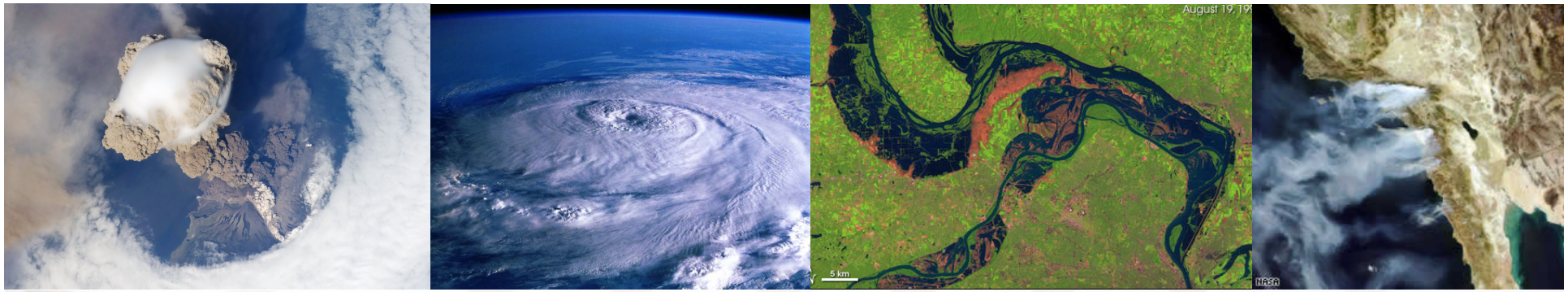
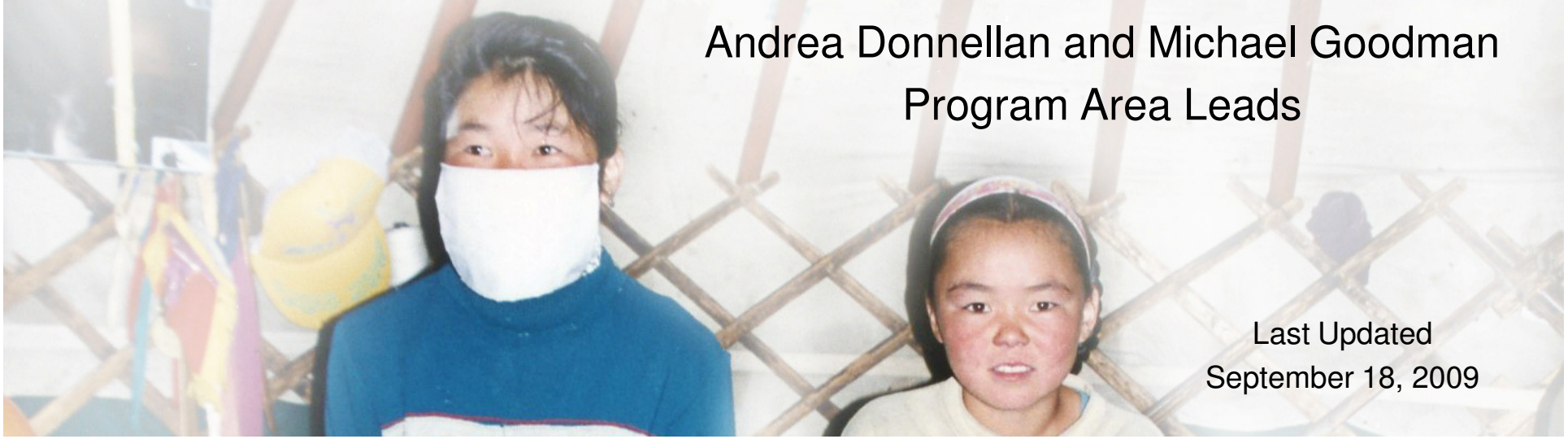


Applied Sciences

NASA's Decadal Survey Missions and Natural Disasters Program

Andrea Donnellan and Michael Goodman
Program Area Leads



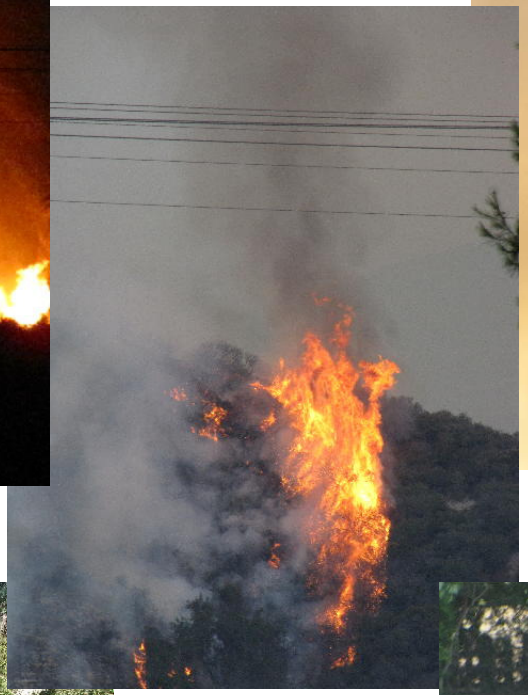
Last Updated
September 18, 2009

NASA, Natural Disasters, and the SDR

- NASA is a research agency
- In the event of a disaster NASA applies available assets
- Some overlap between disaster response and science
  - *Immediate need for information greater for disaster response than for science*
- Challenge is to move from research to operations
  - *Need existing partnerships and collaborations*
  - *Simulations develop communication and identify existing gaps*
- Decadal survey missions provide an opportunity to engage in the process early
  - *Design missions for disaster mitigation and response as much as possible*
  - *Engage agencies in the design process*
  - *Additional needs or capabilities may require agency contributions*

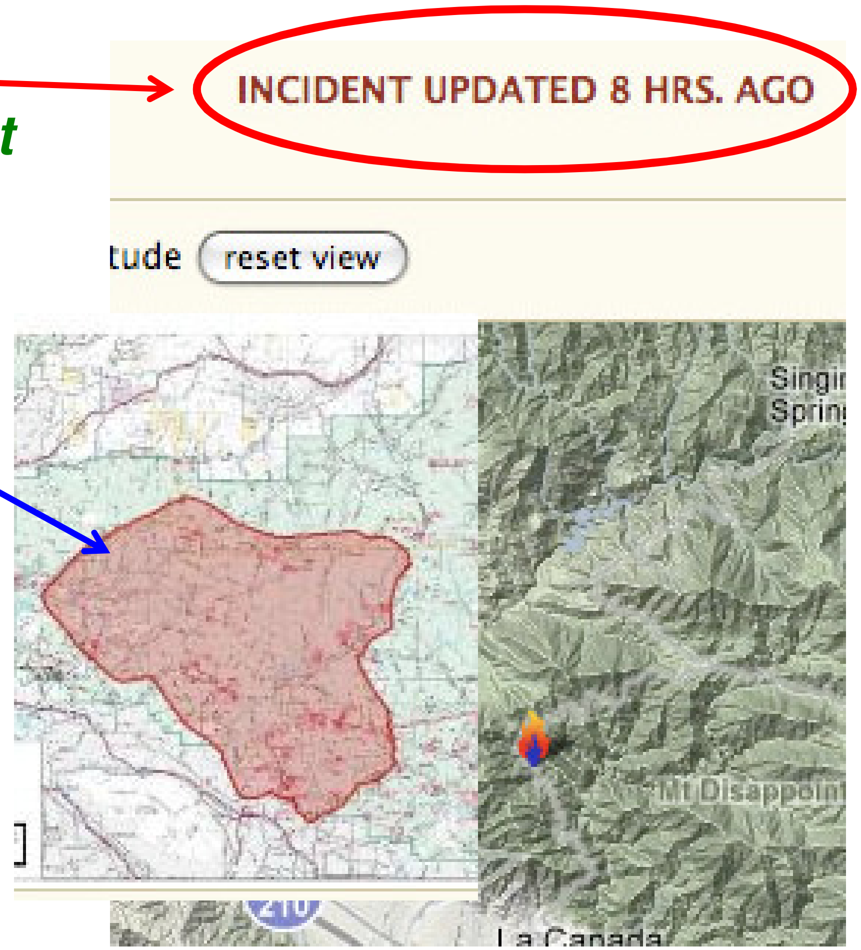
A Recent Example: Wildfires

August 29, 2009 El Prieto Road, Altadena, California



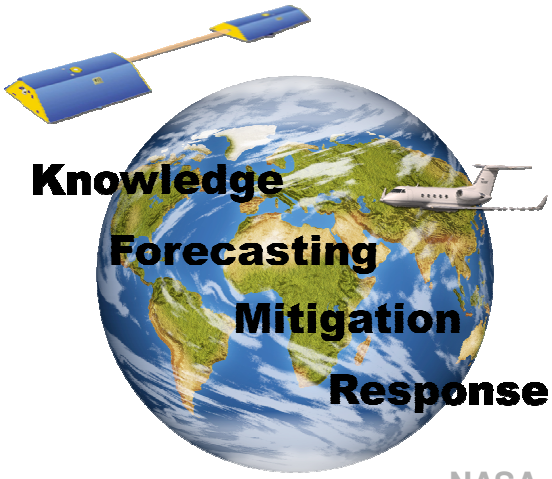
2009 Los Angeles Area Station Fire

- Over 145,000 acres and over 90 structures burned
- Over 10,000 homes and 2500 other structures threatened
- Information difficult to obtain
  - *Not updated frequently*
  - *Different information from different sources*
  - *Not at the individual or neighborhood level resolution*



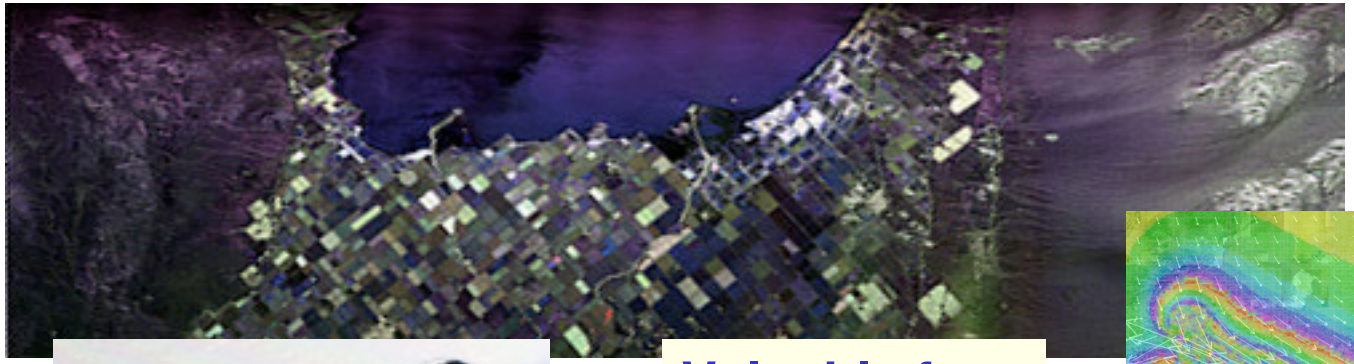
Flow of Information

- Communication between individuals occurred by
  - *On scene people*
    - Ground observers transmitting information to command center
    - Sheriff asking fire personnel for status updates as they drove out
    - Displaced people asking for information
  - *Social networks*
  - *Telephone and e-mail*
- Capabilities of SDR members range from spaceborne to ground logistics
- **How can we establish a clear flow and connections between the agency capabilities to reduce impacts of natural disasters?**

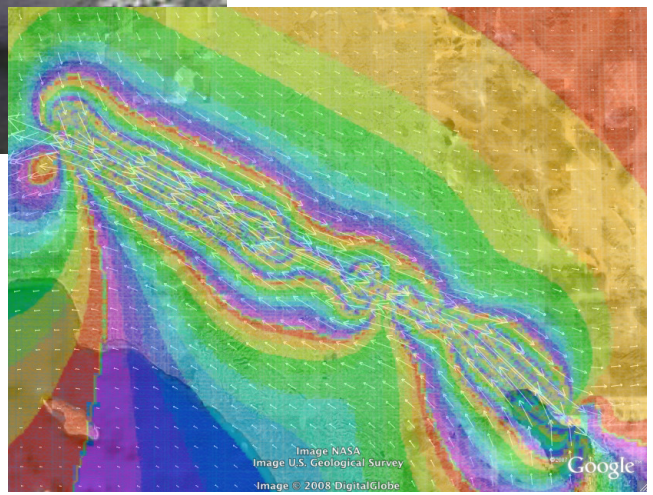


Simulated Exercises: Southern California Shake Out

- Simulated earthquake on the San Andreas fault
  - *Extensive participation in California*
- Walked through logistics of acquiring UAVSAR data
- Provided UAVSAR imagery (or simulated imagery) to the State Operations Committee
- Need understanding of what the imagery means



Valuable for establishing relationships prior to disasters



NASA Natural Disasters Program Area

Purpose

To bring NASA capabilities in the area of spaceborne and airborne platforms and observations, higher level data products, and modeling and analysis to improve forecasting, mitigation, and response to natural disasters

Derived from the White House Office of Science and Technology Policy (OSTP) **Subcommittee on Disaster Reduction** (SDR)

- **Six Grand Challenges**

- **Provide hazard and disaster information where and when it is needed**
- **Understand the natural processes that produce hazards**
- Develop hazard mitigation strategies and technologies
- Recognize and reduce vulnerability of interdependent critical infrastructure
- Assess disaster resilience using standard methods
- Promote risk-wise behavior

NASA

Other Agencies

Disasters as Defined in *Grand Challenges for Disaster Reduction* (http://www.sdr.gov)

- **Earth Surface**
  - *Volcano*
  - *Earthquake*
  - *Tsunami*
  - *Coastal Inundation*
  - *Flood*
  - *Landslide and Debris Flow*
  - *Wildland Fire*

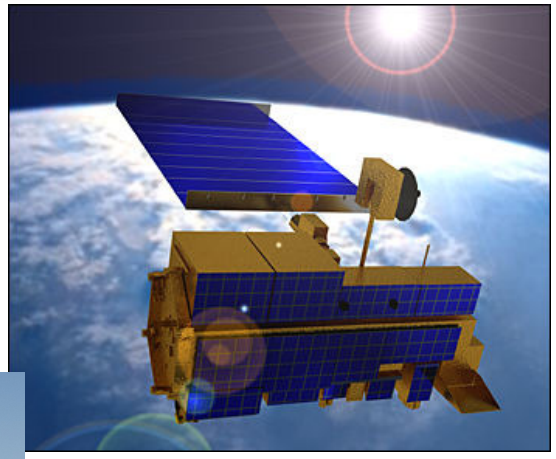
- **Weather**
  - *Hurricane*
  - *Tornado (not currently funded by NASA)*
  - *Winter Storm*
  - *Heat wave*
  - *Drought*

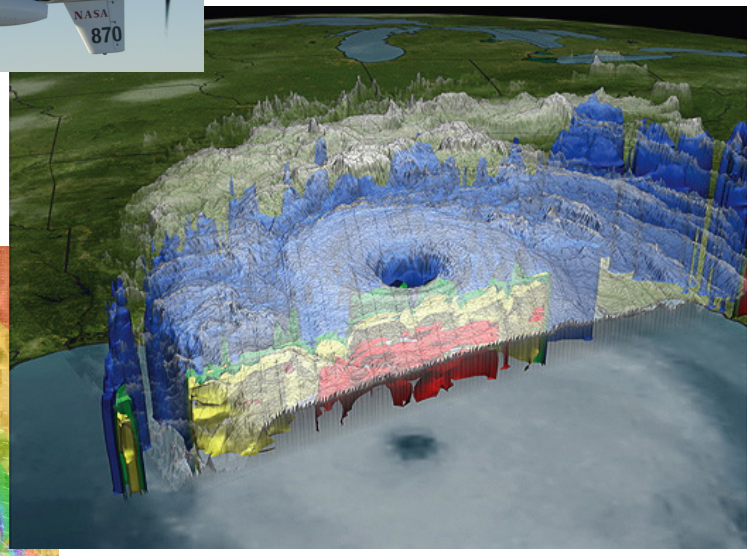
NASA funds projects in these areas

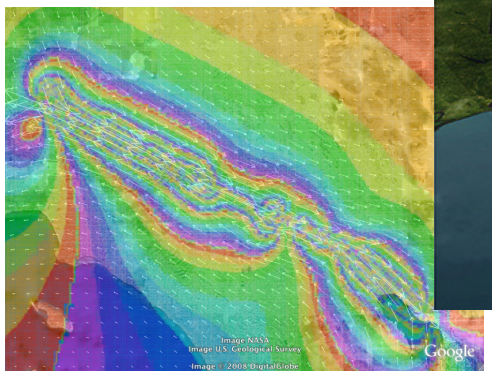
- **Health and well being**
  - *Technological Disasters*
  - *Human and Ecosystem Health*

NASA Capabilities

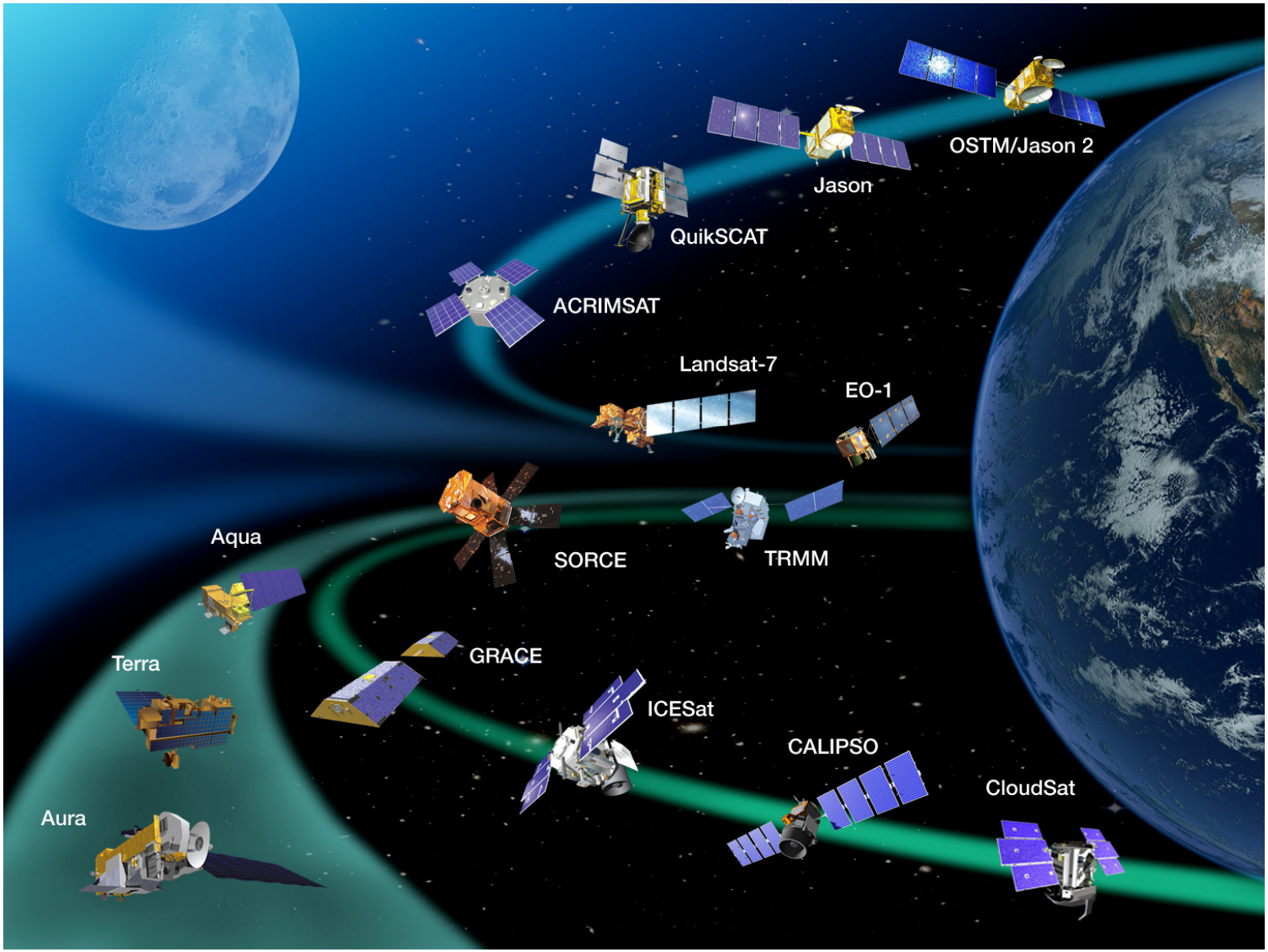
- Spaceborne
  - *Existing missions: MODIS, ASTER, LANDSAT, QuickSCAT, JASON..*
  - *Decadal survey missions: SMAP, DESDynI, HyspIRI*
- Airborne
  - *UAVSAR – Radar*
  - *LVIS – Lidar*
  - *Thermal Infrared*
- Data processing and analysis
- Modeling and analysis







NASA Missions



Natural Disaster Program Current Projects

Earthquake

Active Fault Detection and Evaluation from Multispectral Imagery and LiDAR

Florante Perez
Department of Conservation, California Geological Survey
California Department of Conservation

Earthquake Disaster Evaluation and Response

Margaret Glasscoe
Jet Propulsion Laboratory

USGS, CGS, OES

Tsunami

Earthquake and Tsunami Alert System from Real-Time GPS

Yoaz Bar-Sever
JPL

Hurricane

U.S. Hurricane Landfall and Climate: Reinsurance Decision Support

Timothy Hall
NASA Goddard Institute for Space Studies
NASA/Goddard Space Flight Center

Enhanced Decision Making using NASA Data within NOAA, NWS, and FEMA

Dave Jones
StormCenter Communications, Inc.

NWS SR HQ, FEMA REGION VI, MSFC

Flood/Landslide

Global Flood and Landslide Monitoring/Forecasting

Fritz Policelli/Bob Adler
GSFC/UMD

Wildfires

Predicting Forest Fire from Microwave Sensing of Fuel Loads

Sassan Saatchi
University of California, Los Angeles

University of California, Los Angeles

Human Health

Atmospheric Stability Analysis for Homeland Security Applications

Stephen Lord
NOAA/NCEP

Technological

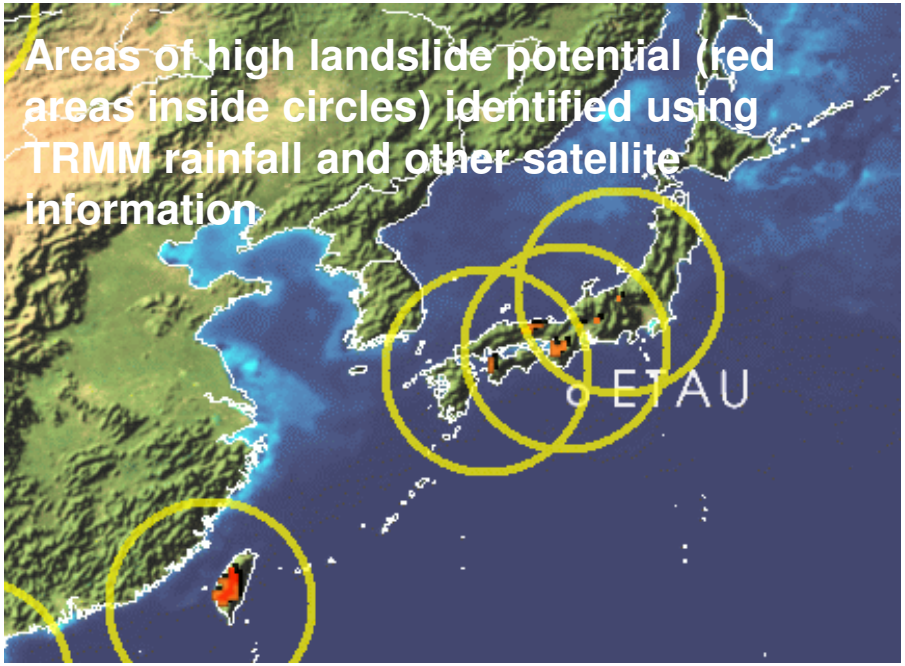
Monitoring Levees and Subsidence in the Sacramento-San Joaquin Delta using UAVSAR

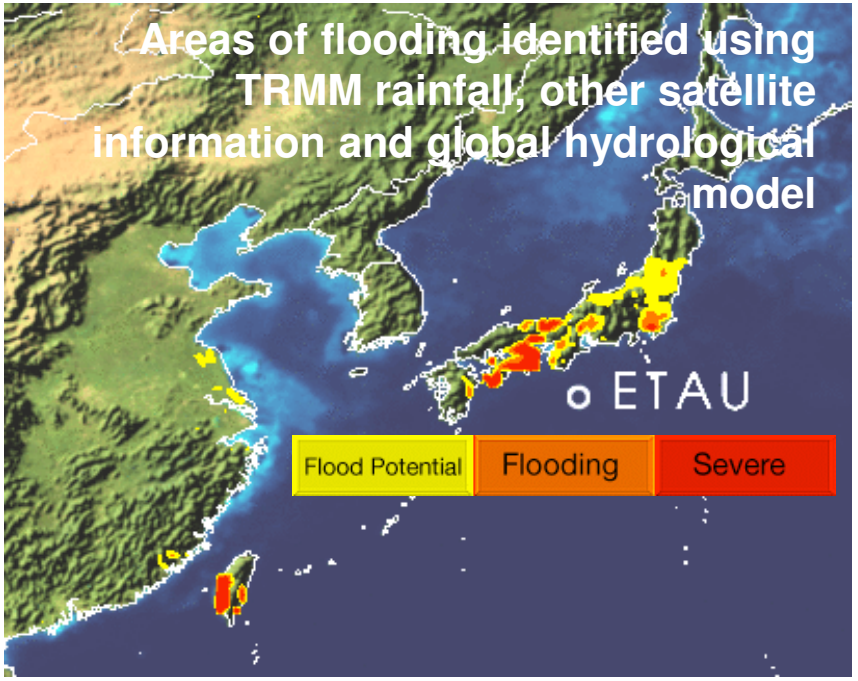
Cathleen Jones
Jet Propulsion Laboratory
California Department of Water Resources; US Geological Survey

Landslides and Flooding in Taiwan and Japan

Real-time Global Monitoring Using Satellite Data (including TRMM Rainfall Estimations) and Hydrological Models and Landslide Algorithms

10 AUG 2009 1200 UTC





400 unaccounted for in Taiwan mudslide

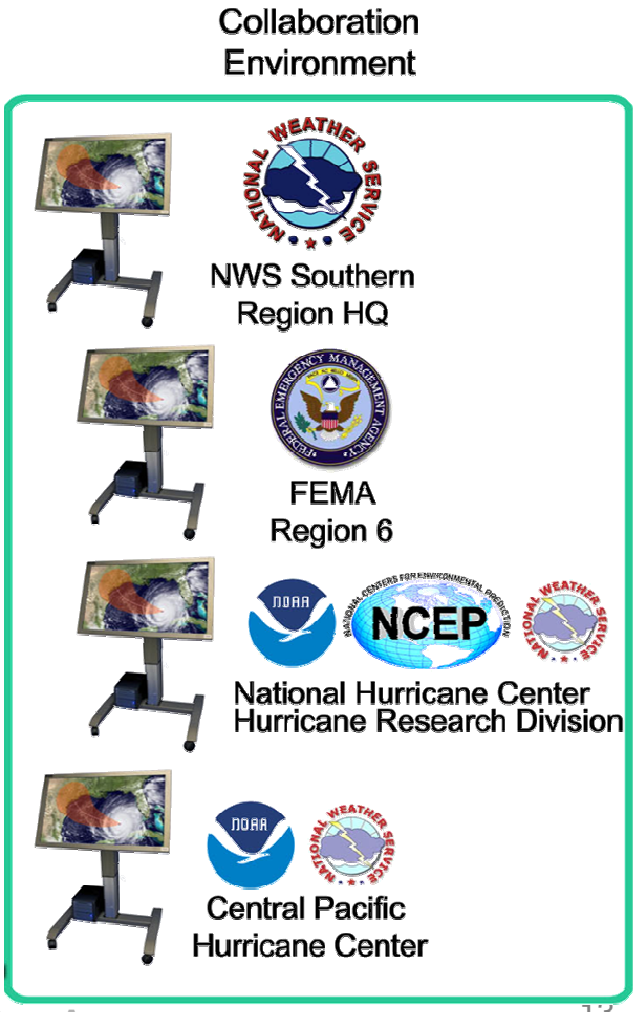
PETER ENAV, The Associated Press, Monday, August 10, 2009; 3:32 PM

TAIPEI, Taiwan -- A mudslide touched off by a deadly typhoon buried a remote mountain village, leaving at least 400 people unaccounted for Monday, and military rescue helicopters unable to land because of the slippery ground dropped food to desperate survivors

Bob Adler – U. Maryland, GSFC
Pierce, Policelli, Hong, Yilmaz, Kirschbaum, Huffman

StormCenter: Communication and Collaboration Tool

Enhance visualization and collaboration capabilities between NWS and FEMA Region VI while integrating NASA data into the decision making process



Dave Jones – StormCenter Communications

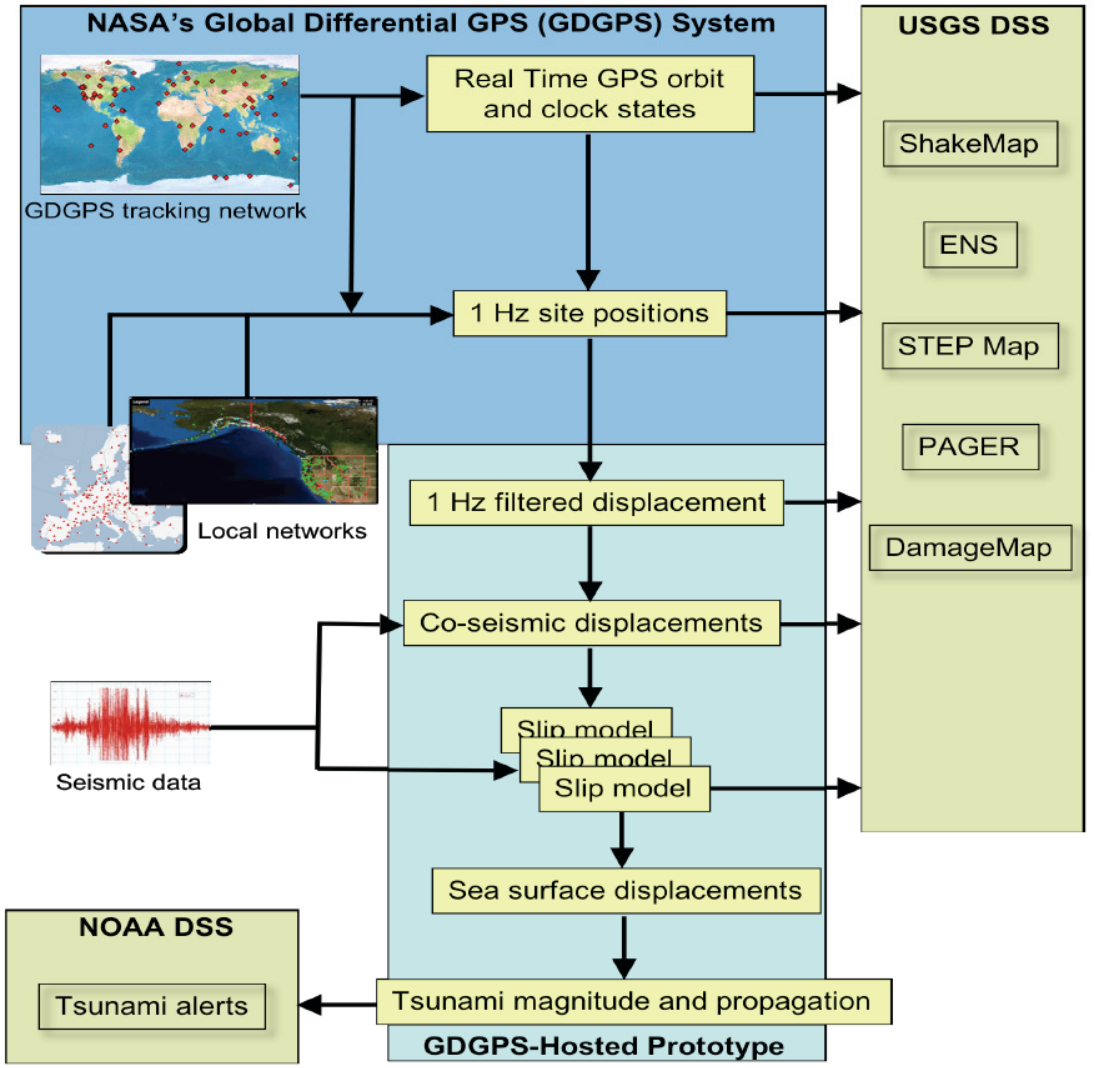
Levees and Water Resources

- Assess and determine changes in condition and integrity of levees
- Support
  - *Emergency response for levee failures*
  - *Delta Emergency Response Plan for major earthquakes*
- Understand subsidence and aquifer discharge and recharge for water management

UAVSAR image of the Sacramento Delta; pixel resolution = 3m x 3m (Cathleen Jones)

GPS Real-Time Tsunami and Earthquake Alert System

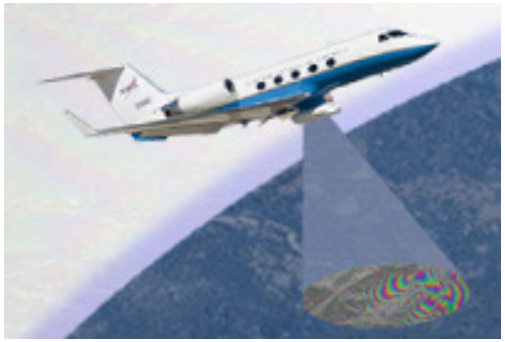
- Assess the magnitude and mechanism of large earthquakes and the magnitude and direction of resulting tsunamis from real-time GPS data
- Improve tsunami warnings by NOAA's Pacific Tsunami Warning Center (PTWC)
- Enhance the USGS post-earthquake damage assessment

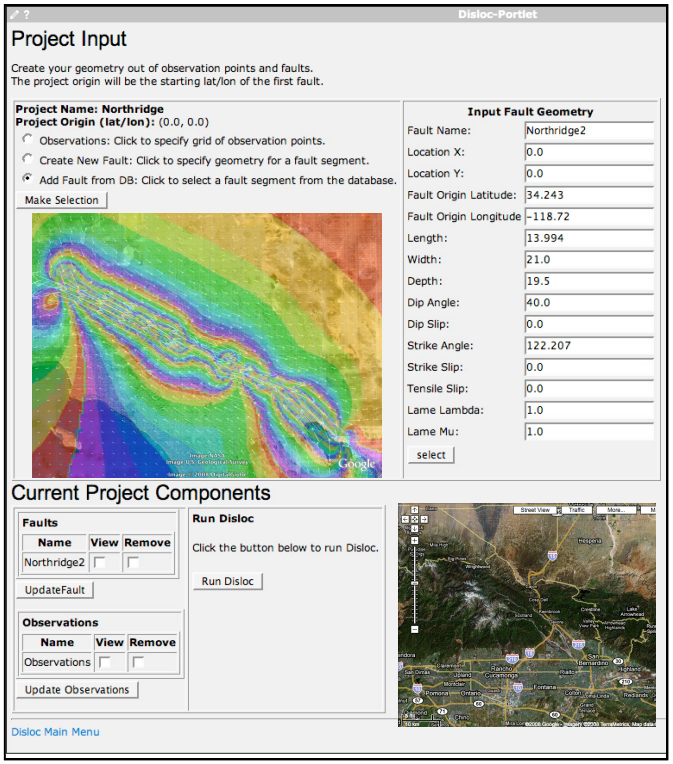


Earthquake Disaster Evaluation and Response

- Provide decision support for earthquake disaster management and response utilizing NASA remote sensing data and modeling software
- Deliver rapid and readily accessible UAVSAR interferograms
- Web infrastructure and map data products for decision-makers
- Developed in partnership with end users in first response and disaster management agencies
  - *USGS*
  - *California Geological Survey*
  - *California Office of Emergency Services*

Earthquake Data Enhanced Cyber-Infrastructure for Disaster Evaluation and Response (E-DECIDER)





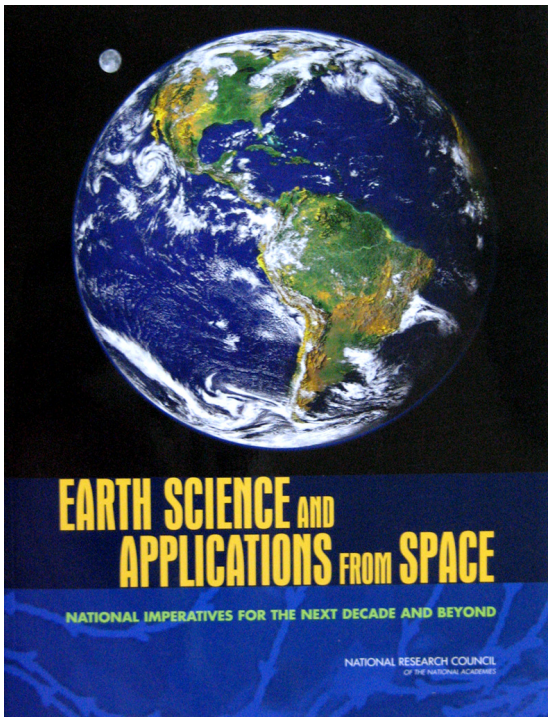
Maggi Glasscoe - JPL

Decadal Survey

Earth Science and Applications from Space:
A Community Assessment and Strategy for the Future

Goals

- Ensure practical benefits for humankind play equal role to that of acquiring new knowledge about Earth
  - *Short-term needs*
    - Weather forecasts
    - Warnings for protection of life and property
  - *Longer-term scientific understanding necessary for future*
- Realize new applications that will benefit society



National Aeronautics and Space Administration (NASA) Office of Earth Science
National Oceanic and Atmospheric Administration (NOAA)
National Environmental Satellite Data and Information Service (NESDIS)
U.S. Geological Survey (USGS) Geography Division

Tier 1 Decadal Survey Missions and Disasters

SMAP	DESDynI	CLARREO	ICESat-II
Landslide and Debris Flow	Human and Ecosystem Health	Winter Storm	Human and Ecosystem Health
Flood	Landslide and Debris Flow	Technological Disasters	Wildland Fire
Winter Storm	Earthquake		
Heatwave	Volcano		
Human and Ecosystem Health	Wildland Fire		
Wild land Fire	Drought		
Drought	Flood		
Coastal Innundation	Coastal Inundation		
Hurricane	Technological Disasters		
	Hurricane		
	Tsunami		

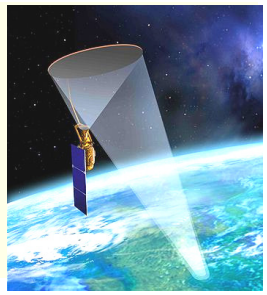
Part of mission
Potential application

SMAP

Soil Moisture Active and Passive

Objective: *Soil moisture and freeze-thaw for weather and water cycle processes*

Instrument: *Active and passive microwave*



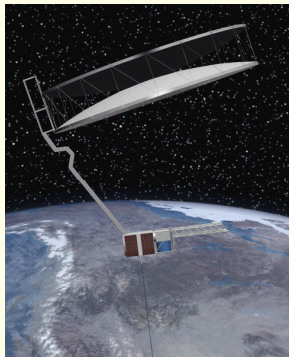
Coastal Inundation	Drought	Flood	Heatwave	Human and Ecosystem Health	Hurricane	Landslide and Debris Flow	Wildland Fire	Winter Storm
Maps of coastal innundation	Early warning decision support	Key variable; improved forecasts, especially in medium to large watersheds; protect downstream resources; soil infiltration conditions	Early warning decision support	Decision support for malaria and other waterborne diseases	Affected landfall area	Soil moisture is a key variable; better prediction through consistent observations in mountainous regions	Fuel loading	Operational severe weather forecasts

DESDynI

Deformation, Ecosystem Structure, and Dynamics of Ice

Objective: *Surface and ice sheet deformation for understanding natural hazards and climate; vegetation structure for ecosystem health*

Instrument: *SAR/InSAR and Lidar*



Coastal Inundation	Drought	Earthquake	Flood	Human and Ecosystem Health	Hurricane	Landslide and Debris Flow	Technological Disasters	Tsunami	Volcano	Wildland Fire
Maps of coastal innundation	Early warning decision support	Likelihood as a function of location; improved risk management	Mapping of flood zones	Vegetation structure for ecosystem health; vector-born and zoonotic disease; decreased exposure to tectonic hazards	Mapping affected landfall area	Predict places and times; improved risk management	Mapping affected area	Relation to earthquake	Movement of magma; predict places and times of eruptions; improved risk management	Fuel loading; mapping of burned areas

CLARREO

Climate Absolute Radiance and Refractivity Observatory

Objective: *Solar and Earth radiation; spectrally resolved forcing and response of the climate system*

Instrument: *Radiance and Refractivity*

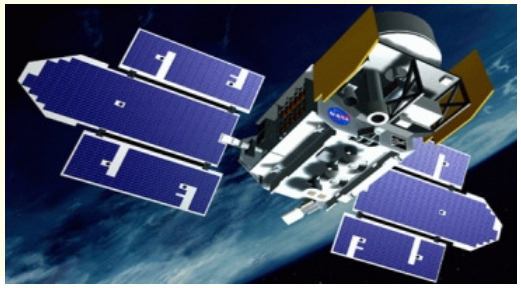
Technological Disasters	Winter Storm
Decision support for military and civilian communication	Changes in storm patterns associated with temperature patterns

ICESAT-II

Ice, Cloud, and Land Elevation Satellite

Objective: *Ice sheet height changes for climate change diagnosis*

Instrument: *Lidar*

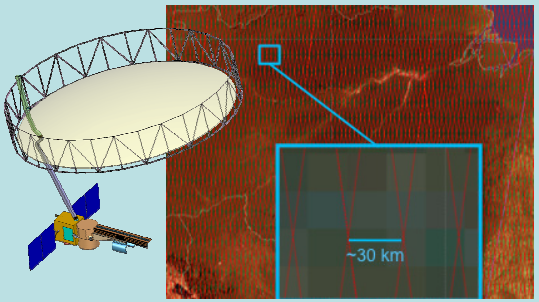


Human and Ecosystem Health	Wildland Fire
Vegetation structure for ecosystem structure; predicting the effects of sea level change on growing populations and infrastructure	Fuel loading

Applications for Missions

- Include the applications community early in the mission design process
- Balance science, applications, and response objectives of the mission
  - *Flow applications needs into the mission trades/design*
  - *Input to mission design early in the design process*
- What data products are useful for the applications community?
  - *How quickly do they need to be disseminated?*
- Define roles of other agencies and how they fit into the missions
  - *Particularly in non-overlapping regions with the existing targets*
  - *Responsibilities of other agencies to mission for meeting their needs*

Workshops
- **Objectives**
- **Needs**
- **Targets**



Participation of end-users
- **Mission design**
- **Operations**

Interagency
- **Dialogue**
- **Involvement**

DESDynI Applications Workshop

- Over 50 participants in the workshop and five contributed posters from the broader community
  - *Seemed appropriately sized*
- Attendees included representatives several agencies and centers
- There was **significant participation by first responders**
- No new instruments or modes were requested for the DESDynI mission
- Applications **needs mainly impact**
  - ***Duty-cycle***
  - ***Downlink capacity***
  - ***Data latency***
  - ***Generation of high-level products***
- **Future workshops** (for all decadal survey missions)
  - *More clearly define participants from the applications community*
  - ***Agency co-sponsorship***
  - *Identify any additional commitments that may be needed to meet the applications goals*

DESDynI Workshop Recommendations

- Establish an interagency working group to explore potential roles and responsibilities for Decadal Survey missions
  - *For disasters SDR is the appropriate venue*
- Decadal survey missions workshops
  - *Engage disaster mitigation and response organizations*
  - *Vet workshop reports with the wide communities*
- Allow for further iteration of potential observation needs, data/information products, and temporal and spatial sampling throughout the course of the mission concept development
- Establish a capability for event response and recovery
  - *Rapid downlink and dissemination of quick-look data products*
- Develop end user products for decision support
- Establish an open data policy to enable broad usage
- Enable international cooperation and collaborations

Applicable to other missions and disaster response

Developing Partnerships

- Keep dialogue open
- Natural Disasters workshop – early spring
  - *Would benefit from SDR member participation*
- Simulated exercises
  - *ShakeOut*
  - *Develop others?*
- Incentivize partnerships with other agencies and organizations
  - *Joint solicitations?*
  - *Required participation in NASA Applied Sciences calls*
- Engagement at the state level?
- How do we flow capabilities from research (NASA) to operations (other agencies)?

Summary

- NASA as a research agency develops new instruments, analysis tools and other capabilities that can be applied to natural disasters
- Developing better flow of information would improve disaster response
  - *Catalog capability, product, applicable disaster, point of contact on NASA and other agency side*
- Need to develop improved mechanisms for transferring research tools to operational tools
- For the Decadal Survey Missions opportunities exist to express needs early in the mission design process
  - *Need to understand additional needs and commitments for meeting those needs*
  - *Opportunity to maximize return from the missions*