Tactical Fire Remote Sensing

Sensing Advisory Committee

8 November 2012
NIFC Training Auditorium
Boise, ID

TFRSAC Agenda; 8 November 2012

8:30 AM **Meeting Start**

•Morning Presentations (15-30 min each)

Welcome and introductions (15 min)	Quayle / Ambrosia
2012 Wildfire Season Brief (15 min)	Quayle / Mellin
FS Outlook Budget and Focus (15 min)	Hinkley
NASA Outlook / Budget and Focus (15 min)	Ambrosia
AMS Update / Status (30 Min)	Ambrosia / Hinkley

10:00 AM **Break** (20 min)

USFS UAS Advisory Group Update (25 min)	Quayle / Grell / Roth
UAS Updates (30 min)	Vince / Hinkley / Hutt
H.R. 658 and implications	
CalFire Update (25 min)	Strazzo / Bloxham (?)
International Partner Activity Update (15 min)	Pastor

12:00 pm **Lunch** (1 hour)

TFRSAC Agenda; 8 November 2012

1:00 PM

– S-NPP VIIRS Presentation	E. Ellicott
– Sensor Web (20 min)	D. Mandl
– NASA AIST Project / AMS Collaboration (20 min)	D. Mandl
– WAI (30 min)	J. Green

2:30 PM Break (20 min)

2:50 PM

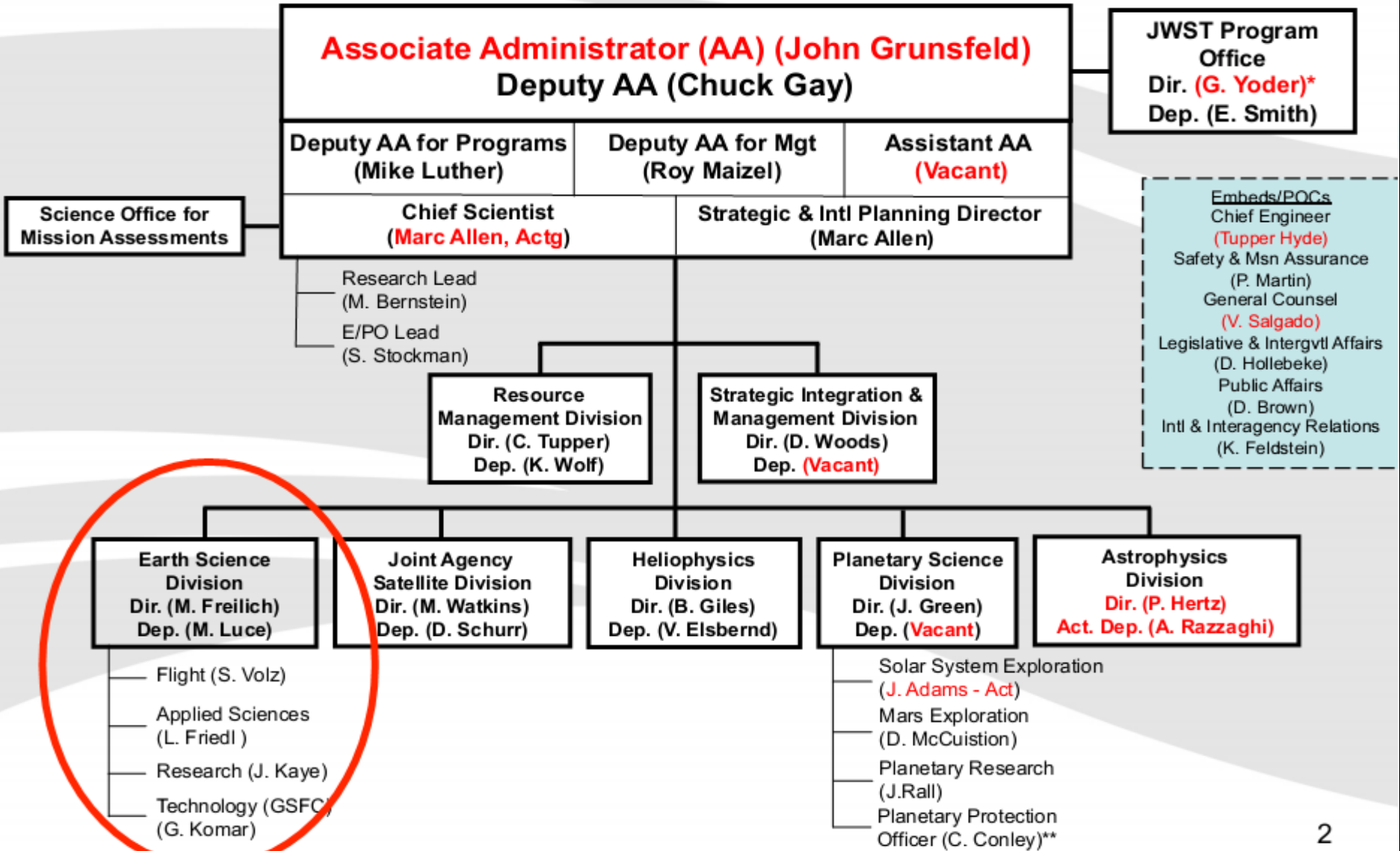
– NASA ROSES 2012 Wildfire Proposals	Lindsay / Ambrosia
– Global Hawk Missions	D. Sullivan
– RxCadre / UAS Project at Eglin AFB	Zajkowski
– Zeppelins / Airships Supporting Fire Ops	Francis Govers
– New Run Road UAS Project	D. Yoel
– New areas of USFS / NASA Collaboration	Open Discussion

5: 00 PM **Dinner plans and adjourn for day**

6:30 PM **Meet for dinner @ nearby restaurant (TBD)**

NASA Outlook Budget & Focus

NASA Science Mission Directorate



* Direct report to NASA Associate Administrator
** Co-located from the Front Office

NASA Disaster Program

- **NASA HQ: Earth Sciences, Applied Science Program, Disaster Management Element:**

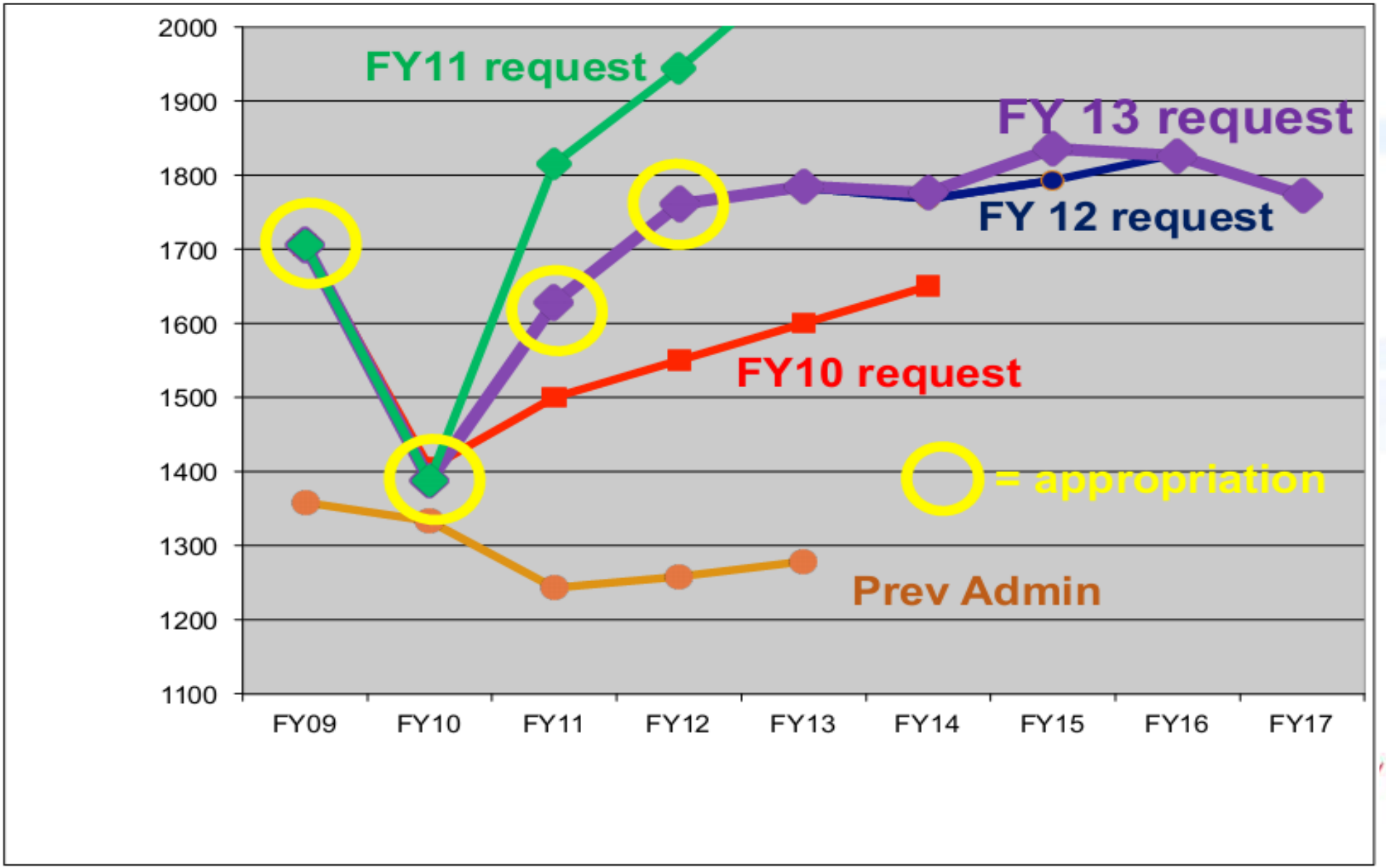
  Program Manager: Frank Lindsay, PhD.

- **Oversees ROSES calls related to Disaster Elements:**
  - **ROSES 2011; A33 - DISASTERS**
  - **ROSES 2011; A35 - WILDFIRES**

From 2013 Budget Plan:

- Provides $1.8 billion for research and a robust fleet of Earth observation spacecraft to strengthen U.S. leadership in the field, better understand climate change, improve future disaster predictions, and provide vital environmental data to Federal, State, and local policymakers.

Earth Science Budget - 2013



NASA ROSES 2011 Wildfire Proposals

- **ARRA-funded effort to sustain and mature data collection over fires and partnership arrangements (2009-2011) ended.**

- **NASA ROSES 2011, A35 ES Applications: WILDFIRE**
  - Implemented in two stages:
    - Stage 1: Feasibility Study (12-months;
    - Stage 2: Option 3-year Decision Support projects awarded at end of Stage 1.
  - Proposals submitted: 16 December 2011; proposed start dates: June 2012; Selection Letters sent ~10-8-12
  - We (NASA-ARC / USFS / NIFC team) were NOT selected, despite having very high scores.
  - List of successful, unknown (as of 11-2-12).

AMS Transition Update

Agreement: NASA-ARC and USFS

AMS Transfer Agreement

- Addendum to / reference Interagency Agreement – SAA2-401894 between USFS-RSAC and NASA-ARC.
- Agreement signed by S. Hipskind (Chief, Earth Science Division, NASA-ARC) and T. Harbour (Director, Fire & Aviation Management) on 8/27/12 & 9/14/12 respectively.
- Transfer of AMS airborne sensor to USFS.
- Allow partnership use to support NASA and community Fire Research objectives…

  "…to "extent that there is excess capacity as a reimbursable option."
- Partners "work-share" in sensor system operational transition.
- Terms of agreement: 14 September 2012 to 13 September 17 (5-years).

AMS Wildfire Instrument

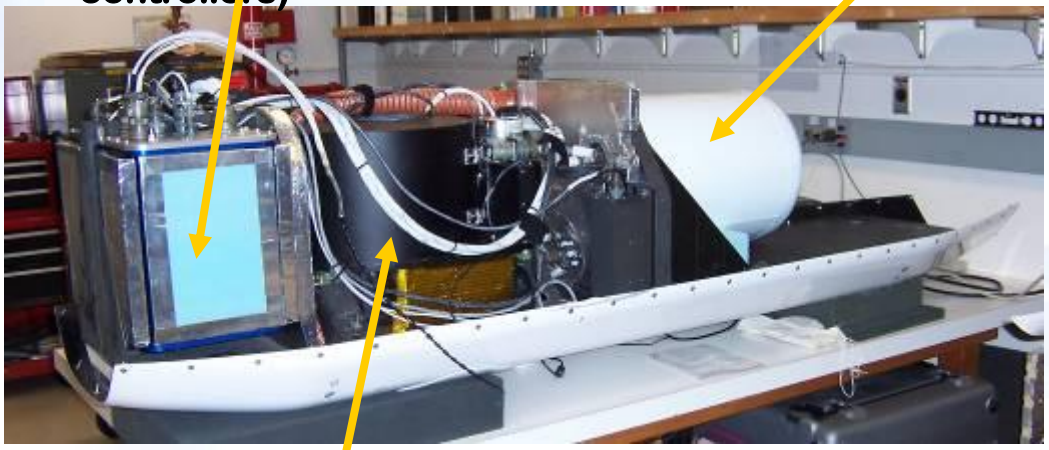
AMS Wildfire Sensor

Band	Wavelength μm	
1	0.42 - 0.45	
2	0.45 - 0.52	(TM1)
3	0.52 - 0.60	(TM2)
4	0.60 - 0.62	
5	0.63 - 0.69	(TM3)
6	0.69 - 0.75	
7	0.76 - 0.90	(TM4)
8	0.91 - 1.05	
9	1.55 - 1.75	(TM5) (high gain)
10	2.08 - 2.35	(TM7) (high gain)
11	3.60 - 3.79	(VIIRS M12) (high gain)
12	10.26 - 11.26	(VIIRS M15) (high gain)
13	1.55 - 1.75	(TM5) (low gain)
14	2.08 - 2.35	(TM7) (low gain)
15	3.60 - 3.79	(VIIRS M12) (low gain)
16	10.26 - 11.26	(VIIRS M15) (low gain)

Total Field of View: 42.5 or 85.9 degrees (selectable)
IFOV: 1.25 mrad or 2.5mrad (")
Spatial Resolution: 3 – 50 meters (variable)

Two environmental enclosures (data disks & GPS; and power supplies & controllers)

Data System Enclosure



Scan Head

AMS Transition Responsibilities

US Forest Service

- Coordinate / cooperate with NASA-ARC in AMS sensor installation, training and maintenance;
- Participate with other partners to support ongoing satellite sensor calibration and validation efforts;
- Cooperate in technology transfer activities.

AMS Transition Responsibilities

NASA-ARC

- Provide system training in the operational use of the AMS sensor and ancillary equipment;
- Coordinate with / advise the Forest Service on sensor installation on USFS aircraft;
- Provide guidance / advice as maintenance / repair issues arise;
- Direct external cooperators to the USFS for the purpose of cooperative research efforts which directly involve the use of the AMS sensor;
- Support technology transfer, education and outreach activities.

AMS Transition Schedule

- Short-term (~1yr) support from NASA HQ to NASA-ARC engineering / management staff to get AMS operational on USFS aircraft.
- Allow testing in off-fire-season 2012/13 with ARC team.
- Establish framework to mature and exchange support capabilities between agencies related to fire / disaster imaging.

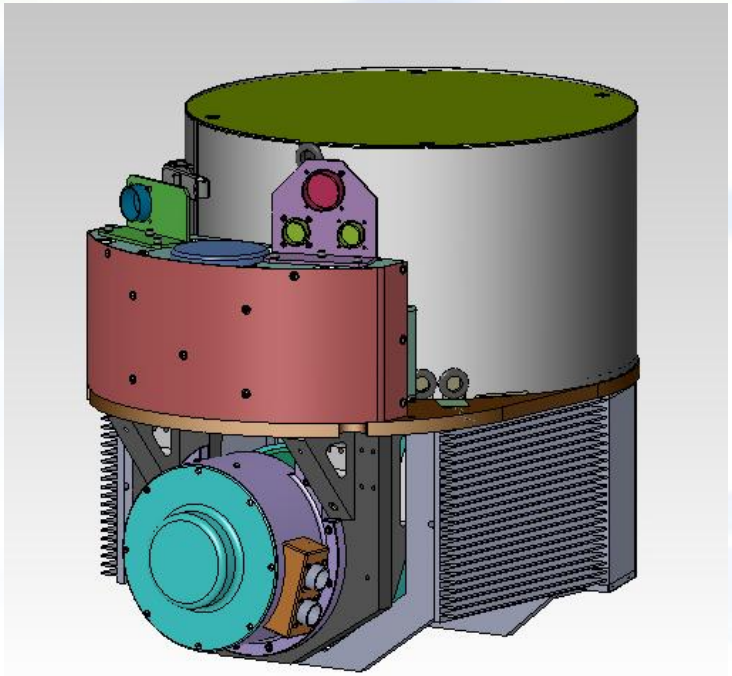
Schedule:

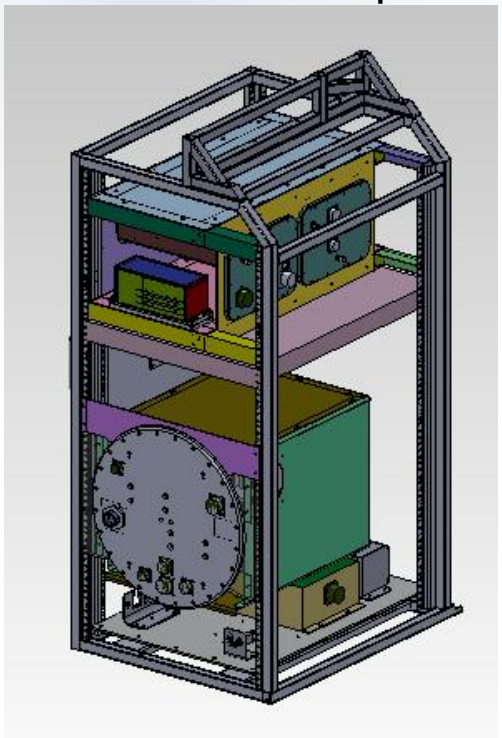
Engineering Fit checks:	11/12 to 1/13
Installation:	2/13
Test Missions:	3/13-4/13
Operational Use:	summer 2013

AMS Integration Tasks

Create AMS scan-head installation kit for Citation:

- Modify existing mounting fixtures or design/fab new ones
- Adapt AMS cabling to Citation
  - Power
  - pressure-bulkhead





- Adapt AMS components to available rack space
- Connect to Air Cell hardware

AMS Software Tasks

- Update operating system on both AMS processors
- Incorporate fixes and enhancements from eMAS development
- Add features as needed for Citation operations
- Configure network setup for Air Cell communications
- Documentation
- Set up ground station
- Train sensor technicians, operators and interpreters

AMS Transition

On board Processing Software

- NBR – changed to a quantitative image product
- Improved responsiveness – testing half sized segments
- Autosend – interface to Air Cell system
- Running “ground station” onboard vs. remotely

Instrument Payload Module (IPM) / AMS Collaboration Task

NASA-GSFC IPM Test Development

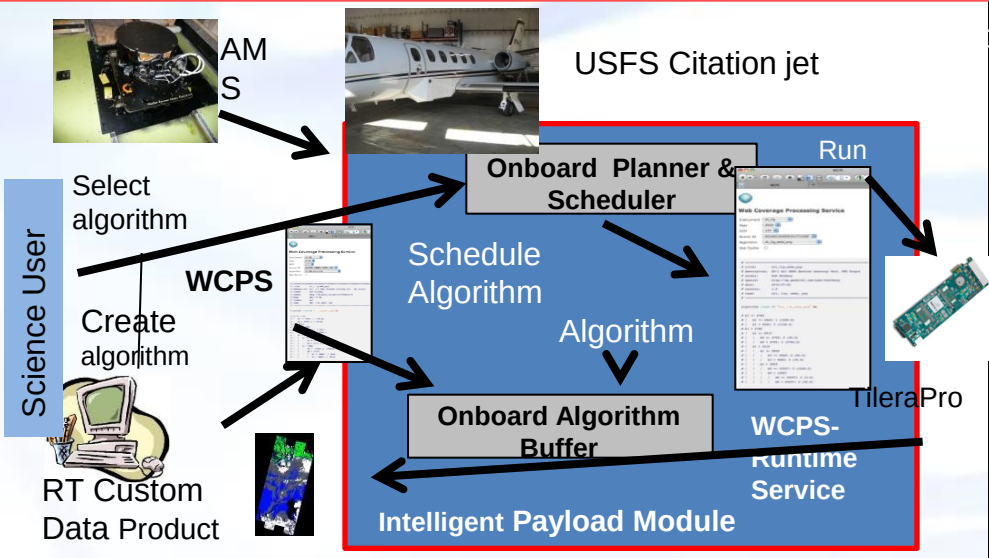
- Dramatically improve on-board processing (OBP) for high data rate missions, in particular, HyspIRI satellite mission (~2022)
- Build a series of increasingly complex and higher fidelity onboard computation scenarios
- Mesh with realistic operational scenarios using airborne assets
  - Use HyspIRI as the target for a sample Decadal mission
  - Gather benchmarks to enable future design tradeoff decisions
- Infuse lessons learned into operations concept for the HyspIRI mission and possibly similar NASA Decadal Mission

- Partner with NASA-ARC and USFS / NIFC to allow Instrument Payload Module (IPM to interface to AMS during mission phases to testbed / prove capabilities.

IPM Airborne Approach

Objective

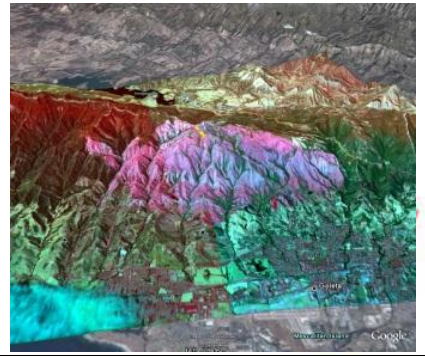
- Employ Tilera components on airborne sensor missions to ensure operability and enhance the TRL levels for future satellite (HyspIRI)operations via the use of multicore processor technology.
- Demonstrate the end-to-end operations concept for use of the Intelligent Payload Module (IPM) for low latency users of NASA Decadal Survey missions using **airborne** vehicles as initial feasibility testbed platforms:
- Provide delivery of data products in near real-time for quick-looks assessment of processed information from a proven autonomous sensor system



Graphic shows vision to develop & validate the HyspIRI operations concept for the high-speed multicore onboard processor Intelligent Payload Module (IPM) using a USFS Citation jet and the NASA AMS sensor system.

Approach

- Integrate IPM test-bed into box that can be flown in collaboration with the NASA Autonomous Modular Scanner (AMS) sensor onboard a US Forest Service Citation jet, during missions of opportunity over fires in the western US.
- Configure the IPM as though it is on a satellite:
  - Send real-time processing commands through IPM, dictating development of AMS sensor Level II products to derive / deliver.



Airborne Mission Test Collaboration

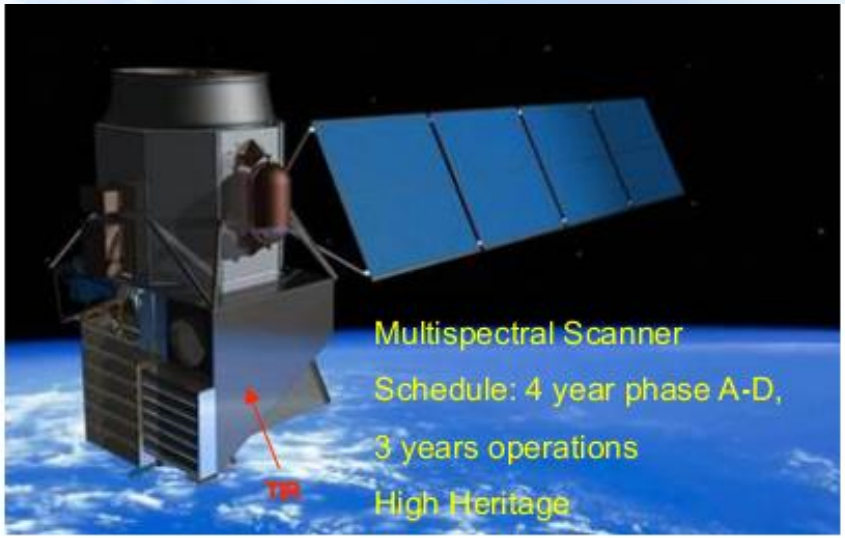
US Forest Service, National Interagency Fire Center – National Infrared Operations (NIFC-NIROPS); NASA-Ames Research Center; CSUMB, UPC

IPM Installation

- **Intelligent Payload Module (IPM):**
  - Small box containing Tilera TILEncore GX board for processing AMS data and streaming NRT products to data telemetry system (AirCell) for use on ground.
- **Requires either of two scenarios:**
  - Two-way comm through AirCell between ops on ground and sensor package.
  - Operator on-board A/C to manage data flow tests.
- Can probably be completed during AMS shakedown mission series,

NASA Hyperspectral Infrared Imager (HyspIRI) Mission Design Plans

NASA HyspIRI TIR Channels



Science Questions:

TQ1. Volcanoes/Earthquakes

– How can we help predict and mitigate earthquake and volcanic hazards through detection of transient thermal phenomena?

• TQ2. Wildfires

– What is the impact of global biomass burning on the terrestrial biosphere and atmosphere, and how is this impact changing over time?

• TQ3. Water Use and Availability

– How is consumptive use of global freshwater supplies responding to changes in climate and demand, and what are the implications for sustainable management of water resources?

• TQ4. Urbanization/Human

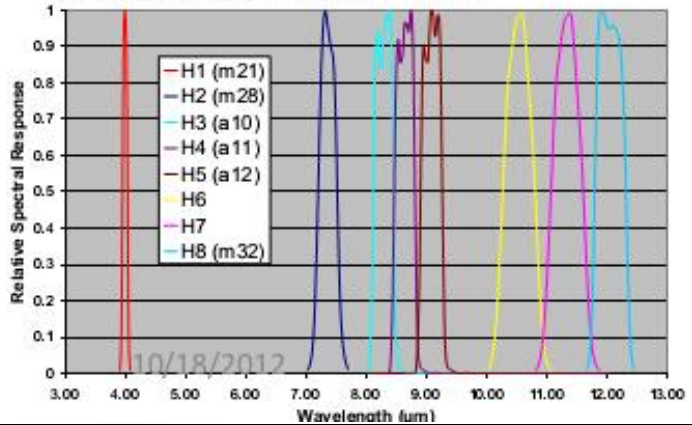
– How does urbanization affect the local, regional and global environment? Can we characterize this effect to help mitigate its impact on human health and welfare?

• TQ5. Earth surface composition and change

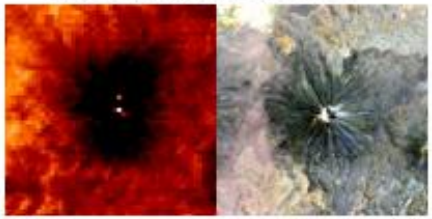
– What is the composition and temperature of the exposed surface of the Earth? How do these factors change over time and affect land use and habitability?

Measurement:

- 7 bands between 7.5-12 µm and 1 band at 4 µm
- 60 m resolution, 5 days revisit
- Global land and shallow water

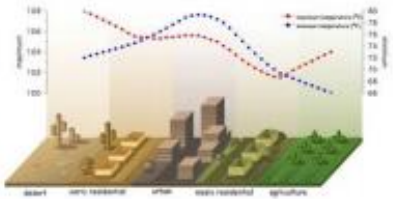


Andean volcano heats up

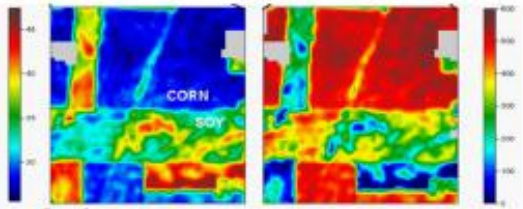


Volcanoes

Urbanization



Water Use and Availability

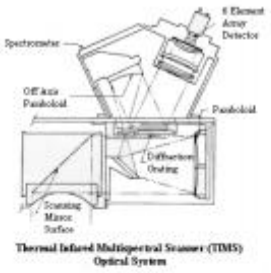


Surface Temperature

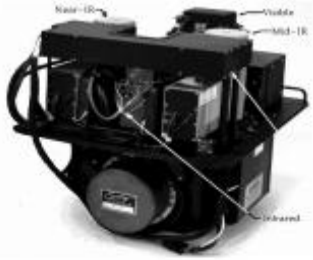
Evapotranspiration

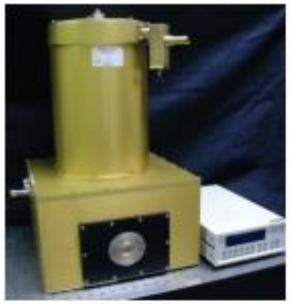
HyTES, PHyTIR, and HysplRI

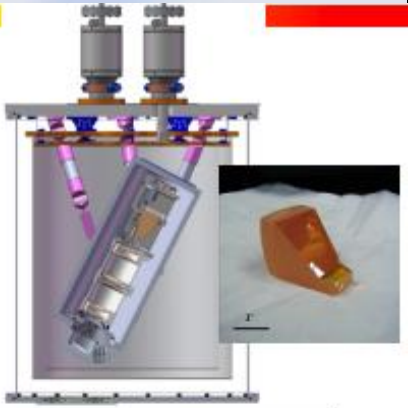
Airborne Instruments



Thermal Infared Multispectral Scanner (TIMS) Optical System

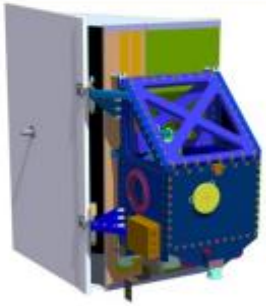


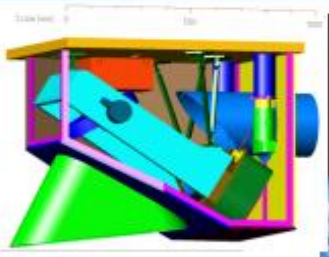




Airborne Name	TIMS	MASTER	QWEST	HyTES
First Year of Operation	1980	1998	2008	2012
Number of TIR Bands	6	10	56	256

Spaceborne Instruments (incl. lab prototypes)





Spaceborne Name	ASTER	Landsat 8 (LDCM)	PHyTIR	HyspIRI-TIR
First Year of Operation	1999	2013	2014	2020
Number of TIR Bands	5	2	8	8
Swath Width	60 km	185 km	600 km	600 km
Pixel Size	90m	100 m	60 m	60 m

HysplRI, HyTES, and PHyTIR

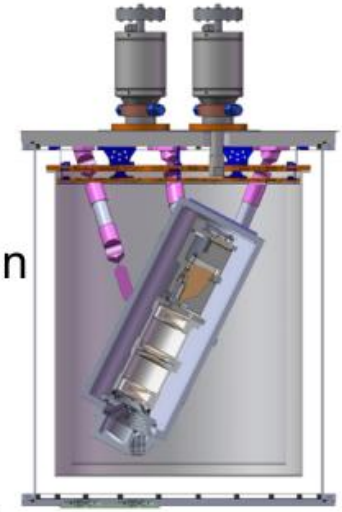
VSWIR

TIR

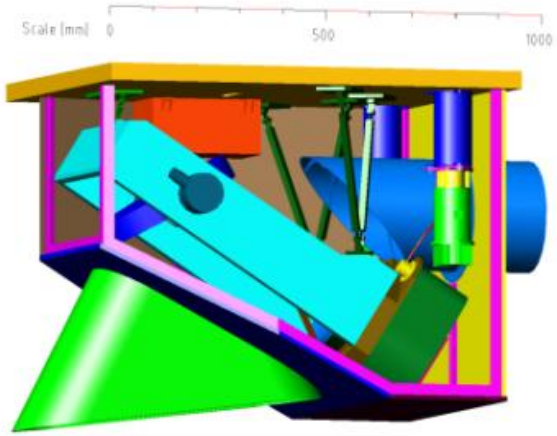
Hyperspectral Infrared Imager (HysplRI)

Science Risk Reduction

Engineering Risk Reduction



Hyperspectral Thermal Emission Spectrometer (HyTES)



Prototype HysplRI Thermal Infrared Radiometer (PHyTIR)

HysplRI TIR Science Measurement Requirements

PARAMETER	BASELINE	SCIENCE REQUIREMENT
Ground Resolution (m)	60	<100
Revisit (days)	5	<6
Noise equivalent delta temperature (K)	0.2	<0.3
Absolute accuracy (K)	0.5	<1
Saturation – low temperature bands (K)	500	>400
Saturation – high temperature band (K)	1200	>1100
Overpass time (hh:mm)	10:30am	10-3pm
Nighttime imaging	Yes	Required
Number of Bands (spectral range: 3 – 12 µm)	8	>=8
Coverage	Land and coastal regions	Land and coastal regions
Data latency	2 days	< 1 week

PHyTIR and HyTES

Prototype HysplRI Thermal Infrared (PHyTIR)
for the HysplRI TIR Instrument

VSWIR

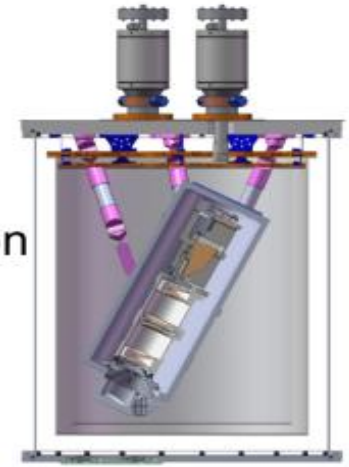
TIR

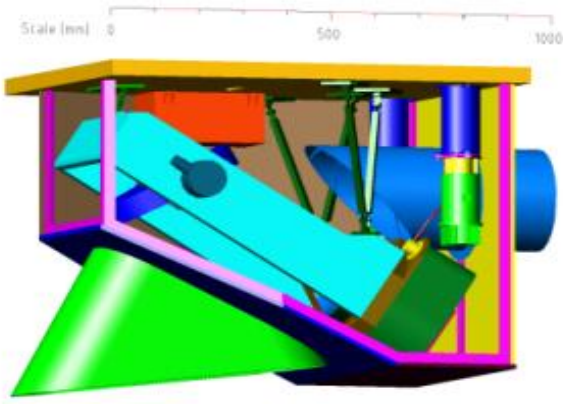
Hyperspectral Infrared Imager (HysplRI)

Science Risk Reduction

Engineering Risk Reduction

Hyperspectral Thermal Emission Spectrometer (HyTES)



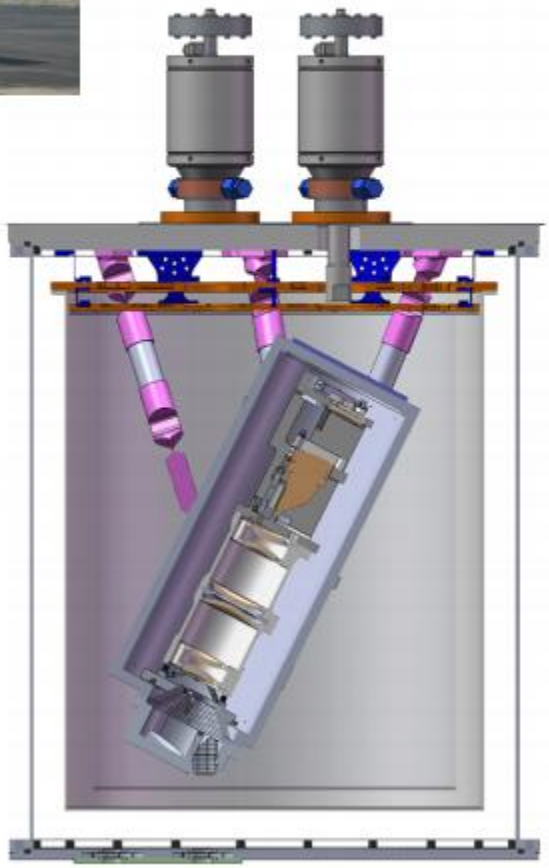


Prototype HysplRI Thermal Infrared Radiometer (PHyTIR)

HyTES Instrument

Hyperspectral Thermal Emission Spectrometer (HyTES)

First Flights in July 2012



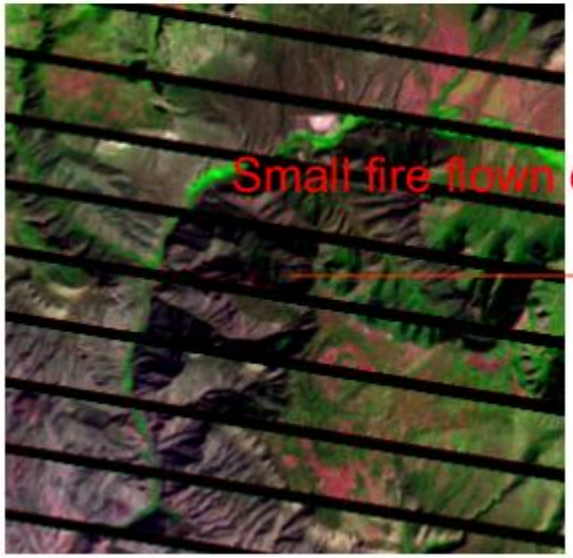
Instrument Characteristic	HyTES
Mass (Scanhead)[1]	12kg
Power	400W
Volume	1m x 0.5m (Cylinder)
Number of pixels x track	512
Number of bands	256
Spectral Range	7.5-12 µm
Frame speed	35 or 22 fps
Integration time (1 scanline)	28 or 45 ms
Total Field of View	50 degrees
Calibration (preflight)	Full aperture blackbody
Detector Temperature	40K
Spectrometer Temperature	100K
Slit Length and Width	20 mm x 39 µm
IFOV	1.7066
Pixel Size/Swath at 2000 m flight altitude[2]	3.41m/1868.33m
Pixel Size/Swath at 20,000 m flight altitude[2]	34.13m/18683.31m

1. Does not include 1 rack of electronics to operate instruments; 2. Includes ~27 calibration pixels

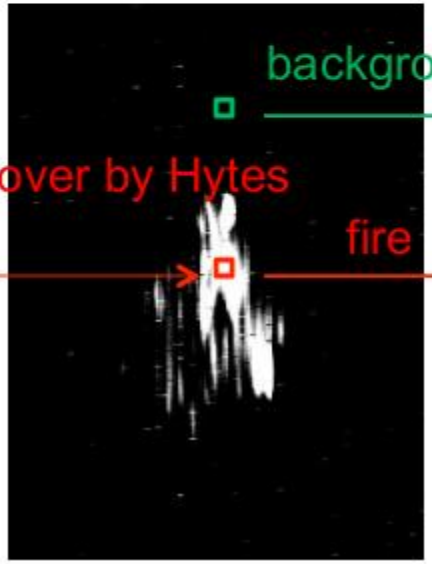
HyTES Fire Data Collection

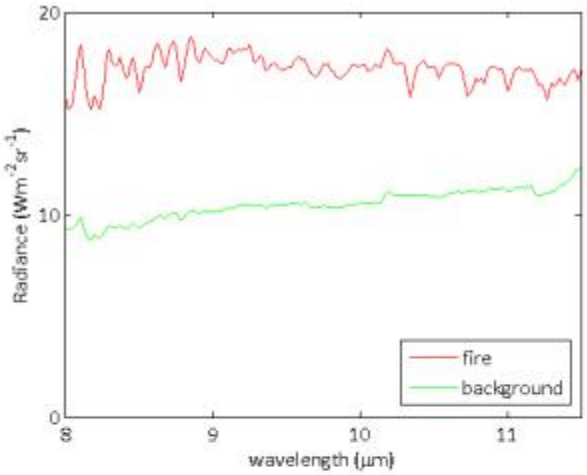
2012 Colorado fires (pictures from the Denver Post)

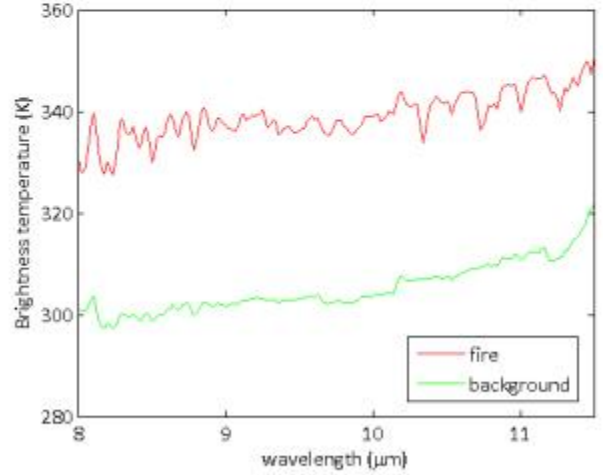
Post-fire Landsat 7 scene (RGB-743)



HyTES scene (11 µm) acquired on July 22, 2012







NOTE: the small fire was not detected by the MODIS active fire product (MO(Y)D14) nor the burned area product (MCD45)

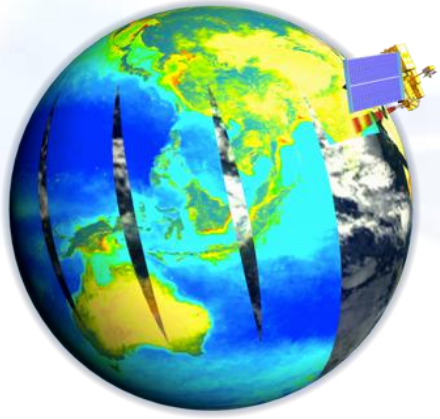
NASA-ARC SBIR Developments

- Successful program to develop, test and apply new instrument design concepts to improve wildfire science and applications uses. These proposals have been "assigned" to NASA-ARC for evaluation and management.

- **Two current SBIR developments in various stages of maturity**:
  - 2008 – Wide Area Imager (WAI); Xiomas
    - Phase III, in operations testing for use by partners in USFS
    - Partnership arrangement with Photo Sciences for use as well.
  - 2011 – Thermal Mapping Airborne Simulator for Small Satellite Sensor (TMAS); Xiomas.
    - Completed Phase I; under evaluation for Phase II.

TMAS For a SmallSat Concept

- Discussions with NASA ARC SmallSat Development Office (C. Frost) about a design concept for expansion of the TMAS envelope to include development into a SmallSat instrument candidate for supporting wildfire observations from an orbital system at high spatial resolution, daily temporal resolution and globally.



TMAS

- 110 degree field of view (same as MODIS)
- 94 meter spatial resolution (similar to ASTER)
- 3 Spectral Bands (more can be added in Phase III)

- Operating at the same altitude and velocity as MODIS the TMAS will have the same capability to map the globe every one to two days

NASA UAS Updates

AV DragonEye UAS

- Surplused from USMC to BLM; BLM to NASA-ARC; received 7/12.
- US Marine Corps aircraft and operating system (ref TM11015A-12&P/2A). Built by AeroVironment. (9 years of operations by DOD)
- COTS system (no changes to any system component except map uploading).

- **Class 1 UAS**
- **Aircraft specs**
  - Wingspan: 45 inches
  - Length: 36 inches
  - Weight: <6 pounds
  - Cruise speed: 35 mph
  - Max altitude: 500’ AGL
  - Power: Electric propulsion
- **Aircraft possesses a Stage III frequency clearance for CONUS use**.
  - Aircraft GCS operates using a digital FM transmitter in the frequency range of 381 MHz-400 MHz with a max output power of 1 watt.
  - The vehicle operates using a digital FM video and telemetry transmitter in the frequency range of 1,765 MHz-1,840 MHz with a max output power of 2 watts.
- **Ames inventory catalogued, systems ground test**ed. GCS reloaded with regional maps. Flight lines developed and simulations run.

DragonEye UAS

- Per DOD specifications, system consists of 1 ea ground station, 3 ea aircrafts, complete with nose payloads (3 ea cameras per nose) and extensive spare parts and repair kit.

- ARC has ~25 complete kits (~75 UAS platforms), plus spares.

Airframe disassembled

Ground Control Station

Test Mission Plan

- **FHL Test Flights November 29/30, 2012**

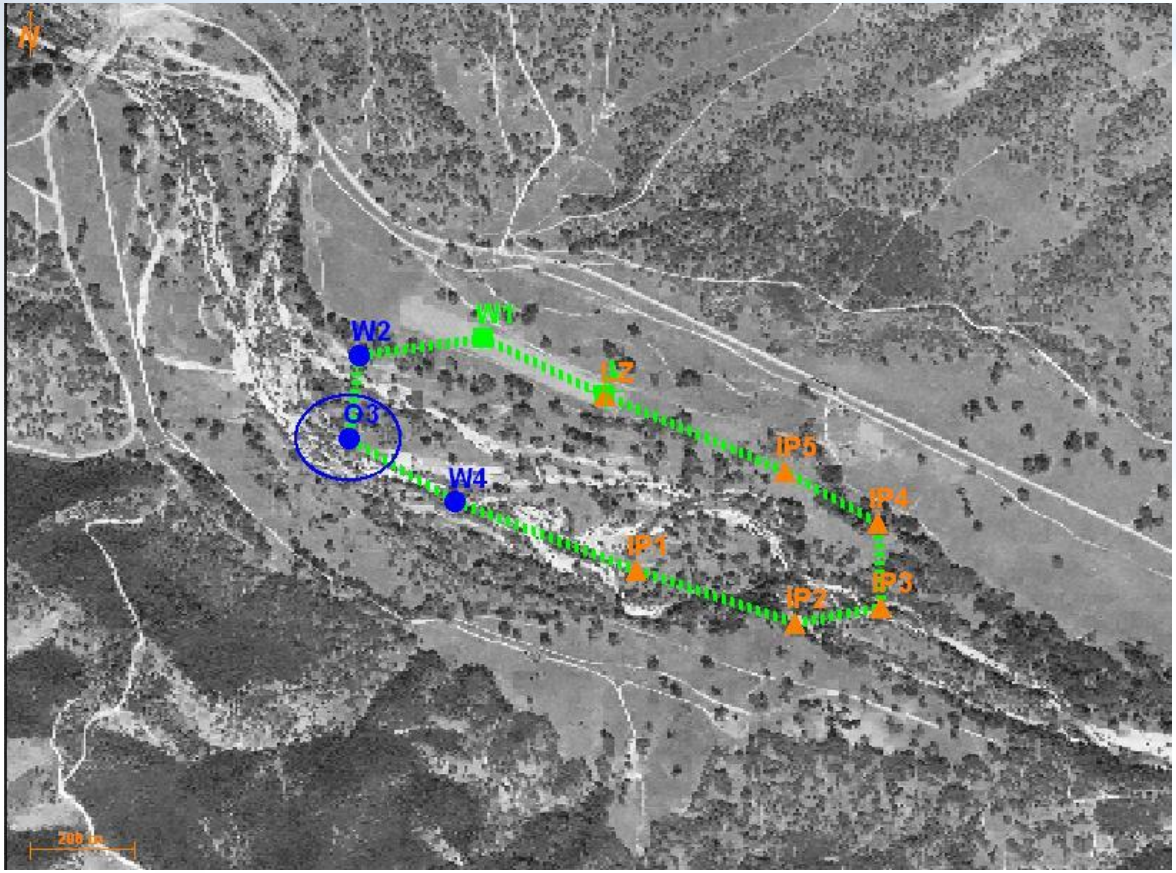
- Goal: aircraft familiarization and crew proficiency development
  - Day one, system set up and aircraft launch and landing
  - Day two exercise of flight lines.

- Secondary goal: payload familiarization, imagery collection
- Dragon Eye Team: (SIERRA Core Team)
  - PIC, Don Herlth
  - Crew Chief, Richard Kolyer
  - GCS, Bruce Storms
  - RSO, Randy Berthold

- Met all FHL regulations for flight and ground operations, spectrum management and safety.

DragonEye Shakedown Mission

- **Area of operations:** Tule Airfield, a remote, isolated area, utilized for GSAR payload. No urban habitation for 5 mile radius.



Flight operations will not exceed ¼ mile west of Tule Airfield nor 2 miles south.

Questions?