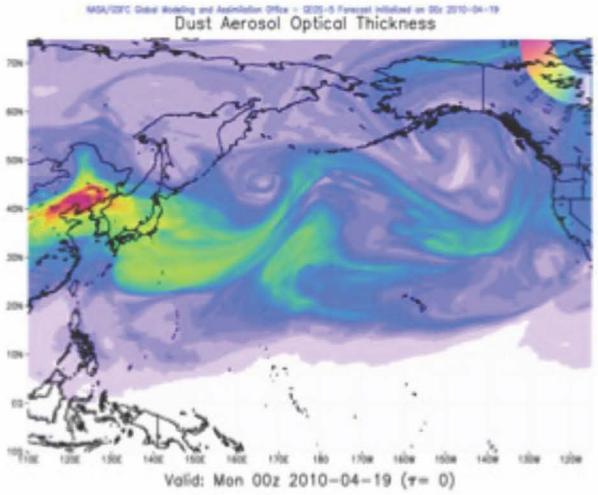


First Tropics Flight
April 13-14, 24.3 hrs
- Satellite Validation
- NCAR Aircraft Over-flight
- Tropics Measurements

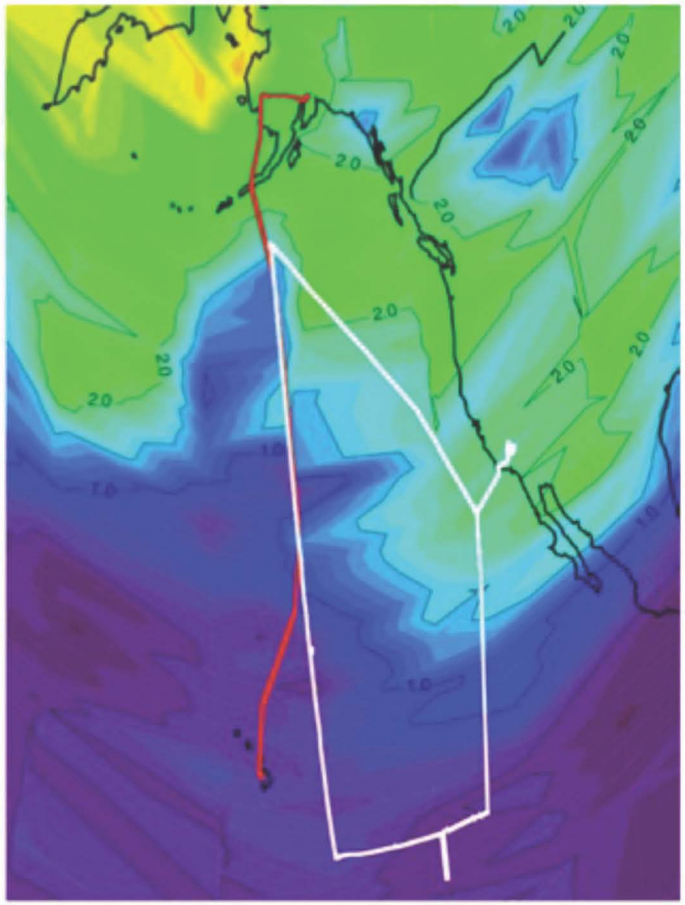
GloPac Science Highlights



Intercept an Arctic vortex fragment that broke off on about March 28



Sample Asian dust from the Gobi Desert



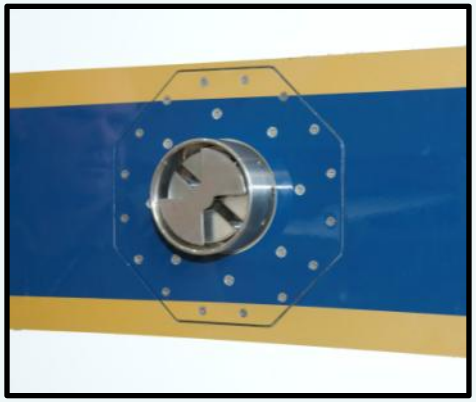
Rendezvous with the NSF GV aircraft and underfly the Aura satellite.

Genesis and Rapid Intensification Processes (GRIP)

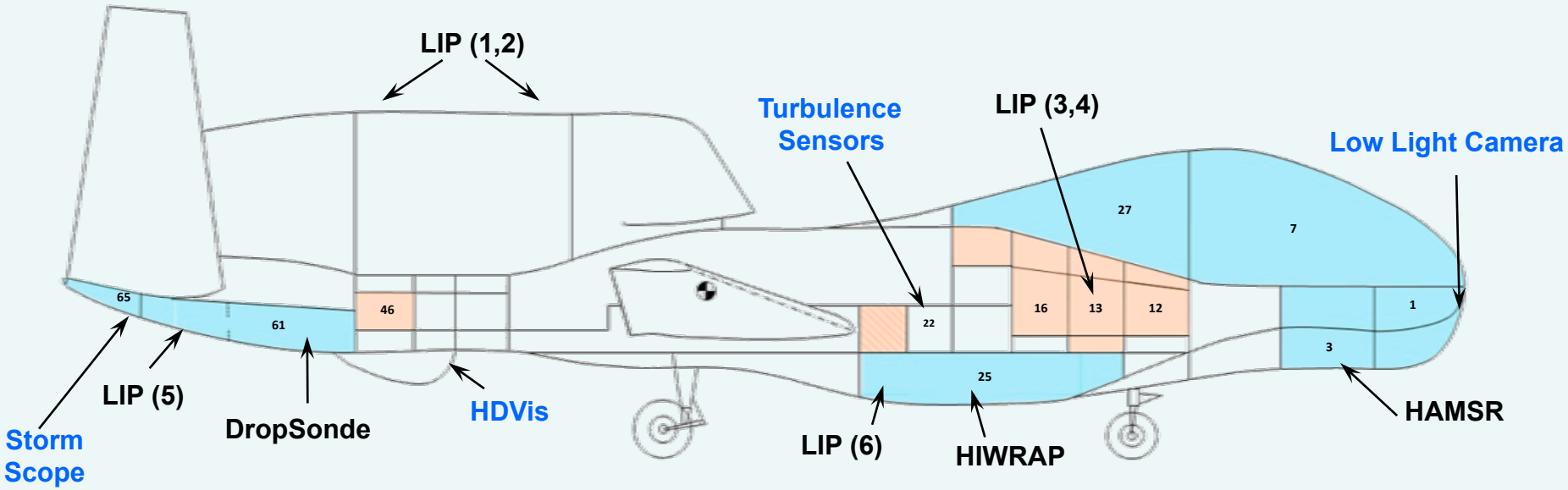
Second Global Hawk Science Mission (August-September 2010)

GRIP Goals

- Demonstration of Global Hawk Capabilities for Severe Storm Research
- Multi-agency, Multi-aircraft Research Campaign
- Improve Intensification Forecasts Models
- Integration of New Global Hawk Payloads and New Aircraft Systems



GRIP Instrumentation



HIWRAP - **High Altitude Imaging Wind and Rain Profiler**

DropSonde - **NOAA DropSonde System**

HAMSR - **High Altitude MMIC Sounding Radiometer**

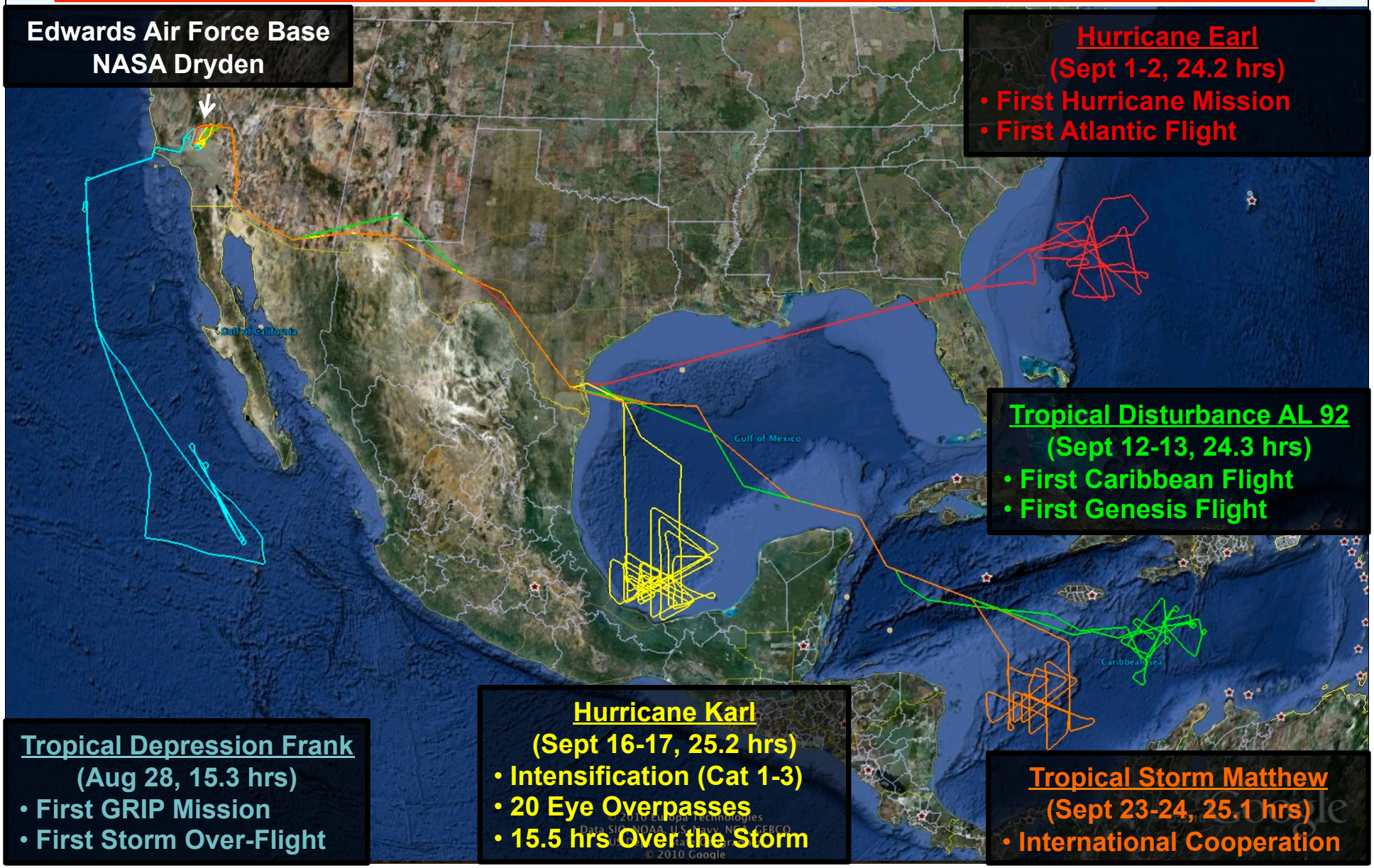
LIP - **Lightning Instrument Package**

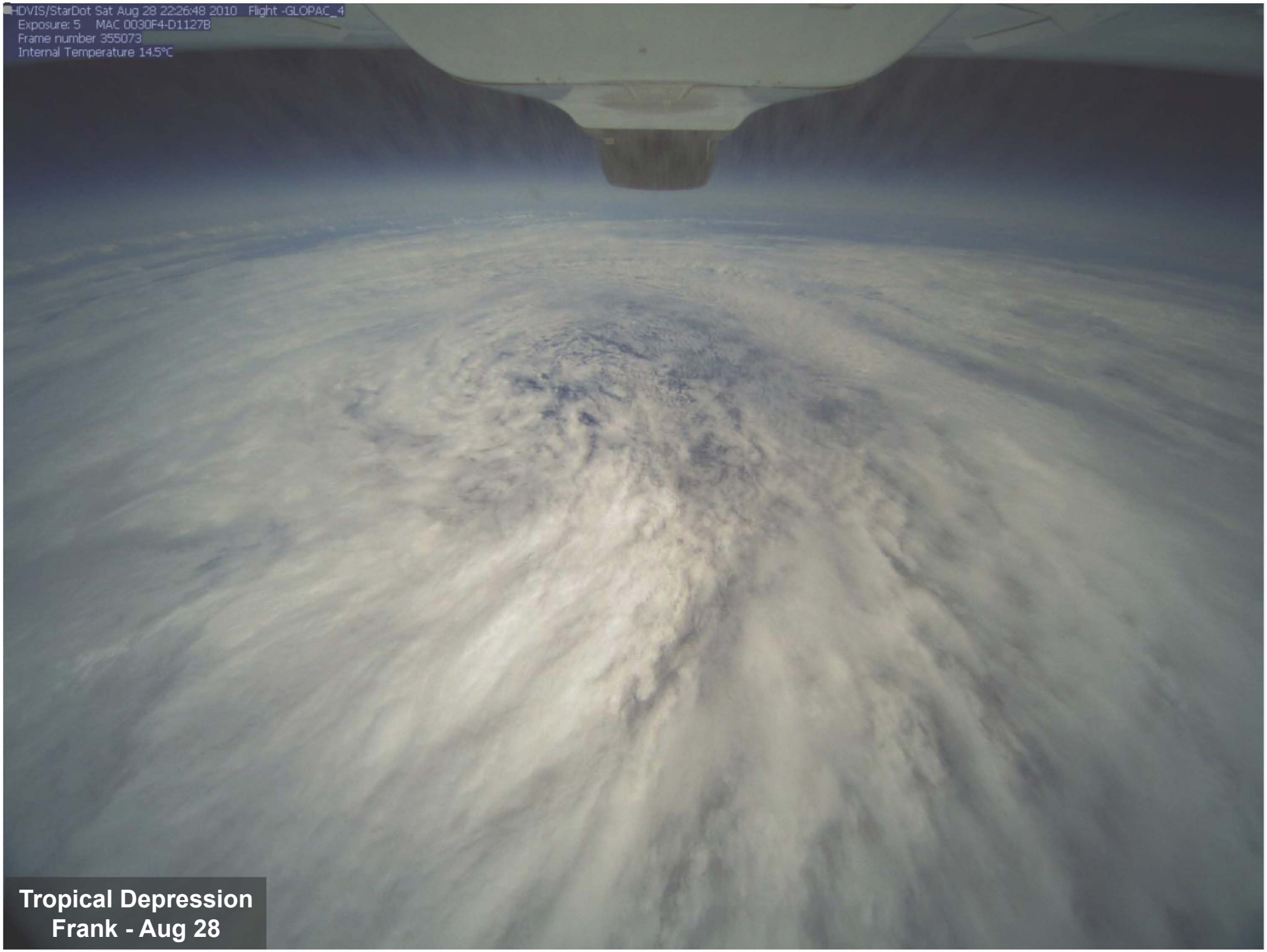
2 Cameras - **HDVis and Low Light for Pilot Situational Awareness**

Storm Scope - **Lightning Detection Display in the GHOC**

Accelerometers - **Real-time Turbulence Time-history Display in the GHOC**

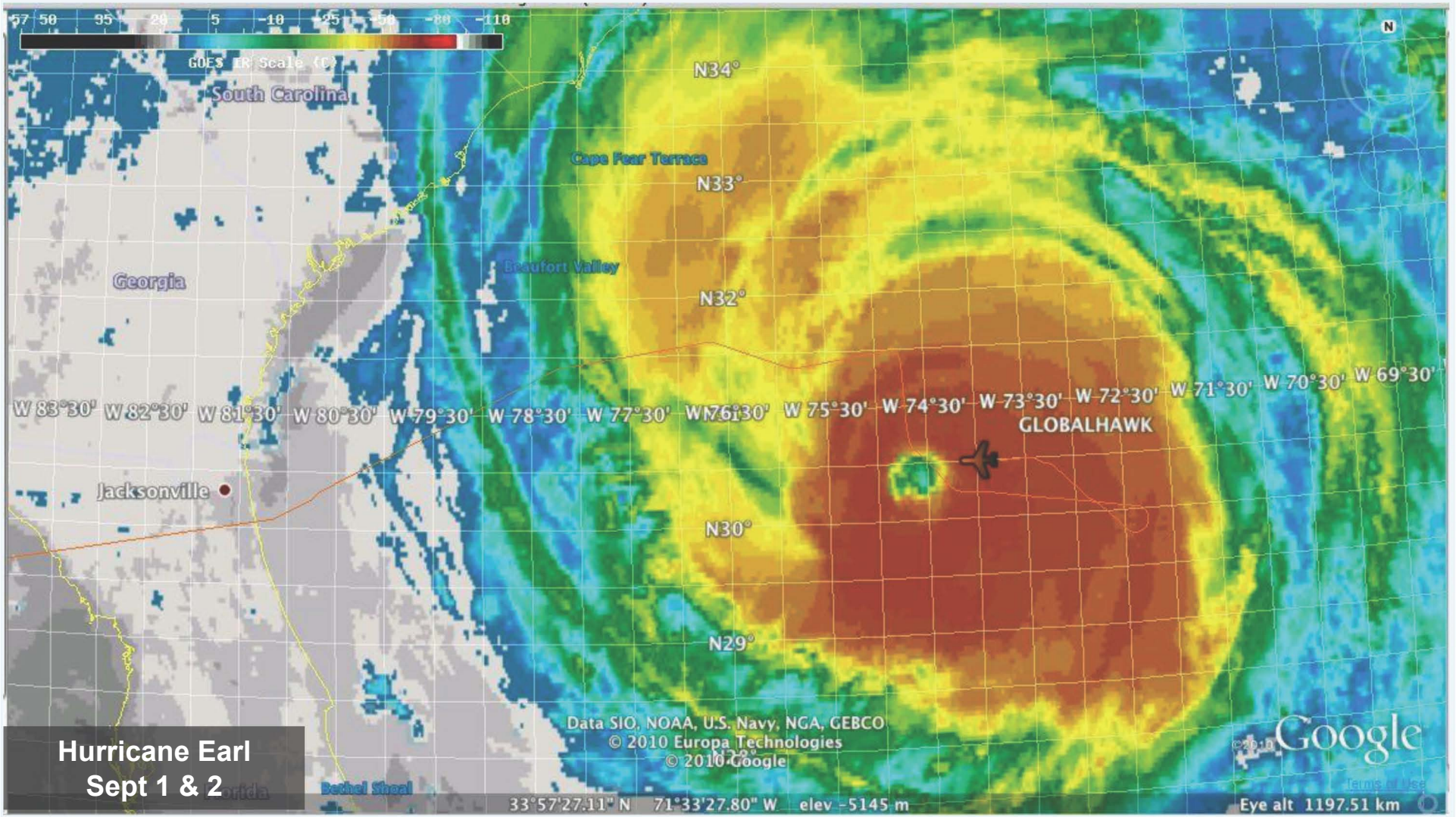
Genesis and Rapid Intensification Processes (GRIP) 2010 Global Hawk Flights





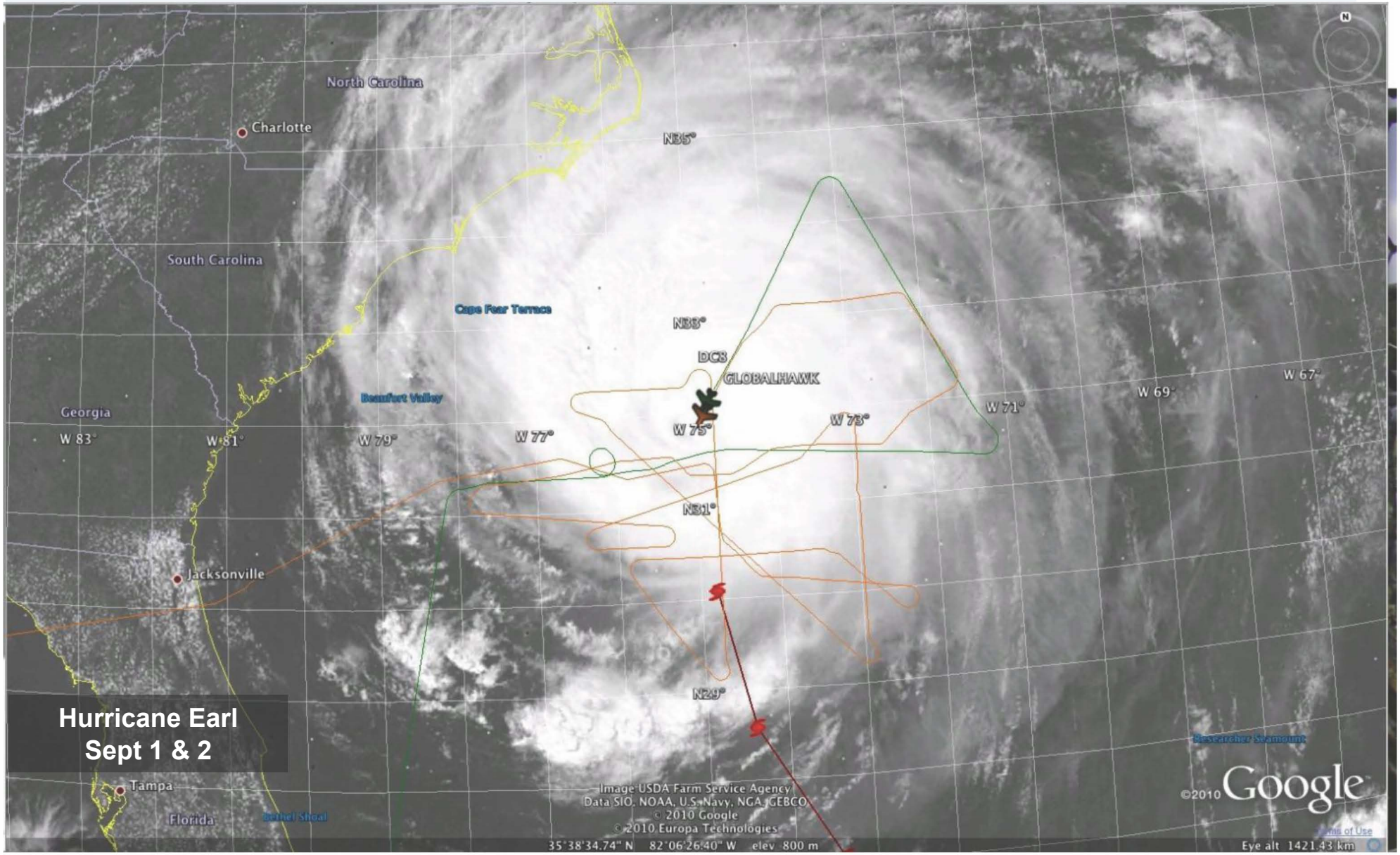
Tropical Depression Frank - Aug 28

Real Time Mission Manager

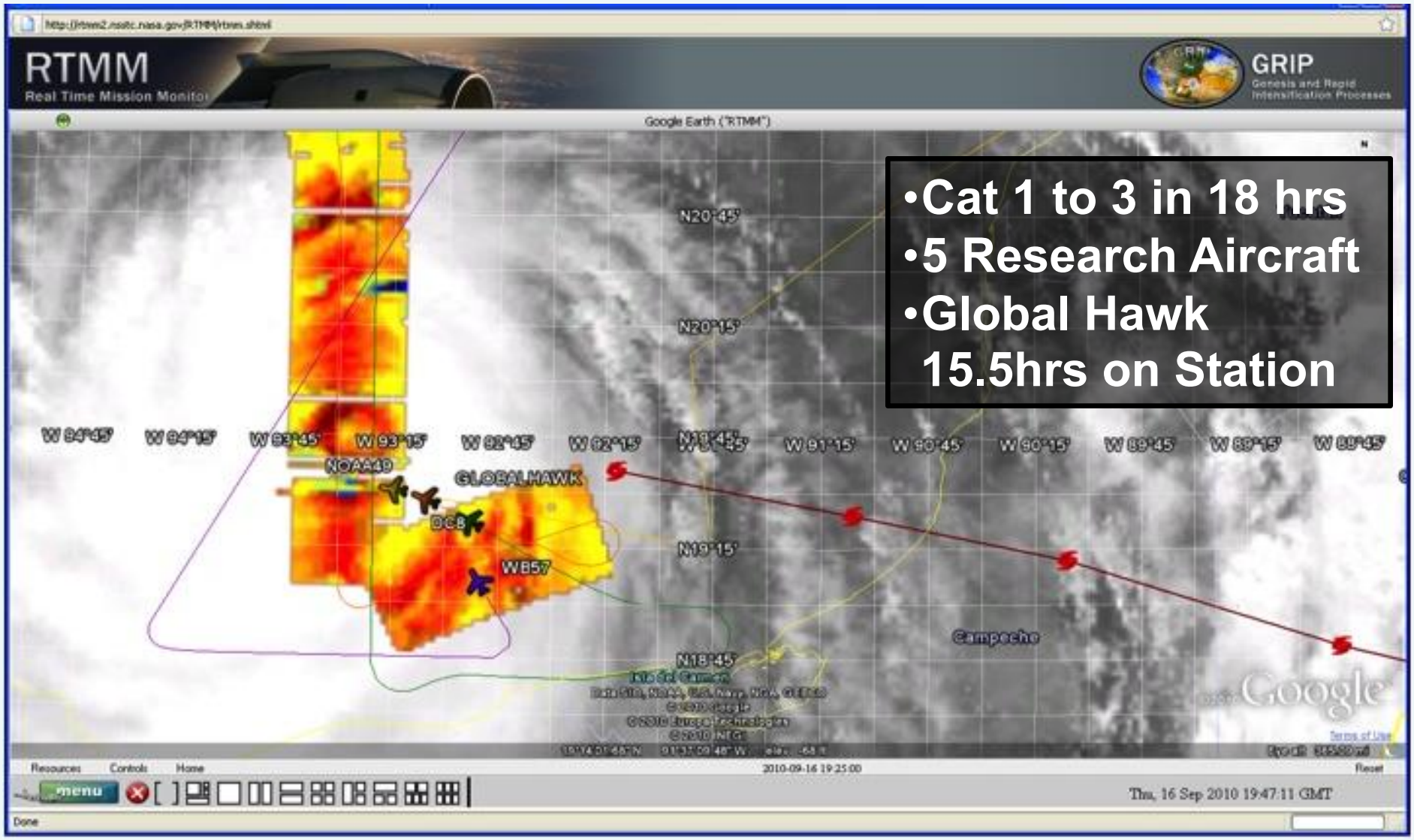


Hurricane Earl
Sept 1 & 2

Real Time Mission Manager



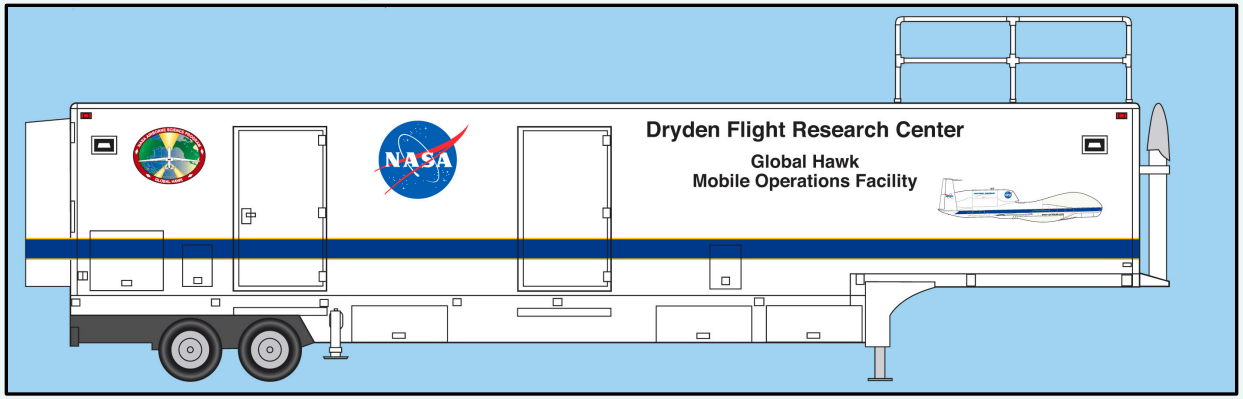
Intensification of Hurricane Karl



Upcoming Projects

Capability Developments for Deployments

All Three Systems on-line by September 2011

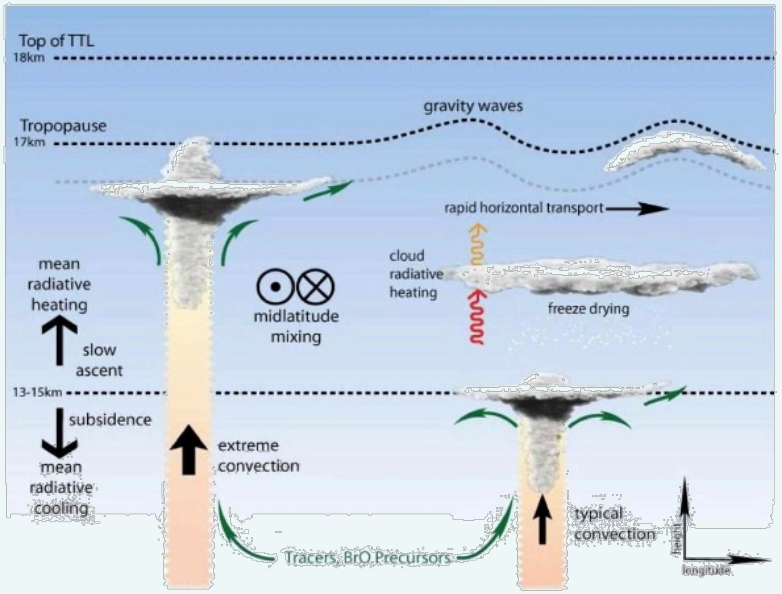


Aircraft Command and Control Facility

Ku Portable Ground Station

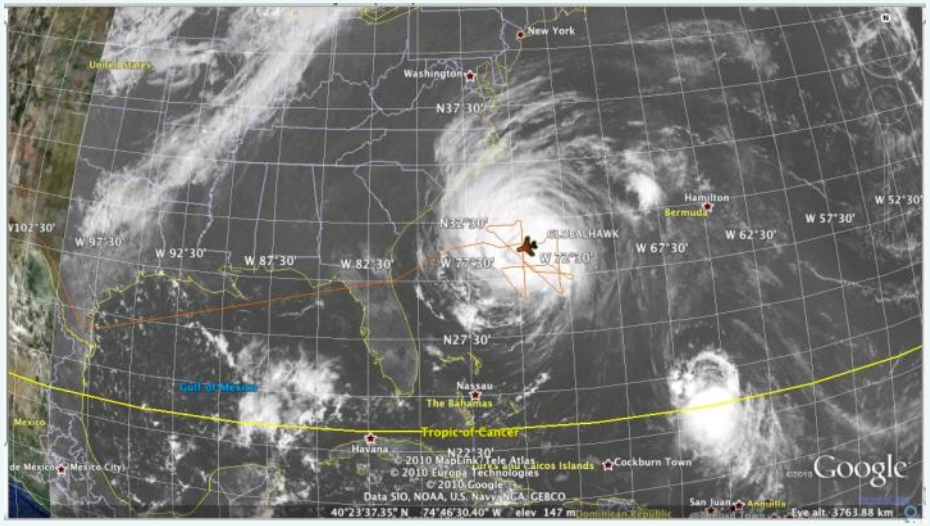
A Payload Operations trailer, with extendable sides to accommodate 14 Scientists, is)

Future Missions



ATTREX

Airborne Tropical TRopopause EXperiment



HS3

Hurricane and Severe Storm Sentinel (HS3) mission

UAV SAR

Reconfigurable polarimetric L-band SAR designed for repeat pass deformation measurements.

Global Hawk Project Team

Project Management, Pilots, Aircraft Mechanics, Avionics Technicians, Operations Engineers, Software Developers, Quality Assurance, Logistics, Public Affairs, Flight Test Engineers, Crew Chiefs, Configuration Management, Systems Engineers, System Safety, Range Safety, Ground Control Station Developers, Communications Engineers

Summary

- NASA Dryden owns three Global Hawk aircraft.
- A ground control station has been constructed and certified.
- 29 Flights were conducted during the first year of operations.
- Two major science campaigns have been conducted with all objectives met.