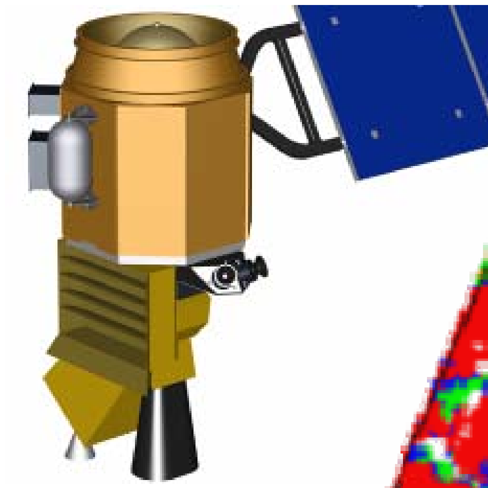
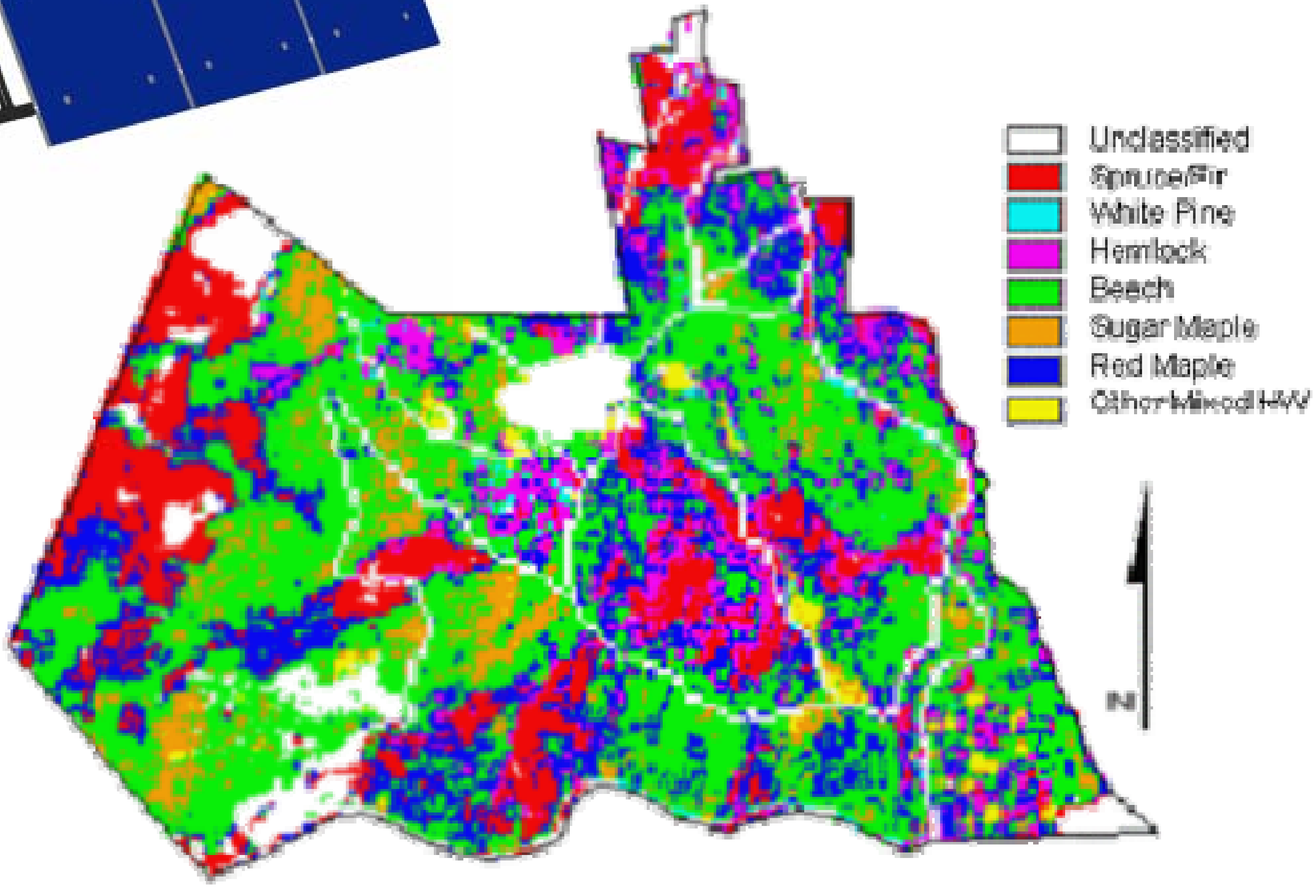
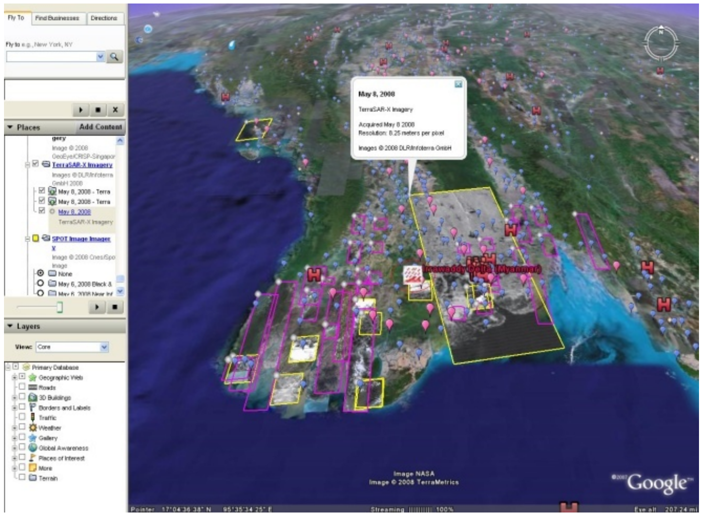






Technology & Ground Communication for HyspIRI

Dan Mandl 10-22-08

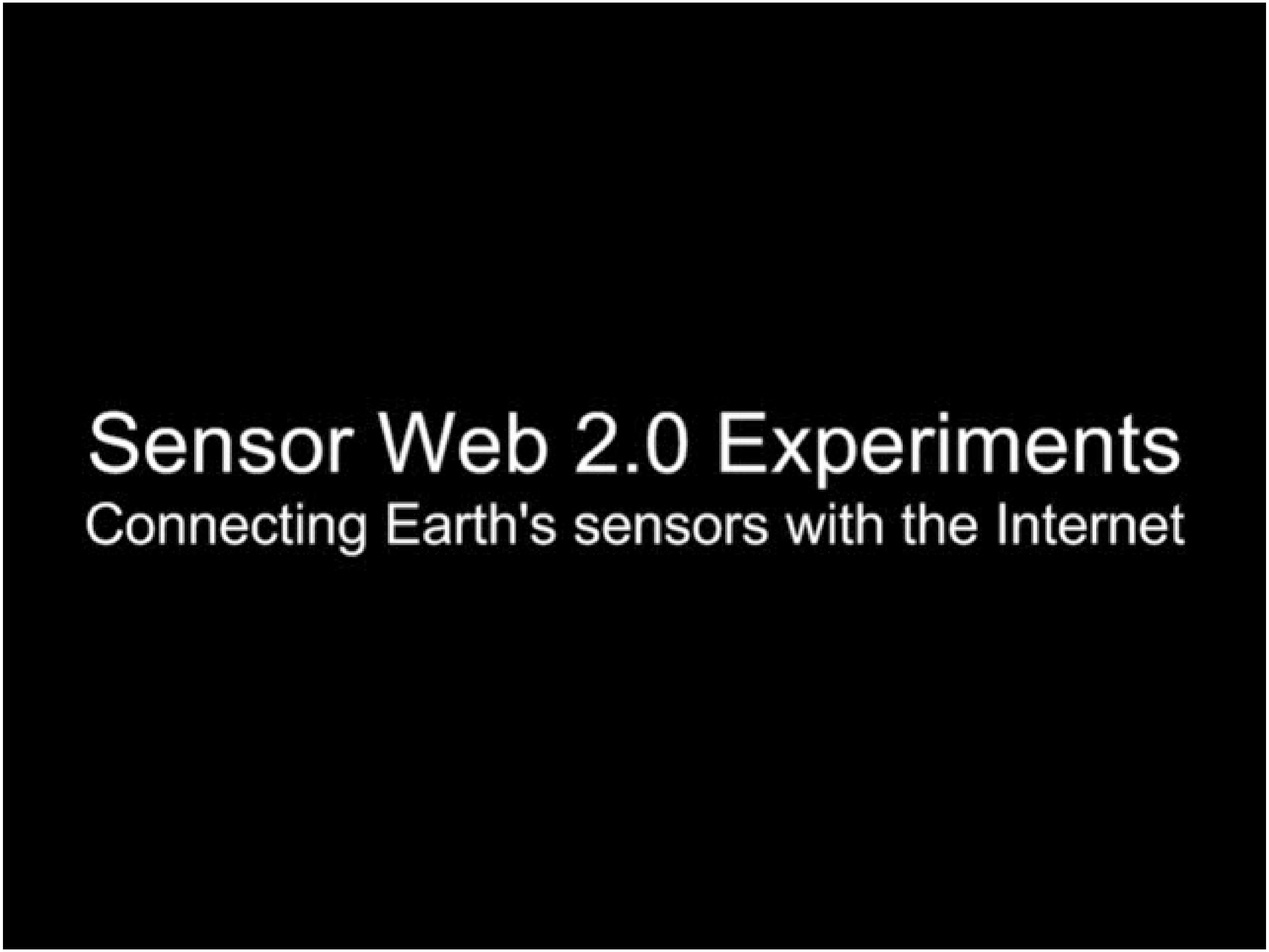
Agenda

- SensorWebs
- Onboard processing
- Ground communication

SensorWebs:

A set of heterogeneous sensor assets acting in concert to collect, process and transmit a set of coordinated measurements.

Movie

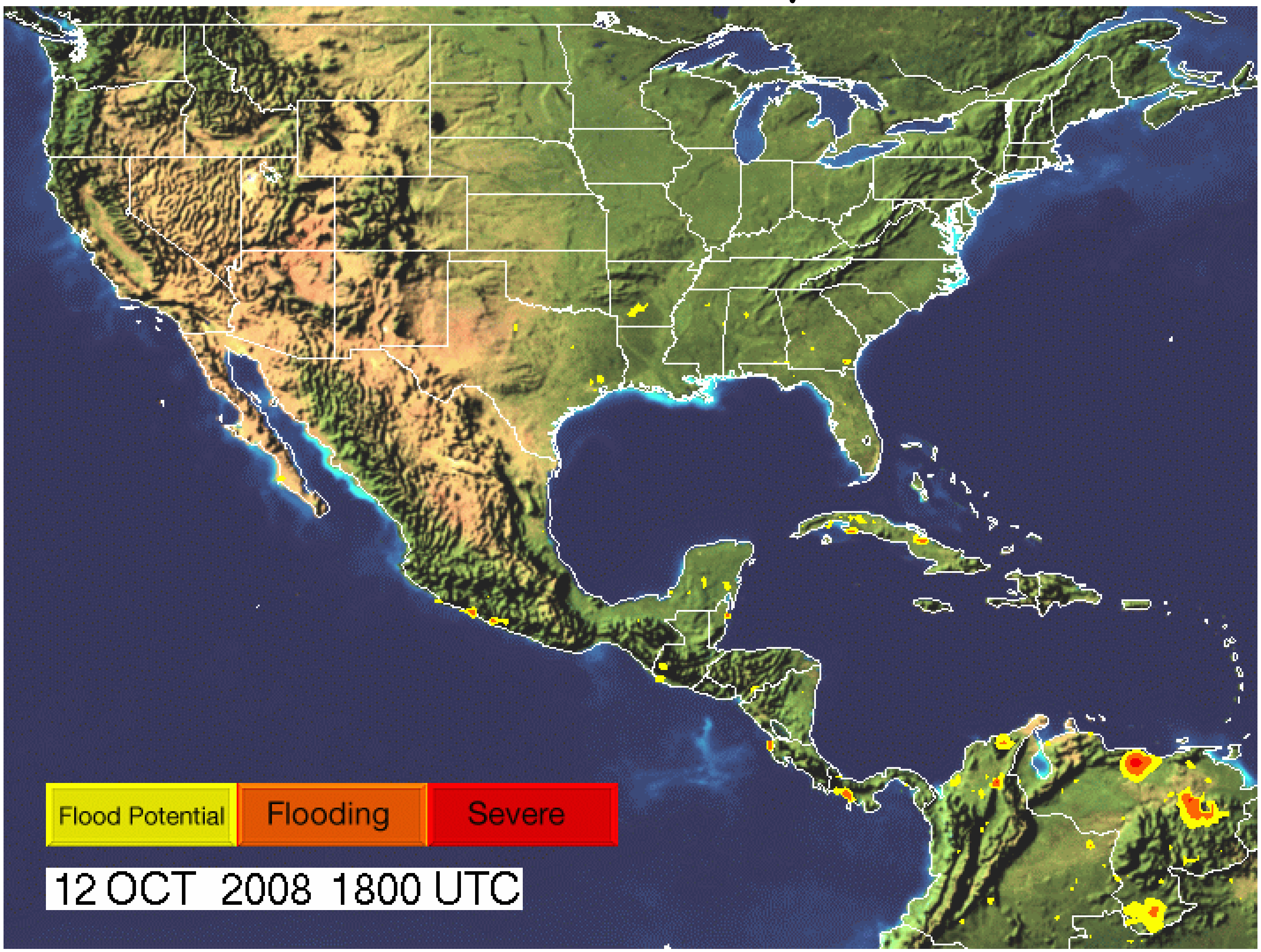

Sensor Web 2.0 Experiments
Connecting Earth's sensors with the Internet

Overview of EO-1 SensorWeb Efforts

- Goal is to lower cost and increase speed and flexibility to create customized science data products
  - Automated workflows
  - Facilitate Internet experience
- Collaborations
  - DoD
  - Global Earth Observing System of System (GEOSS) Architecture Implementation Pilot (AIP)
  - Committee on Earth Observing Satellite (CEOS) Working Group on Information system and Services (WGISS) Societal Benefit Area (SBA) demonstrations
  - United Nations Platform for Space-based Information for Disaster and Emergency Response (UN-SPIDER)
- Focus has been on disaster response
  - Fires
  - Floods
  - Volcanoes

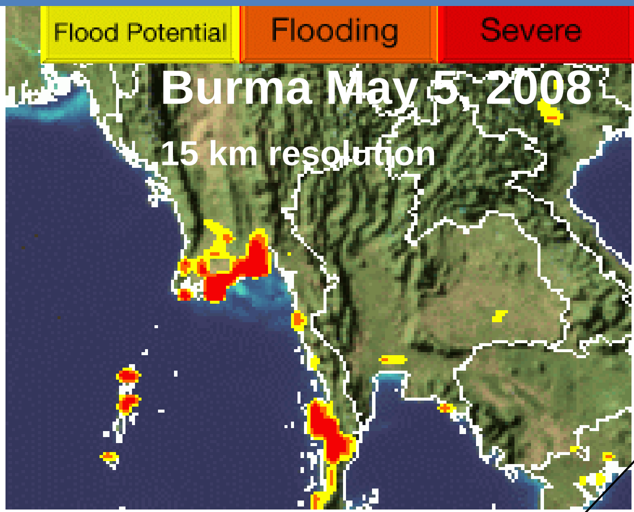
Sample Flood SensorWeb Scenario

Flood Potential Model Derived from 24 Hour Global Forecast System Rainfall Prediction – Created Oct 11, 2008

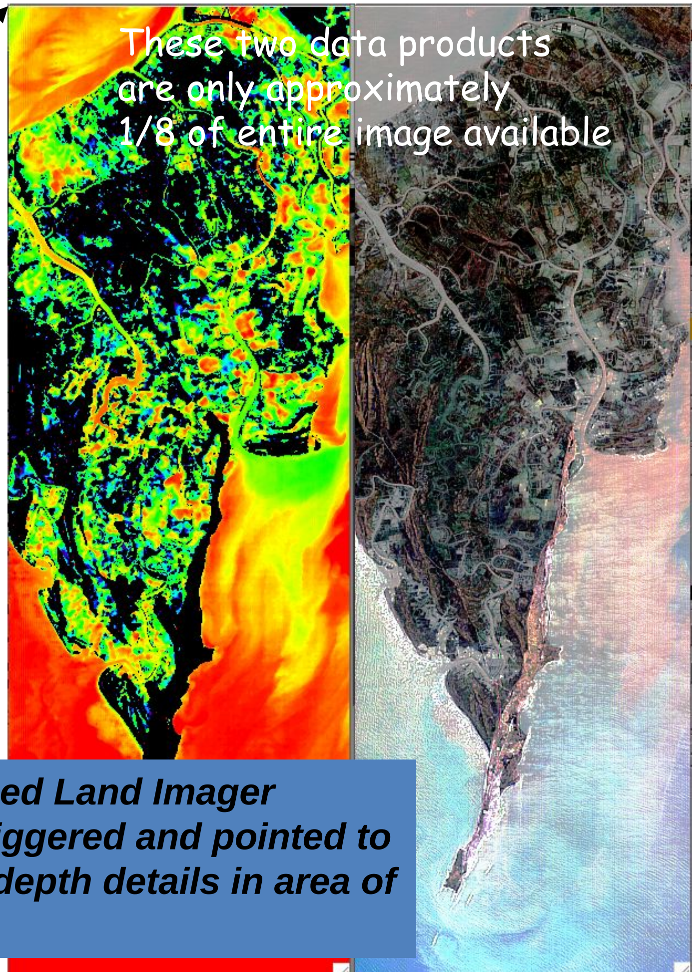


Myanmar Flood Sensor Web Exercise

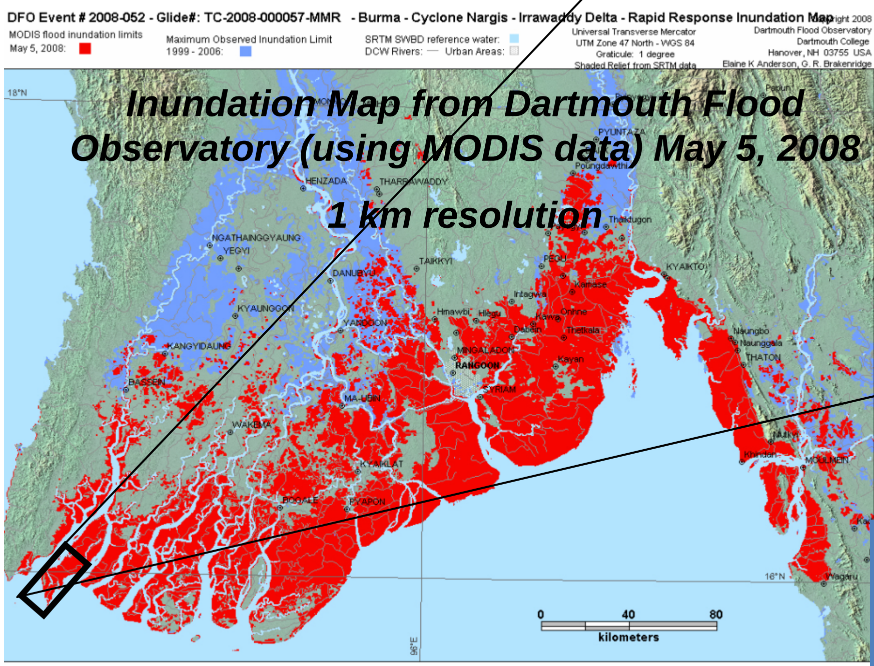
1. *Real-time flood estimate using global hydrological model and satellite rainfall estimate - Adler*



4. *Future experiment will be to substitute predicted rainfall versus real time rainfall estimate into Adler model to obtain predicted flood warning and automatically task EO-1 in area of interest and create MODIS and EO-1 data products*



Water Depth Classifier True color Advanced Land Imager 30m May 5, 2008



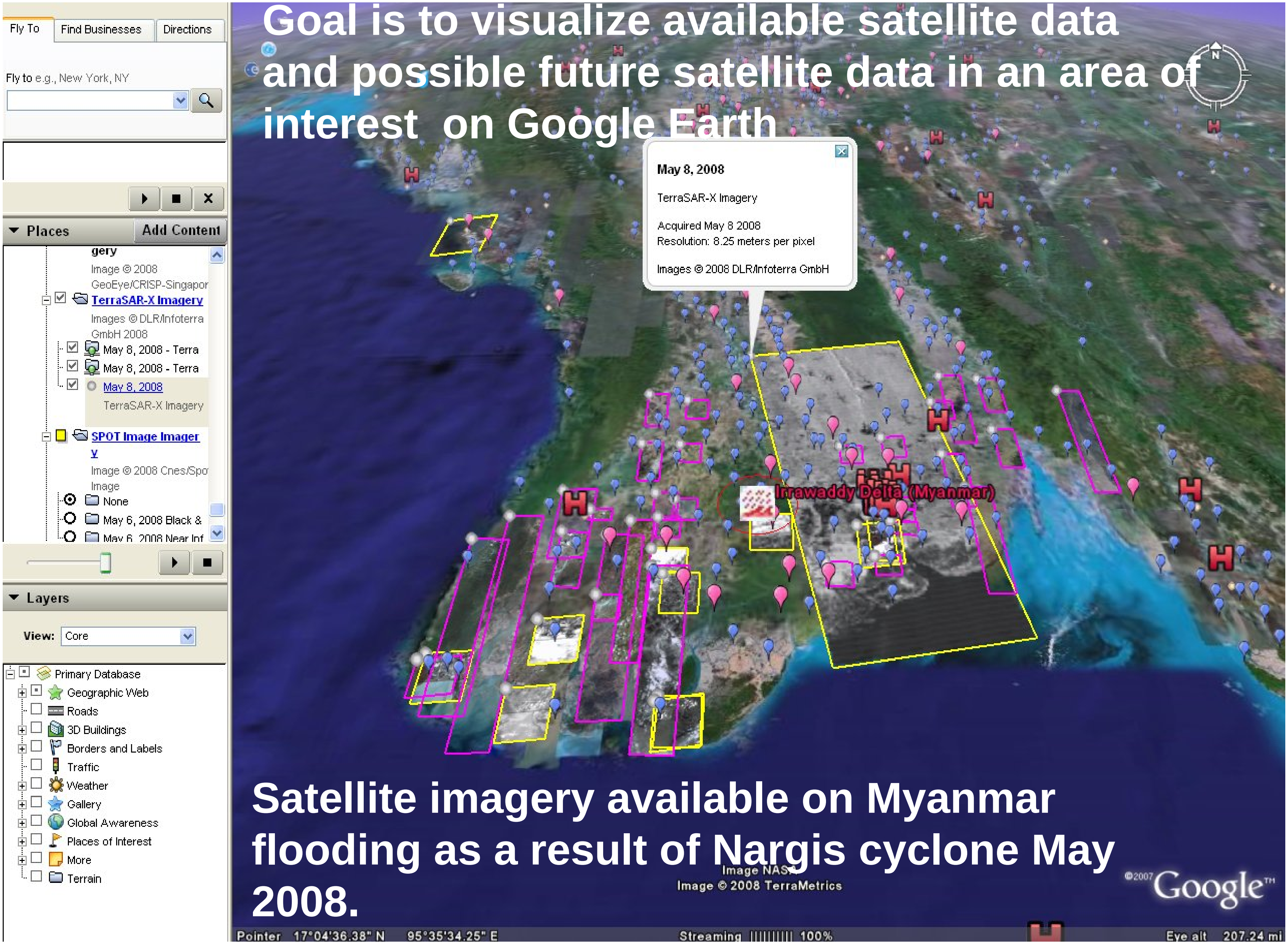
3. *EO-1 Advanced Land Imager automatically triggered and pointed to get more water depth details in area of interest.*

2. *MODIS used to validate flood locations with direct observation*

Red - deep
Yellow - medium 1
Green - medium 2
Blue - shallow
Black - no water

Year 2 Accomplishments & Activities

Goal is to visualize available satellite data and possible future satellite data in an area of interest on Google Earth

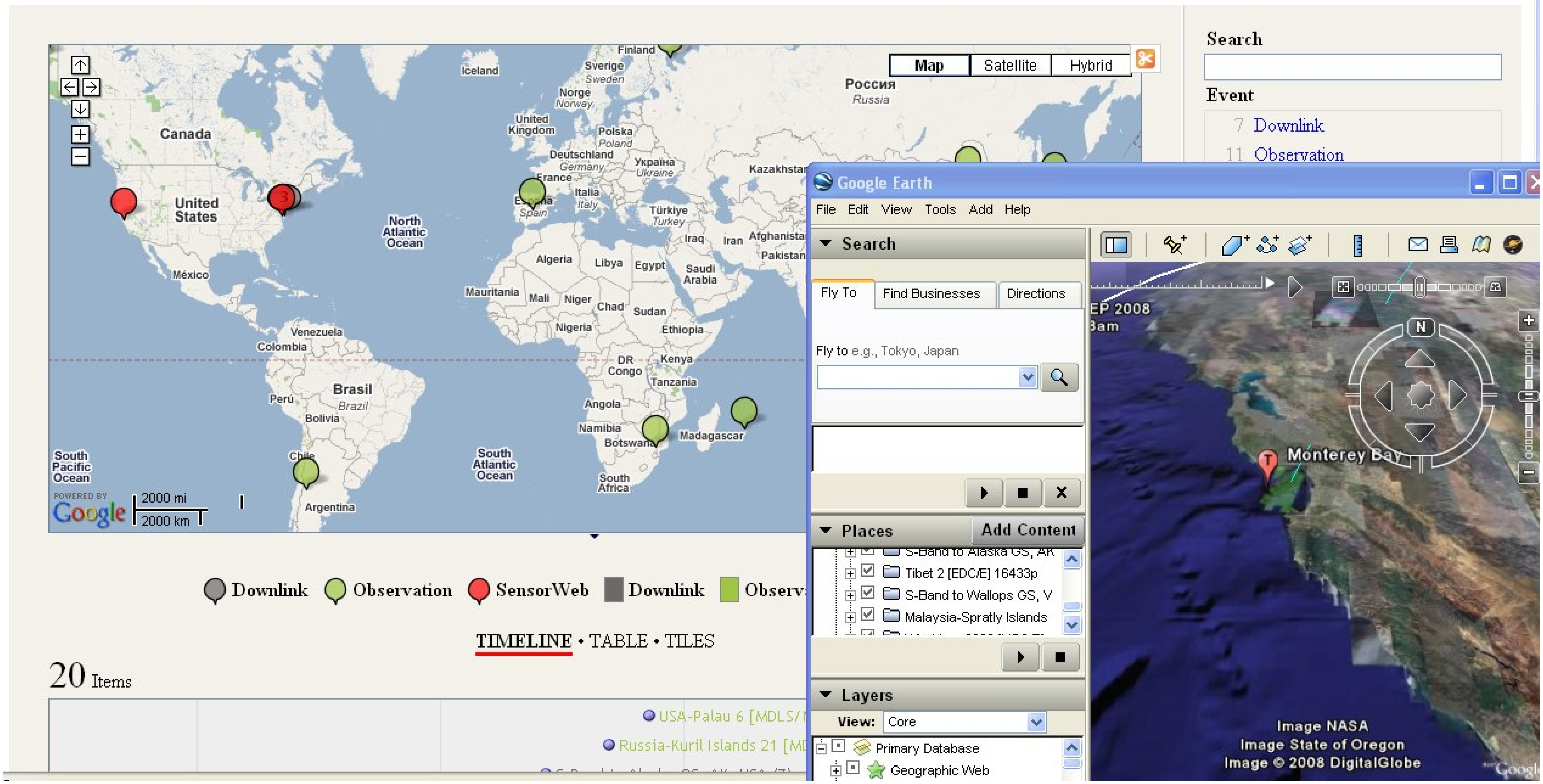


Satellite imagery available on Myanmar flooding as a result of Nargis cyclone May 2008.

Earth Observing 1 (EO-1) Campaign Manager

Current EO-1 Schedule

KML file available here



NorthCal Fires	Northern California Fires	fire	patrice	Yosemite Telegraph Fire, Basin Complex, Whiskeytown Complex, ...	06/29/2008 02:13 PM	06/29/2008 09:18 PM	0.4	Edit Delete Show
NSP	Nationa Signature Program	intel	patrice	TA-03, TA-02, TA-01	03/03/2008 10:25 AM	05/16/2008 12:42 PM	0.2	Edit Delete Show
Oceans Innovation	Oceans Innovation Workshop Demo	algae	patrice	Monterey Bay	09/10/2008 06:18 PM	09/16/2008 06:38 PM	1.0	Edit Delete Show
Salt Marshes	To determine salinity contents of flooded areas	flooding	patrice	Lancaster, VA	07/26/2008 02:36 PM	07/26/2008 02:36 PM	-	Edit Delete Show
SoCal Fires	Southern California Fires	fire	patrice	-	09/06/2007 12:00 AM	06/28/2008 09:23 PM	0.0	Edit Delete Show
UAV	NASA Ames Ihkana flight scenario	fire	veri_pat	Flood	09/06/2007 12:00 AM	06/04/2008 02:00 PM	0.0	Edit Delete Show
UAV 2	NASA Ames Ihkana Flight Scenario	fire	scott	UAV 2 Test	09/17/2008 12:40 AM	09/17/2008 12:40 AM	-	Edit Delete Show
UAV 3	-	fire	UNKNOWN	California	09/18/2008 03:53 PM	09/18/2008 03:53 PM	-	Edit Delete Show

Scenario/Campaign Tasking Requests for UAV 3

Search Create New

Title	Content	Geolocation	Scenario Feasibilities

Tasking Request:

Title:	California
Description:	
Category:	
Latitude:	41.3
Longitude:	-123.8
Country Code:	US
Country Name:	United States
Zone Number:	36
Zone Name:	Northern California
Region Number:	3
Region Name:	Oregon, California and Nevada
Admin Code:	CA
Admin Name:	California
Nearby:	Notchko, Surgone, Shregegon (historical), Mettah, Pekwan (historical), Pecwan, Johnsons, Waseck, Wright Place, Martins Ferry (historical)
Created At:	Fri, 19 Sep 2008 02:32:22 -0000
Updated At:	2008-09-19
	Show Map
Feasibilities	

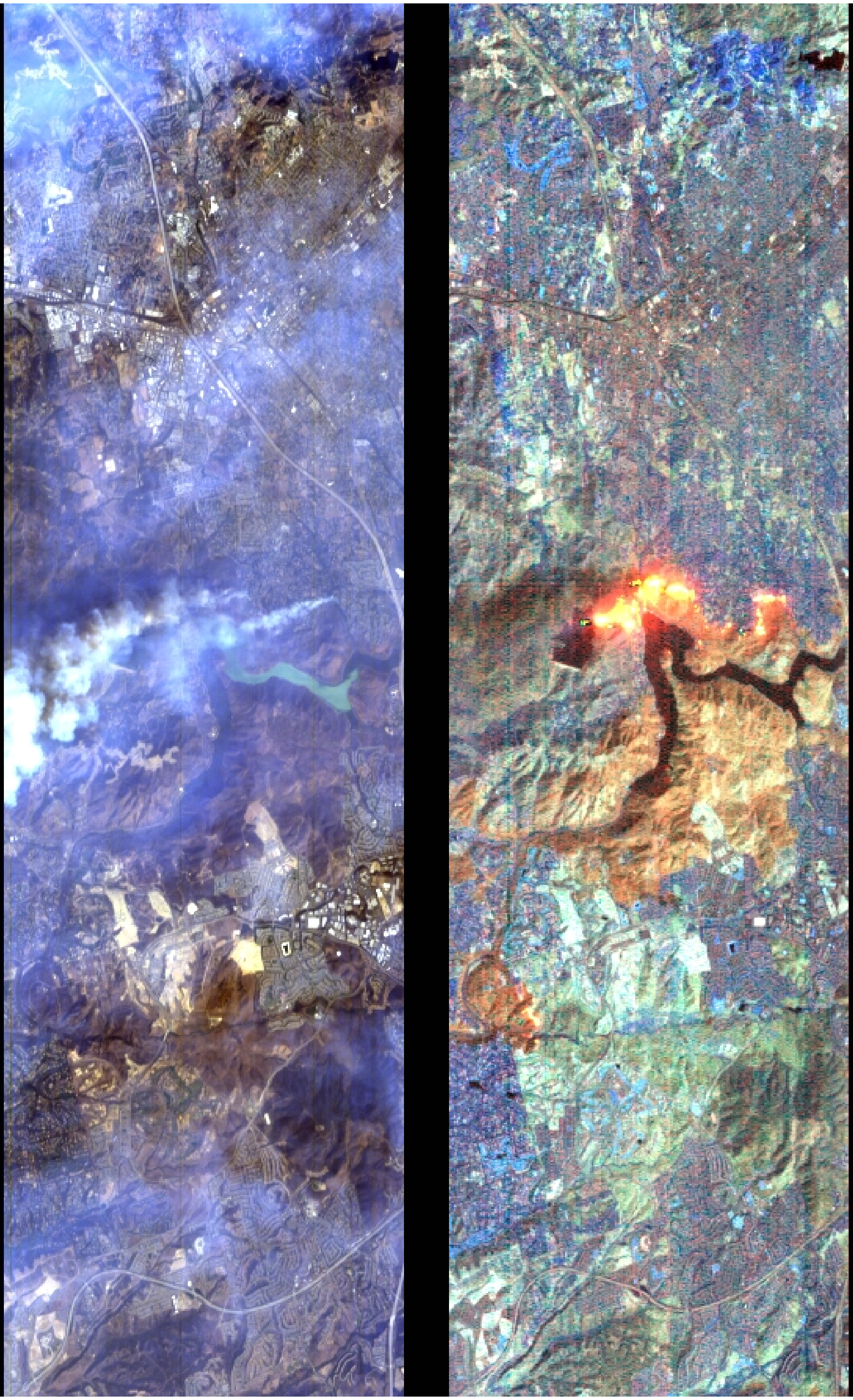
1 Found

USAFRICOM	USAFRICOM Testing	flooding	cappelaere	Zimbabwe	06/19/2008 02:58 PM	06/19/2008 02:58 PM	-	Edit Delete Show

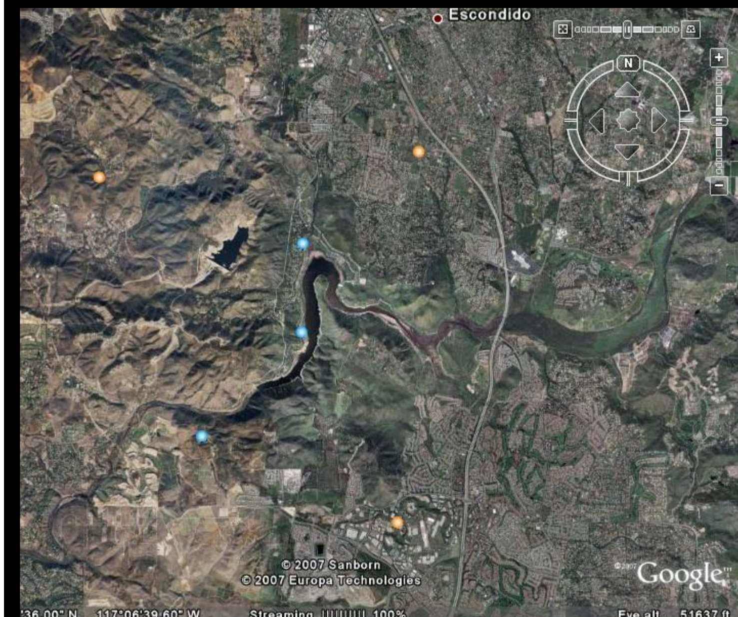
EO-1 Hyperion Views Witch Wildfire on October 23, 2007

The images to the right were obtained from the Hyperion imaging spectrometer on-board NASA's EO-1 satellite. This instrument samples the Earth's surface radiation in 220 contiguous wavelength intervals from 400 to 2500 nanometers, spanning the spectrum from visible light to shortwave infrared (SWIR).

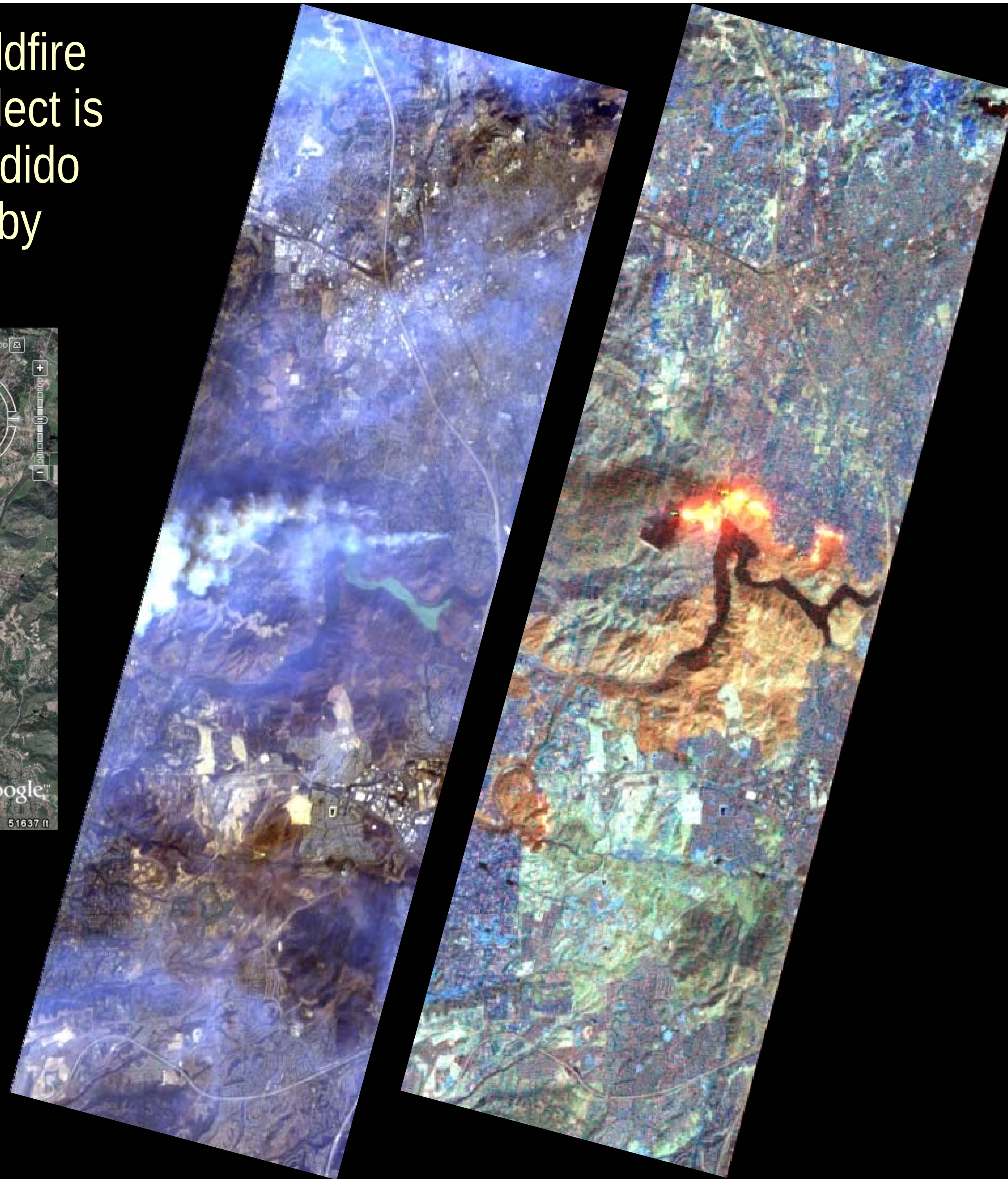
The leftmost visualization, a composite of red, blue and green radiation, displays the scene as the human eye would perceive it. To the right is a composite of three SWIR bands which are sensitive to emissive properties associated with fires and lava flows.



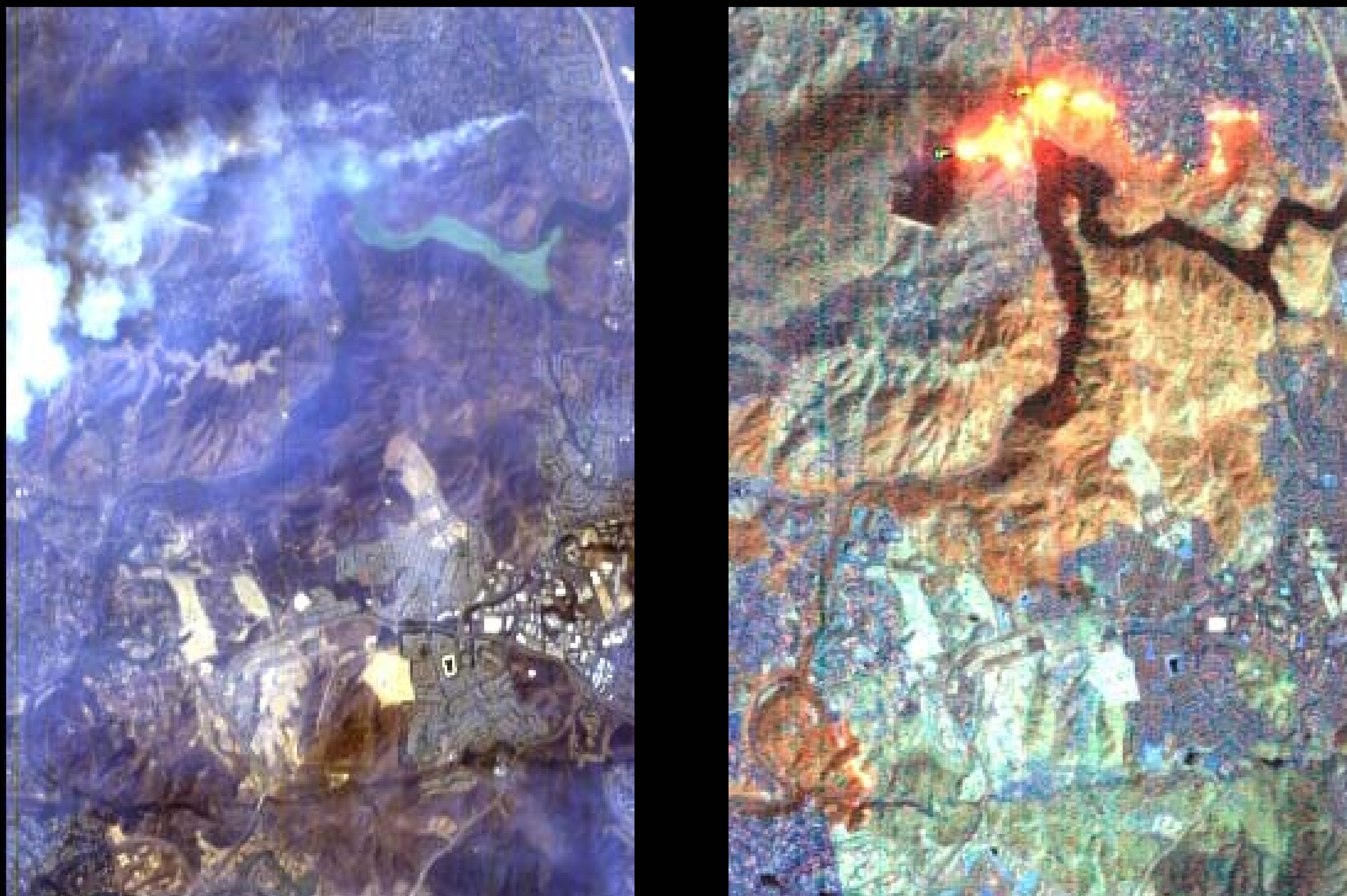
The portion of the Witch wildfire viewed in this Hyperion collect is located just south of Escondido California as shown below by Google Earth.



The Google Earth representation of this area is derived from previously acquired imagery.

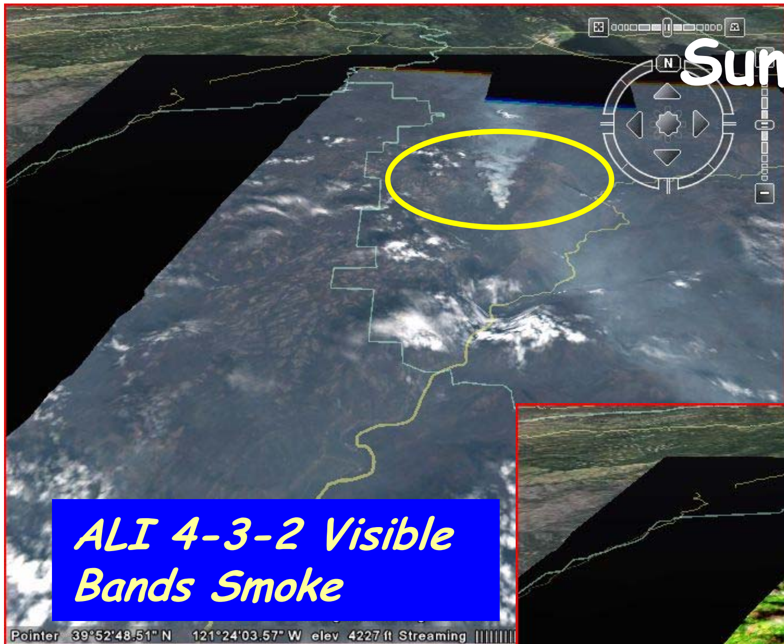


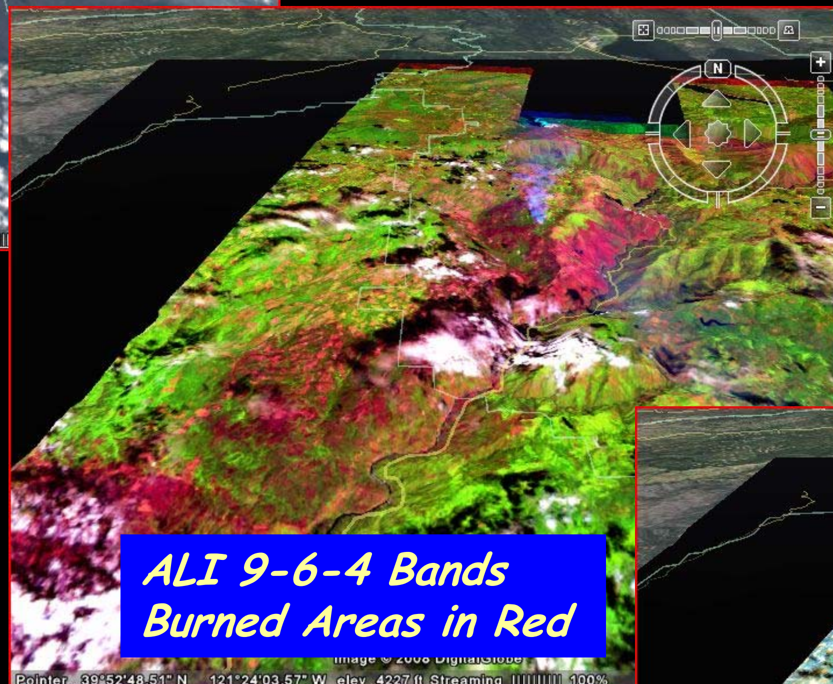
EO-1 Hyperion Views Witch Wildfire on October 23, 2007

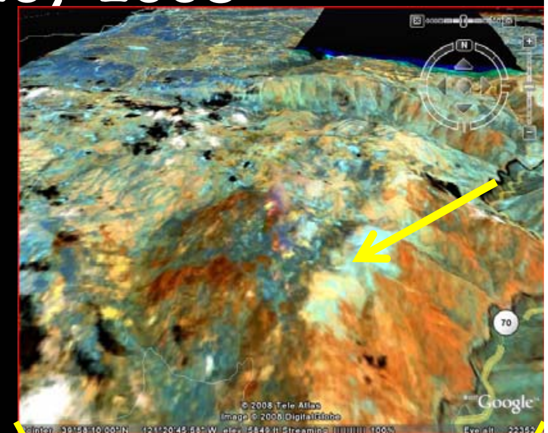


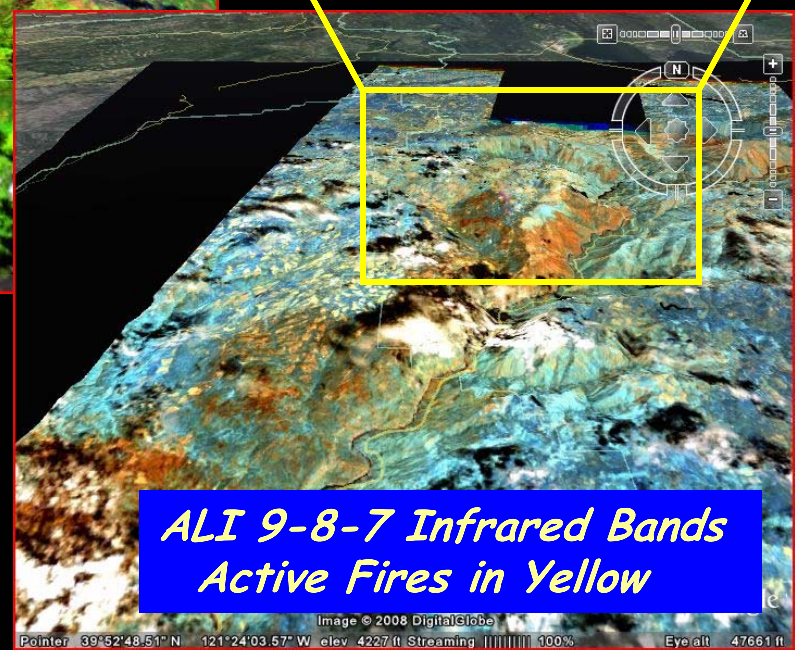
Summer 2008 Fire Sensor Web Demo

Zoom In of Earth Observing 1 Image of Northern California Fires and Smoke, July 20, 2008 11:28 am Pacific



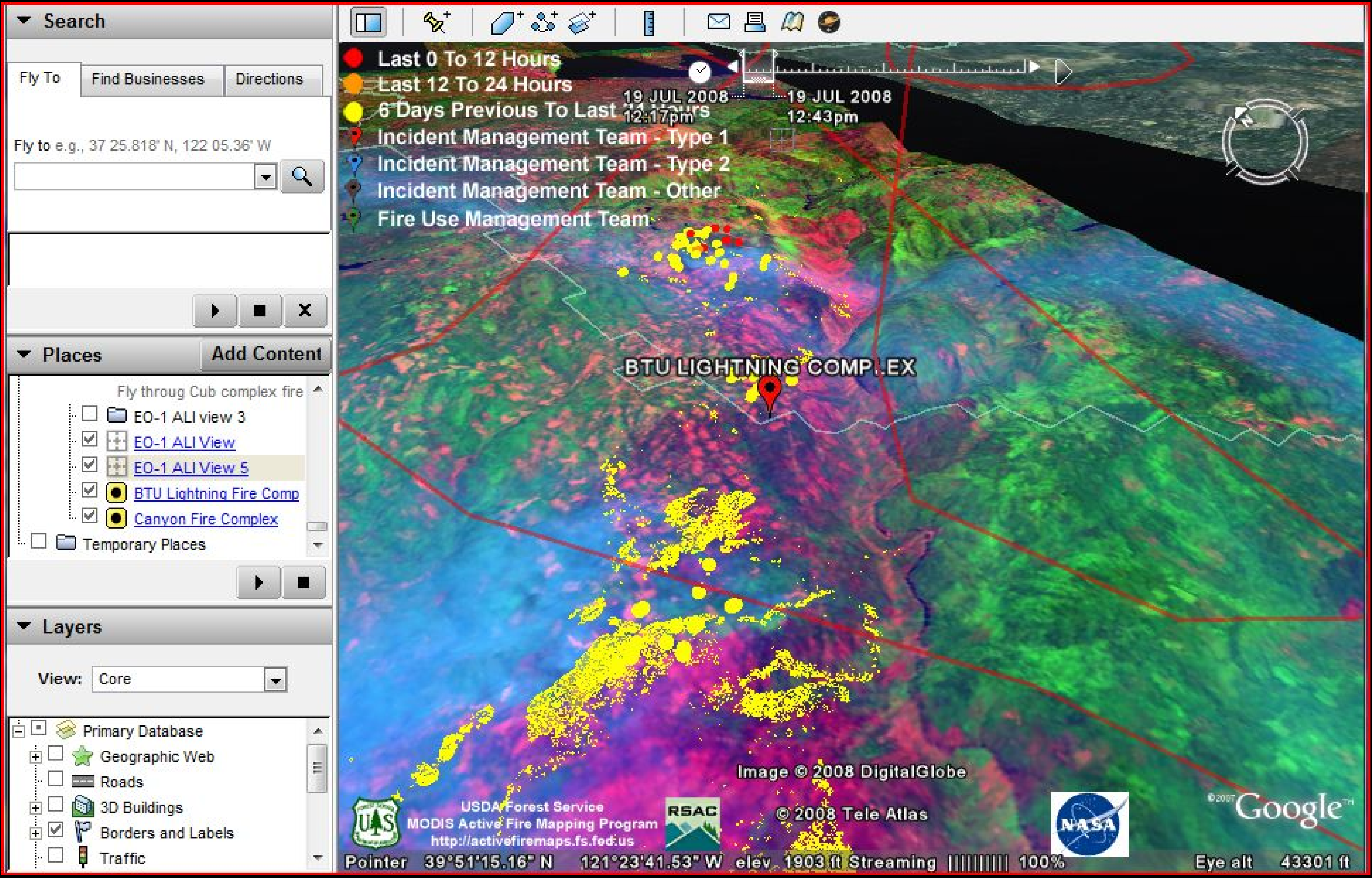




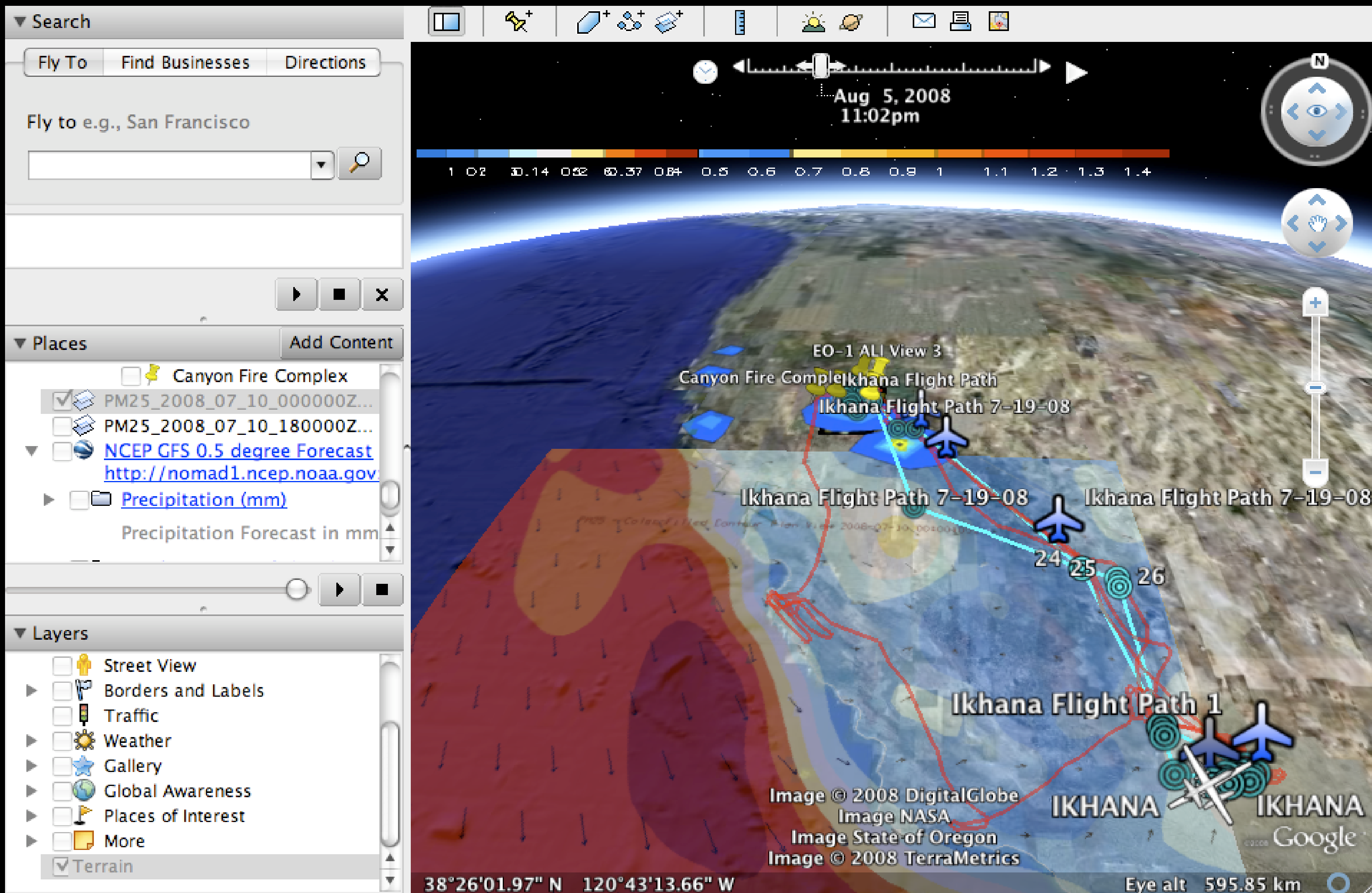


- Smoke can be seen in the visible bands (4-3-2)
- Burned area is depicted in red using bands (9-6-4)
- Active fires appear yellow in bands (9-8-7)
- Use of higher numbered bands penetrate smoke

AMS hot pixels, MODIS hot pixels and EO-1 ALI Burn Scars

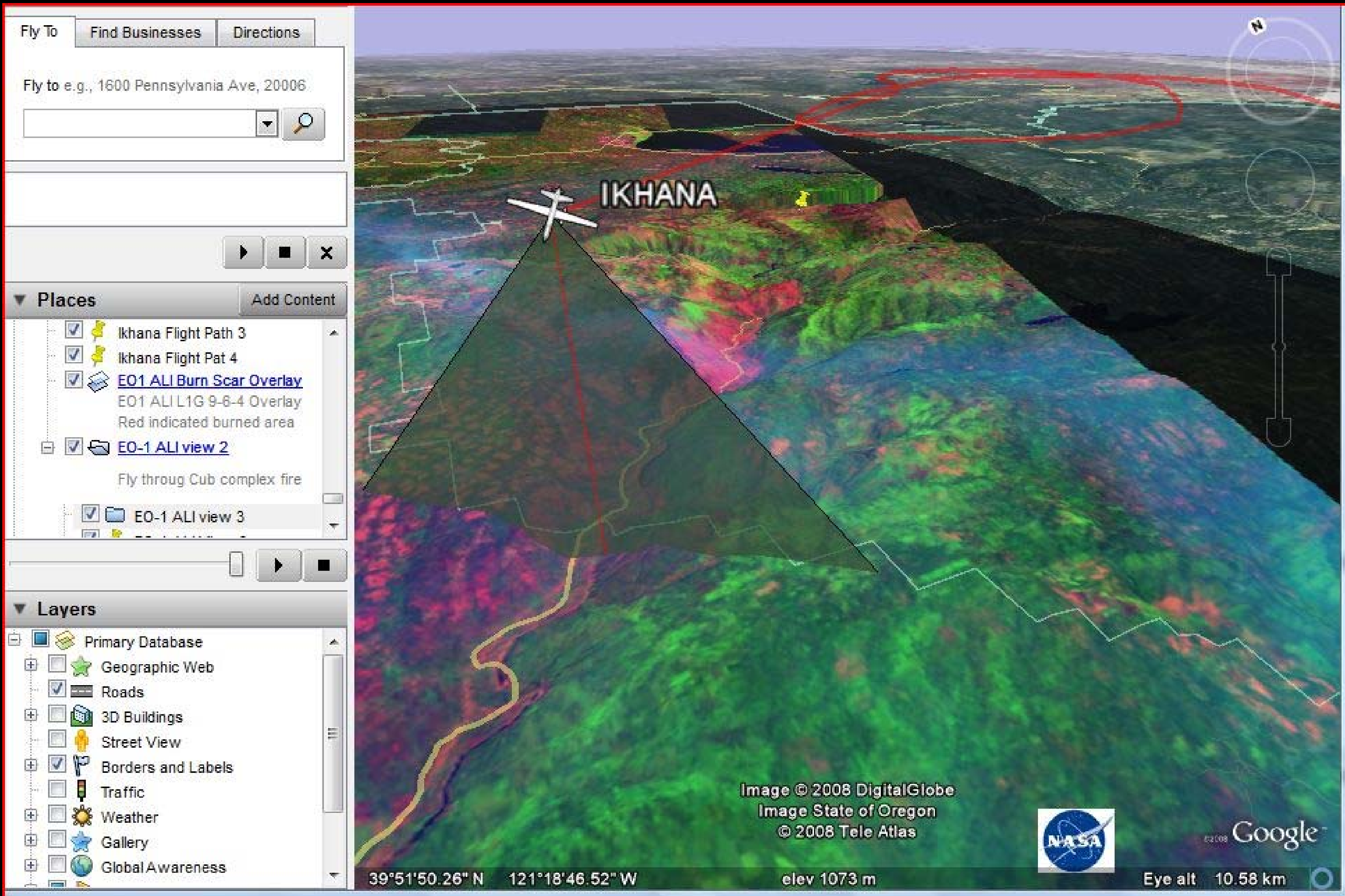


Summer 2008 Fire Sensor Web Demo
With Smoke Forecast (Falke) and Wind Forecast (NOAA)



Year 2 Accomplishments & Activities

Monitoring Ikhana Overflight on July 19, 2008 in Realtime

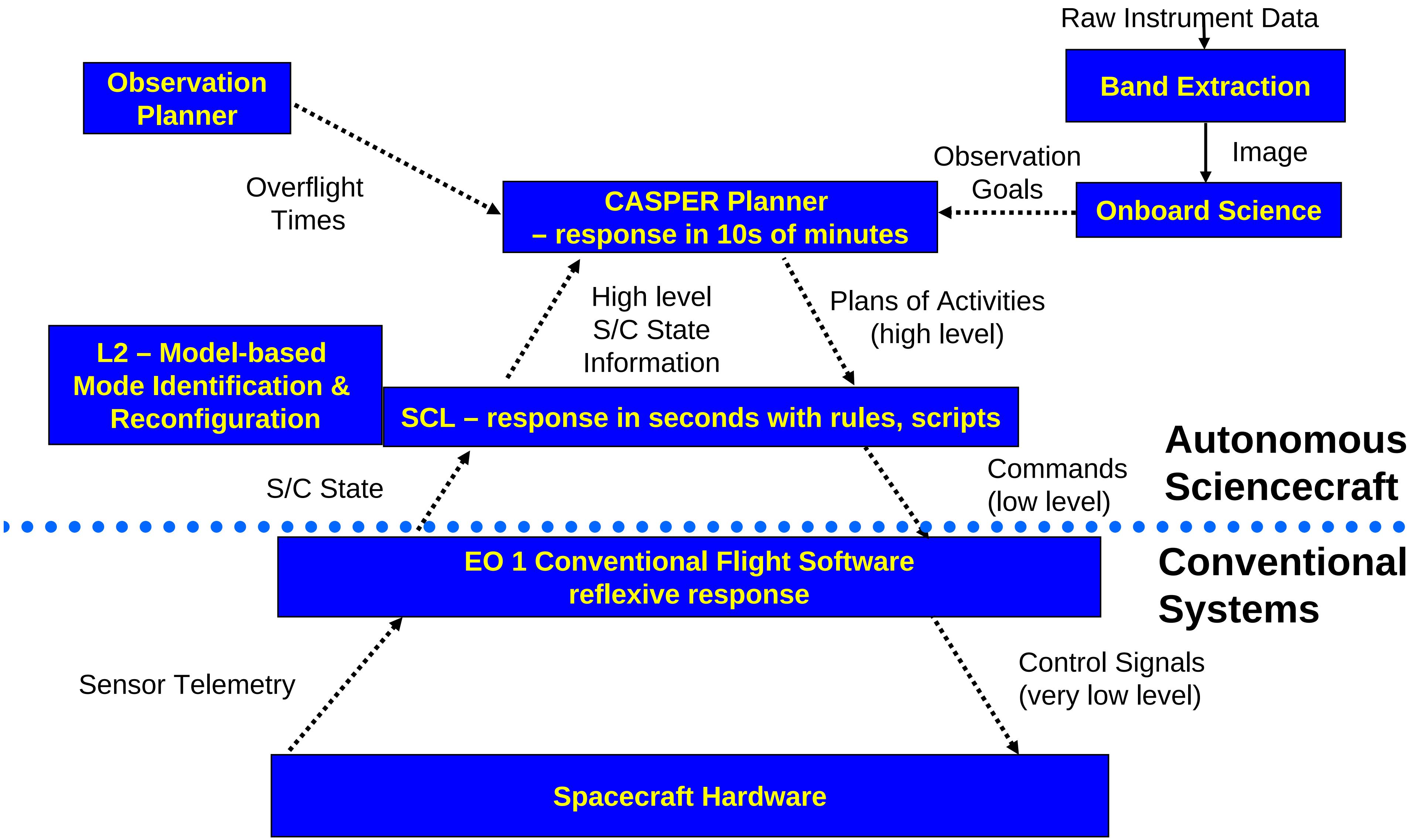


Applicability to HyspIRI

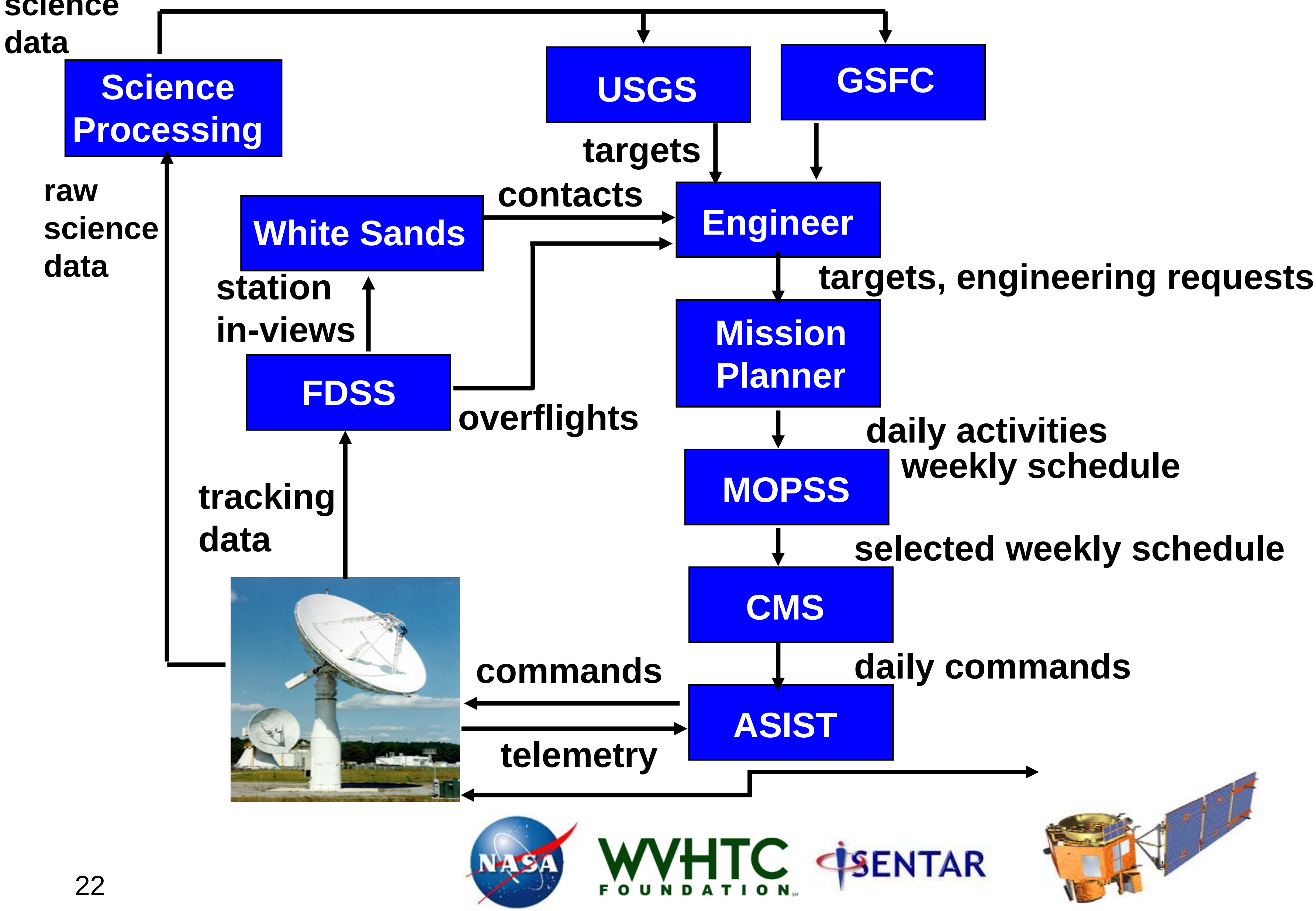
- Although HyspIRI will be operated in survey mode, onboard software can trigger other assets when user specified features (such as hot pixels) are detected.
- User defined algorithms can be loaded onto HyspIRI to monitor observations in real-time and produce data subsets
- Onboard algorithms can calculate available downlink capacity to optimize direct broadcast.

Onboard processing

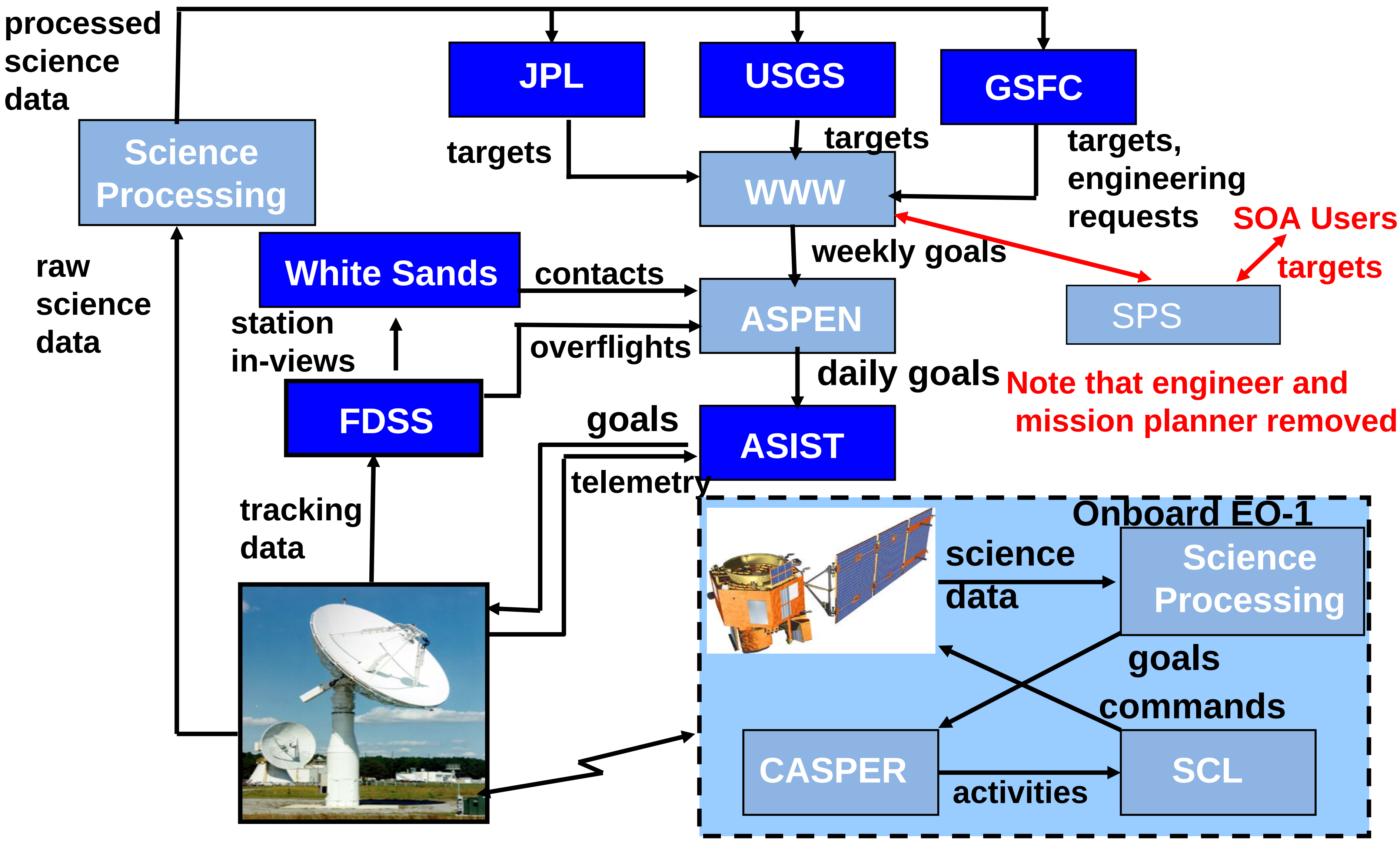
ASE Flight Software Architecture



Original Operations Flow to Task Sensors & Access Science



Revised Operations Flow To Task Sensors and Access Science Data Using Onboard Autonomy



Applicability to HyspIRI

- Saving $1 million per year in ops costs
- Flexibility for new operations concepts post-launch

Ground Communications

High Speed X-Band Downlink

- GeoEye downlinks 740 Mbps
  - KSAT operates ground station at Svalbard
  - GeoEye uses following ground stations
    - Point Barrow Alaska
    - Denver, CO
    - Dulles Airport
    - Svalbard
  - Two downlinks on X-band, transmitted as RHCP and LHCP respectively
  - uses 2 receivers, one for each of the streams, at 370 Mbps each.
  - Modulation is OQPSK
  - Reed-Solomon is applied for error correction
- Kongsberg Spacetec (KPST) recommendations
  - Be CCSDS compliant.
  - Be compliant to the recommendations outlined by the CMLP study from JPL

High Speed X-Band Downlink

- KSPT intends to support the Coding, Modulation, and Link Protocol (CMLP) Study recommendations with HRDFEP.
  - Les Deutsch Jet Propulsion Laboratory and Frank Stocklin Goddard Space Flight Center January 10, 2008
  - HRDFEP is receiver, data capture and processing, and can do Level 0 or higher order processing - like optical instruments or SAR (Synthetic Aperture Radar). It also supports data storage and distribution. And it can operate either automatically or scheduled. A data driven receiver is an option being considered.

High Speed Ka-Band Downlink

14th Ka and Broadband Communications Conference

Matera, Italy

Toward an Operational Ultra High Rate Ka-Band Data Service In NASA's Tracking and Data Relay Satellite System

Keiji Tasaki
NASA/Goddard Space Flight Center
Greenbelt, MD USA
Don Morales
Honeywell Tech. Services, Inc., USA

September 25, 2008

Ka Band- Facts, Figures and Plans

- **~11,500 hours/mo. of support at 99.95% proficiency (~14,000 hrs with STS)**
- **Supported Missions: AIM, Aqua, ATV, Aura, CNOFS, GLAST, GP-B, HST, ISS, L-5, L-7, SPTR, STS, Swift, TERRA, THEMIS, TRMM, XTE**
- **Swap TDRS-3 with TDRS-7 by early 2009 to ensure service continuity in the Indian Ocean Region.**
- **Complete the replacement of the ground terminal receivers by 2012.**
- **Make TDRS-K and TDRS-L operational as necessary in the 2012-2013 timeframe.**
- **Add ultra high-rate data relay capability of over 1giga bits per second (1Gbps) at Ka-Band between customer platform and TDRS by 2012.**

Ka Band Implementation Schedule

2008	2009	2010	2011	2012

MA IR Replacement

High Data Rate Receiver Replacement

(Including the Ultra High Data Rate)

Ground Terminal S/W Changes & H/W Additions

Support S/W Changes

K/L Change Integration

Laser Communications

- Working group
  - Contact H. Shaw/GSFC
- Pursuing prototype for NASA
- More info TBS

Direct Broadcast

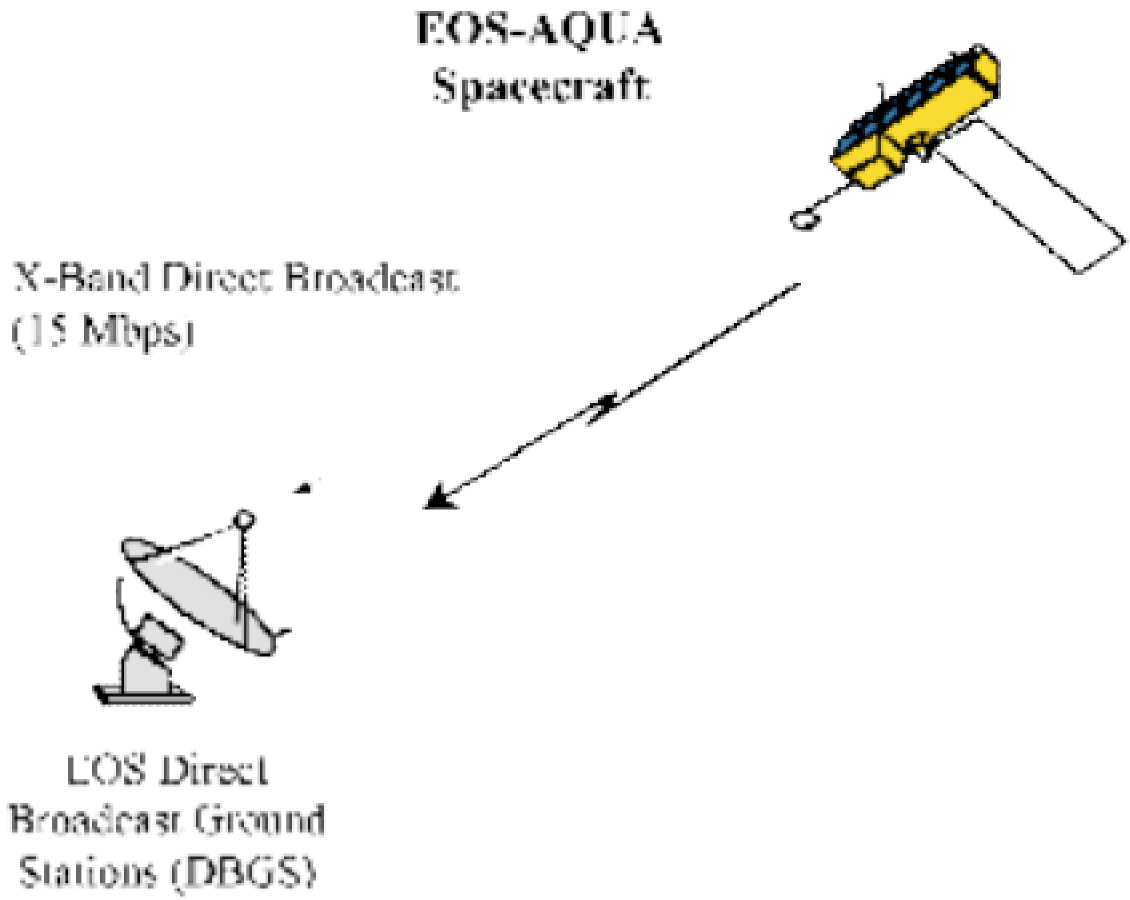


Figure 1.2-1 X-band Direct Broadcast Downlink

Possible Scenario with DB

- Loadable algorithms define subset of data to downlink thru DB
- Onboard SW calculated DB data downlink capacity
- Portions of subset data downlinked through multiple DB ground stations
- Data reassembled on ground similar to peer-to-peer music network such as Nabster
- Tools to manipulate, edit and load onboard algorithms and related workflows potentially developed under ESTO proposal
  - Next generation flight SW
  - Potentially lowers cost of flight SW maintenance
  - Provides post-launch mission flexibility
  - Provides Internet type of access to HyspIRI data via web services and tools