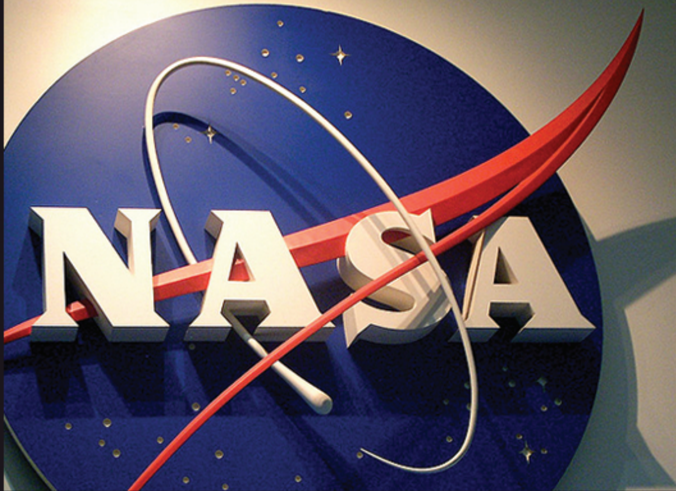
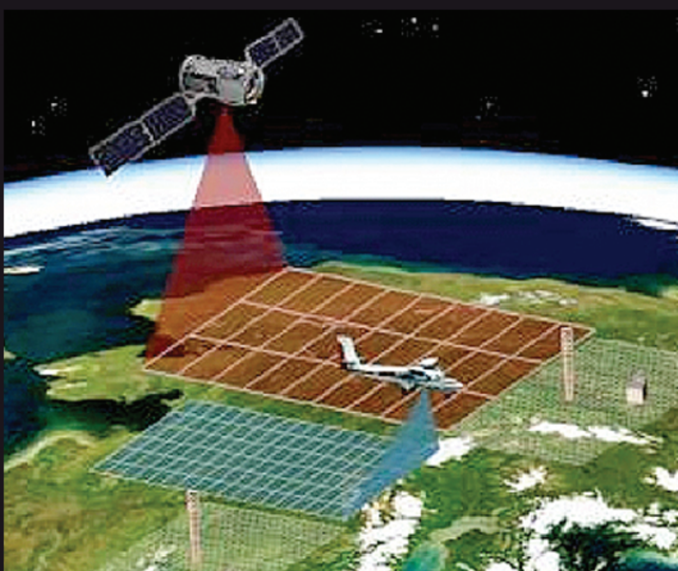
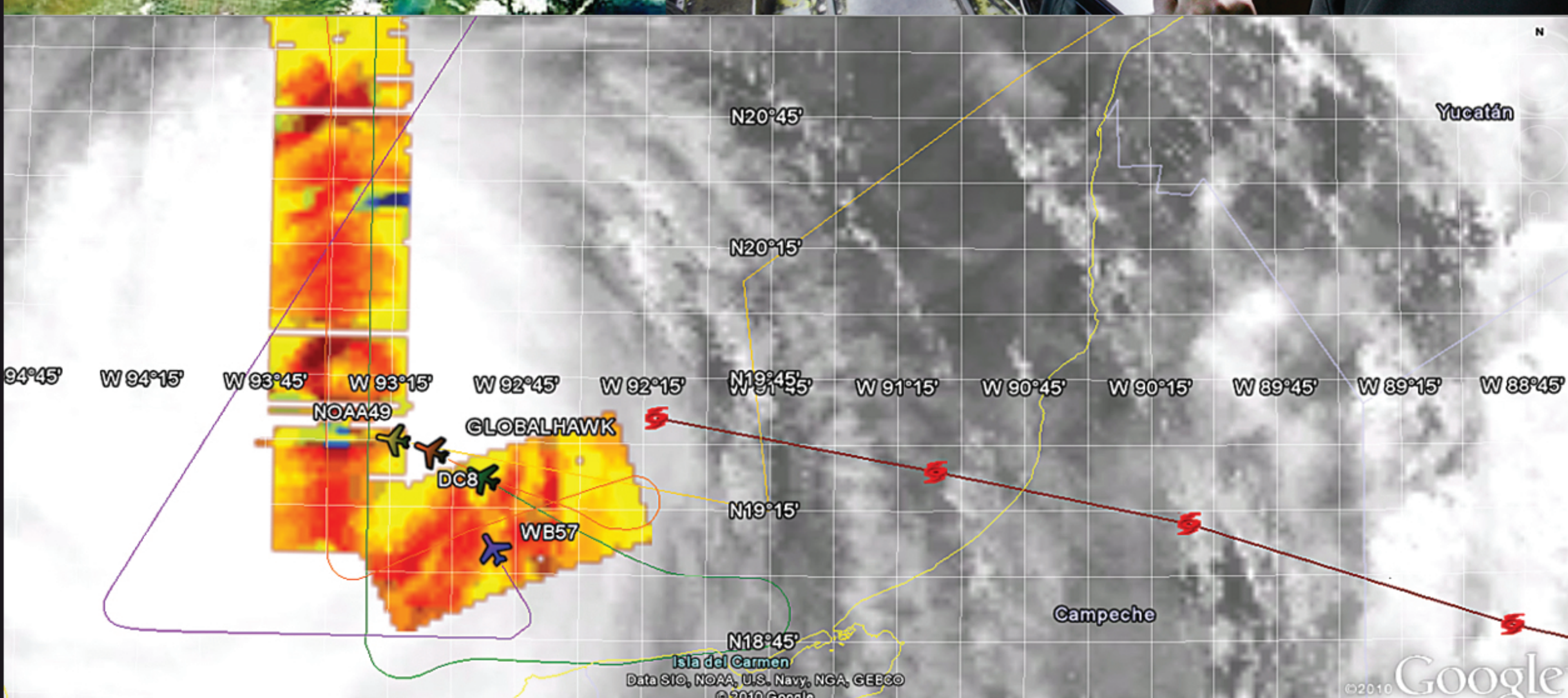


AIRBORNE SCIENCE PROGRAM
2010 ANNUAL REPORT





Airborne Science Program

ANNUAL REPORT 2010

National Aeronautics and Space Administration

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Appendices

From the Director

I'd like to start off my first Airborne Science Program Annual Report by echoing what I wrote for my first Airborne Science Newsletter; I am excited and proud to be a part of the NASA Airborne Science Program. I continue to be impressed with the hard work and dedication of the people and am looking forward to another successful year in 2011. I also want to again thank Randy Albertson for his leadership and tutelage over these past few months and for keeping me on the right track.

This year has been another busy year with over 2700 flight hours flown, including deployments all over the world. We supported numerous satellite calibration and validation flights, multiple Earth Science missions including two Operation IceBridge deployments (Arctic and the Antarctic), as well as multiple deployments to the Gulf of Mexico for the response to the Gulf oil spill disaster. In addition, we trained 29 undergraduate and graduate students through our Student Airborne Research Program and participated in several major conferences to help spread the word about what we do.

Even though it was a great year, it was not without its problems. We had maintenance and scheduling issues, which caused us to miss several data collection opportunities. We need to ensure, to the best of our abilities, that doesn't happen in the future. We are looking at better ways to manage our infrastructure, train our people, and utilize our resources to meet Earth Science requirements. I've challenged the program leadership to take a long hard look in the mirror and remember why we exist and what we need to do as a program to perform our mission, on budget and on time. That is not to say that everyone hasn't been doing their best, however, as an outsider looking in there are always ways to do things better. We will never be satisfied with the status quo, but will continue to more effectively and efficiently run the Airborne Science Program.

As part of continually improving the program, I am actively seeking feedback. I've started reaching out to the scientific community and will continue to do so throughout 2011. In addition to feedback, we have begun a series of infrastructure improvement projects to make the program more effective and efficient. We are revamping our website to make it easier to use and provide the information needed by the scientific community. We are also modernizing and updating our instrument interfaces for both power and data and improving our support systems. Again, I welcome suggestions on how to improve the program for you.

Thank you for taking the time to read this year's annual report. We hope we have provided useful information and given you an understanding of our capabilities and accomplishments in 2010.

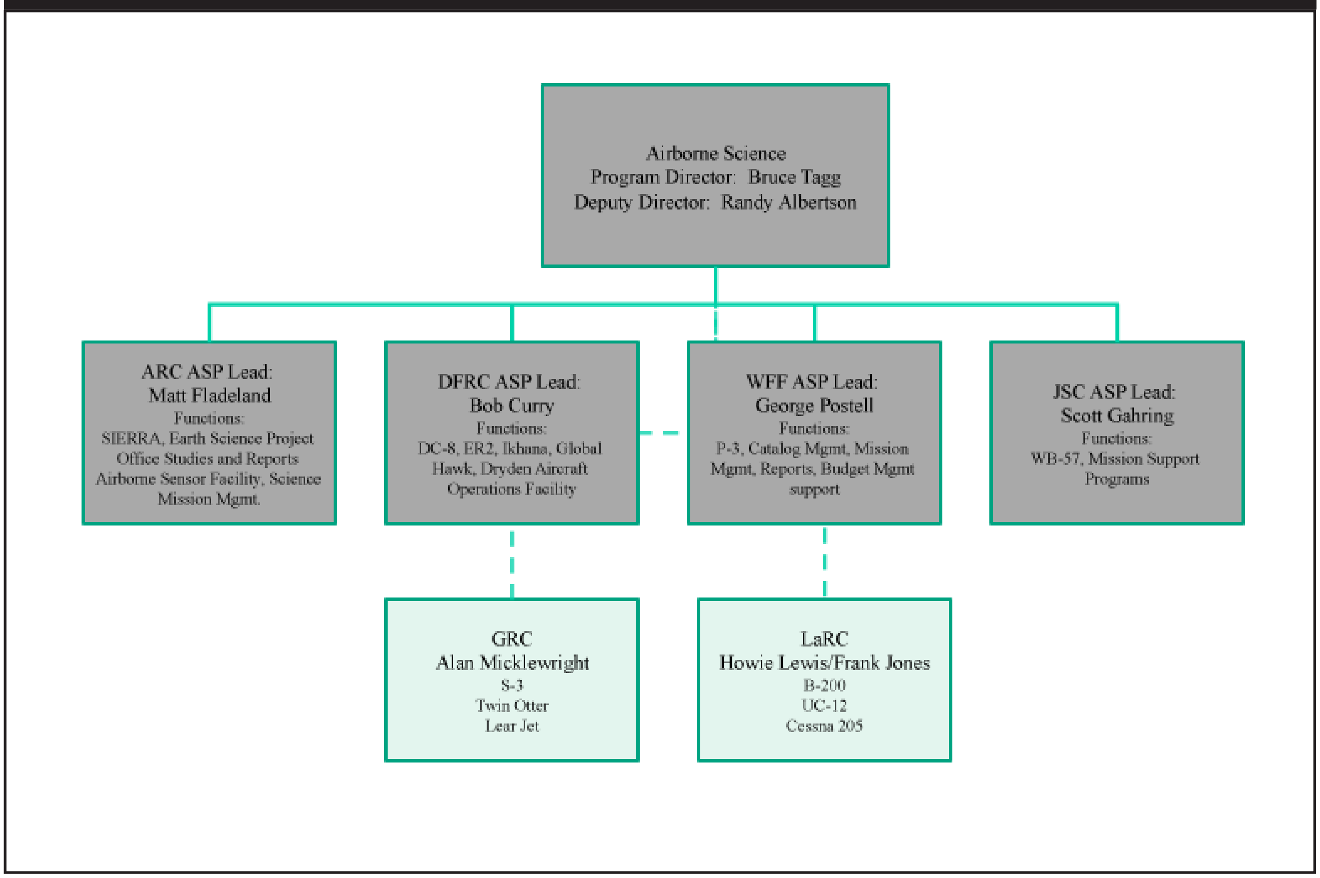
Bruce Tagg
Airborne Science Program Director

The Airborne Science Program: FY10

Introduction and Program Highlights

The Airborne Science Program (ASP) consists of the elements shown in Figure 1. Mr. Bruce Tagg became the Director of ASP in April 2010. The program structure is unchanged from FY09.

Fig. 1: NASA Airborne Science Program Structure.



The ASP had a busy year in 2010, with over 2700 flight hours and missions for more than 200 scientists. Among other major events, ASP flew the new Global Hawk Unmanned Aircraft System (UAS) in two science missions.

Another highlight of 2010 was the selection of 5 Earth Venture-1 (EV-1) projects. These 5-year projects, to be managed by the Earth System Science Program (ESSP) office at NASA LaRC, will use suborbital / airborne capability to perform relevant Earth science over a sustained period. The list of awarded projects and the aircraft to be used are included in Table 1.

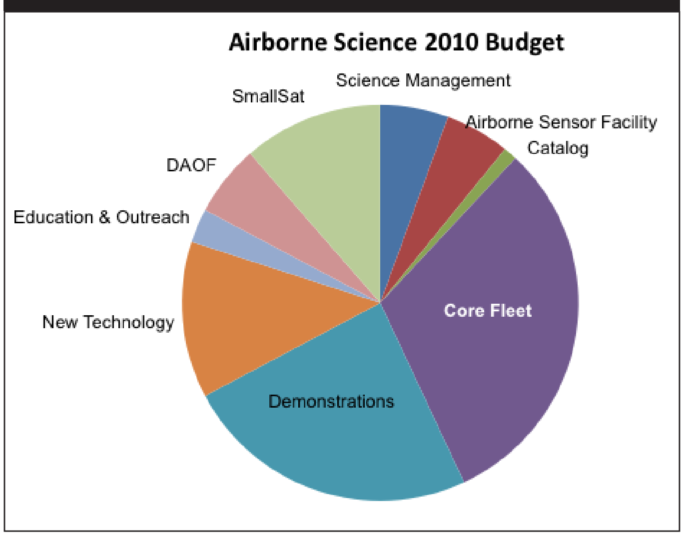
Table 1: EV-1 Projects.

Title	PI Institution	Aircraft
Airborne Microwave Observatory of Subcanopy and Subsurface (AirMOSS)	University of Michigan / JPL	G-III
Airborne Tropical Tropopause Experiment (ATTREX)	ARC	Global Hawk
Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE)	JPL	Twin Otter
Deriving Information on Surface Conditions from COlumn and VERtically Resolved Observations Relevant to Air Quality (DISCOVER-AQ)	LaRC	B-200, P-3B
Hurricane and Severe Storm Sentinel (HS3)	GSFC	2 Global Hawks

Budget

The FY10 budget for the Airborne Science Program was $44,099,000, which included the UAS/Smallsat Project and Operation IceBridge (OIB). The breakout of major components is shown in Figure 2. The history of the program's budget is shown in Figure 3. Future budgets are subject to change at any time and may be reduced even further depending on how NASA treats Civil Servant labor, which is currently included in the numbers.

Fig. 2: ASP FY10 Budget.



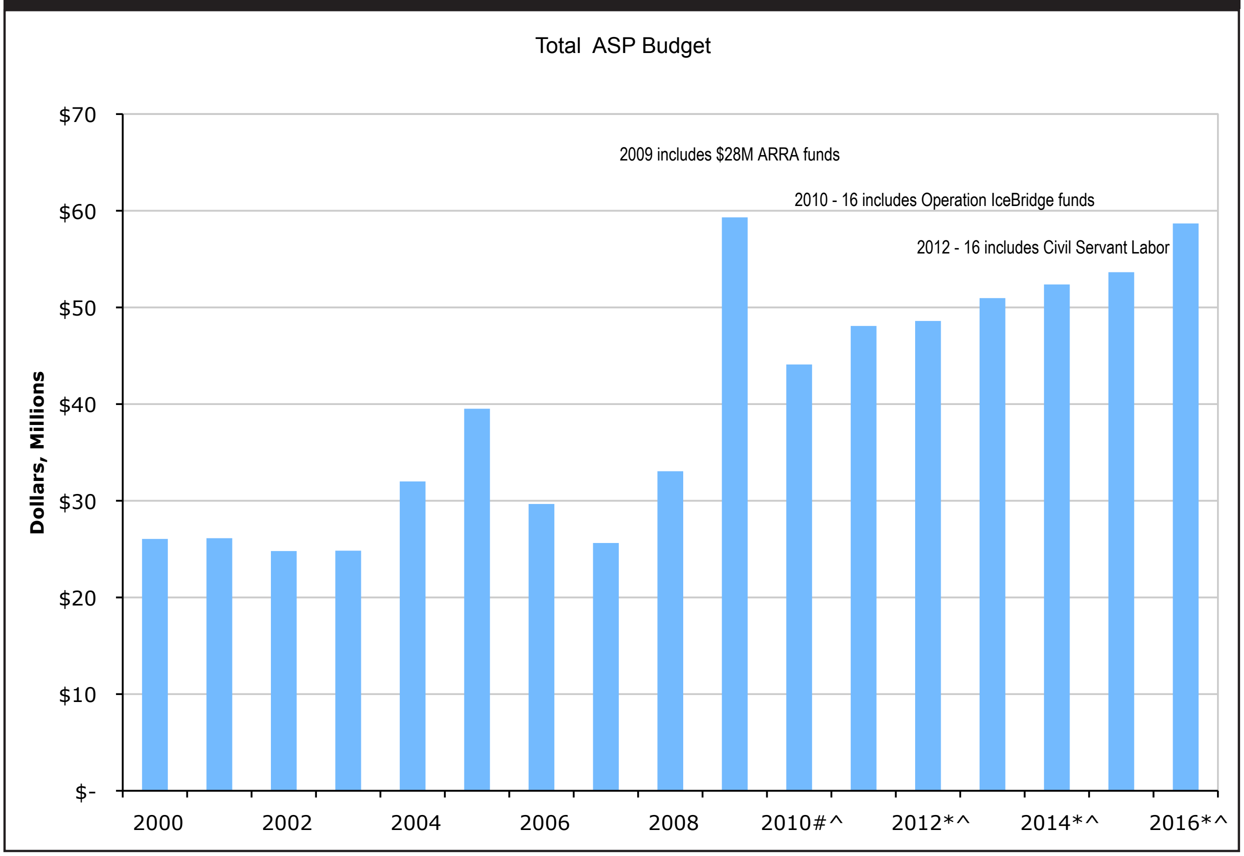
The Airborne Science Program was originally allocated $29,046,000 in American Recovery and Reinvestment Act (ARRA) funding. In FY2010, the program was fully engaged in developing statements of work and contracts as well as going through specialized ARRA reviews. There were a number of programmatic adjustments to the allocation due to activities like the Orbiting Carbon Observatory recovery effort that resulted in ending 2010 with an ARRA budget of $24,046,000.

Categories of ARRA investments included:

- WB-57 aileron refurbishment/replacement
- DC-8 parts aircraft acquisition, engine inspection and auxiliary power unit, control surfaces and cabin windows overhauled
- Funding for seven Operation IceBridge science and instrument teams
- A third UAVSAR pod
- Science aircraft navigation data recorder upgrades and new instrument interfaces. (See page 42.)
- Dryden Aircraft Operations Facility infrastructure improvements including life support facility, fuel tank installation, science lab construction and completing administrative and operations area build out
- King Air B200 modification
- UAS in the National Air Space concept of operations development
- Mobile Global Hawk Operations Center design and fabrication

As a result of ARRA funding, the program was able to acquire parts and services that will enhance DC-8 and WB-57 reliability, the first NASA Global Hawk Mobile Operations Center acquisition was initiated, updated common instrument interface standards on high-altitude aircraft were accelerated, Operation IceBridge science and instrument teams were funded, UAS in the NAS studies commissioned and infrastructure investments fulfilled.

Fig. 3: ASP recent and projected budgets.



\ PPBE 13 budget documents
 # MFPR reporting
^ Includes OIB

Recognition and Awards

On March 11, 2010, the Airborne Science Program Office selected four nominations to receive awards. Selection was based upon the deliberations and recommendations of the ASP Awards Committee, with representatives from each NASA center. All awardees, or their designees, received their awards during the Spring 2010 Airborne Science Team meeting. The awardees were:

J. Brockton Howe
Project Management Excellence

In recognition for engineering excellence during the execution of the multi-faceted, multi-year project to increase the allowable gross weight of the WB-57 and to add the ER-2 Superpods to the aircraft.

CASIE Project Team
Group Award

In recognition of exemplary performance and significant technical and managerial accomplishments in carrying out the first SIERRA science mission to Svalbard, Norway in support of the International Polar Year.

David Van Gilst
Engineering Excellence

For exceptional performance in network, data display, software and communications engineering and outstanding customer service for multiple ASP platforms

James Demmers
Outstanding Achievement

For outstanding Achievement in the performance of duties in support of the NASA Glenn Research Center T-34 hyperspectral imaging deployment to Aguadilla, Puerto Rico from January 24 - February 4, 2010.s

Science Support

Major missions flown in 2010

The Airborne Science Program flew more than 2700 flight hours in support of Science Mission Directorate (SMD) Earth Science. Included were a number of significant accomplishments. NASA's Global Hawk UAS flew its maiden science mission in Global Hawk Pacific (GloPac), traversing the Pacific Ocean and high Arctic carrying eleven atmospheric science payloads. Figure 4 below shows the path of Science Flight #3, reaching 85N in April 2010. GloPac also paved the way for Global Hawk to join the Genesis and Rapid Intensification Processes (GRIP) mission, along with the DC-8 and WB-57, during the Atlantic Hurricane season.

In FY 2010, Operation IceBridge (OIB) flew productive missions in Antarctica in the fall and in Greenland and Alaska in the spring. OIB has been so successful in providing much needed information on the cryosphere that SMD plans yearly spring and fall missions for the upcoming five years, with the intention of having the Global Hawk join other assets in this effort.

Also in 2010, ASP supported major disaster management missions by monitoring conditions in Haiti following the January earthquake, and in the Gulf of Mexico, following the explosion of the Deepwater Horizon. Figure 5 shows imagery obtained with NASA's MASTER instrument flying on the ER-2.

Also, in support of future satellite missions, ASP utilized the UAVSAR in a US and Canadian partnership to develop and validate soil moisture algorithms and products from two new satellite platforms: the ESA Soil Moisture Ocean Salinity (SMOS) and the NASA Soil Moisture Active Passive (SMAP) missions.

Fig. 4: GloPac Science Flight 3 and flight lines reaching 85N.

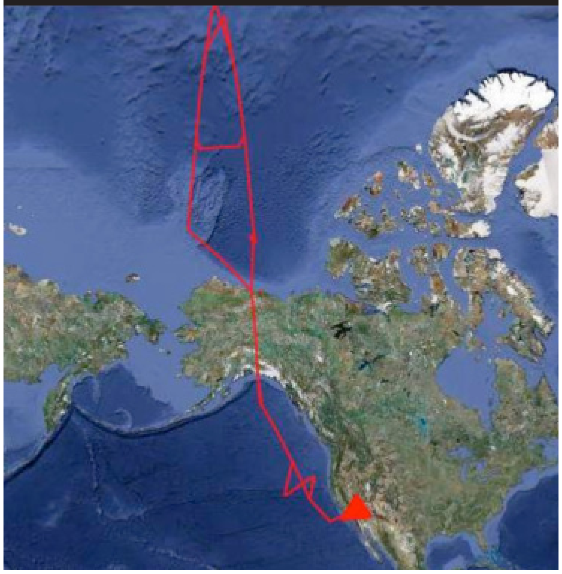
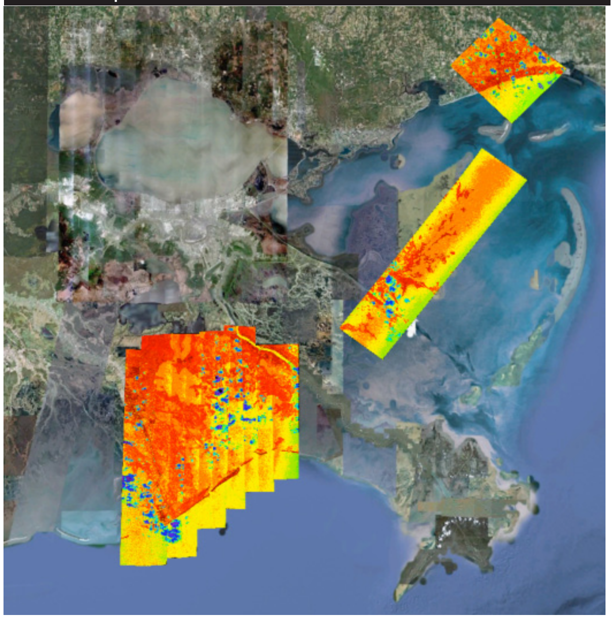


Fig. 5: MASTER thermal infrared imagery acquired by the ER-2 31 on July 2010 over the Deepwater Horizon Gulf oil spill.



Science Support Data

The annual Airborne Science Call Letter was distributed in July of 2009. There were 175 flight requests submitted in 2010. Seventy-four flight requests were completed, some were deferred and the rest were withdrawn or canceled, depending upon the availability of resources at the time of the request. The details are listed in Table 2 below.

Flight requests were submitted for 15 aircraft platforms and flew more than 2700 flight hours in all. Several large campaigns were successfully conducted this year (GloPAC, Operation IceBridge, GRIP and more). Aircraft utilization is indicated in Figure 6.

Table 2: FY10 Flight Request Summary

Aircraft	Submitted	Total Approved	Total Completed	Total Science Flight Hours Flown
DC-8	16	13	13	650.8
ER-2	29	19	11	188.8
P-3	9	5	2	112.1
WB-57	12	5	4	40.0
Twin Otter	22	10	9	292.1
B-200	12	7*	6	274.6
Aerosonde	1	0	0	0
Cessna 206	1	1*	1	18.3
Global Hawk	6	3	3	227.3
Gulfstream G-3	38	32	24	278.8
Ikhana	1	1	0	0
Learjet 25	1	1*	1	14.6
SIERRA	6	1*	1	10
T-34	3	2*	2	73.7
Other**	18	14	14	523.1
TOTAL:	175	113	90	2704.2***

KEY

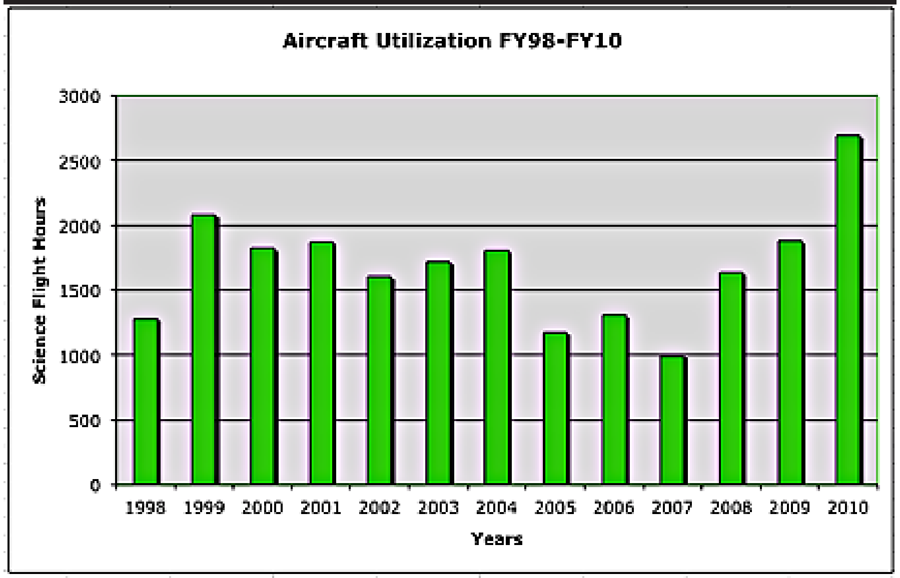
Submitted:	Flight Request entered into the system.
Total Approved:	All flight requests that have been approved.
Total Completed:	Flight requests completed in FY10.

**Some internally approved Langley B-200, Cessna 206, GRC Learjet 25 and T-34 flight requests were separate from the ASP FR system but the completed science hours are reflected in this summary.*

***Other Aircraft for 2010 include: Air Greenland Otter, Air Greenland TO, Cessna 182 or equivalent, DHC-3, Erickson Aircrane Helicopter, F-18, FS King Air, Kenn-Borek BT-67 (DC-3), Piper Aztec; URF, Piper Navajo (N11UT), PNNL/Battelle G-1, Shrike Commander, U Tenn Navajo, Ultima Thule TO, Viking 300 UAV, Wyoming King Air, Zeppelin.*

****The "Total Hours Flown" column includes all flight hours for flight requests with a status of Completed for 2010. For multi-year missions, this may include hours flown in years prior to 2010. Aircraft hours flown for maintenance, check flights and pilot proficiencies are not included in these totals.*

Fig. 6: Aircraft Utilization; ASP science flight hours are continuing to increase.



The ASP supported science missions, as indicated in Table 3. Note that some of the missions support emergency response, cal/val and education. ASP also supported instrument development test flights (Table 4, page 10) of sensors developed under the Earth Science Technology Office Instrument Incubator and Airborne Instrument Technology Transfer programs.

Table 3: Science Missions flown in FY10.

Mission	Aircraft	Flight Hours	Location	Sponsor	PI	Instrument
Science Missions						
Genesis and Rapid Intensification Processes (GRIP)	Global Hawk, DC-8, WB-57	290	mid-Atlantic, from DFRC, Ft. Lauderdale and JSC	Kakar	Vasques, ARC	MMS; APR02; CAPS/CVI/ PIP;LASE; Dropsondes
GloPac - Global Hawk Pacific	Global Hawk	104.8	DFRC > Pacific, Arctic	Albertson	Craig, ARC	Atmospheric chemistry packages
Earth surface, interior and vegetation	G-III	178	CA, HI, WA, Costa Rica, Panama	Dobson	Jones, Donnelan, etc., JPL	UAV-SAR
ABACATE: Airborne Biodiversity Assessment of Coastal and Terrestrial Ecosystems	T-34	49.6	GRC	DeTroge	Lekki, GRC	GRC HSI
GLEAM: Great Lakes Environmental Analysis Measurement	T-34	24.1	GRC, Detroit River	NOAA	Lekki, GRC	GRC HSI
CalNex & CARES	B-200 - LARC	18.3	Ontario & Sacramento	DOE	Hostetler, LaRC	HSRL, RSP, Applanix
Joint EPA Sensors Mission	Cessna 206	15.5	NASA Langley	EPA	Szykman, LaRC	EMVIS

(Table 3 continued)

Mission	Aircraft	Flight Hours	Location	Sponsor	PI	Instrument
Emergency Response						
Haiti	G-III	40.2	Haiti	Dobson	Lundgren, GSFC	UAV-SAR
Gulf Coast oil spill	ER2, B-200, G-III	195.3	Gulf of Mexico	Bontempi, Wickland, Goodman, Dobson	Leifer (UCSB), Ustin (UCD), Wright (USGS), Jones (JPL)	AVIRIS, MASTER, DCS, Flurescent Lidar, UAV-SAR
Southern California Post-Fire Assessment	ER-2, B-200	22.5	So. Cal	Wickland	Hook, Roberts	AVIRIS, MASTER
Cal/Val						
CALIPSO Validation for FY10	B-200 - LaRC	20	NASA Langley & Caribbean	Considine	Hostetler, LaRC	HSRL & RSP
Education						
SARP 2010	DC-8	24.9	Palmdale, CA	Albertson	Shetter, UND	MASTER; WAS

Table 4: Instrument test flights flown in FY2010.

Mission	Aircraft	Flight Hours	Location	Sponsor	PI	Instrument
Instrument test						
AirMSPI	ER-2	4.2	SoCal	Kakar	Diner, JPL	AirMSPI
SIMPL SERC Deployment	Lear-25	14.6	MD	ESTO, GSFC	Harding, GSFC	SIMPL
HIWRAP	WB-57	11.5	JSC	Kakar	Heymsfeld, GSFC	HIWRAP
Polscat	Twin Otter	31	Colorado	Entin	Dinardo, JPL	Polscat
HIRAD	WB-57, Global Hawk	36.9	JSC, DFRC	Kakar	Miller, MSFC	HIRAD

To assist the science community in having up-to-date information about sensors available to fly on NASA aircraft, a new Sensor Database is under construction. The basic format is shown in Table 5. Operational and integration details for the instruments will be included in the database information on the ASP website. Instructions for instrument operators and users will be available in early 2011.

Table 5: New Sensor database under construction.

Type	Name and Acronym	Specific type	Facility or PI	Aircraft	Detailed Charactersitics	TRL and availability
Passive						
Active						
Pasive / active						
In situ						

The ASP is also supporting future Earth Science satellite missions through flights that highlight algorithm development and instrument test or cal/val planning. Table 6 indicates a sample of 2010 ASP efforts in support of Decadal Survey Missions.

As an example of support for future satellite missions, ASP utilized the UAVSAR in a U.S. and Canadian partnership to develop and validate soil moisture algorithms and products from two new satellite platforms; the ESA Soil Moisture Ocean Salinity (SMOS) and the NASA Soil Moisture Active Passive (SMAP) missions. SMOS, which was launched in late 2009, is in its post-launch calibration/validation (cal/val) phase. The campaign, known as CanEx (Canadian Experiment), provided aircraft and ground-based validation of the SMOS brightness temperature and soil moisture products. SMAP is due for launch in 2014. CanEx contributed to SMAP's pre-launch algorithm development and validation and established post-launch validation infrastructure. In addition to the active L-band UAVSAR G-III aircraft, a Canadian Twin-Otter aircraft equipped

Table 6: Decadal survey mission support.*

Mission	Aircraft	Flight Hours	Location	Sponsor	PI	Instrument
Support for Decadal Survey Missions						
SMAP						
SMAPVEX 10	G-III	39.9	Sasakatoon, Canada	Entin	Jackson, USDA	UAVSAR
Multi-resolution snow products for the hydrologic sciences.	ER-2	5.7	Coloardo, USA	Entin	Painter, U UT	AVIRIS, MASTER
ICESat-2						
Operation IceBridge: Antarctic	DC-8	283.5	Chile > Antarctica	Albertson / ASP	Martin, UWA	ATM; LVIS; MCoRDS
Operation IceBridge: Antarctic	DC-8, P3-B, DCH-3	304.8	Thule, Greenland/ Fairbanks, Alaska/Iceland	Albertson / ASP	Koenig, GSFC	ATM; LVIS; UAF Lidar
DESDynI						
Desdyni: INSAR observations of forest gradient in Central America	G-III	6.5	Costa Rica/ Panama	Dobson	Hensley, JPL	UAVSAR
DESDynI	G-III	6.1	US MS/LA/AR	Cox	Aanstoos, MSU	UAVSAR
Airborne lidar data collection in Chile and Greenland in support of NASA DESDynI Mission	DC-8	8.5	Chile and Thule, Greenland	Blair	Blair, GSFC	LVIS
ASCENDS						
ASCENDS Test Flights	DC-8	29.8	DFRC	Jucks, Kakar	Browell, LaRC	ACCLAIM
AID for ASCENDS 3	B-200-LaRC	19.2	NASA Langley	Jucks	Browell, LaRC	ACCLAIM and In situ
HYSPIRI						
Multiple AVIRIS and Master experiments	ER-2, B-200	12.4	UT, CO, CA, NM, NV	Turner, Platnick, Jucks	Townsend, French, Pollock	AVIRIS, MASTER

**This is not a comprehensive list.*

with a passive L-band radiometer was flown simultaneously to simulate the active and passive capabilities of SMAP. Intensive ground based sampling of a large number of fields was also obtained concurrent with aircraft and satellite-overpass data acquisition. Over a two-week period, seven sets of images were obtained over an agricultural region at various points in the wet / drying cycle. One mission was also conducted in a boreal forest region.

Requirements Analysis

The Program is guided by the requirements set forth by the science community and the mission teams that use aircraft to carry science payloads in support of NASA earth observing satellites. In FY2010 the Program completed a preliminary analysis of requirements related to the missions suggested by the NRC Decadal Survey. The survey of related instruments, planned calibration validation plans, and future campaigns provided insights into future aircraft usage, and guide modification and upgrades. Figure 7 below shows a summary of anticipated aircraft support for future missions.

Another important aspect of ASP program analysis is the 5-yr planning process. By developing these projections with stakeholders, ASP management and aircraft teams can plan maintenance cycles, and work to reconcile possible schedule conflicts before they impact science or mission goals. The current 5-yr plan is shown in Appendix A.

Fig. 7: ASP Aircraft are anticipated to support many upcoming satellite missions.

NASA Airborne Science Program supporting Decadal Survey Missions	Glory	Aquarius	NPP	LDCM	OCO-2	GPM	SAGE-III	GOES-R	CLARREO	SMAP	ICESat-II	DESDynI	Hyspiri	ASCENDS	SWOT	GEO-CAPE	ACE	LIST	PATH	GRACE-III	SCLP	GACM	3D-Winds
DC-8					■	■	■				■			■ ● ● ●			■ ○						■ ● ●
ER-2			■			■	■	■	■ ○		■						■ ○ ○ ●						■ ○
WB-57																■ ●						■ ●	■ ●
P-3	■ ○	■								■	■					■ ○	■ ○						
G-III / UAVSAR											■ ○	■			■ ○								
Lear									■ ●					■ ●				■ ●					
B-200				■										■	■								
Global Hawk						■					■	■			■								
SIERRA										■													
Twin Otter												■ ○	■ ●										

● - IIP-funded instruments

○ - AITT-funded instruments

NASA Aircraft Platforms

The task of providing sustained access to highly modified aircraft for research observations requires a diverse portfolio of NASA investments in core aircraft, coupled with strategic partnerships with NASA centers, other agencies and industry. The core platforms sustained by NASA ASP include the WB-57, ER-2, DC-8, G-III, P-3B, and Global Hawk. All are unique, highly modified aircraft with significant investments in ports, hard points, pods and other infrastructure.

NASA has also invested in a few new technology platforms to determine and demonstrate their potential utility to airborne Earth system science investigations. As a result of significant investment and successful performance in 2010, Global Hawk is now considered part of the core fleet. SIERRA and Ikhana are also recent graduates of the new technology program.

Also available are two NASA B-200's, a UC-12, OV-10, Lear Jet 25, S-3 Viking, Twin Otter, and T-34

The nominal flight regimes for the NASA aircraft are shown in Figure 8. The aircraft characteristics are summarized in Table 7 (page 14).

These national assets provide assured access to capabilities that cannot be found anywhere else, including very high altitudes, extreme duration flight, and large payload, all for a reasonable hourly cost to the project.

When the user requirements cannot be met by NASA core aircraft capabilities, other government

Fig. 8: Flight regimes of NASA core aircraft with nominal payloads.

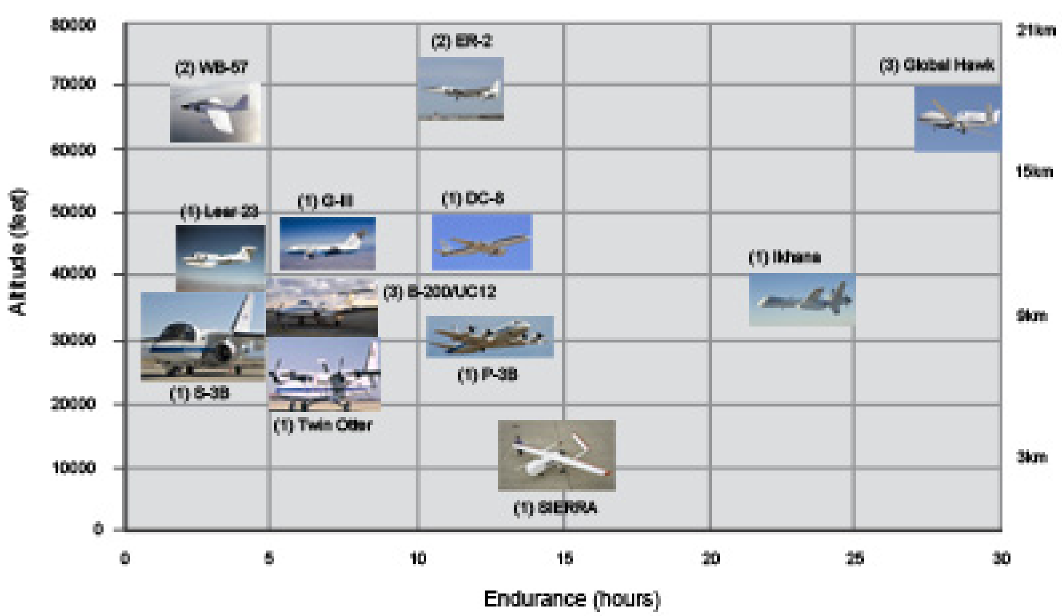


Table 7: NASA aircraft performance characteristics.									
Airborne Science Program Resources	**Platform Name**	**Center**	**Duration (Hours)**	**Useful Payload (lbs.)**	**GTOW (lbs.)**	**Max Altitude (ft.)**	**Airspeed (knots)**	**Range (Nmi)**	**Internet and Document References**
Core Aircraft	ER-2	NASA-DFRC	12	2,900	40,000	>70,000	410	>5,000	http://www.nasa.gov/centers/dryden/research/AirSci/ER-2/
	WB-57	NASA-JSC	6	6,000	63,000	65,000	410	2,172	http://jsc-aircraft-ops.jsc.nasa.gov/wb57/
	DC-8	NASA-DFRC	12	30,000	340,000	41,000	450	5,400	http:///.nasa.gov/centers/dryden/research/AirSci/DC-8/
	P-3B	NASA-WFF	12	16,000	135,000	30,000	330	3,800	http://wacop/wff.nasa.gov
	Gulfstream III (G-III) (mil: C-20A)	NASA-DFRC	7	2,610	45,000	45,000	459	3,400	http://airbornescience.nasa.gov/platforms/aircraft/g3.html
	Global Hawk	NASA-DFRC	31	1500	25,600	65,000	335	11,000	http://airbornescience.nasa.gov/platforms/aircraft/globalhawk.html
NASA Catalog Aircraft	King Air B-200 AND UC-12B	NASA-LARC	6.2	4,100	12,500	35,000	260	1250	http://airbornescience.nasa.gov/platforms/aircraft/b-200.html
	DHC-6 Twin Otter	NASA-GRC	3.5	3,600	11,000	25,000	140	450	http://www.grc.nasa.gov/WWW/AircraftOps/
	Learjet 25	NASA-GRC	3	3,200	15,000	45,000	350/.81 Mach	1,200	http://www.grc.nasa.gov/WWW/AircraftOps/
	S-3B Viking	NASA/GRC	>6	12,000	52,500	40,000	450	2,300	http://www.grc.nasa.gov/WWW/AircraftOps/
	Ikhana (Predator-B)	NASA-DFRC	30	3,000	10,000	52,000	171	3,500	http://airbornescience.nasa.gov/platforms/aircraft/predator-b.html
	SIERRA	NASA-ARC	11	100	400	12,000	60	550	http://airbornescience.nasa.gov/platforms/aircraft/sierra.html

agency aircraft can be suggested, as discussed later. Alternatively, the commercial aircraft may be a more appropriate choice. Commercial aircraft that respond to the yearly Broad Agency Announcement and clear interviews and inspections are then available under a Blanket Purchase Agreement (BPA) to immediately respond to project needs.

NOTE: Flight profiles for all aircraft are located in Appendix B, beginning on page 51.

Large Aircraft

NASA DC-8
Dryden Flight Research Center

Major Modifications in FY2010:

- **INMARSAT Satellite Communications System**
  Provides dual channel high-speed (up to 432kbs per channel) satellite uplink-downlink system for telephone services and transferring data to and from the aircraft in flight to support science mission objectives and aircraft operations requirements.
- **Edgetech Model 137 Vigilant Hygrometer**
  Measures the dewpoint of the outside air to determine relative humidity.
- **Rosemount 102E4AL Total Air Temperature Sensor**
  This provides a precise, fast response measurement of the total air temperature of the outside air.
- **AIMMS-20 Air Data Probe**
  This probe provides 3D winds measurements, humidity, and high data rate position and attitude data.
- **Ktech Corporation airborne telemetry tracking/receiving system**
  The DC-8 has been modified to allow rapid integration of the contractor owned Ktech Corporation telemetry tracking system to facilitate the capability to receive and record downrange missile telemetry data streams during boost/staging phases for systems health monitoring purposes.

FY2010 Missions/Flight Hours:

- Operation IceBridge Antarctic 2009 = 269.2 hrs
- Operation IceBridge Greenland 2010 = 132.7 hrs
- DESDynI Greenland (LVIS Instrument) = 7.5 hrs

Fig. 9: NASA DC-8.

- Hayabusa Reentry Observation = 43.6 hrs
- Student Airborne Research Project II (SARP II)= 13.8 hrs
- ASCENDS (CO_2 Instrument Development) = 29.8 hrs
- GRIP (Hurricane Genisis & Rapid Intensification Processes) = 138.9 hrs
- Total flight hours = 635.5 hrs

Aircraft Specifications:

Representative DC-8 flight profiles are shown in Appendix B, page 51.

Aircraft Info:

http://www.nasa.gov/centers/dryden/aircraft/DC-8/index.html

About the aircraft

The NASA DC-8 is one of several research platform aircraft used to support the earth science community under NASA Headquarters' Science Mission Directorate, Airborne Science Program. The Agency's DC-8 Airborne Laboratory aircraft is located at the Palmdale California Dryden Aircraft Operations Facility (DAOF) where DC-8 flight operations are managed by the NASA Dryden Flight Research Center. The DC-8 flies three primary missions: sensor development, satellite sensor verification and basic research studies of the Earth's atmosphere and surface.

P-3B Orion
NASA Wallops Flight Facility

Major Modifications in FY2010:

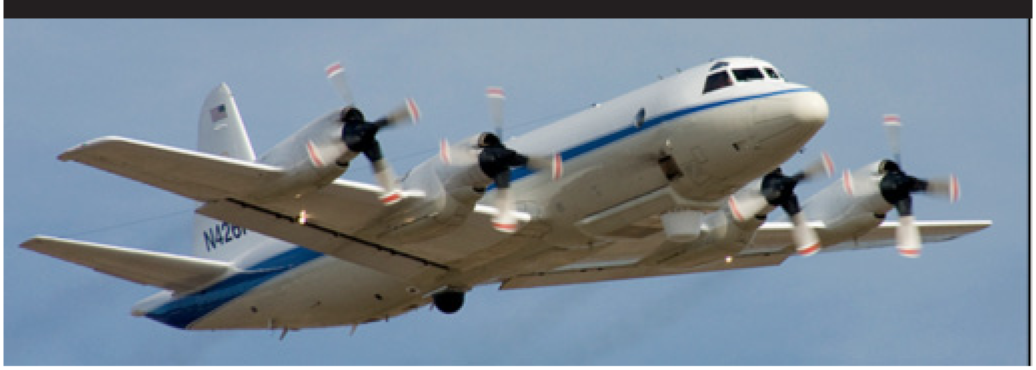
During fiscal year (FY) 2010, an upgraded aircraft project data system was installed and operated by the University of North Dakota. Updated sensors to the system include digital video cameras, hydrometer, IR temperature sensor, total air temperature probe, angle of attack and sideslip probes, cabin air pressure, and INMARSAT satellite uplink/downlink capability (internet and phone service) along with the REVEAL system. The data system supplies information from the assorted aircraft probes/antennas along with a myriad of aircraft flight parameters (airspeed, altitude, heading, roll/pitch/yaw information, GPS, timing, ARINC 429 bus data, etc.) via Ethernet lines to each experimenter station.

A separate data collection system was also installed for use during Engineering Check Flights (ECF). This flight test data system provides angle of attack and sideslip data along with static and dynamic pressure data via a wing mounted boom assembly. Several cabin sensors were installed on the control cables and yokes to determine control surface deflections and forces along with a tail mounted accelerometer. Data provided by this system is evaluated post ECF to quantitatively determine the effect large aircraft modifications have on the overall performance of the P-3 in order to fly at an optimized safe flying regime.

Updated experimenter equipment racks were designed and manufactured in FY10. These racks are designed as single bay racks, which can be bolted together to form standard double bay racks inside the aircraft. Each rack can be preloaded prior to aircraft install and can support up to 490lbs of equipment (980lbs total in double bay arrangement). The new design allows for easier shipping and aircraft installation along with compatibility with other aircraft.

Wallops acquired ten P-3 standard wing pylon mounts capable of supporting a wide array of wing-mounted sensors and probes. Along with the wing pylons, Wallops acquired a P-3 fiberglass tail boom for the aft tailcone, which is capable of supporting radar and magnetic field research.

Fig. 10: NASA P-3B.



Aircraft Specifications:

- **Duration:** 8 Hous (12 hours with augmented crew)
- **Useful Payload:** 14,700 lbs
- **Gross Take-off Weight:** 135,000 lbs
- **Onboard Operators:** 18 (including flight crew)
- **Max Altitude:** 30,000 ft.
- **Max. Air Speed:** 400 knots true airspeed (KTAS)
- **Max. Range:** 4,000 nm

The P3-B is shown in Figure 10. Representative flight profiles are shown in Appendix B, page 52.

Aircraft Info:

http://airbornescience.nasa.gov/platforms/aircraft/p-3b.html.

High Altitude Aircraft

NASA ER-2 (2 aircraft)
Dryden Flight Research Center

Major Modifications in FY2010:

No major modifications took place in FY2010.

FY2010 Missions/Flight Hours:

- Tropospheric Wind Lidar Experiment (TWiLiTE) 2009= 5.4 hrs
- Airborne Visible/Infrared Imaging Spectrometer Calibration & Validation 2009 = 3.7 hrs
- Atmospheric Carbon Observation from Space (ACOS) 2009 = 2.4 hrs
- Gulf Oil Spill monitoring and assessment phase 1 Deployment 2010 = 76.6 hrs
- Forest Genetic diversity and assessment of below ground microbial communities in populous tremuloides = 7.1 hours
- Characterization of forest functional types and their role in mediating ecosystem response to global change = 8.0 hrs.
- Northrop Grumman Multi-Role Tactical Communications Data Link (MR-TCDL) Deployment 2010 = 36.0 hrs
- Gulf Oil Spill monitoring and assessment phase 2 Deployment 2010 = 62.3 hrs
- Large Area Collectors (LAC) 2010 = 20.0 hrs
- Sandia National Laboratories HATS Sensor = 42.7 hrs
- Total flight hours = 264.2 hrs

Fig. 11: NASA ER-2.

About the aircraft

NASA operates two ER-2 (806 & 809) aircraft as readily deployable high altitude sensor platforms to collect remote sensing and in situ data on earth resources, atmospheric chemistry and dynamics, and oceanic processes. The aircraft also are used for electronic sensor research, development and demonstrations, satellite calibration and satellite data validation. Operating at 70,000 feet (21.3 km) the ER-2 acquires data above ninety-five percent of the earth's atmosphere. The aircraft also yields an effective horizon of 300 miles (480 km) or greater at altitudes of 70,000 feet.

Specifications for the ER-2 are listed in Table 8. The aircraft is shown in Figure 11. A representative flight profile is shown in Appendix B, page 52.

Aircraft Info:

http://www.nasa.gov/centers/dryden/aircraft/ER-2/index.html.

Table 8: Specifications for the ER-2.

Crew	One Pilot
Length	62 feet, 1 inch
Wingspan	103 feet, 4 inces
Engine	One General Electric F-118-101 engine
Max altitude	Above 70,000 feet
Endurance	Over 10 hours
Max payload	2600 lbs.
Cruise speed	~400 knots above 65,000 feet altitude (~210 meters/sec)

WB-57 (2 aircraft)
NASA Johnson Space Center

Major Modifications in FY2010:

- Gross weight increase
- Superpod modification

FY2010 Missions/Flight Hours:

- HIWRAP/HIRAD/DLH test flights
- GRIP mission

Total flight hours:

- for SMD – 61.6
- for N926 – 344.9
- for both WB-57s – 633.1

Major FY10 Activities:

- This year brought greatly increased capability for the WB-57. Test flights were completed for gross weight increase and superpods modification. As the maximum gross weight for the aircraft increase from 63,000 to 72,000 pounds, increasing the flight duration to approximately 6.5 hours. The payload capacity increased from 6,000 to 8,800 pounds.
- Test flights were flown in 2010 spring for the HIWRAP, HIRAD, and DLH instruments.
- In summer 2010, the WB-57 joined the GRIP mission. The aircraft flew through Hurricane Earl and Tropical Storm Karl. Two media days were held with many local papers and news stations participating.

Aircraft specifications:

- The two NASA WB-57 aircraft can fly as high as 55,000 ft with total flight duration up to 6.5 hours.

Fig. 12: NASA WB-57 on first flight with four superpods.

- The WB-57 is shown in Figure 12. Representative flight profiles are shown in Appendix B, page 53.

Aircraft Info:

- http://jsc-aircraft-ops.jsc.nasa.gov/wb57/

Global Hawk Unmanned Aircraft System (UAS)
Dryden Flight Research Center

The two NASA Global Hawks, managed by the Dryden Flight Research Center, are mid-wing, long-range, long-endurance single-engine unmanned jet aircraft that typically operate as fully autonomous vehicles. The NASA Global Hawk air vehicles are the same geometry as the USAF RQ-4A (Block 10) air vehicles, and have similar performance characteristics. The Global Hawk provides a unique combination of high altitude and long endurance performance capabilities. It has demonstrated the capability to carry more than 1200 lb of payload to 65,000 ft altitude with mission endurance over 30 hours and a total range in excess of 10,000 nm. The Global Hawk is shown in Figure 13.

The typical flight profile for the air vehicle, shown in Appendix B, page 53, consists of a rapid climb to approximately 50,000 ft. Then the air vehicle climbs at a steady rate as fuel is expended until the air vehicle reaches its maximum operational altitude of 65,000 ft. Then the air vehicle typically remains at the maximum operational altitude until it returns to the operations base and descends for landing.

Fig. 13: Global Hawk during range flight take-off.

Currently, Global Hawk flights begin and end at Edwards Air Force Base (EAFB), which is the location of the NASA Global Hawk Operations Center (GHOC). Range circles for flights over the Pacific Ocean from EAFB are shown in Figure 14-a. A portable version of the GHOC is in development and will be operational in late FY11. This new facility will permit operations from other locations, such as the Wallops Flight

Table 9: Global Hawk flights in FY10.

Dates	TN871	TN872	Flight Objectives
10/23/09 - 3/11/10		32.4	Check-out flights, pilot proficiency
4/2 - 4/30/10		82.7	GloPac
5/27 - 6/29/10	11.7		Check-out flights, pilot proficiency
8/15 - 9/24/10		122.7	GRIP
Total	**6 flights/11.7 hrs**	**20 flights/237.8 hrs**	

Facility (WFF). Range circles from WFF for the Atlantic Ocean, Gulf of Mexico, and Caribbean are shown in Figure 14-b. Figures 15-a shows the range circles for the Arctic region from both EAFB and WFF. One option for Antarctic missions is to conduct operations from the Edinburgh Royal Australian Air Force Base. Range circles for flights from Edinburgh to the Antarctic continent are shown in Figure 15-b.

The two Global Hawks flew more than 250 hours combined in FY10, as indicated in Table 9.

Fig. 14-a: Global Hawk range circle from EAFB.

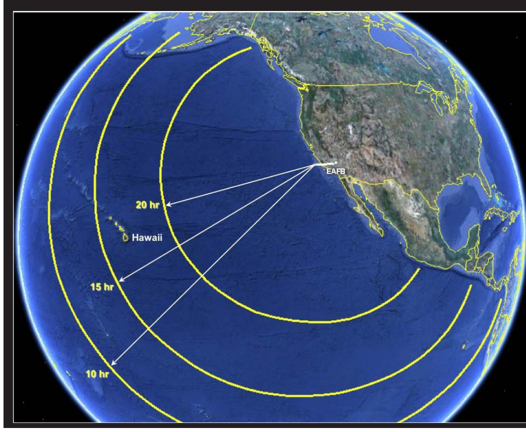


Fig. 14-b: Global Hawk range circle from WFF.

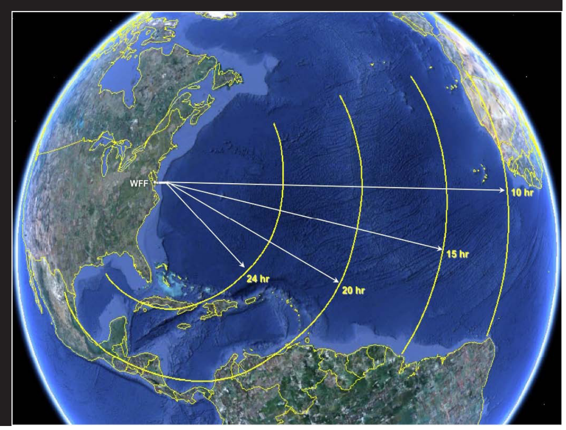


Fig. 15-a: Global Hawk range circle from EAFB.

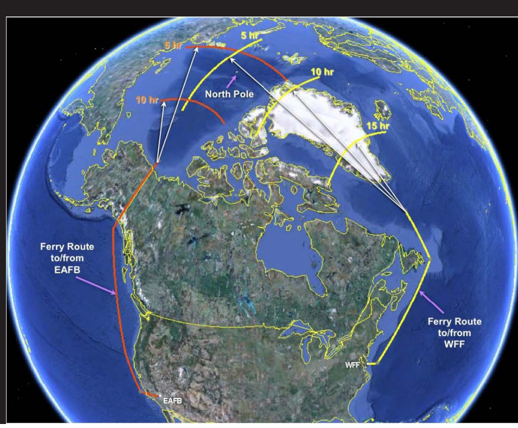
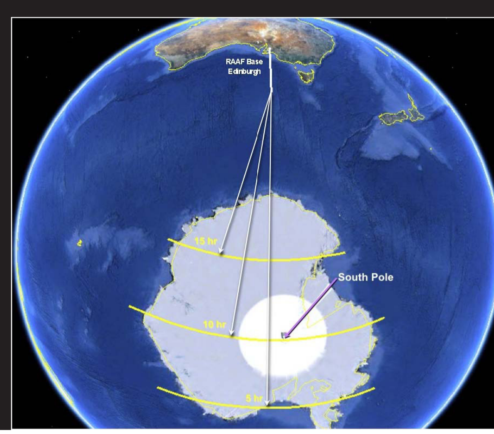


Fig. 15-b: Global Hawk range circle from Australia.



Small and Medium Aircraft

NASA Gulfstream-III (C-20A)
Dryden Flight Research Center

Major Modifications in FY2010:

No major modifications or capability enhancements to the G-III were performed in FY10.

FY2010 Missions / Flight hours:

The G-III, carrying UAVSAR, flew both local missions and deployed missions in FY10 as listed in Table 9. The local missions, based from the Dryden Airborne Operations Facility (DAOF) supported primarily Earth Surface and Interior science objectives. The deployments to various U.S., Canadian, and Central American locations supported a variety of ecosystem measurements.

Aircraft Specifications:

Nominal UAVSAR science missions are conducted at 41kft geometric altitude (~40kft pressure altitude) with a maximum on-station time of about 6 hours. The aircraft is shown in Figure 16 and the typical flight profile is shown in Appendix B, page 54.

Aircraft Info:

http://airbornescience.nasa.gov/platforms/aircraft/g3.html.

Fig. 16: NASA G-III carrying UAVSAR in pod under the fuselage.

Table 10: Local Missions and Deployments of the UAVSAR on the NASA G-III.		
Local Missions		
All missions flown from the G-III home base in Palmdale, CA.	California fault lines (2 sets) SoCal Earthquake response	
	Sacramento Delta Levee Monitoring	
	Sacramento Delta Tidal Study	
	Redwood Forest (AIST)	
	San Gabriel Landslides (USGS)	
	San Joaquin Soil Moisture	
	Yellowstone	
	UAVSAR Engineering	
Deployed Missions		
Hawaii	Volcanoes Mapping	January 4-11, 2010
Costa Rica	Gulf Coast Subsidence Mississippi Levees Haiti Earthquake Response Biomass Volcanoes Mayan Archeology Missing Aircraft	January 25 - February 15, 2010
Saskatoon	Soil Moisture (SMAP)	June 1-16, 2010
Gulf of Mexico	Oil Spill	June 22-24, 2010
Alaska	Volcanoes Biomass - Capital Forest	August 3-6, 2010
Total FY10 Flight Hours = 447		

NASA Ikhana UAS
Dryden Flight Research Center

The Ikhana UAS, shown in Figure 17, is a long endurance aircraft.

In previous years, the Ikhana has flown significant missions to monitor and map wildfires in the Western U.S. Similar activity is anticipated for the future. In FY10, the Ikhana supported missions for non-NASA customers.

Major modifications in FY2010:

NASA did not invest in any modifications or enhancements for Ikhana in FY10.

FY2010 Missions/Flight hours:

A total of 42.0 hours for a non-NASA customer.

Aircraft Specifications:

Flight duration:

- >24 hours at optimal altitudes, 20-30k ft.
- Payload: Over 3000 lbs of radar, sensors, communications and imaging equipment.
- POD available to carry remote sensing payloads.

Aircraft info

URL: http://www.nasa.gov/centers/dryden/aircraft/Ikhana/index.html.

Fig. 17: NASA Ikhana UAS.

NASA B-200
Dryden Flight Research Center

The remote sensing configuration of the Dryden B-200, shown in Figure 18, is identical to the Langley aircraft that has been in service for many years. Experimenters will be able to use either aircraft without additional sensor integration design. The Dryden aircraft will increase availability of the popular B-200 type and provide more cost effective support for West coast missions due to its basing location in southern California. The Dryden B-200 also has a high bandwidth antenna to support payload data links.

Major Modifications in FY2010:

- Re-configuration to enable nadir oriented remote sensing using FAA certified design and previously implement on the Langley B-200.
- 2 Nadir ports with removable BK-7 glass windows. (See Figure 19)
- One port equipped with a pressure housing for IR systems
- Sliding Foreign Object Debris (FOD) doors and air deflection fence
- Pilot's flight control system for remote sensing missions
- Rear Compartment equipment racks
- Chelton 7000 Inmarsat SwiftBroadband antenna

All modifications to the airplane are now complete and have been validated in flight. The airplane is ready to begin science missions and several mission plans for 2011 are in progress.

FY2010 Missions/Flight Hours:

Functional check flights were flown; no science missions were conducted.

The flight profile for the Dryden B-200 is the same as that for the Langley B-200, described in Appendix B, page 54.

Fig 18: NASA B-200.

Fig 19: Camera ports on the DFRC B-200.

Hawker Beechcraft B-200 King Air
NASA Langley Research Center

Major Modifications in FY2010:

There were no major modifications in FY10.

FY2010 Missions/Flight Hours:

- CALIPSO Cal/Val
- CalNex and CARES

Total flight hours: 186.3

Aircraft specifications:

- Service ceiling = 35,000 ft
- Time on station (with 3 crew, at 28,000 ft,
- 500 lb payload, 190 KTAS) = 4.25 hr
- Two nadir portals
- One 1-in dia. Zenith portal
- Pressure dome fr aft nadir portal
- GPS antenna
- 4200 W research power
- Applanix

Representative flight profiles for the B-200 are shown in Appendix B, page 54.

Aircraft info:

URL: http://airbornescience.nasa.gov/platforms/aircraft/b-200.html.

The Langley B-200 is shown in Figure 20.

Fig. 20: NASA Langley B-200.

Hawker Beechcraft UC-12B Huron
NASA Langley Research Center

Major Modifications in FY2010:
There were no major modifications in FY10.

FY2010 Missions/Flight Hours:

- AID for ASCENDS3

Total flight hours: 19.2

Aircraft specifications:

- Service ceiling = 31,000 ft
- Time on station (with 3 crew, at 28,000 ft, 500 lb payload, 190 KTAS) = 4.25 hr
- Two nadir portals
- One 1-in dia. Zenith portal
- Pressure dome fr aft nadir portal
- GPS antenna
- 4200 W research power
- Applanix available

The flight profile for the UC-12 is essentially the same as the B-200, shown in Appendix B, page 54. The UC-12 aircraft is shown in Figure 21.

Fig 21: NASA Langley UC-12B.

Cessna 206 Stationair
NASA Langley Research Center

Major Modifications in FY2010:

There were no major modifications in FY10.

FY2010 Missions/Flight Hours:

- Joint EPA sensors mission.

Total flight hours: 18.3

Aircraft specifications:

- Service ceiling = 15,700 ft
- Time on station (with 3 crew, at 10,000 ft, 500 lb payload, 150 KTAS) = 5.7 hr
- Two zenith portals
- LaRC General Aviation Baseline Research System
- Researcher work station
- Belly cargo pod with nadir portals
- 840 W research power

The Cessna 206-H is shown in Figure 22. Nominal flight profiles are shown in Appendix B, page 55.

Fig 22: NASA Langley Cessna 206-H.

Rockwell OV-10G Bronco
NASA Langley Research Center

During FY10, NASA acquired two OV-10G aircraft (Figure 23). The basic specifications are listed below. No missions were flown in FY10.

Aircraft specifications:

- Service ceiling = 25,000 ft
- Time on station (with 2 crew, at 20,000 ft, 500 lb payload, 124 KTAS) = 4.6 hr
- 72 cu.ft. cargo compartment
- Wing pylons
- Centerline hard points
- Nose compartment

Nominal flight profiles are shown in Appendix B, page 55.

Fig 23: NASA Langley OV-10G Aircraft.

S-3B Viking
NASA Glen Research Center

Major modifications in FY2010:

- Wing-pylon wiring for research payloads.
- 3-inch diameter nadir port for Hyper-spectral imager.
- Pylon mounted research pod with nadir port (16-inch) engineering design.
- LED lighting for research stations.

FY2010 Missions/Flight Hours:

No dedicated science missions or deployments were flown in FY10.

Total flight hours: 61.1 for other purposes.

Aircraft specifications:

- Surface to 40,000 ft msl
- 120-420 KIAS
- Range up to 2300nm.

Fig 24: GR 1 S-3B Viking aircraft.

Representative flight profiles are shown in Appendix B, page 56.

The aircraft is shown in Figure 24. The new port is shown in Figure 25.

Aircraft Info:

http://www.grc.nasa.gov/WWW/AircraftOps/index.htm

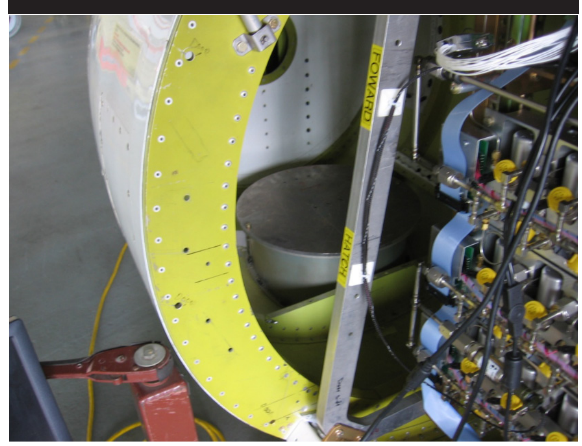


Fig. 25: Nadir port on the S-3 Viking .

DHC-6 Twin Otter
NASA Glen Research Center

Major modifications in FY2010:

- Engine overhaul.
- Nadir port mod planned for FY11

FY2010 Missions/Flight Hours:

None; maintenance and mod work all year.

Total flight hours: 4.5

Aircraft Specifications:

- Surface to 25,000 ft msl.
- 100-140 KIAS
- Range up to 420nm

The Twin Otter is shown in Figure 26. Nominal flight profiles are shown in Appendix B, page 56.

Aircraft Info:

http://www.grc.nasa.gov/WWW/AircraftOps/index.htm

Fig 26: GRC Twin Otter aircraft.

Learjet 25
NASA Glen Research Center

Major modifications in FY2010:

There were no major modifications in FY10.

FY2010 Missions/Flight hours:

- SIMPL (NE US)
- Solarcell (CLE)
- NAIMS (NASA Ames)

Total flight hours: 56.0

Aircraft Specifications:

- Surface to 45,000 ft msl.
- 350kias/0.81m
- Range up to 1100nm

The Learjet is shown in Figure 27. Nominal flight profiles are shown in Appendix B, page 57.

Aircraft Info

http://www.grc.nasa.gov/WWW/AircraftOps/index.htm

Fig. 27: GRC Leartjet 25

T-34C Turbo-Mentor
NASA Glen Research Center

Major modifications in FY2010:

- 3-inch diameter nadir port.
- Auto-pilot mod planned for FY11.

FY2010 Missions/Flight Hours:

- Puerto Rico Bio-diversity Hyperspectral
- Detroit River Hyperspectral

Total flight hours: 169.3

Aircraft Specifications:

- Surface to 25,000 ft msl.
- 100-200 KIAS
- Range up to 550nm

The T-34C is shown in Figure 28. Nominal flight profiles are shown in Appendix B, page 57.

Aircrafr Info:

http://www.grc.nasa.gov/WWW/AircraftOps/index.htm

Fig 28: T-34C Turbo-Mentor.

SIERRA UAS
NASA Ames Research Center

In FY2010 the SIERRA UAS became an operational system, following the successful 2009 CASIE mission deployment to Svalbard, Norway. Major capability enhancements took place in 2010. Work began on the design and integration of the largest payload to date, a wideband ground penetrating SAR operating from 300-3000Mhz. The S-WAVE (Soil water and vegetation experiment) consists of a partnership between NASA, USDA-USFS, and DOI-USGS to evaluate new radar technologies for simulating SMAP and DESDynI data products, while investigating lower frequencies and polarizations for reducing uncertainties in soil moisture and above and below ground vegetation structure. The mission required a larger nose as well as a mast for the radar antenna, in addition to a more powerful alternator to support the significant power requirements. The SIERRA is shown in Figure 29. The flight profile is in Appendix B, page 58.

Current specifications for the SIERRA are maximum payload of 100 lbs to 10,000 ft for 4 hours, or payload of 50 lbs at 1000 ft for up to 11 hours.

In 2010, flights were conducted at Camp Roberts, California under a reimbursable mission for Shell to evaluate radar systems for mammal monitoring and search and rescue. Total flight hours for the year: 10.

Aircraft Info:

http://airbornescience.nasa.gov/platforms/aircraft/sierra.html

Fig 29: SIERRA UAS with ground penetrating SAR.

Commercial / BPA Aircraft

The listing of manned and unmanned aircraft systems (UAS) (Table 11) are part of the Airborne Science Commercial Catalog. Many of the commercial aircraft have been incorporated into a Blanket Purchase Agreement (BPA) that establishes rates and a contract mechanism to quickly use the companies' services. At the same time, there is no minimum purchase requirement. The NASA Wallops Flight Facility is responsible for maintaining the catalog and contract support. Additional aircraft will be available in the near future. To find out more or contract the use of one of these aircraft, please contact Mike Cropper at 757-824-2140, Michael.C.Cropper@nasa.gov.

Table 11: Aircraft services available through NASA Blanket Purchase Agreement.

Aircraft	Location
Twin Otter (DHC-6)	CO, AK
King Air (B-200)	VA
Cessna 402B	MD
Piper Aztec	MD
Piper Arrow	MD
L-1011	MD
Gulfstream I	WA
OV-1	FL
SAAB 340	VA
Learjet 24D	FL
F-104	FL
J-32	UT
Grob Egrett	CA
King Air (B100/B200)	VA
Beechcraft Baron (B-55)	VA
Piper Navajo	TN
Piper Saratoga	TN
Cessna 210	TN
Extra 300	TN
B-727	FL
Cessna 310	WV
Gulfstream II, III	IL
Learjet 35, 36	GA
Cessna Citation II	ND
Stemme S10	ME
Commercial UAS	
TARZAN TD-1c	OH
Super Ferret	OH
Viking 100/300/400	MD
Vector P	MD
Sky Jumper	MD
Aerosonde Mk4	VA

Non-NASA Government Aircraft

Since the late 1990s, with the establishment of the Interagency Coordinating Committee for Airborne Geosciences Research and Applications (ICCAGRA), and through the Interagency Committee for Aviation Policy (ICAP), there has been an effort to educate the broader research community about the existence of federal (or contractor) aircraft available for airborne research.

The following Table 12 identifies NASA's partner airborne/geoscience research agencies. It also lists the fleet they operate and provides a point of contact to discuss access and use of agency aircraft.

Table 12: NASA's partner airborne/geoscience research agencies.

Agency	Aircraft	Contact
National Oceanographic and Atmospheric Administration (NOAA)	WP-3D (2 aircraft)	James McFadden Jim.d.mcfadden@noaa.gov
	Gulfstream IV-SP	
	Cessna Citation	
	Gulfstream Jet Prop Commander	
	Twin Otters (4 aircraft)	
	Rockwell Aero Commander (2 aircraft)	
	King Air	
	Shrike Commander	
U.S. Dept. of Energy	Gulfstream I	Jason Tomlinson Jason.Tomlinson@pnl.gov
National Science Foundation (NSF)	C-130Q	Jeff Stith stith@ucar.edu Jim Huning jhuning@nsf.gov
	Gulfstream V	
	LC-130 ski aircraft	
University of Wyoming	King Air	Al Rodi rodi@uwyo.edu
Naval Research Laboratory (NRL)	P-3 carrying Doppler radar, ELDORA	Garron Morris Garron,Morris@nrl.navy.mil
Center for Interdisciplinary remotely piloted aircraft systems (CIRPAS)	Twin Otter	Bob Bluth rtbluth@nps.edu
	Pelican OPV	
	Cessna 337	
	Predator UAV	

ASP Facility Science Instrumentation

Airborne Sensor Facility

The Airborne Science Program provides a suite of facility instrumentation and supporting systems for community use by NASA investigators. These include multi-spectral infrared sensors (jointly supported by the EOS Project Science Office) and other imaging devices that support multidisciplinary research applications; together with stand-alone navigation systems for precise determination of platform position and attitude. These are supported primarily by the Airborne Sensor Facility (ASF) at Ames Research Center, together with engineers at UND/NSERC and NASA Dryden. The ASF also operates a community instrument calibration facility under the supervision of the EOS Program, which supports a variety of NASA airborne remote sensing systems. Table 13 lists the instrumentation and supported platforms.

Table 13: Instrumentation maintained by the Airborne Sensor Facility (ASF).

Instrument / Description	Supported Platforms
MASTER (MODIS/ASTER Airborne Simulator) 50 ch multispectral line scanner V/SWIR-MW/LWIR	B-200, CD-8, ER-2, WB-57
MAS (MODIS Airborne Simulator) 50 ch multispectral line scanner V/SWIR-MW/LWIR	ER-2
AMS (Autonomous Modular Sensor) 12 ch multispectral line scanner V/SWIR-MW/LWIR	Ikhana UAS, B-200, ER-2
DCS (Digital Camera System) 16 MP natural color or color infrared camera	B-200, DC-8, ER-2, Twin Otter, WB-57
DMS (Digital Mapping System) 21 MP natural color camera	DC-8, P-3B
POS AV 510 (3) Position and Orientation Systems DGPS w/ precision IMU	B-200, DC-8, ER-2, Ikhana UAS, P-3B
POS AV 610 (2) Position and Orientation Systems DGPS w/ precision IMU	DC-8, P-3B
HDVIS High Definition Time-lapse Video System	Global Hawk UAS
LowLight VIS High Definition Time-lapse Video System	Global Hawk UAS

New Instrument: PRISM

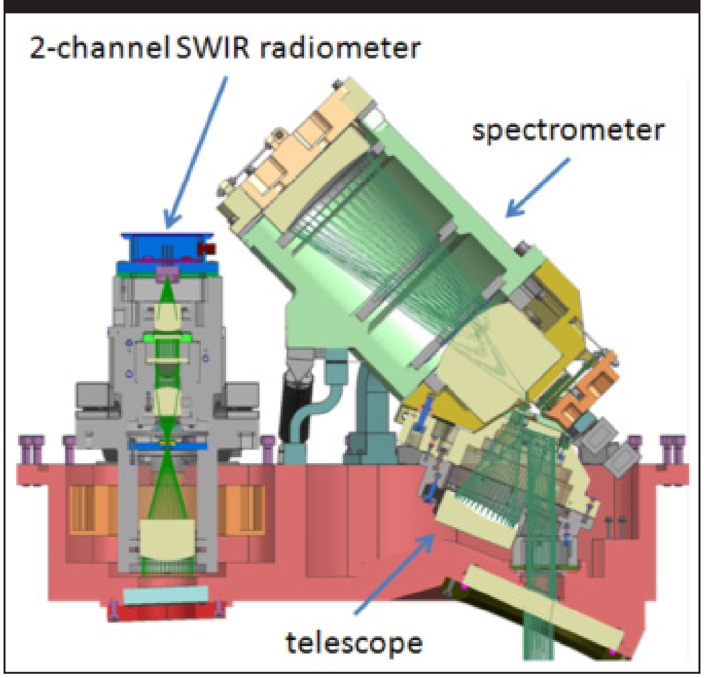
Funding through ARRA has provided the ASP an opportunity to develop a much-desired, new sensor for science. The Portable Remote Imaging Spectrometer (PRISM) is a pushbroom imaging spectrometer currently under development at the Jet Propulsion Laboratory that is sponsored by NASA's Earth Science and Technology Office and the Airborne Science Program. Science collaborators include Dr. Heidi Dierssen, University of Connecticut, and Dr. Bo-Cai Gao, Naval Research Laboratory.

PRISM is intended to become a NASA facility instrument upon completion and delivery in 2012. It is specifically designed for the challenges and needs of airborne coastal ocean science research. It covers the 350-1050 nm range with a 3.1 nm spectral sampling and a 0.95 mrad spatial sampling, with 610 spatial cross-track elements. It also incorporates two additional wavelength bands at 1240 and 1610 nm in a spot radiometer configuration to aid with atmospheric correction.

The design provides for high signal to noise ratio (>2000 at 450 nm under typical dark water conditions), high uniformity of response (>95%), and low polarization sensitivity (<2%). PRISM is adaptable to several airborne platforms, (e.g. Twin Otter, ER-2, B200, and more) with the first demonstration currently planned on a B200 aircraft. A schematic of the instrument is shown in Figure 30.

In the first year of development PRISM completed its design phase and had most parts fabricated. Requirements Review, Design Review, and Year-End review milestones were met successfully. Assembly and alignment has begun and will continue through the spring and summer of 2011. In 2012, laboratory calibration will be followed by flights over specified water targets, which will test the sensor's ability to recover atmospherically corrected surface data over the coastal ocean environment.

Fig. 30: Schematic of the PRISM instrument.



Airborne Science Information Technology and Communications Support Systems

ASP Website and Flight Request System

The Airborne Science Program maintains aircraft and sensor assets to support the Science Mission Directorate (SMD). The flight request system manages and tracks the allocation of the ASP aircraft and facility sensors. The Science Operations Flight Request System (SOFRS) is a web-based database to facilitate the review and approval process for every airborne science mission using NASA SMD funds, personnel, instruments or aircraft. Requests for these assets and the scheduling of their use are accomplished through SOFRS. This system was designed to allow researchers who are funded by NASA or other agencies to have access to unique NASA aircraft, as well as commercial aircraft with which NASA has made contracting arrangements. The only way to schedule the use of NASA SMD platforms and instrument assets is to submit a Flight Request for approval through SOFRS on the Airborne Science web page (http://airbornescience.nasa.gov/sofrs).

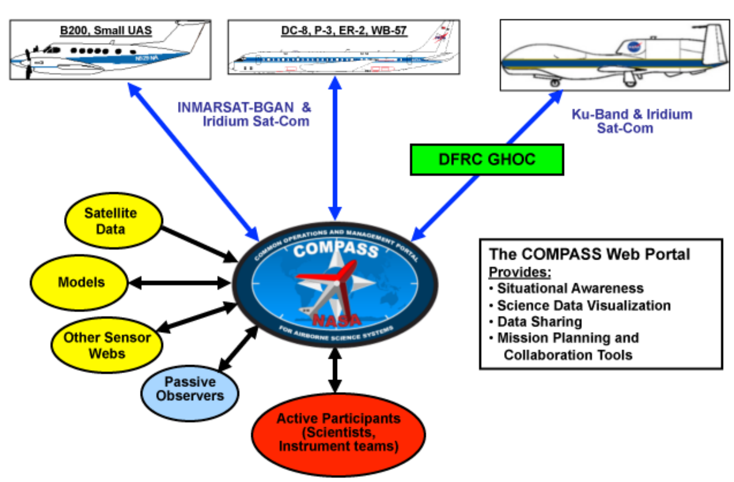
The SOFRS team strives for continuous improvement by improving the interface with users and the data products. In 2009, the focus was on making the steps to submit a Flight Request easier with detailed procedures and an explanation for each field requested. This year, the focus was on the products the database can produce. Aircraft leads can now export an excel spreadsheet of all the Flight Requests they are associated with when needed. SOFRS administrators now have more tools to respond to changes and additions more efficiently and management has more products to track progress. More improvements for all users are in work for 2011.

Data and Communication Systems

Sensor Network Infrastructure

A state-of-the-art real-time data communications network is being implemented across the Airborne Science Program core platforms (see Figure 31). Utilizing onboard Ethernet networks and satellite communications systems, it is intended to maximize the science return from both single-platform missions and complex multi-aircraft science campaigns. It also leverages the extensive data visualization software developed for the NASA DC-8 aircraft, together with data synthesis technologies funded through ESTO and Applied Science Program grants. The sensor network architecture includes standardized instrument interfaces, a new Experimenter Interface Panel (EIP. See Figure 32.), and an airborne network server and sat-com gateway known as the NASDAT (NASA Airborne Science Data and Telemetry system - the follow-on to the prototype REVEAL system.) These capabilities were successfully demonstrated on the Global Hawk UAS during its inaugural science campaigns in 2010, and will be incrementally implemented on the DC-8, P-3B, ER-2, and the WB-57 aircraft. Other similarly equipped platforms, as indicated in Table 14, may also connect to the airborne sensor network.

Figure 31: The Real-Time Airborne Science Data Network Architecture.



Satellite Communications Systems

Several types of airborne satellite communications systems are currently operational on the core science platforms. High bandwidth Ku-Band systems, which use a large steerable dish antenna, are installed on the Global Hawk and Ikhana UAS. New Inmarsat BGAN (Broadband Global Area Network) multi-channel systems, using electronically-steered flat panel antennas, are now installed on many of the core aircraft. Data-enabled Iridium satellite phone modems are also in use on most of the science platforms as well. Although these have a relatively low data rate, unlike the larger systems they operate at high polar latitudes and are light weight and inexpensive to operate.

Table 14: Sat-Com systems supported by ASP.

Sat-Com System Type	Data Rate (nominal)	Equipped Platforms
Ku-Band (single channel	> 1 Mb/sec	Global Hawk & Ikhana UAS
Inmarsat BGAN (two channel systems)	432 Kb/sec per channel	DC-8, WB-57, P-3B, S-3B, DFRC B-200 (ER-2 in 2011)
Iridium (1-4 channel systems)	2.8 Kb/sec per channel	Global Hawk, DC-8, P-3B, ER-2, WB-57, G-3, SIERRA, others

Future Data and Communication Infrastructure

The ARRA Act provided a much needed stimulus to ASP onboard data systems and telemetry. The SensorNet project implemented at the Ames Airborne Sensor Facility is upgrading the navigation data recorders and will provide new payload data- systems and processing capabilities for onboard data reduction and telemetry handling.

Figure 32: The Experimenter Interface Panel (EIP).

Global Hawk Operations Center

The Global Hawk Operations Center (GHOC) is a fixed facility located in a building at DFRC. Most of this facility can be seen in Figure 44. This picture was taken during the GRIP campaign in September 2010. The GHOC is used to support all ground testing, training, and flight operations of the NASA Global Hawk air vehicles. The GHOC consists of consoles used for the command and control of the air vehicle, monitoring of the air vehicle systems, air traffic control coordination, mission planning, and all payload-related command and control and data display functions. The GHOC consists of three rooms, the Flight Operations Room (FOR), the Payload Operations Room (POR), and the Support Equipment Room (SER). The FOR contains workstations for the pilot, co-pilot, mission director, GHOC operator, and a range safety officer. The POR has workstations for up to 14 customers. Each POR workstation is connected to the air vehicle payload network via Iridium and Ku Satcom links. The SER contains the racks of equipment that support the workstations located in the FOR and POR. The SER also serves as an observation area while missions are being conducted.

Fig. 31: Global Hawk Operations Center.

Global Hawk Mobile Operations Facility (GHMOF)

Funding from ARRA was also instrumental in the development of the Global Hawk Mobile Operations Facility (GHMOF). Currently, Global Hawk flight operations are restricted to flights beginning and ending at Edwards Air Force Base. This restriction limits or eliminates the ability to collect scientific data at important locations around the world. A portable ground station will permit flight operations at deployment out of the U.S. East Coast enabling improved Greenland and Atlantic hurricane coverage as well as coverage of Europe and portions of Africa. An Alaska deployment location will provide improved Arctic and northern Pacific coverage while a Southern Hemisphere deployment location will enable flights over the Antarctic region, surrounding oceans, and other landmasses in the Southern Hemisphere.

For future remote deployments, the GHMOF is in development. It is scheduled to be operational in September 2011 and provides the same functions currently provided by the Flight Operations Room in the GHOC and is contained in a 53 ft long trailer that is air transportable. A companion trailer is also in development for remote payload operations and will have 14 workstations for customers. This facility will be operational in early FY12. In addition, a portable Ku ground station is being developed for use at EAFB and deployment locations.

Common Operations Management Portal for Airborne Science Systems (COMPASS)

The program also kicked off the COMPASS project, a joint effort between ARC, DFRC, MSFC, and UND to develop the next generation of online mission planning and execution tools. The project will marry expertise and lessons learned from previous work on the Real-Time Mission Monitor (RTMM), the Collaborative Decision Environment (CDE), and the Global Hawk Operations Center (GHOC) to provide a comprehensive set of mission tools in a seamless collaborative environment. The end product will enable scientists to visualize data and models to inform mission planning, and provide a communications platform at all organizational levels, including a bridge to the public.

Education and Outreach

Student Airborne Research Program

The second NASA/NSERC Student Airborne Research Program (SARP) was held during June and July 2010. The 6 week program was designed to expose and engage advanced undergraduate and early graduate students into NASA research and airborne science and engineering. The program was based at both the University of California at Irvine in Irvine, California, for the lectures and data analysis, and the NASA Dryden Aircraft Operations Facility in Palmdale, CA for the preparation for and execution of two 6 hour research data flights.

The program contained the following elements:

- An introductory student poster session. The 28 participants (shown in Figure 32) from 24 different universities in 18 states presented their varied research interests to other participants, lecturers, and SARP faculty and staff.
- Lectures on NASA research programs, the Airborne Science Program, instrumentation, meteorology, atmospheric chemistry research,

Fig. 32: Participants and research mentors at the DC-8 for the first data flight.

remote sensing techniques, oceanography, agricultural practices, instrument integration, airborne data systems, and sustainability and the environment.

- Experiences with instrument integration, flight planning, and data collection on two six hour flights on the NASA DC-8.
- Research projects included the atmospheric, oceanography, and land use topics.
    - o Atmospheric effects of emissions from large commercial dairies in the Central Valley
    - o Distribution and abundance of giant kelp in Santa Barbara Channel and Monterey Bay
    - o Evapotranspiration from almond and pistachio orchards and row crops in the Central Valley.
- Multispectral remote sensing and in situ sampling techniques were employed.
- Field trips for ground truth validation the airborne measurements.
    - o In situ measurements in almond orchards during the DC-8 overflight
    - o Comprehensive air sampling on the ground surrounding a dairy farm
    - o Collection of reference spectra in kelp beds from a boat in Monterey Bay
- Sample and data analysis after the research flights.
- The program culminated with each of the participant's formal presentations of results and conclusions.
- The participants with the best presentations in their research area were given the opportunity to present at the NASA booth during the Fall American Geophysical Union meeting in San Francisco.

Collaborations and Partnerships

The Airborne Science Program contributed to Working Group I/1 in ISPRS's Technical Commission I which was chartered to improve interface standardization of airborne platforms internationally. Ten Terms of Reference (TOR) were established to address different aspects of airborne science with each of the TORs consisting of representatives from the United States, Europe and other countries that operate airborne research platforms. The Airborne Science Program supports WGI/1 with membership on each TOR in addition to providing leadership.

The past year was an active one for many TORs. Meetings were held in Europe, and Canada as well as in the United States. Organizations that are informally affiliated with Working Group I/1 also held meetings at which the Working Group programs were discussed. The Working Group has been able to leverage off of other international meetings that have airborne sessions such as the International Conference on Airborne Research of the Environment which was held in Toulouse where many members from the WG I/1 participated in TOR meetings (Figure 33).

Although still in development, ISPRS TC1 WG I/1 Standardization of Airborne Platform Interface has already significantly increased the coordination between the US and European communities and looks to expand its membership to Pacific Rim countries. See Working Group I/1 website http://www.commission1.isprs.org/wg1/ for more detail.

Fig. 33: WG1/1 Attendees at the International Conference on Airborne Research of the Environment (ICARE) meet in Toulouse, France, Oct. 2010, to assess progress and plan for the next year.

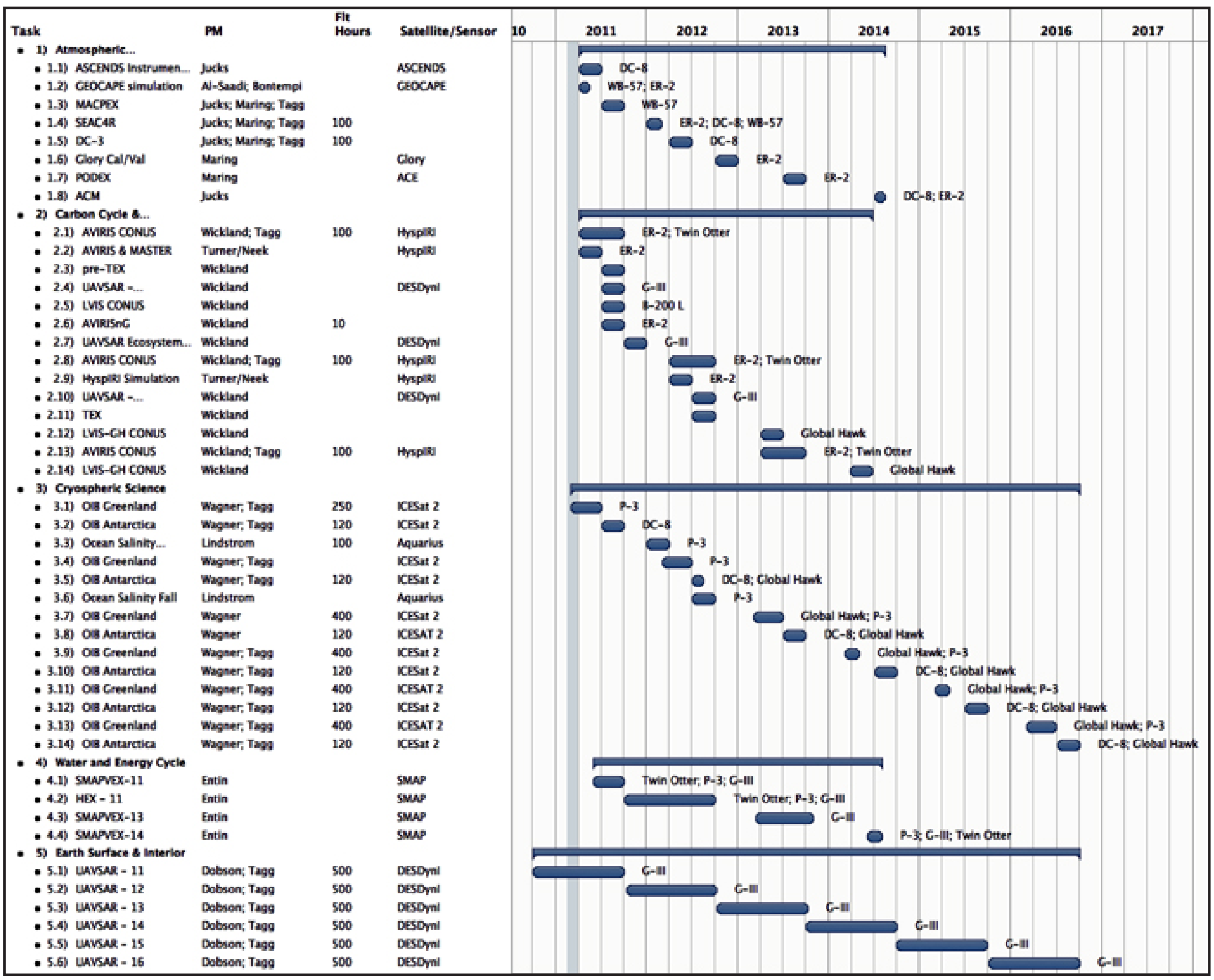
The Airborne Science Program was very involved in the Interagency Working Group for Airborne Science and Telecommunications Systems (IWGADTS) by providing the co-chair, Lawrence Freudinger, and members, predominantly from the Airborne Sensor Facility. This past year IWGADTS met in Toulouse, France jointly with international colleagues at the International Conference on Airborne Research for the Environment.

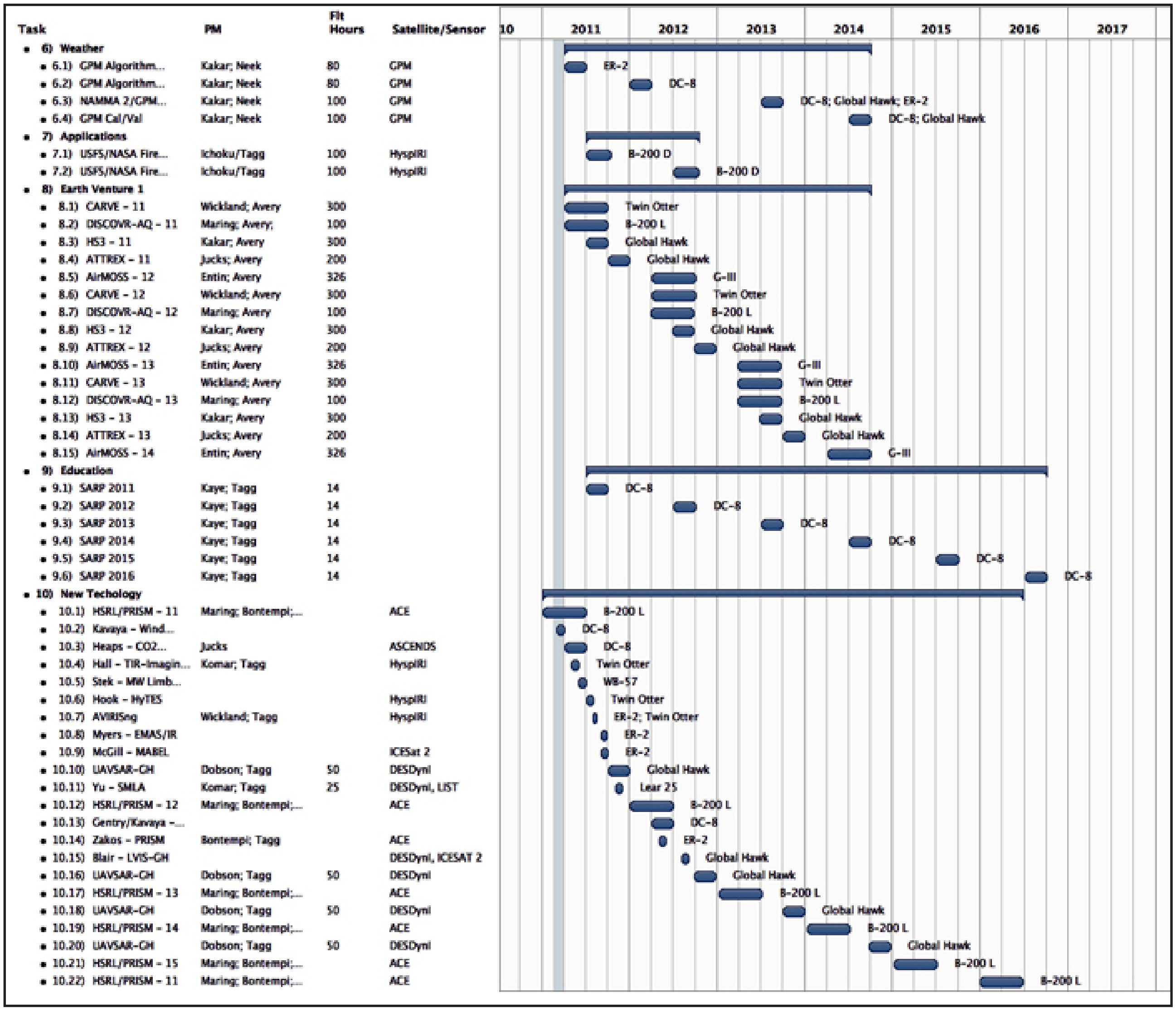
The Airborne Science Program also participates on the Arctic Monitoring and Assessment Program (AMAP) UAS Expert Group which is focused on assisting the international Arctic scientific community with understanding the challenges associated in flying UAS with a particular focus on airspace issues. The UAS Expert Group is co-led by Ms. Brenda Mulac of NASA's Airborne Science Program (United States) and Dr. Rune Storvold of NORUT (Norway). Representatives from each of the Arctic countries.

In 2010, the UAS Expert Group met in Copenhagen in April, and in St Petersburg in October. As a result of these meetings, a clear understanding of the state of current access and regulations development in each of the Arctic countries has been reached, and a document that identifies the regulation and access methods in each country is being created.

Appendix A

Five-Year Planning Schedule

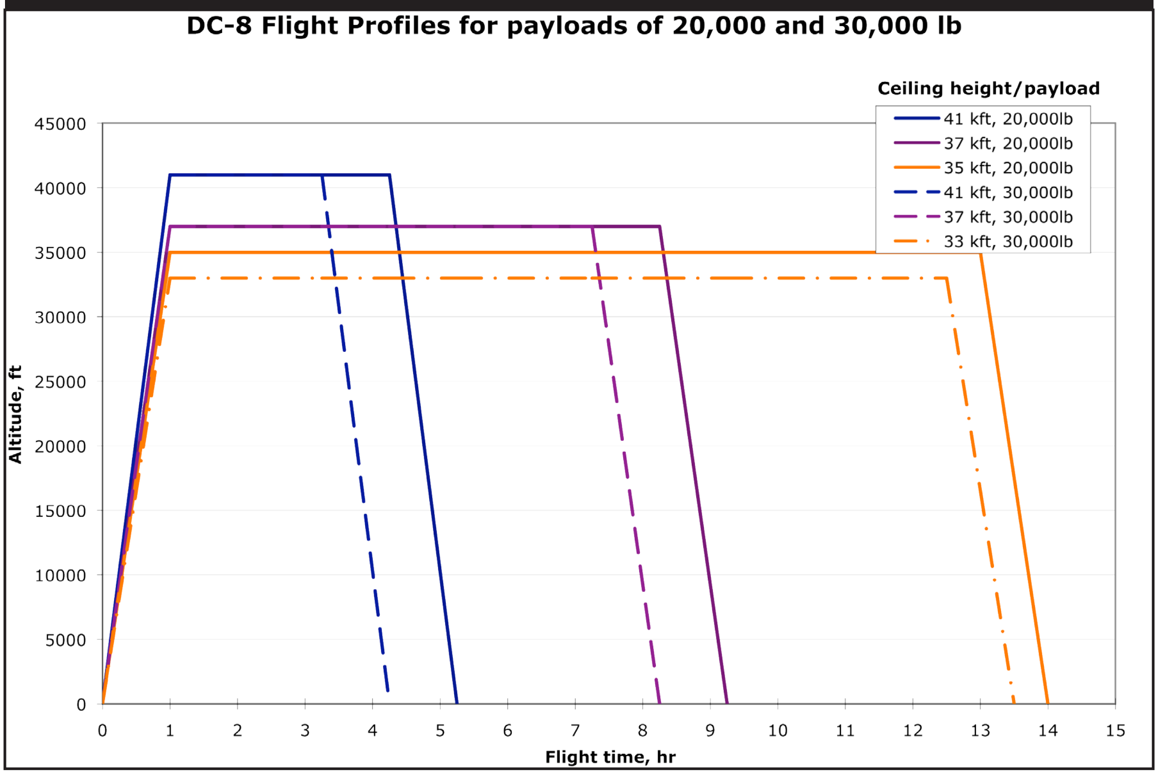



Task
PM
Flt Hours
Satellite/Sensor
10
2011
2012
2013
2014
2015
2016
2017
6) Weather
6.1) GPM Algorithm... Kakar; Neek 80 GPM ER-2
6.2) GPM Algorithm... Kakar; Neek 80 GPM DC-8
6.3) NAMMA 2/GPM... Kakar; Neek 100 GPM DC-8; Global Hawk; ER-2
6.4) GPM Cal/Val Kakar; Neek 100 GPM DC-8; Global Hawk
7) Applications
7.1) USFS/NASA Fire... Ichoku/Tagg 100 HyspIRI B-200 D
7.2) USFS/NASA Fire... Ichoku/Tagg 100 HyspIRI B-200 D
8) Earth Venture 1
8.1) CARVE - 11 Wickland; Avery 300 Twin Otter
8.2) DISCOVR-AQ - 11 Maring; Avery; 100 B-200 L
8.3) HS3 - 11 Kakar; Avery 300 Global Hawk
8.4) ATTREX - 11 Jucks; Avery 200 Global Hawk
8.5) AirMOSS - 12 Entin; Avery 326 G-III
8.6) CARVE - 12 Wickland; Avery 300 Twin Otter
8.7) DISCOVR-AQ - 12 Maring; Avery 100 B-200 L
8.8) HS3 - 12 Kakar; Avery 300 Global Hawk
8.9) ATTREX - 12 Jucks; Avery 200 Global Hawk
8.10) AirMOSS - 13 Entin; Avery 326 G-III
8.11) CARVE - 13 Wickland; Avery 300 Twin Otter
8.12) DISCOVR-AQ - 13 Maring; Avery 100 B-200 L
8.13) HS3 - 13 Kakar; Avery 300 Global Hawk
8.14) ATTREX - 13 Jucks; Avery 200 Global Hawk
8.15) AirMOSS - 14 Entin; Avery 326 G-III
9) Education
9.1) SARP 2011 Kaye; Tagg 14 DC-8
9.2) SARP 2012 Kaye; Tagg 14 DC-8
9.3) SARP 2013 Kaye; Tagg 14 DC-8
9.4) SARP 2014 Kaye; Tagg 14 DC-8
9.5) SARP 2015 Kaye; Tagg 14 DC-8
9.6) SARP 2016 Kaye; Tagg 14 DC-8
10) New Techology
10.1) HSRL/PRISM - 11 Maring; Bontempi;... ACE B-200 L
10.2) Kavaya - Wind... DC-8
10.3) Heaps - CO2... Jucks ASCENDS DC-8
10.4) Hall - TIR-Imagin... Komar; Tagg HyspIRI Twin Otter
10.5) Stek - MW Limb... WB-57
10.6) Hook - HyTES HyspIRI Twin Otter
10.7) AVIRISng Wickland; Tagg HyspIRI ER-2; Twin Otter
10.8) Myers - EMAS/IR ER-2
10.9) McGill - MABEL ICESat 2 ER-2
10.10) UAVSAR-GH Dobson; Tagg 50 DESDynI Global Hawk
10.11) Yu - SMLA Komar; Tagg 25 DESDynI, LIST Lear 25
10.12) HSRL/PRISM - 12 Maring; Bontempi;... ACE B-200 L
10.13) Gentry/Kavaya -... DC-8
10.14) Zakos - PRISM Bontempi; Tagg ACE ER-2
10.15) Blair - LVIS-GH DESDynI, ICESAT 2 Global Hawk
10.16) UAVSAR-GH Dobson; Tagg 50 DESDynI Global Hawk
10.17) HSRL/PRISM - 13 Maring; Bontempi;... ACE B-200 L
10.18) UAVSAR-GH Dobson; Tagg 50 DESDynI Global Hawk
10.19) HSRL/PRISM - 14 Maring; Bontempi;... ACE B-200 L
10.20) UAVSAR-GH Dobson; Tagg 50 DESDynI Global Hawk
10.21) HSRL/PRISM - 15 Maring; Bontempi;... ACE B-200 L
10.22) HSRL/PRISM - 11 Maring; Bontempi;... ACE B-200 L

Appendix B

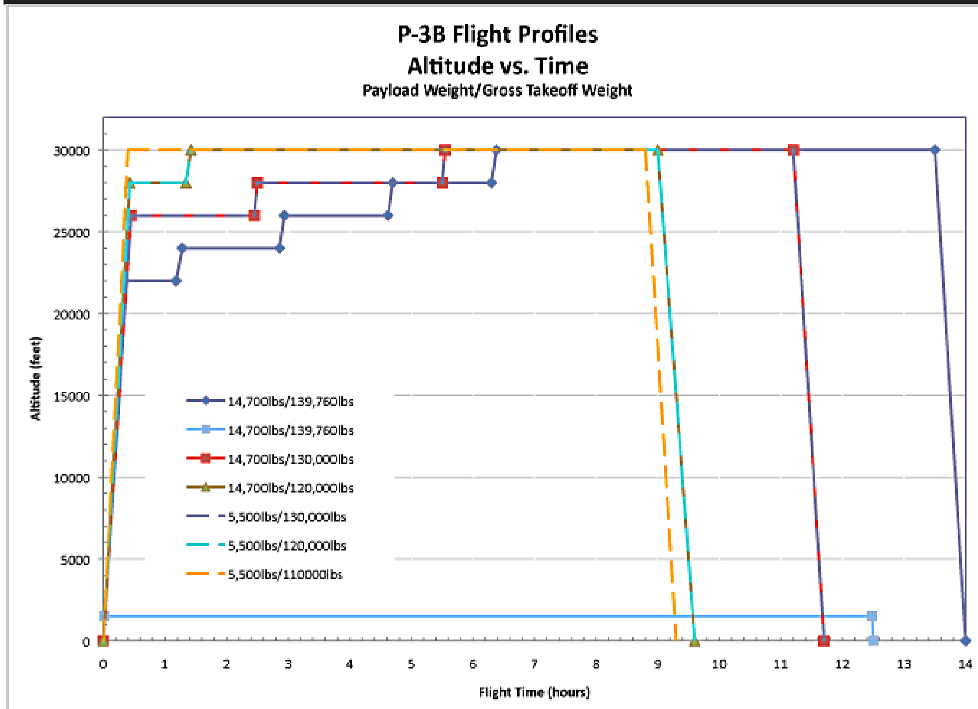
Aircraft Flight Profiles

Fig. B1: DC-8 Flight Profiles for payloads of 20,000 and 30,000 lbs.



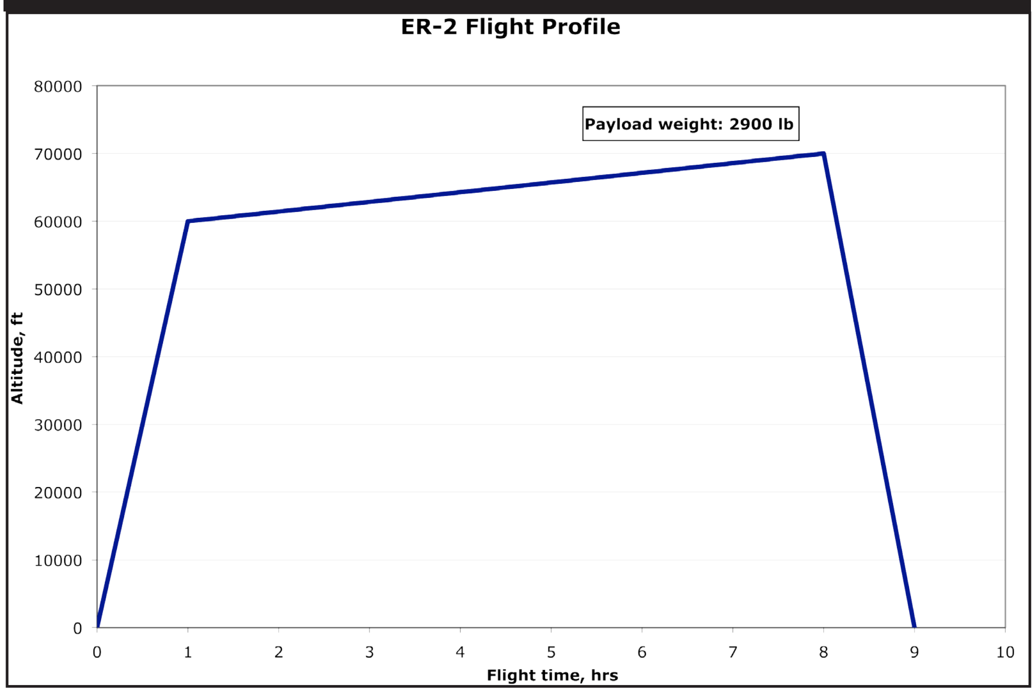
Note: DC-8 details are on page 15.

Fig. B2: P-3B Flight profiles.



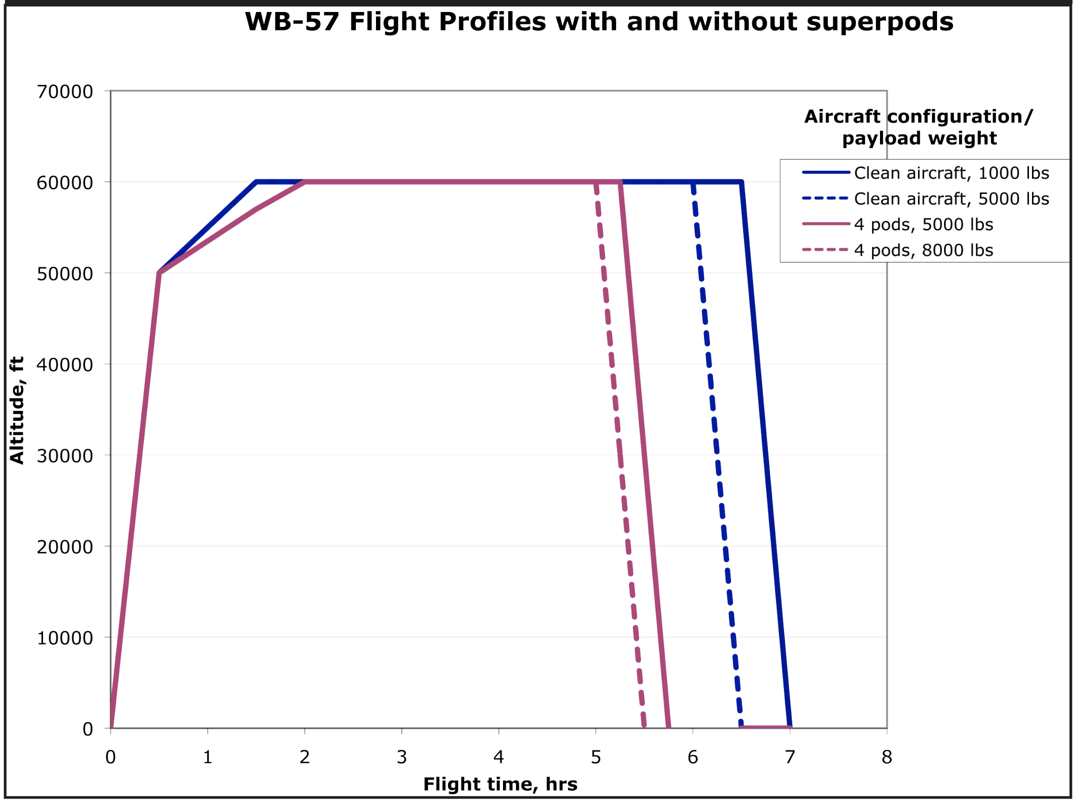
Note: P-3B details are on page 16.

Fig. B3: ER-2 Flight Profile.



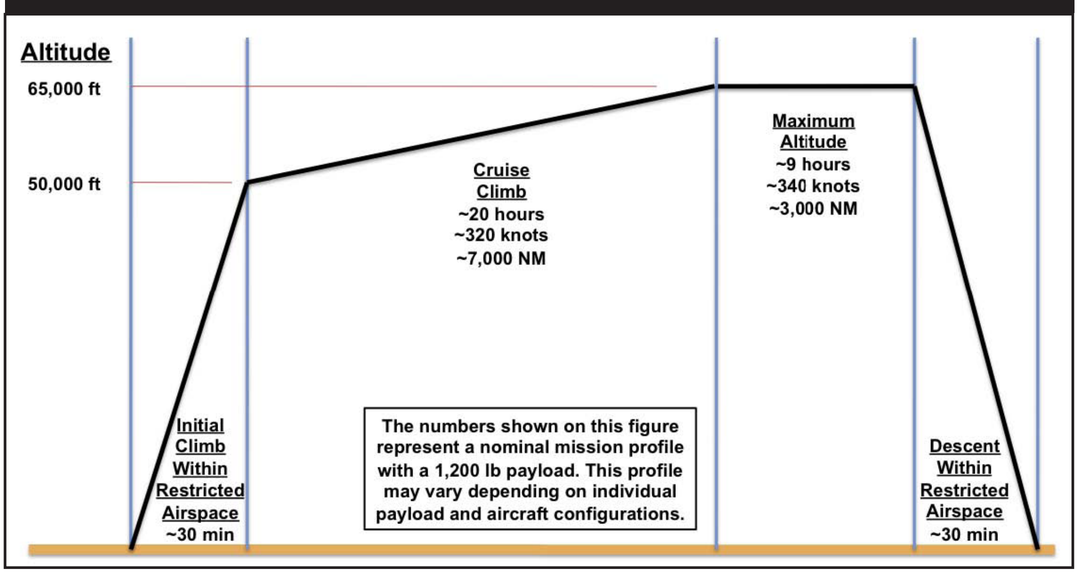
Note: ER-2 details are on pages 18-19.

Fig. B4: WB-57 Flight Profiles.



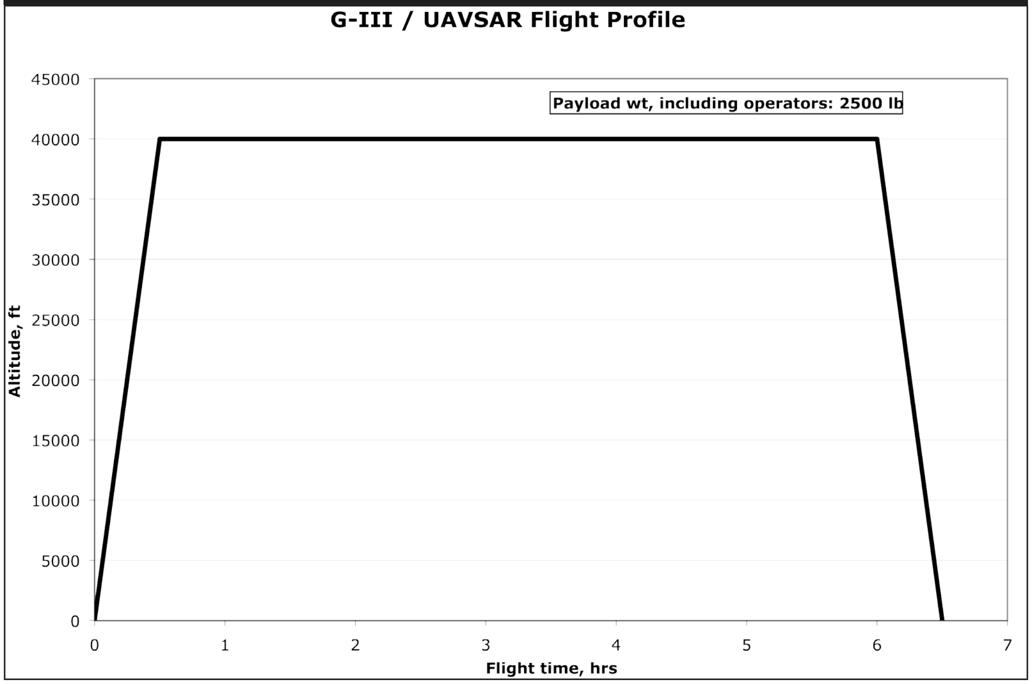
Note: WB-57 details are on page 20.

Fig. B5: Global Hawk nominal flight profile



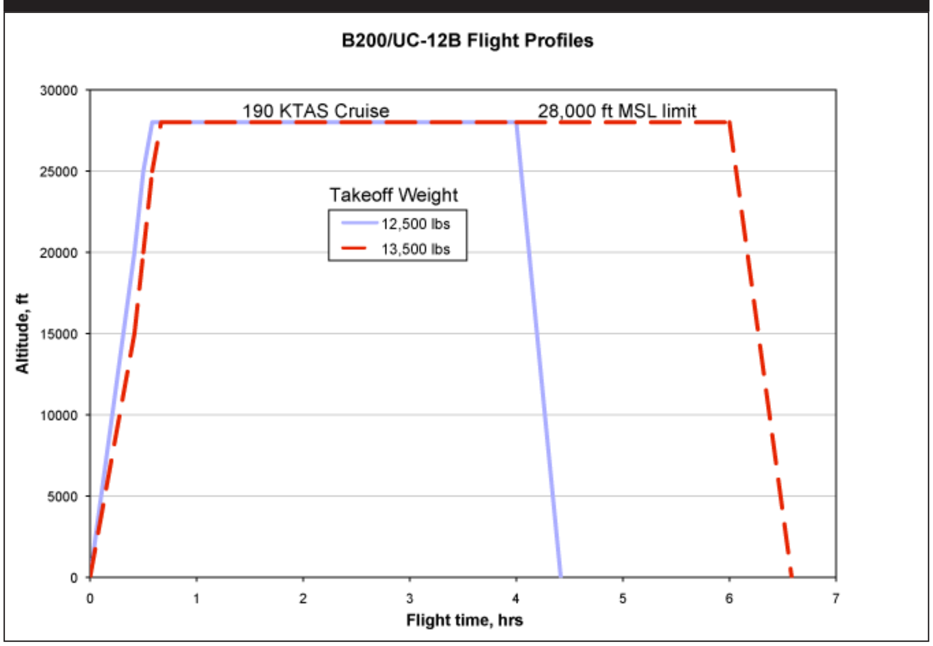
Note: Global Hawk details are on pages 21-22.

Figure B6: NASA G-III flight profile.



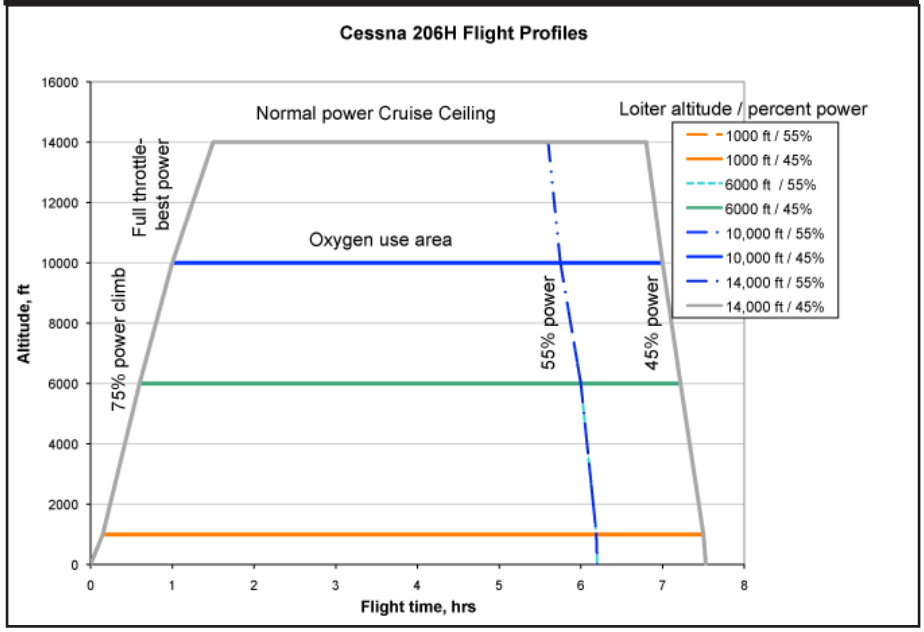
Note: G-III details are on pages 23-24.

Fig. B7: Flight profile for the Langley and Dryden B-200 aircraft.



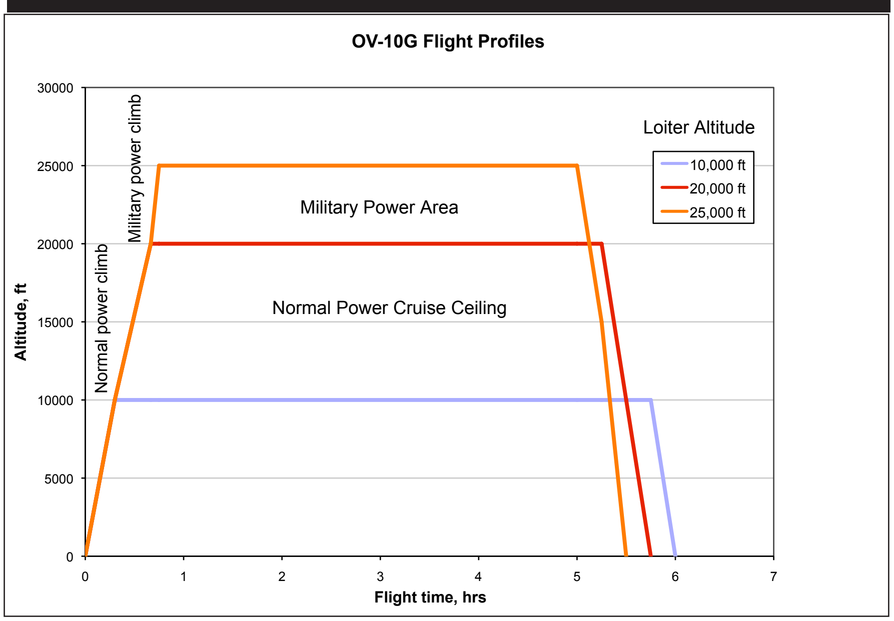
Note: B-200 details are on pages 26-27.

Fig. B8: Flight profile for the Langley Cessna 206-H aircraft.



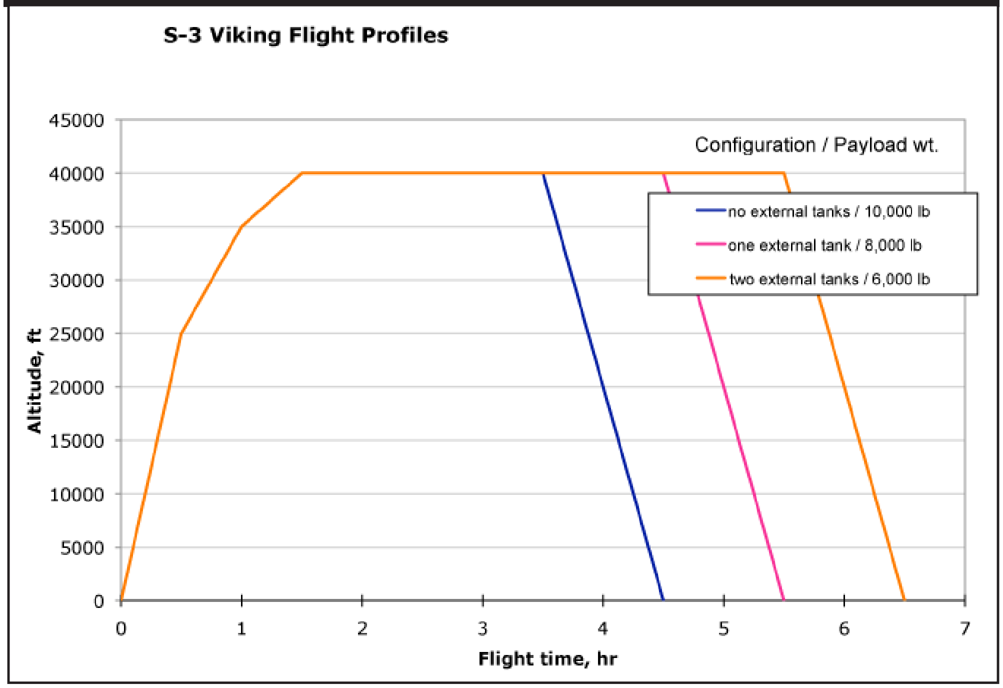
Note: Cessna 206-H details are on page 29.

Fig. B9: Flight profile for the Langley OV-10G.



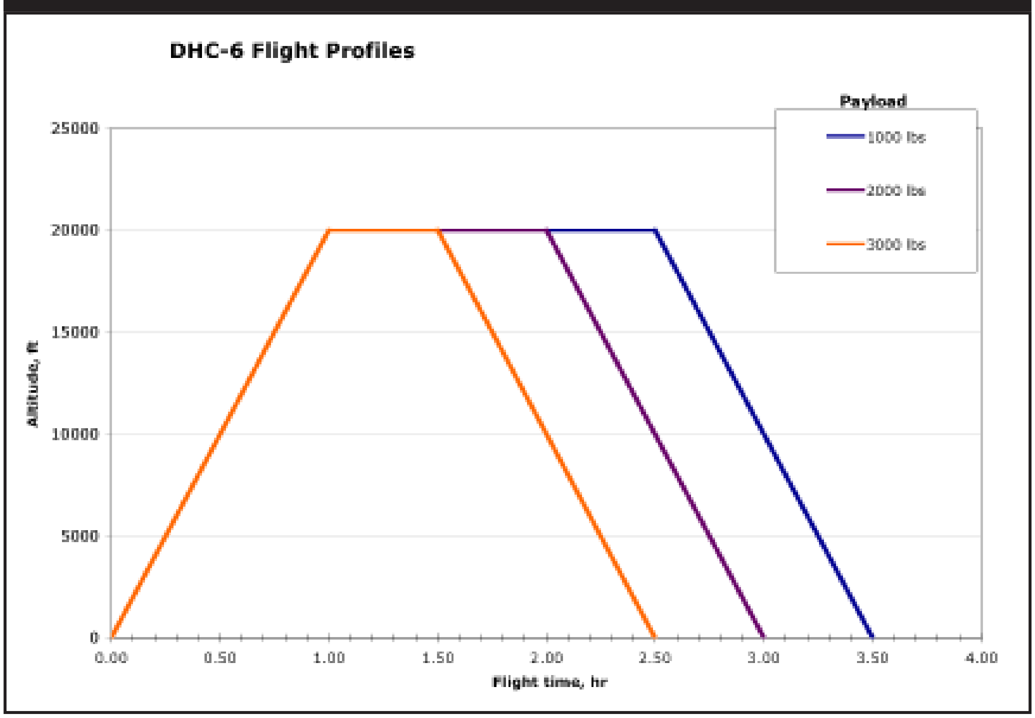
Note: OV-10G details are on page 30.

Fig. B10: GR2 Viking flight profile.



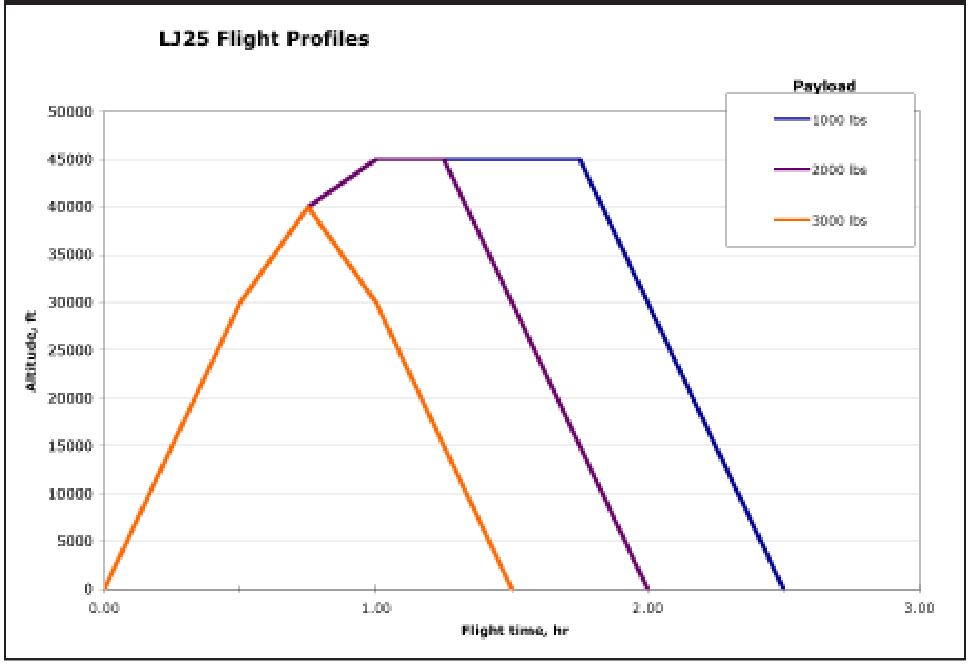
Note: S3-B Viking details are on page 31.

Fig. B11: DHC-6 flight profile.



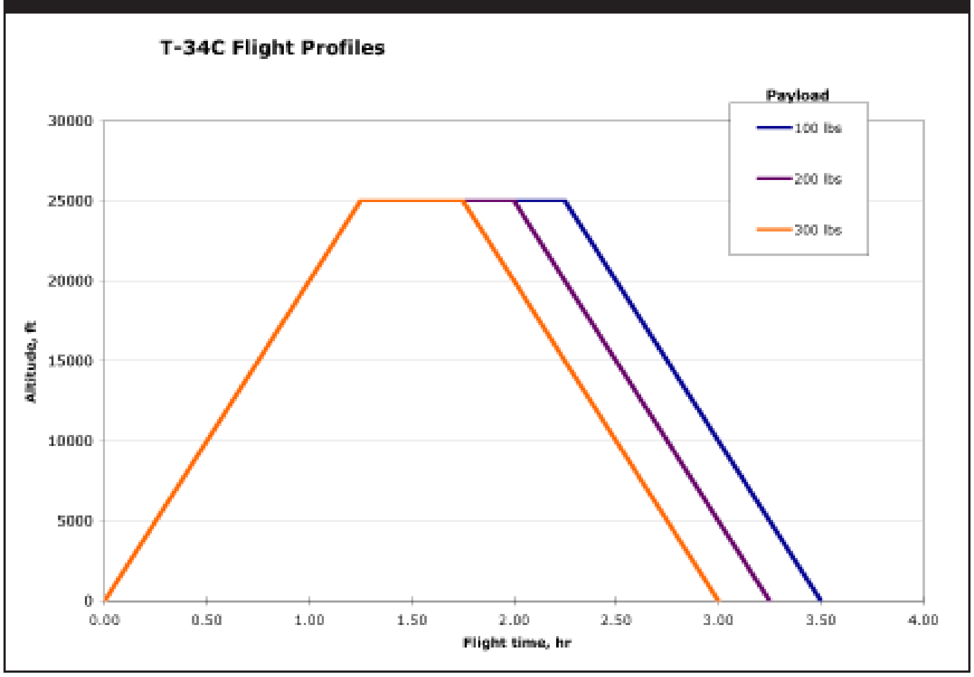
Note: DHC-6 details are on page 32.

Fig. B12: Learjet 25 flight profile.



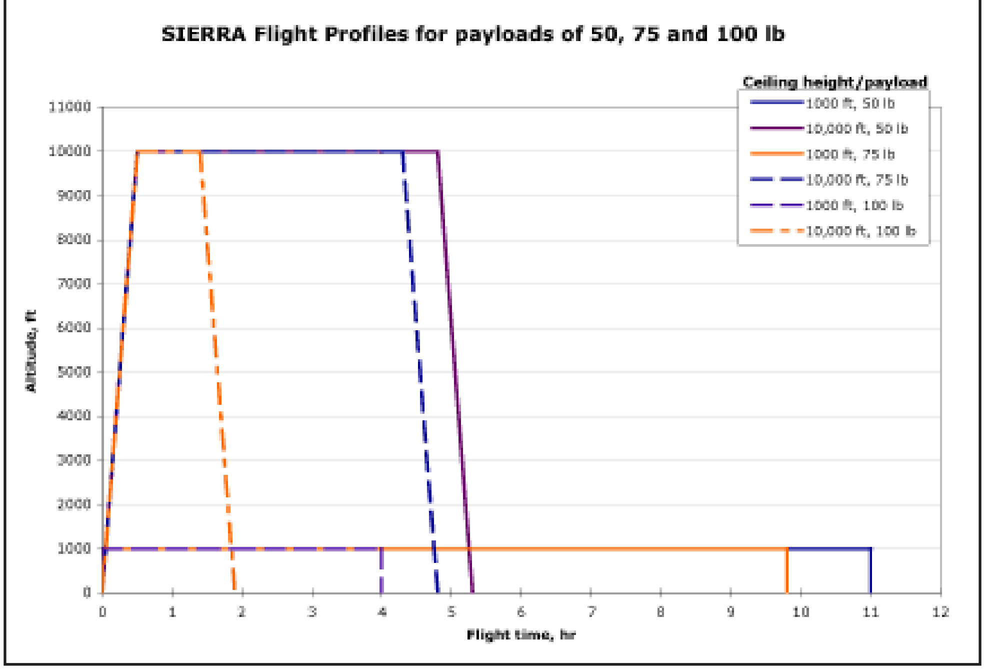
Note: Learjet 25 details are on page 33.

Fig. B13: T-34C flight profiles.



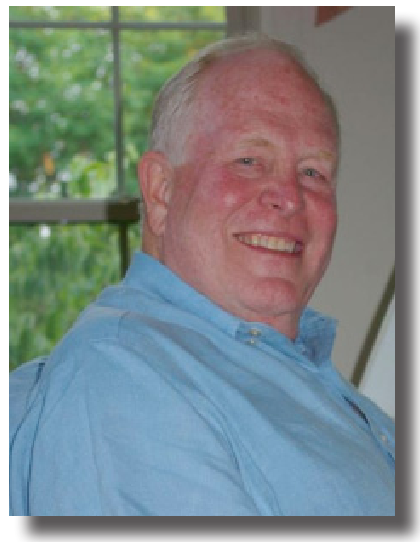
Note: T-34C details are on page 34.

Fig. B14: SIERRA flight profiles.



Note: SIERRA details are on page 35.

Appendix C
Airborne Program History



Jim Huning

Introduction

Over the years NASA has pioneered Earth System Science and observations, laying the foundation for a solid understanding of the physical process that drive our dynamic planet. Understanding our complex planet, how it supports life and how human activity impacts the environment is one of our greatest challenges. The Airborne Science Program provides unique observations into the processes that drive our environment, and opportunities to verify and validate satellite measurements, along with support for development for of new sensor systems and activities inspiring new scientists and engineers.

The Airborne Science Program has evolved over this time, reflecting the pressing priorities, (and personalities) of the agency. From 1964, when Ole Smistad headed the JSC Aircraft Office and flew the Convair 240 on a remote sensing missions supporting ERTS, to the present day UAS missions monitoring the polar ice packs, the ASP has provided the leadership and resources to make critical observations, in diverse and sometimes hostel environments. James (Jim) Huning served as Director of the Airborne Science Program from 1989 to 1998, overseeing significant growth in the program, and consolidation of the aircraft at Dryden Flight Research Center.

Jim Weber interviewed Jim Huning in November 2007 as part of an ASP activity to capture the history of the program. This summary, contributed by Steve Wegener, attempts to highlight some of the important activities and contributions that occurred during Jim's tenure with the program.

Author's perspective

I've tried capturing a slice of ASP history from a too brief November 15, 2007 interview Jim Weber and Andy Roberts had with Jim Huning, former Director of the Airborne Science Program within NASA's Earth Science Division. The Interview was 51 pages long, and it is tricky to distill such a rich history into these few pages. Fortunately many of the readers of this ASP Annual Report have an understanding of the scope of the Airborne Science Program, and can appreciate many of Jim's challenges in context. I encourage you visit the ASP history page to download Jim's interview and enjoy a more intimate insight into the program than I'm able to capture here.

Jim's tenure

Jim worked with FAA prior to coming to NASA. Jim anchored the Airborne Science Program from 1989 to 1999. Other directors have included:

- Olav (Ole) Smistad (1968-1982 JSC Aircraft Office),
- Barney Nolan, (82-88)
- Jim Huning (1989-1996, 1997-1999),
- Gary Shelton (1996, 1999)
- Sherwin Beck (1999)
- Cheryl Yuhas (2000- 2006),
- Andy Roberts 2007-2009,
- Bruce Tagg 2010-present

Jim served as Director of ASP from 1989 to 1998 when he retired, then again as a consultant 98-99, In 1999 Jim had an opportunity work with NSF to oversee the acquisition and modification of a new mid size jet for airborne science. The opportunity was just too great and so he returned to government service.

Jim reported to Shelby Tilford, and his deputy, Wes Huntress. Shelby was the Division Director of Code EE, Earth Sciences Fisk was Associate Administrator of OSSA, the Office of Space Science and Applications, a very large organization. Dan Goldin (1996) separated OSSA into Micro-Gravity, Earth Sciences and Space Science, Shelby Tilford became Acting Associate Administrator for Earth Sciences.

To say it was a dynamic environment is an understatement.

U-2 Highlights

Jim became director of ASP right after the Airborne Antarctic Stratospheric Experiment, confirming CFCs were a major factor in the spring ozone depletion observed over the south polar region. The ER-2 proved critical in assessing the physical process driving the ozone depletion the pilots were able to penetrate the stratospheric polar vortex where chemical conversion was happening.

Ames had three of the older U-2 B and C models that Marty Knutson brought on board. NASA acquired 2 U2R's without engines. We borrowed engines from the Air Force on a lease agreement. The Air Force was not able to use all their U2's. So they loaned us another U2-R, and we converted it to an ER2. The older U-2 models were phased out.

About this time the Air Force was upgrading their U-2 fleet with new engines and other enhancements. It was important that NASA buy into the program or the ER-2s could have been isolated technologically from the AF support chain. The cost associated with that re-engining was about 13 million dollars.

Bob Watson supported the upgrade. Jim worked with Bob and other program officers to identify funding over several years to make sure we had the total amount needed. Then at Ames, Andy Roberts worked the scheduling so that we were put into the proper slot for the work. It was as much an art as a science! The engines were GE F118s, which is the same engine as the B-2 bomber. The engines required environmental and human health protection, too, because they used hydrazine for starting. That was an additional nearly $500,000 for the Moffett Field improvements. The engines required environmental and human health protection, too, because they used hydrazine for starting. The upgrade program was complete in FY '97.

Another upgrade was explored; real time satellite communications via Ku. Jim and Andy Roberts were able to leverage a roughly six million-dollar Starlink communications system from the Air Force. Starlink was to utilize the NASA Tracking and Data Relay Satellite System

(TDRSS). The system required from HQ about 500 thousand dollars, which actually was a very good deal for us, but we did have scheduling problems with TDRSS for the data relay as I recall. Unfortunately continuation funding was not available, and the user community couldn't justify the additional expense. This was a capability ahead of its time.

DC – 8 Highlights

One of the big issues I had at Airborne Office was the pressure on the DC8. The DC8 was, and is primarily, in my opinion, a flying chemistry laboratory. Chemistry missions require lots of inlets, pumps, and often compressed gases, scientists on board and a large complement of instruments to get the big picture. That was a great aircraft for that type mission and it still is as far as far as the national fleet is concerned. The competition for the DC-8 was the JPL developed AIRSAR, a large side looking synthetic aperture radar. It was a pretty substantial piece of equipment, and it required the antennas mounted on the fuselage and large transmitters in the cabin C, L and P bands). Consequently, there was this tension that always existed between the AIRSAR community, solid earth community, and the airborne chemistry community as to whom would get access to the DC8. That's when Jim implemented the five-year planning process. The idea was to try to coordinate the various discipline managers and plan major programs for the out years. So then the broad community would know that in year X the DC-8 was allocated for solid earth investigations and in year Y it would be allocated for chemistry or terrestrial ecology. After an initial breaking in period the 5 year plan was pretty well accepted by the community and programs were planned reasonably smoothly. At this time the last 707s came off the assembly line at Boeing. It was, as I recall, an E-6, and a hardened aircraft. The USAF did not need it and so the USAF flew it to Davis Monthan AFB in Arizona. It still had it anti-corrosion green paint job. It only had a total of 16.8 hours on it! The Air Force would transfer it to NASA for one dollar (that was probably just a general statement, I think it could have transferred without any charge). I envisioned the 707 as the dedicated AIRSAR aircraft. On a site visit, several HQ personnel, including Dr. Tilford, the JPL AIRSAR team, and Ames personnel went to inspect the aircraft. After the site visit and follow on discussion it was decided not to implement the AIRSAR plan. It would have been a great solution, but the primary reason it didn't happen was a decision by Dr. Tilford.

While Jim was not pleased with that decision, he did appreciate his reasoning, and the fact that he had to look at budget situations across his entire program. He did not have two different aircraft because that meant either increasing staff or having to cross train people. The fixed costs of having those two aircraft would increase the required budget by something on the order of $5M back then. Dr. Tilford's decision paid out in later years when the application of the AIRSAR dropped off, and the need no longer existed.

There was also the issue of a spare engine for the DC-8, something that Jim kept lobbying Dr. Tilford for. Shelby never approved purchasing a spare CFM engine for the DC-8, which would have been at the time, 3.5-4.0 million dollars. Shelby always said no about getting a spare engine. His position was 'Why would I want to take out of our budget three and a half four million dollars. Buy a piece of equipment set it on a shelf as something we may need?' He said if the engine goes down and we have to get a new engine, we'll buy one. But I don't want to spend the money and set something on the shelf. That makes sense. That is why he was the boss! The DC-8 ended up having to get a new engine as a result of bird ingestion, the DC-8 was on a mission and we had a 48-hour turn around from the company in Chicago. So Shelby was right. I mean there was no reason to let the money sit on a shelf – when it was needed he was able to get the money from higher ups!, So, you know, Shelby was an excellent manager. He really did understand that we had more issues than I thought and he had to. I really liked Shelby. He was great to work for.

Consolidation Highlights

Consolidation was bringing all the aircraft to the Dryden Flight Research Center. The intent was a cost savings by consolidating the aircraft operations.

Consolidation was mandated by the administrator Mr. Goldin. And, the activity was evaluated by a number of people including Mal Peterson. Also involved was the Inspector Generals Office, explaining that their evaluation was done for consolidation was suppose to highlight cost savings and not impact science. There had been a complete written report, showing that it was really cost effective to do this. And I in turn pointed out that there were a large number of fallacies in this report.

From the get-go this was a political hot potato. I received a letter, or a copy of a letter sent to NASA. A lot of people were copied on the letter, which was from 6 Senators and a lot of members of the House. The letter stated that no aircraft, east of the Mississippi, would go to Dryden and that would be written into the NASA appropriations. This is getting real interesting, I thought!

When all was said and done, the consolidation occurred. Almost everyone from Ames was offered a position at Dryden and people either went or retired, unless they found another position within Ames. Obviously it was hard on families, and less so on single folks.

Inter-agency cooperation highlights

The need for interagency cooperation is obvious and led to the formation of the ICCAGRA group, the Inter-Agency Coordinating Committee for Airborne Geosciences Research and Applications. It was formed by Jim representing NASA, and representatives from NOAA, ONR, and the NSF. ICCAGRA was an organization formed to try and foster more inter-agency coordination, even asset sharing, of our various facilities. Because we were all realizing that we're fiscally constrained and this is a way of improving our activities. Recently it has jumped up to a new level. But it's a pro-active activity for airborne geo-sciences. This type of organization had really been lacking in the past. Breaking down our individual agency institutional barriers is not a trivial task!

We are also involved in trying to extend this cooperation to the larger international community. We at NSF are working this because of the developments between our GV and the German DLR's G550 aircraft. We have been able to collaborate significantly with them.

We're doing some common pods for instrument development, and we also have a great relationship with CNES in France. We have a good relationship now with CMA in China, and also with the National Technical University in Taiwan, on doing joint development programs. So both nationally and internationally we're going to be expanding.

Summary

Jim headed the Airborne Science program over a decade, modernized and streamlined operations, and skillfully managed the consolidation of the aircraft at Dryden. Jim's leadership was instrumental in expanding and maintaining a creative, flexible and responsive world-class airborne research capability at NASA and later NSF.

Appendix D

Acronyms and Abbrieviation

A

AAPEx	Alternative Aviation Fuel Experiment
ACCLAIM	Advanced Carbon and Climate Laser International Mission
ACOS	Atmospheric Carbon Observation from Space
AID	Aircraft Instrument Demonstration
AIIT	Airborne Instrument Technology Transfer
AIMMS	Aircraft Integrated Meteorological Measurement System
AirMSPI	Airborne Multiangle SpectroPolarimetric Imager
AMAP	Arctic Monitoring and Assessment Program
ARRA	American Recovery and Reinvestment Act
ASCENDS	Active Sensing of CO2 Emissions over Nights, Days and Seasons
ASP	Airborne Science Program
AVIRIS	Airborne Visible and Infrared Imaging Spectrometer

B

BGAN	Broadband Global Area Network
BPA	Blanket Purchase Agreement

C

CALIPSO	Cloud Aerosol Lidar and Infrared Pathfinder Satellite Observation
CalNex	California Research at the Nexus of Air Quality and Climate Change
Cal/Val	Calibration/Validation
CanEx	Canadian Experiment
CASIE	Characterization of Arctic Sea Ice Experiment
CIRPAS	Center for Interdisciplinary Remotely Piloted Aircraft Systems
CDE	Collaborative Decision Environment
COMPASS	Common Operations Management Portal for Airborne Science Systems

D

DAOF	Dryden Aircraft Operations Facility
DESDynI	Deformation, Ecosystem Structure and Dynamics of Ice
DFRC	Driden Flight Research Center
DLH	Diode Laser Hygrometer
DOI	Department of the Interior

E

EAFB	Edwards Air Force Base
ECF	Engineering Check Flights
ESA	European Space Agency
ESTO	Earth Science Technology Office
EIP	Experimenter Interface Panel

F

FAA	Federal Aviation Administration
FOD	Foreign Object Debris
FOR	Flight Operations Room

G

GHOC	Global Hawk Operations Center
GHMOF	Global Hawk Mobile Operations Facility
GLEAM	Great Lakes Environmental Analysis Measurement
GloPac	Global Hawk Pacific Mission
GRIP	Genesis and Rapid Intensification Processes

H

HIRAD	Hurricane Imaging Radiometer
HIWRAP	High Altitude Imaging Wind and Rain Profiler
HYSPIRI	Hyperspectral InfraRed Imager

I

ICCAGRA	Interagency Coordinating Committee for Airborne Geosciences Research and Applications
ICAP	Interagency Committee for Aviation Policy
ICESat	Ice, Cloud and Land Elevation Satellite
ISPRS	International Society for Photogrammetry and Remote Sensing

IIP	Instrument Incubator Project
IWGADTS	Interagency Working Group for Airborne Science and Telecommunications System

K

KTAS	Knots True Airspeed

L

LAC	Large Area Collectors
LaRC	Langley Research Center
LVIS	Laser Vegetation Imaging Sensor

M

MASTER	Modis/Aster Airborne Simulator
MR-TCDL	Multi-Role Tactical Communications Data Link
MSFC	Marshall Space Flight Center
MR-TCDL	Multi-Role Tactical Communications Data Link

N

NASDAT	NASA Airborne Science Data and Telemetry
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NSF	National Science Foundation

P

POR	Payload Operations Room
PolSCAT	Polarimetric Scatterometer
PRISM	Portable Remote Imaging Spectrometer

R

REVEAL	The Research Environment for Vehicle-Embedded Analysis on Linux
RTMM	Real-Time Mission Monitor

S

SAR	Synthetic Aperture Radar
SARP	Student Airborne Research Program
SER	Support Equipment Room
SERC	Smithsonian Environmental Research Center

SFC	Space Flight Center
SIERRA	Sensor Integrated Environmental Remote Research
SIMPL	Slope Imaging Multi-polarization Photon-Counting Lidar
SMAP	Soil Moisture Active Passive Mission
SMAPVEX	Soil Moisture Active and Passive Validation Experiment
SMD	Science Mission Directorate
SMOS ESA	Soil Moisture Ocean Salinity
SOFRS	Science Operations Flight Request System
S-WAVE	Soil, Water and Vegetation Experiment

T

TOR	Terms of Reference
TWiLite	Tropospheric Wind Lidar Technology Experiment

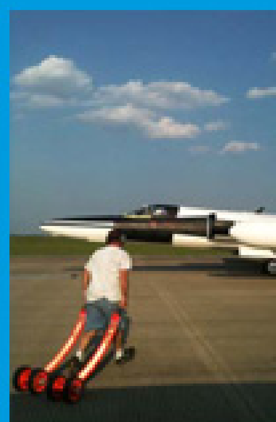
U

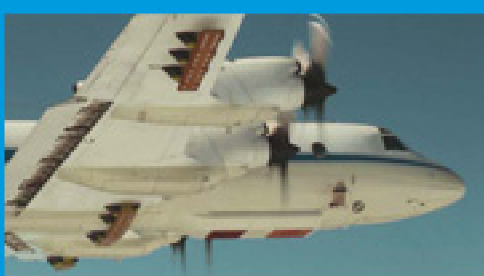
UAVSAR	Unmanned Air Vehicle Synthetic Aperture Radar
USDA	U.S. Department of Agriculture
USFS	U.S. Forrest Service
USGS	U.S. Geological Survey

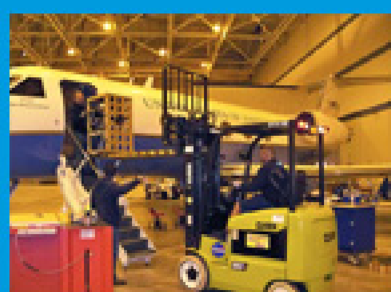
W

WFF	Wallops Flight Facility

In recognition of the people who ensure that Program aircraft and systems are ready to perform the mission.







Thank you for your hard work and dedication to the Airborne Science Program.