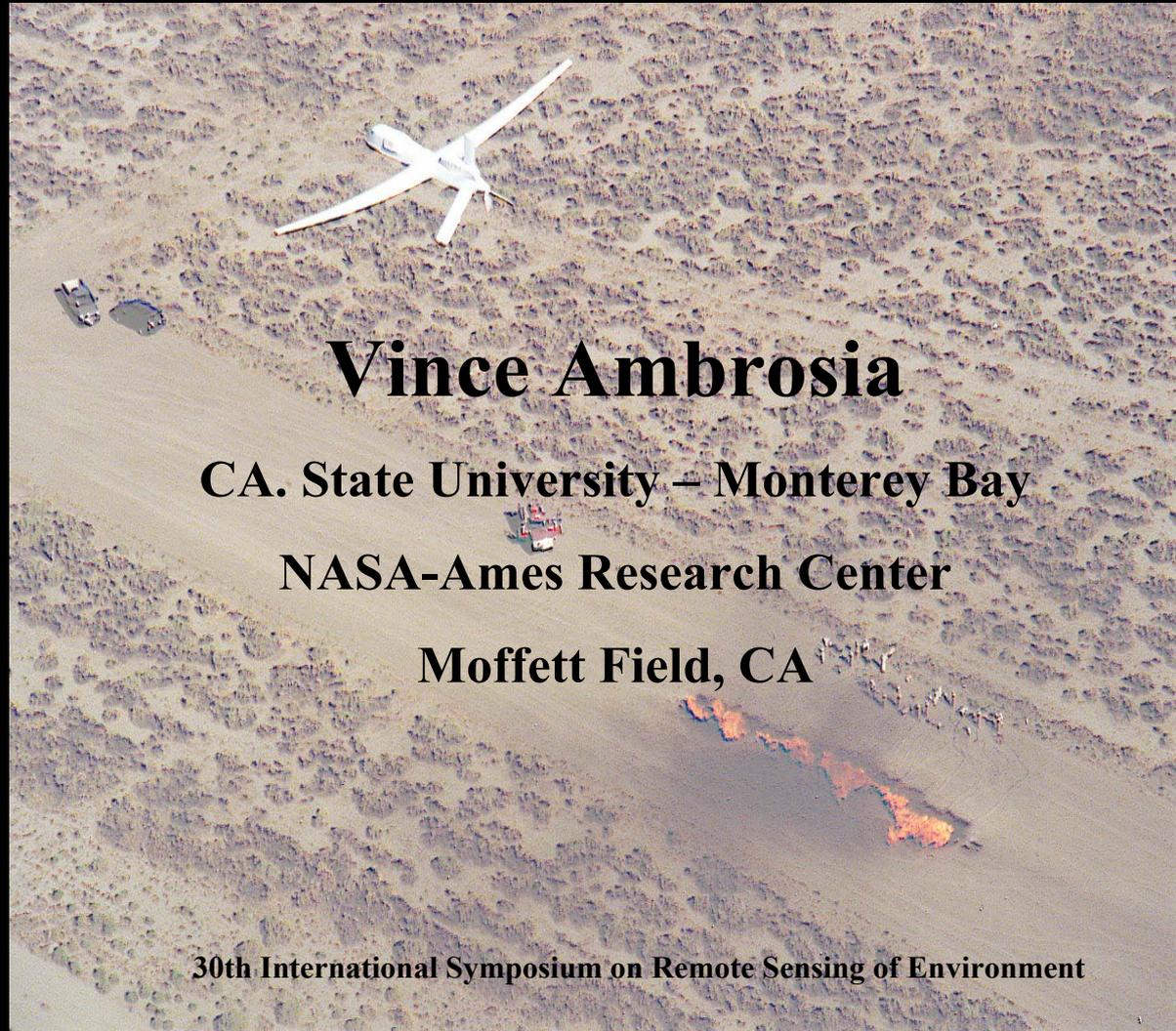


# Disaster Management Applications - Fire



**Vince Ambrosia**

**CA. State University – Monterey Bay**

**NASA-Ames Research Center**

**Moffett Field, CA**

30th International Symposium on Remote Sensing of Environment

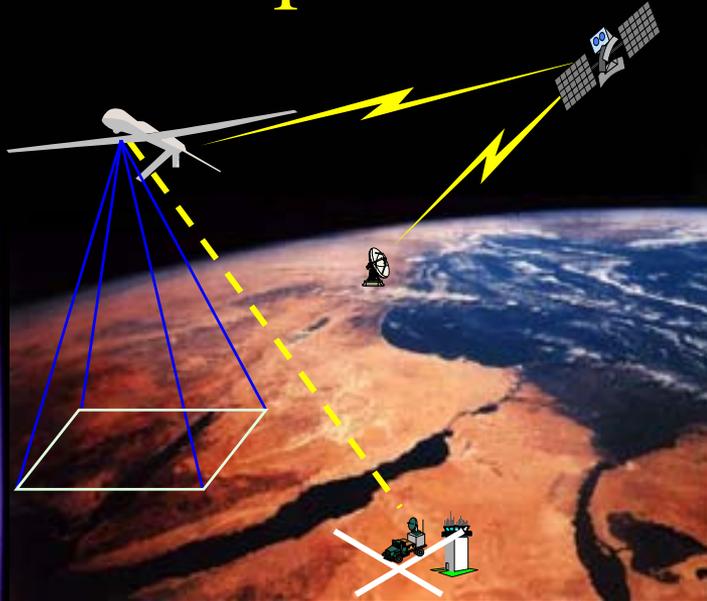




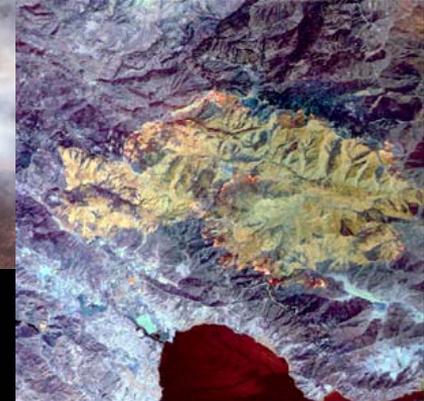
# Key Issues In Use of UAV's For Disaster Management

- **Match the sensor and airframe to the “event.”**
- **Provide autonomous or “remote operation” capabilities to sensor.**
- **Provide capabilities for data telemetry.**
- **Examine data compression if required to telemeter large data volumes.**
- **Capabilities for data handling on ground.**
- **Information distribution to community.**

# UAV Disaster Detection and Warning Concept: The FiRE Demonstration



- UAV platform providing long-duration flights w/o pilot in hazardous conditions (24/7).
- Integrated remote-operated, adaptive, multi-spectral sensor (AIRDAS) payload.
- Integrated OTH satellite telemetry communications.
- Geo-rectify image data in real time.
- Global distribution to WWW.



# UAVs Provide Unique Assets

## Data Acquisition Capabilities For Disaster Management Applications

### UAVs Allow:

- Continuous flight for hours to days
  - Extreme Altitude Flight
  - No pilot on board
  - Real-time telemetry capabilities
- 
- **Digital Imaging Sensors:**
    - **AIRDAS**, DASI, ARTIS, ALFI, Kodak, Bassler, DuncanTech, Microbolometer



# Improved Airborne Platforms (UAVs)

**Goals:** Provide technology development and demonstrations that prove and extend the use of UAVs to collect critical disaster information in real-time to affect decision processes.



**Driving the development of UAV technology for utility in disaster management**



# ALTUS II PLATFORM



## ALTUS Specifications:

**Wing Span:** 55.3 ft.; **Length:** 23.6 ft.;  
**Height:** 9.8 ft.

**Weights:** Max GTOW: 2150 lb; **Payload:**  
330 lb

**Navigation:** Litton LN-100G INS/P-Code  
GPS

**Avionics:** C-Band Line-Of-Sight RF;  
adaptable for OTH Operations; Remote  
Operations or autonomous

## Performance:

**Max Altitude:** 65,000 Feet

**Endurance:** 8 Hours @ 60K ft.  
18 Hours @ 30K ft.  
24 Hours @ 25K ft.

**Max Speed:** 100 KIAS

**Cruise / Loiter Speed:** 65 KIAS

**Range:** ~1500 Mi. at 25K ft.



# Remote Operations of UAV and Payload

Exterior View



Interior View

Ground Control Station

# Airborne InfraRed Disaster Assessment System (AIRDAS)



**Bands:** 1 (0.61 - 0.68)  
2 (1.57 - 1.70)  
3 (3.60 - 5.50)  
4 (5.50 - 13.0)

**Calibration:** IR bands to +600° C.  
Spectral and Radiometric -  
twice a year

**FOV:** 108 degrees

**IFOV:** 2.62 milliradians

**Scan Rate:** 4-23 scans / sec.

**Digitized Swath Width:** 720 pixels

**Ground Resolution:** 8m at 10K feet

# AIRDAS Payload Integration on ALTUS II UAV

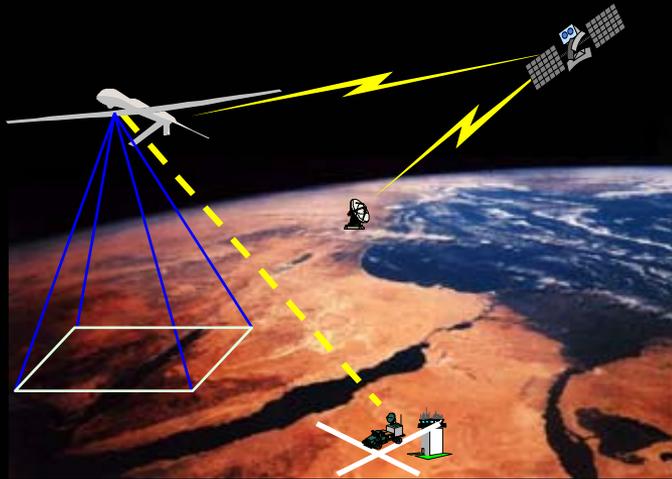


The AIRDAS Optical Head in the ALTUS  
UAV payload compartment



The ALTUS II UAV with the  
AIRDAS payload aboard during FIRE  
Mission

# Real Time Data Telemetry Development



- Integrate a satcom telemetry system on a UAV for telemetry of payload data.
- Test and evaluate transmission of payload data OTH
- Evaluate steerable antenna for UAV integration.
- Evaluate data rate throughput upgrade path for future missions.
- Evaluate cost / benefit of satcom telemetry

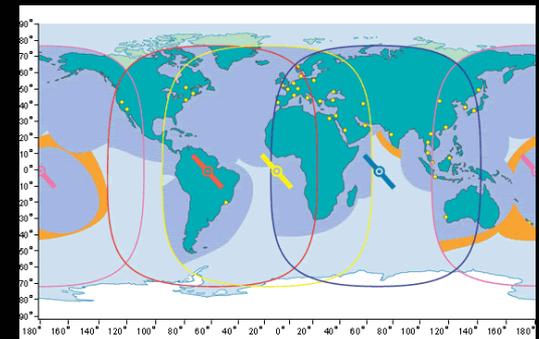
## Develop data telemetry technology for utility in disaster management



NERA WC M4  
64KBS  
Planned to 432 Kbs



INMARSAT Coverage



# OTH Data Telemetry

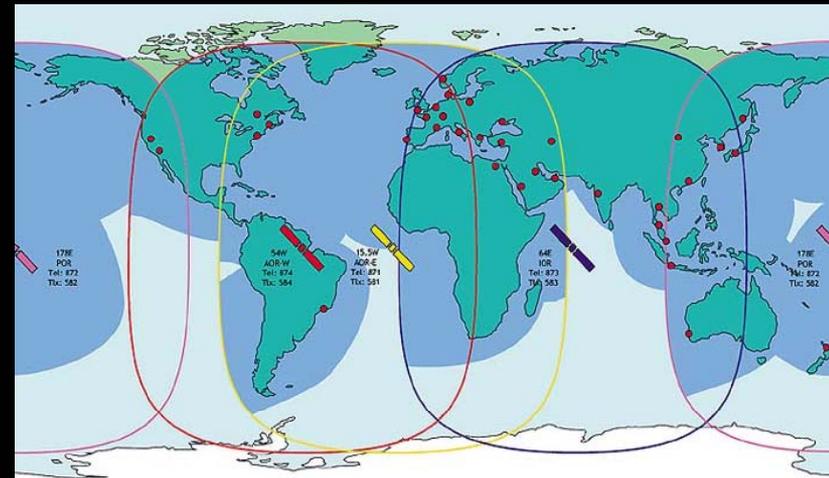


## NERA M4 Mobile World Communicator System

- 64 kbps data full duplex @ \$7.00/minute
- >\$10K for equipment
- Antenna folded out: H=13.4in x W=30.5in x 0.5in
- Two NERA antennas were mounted in the Altus, one on either side of the front bay.

## INMARSAT Global Area Network Service Coverage

- Pure Digital Interface
- Clean Upgrade Path
- Upgrade satcom network to +300Kbs in 2003
- Worldwide coverage



# FiRE Demo Controlled Burn



**Propane fire and fuel pits adjacent to GA-ASI runway**



**ALTUS II takeoff – 6 Sept. 2001**



**ALTUS Climb-out adjacent to fire**

# Data Collection

Five passes made over fire in one hour mission time. Single and multi-band image files (un-rectified) were generated on-board UAV and transmitted to file server at NASA-ARC:



## Single band Image File:

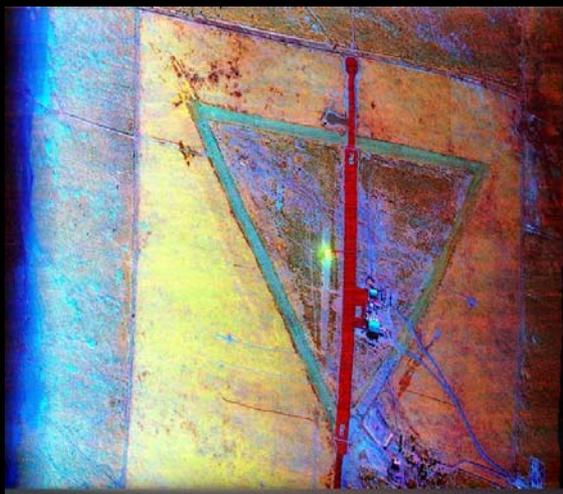
JPEG single band (3);  
compressed onboard UAV  
from signed 16-bit to 8-bit.

## Color Composite Image File:

JPEG 3 band (3, 2, 1); compressed  
onboard A/C from signed 16-bit to  
8-bit.



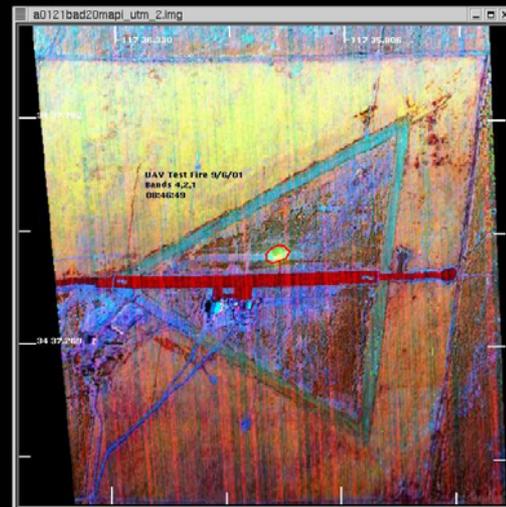
# Geo-Rectification



“Raw”, un-rectified 3-band color composite image telemetered from ALTUS

Terra-Mar’s Data Acquisition Control System (DACS) software uses navigation geometry data to project each pixel to ground location and adjust for terrain (if a DEM is employed in the modeling). Geo-rectification took approximately 6-7 minutes.

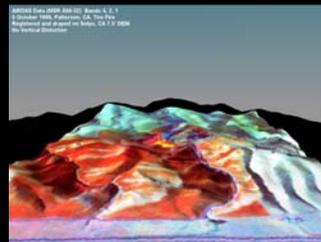
Geo-rectified data and TFW processed in ~10 min., sent to, and accessed at WWW.



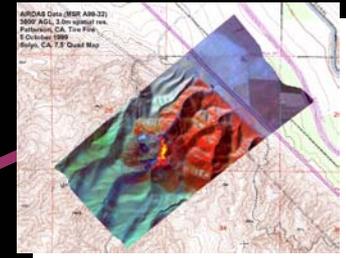
# Disaster (Fire) Decision Support Systems

The ability to telemeter highly calibrated thermal instrument data in near-real-time is essential to supporting tactical fire operations within the fire fighting community

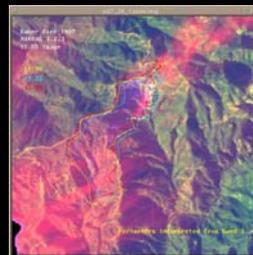
Real-time data geo-rectification procedures allow the tactical fire product to be integrated into the fire manager's decision support system for overlay with other critical data



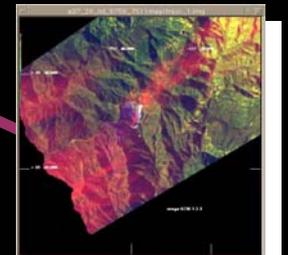
AIRDAS Data – Tire Fire, CA 1999, geo-rectified and overlain on 7.5' digital quad.



AIRDAS Data – Tire Fire, CA 1999, geo-rectified and draped over SRTM terrain data.



AIRDAS Data – Baker Fire, CA 1997, time-series analysis.



AIRDAS Data – Baker Fire, CA 1997, geo-rectified imagery.



Fire Incident Command Center (ICC) – Assimilation of Fire Remote Sensing Information and Data into the Fire Decision Support System.



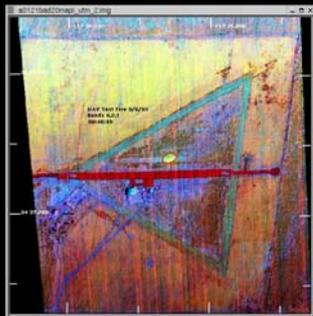
# Attainable Capabilities

- **Operate payload and platform remotely.**
- **OTH data telemetry lock-on and transmission in 1-2 minutes!**
- **Disaster image data available at WWW within 2-3 minutes of collection!**
- **Geo-correction and re-distribution to WWW in 7 minutes!**
- **Total time (from collection to distribution): ~10-15 minutes!!!**

# Heritage of UAV Fire Imaging At NASA-Ames

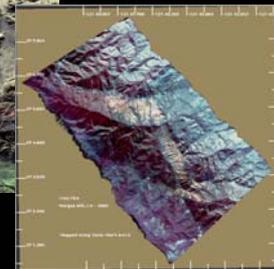
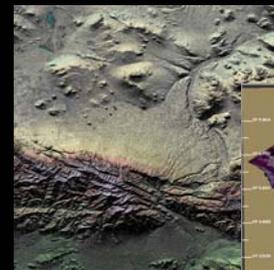
## FiRE (2001)

- AIRDAS system / ALTUS UAV
- NERA / INMARSAT data telemetry – 64 Kbs
- Three channel color data (thermal, IR and vis)
- Data available (geo-rectified ) in 15 minutes



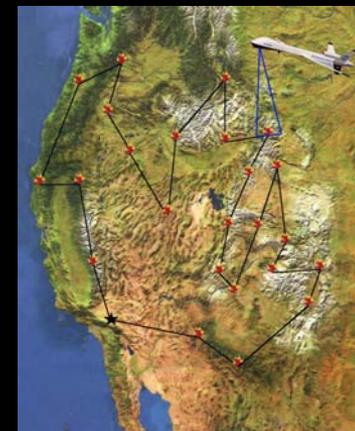
## FiRE II (2004)

- ALTUS II performing in FAA NA
- High Altitude (20-55K ft)
- AIRDAS Payload / 500Kbs Telemetry
- Wildfire Condition
- Real-time scramble and data relay
- Geo-rectify and terrain fit using SRTM



## Western States Mission (2004-2005)

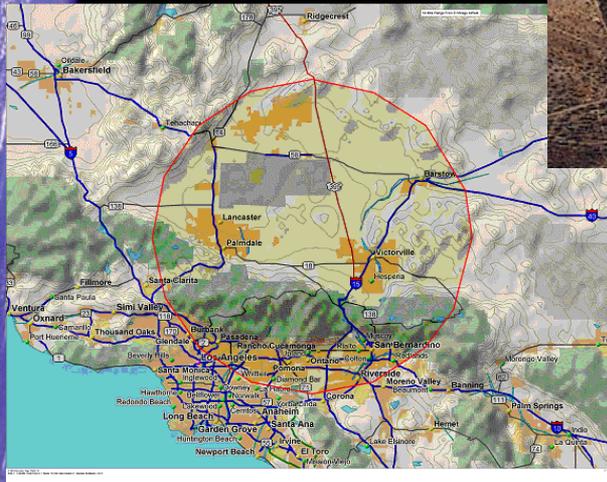
- AIRDAS, Radar, and Skyball systems / ALTAIR UAV
- Multiple channel data (thermal composites)
- Ku Band Telemetry – 512 Kbs
- Data available for many fires over Western US in 10 minutes



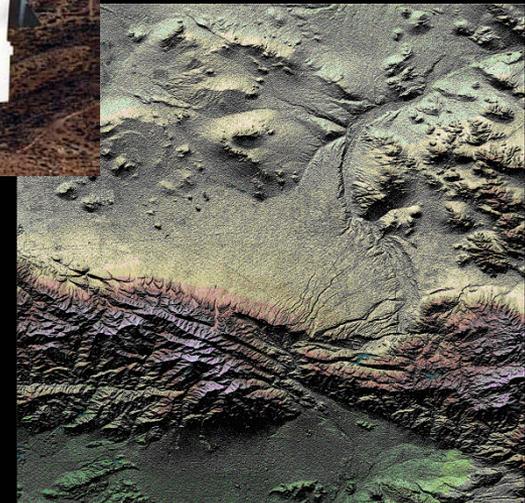
# FiRE II Demonstration Mission



- ALTUS II operating in FAA NA
- High Altitude (20-55K ft)
- AIRDAS Payload / 500Kbs Telemetry
- Wildfire Condition
- Real-time scramble and data relay
- Geo-rectify and terrain fit using SRTM



50 Mile Radius



SRTM Data

# Western States Mission (ALTAIR FiRE)



## ALTAIR Specifications:

**Wing Span:** 84 ft.; **Length:** 36.2 ft.; **Height:** 11.8 ft.

**Weight:** Max GTOW 7700 lbs.; **Payload:** 750 lbs.

**Max Altitude:** 55K feet

**Endurance:** 32 hrs w/ 700 lb payload

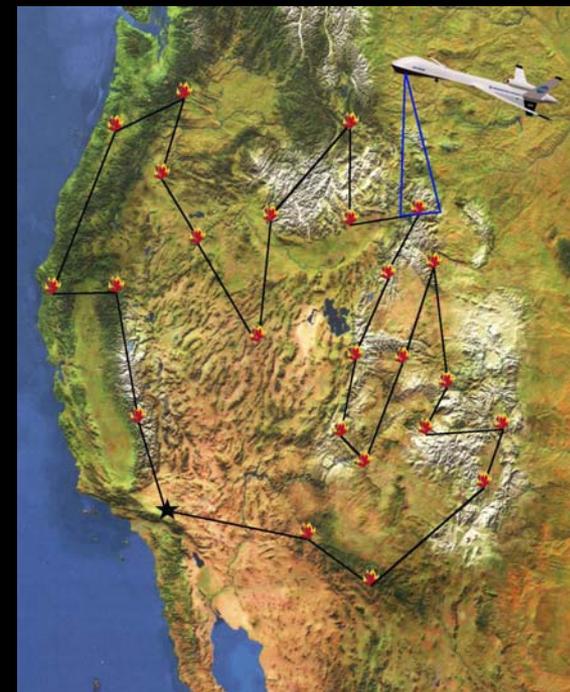
**Cruise / Loiter Speed:** 144 KIAS; **Range:** 4500 nm

**C-Band LOS Range:** 100 nm; 500 Kbs Ku-band  
OTH Operations; Autonomous flight capable

**Navigation:** 3 integrated IMU's & 3 D-GPS

## Mission Plan with ALTAIR UAV:

- Fly +24 Hr Mission over Western US
- Collect AIRDAS data over multiple fires
- Telemeter via Ku-band to ground
- Real-time image rectification
- Distribute information to web and ICC's





# Contact and Further Info

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FiRE Project Web Site:

<http://geo.arc.nasa.gov/sge/UAVFiRE>

UAV Applications Center Web Site:

<http://www.uav-applications.org>

NASA Ecosystems Branch Web Site:

<http://geo.arc.nasa.gov/sge>