ICCAGRA USGS Update – May 2008

Tom Cecere
USGS Land Remote Sensing Program
(703) 648-5551

UAS

In uninterrupted service for over 3000 years

Carrier Pigeons Take Aerial Photos With New Camera

IT IS no longer necessary to send planes over enemy lines to get photos of troop operations—carrier pigeons have now been pressed into service for this hazardous task.

This unusual feat is made possible by the development in Germany of a new diminutive aerial camera which is strapped to the pigeon's breast, as illustrated in the accompanying photo. Two hundred views may be taken while in flight, the shots being made possible only after the bird has left the ground. Each bird also carries a message tube strapped to its leg.

The German government has opened a school to train carrier pigeons for service in aerial photography.

Above are two remarkable panoramic views taken by pigeon carrying aerial camera. Insert shows how camera is carried.

USGS

Boldly Going Where No Man (or Woman) Goes: USGS Unmanned Aircraft

In dangerous and remote areas, such as polar regions, volcanic islands, and expansive deserts, remote-controlled unmanned aircraft can provide more detailed, more timely data about the status of natural resources and environmental conditions than would be feasible by any other means. That is why the U.S. Geological Survey - long known as an authoritative source of aerial photography and satellite-based imagery - today announced that it is establishing a new program for earth observation using Unmanned Aircraft Systems (UAS).

"This exciting approach to earth observation gives scientists a way to look longer, closer, and more frequently at some of the most remote areas of the Earth, places that were previously too dangerous or too expensive to monitor in detail," said Barbara J. Ryan, USGS Associate Director for Geography. "The flexibility and relative low cost of unmanned aircraft systems will enhance our ability to track long-term landscape change. In addition, we can quickly assess landscape altering events, such as wildfires or volcanoes, in areas with challenging logistics."

In many cases, UAS technology is simply the most cost effective way to gather earth observation data for a wide variety of applications: managing federal lands; investigating climate change; mapping and charting; conducting environmental risk assessments; responding to and recovering from natural and human-induced disasters.
Even in less remote areas, manned aircraft flights may not be feasible at times due to long flight durations, hazardous weather conditions, and associated operations cost. Satellite-based observations can be hindered by course image resolution, limited sensor capabilities, and repeat orbiting cycles of days or weeks. The use of UAS technology allows flexibility in delivering timely data. Furthermore, data collection by UAS can be specifically tailored to the required resolution and radiometric parameters of individual investigations.

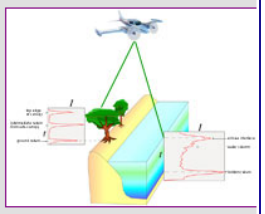
An important focus of the USGS UAS Program, a component of the USGS Land Remote Sensing Program, is to leverage the commitment that the defense and intelligence communities have made in supporting UAS research. Working in partnership with many other Federal agencies, academia, and industry groups, the USGS will promote UAS technology for civil, domestic applications. Offices for the new program will be located at the USGS facility in Lakewood, Colo.

USGS UAS Program Office

The goal of the USGS UAS Program Office will be to support long-term outcomes that will directly benefit the Nation:

- **Improve natural hazard forecasting and the analysis of the impacts on the environment;**
- **Improve our understanding of climate change to better plan for the likely impacts;**
- **Broaden our abilities to monitor land use change and better understand and protect ecosystems;**
- **Assess Arctic ice change and its impacts on ecosystems, coasts, and transportation;**
- **Increase safety and effectiveness of wildland fire management;**
- **Develop precipitation and evaporation forecasting to better manage water resources.**

EAARL - Airborne lidar system for high-resolution submerged and sub-aerial topography



NASA EAARL system [larger version]

NASA's Experimental Advanced Airborne Research Lidar (EAARL) is a raster-scanning, waveform-resolving, green-wavelength (532 nm) lidar designed to map near-shore bathymetry, topography, and vegetation structure simultaneously. The EAARL system has been developed by C. Wayne Wright at the NASA Wallops Flight Facility, Wallops Island, Virginia. The EAARL has been operational since the summer of 2001, when it surveyed the coral reef tract in the northern Florida Keys. Subsequently, several surveys have been carried out by the EAARL system in a variety of coastal communities, including barrier islands along the Atlantic coast, and around the margins of an urbanized Gulf of Mexico estuary. The EAARL green-wavelength laser can penetrate water slightly more than one Secchi disk depth, allowing the sensor to map submerged and sub-aerial topography simultaneously.

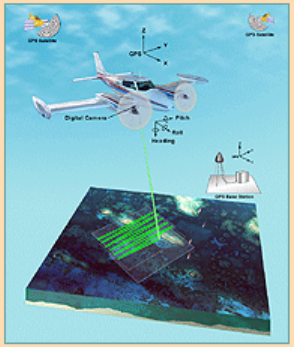
USGS

Tampa Bay Study > Data > Task 1: Mapping

Bathymetry - LiDAR

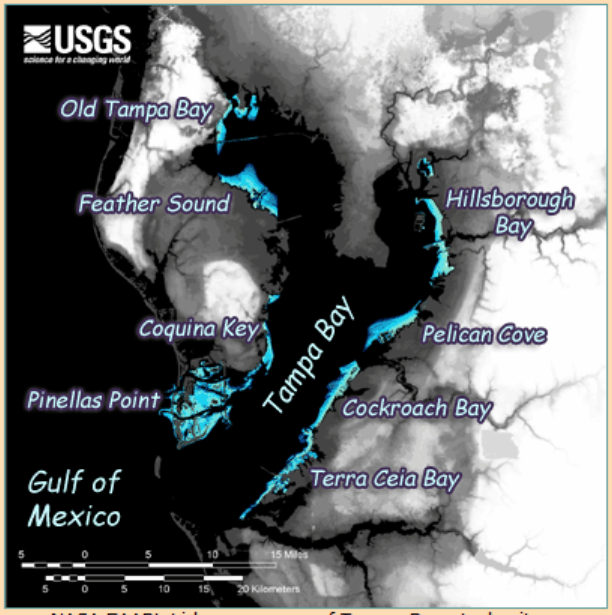
Contact: Dave Zawada
USGS Florida Integrated Science Center, 600 4th Street South, St. Petersburg, Florida 33701

Lidar (**Li**ght **D**etection **A**nd **R**anging) is a method of detecting distant objects and determining their position or other characteristics by analysis of pulsed laser light reflected from their surfaces. Lidar works on the same principle as **RADAR** (**Ra**dio **D**etection **A**nd **R**anging), but lidar uses light waves emitted by a laser (rather than radio waves) to gather data. In its simplest form, lidar is used to determine the distance from the laser to a given object. More sophisticated lidar systems can provide information such as sea-surface roughness, wind velocity, and vegetation density.



Lidar Collection: The NASA Experimental Advanced Airborne Research Lidar (EAARL) collected georectified digital aerial photographs and high-resolution lidar data over Assateague Island. The instrument uses a green laser and a raster scanning mechanism to acquire lidar data. Researchers set up a GPS base station to precisely locate the position of the aircraft and the data it collected. (View enlargement)

Airborne Lidar is now being applied in coastal environments to produce accurate, high resolution, cost-efficient bathymetric and topographic datasets. The USGS Tampa Bay Study is using the NASA **EAARL** (**E**xperimental **A**irborne **A**dvanced **R**esearch **L**idar) to measure both the bathymetry and topography of important areas of the bay and its shoreline. The data will be used to develop hydrodynamic and sediment transport models.



NASA EAARL Lidar coverage of Tampa Bay study sites.
Select individual study site to view enlarged detailed map.
View enlargement of above map.

Study Sites:	GeoTIFF:	GIF:
Terra Ceia Bay	11.6 MB	66.7 KB
Cockroach Bay	10.4 MB	124.4 KB
Pelican Cove	11.9 MB	130.9 KB
Hillsborough Bay	11.3 MB	170.8 KB
Old Tampa Bay	7.7 MB	61.4 KB
Feather Sound	6.1 MB	63.1 KB
Coquina Key	4.6 MB	60.2 KB
Pinellas Point	3.0 MB	80.6 KB

The above datasets are in **GeoTIFF** format.
To view them, you will need GIS software.

Commercial Software:
Global Mapper, ESRI ARC, ERDAS IMAGINE, RSI ENVI.

Free Software: GRASS GIS

A GIF image of the GeoTIFF file, with a background layer showing the location of the lidar data, has been provided.

SEBASS – June 2008 Mission

USGS

- There is a near-term opportunity for the Survey to collect hyperspectral imagery in the long-wave infrared, utilizing the Aerospace Corporation's SEBASS instrument. SEBASS will be flown in June aboard a Twin-otter aircraft over numerous locations in the West (there's also a route connecting Reno and Grand Junction which doesn't appear on the map). For a one-time cost of $25K, a buyer can select a site along the route and receive about 4 hours of LWIR HSI data.

Remote Infrared Hyperspectral Applications

Mineral Exploration • Drill Core Analysis • Geothermal Site Characterization • Environmental Assessment • Subsurface Detection • Planetary Exploration • Ore Grading • Slope Stability

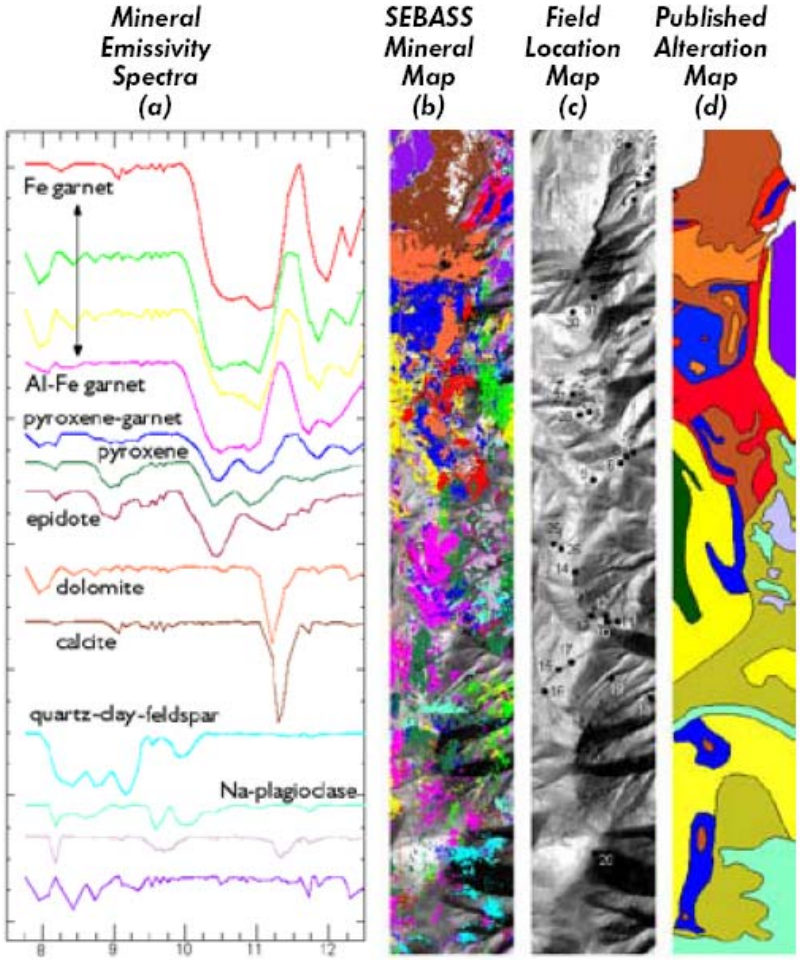
SEBASS Instrument Summary

- Spectral coverage 7.8 to 13.5 µm; 3.0 – 5.5 µm
- 128 Spectral Bands for both MWIR and LWIR
- Effective frame rate up to 120 Hz • IFOV = 1 milliradian; FOV = 128 milliradians (7.3°) • Noise Equivalent Spectral Radiance < 10^{-6} W/cm^2/sr/µm at 120 Hz
- Georeferenced data <15 m accuracy per pixel • Real-time data processing to find targets of interest • On-board calibration sources

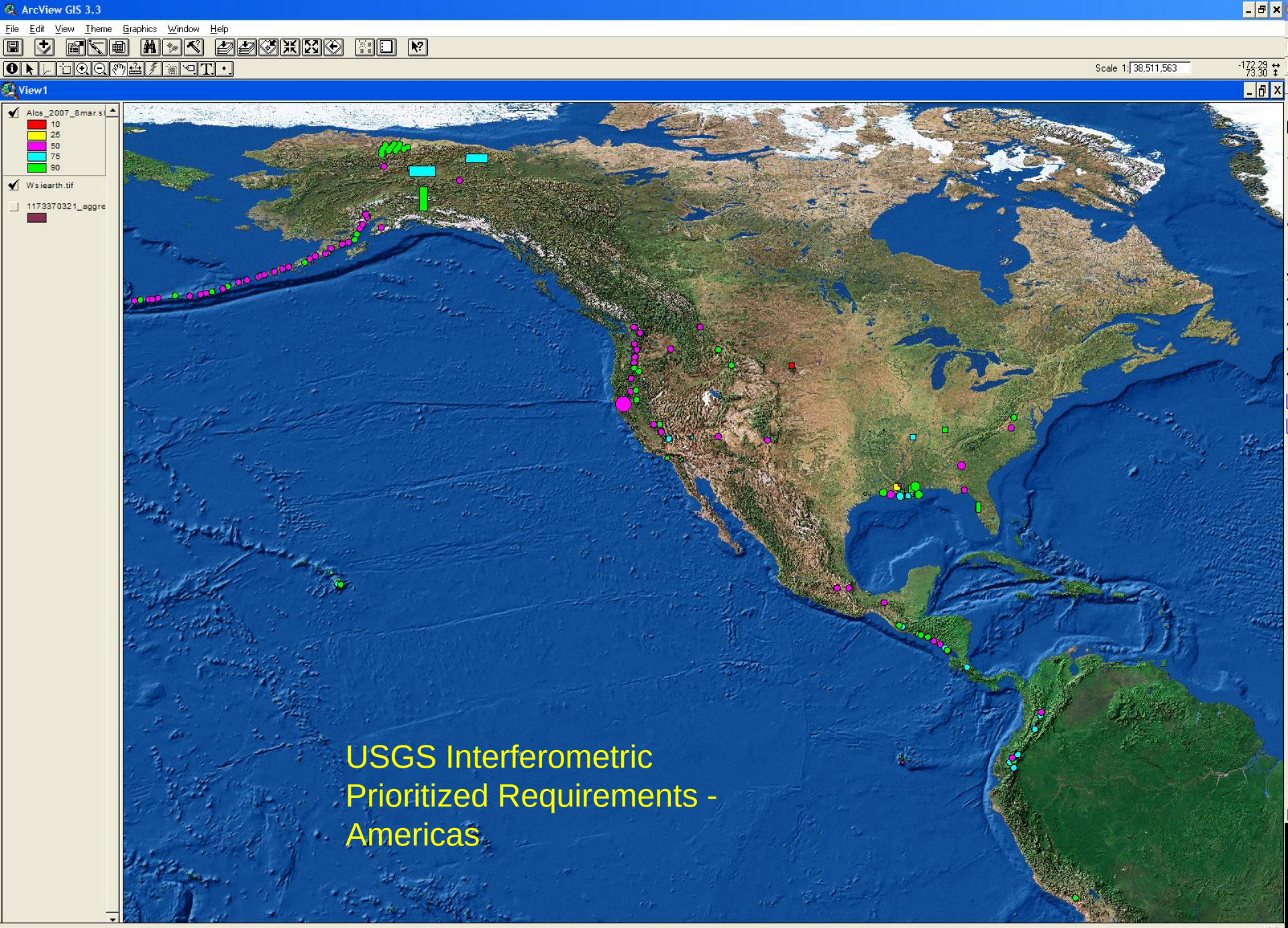
Products

Aerospace can support the entire end-to-end data collection effort starting with site identification, collect planning, collection operations, and data analysis. Typical remote infrared hyperspectral products include:

- Spectrally and radiometrically calibrated hyperspectral data cubes • Georeference files for all data cubes • Atmospherically corrected hyperspectral data cubes • Apparent emissivity data cubes • Maps of spectral detections for specific materials of interest • Maps of regions of unknown spectra • Mosaic products • Field spectra from hand-held spectrometers • Laboratory spectra of samples



This example shows a typical SEBASS data product, which displays colors that represent the presence of various mineral emissivity spectra. This illustration shows (a) emissivity spectra; (b) SEBASS mineral map; (c) SEBASS temperature survey with field sample locations noted; and (d) a geology and alteration map derived from field survey (after Harris and Einaudi, 1982). Note that the SEBASS-derived mineral map (b) closely correlates with the mineral map produced from a field survey (d).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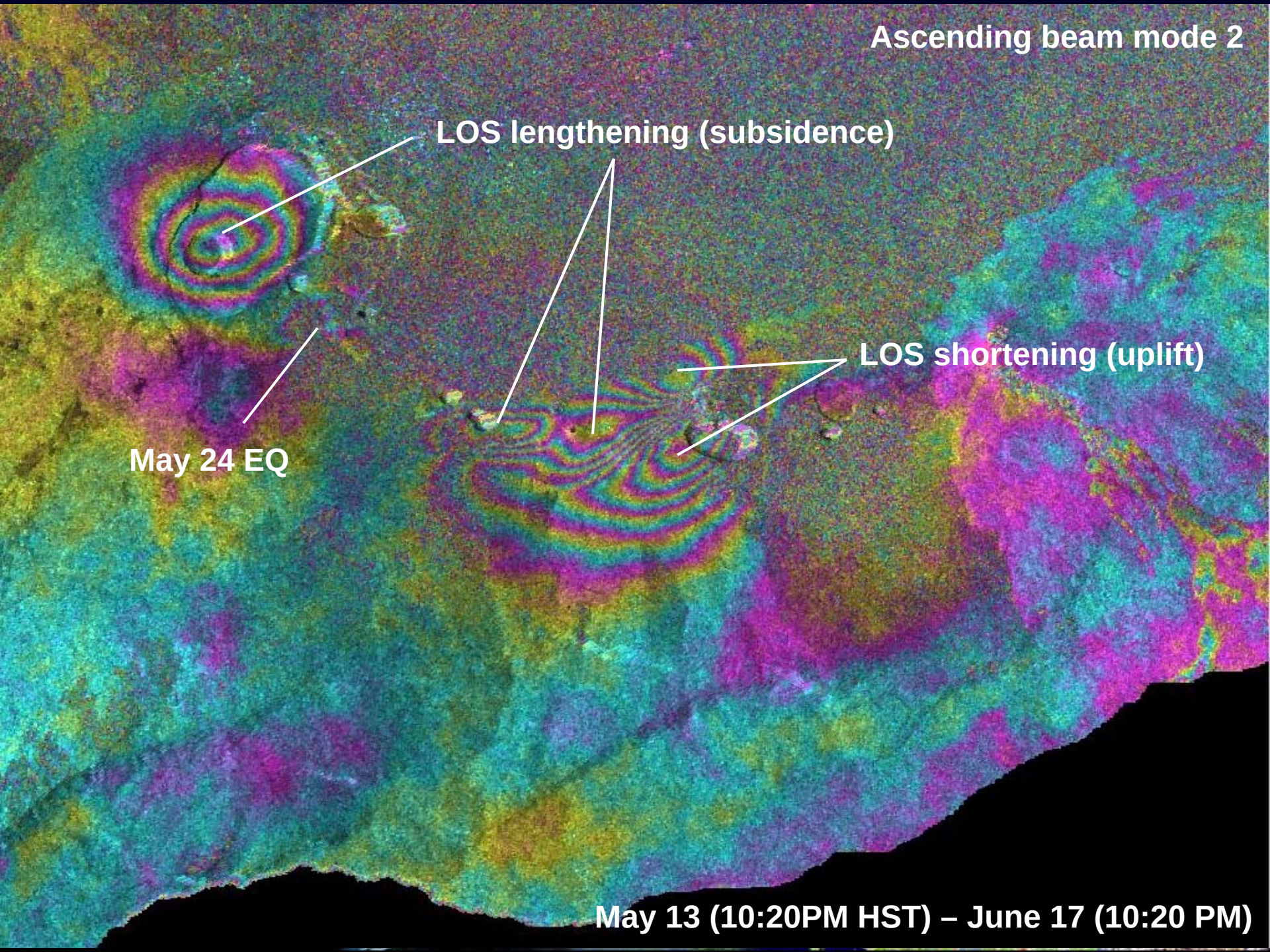
USGS Interferometric
Prioritized Requirements -
Americas

Volcano Monitoring

http://volcano.wr.usgs.gov/vhpstatus.php


Ascending beam mode 2
LOS lengthening (subsidence)
LOS shortening (uplift)
May 24 EQ
May 13 (10:20PM HST) – June 17 (10:20 PM)

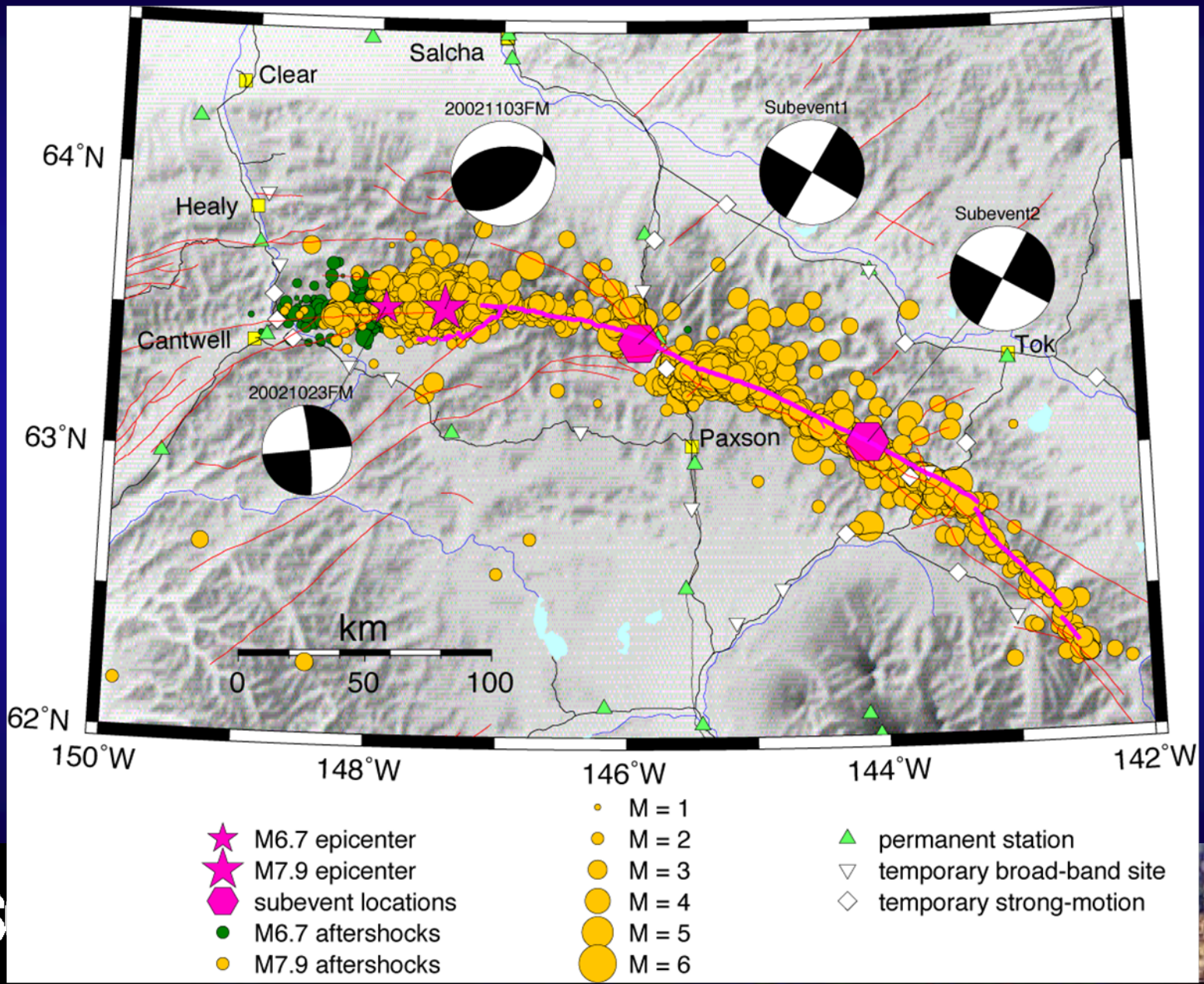
Earthquake Monitoring

http://earthquake.usgs.gov/eqcenter/recenteqsus/

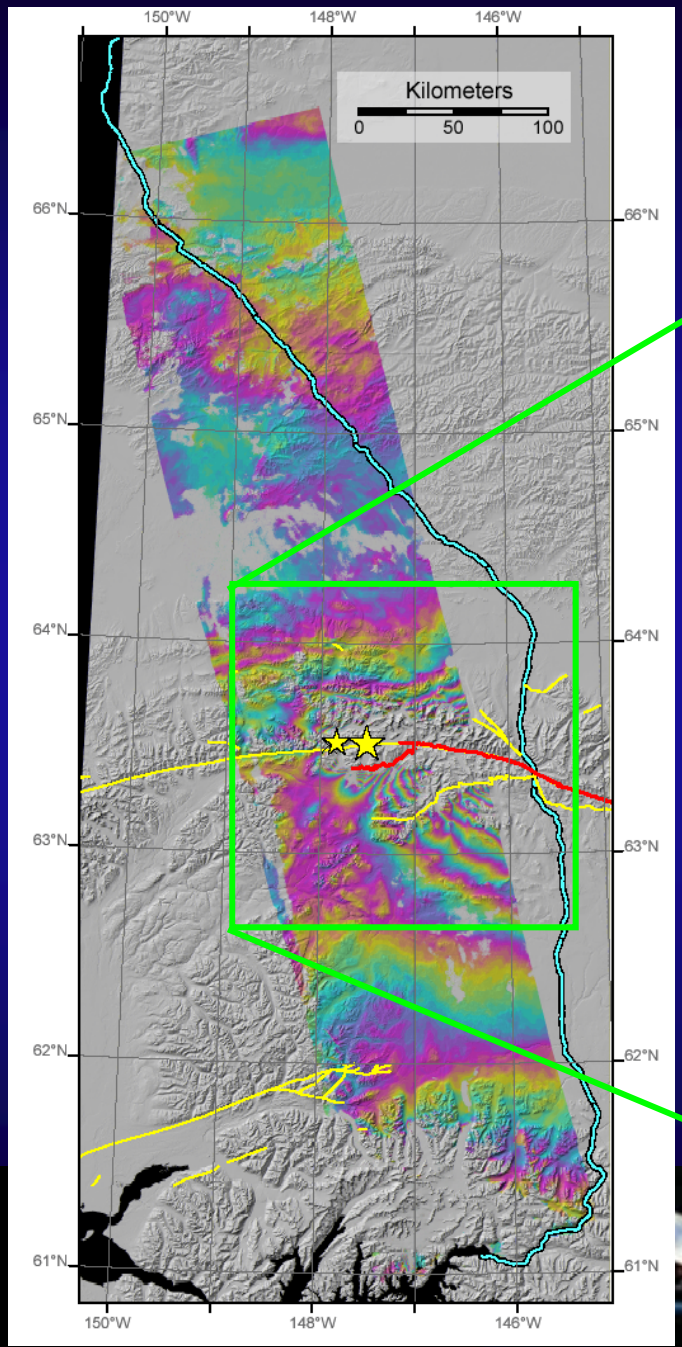
http://earthquake.usgs.gov/eqcenter/recenteqsww/

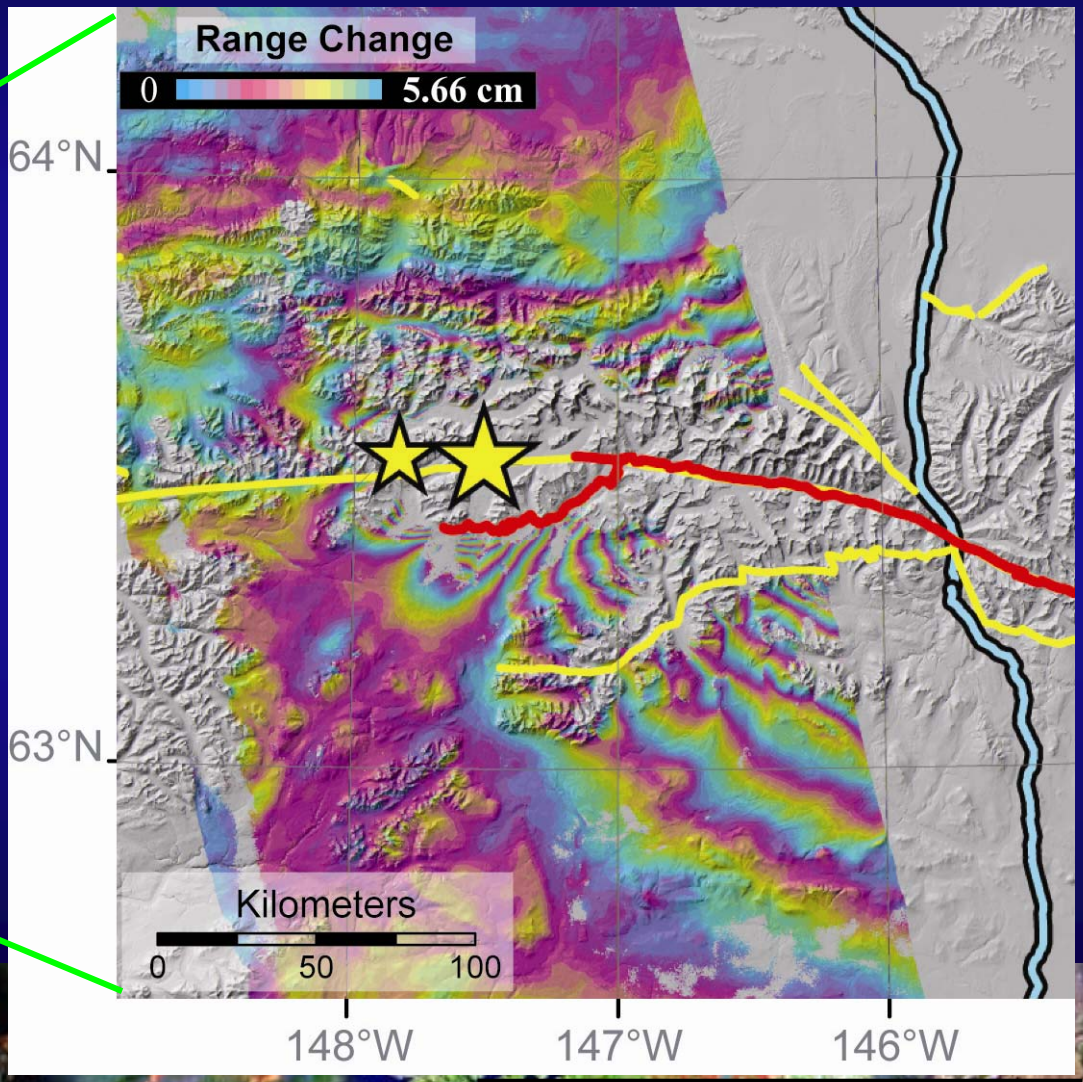
Measuring spatial and temporal patterns of surface deformation in seismically active regions are extraordinarily useful for estimating seismic risks and improving earthquake predictions

Nov 3, 2002 Denali Earthquake



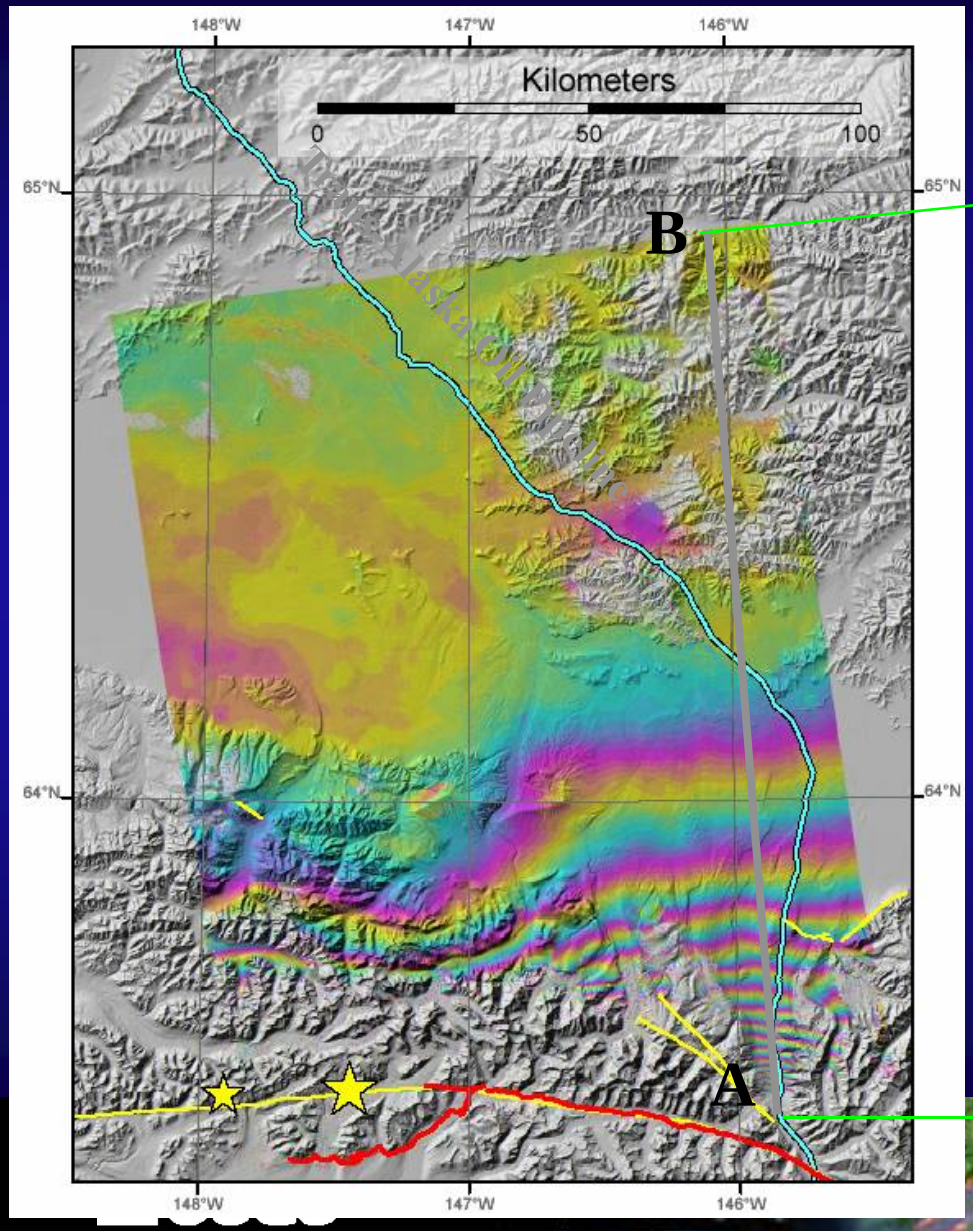
Co-seismic deformation: Nov 3, 2002 Earthquake

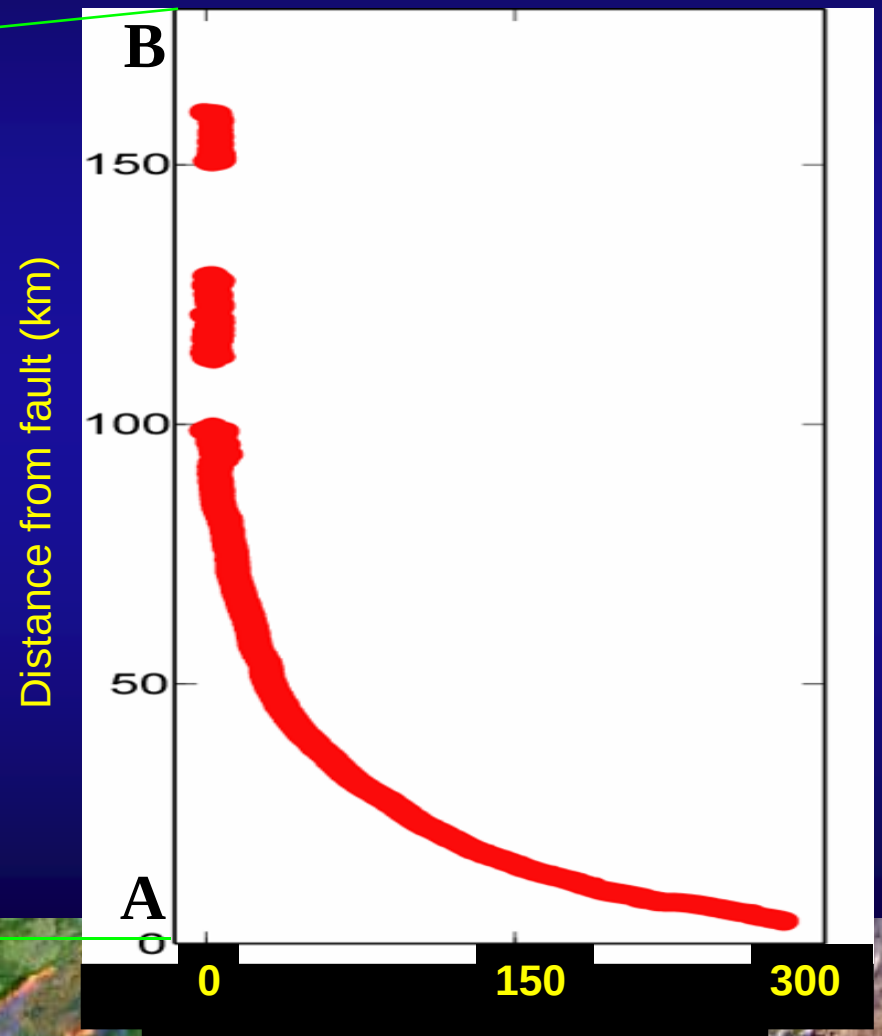




• Lu, Wright, Wicks, EOS, 2003

Co-seismic deformation: Nov 3, 2002 Earthquake



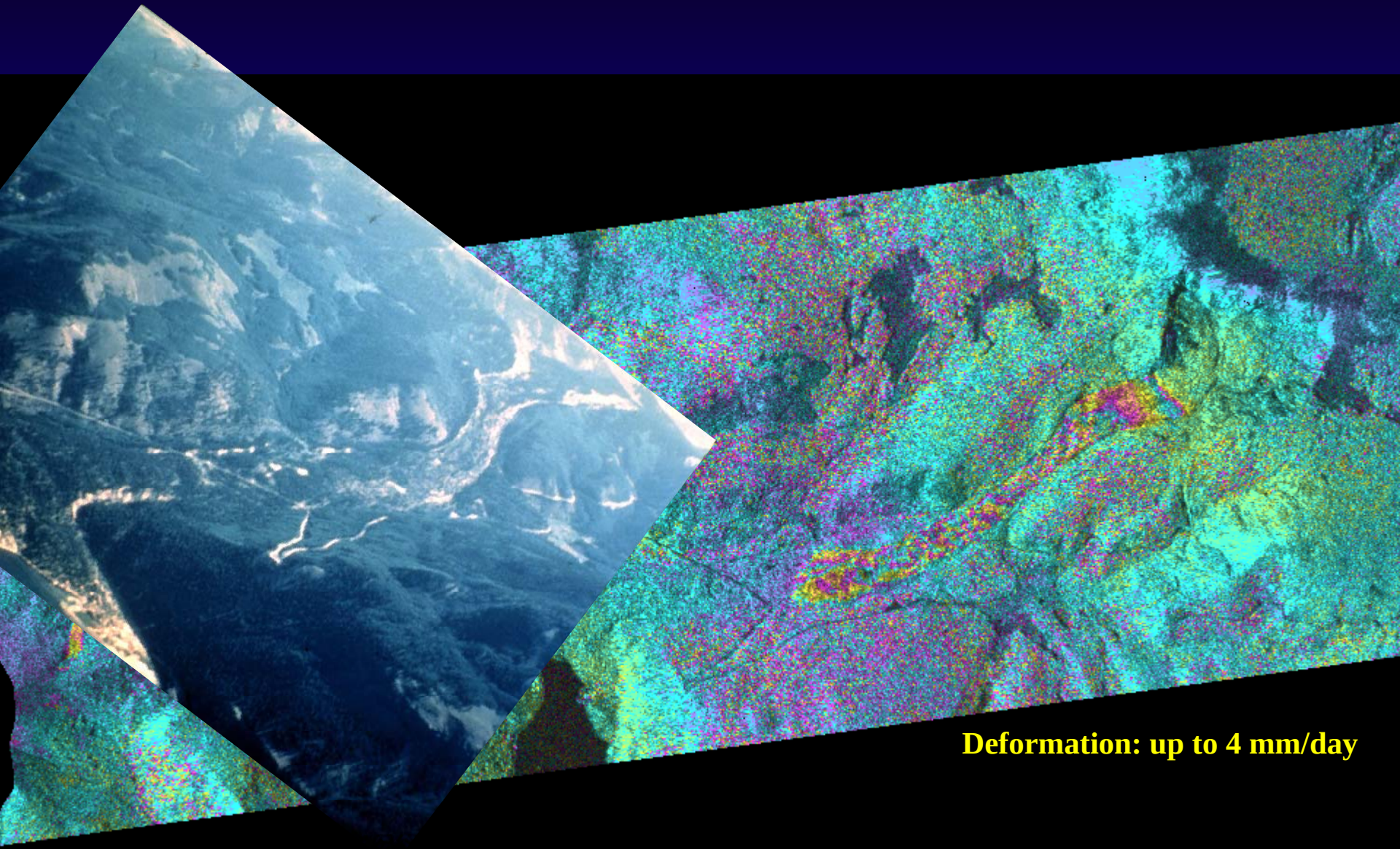


Lu, Wright and Wicks, EOS 84, 2003

Landslides

Measuring and documenting how landslides develop and are activated are prerequisites to minimize the hazards they pose in areas of rapid urban growth

Landslide monitoring from InSAR



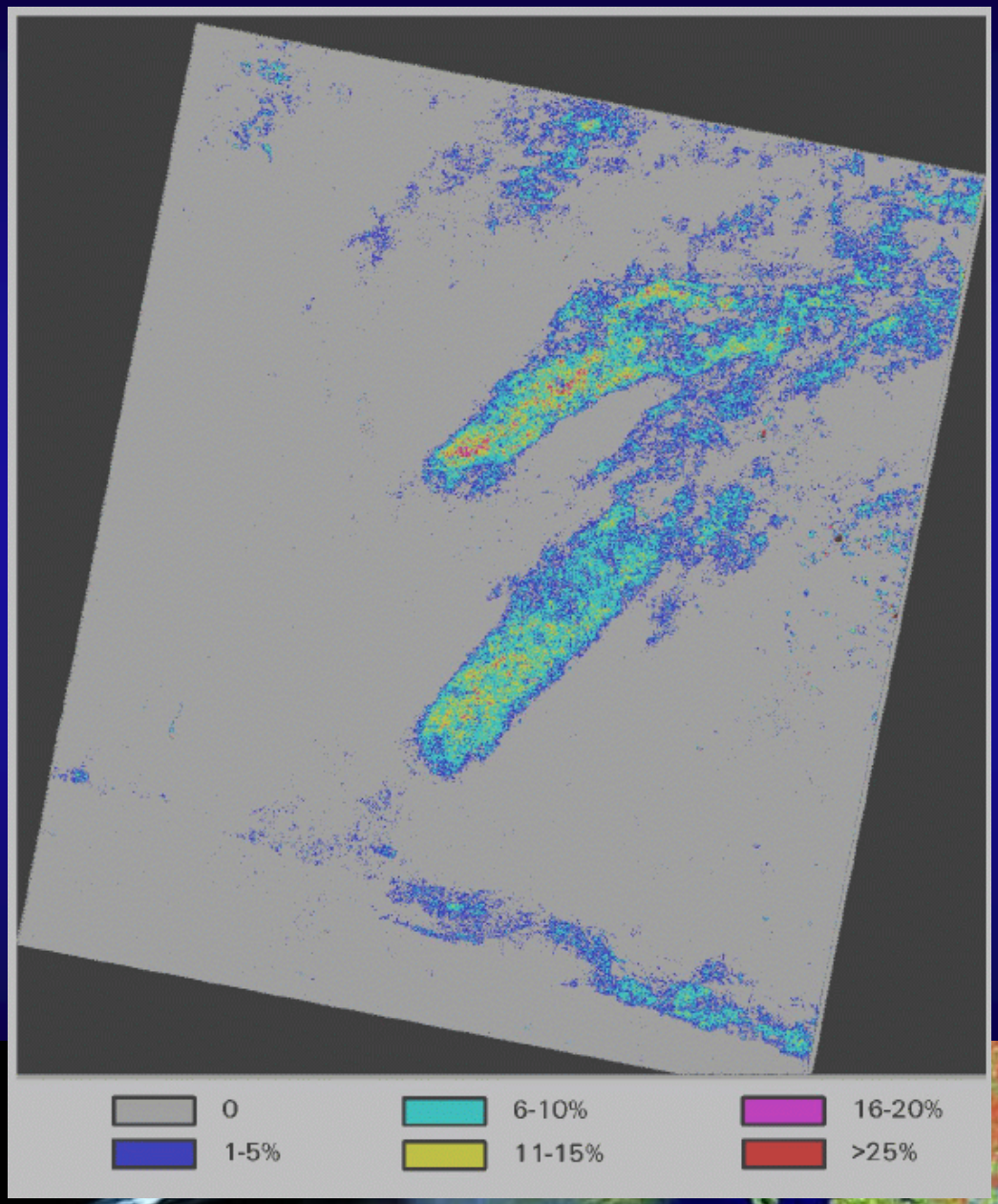
USGS

Range Change

0 2.8 cm

• Lu et al., in prep.

Mapping of changes in soil moisture with multi-temporal SAR images
Carlsbad, New Mexico



Lu and Meyer, IJRS, 2002

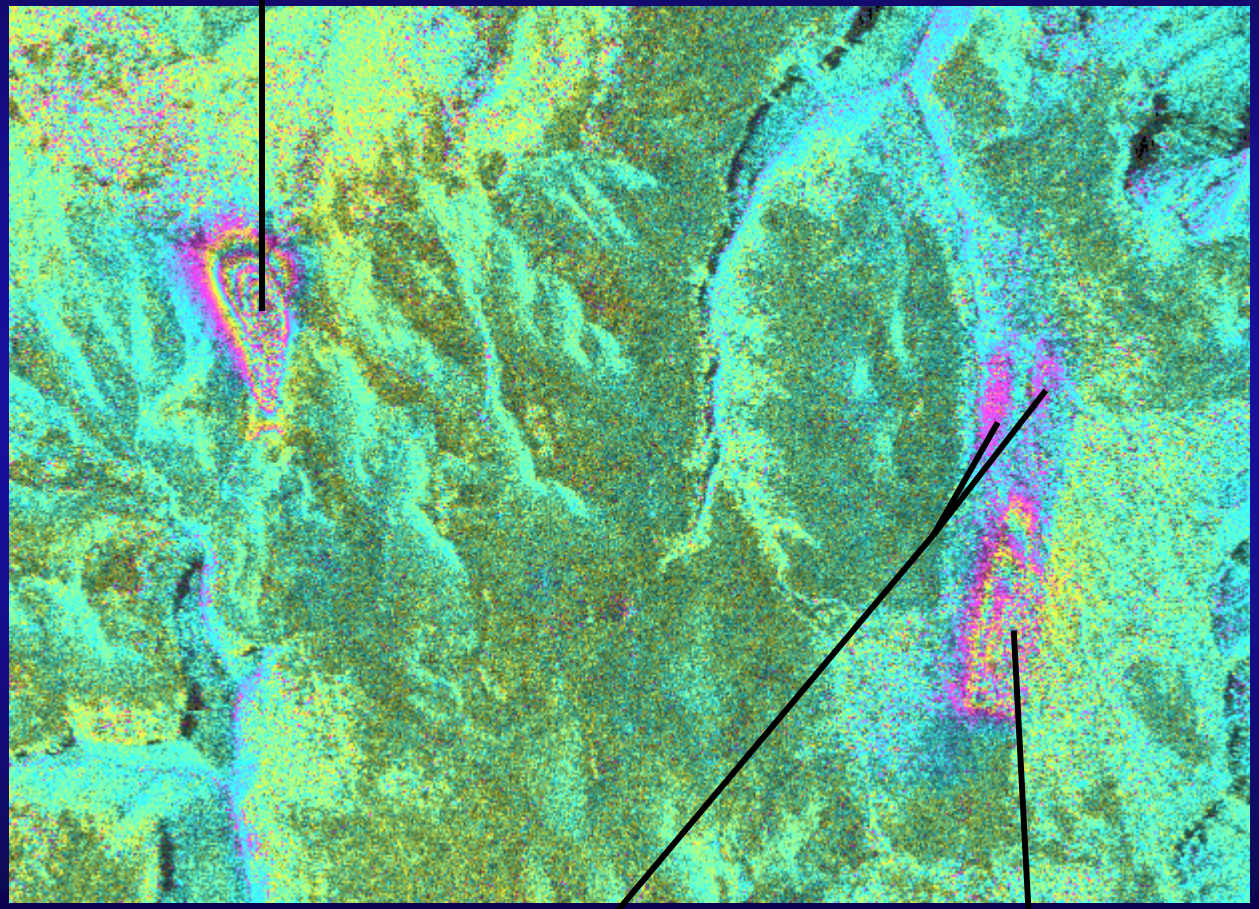
Mapping of Mining-Related Subsidence

USGS

InSAR Image of 12/2006 – 06/2007, Utah

subsidence of > 60 cm

5 km

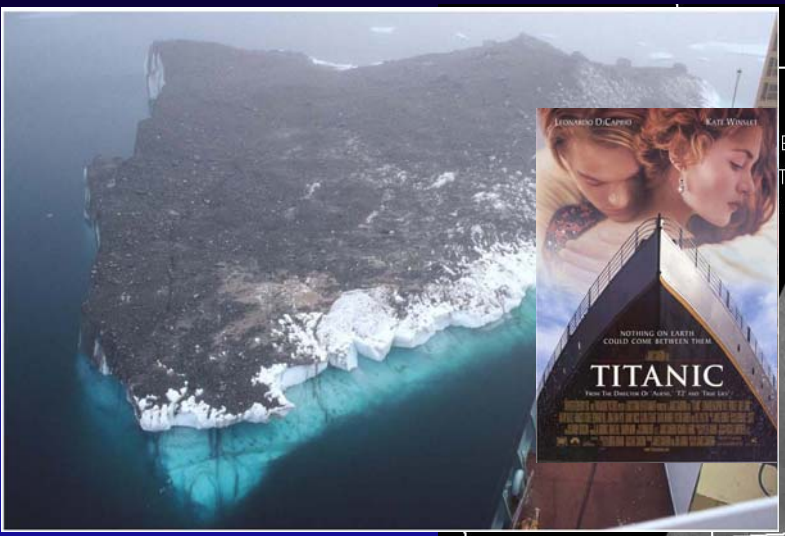


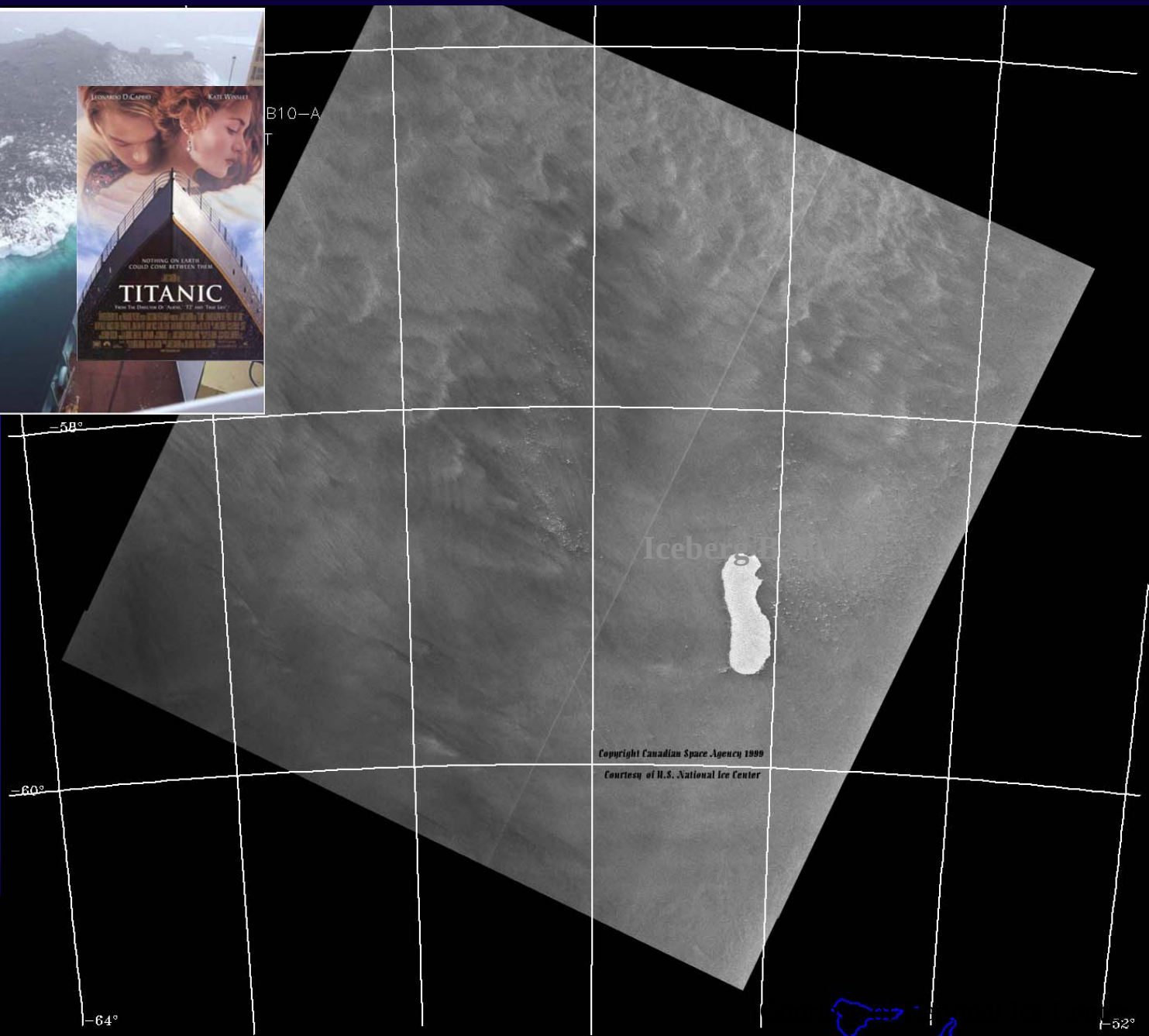
Subsidence of ~5 cm

subsidence of > 30 cm

Glacier and Ice

Iceberg poses threat to mariners

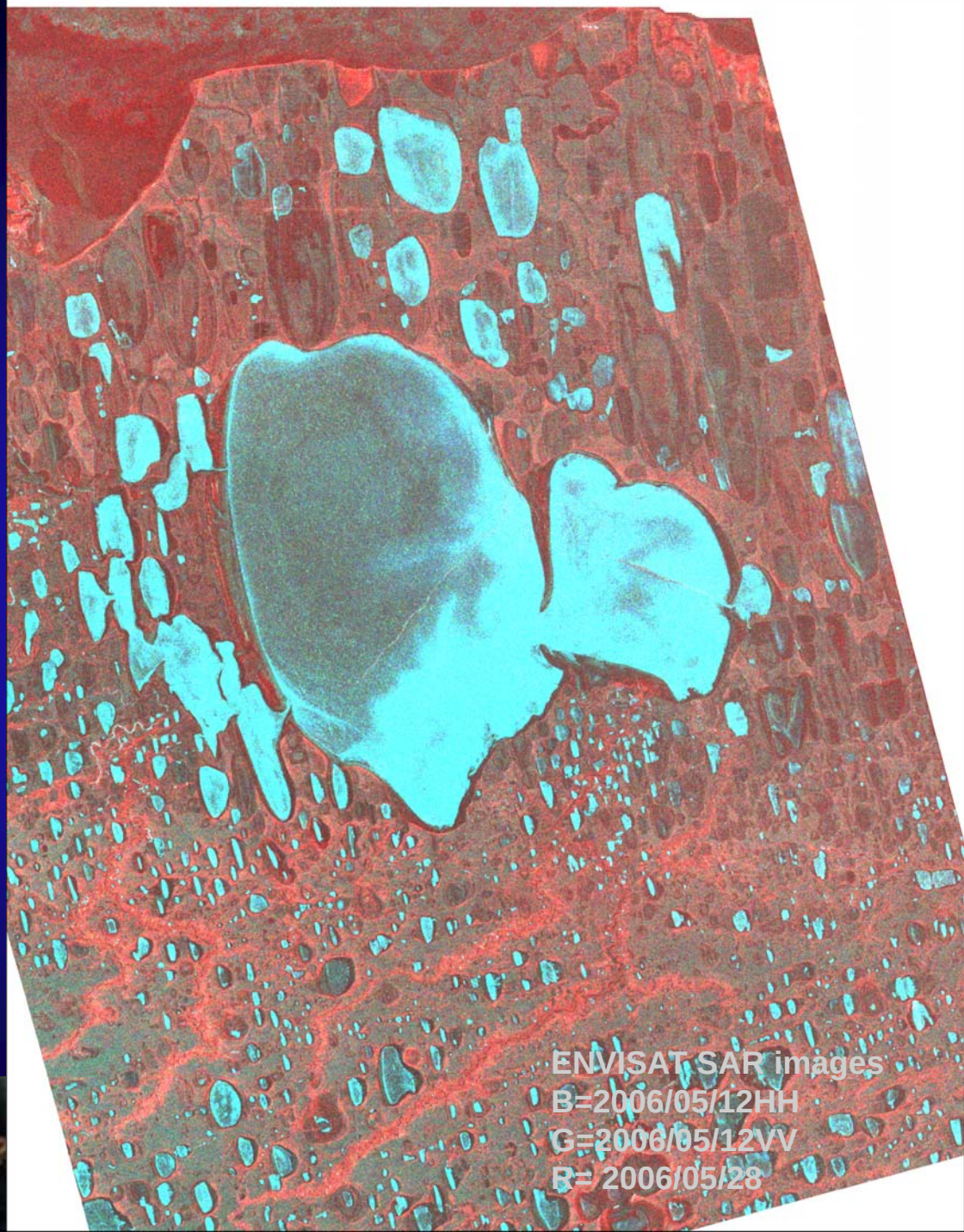




USGS

Barrow ice mapping with SAR

- Blue = Floating ice in 2005/05/12 image
- Red = Bright return in the 2005/05/28 image; The area is very wet in the 2005/05/28 image.
- Black Lakes are ice covered but frozen to the lake bed in the 2005/05/12 image and/or the ice is saturated with liquid water in the 2006/05/28 image.
- The primary threat to nesting habitat is on the southeast shores of the lakes.



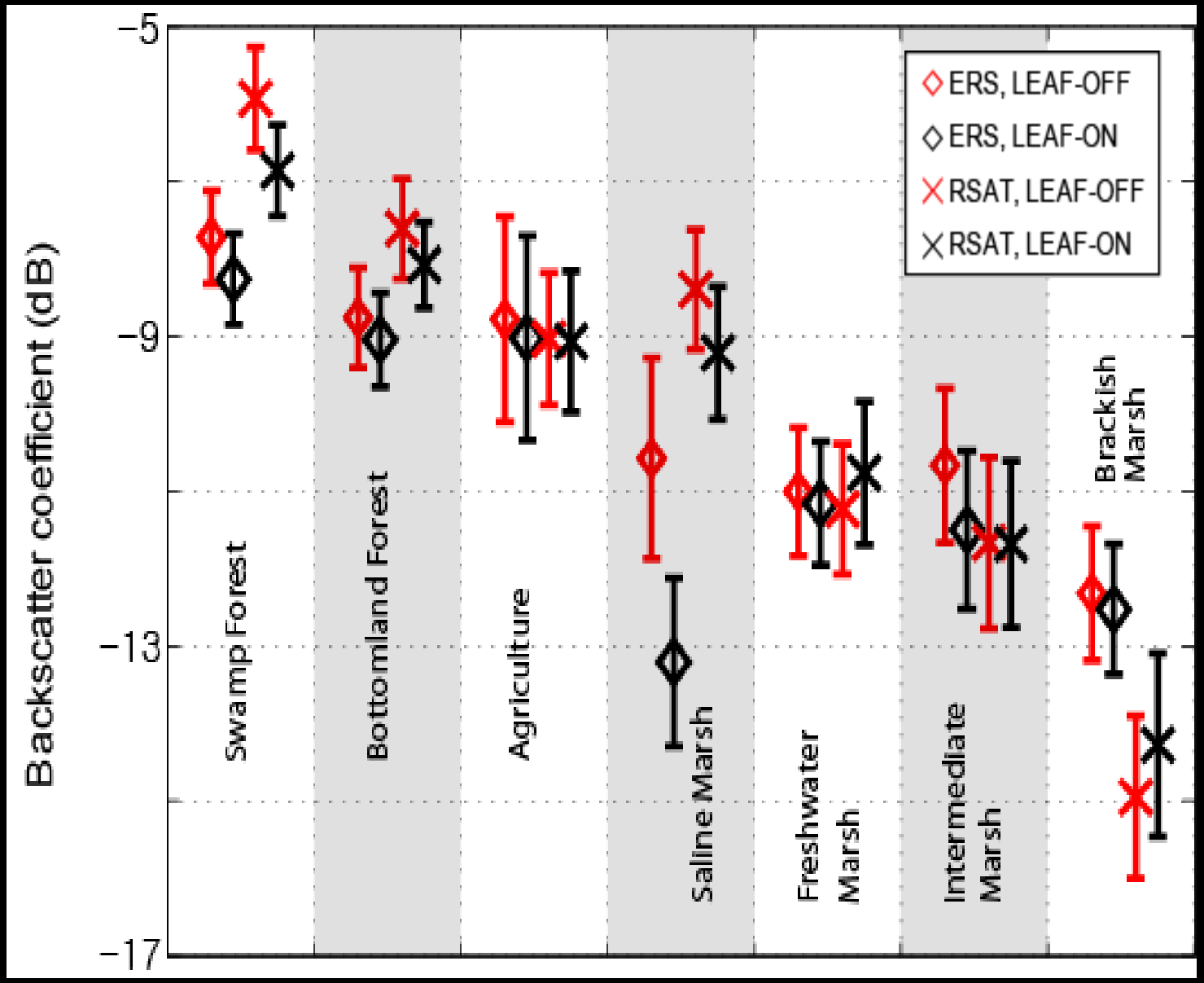
USGS

Land Cover

Crop Classification

ved from multi-temporal C-band ERS-1 SAR images over
Schotten et al, 1995). For regions with persistent clouds,
quent monitoring of crop growth.

Averaged dB values for different vegetation classes



Alaska Volcano Observatory
Current Status Report
Thursday, April 24, 2008 11:28 AM AKDT (19:28 UTC)

CLEVELAND VOLCANO (CAVW #1101-24-)
52°49'20" N 169°56'42" W, Summit Elevation 5676 ft (1730 m)
Current Aviation Color Code: **YELLOW**
Current Volcano Alert Level: **ADVISORY**

Clouds obscured satellite views of Cleveland Volcano last night. AVO has received no information about activity at Cleveland during the past 24 hours.

AVO monitors Cleveland Volcano with satellite imagery as weather allows. The lack of a real-time seismic network at Cleveland means that AVO is unable to track local earthquake activity related to volcanic unrest. Short-lived explosions of ash that could exceed 20,000 ft above sea level can occur without warning and may go undetected on satellite imagery. Please see http://www.avo.alaska.edu/activity/Cleveland.php for more information.

VENIAMINOF VOLCANO (CAVW #1102-07-)
56°11'52" N 159°23'35" W, Summit Elevation 8225 ft (2507 m)
Current Aviation Color Code: **YELLOW**
Current Volcano Alert Level: **ADVISORY**

Seismic data show that low level volcanic unrest continues at Veniaminof volcano. Clear web cam views of Veniaminof Volcano show light steaming continues. No activity was observed in mostly clear satellite views.

AVO will continue to monitor activity at Mount Veniaminof using seismic data, satellite images, internet camera data and observer reports.

CONTACT INFORMATION:
Christina Neal, Acting Scientist-in-Charge, USGS
tneal@usgs.gov (907) 786-7497

Steve McNutt, Coordinating Scientist, UAFGI
steve@giseis.alaska.edu (907) 978-5458

The Alaska Volcano Observatory is a cooperative program of the U.S. Geological Survey, the University of Alaska Fairbanks Geophysical Institute, and the Alaska Division of Geological and Geophysical Surveys.
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CASCADES VOLCANO OBSERVATORY WEEKLY UPDATE
Friday, April 18, 2008 10:40 PDT (Friday, April 18, 2008 17:40 UTC)

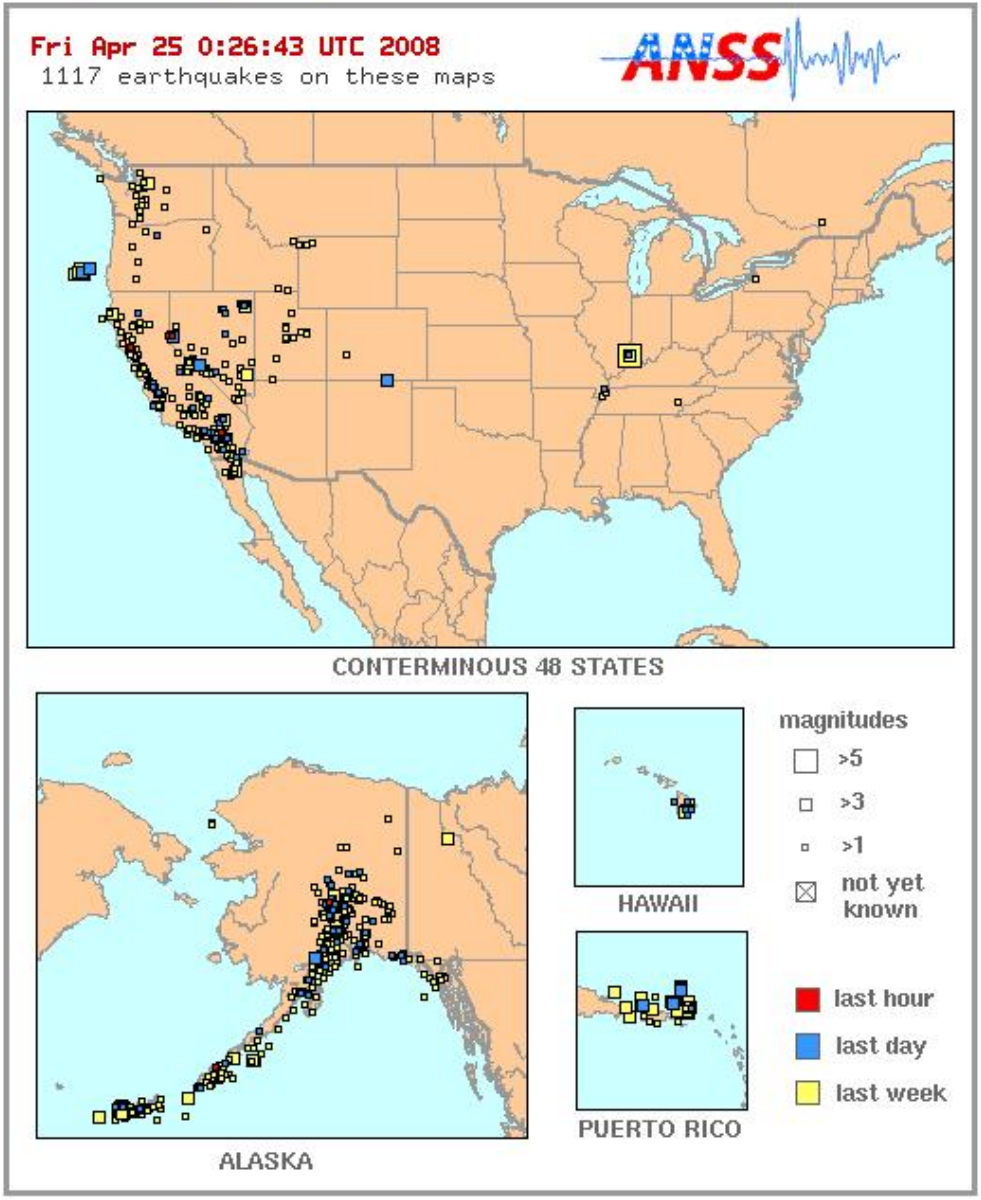
MOUNT ST. HELENS VOLCANO (CAVW#1201-05-)
46.20°N 122.18°W, Summit Elevation 8363 ft (2549 m)
Volcano Alert Level: **ADVISORY**
Aviation Color Code: **YELLOW**

SUMMARY:
The pause in lava dome growth continues, and all our monitoring instruments show trifling or nil volcanic-related activity. This pause, which began in late January 2008, was recognized by absence of measurable growth among successive fixed-camera images, nearly quiescent seismicity, and the absence of tilt signals that might characterize extrusion of lava from the conduit.

We continue to monitor closely for evidence of renewed extrusion or other activity. The new lava dome remains hot in places; thus, it is capable of producing hot avalanches or small steam explosions that could cause hazardous conditions in and around the crater. Sudden melting of snow and ice could send small lahars onto the Pumice Plain and perhaps down the Toutle River as far as the Sediment Retention Structure (SRS). Ash clouds from explosions could affect aircraft.

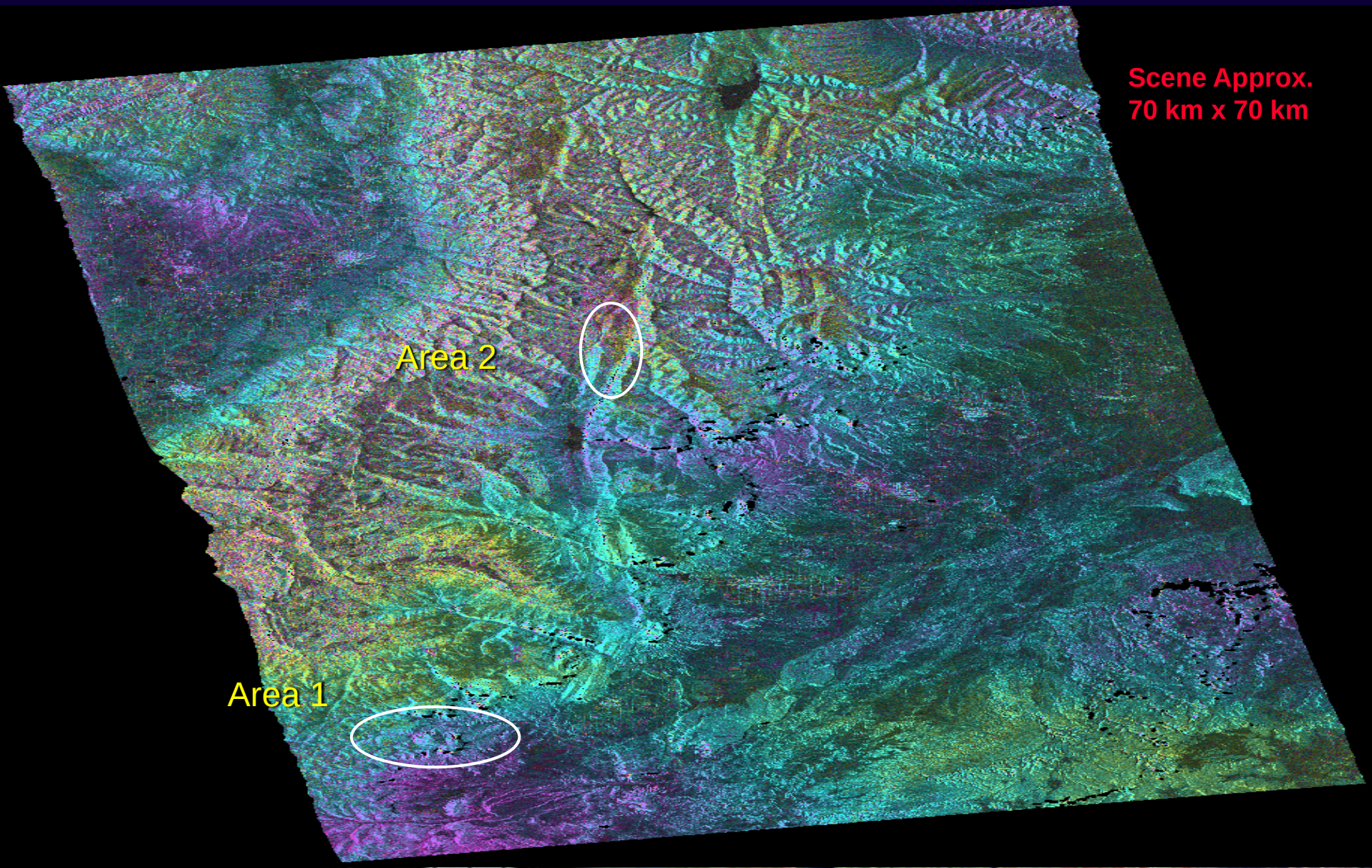
Latest Earthquakes in the USA - Last 7 days

USA earthquakes with M1+ located by USGS and Contributing Agencies.



Mine Monitoring

ALOS PALSAR InSAR image of Dec 6, 2006 – June 8, 2007

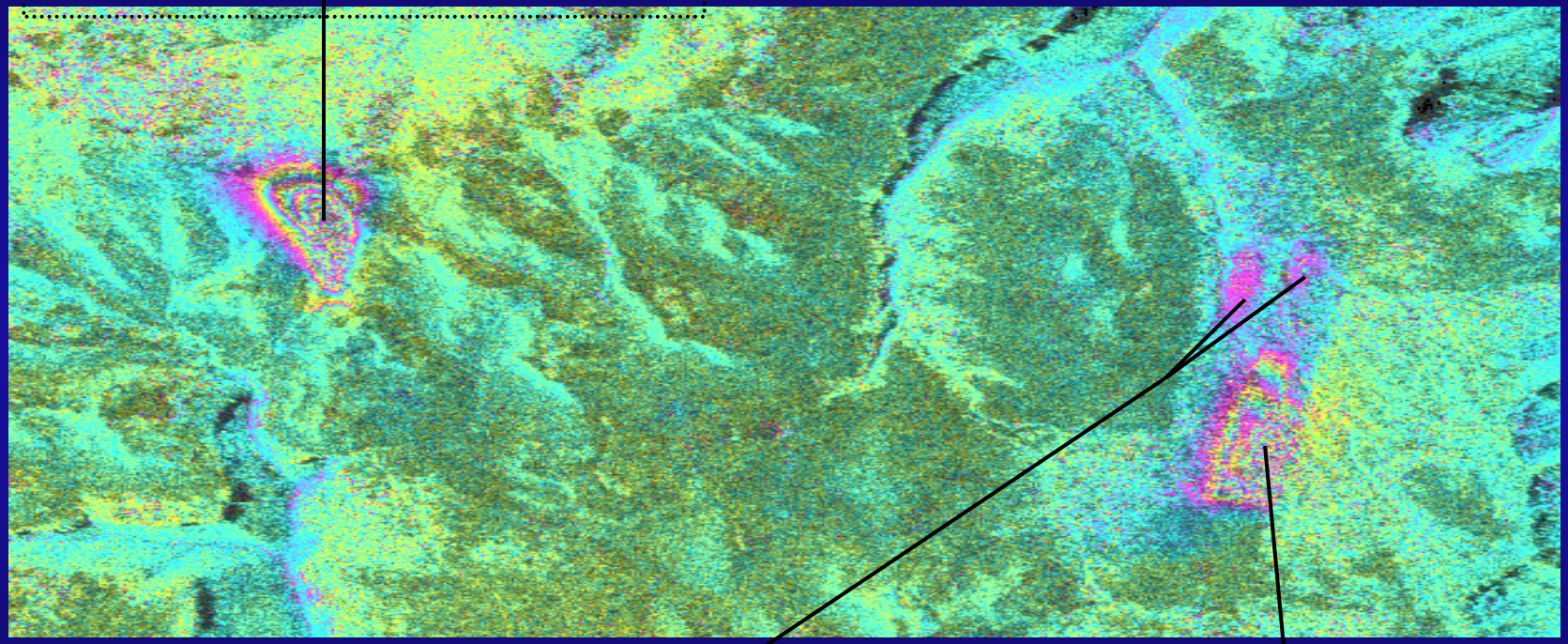


USGS

Zoomed in: Area 1

(38.995N/111.390W)
subsidence of > 60 cm

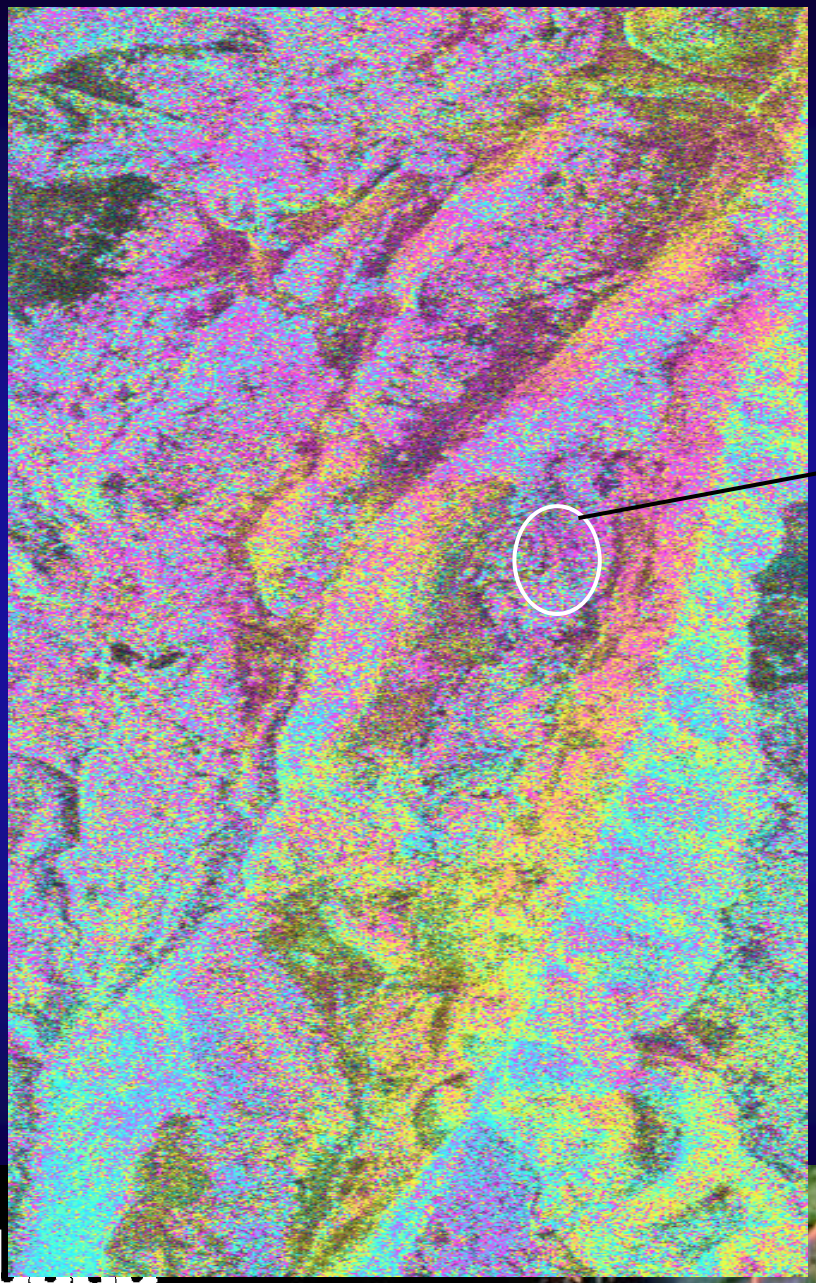
5 km



Subsidence of ~5 cm

(38.986N/111.323W) subsidence of > 30 cm

Zoomed in: Area 2



5 km

(39.465N/111.237W) Approximate location of Aug 6, 2007 earthquake and the collapsed mine. Signal-to-noise ratio is relatively low. Any ground deformation can not be concluded from this image alone.

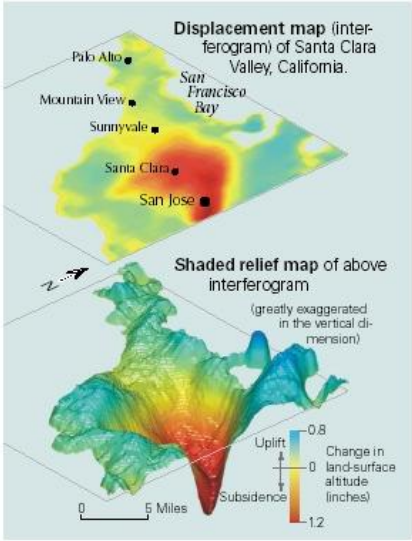
Land Subsidence Monitoring

http://pubs.usgs.gov/fs/fs-051-00/

Measuring Land Subsidence From Space

US Department of the Interior
US Geological Survey
Fact Sheet-051-00
April 2000

A pdf of the report is available (1.6MB).



Interferogram of Santa Clara Valley shows patterns of subsidence and some uplift occurring over 7 months in 1997, from January 4 to August 2. A central subsidence zone, (red) the result of seasonal ground-water pumping, is fully recoverable.

Land subsidence is a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials. Subsidence in the United States has directly affected more than 17,000 square miles in 45 states, and associated annual costs are estimated to be approximately $125 million. The principal causes of subsidence are aquifer-system compaction, drainage of organic soils, underground mining, hydrocompaction, natural compaction, sinkholes, and thawing permafrost (National Research Council, 1991).

A powerful new mapping tool (InSAR) is a critical element in the assessment and mitigation of subsidence. InSAR is capable of remotely sensing small changes in land surface elevation at an unprecedented level of spatial detail. The new displacement maps enhance our capabilities to monitor and manage subsidence caused by the compaction of susceptible aquifer systems, and reveal new insights into the controlling physical processes.

Interferometric Synthetic Aperture Radar (InSAR) is a powerful new tool that uses radar signals to measure deformation of the Earth's crust at an unprecedented level of spatial detail and high degree of measurement resolution.

InSAR is now being used by the USGS and others to map and monitor subsidence caused by the compaction of aquifer systems. Geophysical applications of radar interferometry take advantage of the phase component of reflected radar signals to measure apparent changes in the range distance of the land surface (Gabriel and others, 1989; Massonnet and Feigl, 1998). Ordinary radar on a typical Earth-orbiting satellite has a very poor ground resolution of about 3 to 4 miles because of the restricted size of the antenna on the satellite. Synthetic Aperture Radar (SAR) takes advantage of the motion of the spacecraft along its orbital track to mathematically reconstruct (synthesize) an operationally larger antenna and yield high-spatial-resolution imaging capability on the order of hundreds of feet. The size of a picture element (pixel) on a typical SAR image made from satellite-borne radar may be as small as tens of thousands of square feet, depending how the image is processed.

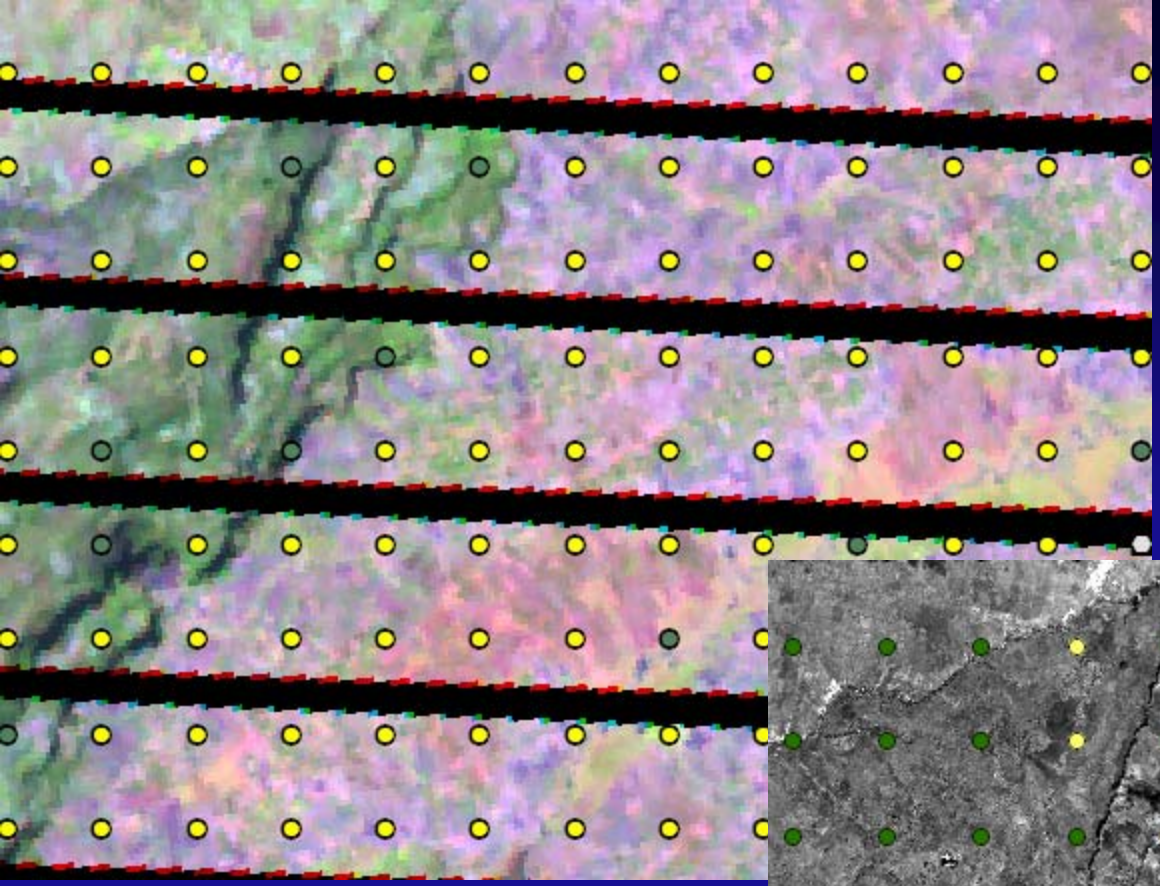
Cropped Area Estimation in Ethiopia

Using commercial satellite imagery from WARP-UNIL to answer a fundamental question of the food security community

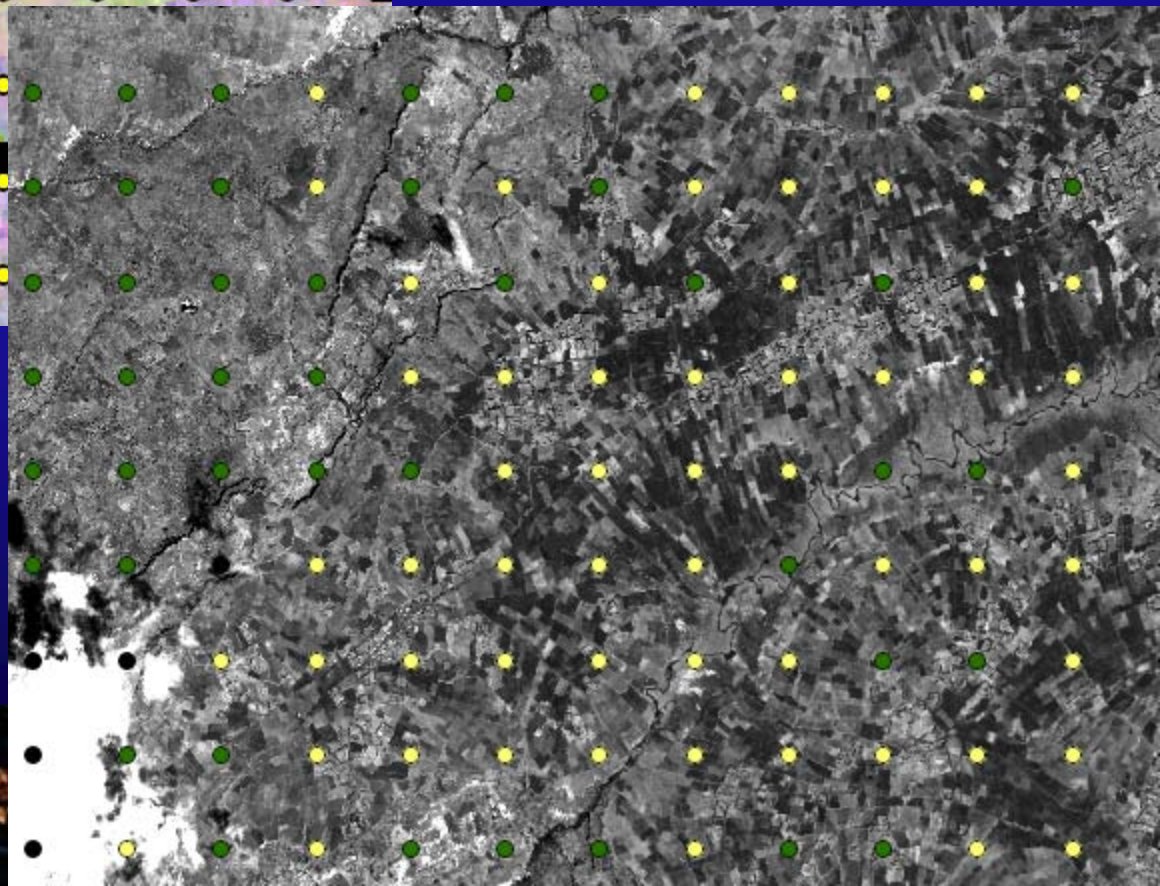
USGS

Background

- Nine million people in Ethiopia are at risk of food insecurity (FEWS NET, Feb 2007)
- Largest food aid recipient in Sub-Saharan Africa
- Good estimates of crop production are needed to properly design food aid programs
  - Too little food aid can result in otherwise avoidable suffering
  - Too much food aid can disrupt markets and create farmer disincentives



TM with classification



IKONOS with classification

USGS

Vision

- Constantly monitor volcanic and earthquake prone regions
  - Better understand what deformation information is telling us about Earth processes
- Utilize radar to monitor heavy cloud cover regions with vital agricultural (or other) resources
- Monitor mine regions where personnel are actively working
- Detect regions of landslide activity due to heavy rainfall
- Detect potential levee failure areas well before they occur

Potential Obstacles

- $
- h/w s/w capabilities
- Standards
- Trained Personnel
- Time

Questions

Email: tcecere@usgs.gov

Phone: 703-648-5551