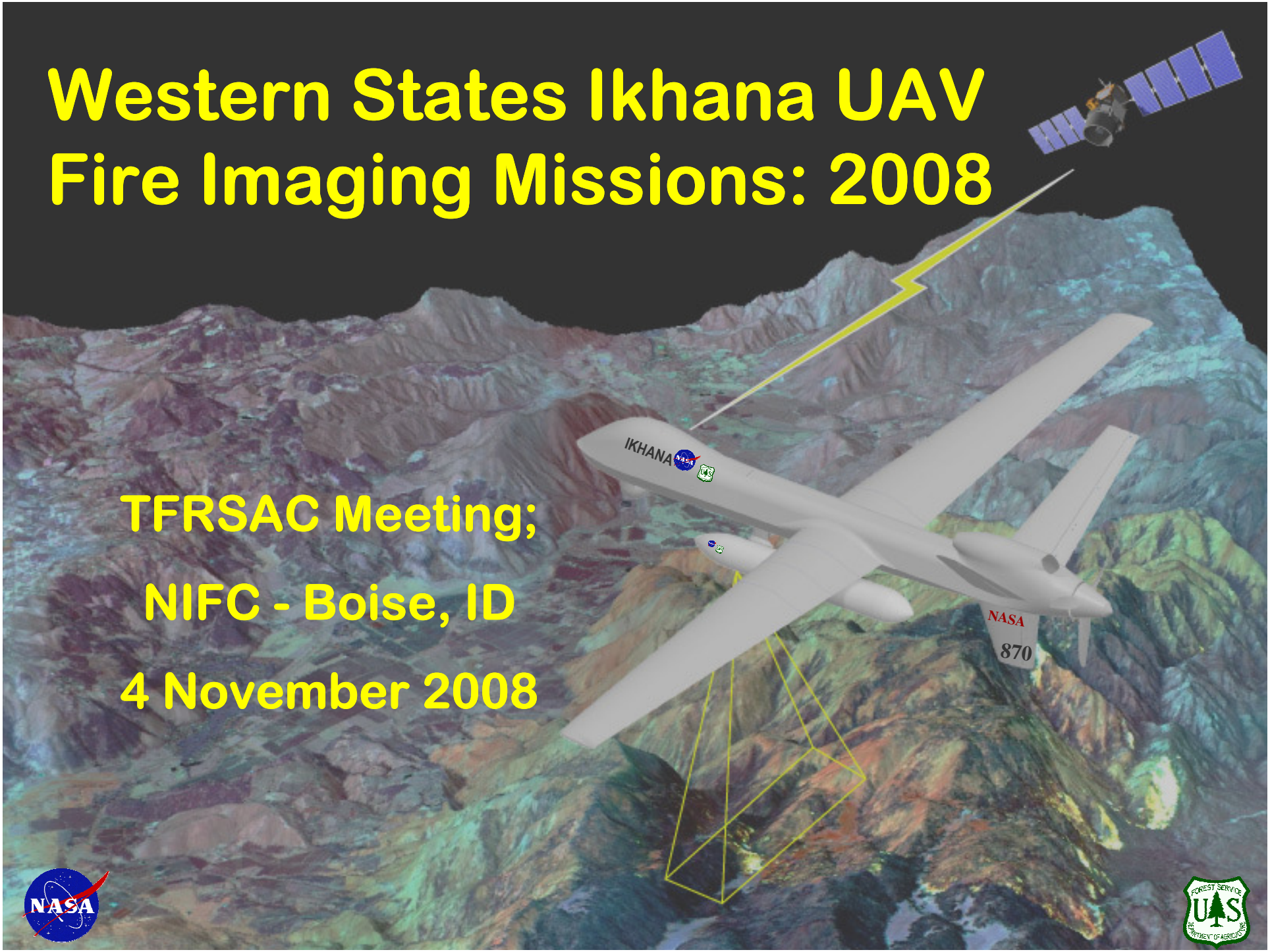
Western States Ikhana UAV Fire Imaging Missions: 2008



TFRSAC Meeting;

NIFC - Boise, ID

4 November 2008

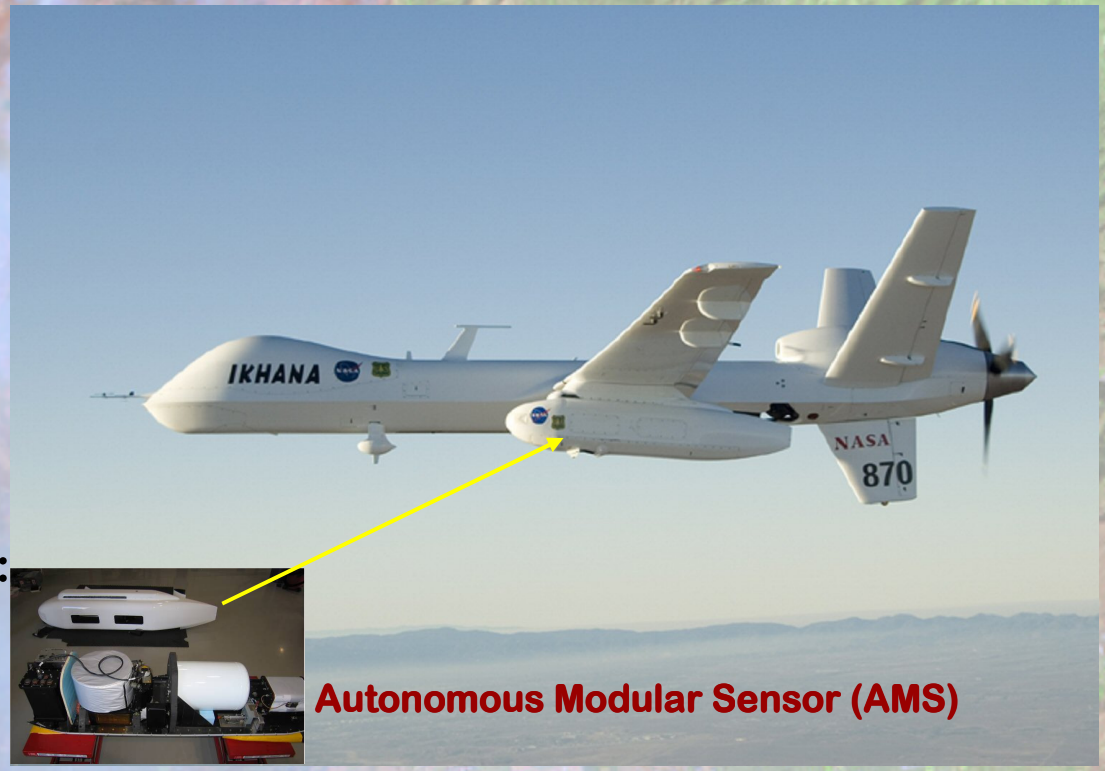
"Turning Swords Into Plowshares"
Adaptation of UAVs to Support Civilian Use

NASA "Ikhana" UAV

The *Ikhana* is a derivative of the Predator B (MQ-9) "*Reaper*" UAV, designed specifically as a NASA science and research platform. *Ikhana* is a Native American Choctaw word meaning: Intelligence, Conscience or Aware

Capable of medium to high altitude operations for ~24-hour periods.
2400 lbs of instruments; Operations: ~50K ft; 170-200kts
Length: 36 feet, Wingspan: 66 feet
Max T/O weight: 10,500 pounds

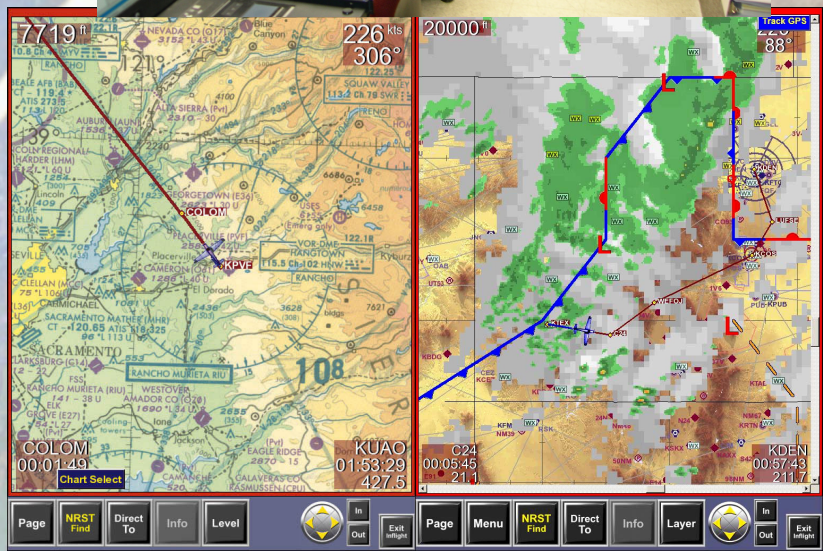
Capable of autonomous payload operations and real-time sensor data delivery to anywhere in the world via an onboard satellite communications system.



NASA Ikhana with Sensor Pod under-wing mount

Ground Systems

- Mobile Ground Control Station
  - Dual pilot control station
  - Electronic navigation charts
  - Weather
  - 6 Engineering/Science workstations
  - Range safety workstation
  - Intercom system throughout
  - Overhead mission displays
  - Telephones
  - Remote video from aircraft start-up/shut-down site
  - Downlink video and data recording



- Mobile 2.4m Ku SatCom Antenna
  - Dual redundant receiver/transmitters

Sensor System: AMS-Wildfire Instrument

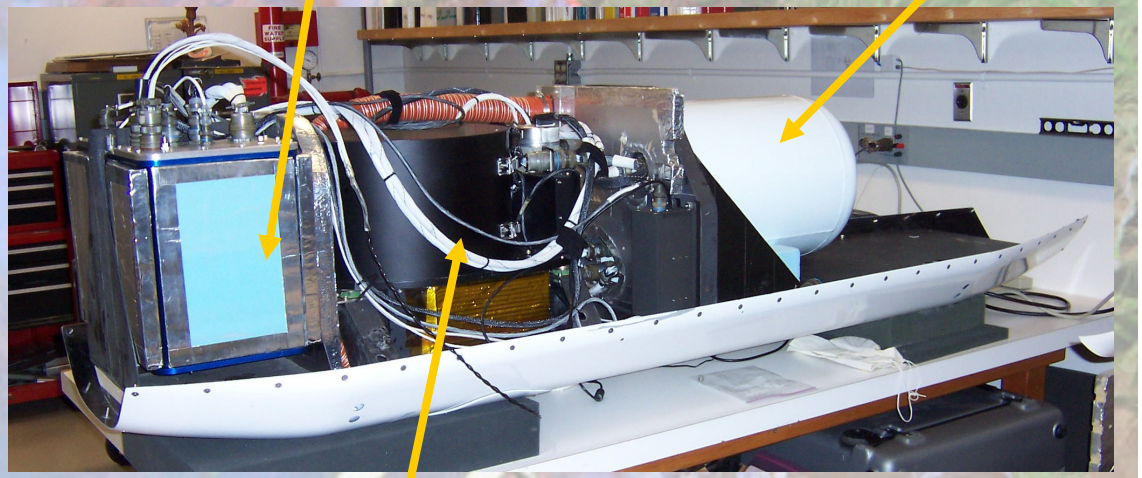
AMS Wildfire Sensor

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)
10	2.08- 2.35	(TM7)
11	3.60- 3.79	(VIIRS M12)
12	10.26-11.26	(VIIRS M15)

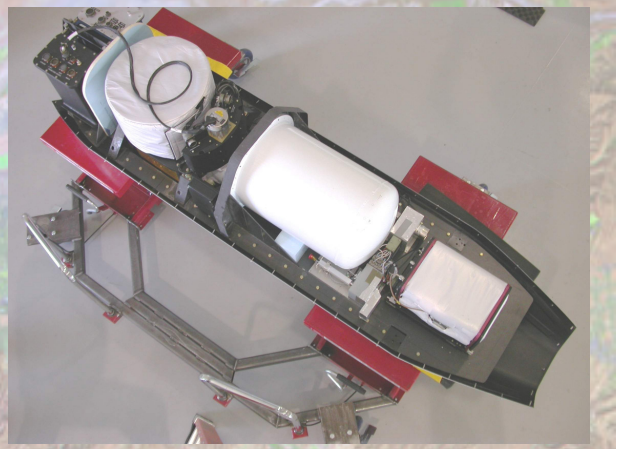
Total Field of View: 85.9 degrees
IFOV: 2.5mrad
Altitude: 25000'
Spatial Resolution: 20m (at sea level)

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

Data System Enclosure



Scan Head

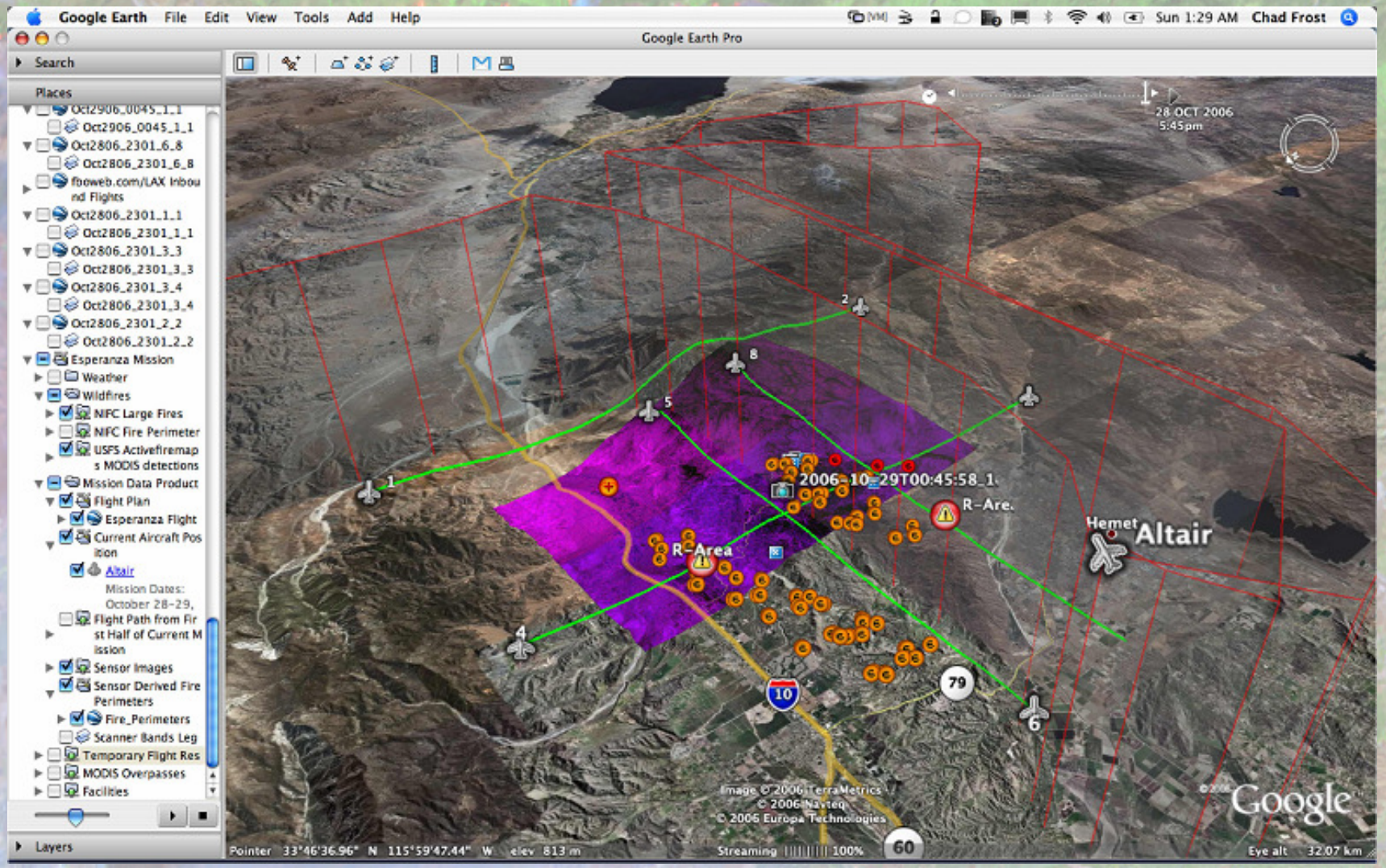


Wildfire - Collaborative Decision Environment (CDE): *Real-Time Information Sharing and Visualization*

The Wildfire-CDE Provides:

- **Aggregation of disparate information sets into a Common Operating Picture (COP):**
  - **Real-Time Airborne sensor data from a multitude of Platforms**
  - **Real-Time Satellite Data Integration (MODIS Fire Detection Data)**
  - **Real-Time Weather Satellite Data**
  - **Real-Time Lightning Strike Detection Data**
  - **Ground-Based Measurement Data (RAWS weather data)**
  - **Mission Planning Tools (for Ikhana Mission Team)**
- **Analysis tools to observe, visualize, and interpret sensor and external data.**
- **Automated mechanisms to generate data products (e.g. GeoTIFF, vector shapes for fire perimeter).**
- **Groupware-like collaboration in communicating and sharing data products.**
- **All data visualized in a "freeware" visualization package---GoogleEarth**

W-CDE: Google Earth Client

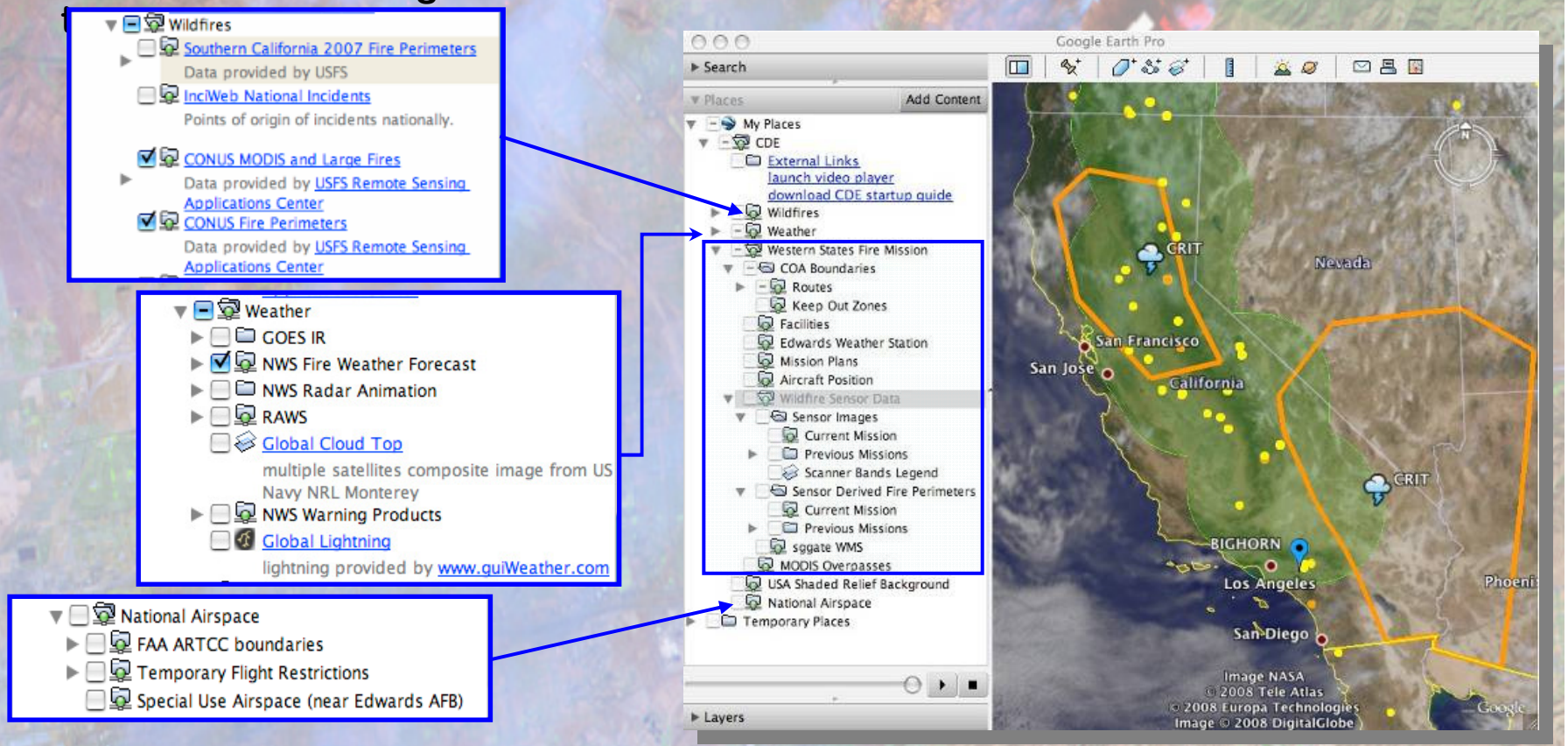


Real-time 3-D rendering and fly through of acquired fire imagery

Wildfire - CDE

Decision support tool for wildfire missions

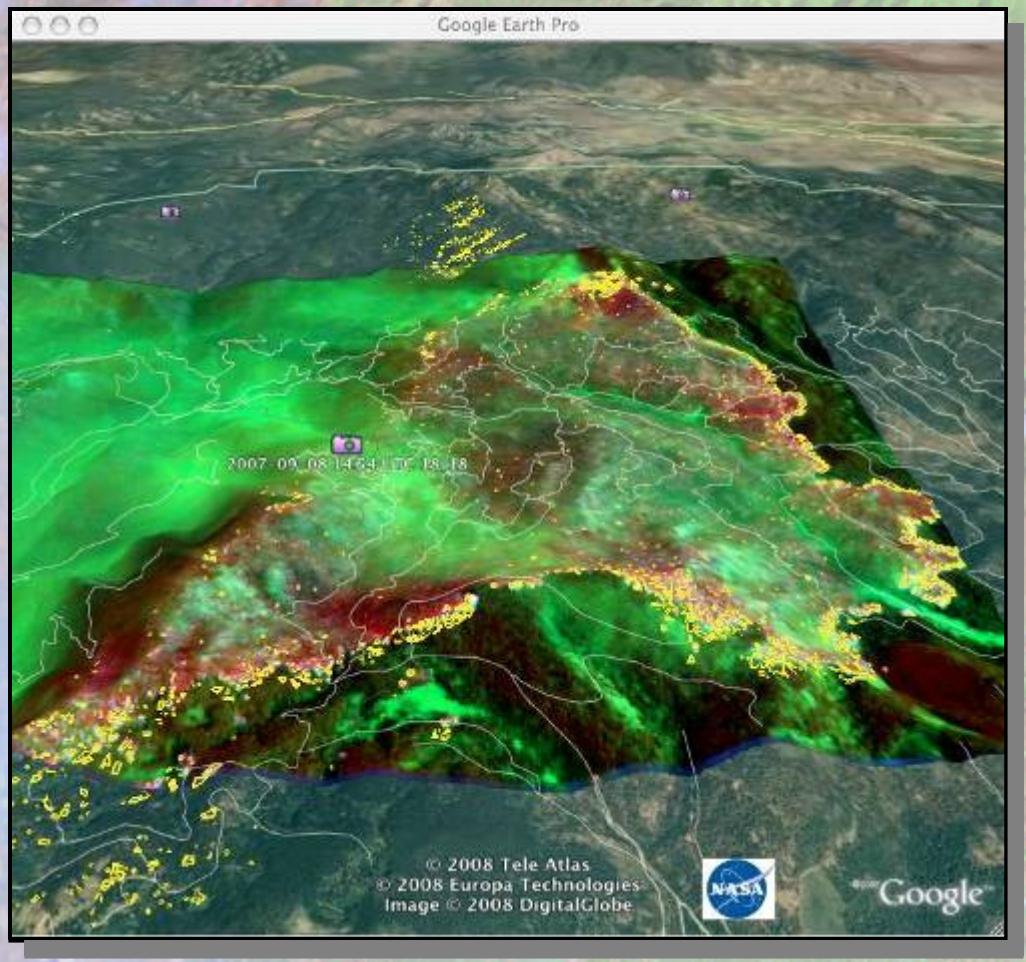
- **Goals**
  - Mission planning
  - Situational awareness
  - Data visualization
  - Collaboration among distributed
- **Users**
  - Mission Development Team
  - Data Products Users



Sensor Data Visualization

Procedure for viewing sensor data in CDE

- Camera placemarks appear when images are available
- Click on icon to display thumbnail image
- Download image from server
- “Hot Pixel” detections are available on separate layer
- Adjust 3D view of data draped on terrain



Fires in California: NASA Support

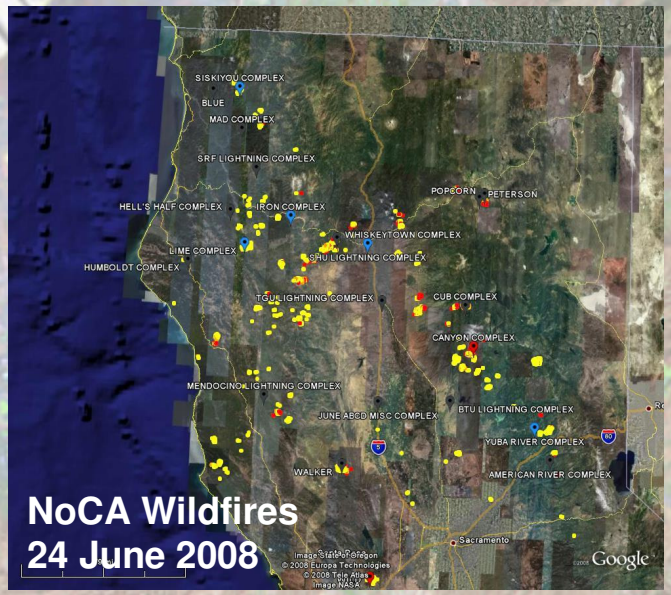
June 21st & 22nd:
CA lightening storms, triple-digit temperatures spawn a few hundred fires.
CalFire calls NASA-Ames WRAP staff at 3:00 AM requesting Ikhana and sensor support (six weeks prior to WRAP team's planned fire missions).

June 24th 9:00 AM
NASA-ARC, NASA-DFRC, NASA-HQ and CalFire telecon: agree to accelerate mission series. Schedule plan drafted to "ready" all systems by 30 June. DFRC engages FAA for emergency "amendment" to COA start. Mission start-up by mid-week 30 June.

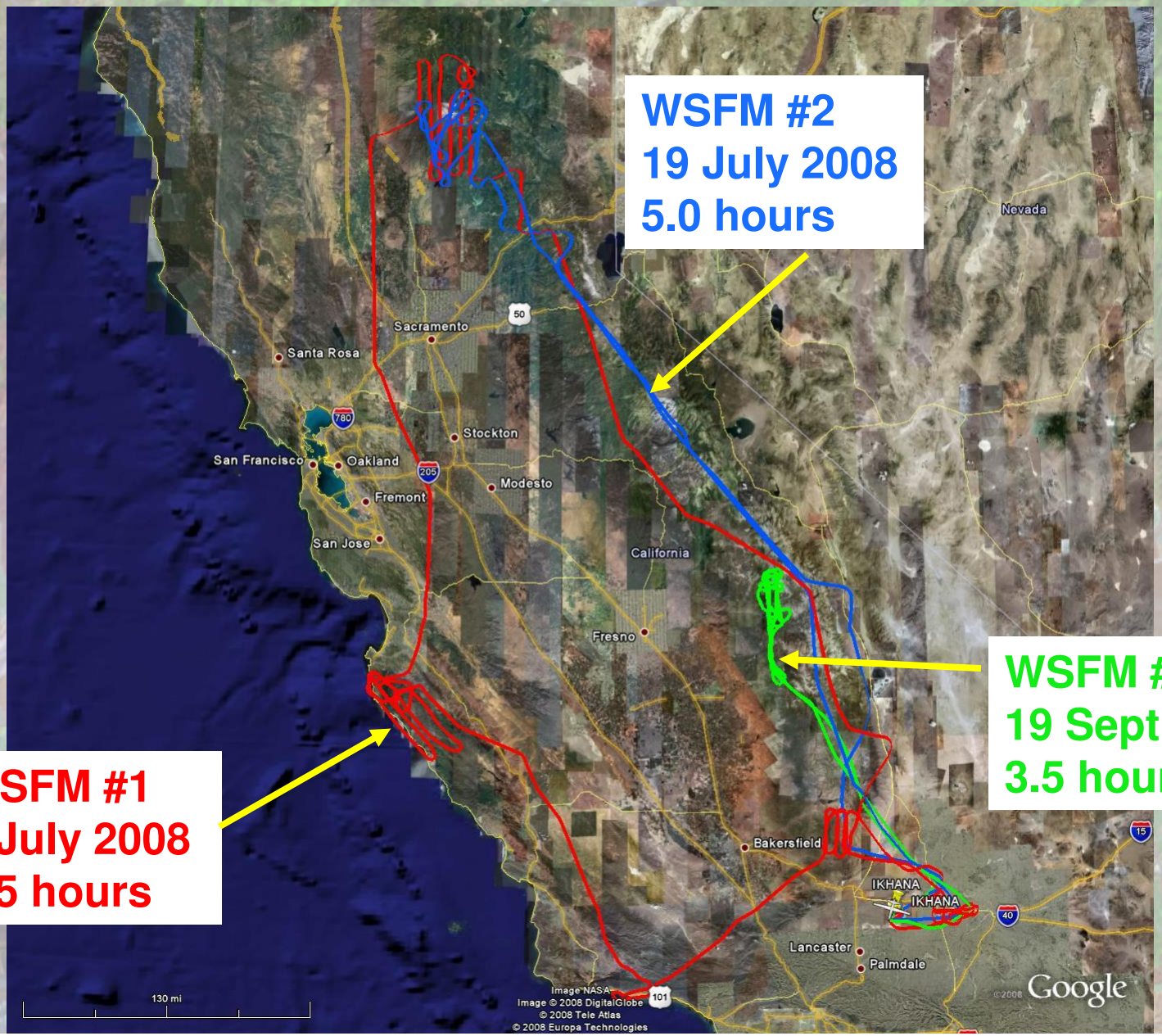
WRAP team anticipates 1-3 missions through 7/12. Missions anticipated to be 8-10 hours duration.

July 7th
FAA approves emergency amendment to COA. Fires to be flown: Piute, Clover, American River Complex, Yuba River Complex, Canyon Complex, Cub Complex, Butte (BTU) Complex, Basin / Indians Complex, Gap Fire.

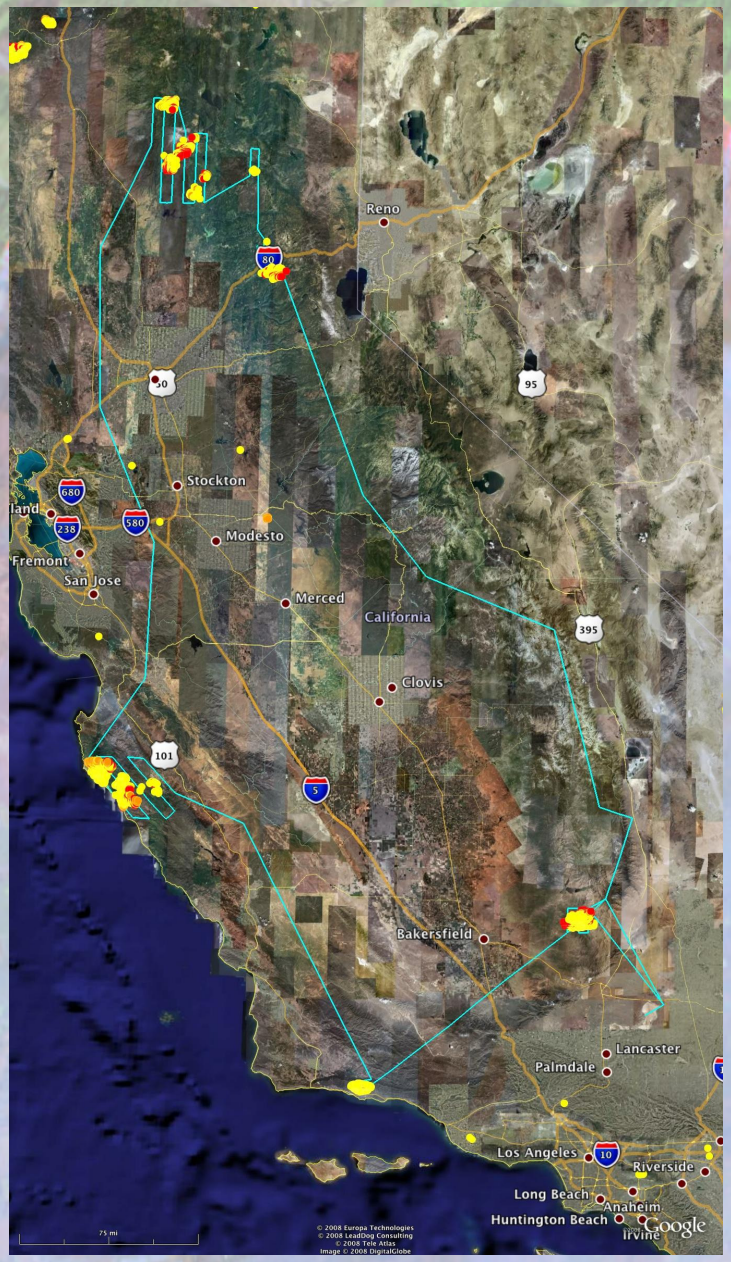
July 8th
0600 PDT: Pre-flight Brief
~0800 PDT: Ikhana T/O for mission
~1900 PDT: Post-mission debrief; Set schedule for First WSFM over No CA fires

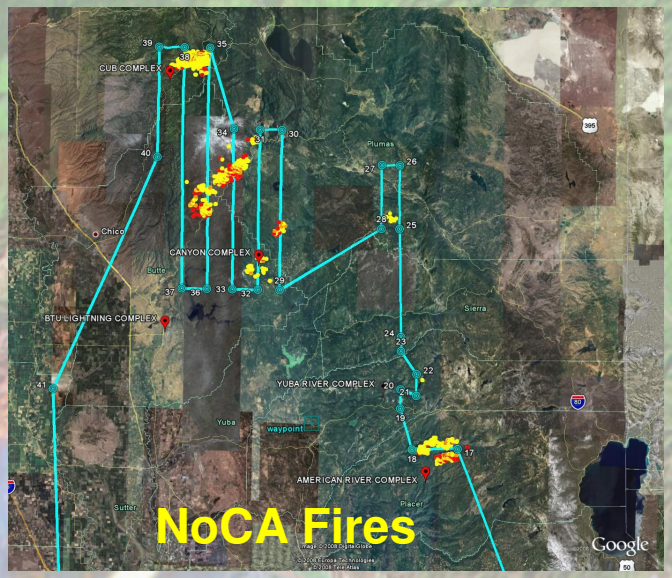


WSFM – 2008 Flight Tracks



WSFM-08 NoCA Mission 1: 8 July 2008





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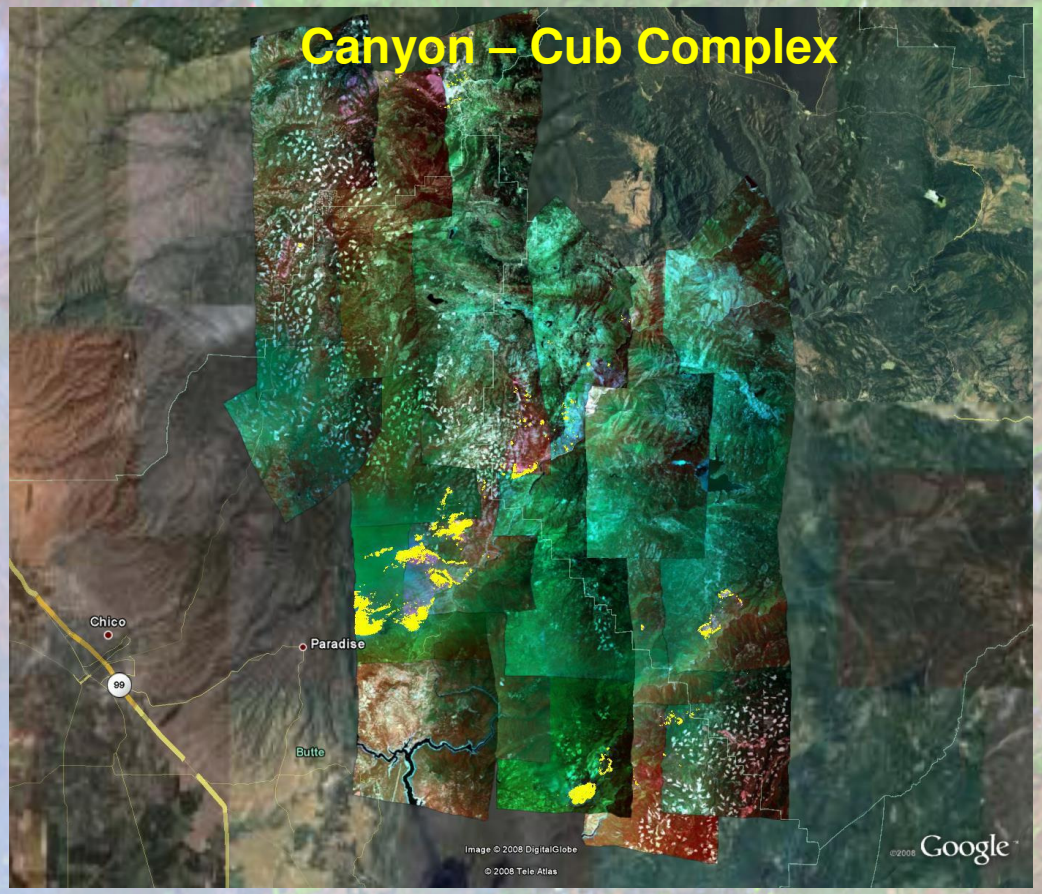

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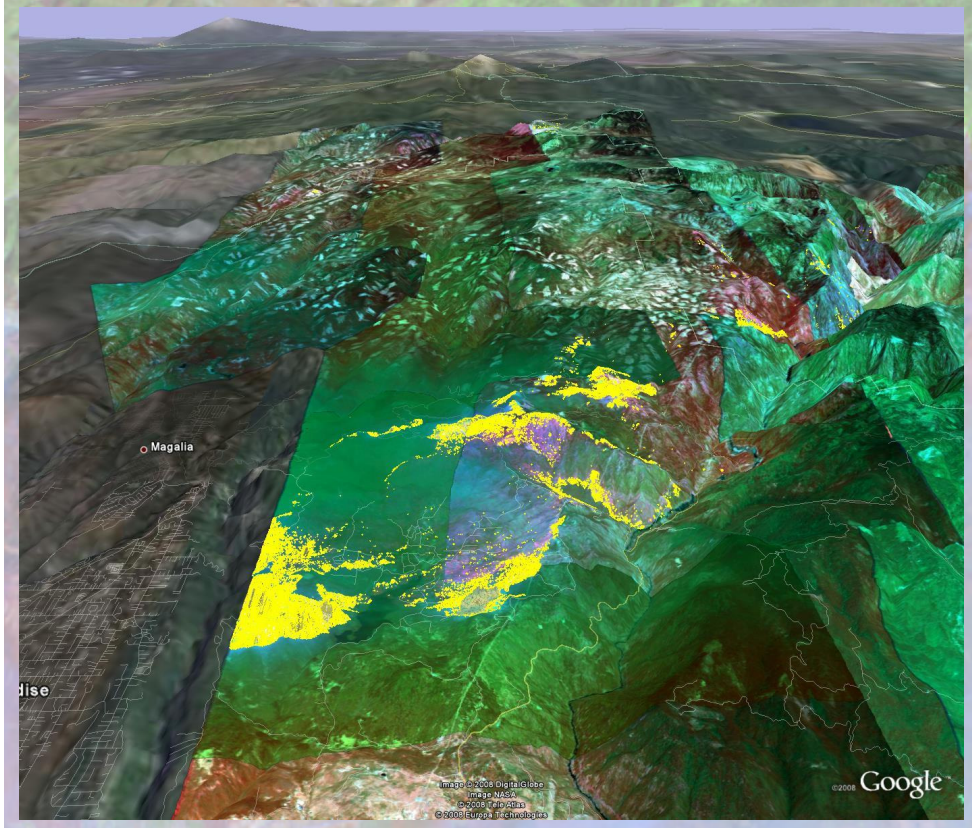
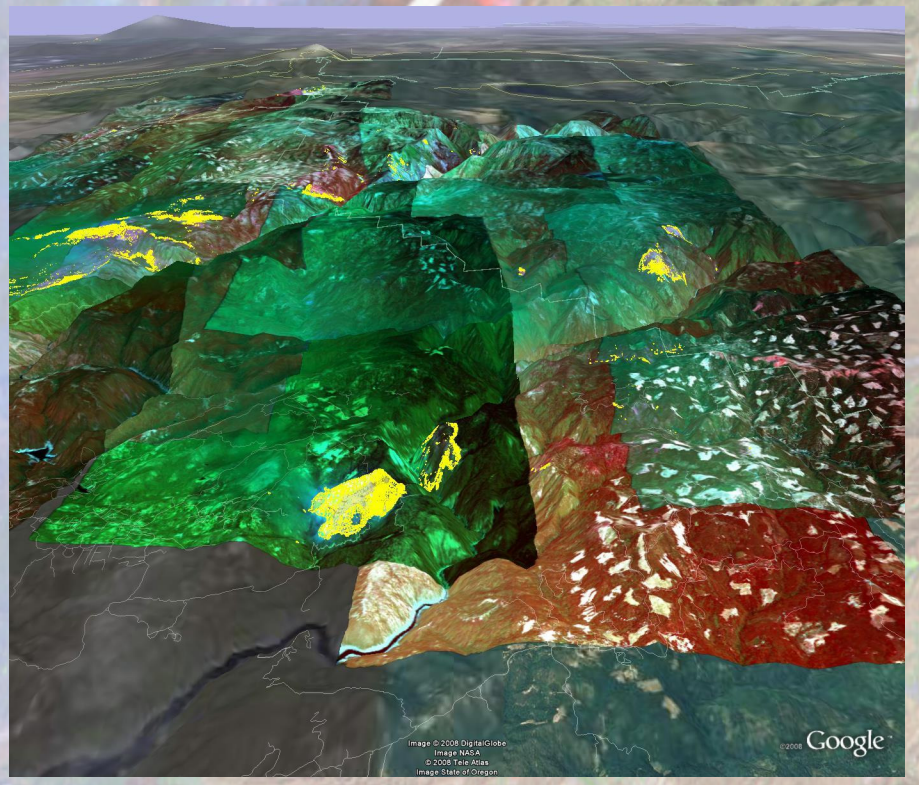


Canyon – Cub Complex



Canyon – Cub Complex

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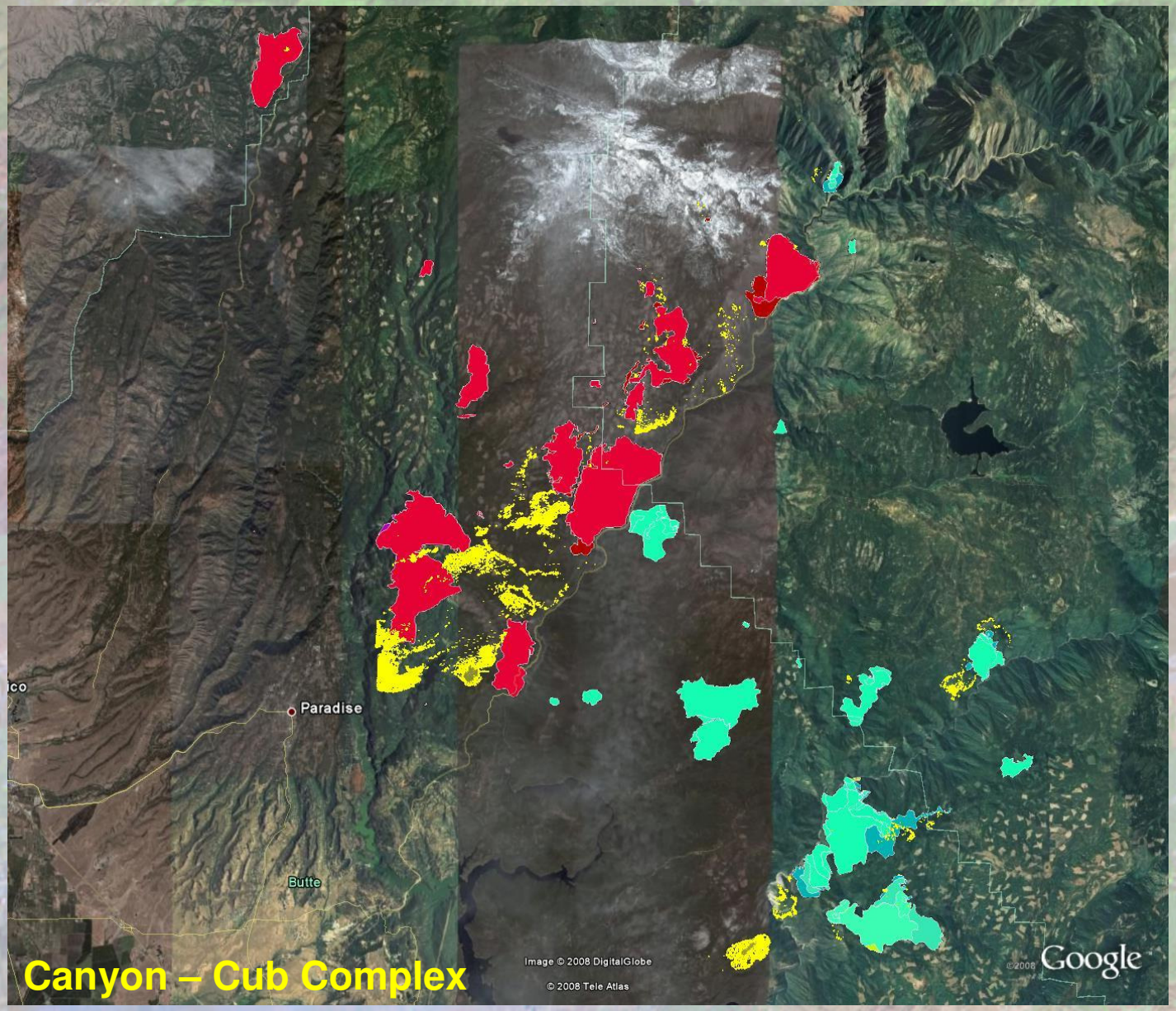

WSFM-08 NoCA Mission 1: 8 July 2008

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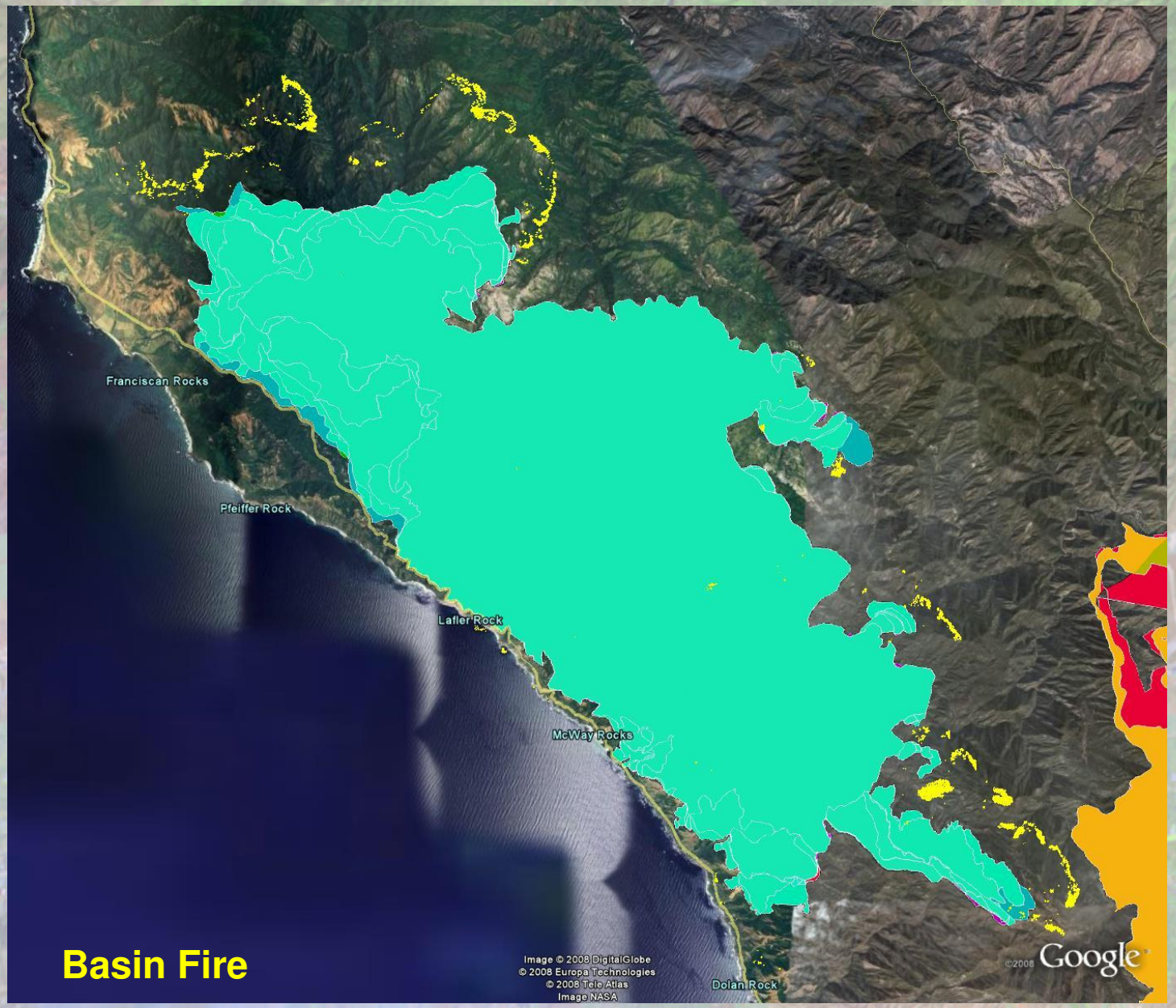

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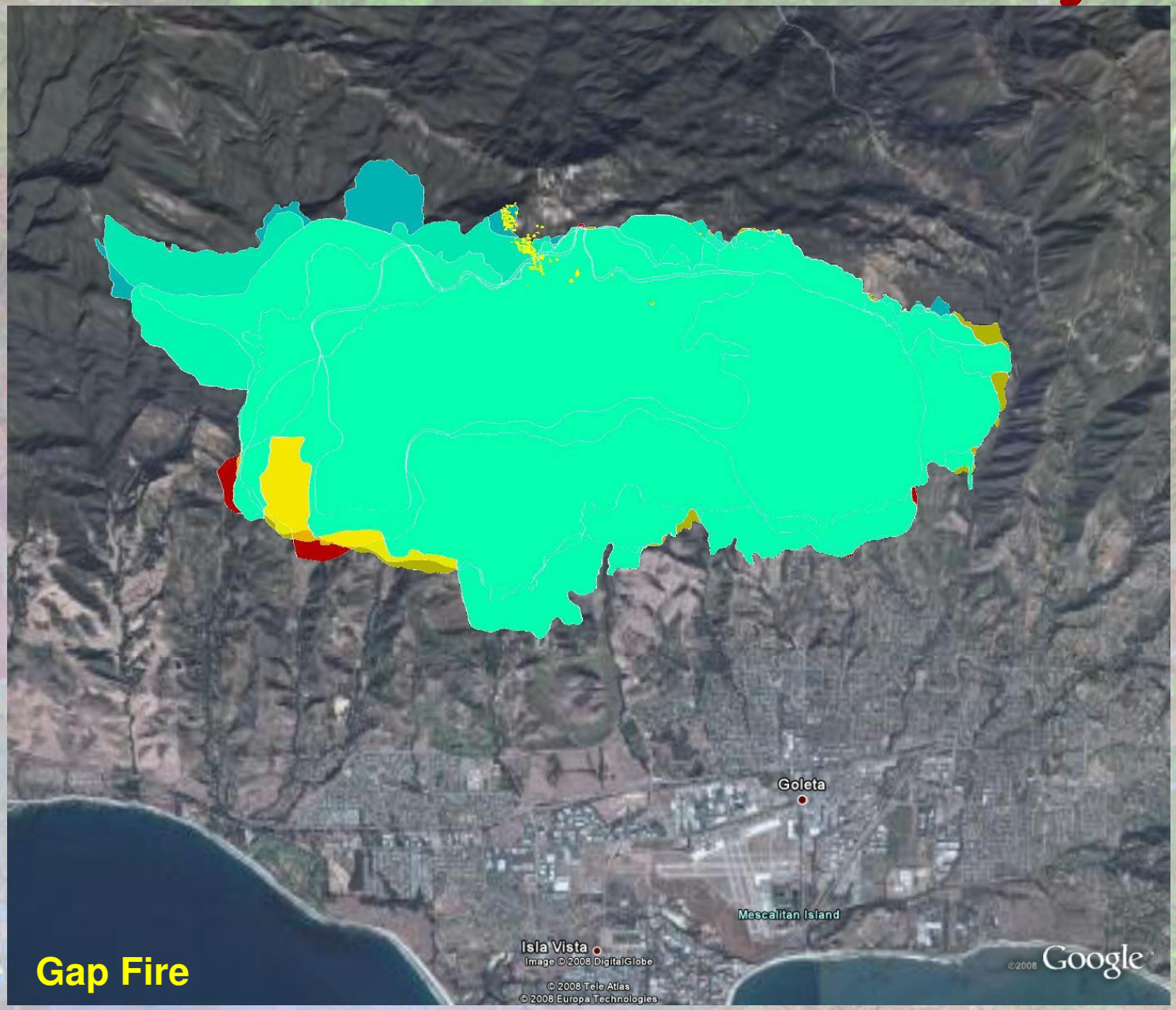

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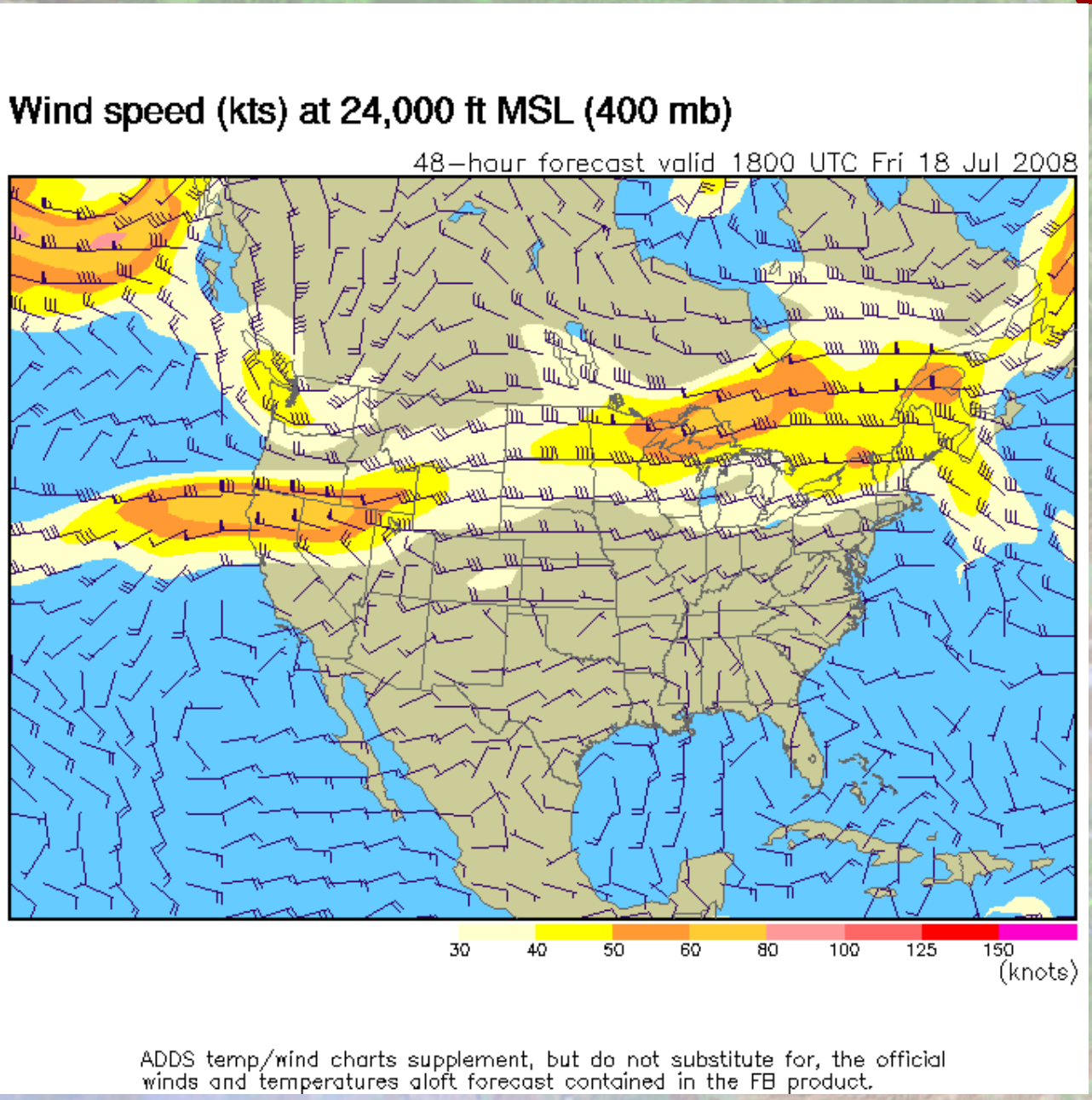

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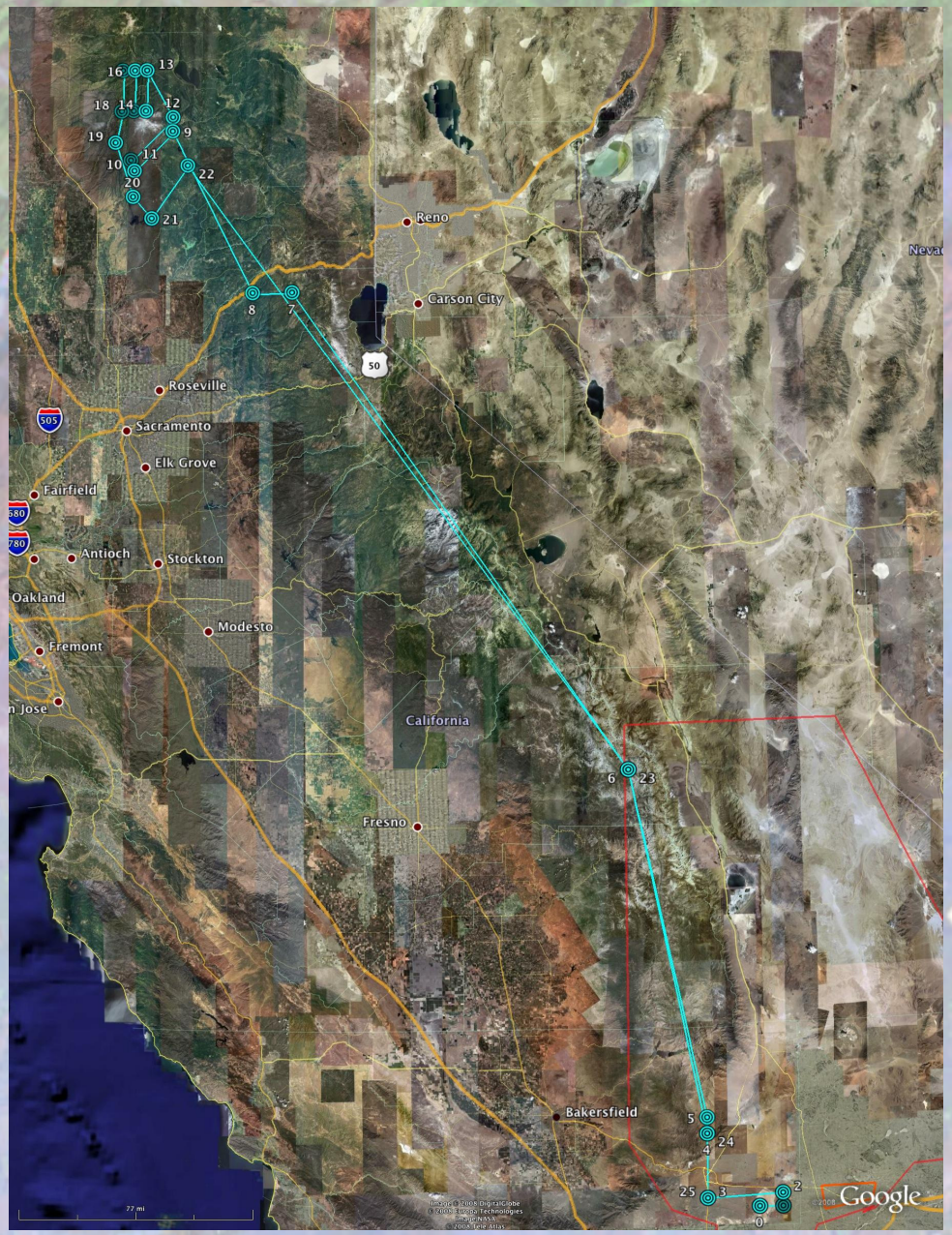
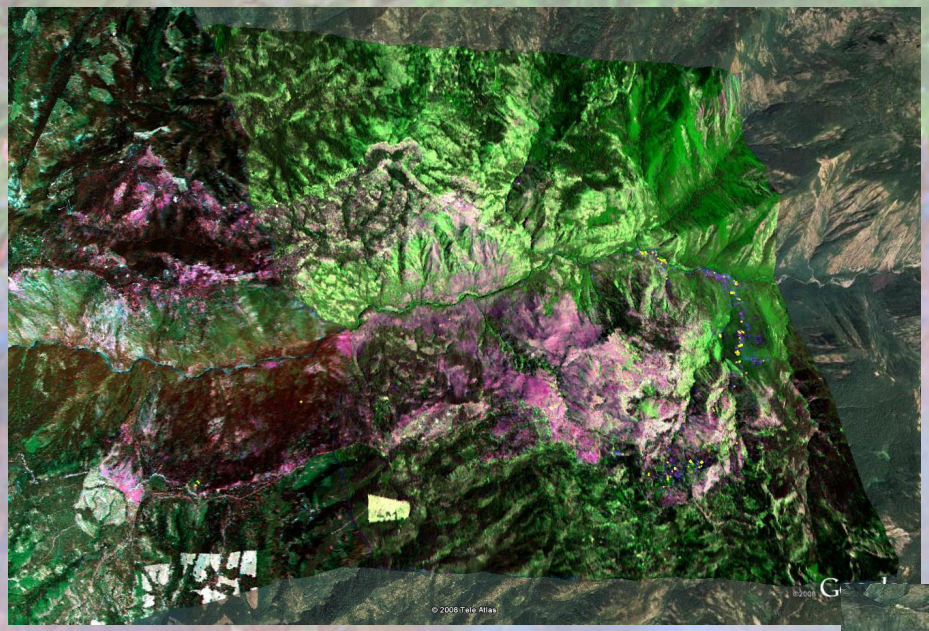


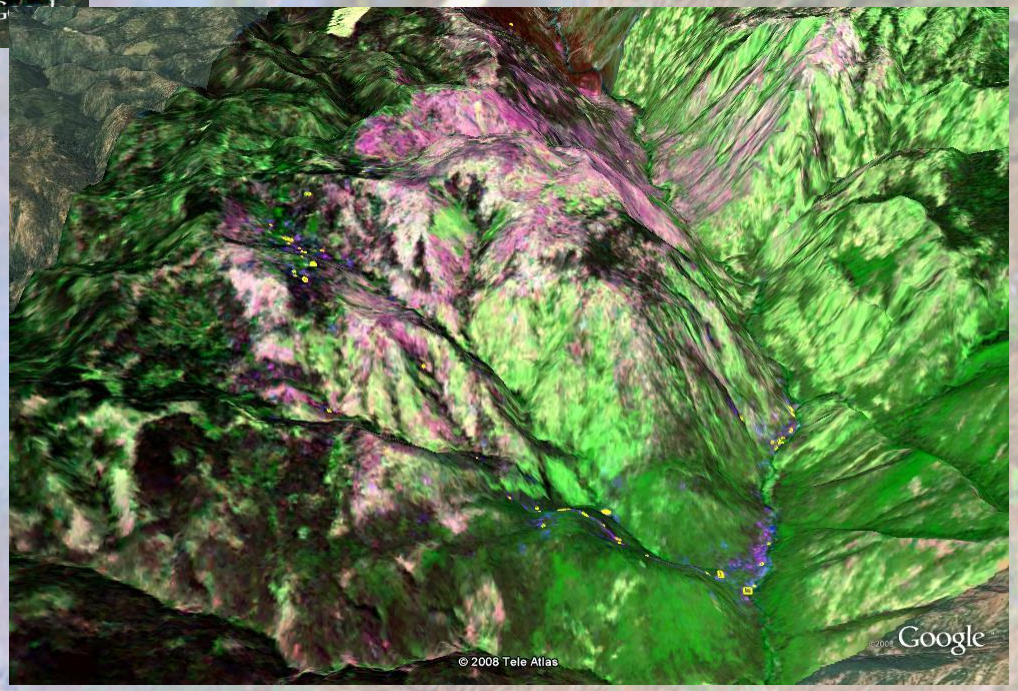
American River, Canyon Complex and BTU Complex

WSFM-08 NoCA Mission 2: 19 July 2008



American River Complex

3D Perspective West View



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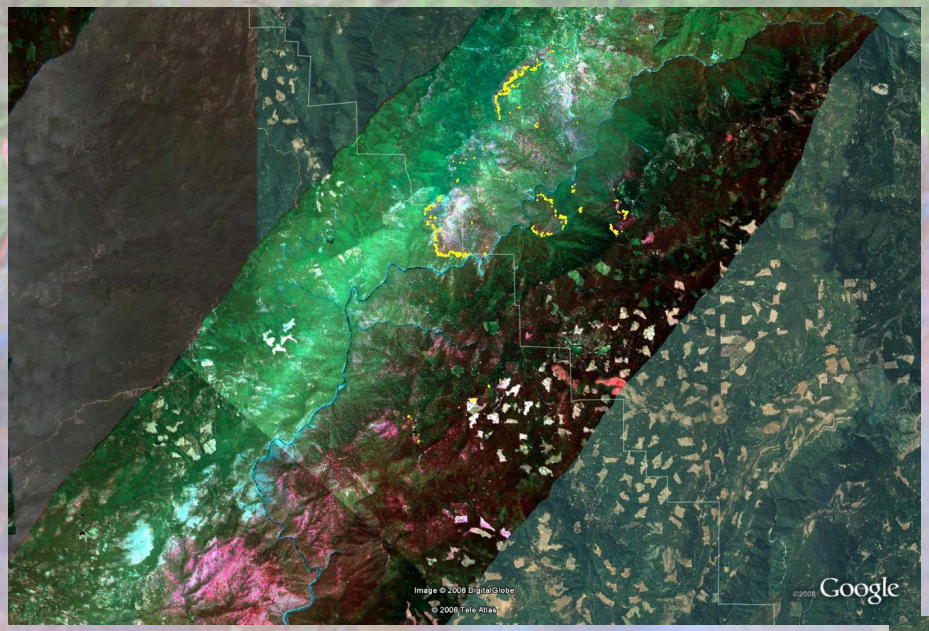
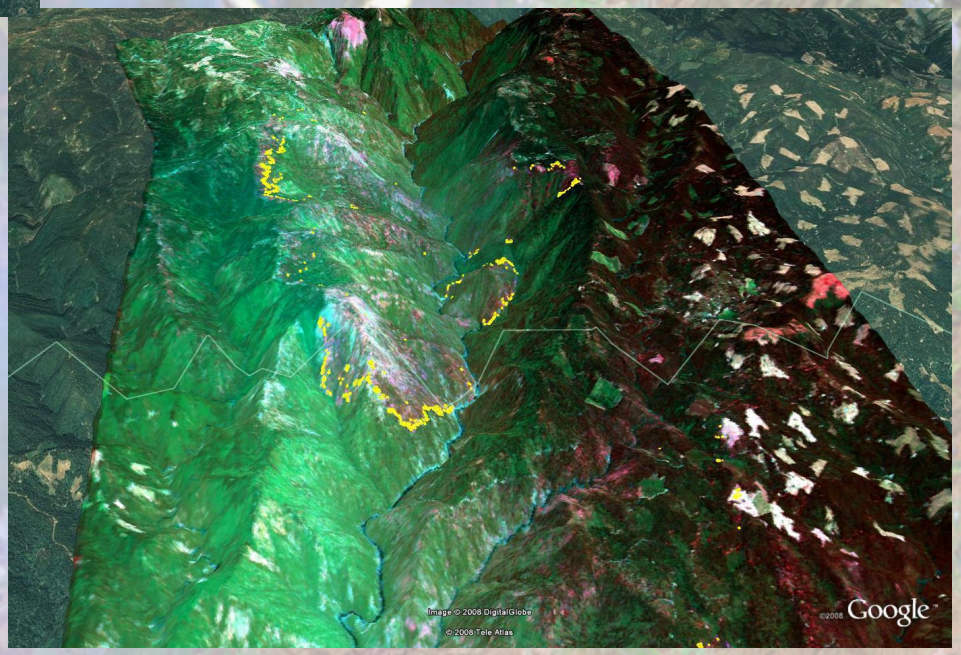
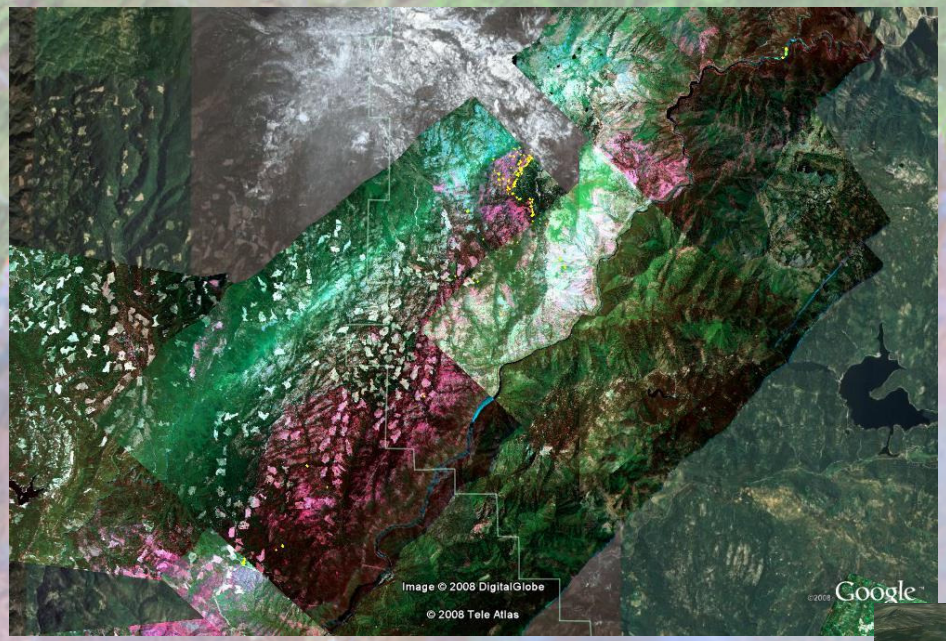


Canyon Complex

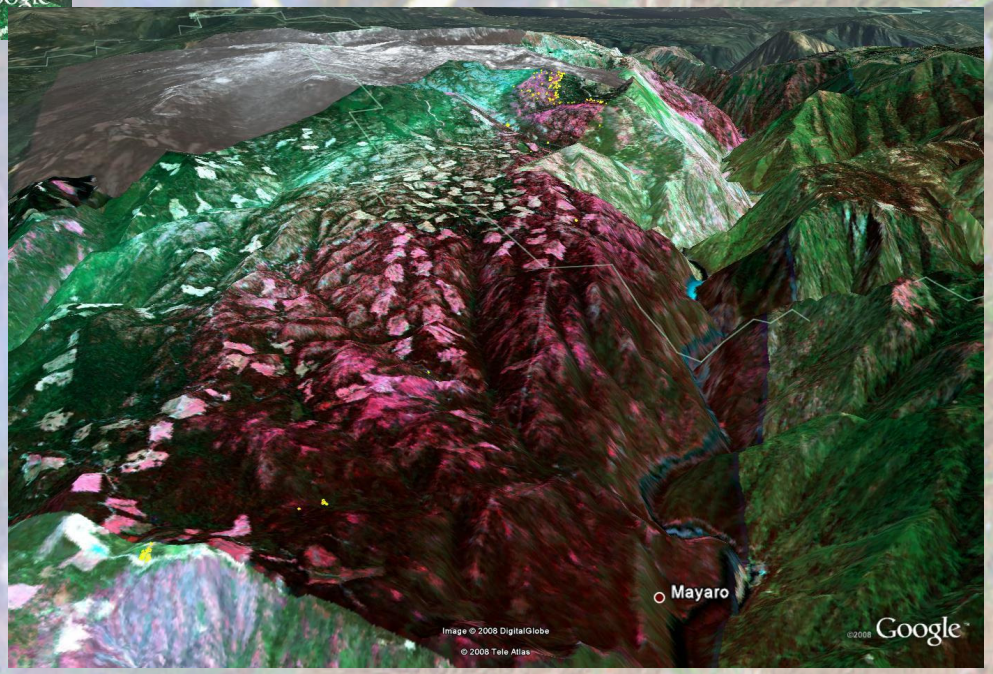


3D Perspective
Northeast View

WSFM-08 NoCA Mission 2: 19 July 2008

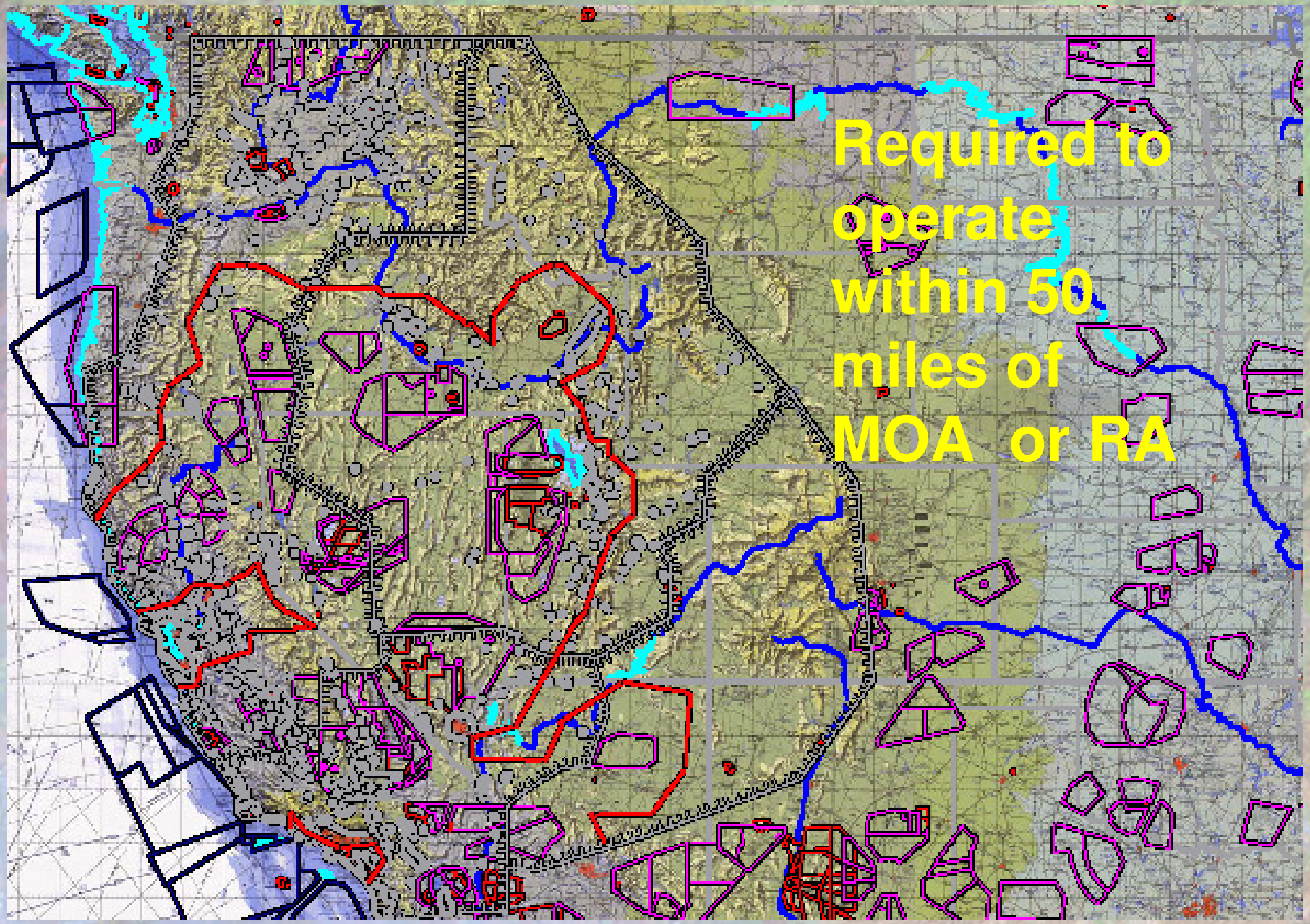


BTU Complex

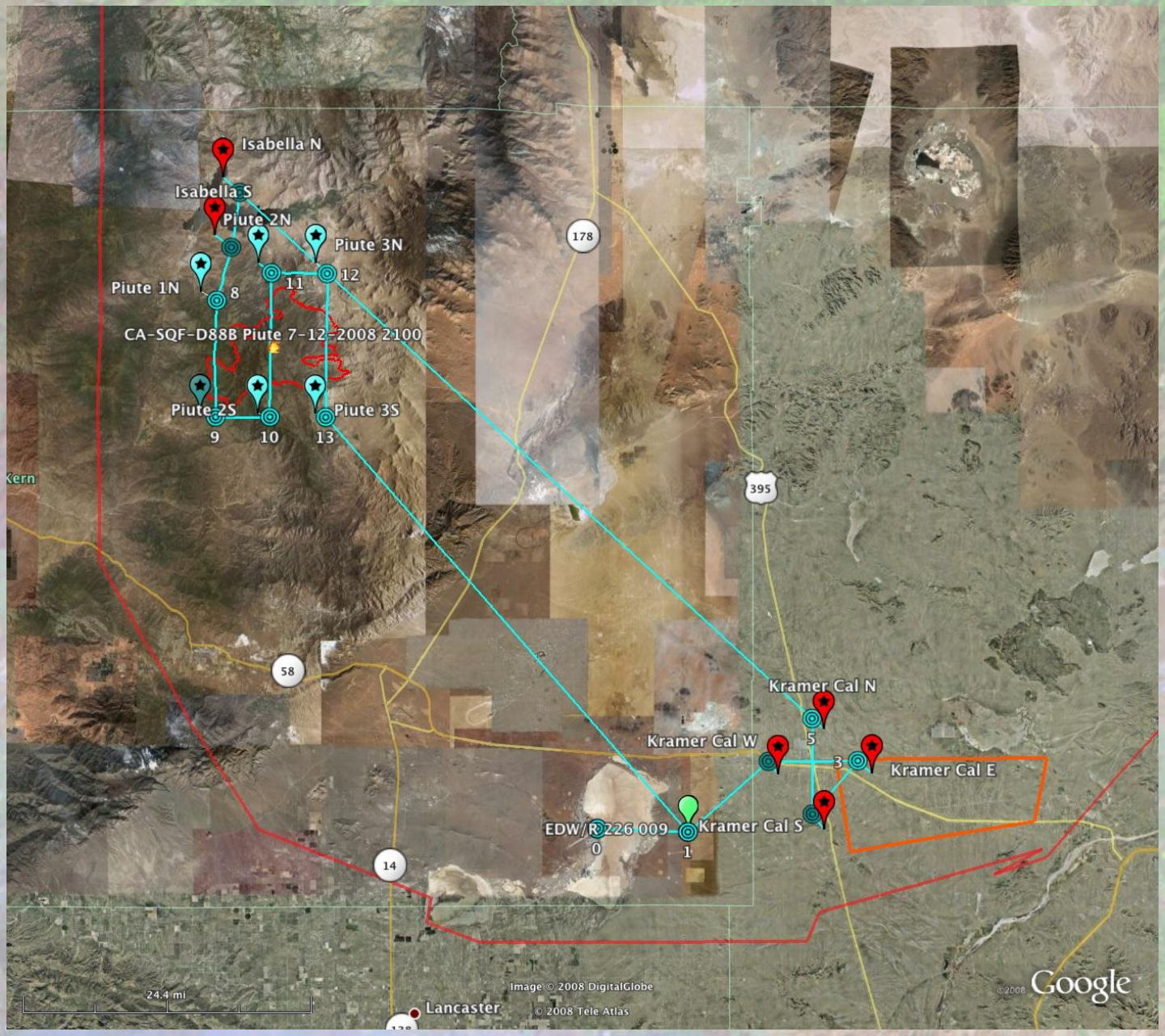


3D Perspective
Northeast View

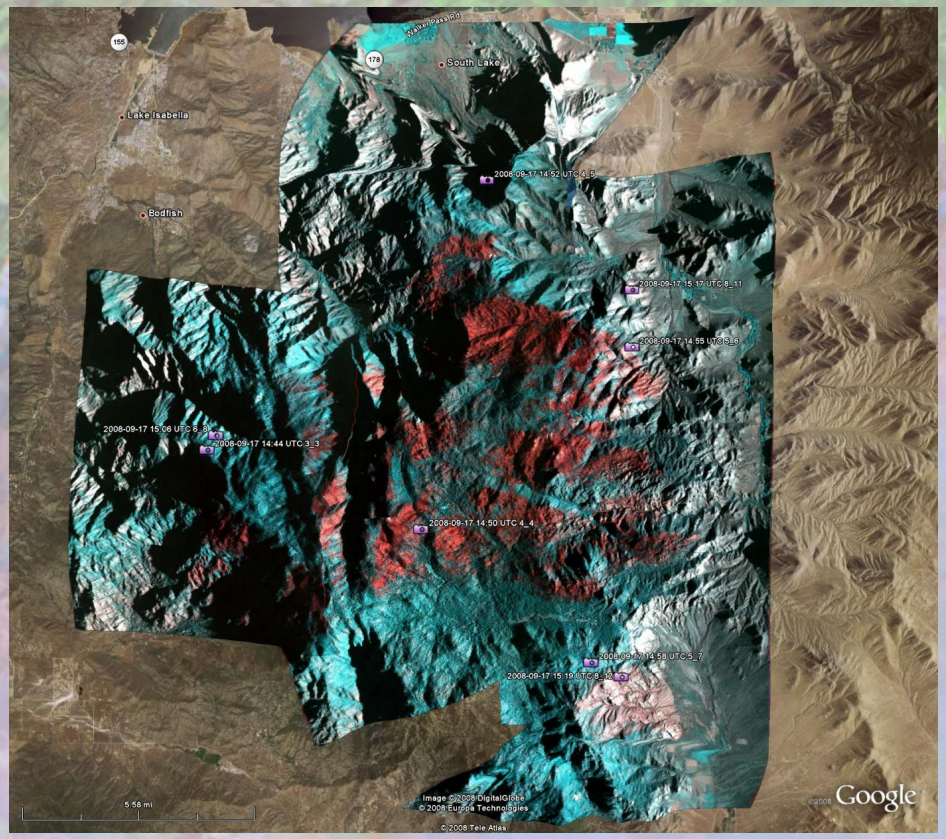
August 2008: FAA COA Rules Change!!!



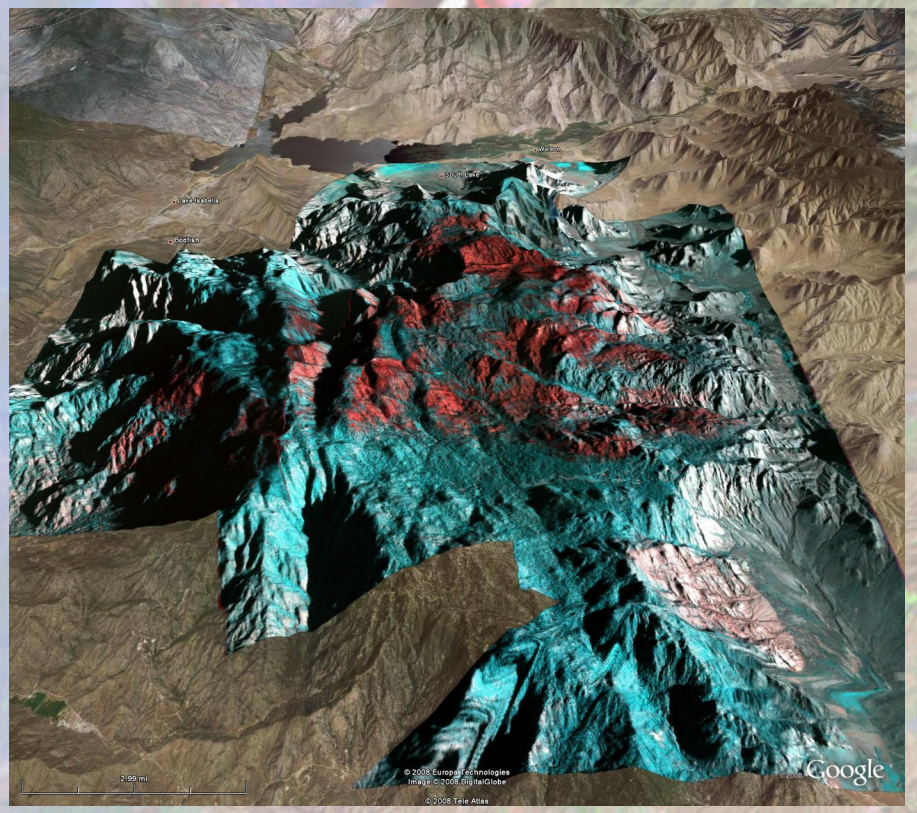
WSFM-08 Test Mission: 17 Sept 2008



WSFM-08 Test Mission: 17 Sept 2008



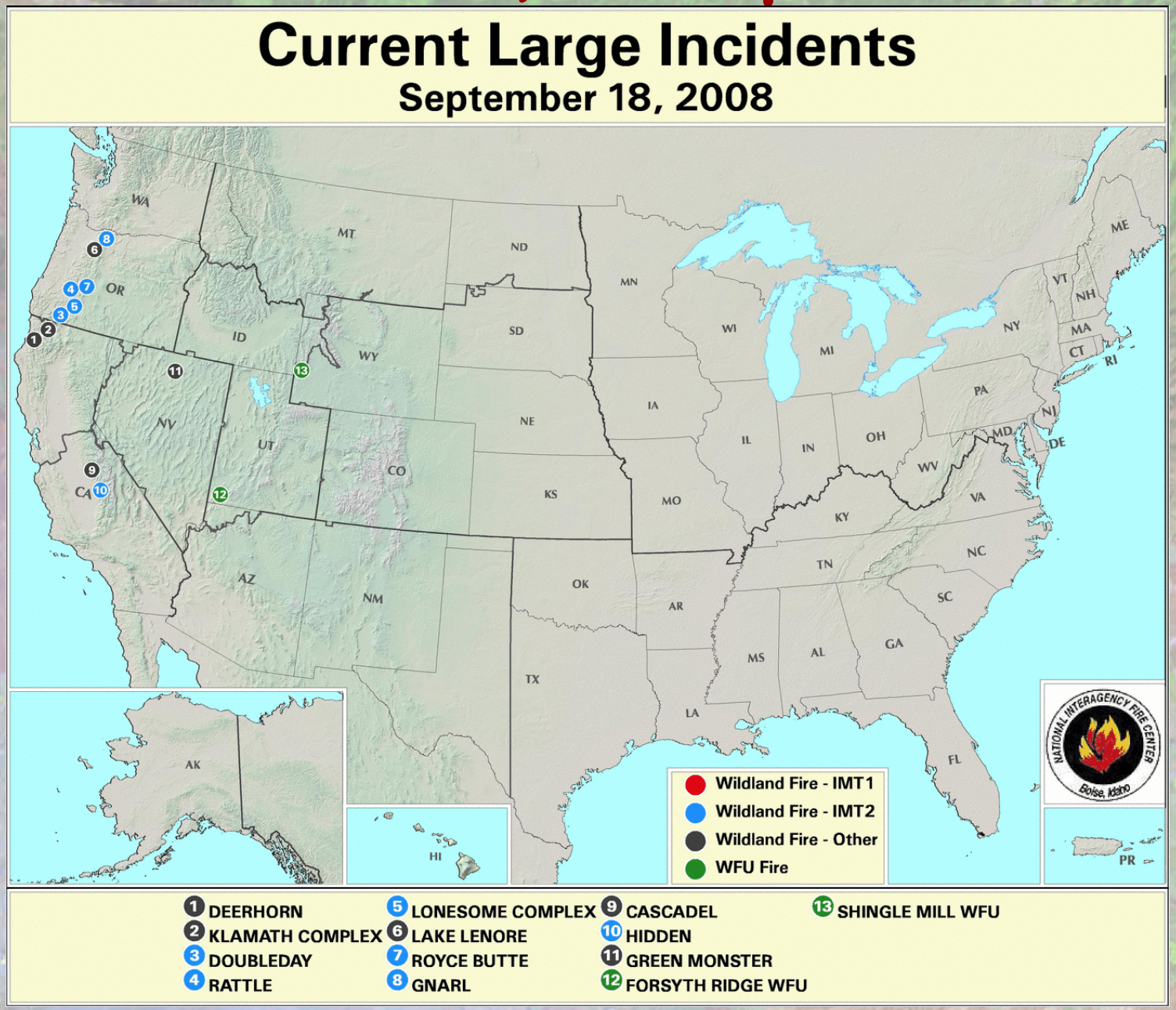
Piute Fire BAER Data



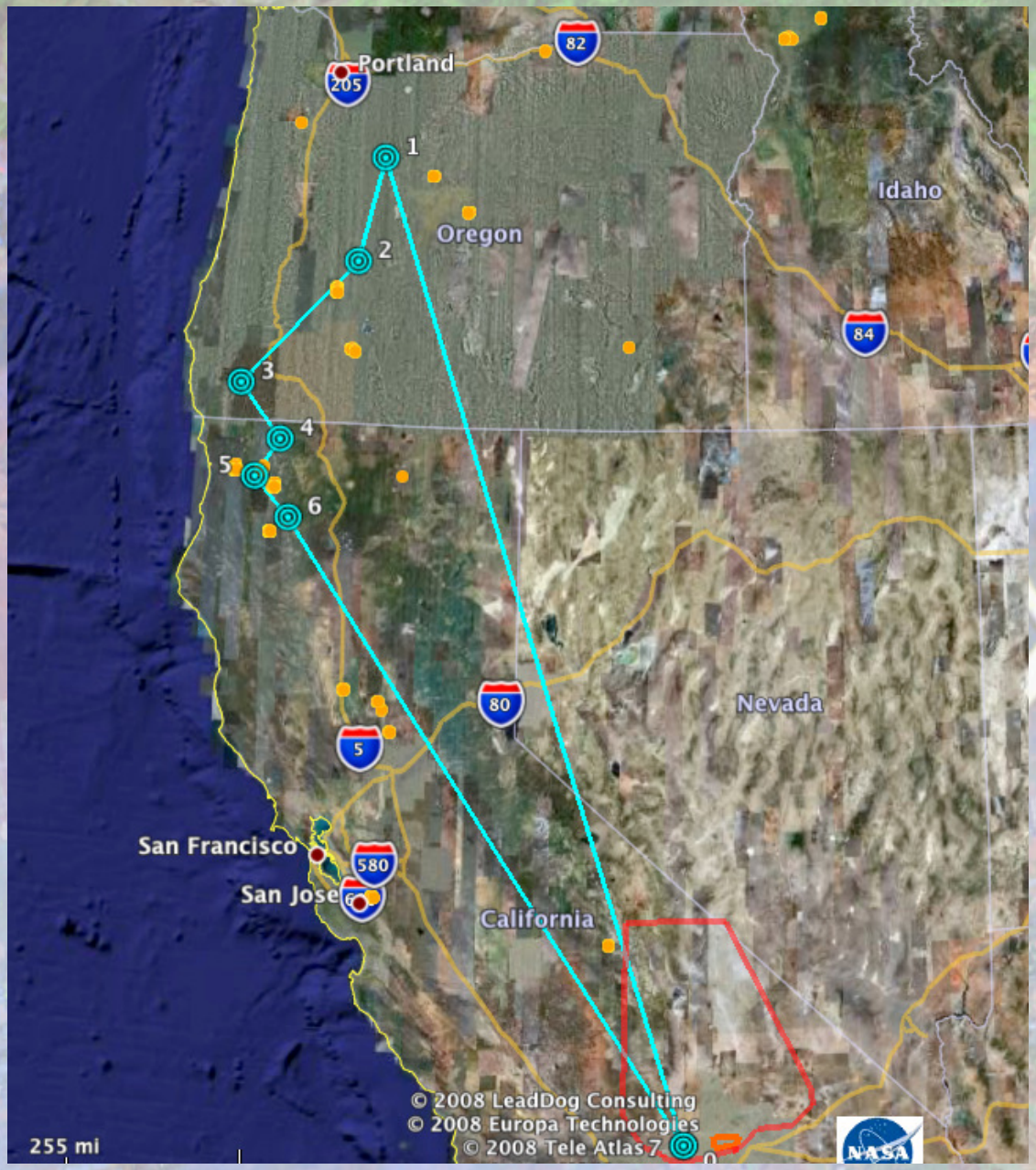
AMS Bands :

10:	2.08- 2.35	(TM7)
7:	0.76- 0.90	(TM4)
8:	0.91- 1.05	

WSFM-08; 18 Sept 2008

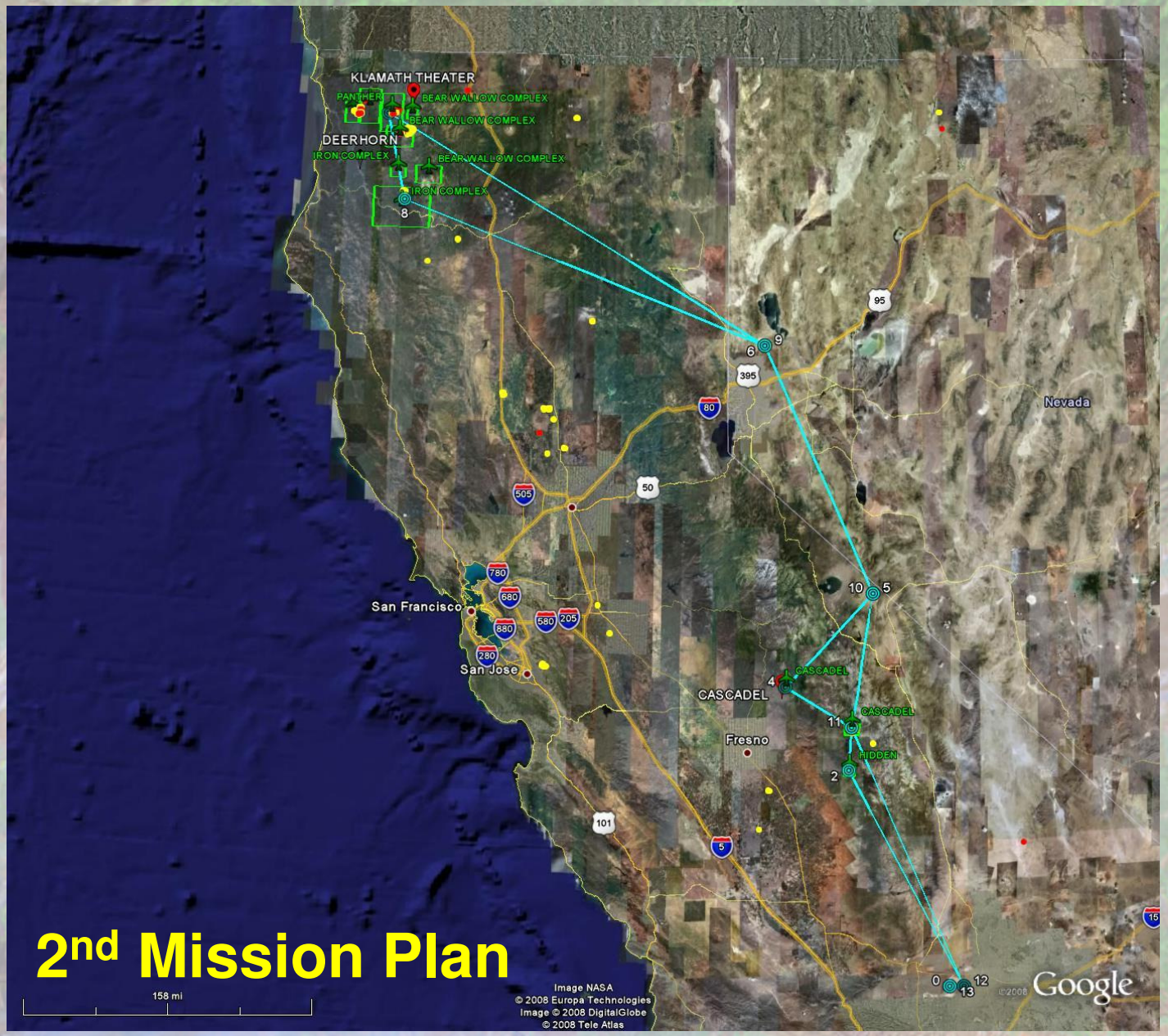


WSFM-08 NoCA Mission 3: 19 Sept 2008



Original Mission Plan

WSFM-08 NoCA Mission 3: 19 Sept 2008

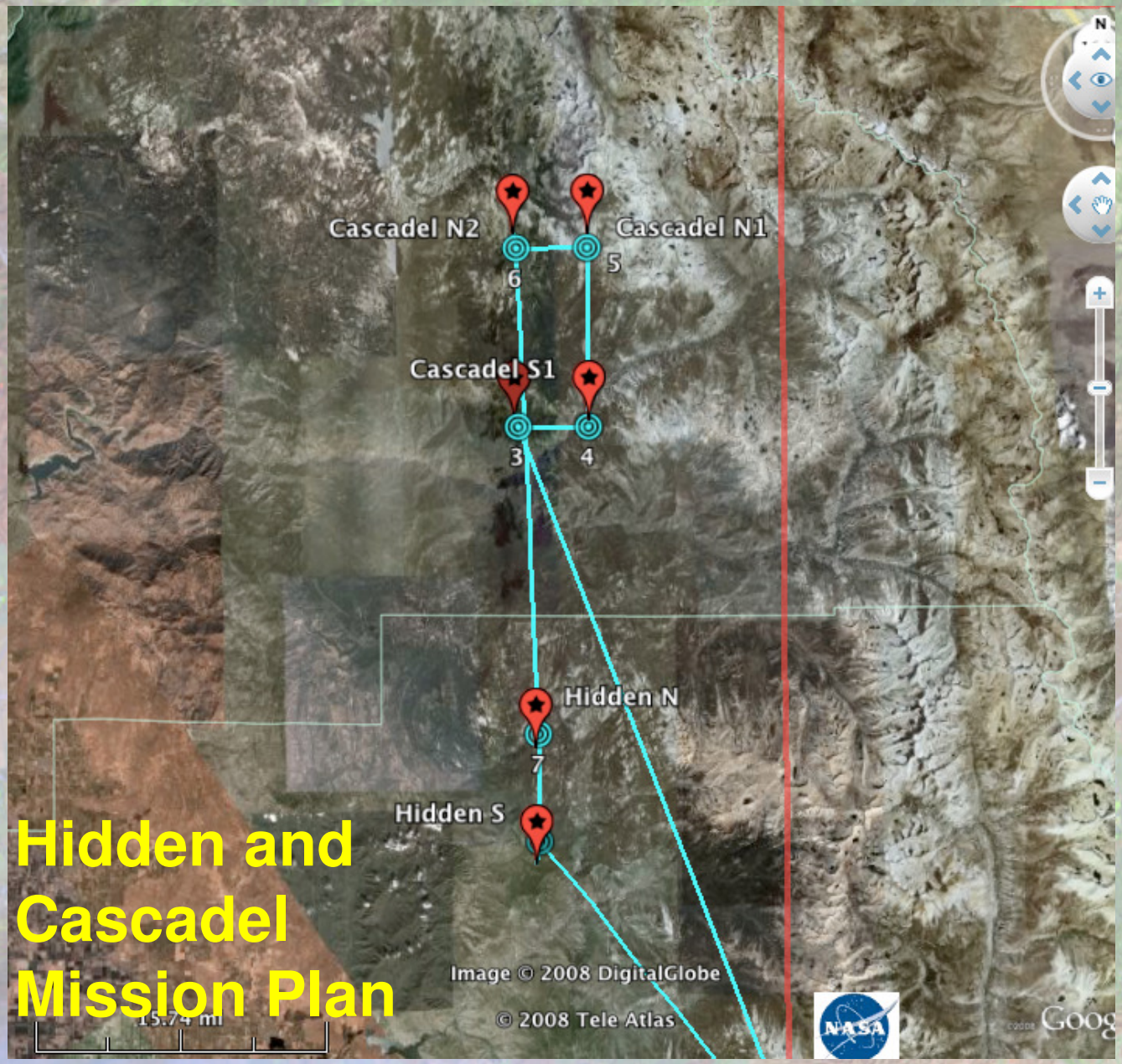


2nd Mission Plan

WSFM-08 NoCA Mission 3: 19 Sept 2008

3rd Mission Plan

WSFM-08 NoCA Mission 3: 19 Sept 2008



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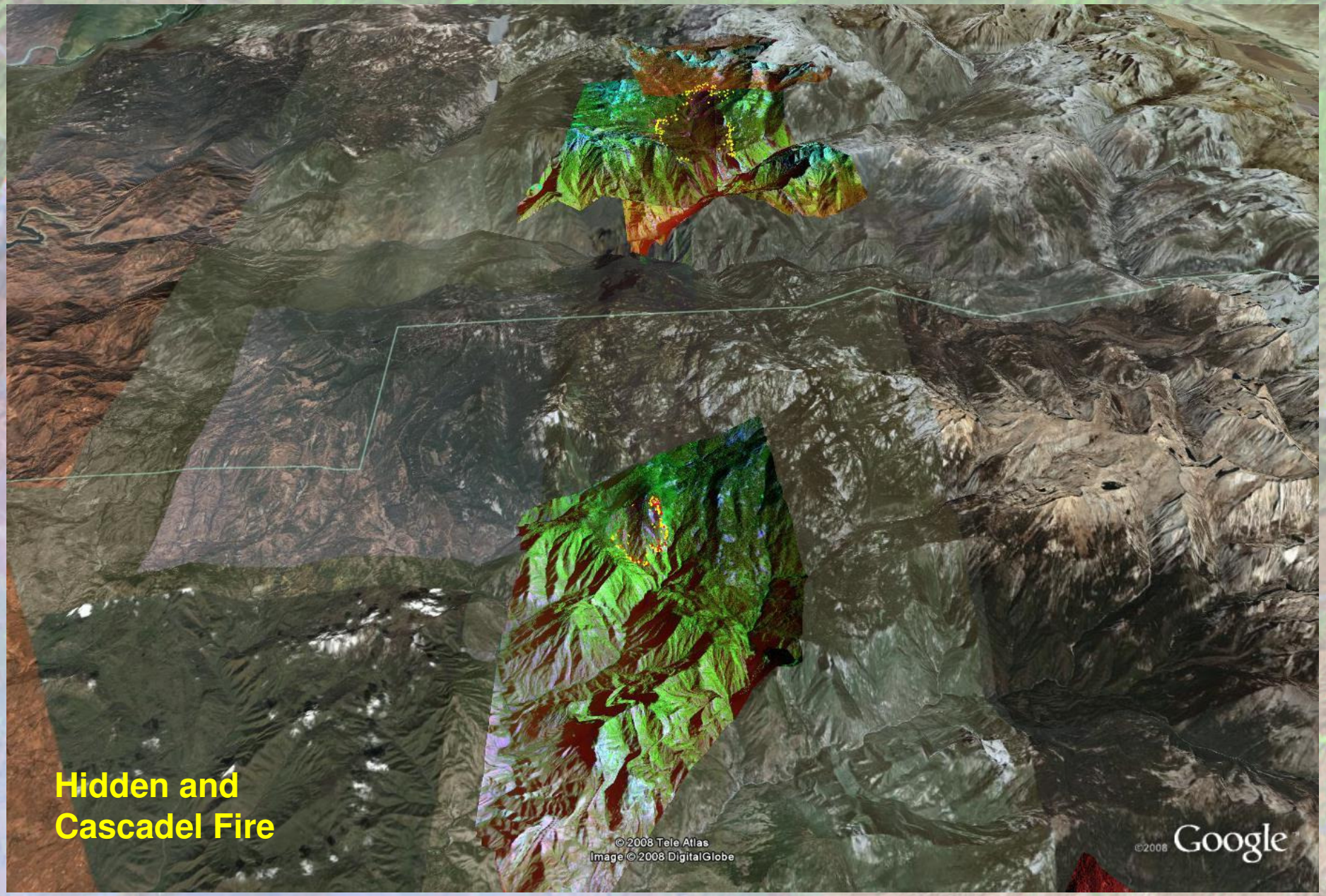

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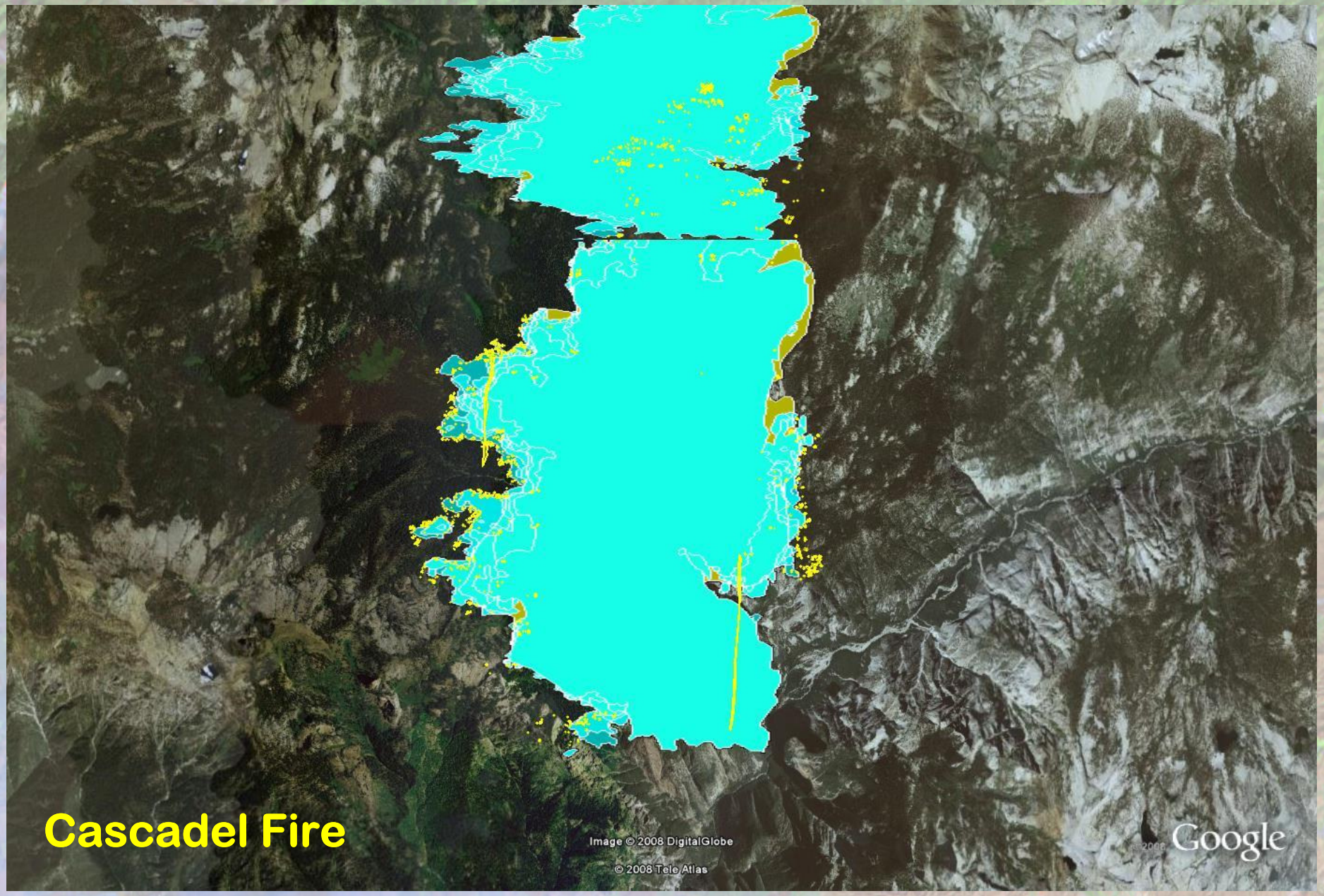

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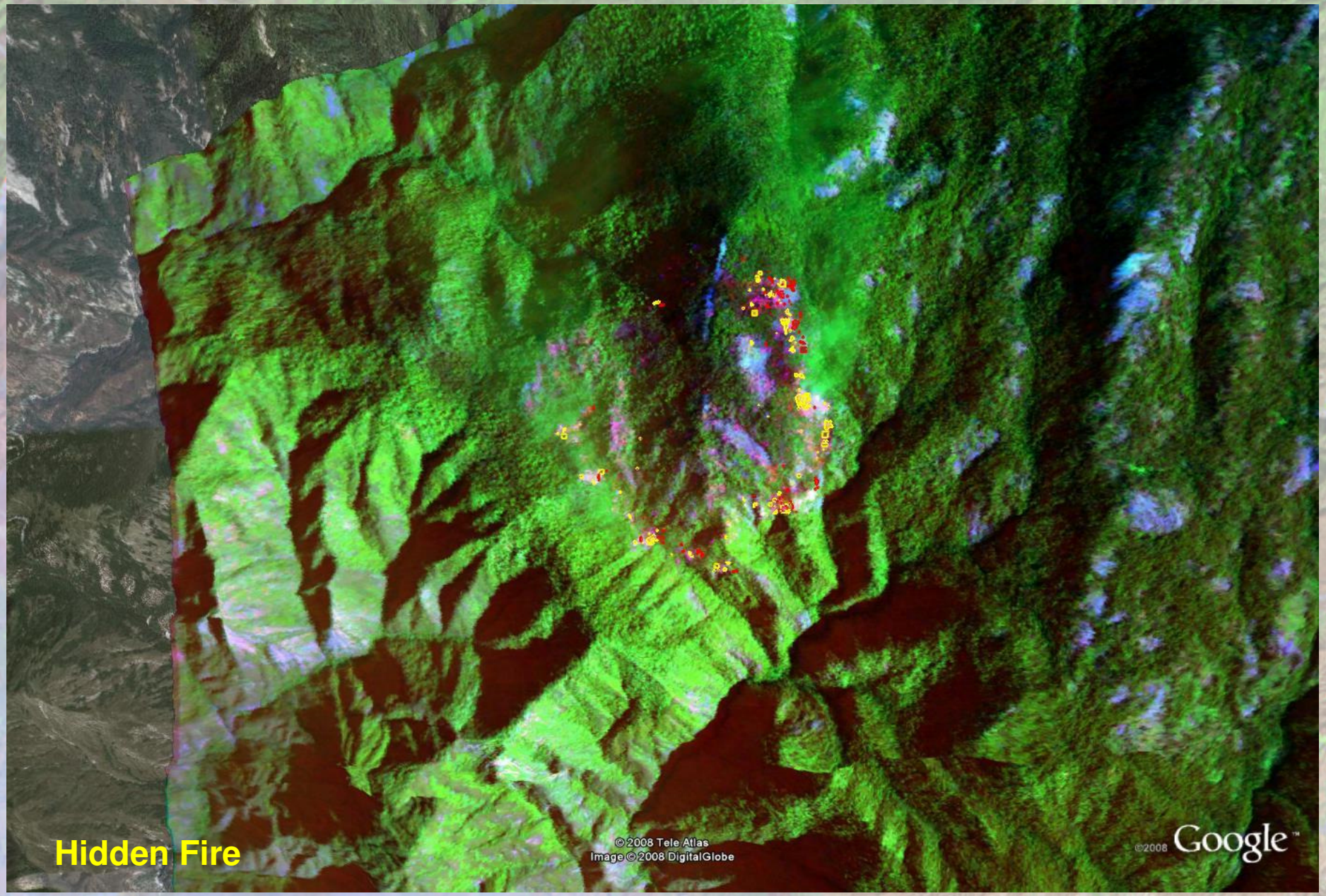

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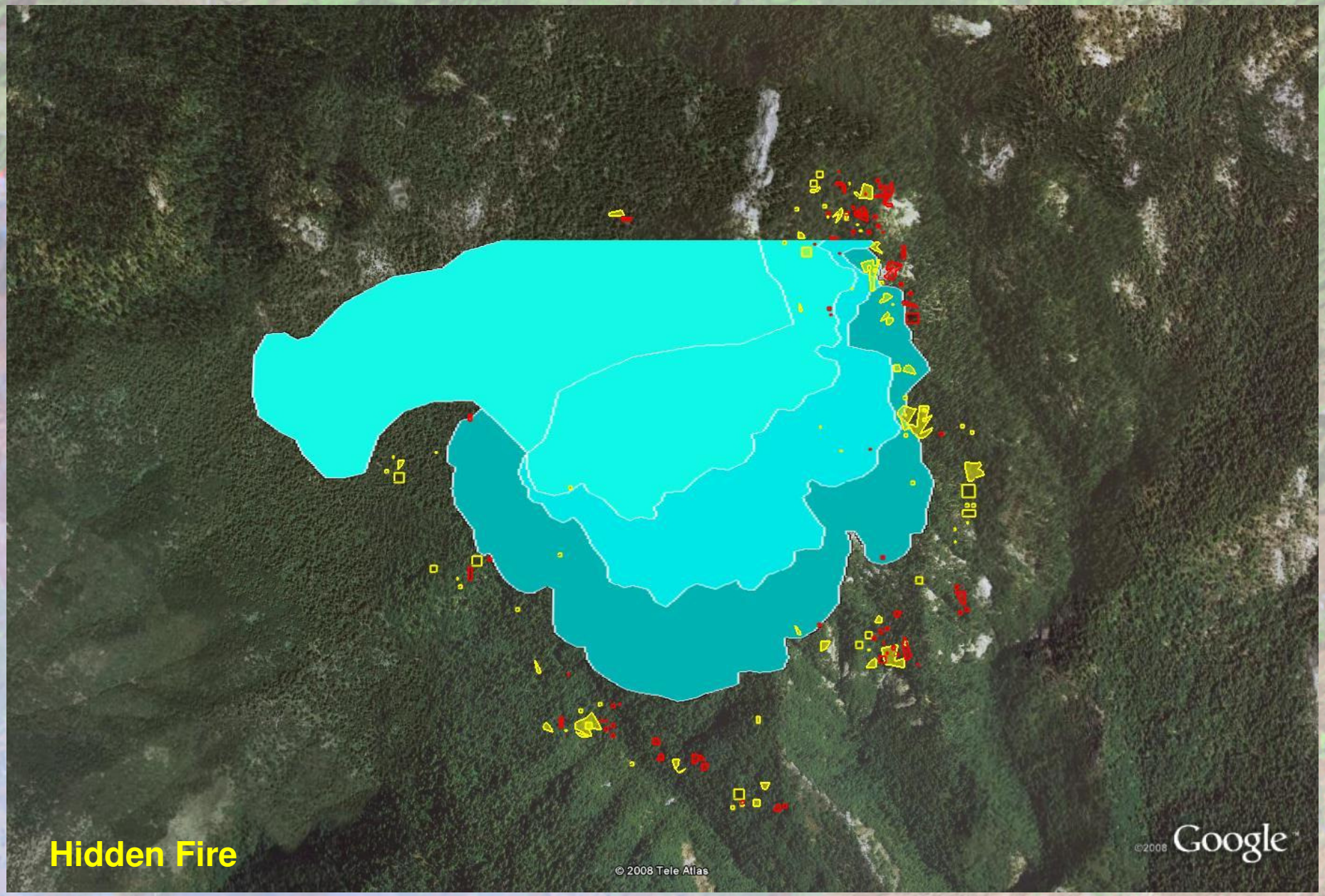

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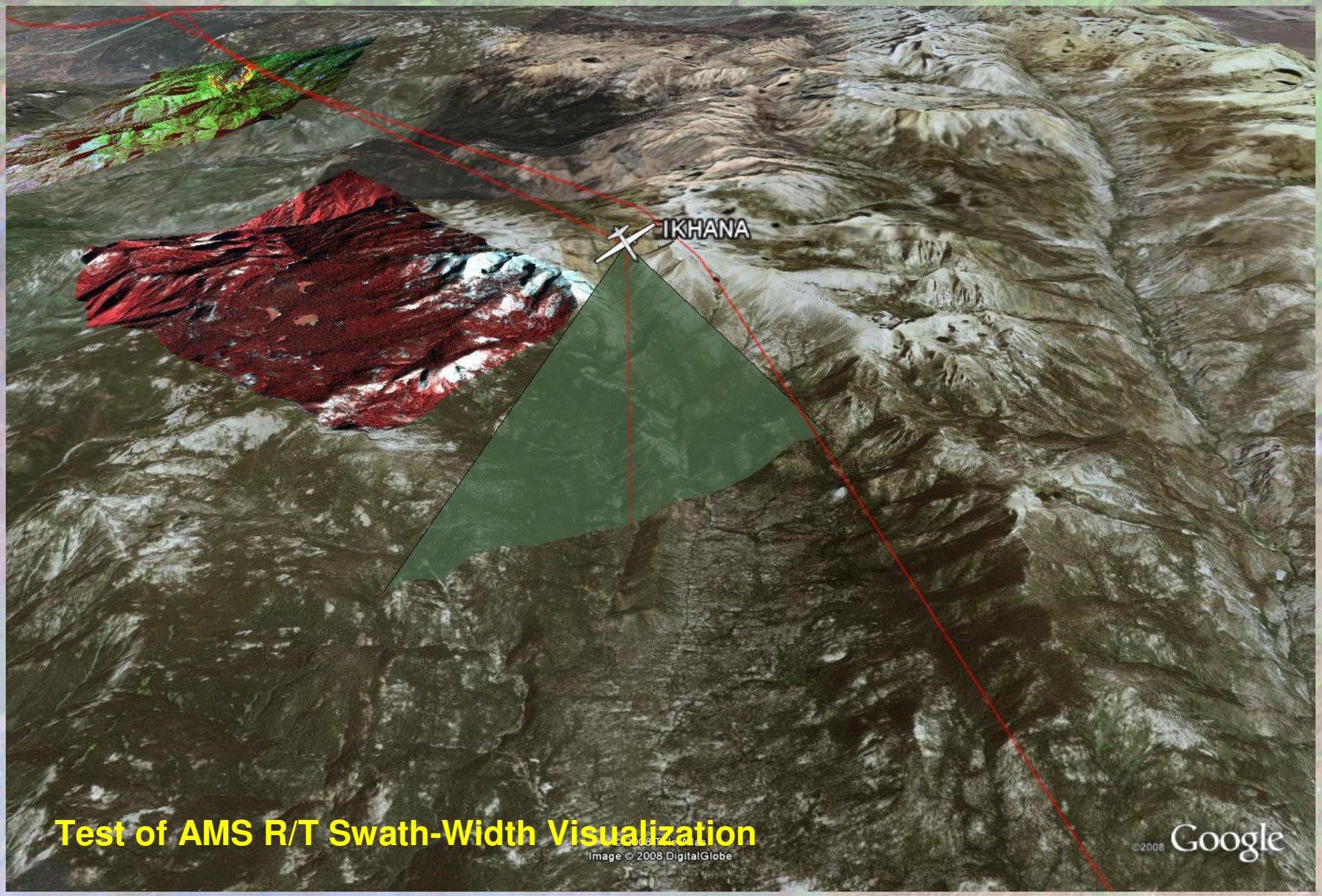
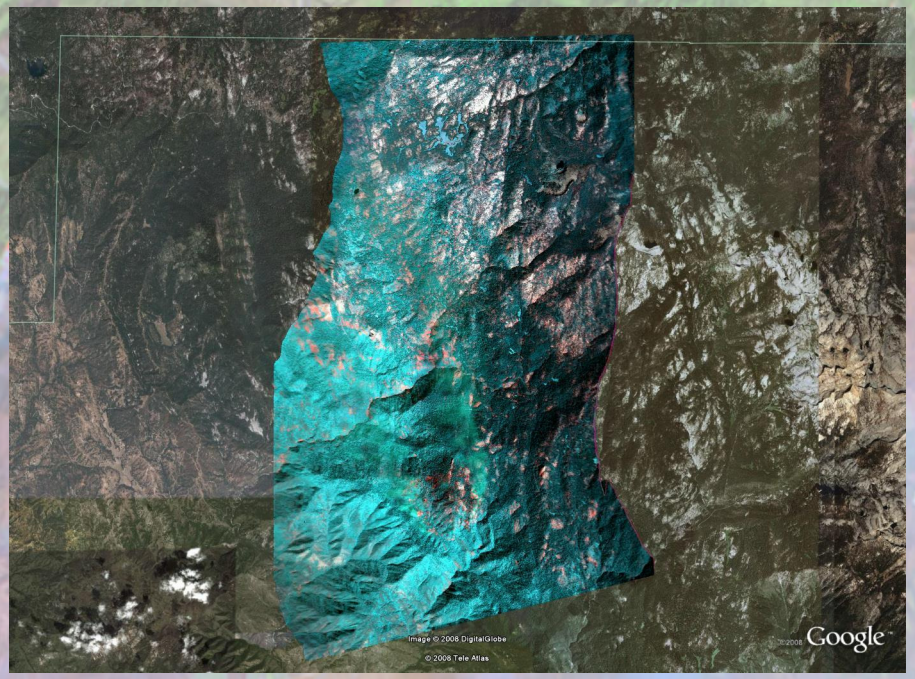
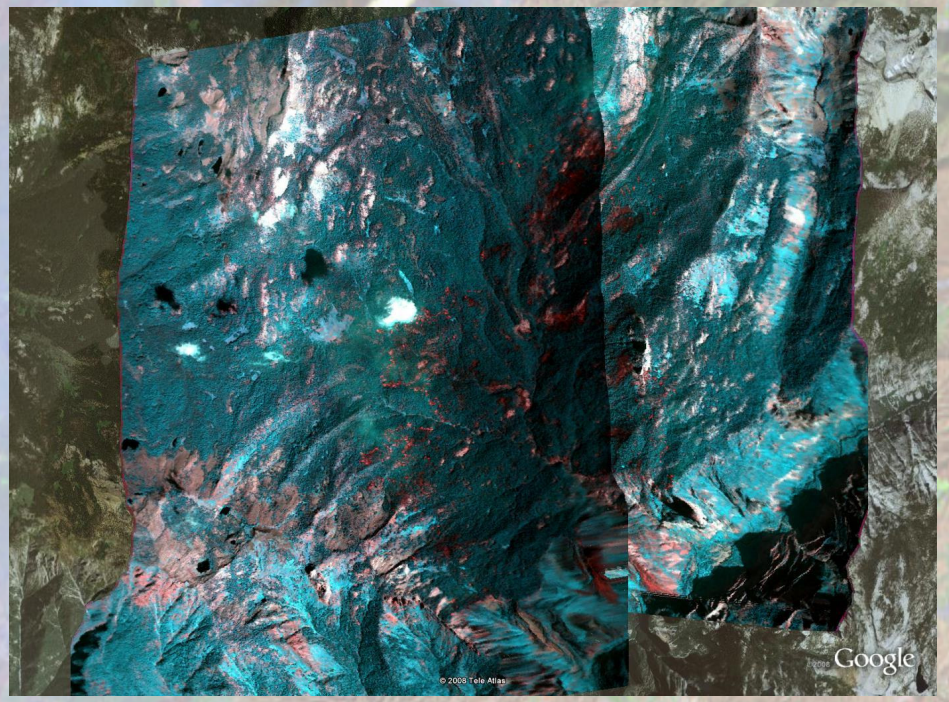


Test of AMS R/T Swath-Width Visualization

WSFM-08 NoCA Mission 3: 19 Sept 2008



Hidden and Cascadel BAER Data



AMS Bands :

10: 2.08- 2.35 (TM7)

7: 0.76- 0.90 (TM4)

8: 0.91- 1.05

Summary of WSFM - 2008

No CA Fires Mission Summary 2008 (as of 10-17-08)

Mission Number	Mission Endurance	Date	Fire Imaged
NoCA #1	9.5 Hours	7/8/2008	Piute Clover Silver North Mountain American River Cub Complex Canyon Complex Basin Gap
NoCA #2	5.03 Hours	7/19/2008	American River Camp Cub Complex Canyon
Engineering Check	3.0 Hours	9/17/2008	Piute (BAER)
Mission #3	3.5 Hours	9/19/2008	Cascadel Hidden

Total Mission Time: 21.0
Total Fires Flown: 16

WRAP 2009

- Integrate fire-critical model-derived data from NASA's Terrestrial Observation and Prediction System (TOPS) and scalable wind model data (NOGAPS) into the W-CDE.
- Mature and integrate new airborne sensor fire detection algorithm capabilities with the NASA-AMS-Wildfire sensor (atmos. correction).
- Develop new airborne post-fire burn severity indices data to feed directly into the W-CDE (post fire NBR data).

ISSUES:

- Unsure of Ikhana use in '09; transitioned to NASA AERO, no longer supported by Airborne Sciences. Costs will go up dramatically.
- AMS-Wildfire is an institutional instrument, will be committed to other projects in spring and fall '09 (ARCTAS) on GH.
- Possible fire demo missions in EU (Greece) in summer '09.

Additional Information

Wildfire Research and Applications Partnership (WRAP) Web Site:

http://geo.arc.nasa.gov/sge/WRAP

Wildfire Collaborative Decision Environment (W-CDE):

Add following in GoogleEarth at: Add / Network Link

http://sggate.arc.nasa.gov:9518/GoogleEarth/CDE.kml