NASA GRIP Aircraft

Genesis and Rapid Intensification Processes

GRIP

August - September 2010

NASA Hurricane Science Research Team

California

Florida
NASA DC-8
DC-8 Communications

REVEAL - Research Environment for Vehicle-Embedded Analysis on Linux

- Real-time aircraft position and data plotted on Google Earth
- X-Chat capability with science team members

Instrument Inter-communications

- Gigabit ethernet data system
- High Res. LCD displays

IRIDIUM and INMARSAT Satcom

- 9600 bps IRIDIUM
- 432kbps INMARSAT

Digital forward and Nadir video system
GRIP DC-8 Payload

**Dropsondes**
(Vertical Profiles of Temp, Press, Humidity and Winds)

**DAWN**
Doppler Aerosol Wind Lidar
(Vertical Profiles of Vectored Horizontal Winds)

**MMS**
Meteorological Measurement System
(Insitu Press, Temp, 3D Winds and Turbulence)

**CAPS, CVI, PIP**
(Cloud Particle Size distributions, Precip Rate, Rain & Ice water content)

**LASE**
Lidar Atmospheric Sensing Experiment
(H2Ov, Aerosol profiles and Cloud distributions)

**APR-2**
Airborne Precipitation Radar Dual Frequency
(Vertical Structure Rain Reflectivity and Cross Winds)
Elements of Coherent (Heterodyne) Doppler Lidar

Pulsed Transmitter Laser
CW Injection Laser

Receiver Optics
CW Local Oscillator Laser*
Optical Signal Detector

Receiver Electronics
Data Acquisition, Processing, and Display

Optical Transmit - Receive Switch
Beam Expanding Telescope
Scanner
Optical Wedge

Aerosol Particles or Clouds

DAWN Transceiver (Transmitter + Receiver)
250 mJ/pulse, 10 pulses/sec.
5.9” x 11.6” x 26.5”, 75 lbs.
(no telescope or scanner)

Optical Transmit - Receive Switch

Predicted DC-8 Performance
• Horizontal vector wind profile from 300 m below DC-8 to ground, thick clouds permitting, ~ 3 min. integration
• Line-of-sight velocity precision better than 1 m/s
• Line-of-sight velocity bias less than 0.1 m/s
• Deliver LOS and/or horizontal wind profiles
• Multiple integration times permitted on same data
• Multiple vertical resolutions permitted on same data
• On board real-time displays
• Archive all data

Tilted Beam - 45 deg elev.
2 Azimuths Horiz. Wind Speed
4 – 45 m/s

Horizontal Wind Direction
220 – 360 deg

Vertical Wind Speed
-3 - +3 m/s

Vertical Signal Power
~ 35 dB

March 11-12, 2009, unattended autonomous operation, ~ 14 hrs, 3-minute shot integration times, 5 Hz
NASA Global Hawk 10/23/09
GHOC Flight Operations Room
GH UAS Communications
GRIP GH Payload

**HAMSAR**
High Altitude MMIC Sounding Radiometer
(Temp, H2Ov, Cloud liquid & ice distribution)

**HIWRAP**
High Altitude Imaging Wind and Rain Profiler
(Horizontal wind vectors and ocean surface winds)

**LIP**
Lightning Instrument Package
(Lightning and Electrical Storm observation)

**Driftsondes**
High Altitude Lightweight Dropsonde
(Vertical profiles of temp, humidity, pressure & winds)
HAMSIR Microwave Sounder on Global Hawk
Bjorn Lambrigtsen, Shannon Brown - JPL

Thermodynamic structure
- T(z), q(z), L(z) - clear & cloudy
- Rain rate, IWP (experimental)
- 1 km V x 2 km H in 40-km swath
- 25 channels: 50, 118 and 183 GHz

Multiple platforms
- ER-2 (CAMEX-4, TCSP)
- DC-8 (NAMMA)
- Global Hawk (ready late 2009)

Convective structure
- Radar-like reflectivity
- 1 km vert.res/40 km swath
- Conv.intens., precip(z), ice(z)

3D reflectivity, Hurricane Emily (2005)
**High-Altitude Imaging Wind and Rain Profiler (HIWRAP)**

**NASA Technology Development**
- Low power solid-state transmitter and pulse-compression
- Single aperture antenna for two beams (incidence 30°, 40°) and two frequencies (14, 35 GHz), conical scan
- High altitude, power efficient real-time FPGA-based digital receiver and processor
- GPM frequencies

**Hurricane Measurements**
- *3D winds (grid point retrieval) and reflectivity*
- *Ocean scatterometry (QuikScat-like measurements)*

![HIWRAP Concept](image)

![Global Hawk Radar Bay](image)
Pre-GRIP

April/May 2010
  • Two test flights; 1 local in DFRC range and 1 24hr flight.

Test of Certificate of Authorization (COA) and Flight Information Regions (FIR) Process
  • GH flight to the Gulf of Mexico, possibly Atlantic

Instruments on board
  • HAMSR
  • HIWRAP
  • GH Wx Instruments
  • LIP?
GH UAS Wx Hazard Mods

Install HD Camera in Aircraft Nose
  • Low-Light / Visual / IR

Install Wx Severe Storm Instruments
  • Storm-scope for lightening detection
  • Data Link NexRad?

Install Turbulence Package
  • Turbulence Sensor w/ Display
GRIP DC-8 Range from FLL
Loiter Capability from DFRC

1500 nm transit flight to Gulf of Mexico

15 hr

20 hr

10 hr
East Pac Loiter Capability
GRIP Aircraft Platforms

Questions?