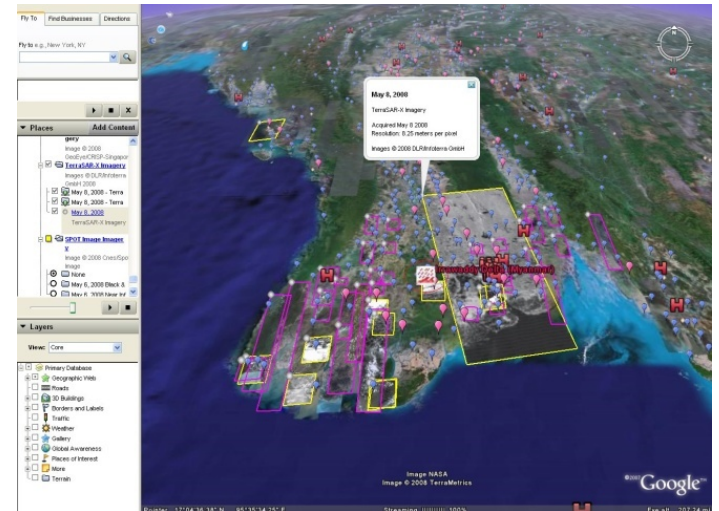


Technology & Ground Communication for HypsIRI

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

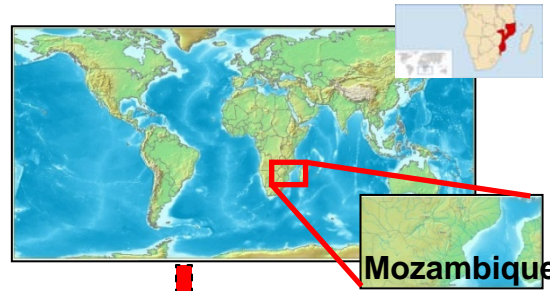
- Goal is to lower cost and increase speed and flexibility to create customized science data products
 - Automated workflows
 - Facilitate Internet experience
- Collaborations
 - DoD
 - Global Earth Observing System of System (GEOSS) Architecture Implementation Pilot (AIP)
 - Committee on Earth Observing 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

From portal select desired theme collated with area of interest



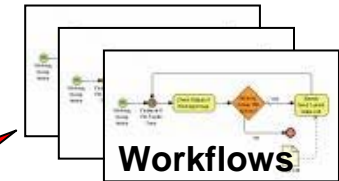
Disaster Management Information System (DMIS)

- Air Quality
- Coral Bleaching
- Droughts
- Earthquakes
- Excessive Heat
- Fire Weather
- Flooding**
- Harmful Algal Blooms (HABs)
- Hurricanes/Tropical Weather
- Oil Spills
- Rip Currents
- Severe Weather
- Space Weather
- Tsunamis
- Volcanoes

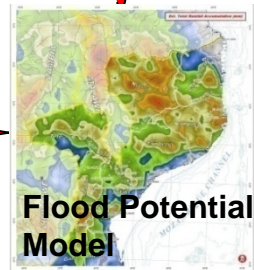


Mozambique

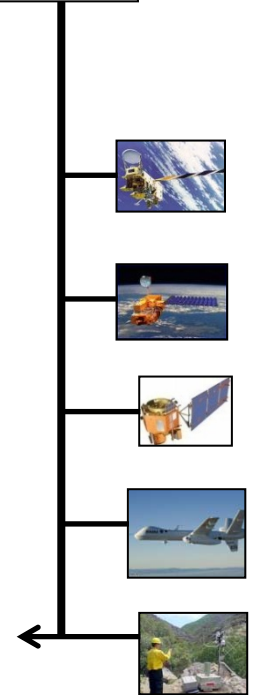
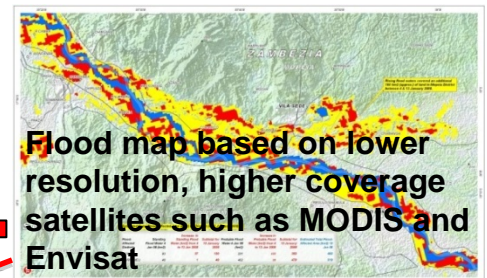
Selected workflow automatically activates needed assets and models



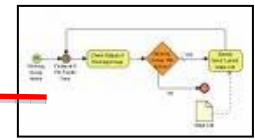
Workflows



Workflow for desired result automatically triggered

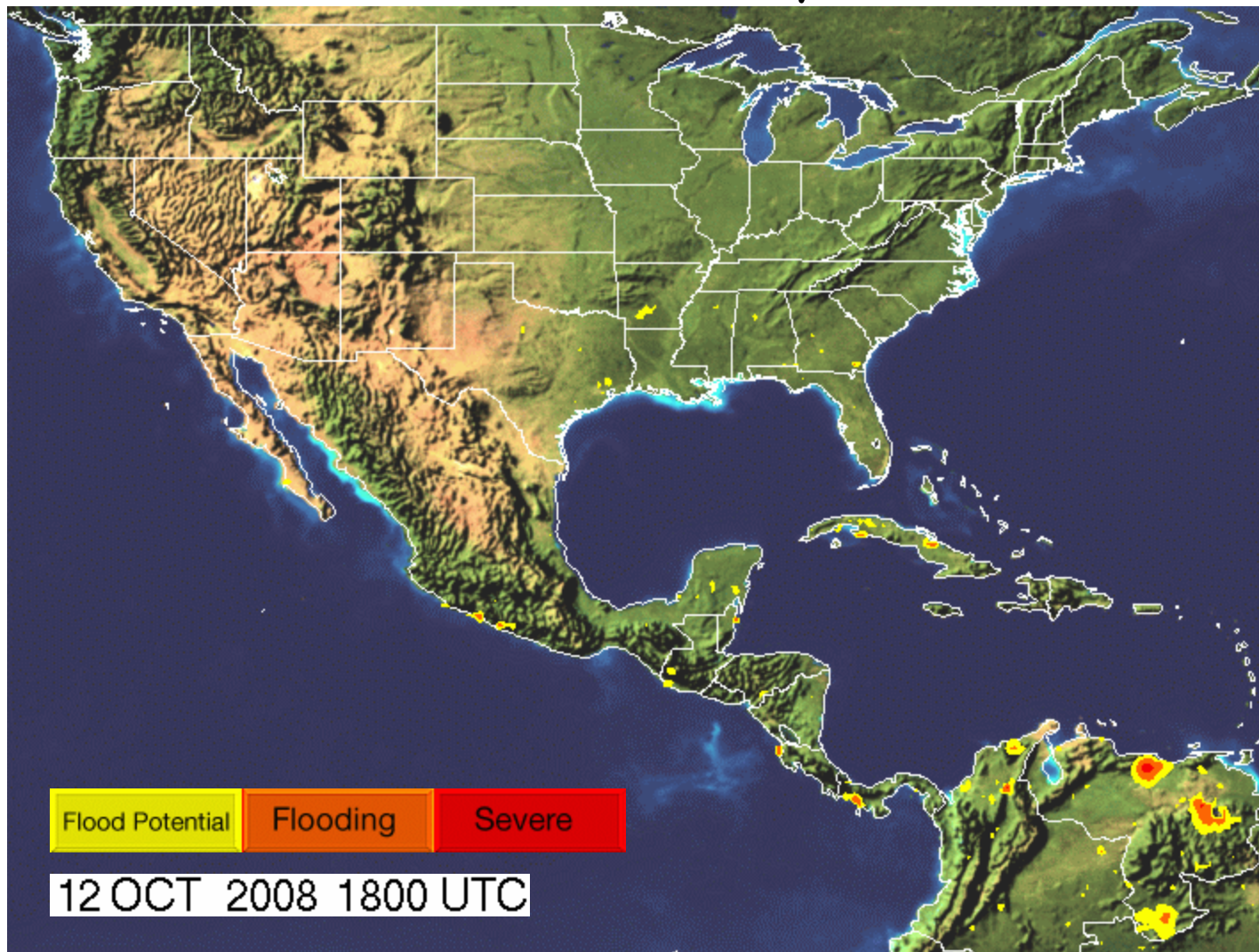


Automatically trigger higher resolution assets (such as Terra SAR) for look at details



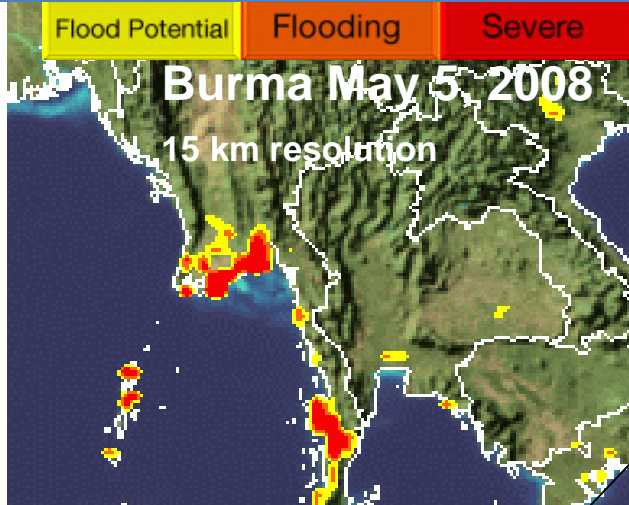
Sample Flood SensorWeb Scenario

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

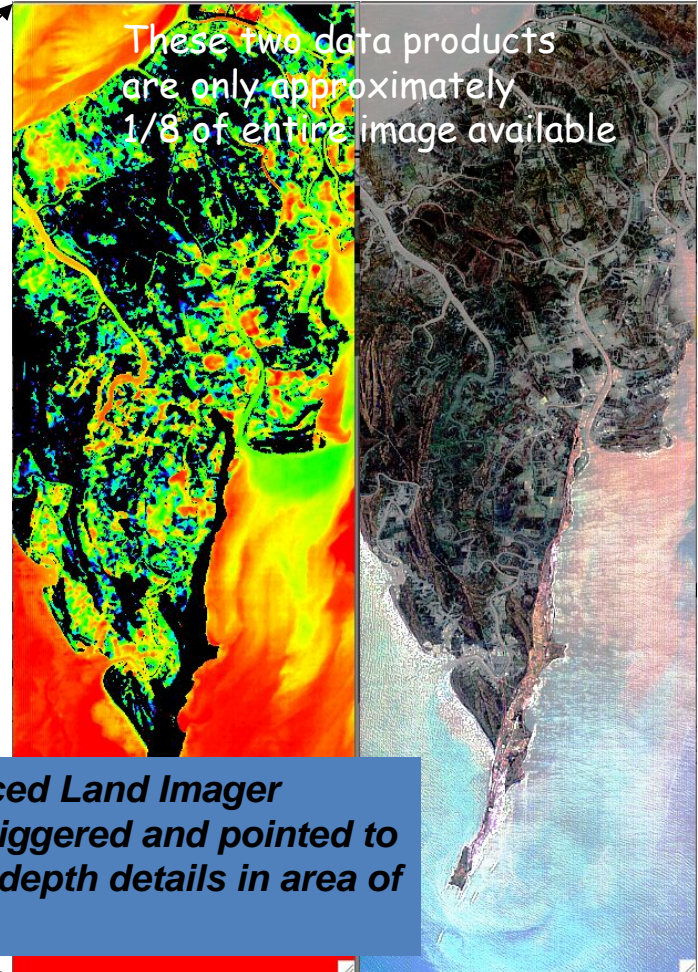


Myanmar Flood Sensor Web Exercise

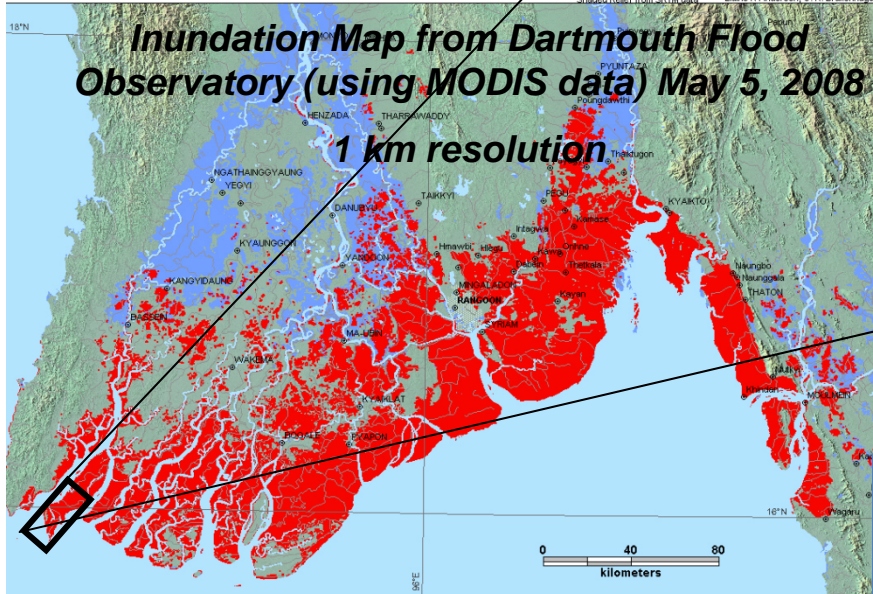
1. Real-time flood estimate using global hydrological model and satellite rainfall estimate - Adler



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



DFO Event # 2008-052 - Glide#: TC-2008-000057-MMR - Burma - Cyclone Nargis - Irrawaddy Delta - Rapid Response Inundation Map, 2008
 MODIS flood inundation limits May 5, 2008: Maximum Observed Inundation Limit 1999 - 2006: SRTM SWBD reference water: DCWR Rivers: Urban Areas: Shaded Relief from SRTM data
 Universal Transverse Mercator UTM Zone 47 North - WGS 84 Orbital: 1 degree
 Dartmouth Flood Observatory Dartmouth College Hanover, NH 03755 USA
 Elaine K. Anderson, G. R. Brakenridge



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

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

2. MODIS used to validate flood locations with direct observation

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

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

May 8, 2008
TerraSAR-X Imagery
Acquired May 8 2008
Resolution: 8.25 meters per pixel
Images © 2008 DLR/Infoterra GmbH

Inrawaddy Delta (Myanmar)

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

Fly To Find Businesses Directions

Fly to e.g., New York, NY

Places Add Content

- gery
- Image © 2008 GeoEye/CRISP-Singapor
- TerraSAR-X Imagery
- Images © DLR/Infoterra GmbH 2008
- May 8, 2008 - Terra
- May 8, 2008 - Terra
- May 8, 2008
- TerraSAR-X Imagery
- SPOT Image Imager
- Image © 2008 Cnes/Sp
- Image
- None
- May 6, 2008 Black &
- May 6, 2008 Near Inf

Layers

View: Core

- Primary Database
- Geographic Web
- Roads
- 3D Buildings
- Borders and Labels
- Traffic
- Weather
- Gallery
- Global Awareness
- Places of Interest
- More
- Terrain

Earth Observing 1 (EO-1) Campaign Manager



Current EO-1 Schedule

[KML file available here](#)

The screenshot displays the EO-1 Campaign Manager interface. On the left, a world map shows various locations marked with colored pins: red for SensorWeb, green for Observation, and grey for Downlink. A legend below the map identifies these symbols. The main area features a Google Earth window with a search bar and a 'Fly to' field. The 'Places' panel on the right lists several locations, including 'USA-Palau 6 [MDLS/]', 'Russia-Kuril Islands 21 [MDLS/]', 'S-Band to Alaska GS, AK', 'Tibet 2 [EDC/E] 16433p', 'S-Band to Wallops GS, V', and 'Malaysia-Spratly Islands'. The 'Layers' panel shows 'View: Core' and 'Geographic Web'. The bottom of the interface indicates '20 Items' and provides navigation options: 'TIMELINE • TABLE • TILES'. The Google Earth window shows a 3D view of the Earth with a red pin on Monterey Bay, California.

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



Feasibilities

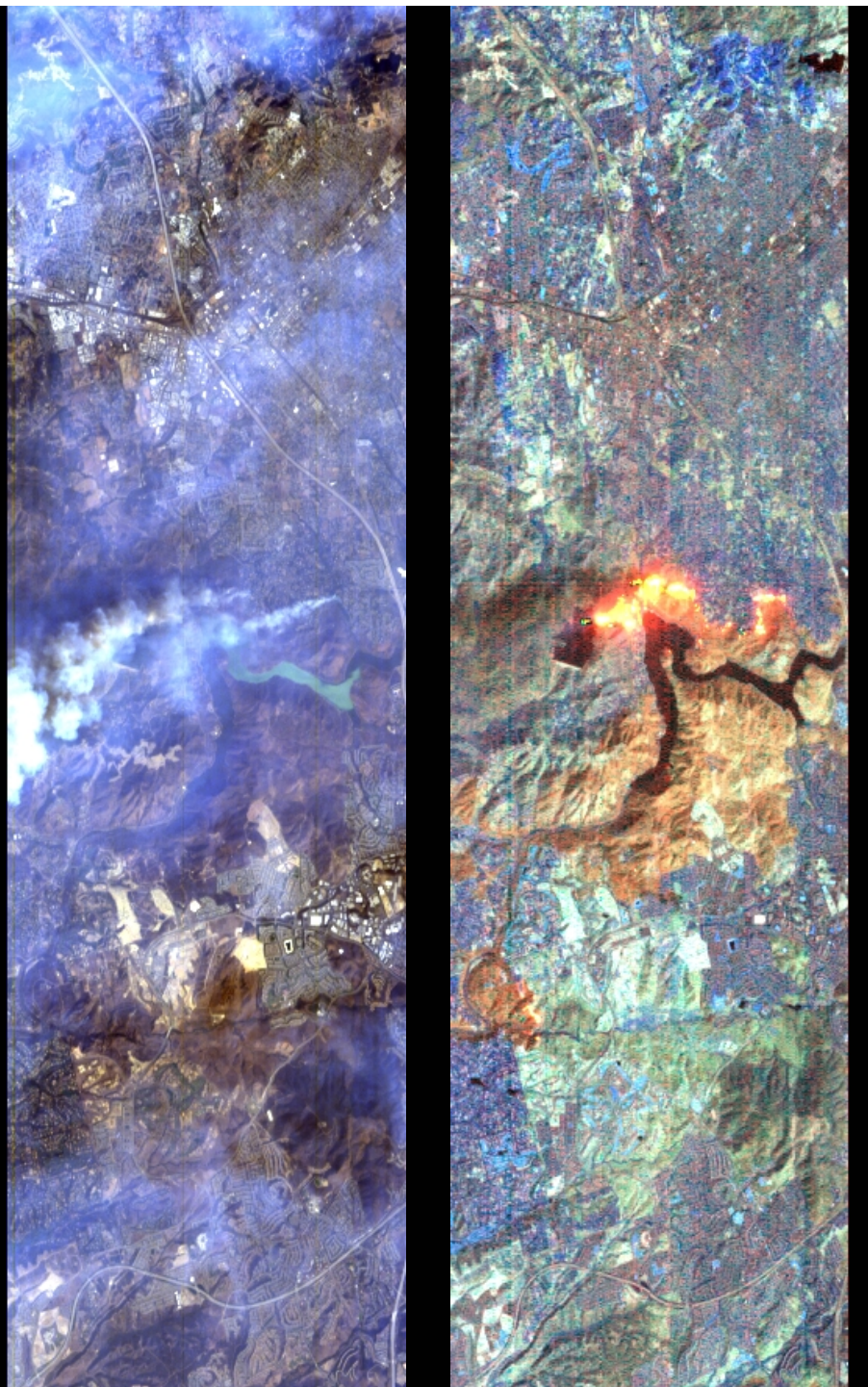
1 Found

USAFRICOM	USAFRICOM Testing	flooding	cappelaere	Zimbabwe	06/19/2008 02:58 PM	06/19/2008 02:58 PM	-	Edit Delete Show
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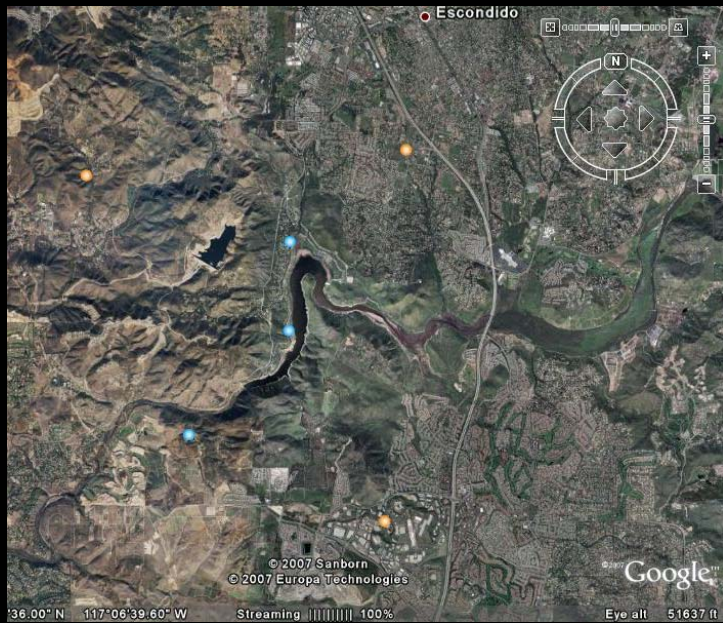
EO-1 Hyperion Views Witch Wildfire on October 23, 2007

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).

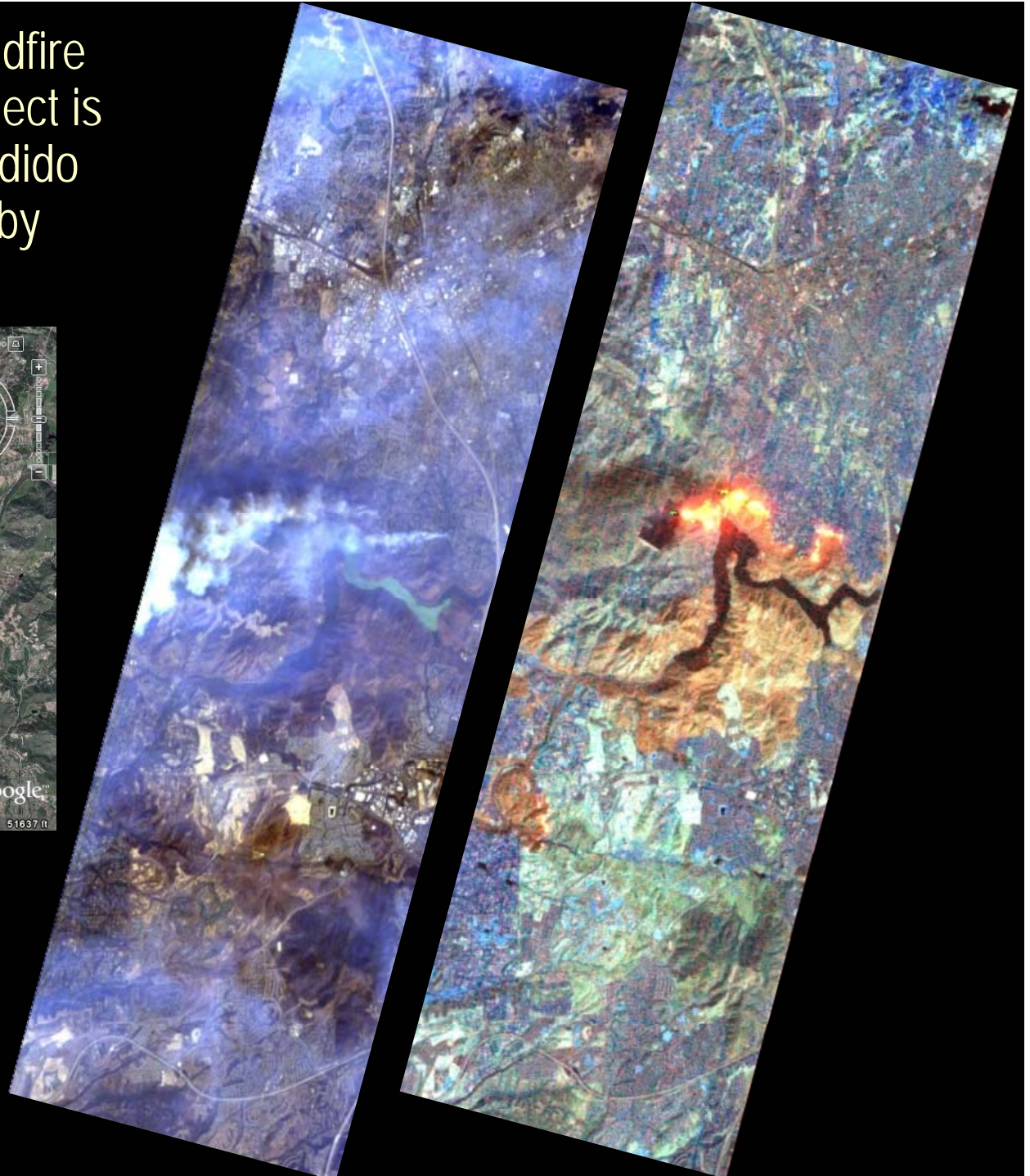
The leftmost visualization, a composite of red, blue and green radiation, displays the scene as the human eye would perceive it. To the right is a composite of three SWIR bands which are sensitive to emissive properties associated with fires and lava flows.



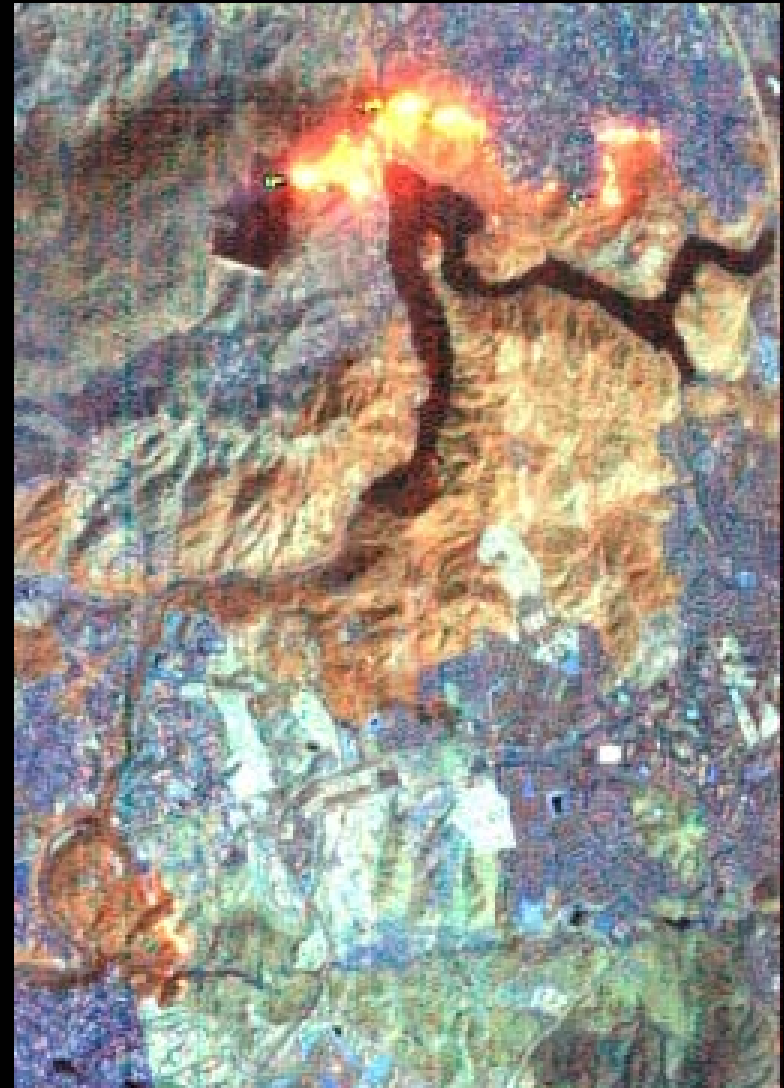
The portion of the Witch wildfire viewed in this Hyperion collect is located just south of Escondido California as shown below by Google Earth.



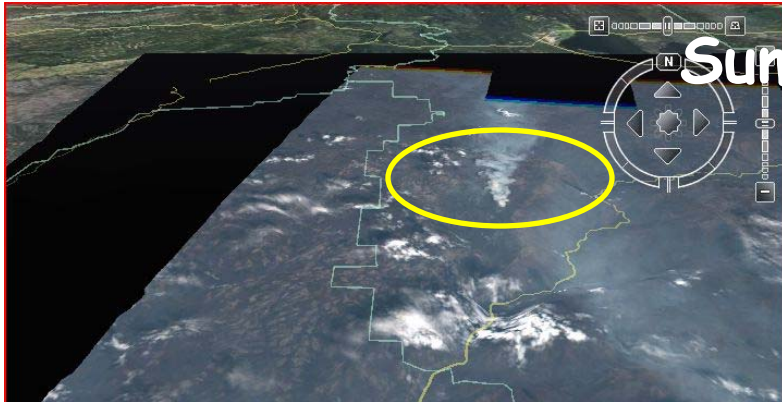
The Google Earth representation of this area is derived from previously acquired imagery.



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

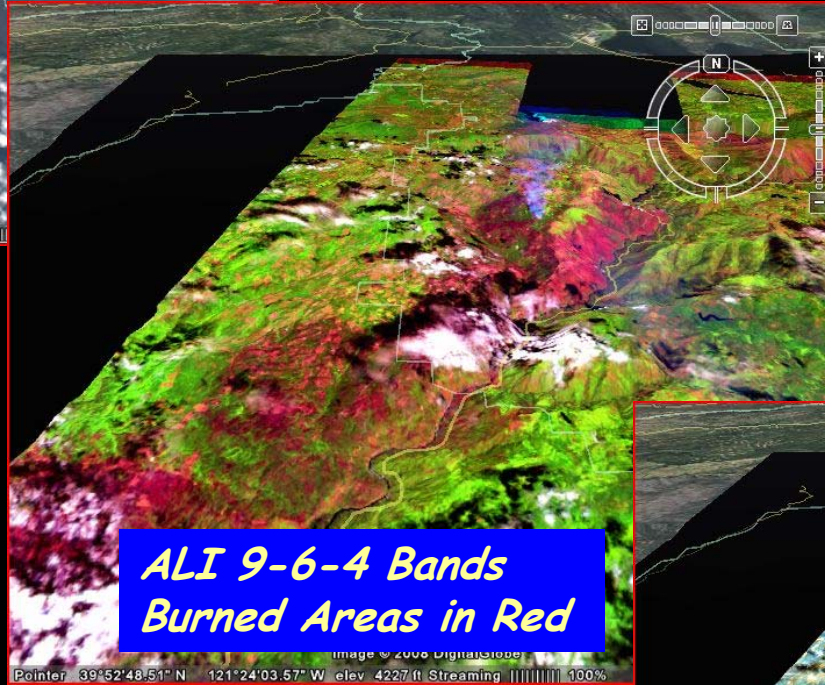


Summer 2008 Fire Sensor Web Demo Zoom In of Earth Observing 1 Image of Northern California Fires and Smoke, July 20, 2008 11:28 am Pacific



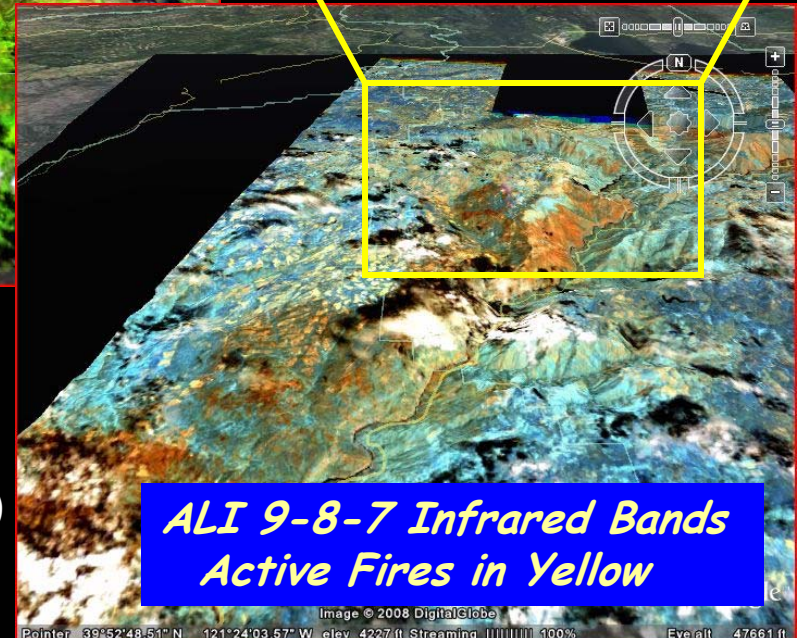
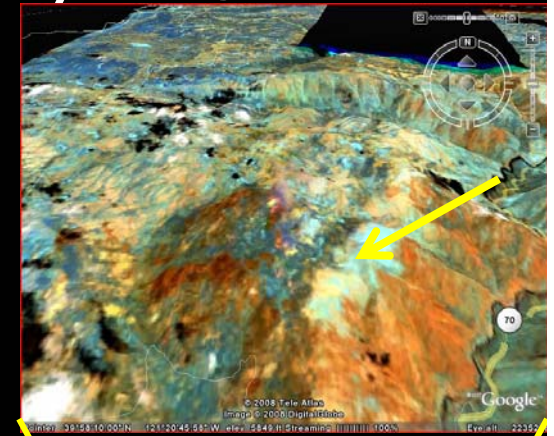
ALI 4-3-2 Visible Bands Smoke

Pointer 39°52'48.51" N 121°24'03.57" W elev 4227 ft Streaming |||||



ALI 9-6-4 Bands Burned Areas in Red

Pointer 39°52'48.51" N 121°24'03.57" W elev 4227 ft Streaming ||||| 100%

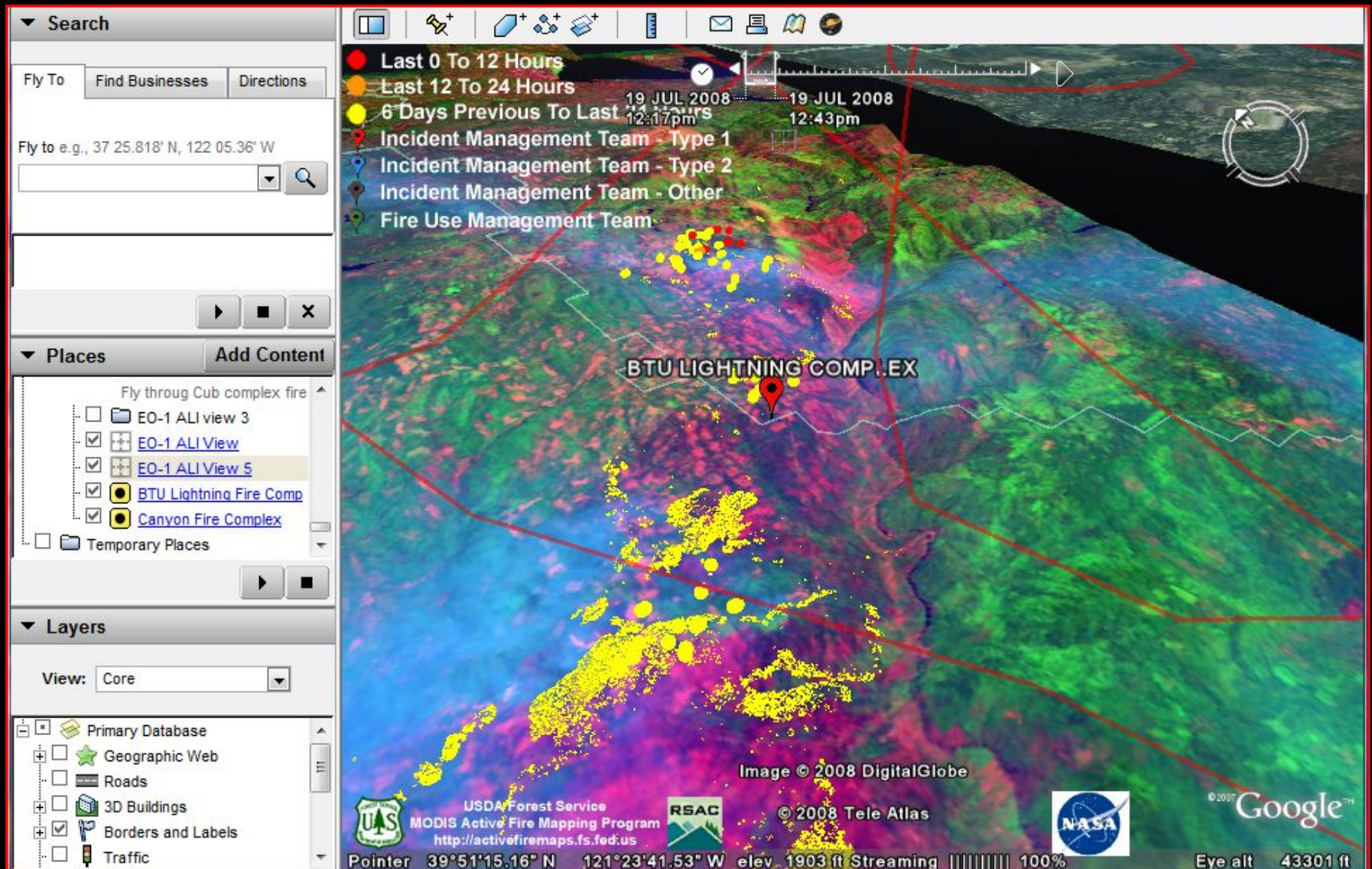


ALI 9-8-7 Infrared Bands Active Fires in Yellow

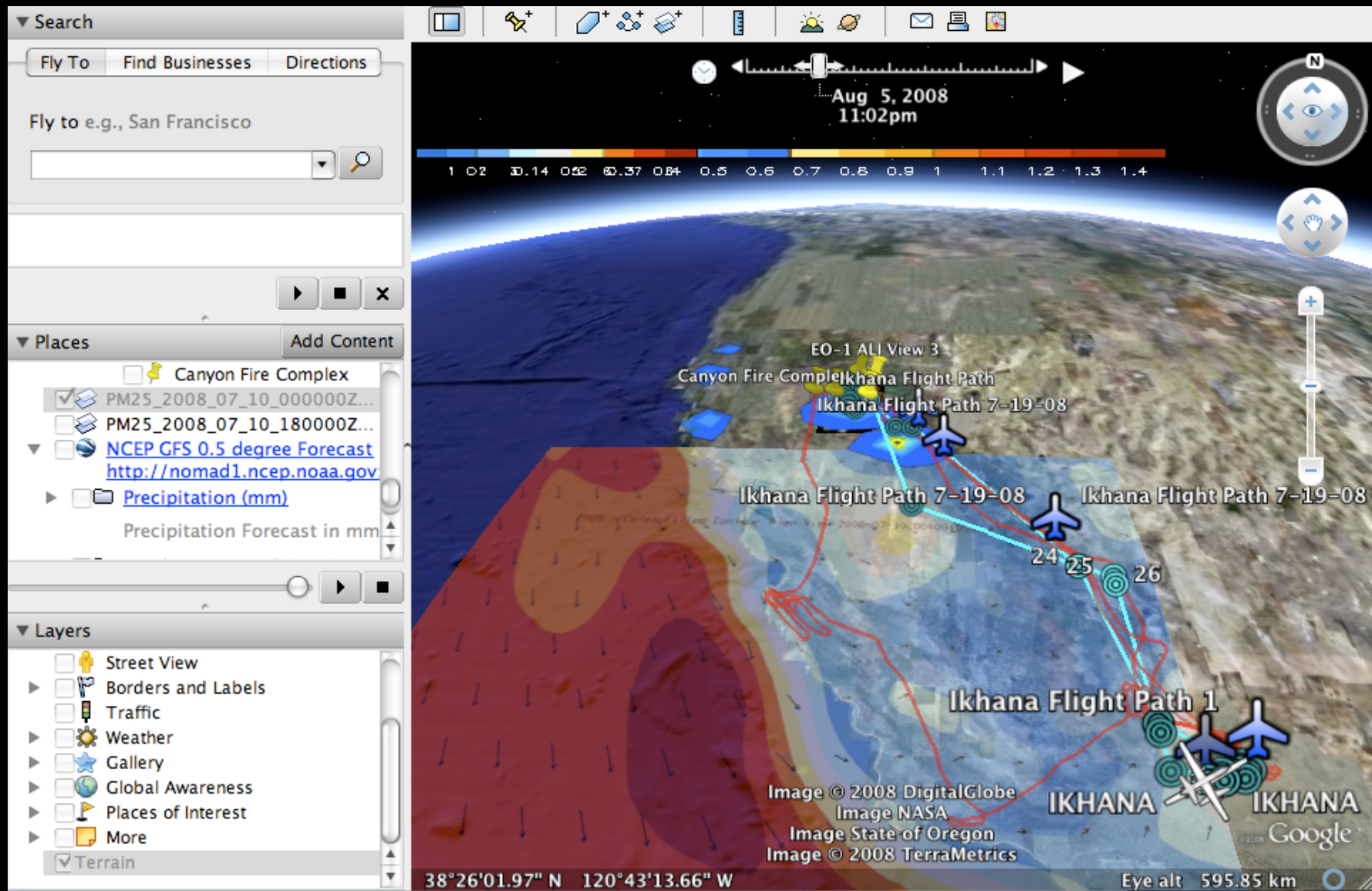
Pointer 39°52'48.51" N 121°24'03.57" W elev 4227 ft Streaming ||||| 100% Eye alt 47661 ft

- 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)



Monitoring Ikhana Overflight on July 19, 2008 in Realtime

Fly To Find Businesses Directions

Fly to e.g., 1600 Pennsylvania Ave, 20006

Places Add Content

- ✓ Ikhana Flight Path 3
- ✓ Ikhana Flight Pat 4
- ✓ [EO1 ALI Burn Scar Overlay](#)
EO1 ALI L1G 9-6-4 Overlay
Red indicated burned area
- ✓ [EO-1 ALI view 2](#)
Fly through Cub complex fire
- EO-1 ALI view 3

Layers

- Primary Database
- Geographic Web
- ✓ Roads
- 3D Buildings
- Street View
- ✓ Borders and Labels
- Traffic
- Weather
- Gallery
- Global Awareness

Image © 2008 DigitalGlobe
Image State of Oregon
© 2008 Tele Atlas

NASA

©2008 Google

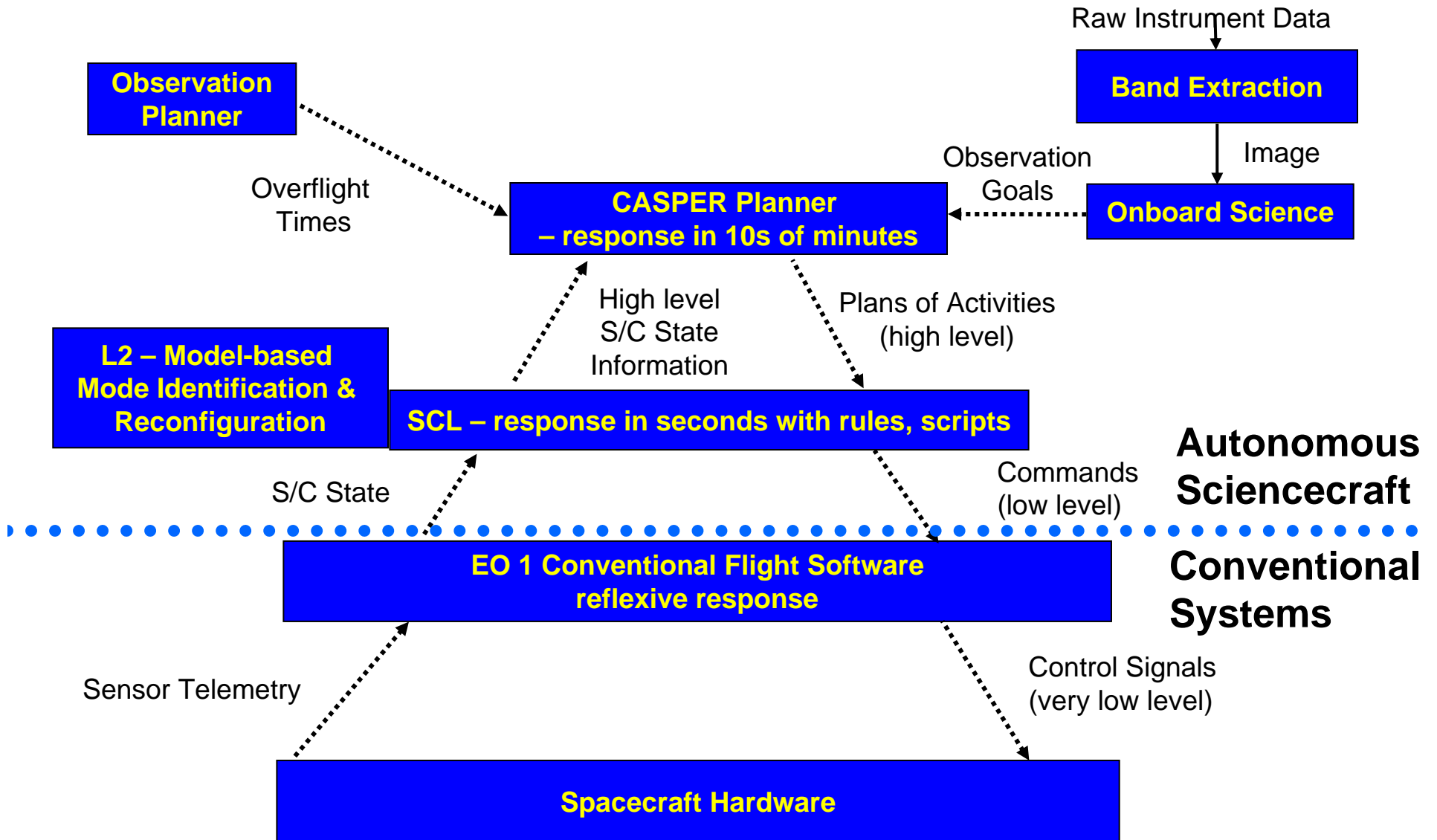
39°51'50.26" N 121°18'46.52" W elev 1073 m Eye alt 10.58 km

Applicability to HypsIRI

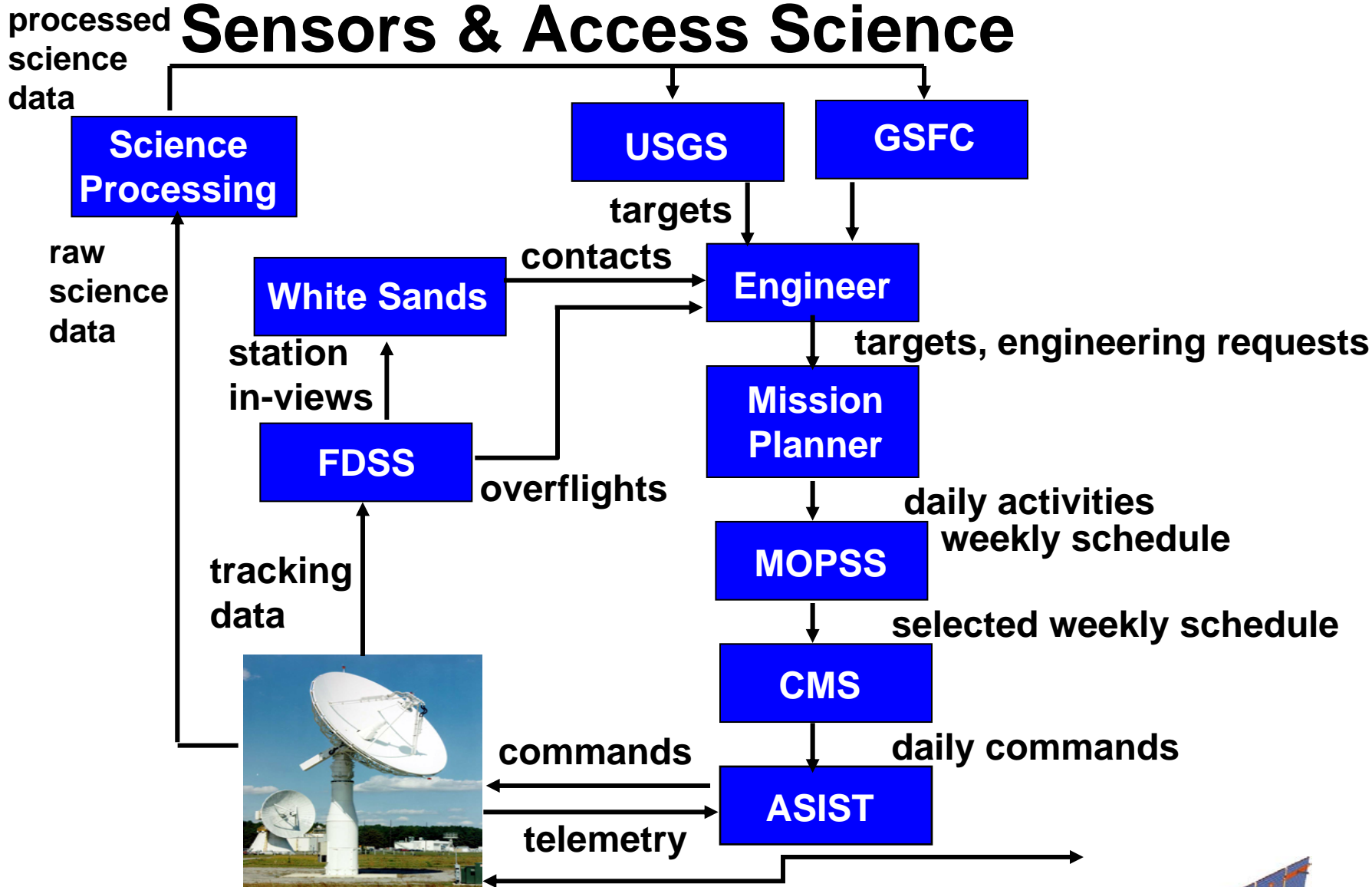
- Although HypsIRI will be operated in survey mode, onboard software can trigger other assets when user specified features (such as hot pixels) are detected.
- User defined algorithms can be loaded onto HypsIRI to monitor observations in real-time and produce data subsets
- Onboard algorithms can calculate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

Onboard processing

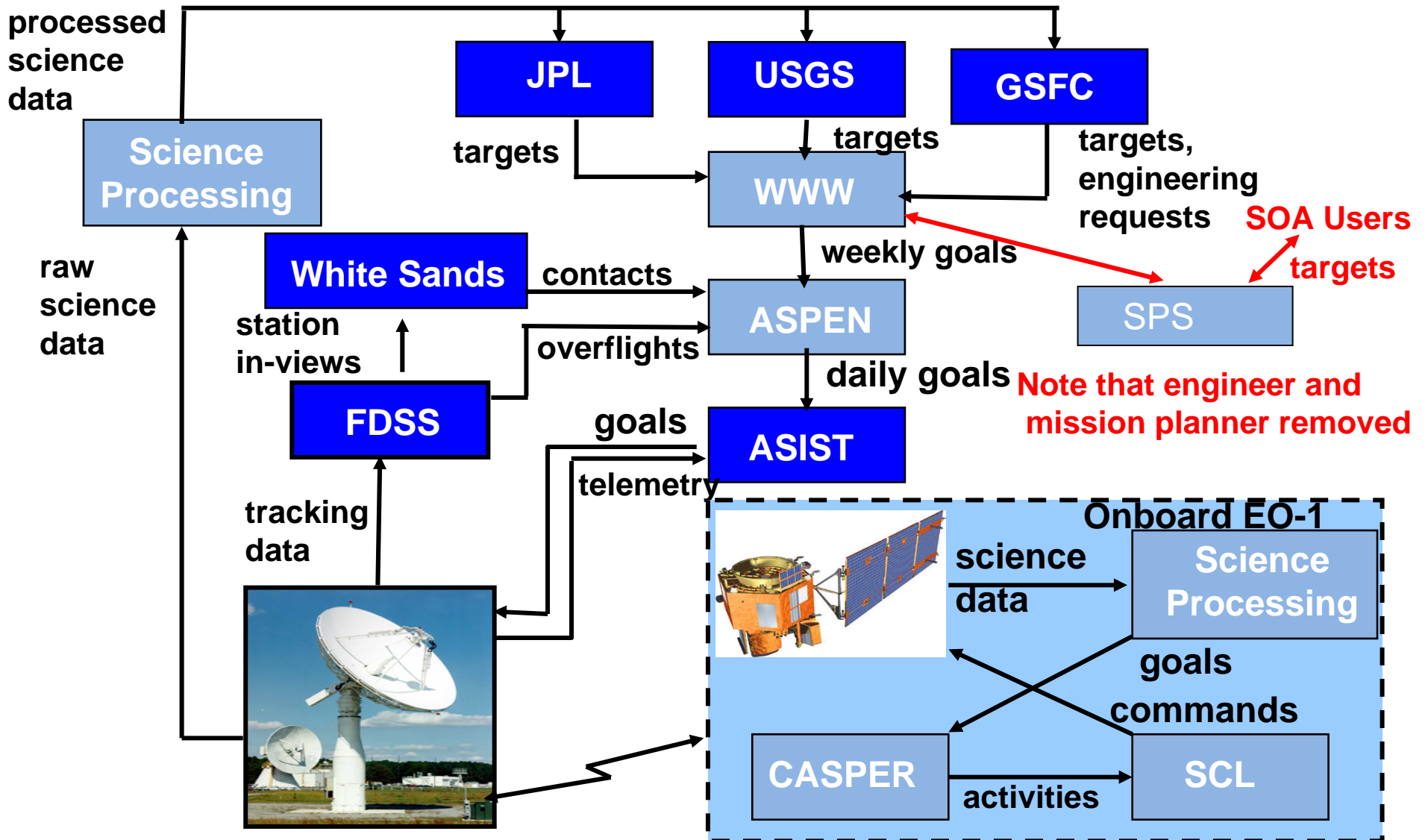
ASE Flight Software Architecture



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

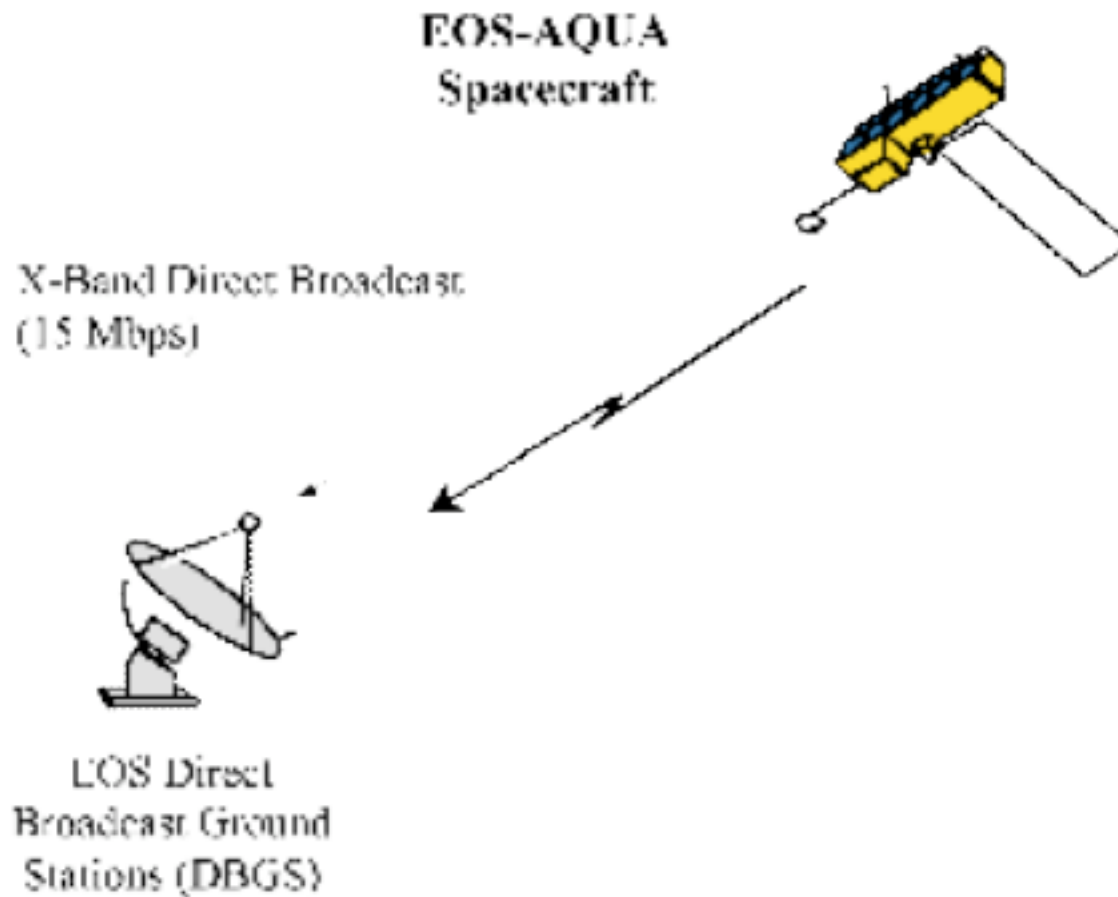


Figure 1.2-1 X-band Direct Broadcast Downlink

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 HypsIRI data via web services and tools