NASA Global Hawk: Project Update and Future Plans

Chris Naftel
Global Hawk Project Manager
NASA Dryden Flight Research Center
19 November 2010
Edwards Air Force Base and NASA Dryden Flight Research Center

Dryden Flight Research Center

Edwards Air Force Base

NASA Dryden Aircraft Fleet
(as of November 2008)
Global Hawk’s Unique Capability
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.

<table>
<thead>
<tr>
<th>Endurance</th>
<th>&gt; 30 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>&gt;11,000 nmi</td>
</tr>
<tr>
<td>Service Ceiling</td>
<td>65,000 ft</td>
</tr>
<tr>
<td>Airspeed (55K+ ft)</td>
<td>335 KTAS</td>
</tr>
<tr>
<td>Payload</td>
<td>1,000-1,500 lb</td>
</tr>
<tr>
<td>Length</td>
<td>44 ft</td>
</tr>
<tr>
<td>Wingspan</td>
<td>116 ft</td>
</tr>
</tbody>
</table>

Cruise Climb from 56-65K ft (max takeoff weight)
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

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

**First Year of Operations** 29 Flights 253 hours
NASA Global Hawk Operations Overview

- UAV Runway
- Mission Staging Location
- Maintenance Hangar & Instrument Lab
- Edwards Air Force Base

NASA Dryden Flight Research Center

Operations Center
Payload Communications Architecture

Wideband Data S-Band (LOS)

Iridium

Wideline (BLOS)

C, Data, and Status & Master Control (6 links)

Ku SatCom

Wideband Data Ku-Band (BLOS)

ATF2 Site

DFRC GHOC

EAFB

LOS

BLOS

FO

FO
Payload Integration and Accommodations

- Experiment Interface Panel & Ethernet Switch (located throughout the aircraft providing power and communications)
- Bay Under the Nose
- Pallets and Hatches
- Mounting Hard Points
- Mounting Rails
- Wing Pods (future capability)
- Payload Integration Software T&E
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

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Description</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACAM</td>
<td>Airborne Compact Atmospheric Mapper (GSFC)</td>
<td>Cross-track scanning spectrographs of NO2, O3, &amp; aerosols.</td>
</tr>
<tr>
<td>CPL</td>
<td>Cloud Physics LiDAR (GSFC)</td>
<td>Backscatter LiDAR for hi-res profiling of clouds &amp; aerosols.</td>
</tr>
<tr>
<td>FCAS</td>
<td>Focused Cavity Aerosol Spectrometer (U. of Denver)</td>
<td>Aerosol size and concentration measurements.</td>
</tr>
<tr>
<td>MMS</td>
<td>Meteorological Measurement System (ARC)</td>
<td>Science quality aircraft state variable measurements.</td>
</tr>
<tr>
<td>MTP</td>
<td>Microwave Temperature Profiler (JPL)</td>
<td>Passive microwave radiometer meas. of O2 thermal emissions.</td>
</tr>
<tr>
<td>HDVis</td>
<td>HiDef Video System (ARC)</td>
<td>Time-lapse nadir color digital imagery with georeferencing.</td>
</tr>
<tr>
<td>Ozone</td>
<td>UAS Ozone (NOAA)</td>
<td>Dual-beam UV photometer for accurate O3 measurements.</td>
</tr>
<tr>
<td>UCATS</td>
<td>UAS Chromatograph for Atmospheric Trace Species (NOAA)</td>
<td>Dual gas chromatographs for N2O, SF6, H2, CO, &amp; CH4 meas.</td>
</tr>
<tr>
<td>ULH</td>
<td>UAS Laser Hygrometer (JPL)</td>
<td>In-situ hi-accuracy atmospheric water vapor measurements.</td>
</tr>
</tbody>
</table>
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

Edwards Air Force Base
NASA Dryden
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, 15.3 hrs)
  - First GRIP Mission
  - First Storm Over-Flight

- **Hurricane Earl** (Sept 1-2, 24.2 hrs)
  - First Hurricane Mission
  - First Atlantic Flight

- **Tropical Disturbance AL 92** (Sept 12-13, 24.3 hrs)
  - First Caribbean Flight
  - First Genesis Flight

- **Hurricane Karl** (Sept 16-17, 25.2 hrs)
  - Intensification (Cat 1-3)
  - 20 Eye Overpasses
  - 15.5 hrs Over the Storm

- **Tropical Storm Matthew** (Sept 23-24, 25.1 hrs)
  - International Cooperation
Real Time Mission Manager

Hurricane Earl
Sept 1 & 2
Intensification of Hurricane Karl

- Cat 1 to 3 in 18 hrs
- 5 Research Aircraft
- Global Hawk
  15.5hrs on Station
Upcoming Projects
Capability Developments for Deployments
All Three Systems on-line by September 2011

Aircraft Command and Control Facility
A Payload Operations trailer, with extendable sides to accommodate 14 Scientists, is:

Ku Portable Ground Station
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.
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.