Airborne Remote Sensing Component of Marine Debris Monitoring

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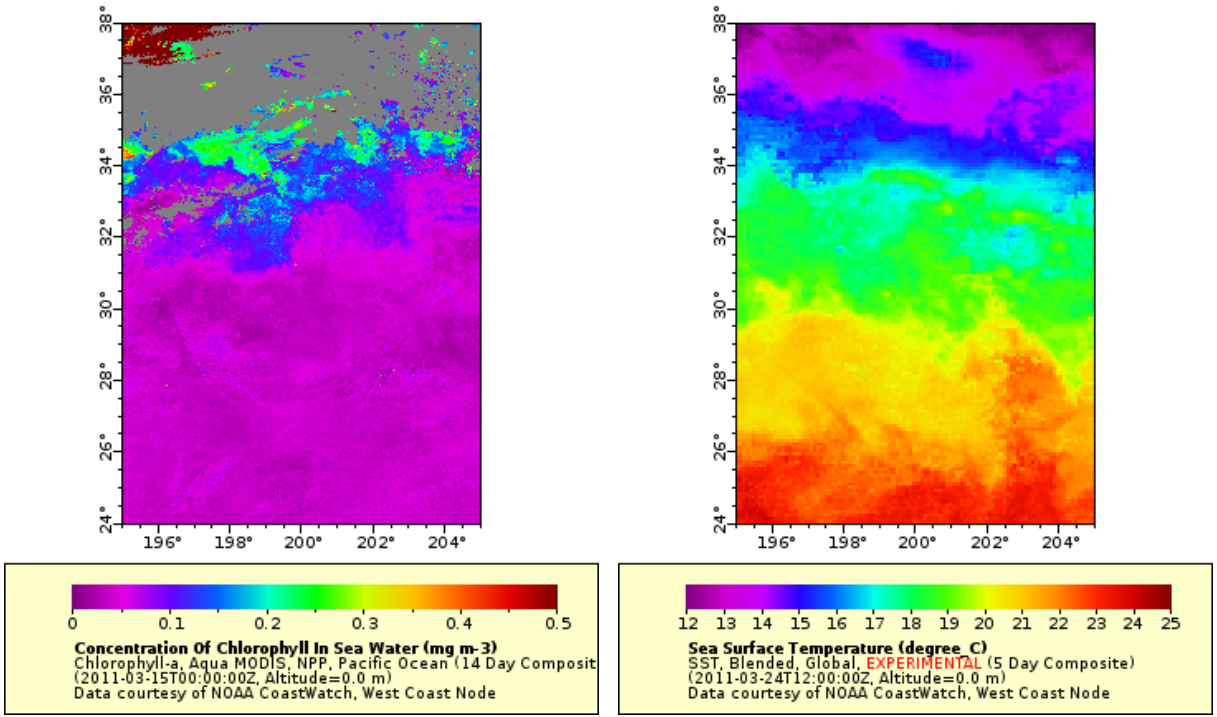
Workshop on Mission Concepts for Marine Debris Sensing

Honolulu, Hi, Jan 19-21, 2016

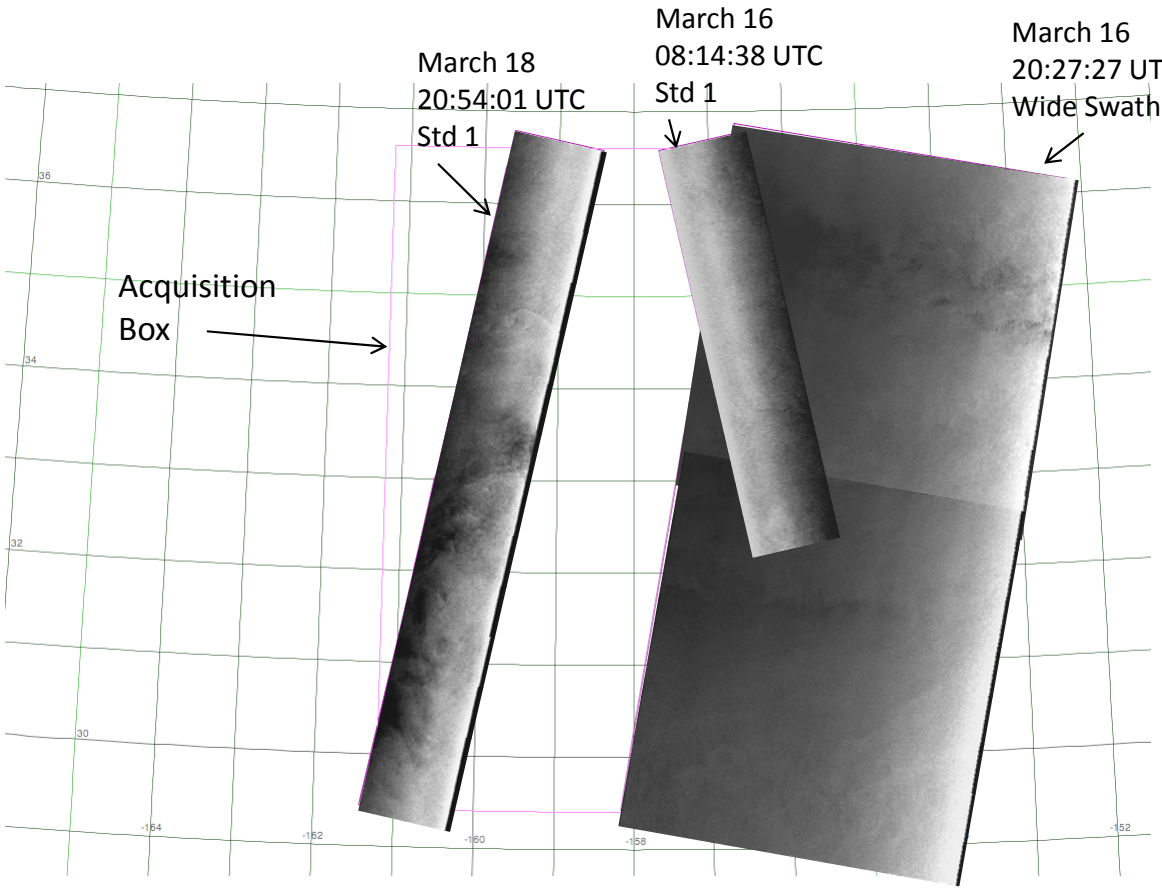
Multistage Remote Sensing Concept

1. Use model and satellite data to determine convergence zones and airborne flight target areas
2. Use Airborne Radar and air-ship telemetry to define fine features of likely concentration of marine debris for ship search
3. Use ship and small UAS to spot and retrieve debris.

MODIS and SST Satellite Interpretatons



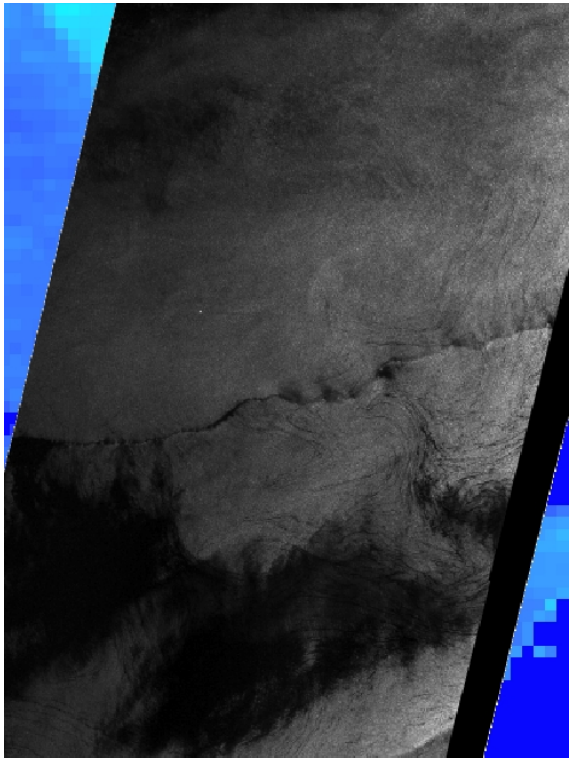
Envisat – March 16 – March 18



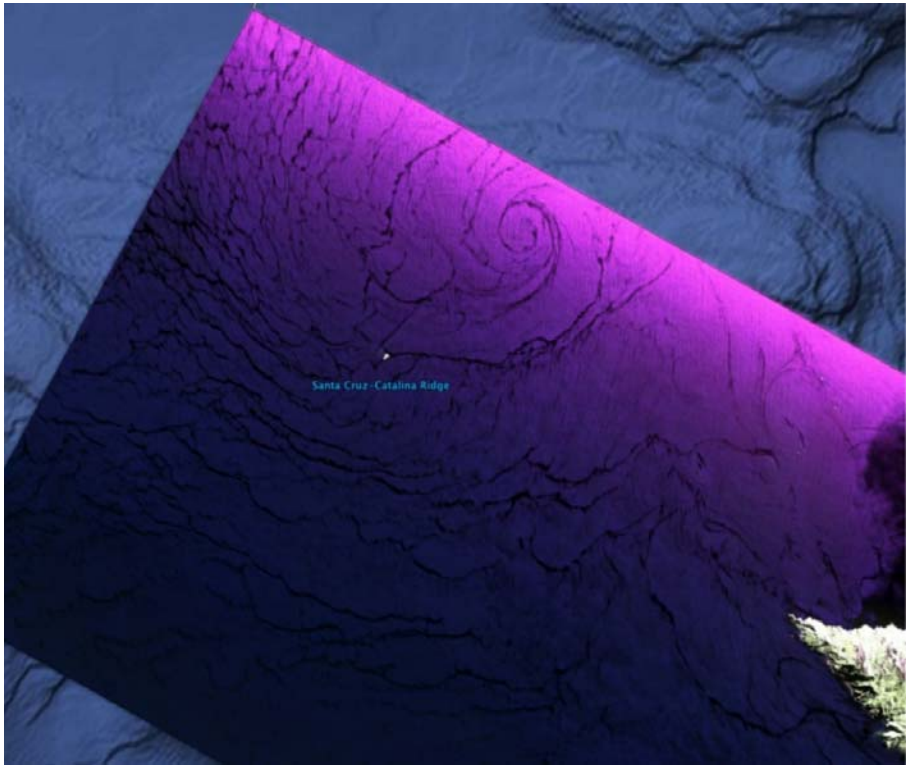
Std= standard beams, 100 km wide swath, 25 m resolution
Wide Swath = 400 km wide swath, 150 m resolution

Ben Holt - JPL

Satellite SAR image showing eddy lines



UAVSAR polarimetric three-color composite image of currents and eddies in the Santa Barbara Channel acquired on September 16, 2009, from the NASA G-III aircraft overlain on Google Earth image (Image courtesy B Holt & Y Lou – JPL).



Gulfstream III

UAV Synthetic Aperture Radar (UAVSAR)

Capabilities

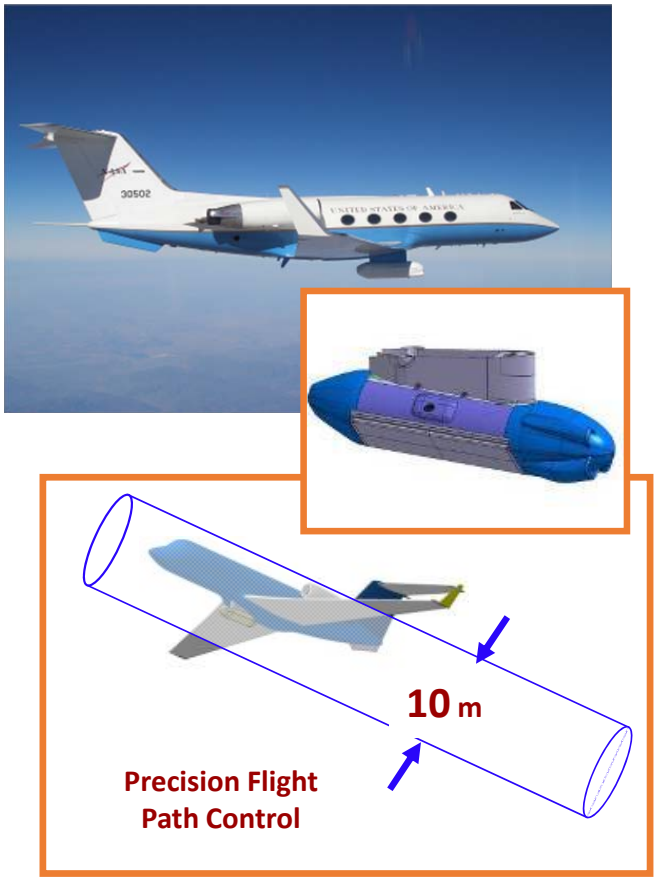
- Ceiling 45,000 ft.
- Duration 6 hours
- Range > 3,400 nautical miles
- Payload 2,610 lbs

Mission Support Features

- Center-line pod/pylon supports UAVSAR instrument
- Precision flight path capability
- Shirtsleeve environment instrument support
- World-wide deployment capability

UAVSAR

- Repeat-pass interferometry
- Ka-, P- and L-band capability (separate pods)
- Designed for UAV simulation



April, 2011 Mission/Feasibility Study

- Satellite Imagery for planning
- USCG C-130 for low altitude visual confirmation of debris
- G-III interprets real time imagery onboard and sends coordinates to C-130 via base station and satphone
- Mission cancelled due to instrument failure
- We returned to Hawaii in May, but it was too late for environmental conditions

DC-8 Flying Laboratory

Large Capacity, Long Range and Endurance

Capabilities

- Ceiling 42,000 ft.
- Duration 12 hours
- Range > 5,400 nautical miles
- Payload 30,000 lbs

Mission Support Features

- Shirtsleeve environment for up to 30 researchers
- Worldwide deployment experience
- Extensive modifications to support in-situ and remote sensing instruments
  - zenith and nadir viewports
  - wing pylons
  - modified power systems
  - 19 inch rack mounting
- AIRSAR Discontinued

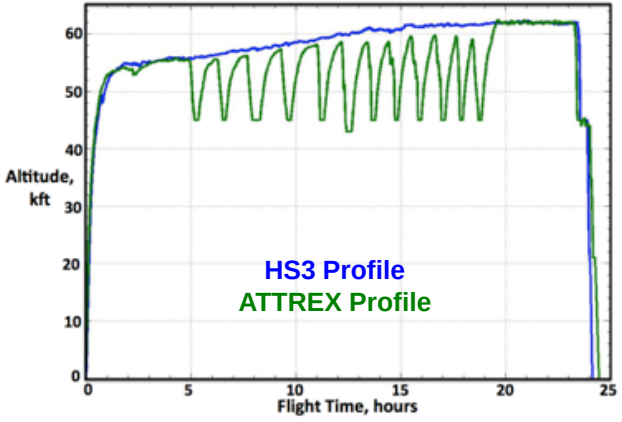
NASA Global Hawks

- **Two Advanced Concept Technology Demonstration (ACTD) aircraft transferred to NASA in September, 2007 (AV-1 and AV-6).**
- **Aircraft are based at the Armstrong Flight Research Center on Edwards Air Force Base.**
- **Configuration and performance similar to standard ‘Block 10’.**

NASA Global Hawk Summary and Capability

- NASA has been flying Global Hawk aircraft for airborne Earth science research since 2010.
- The autonomous aircraft are remotely operated from either NASA Armstrong Flight Research Center, NASA Wallops Flight Facility, or a portable Flight Control Station.
- A NASA/Northrop Grumman team is maintaining, modifying, and operating the 2 ACTD aircraft through a partnership that was established in 2008 and renewed in 2013.
- Currently only AV6 is flying, and a Block 10 aircraft is being made operational using avionics and interfaces from AV1 (early FY17)

Endurance	24-26 hours for Typical Missions 28.6 hours Demonstrated
Range	10,000 nmi
Service Ceiling	65,000 ft, < 50% available A/C payload power 62,500 ft, > 50% available A/C payload power
Airspeed (55,000+ ft)	335 KTAS
Payload	1,200 lb Demonstrated
Length	44 ft
Wingspan	116 ft



Typical Flight Profiles

NASA Global Hawk Asset Overview

Operational Aircraft

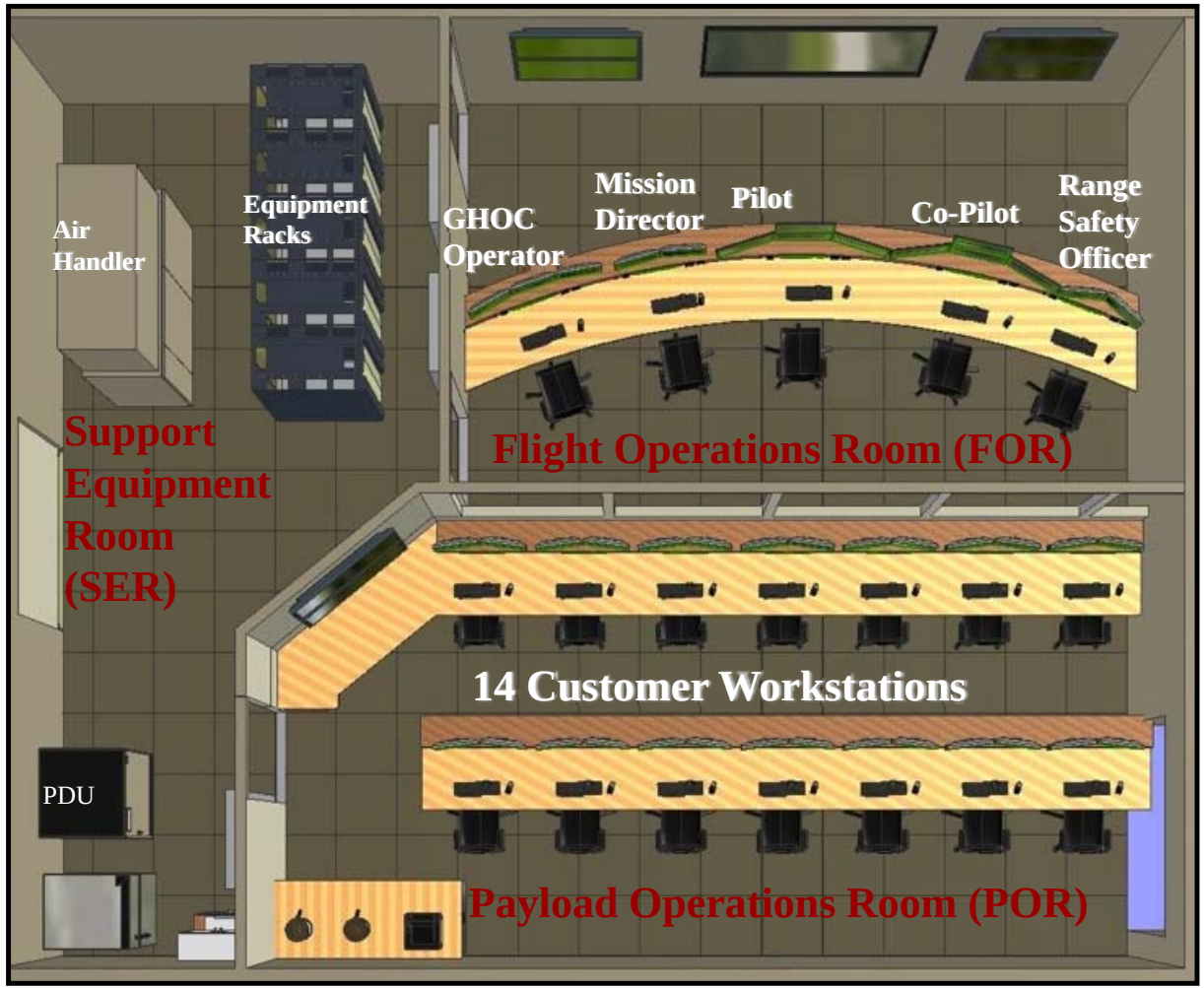
Global Hawk Operations Center – East (WFF)

Portable Ground Systems

Global Hawk Operations Center (AFRC)

Spares Aircraft

Global Hawk Operations Center (GHOC) Room Layout at NASA AFRC



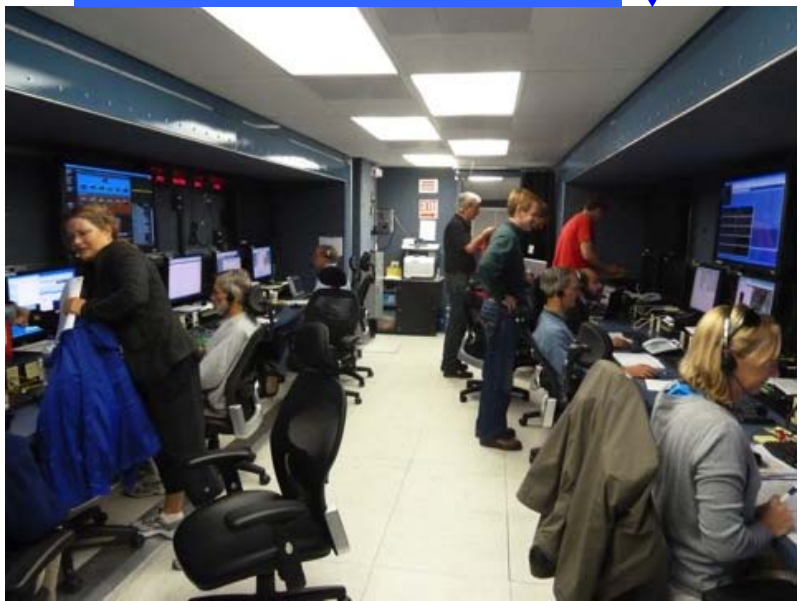
Facility Entrance

GHOC Fully Staffed During a Hurricane Overflight

Portable Ground Control Station Suite used for Deployed Operations

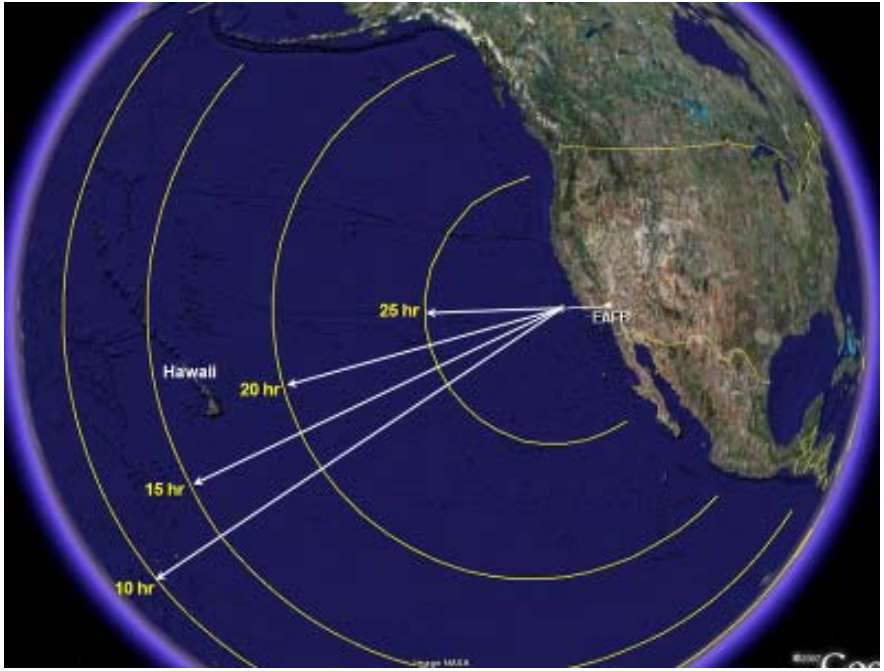
Ku Satellite Ground Station

Payload Mobile Operations Facility



Global Hawk Mobile Operations Facility

Global Hawk time-on-station Based at EAFB



Global Hawk Science Flights (1 of 2)

GloPac
2010

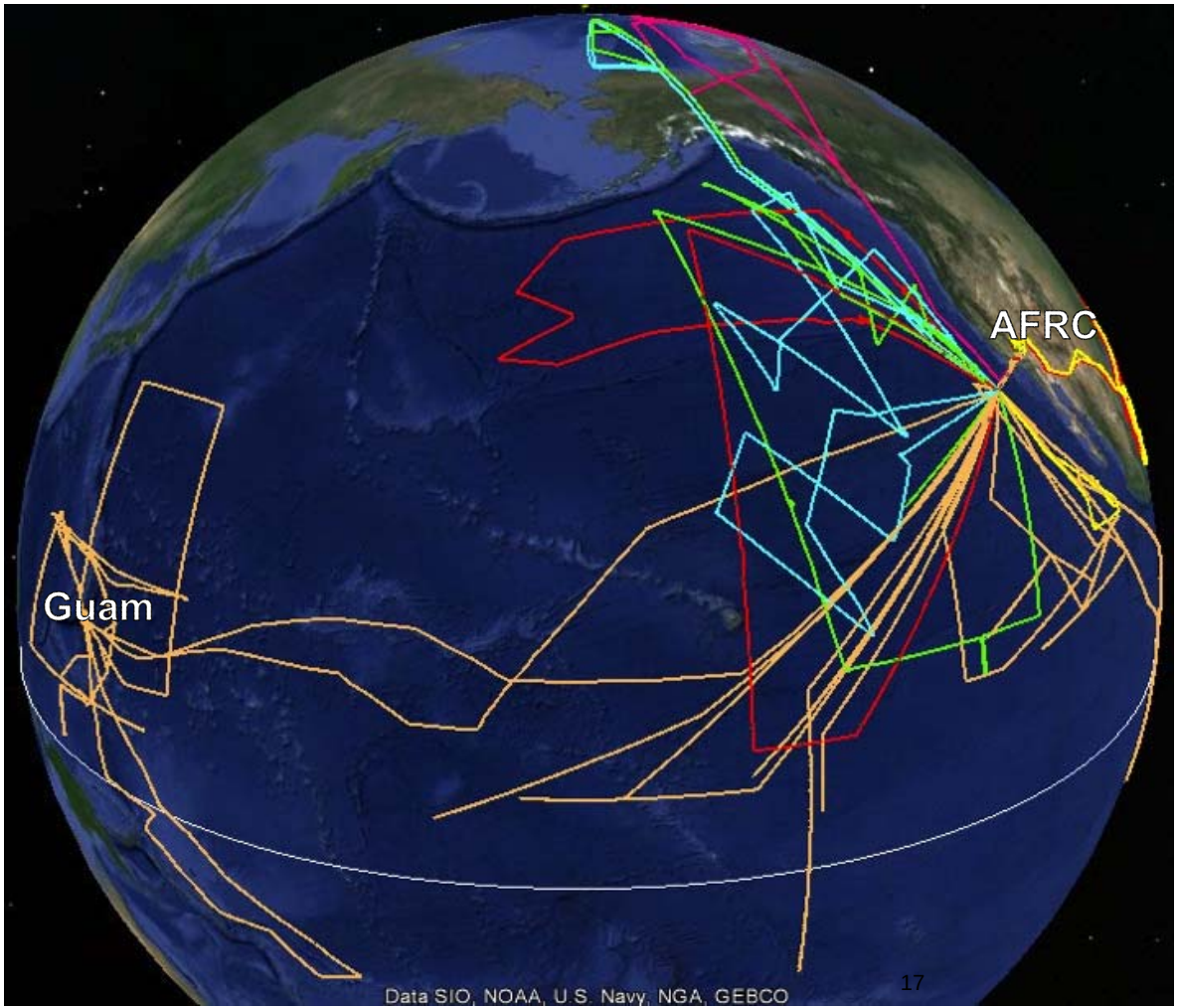
GRIP
2010

WISPAR
2011

HS3
2011, 2012, 2013

ATTREX
2011, 2013, 2014

IceHawk
2013



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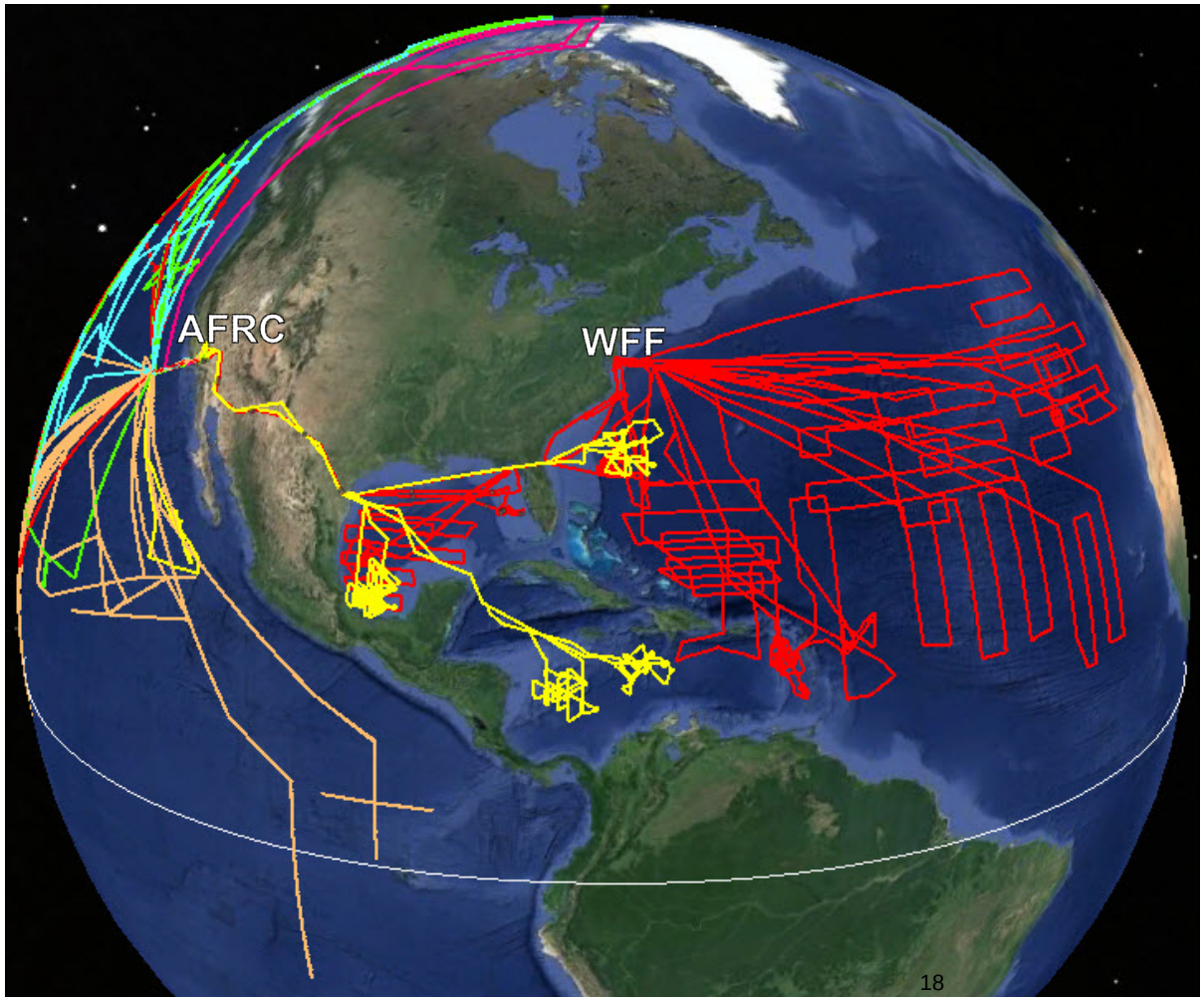
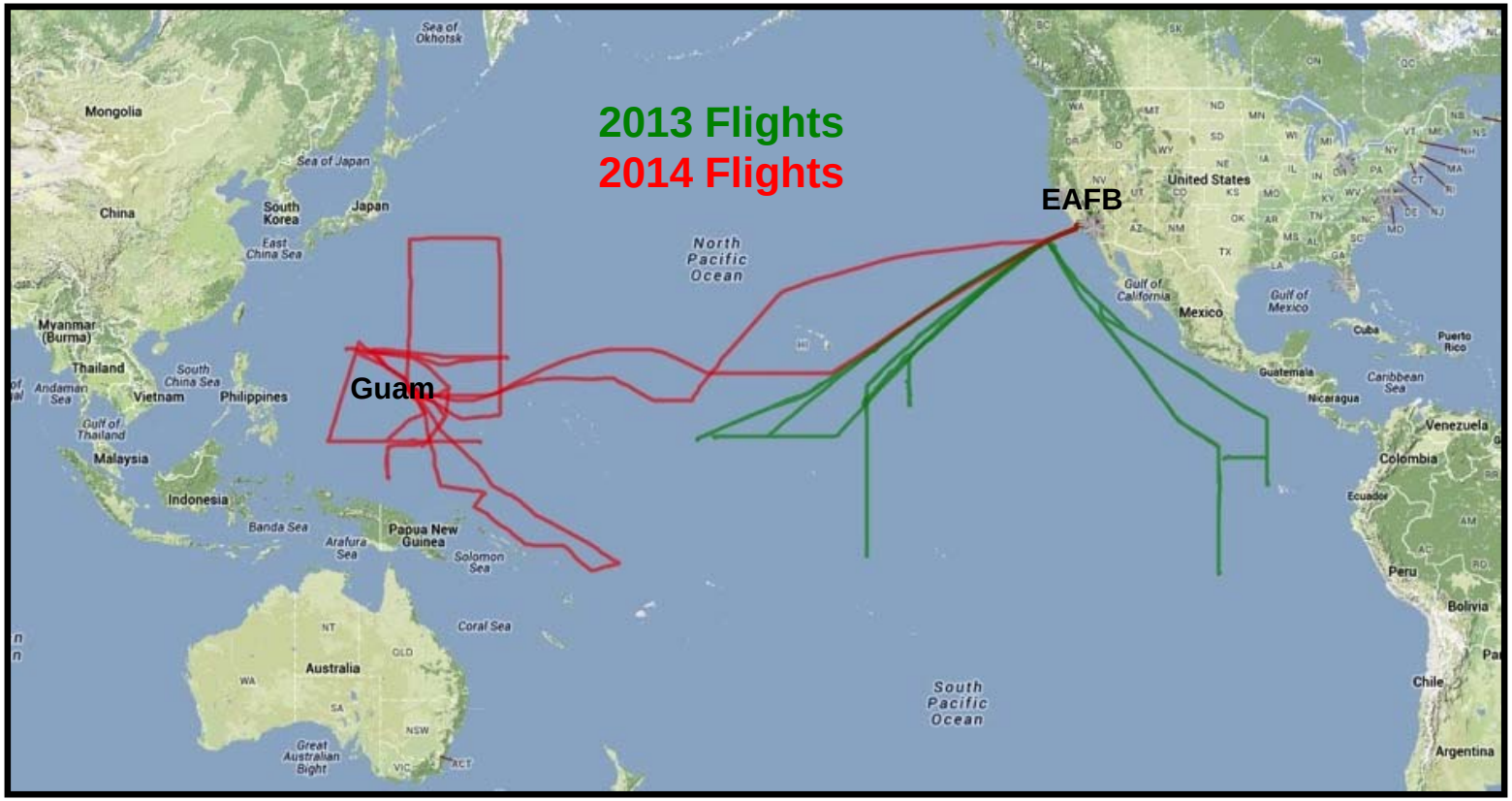


Airborne Tropical Tropopause Experiment Overview

(October-November 2011, February-March 2013, January-March 2014)

- **11 instruments were flown on the NASA Global Hawk aircraft in 2011 and 2013 and 12 instruments were flown in 2014.**
- **18 science missions, totaling 350 flight hours were flown during the 3 ATTREX campaigns.**
- **The flights in 2011 featured the first science demonstration in the tropics.**
- **The flights in 2014 featured the first OCONUS deployment for NASA Global Hawk.**

ATTREX Flight Tracks



IceHawk

(December 2013)

- **The UAV Synthetic Aperture Radar (UAVSAR) was integrated onto the aircraft.**
- **A single flight was conducted over the Pacific Ocean and Canada.**
- **This flight marked the first UAVSAR flight outside of the EAFB range and the first NASA Global Hawk flight over a foreign country.**
- **Coordination with the Canadian Government was straightforward.**
- **The IceHawk flight was funded by Northrop Grumman Co. as a platform capability demonstration-no instrument data were collected.**

Options

- G-III/UAVSAR is operational but limited flight time gives only a few passes over the target areas
- DC-8 has longer duration and ability to accommodate science team but UAVSAR has not been integrated
- Global Hawk has all the components necessary, but needs some component maturation as well as integration and testing of the full-up system
- All three platforms have satellite telemetry capability and telepresence, but large SAR files have not been demonstrated

Discussion