Keeping an Eye on Alaska

Cutting Edge Remote Sensing Activities in the State

FJ Meyer[1) 2)]

[1)]*Earth & Planetary Remote Sensing, University of Alaska Fairbanks*
[2)]*Alaska Satellite Facility (ASF)*

Collaborating Organizations:

My Qualifications

- Technical Expertise:
  - A decade of radar remote sensing research
    - More than 80 publications
    - Four professional awards
    - Chair of several committees and working groups (incl. IEEE Alaska Section GRSS Chapter)
  - Involved in large number of satellite missions

- Experience in Science from Radar:
  - PI of 7 active science projects (~$1.8 M)

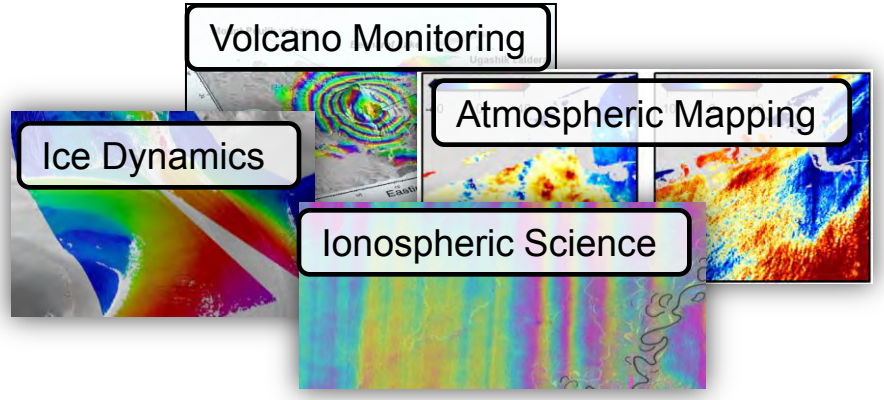


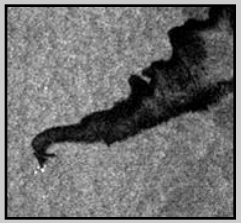
Table of Contents

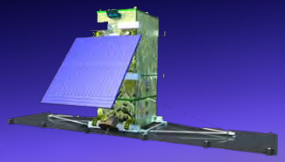
Polarimetric SAR Image over Sea Ice

Image from: http://www.astrium-geo.com

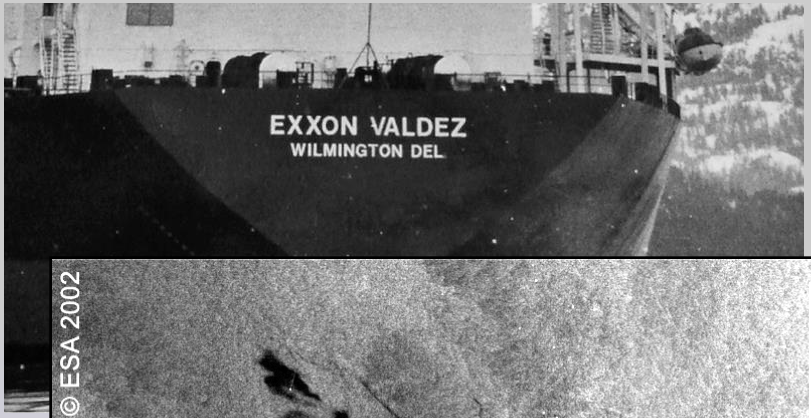
Applications of Remote Sensing for Alaska

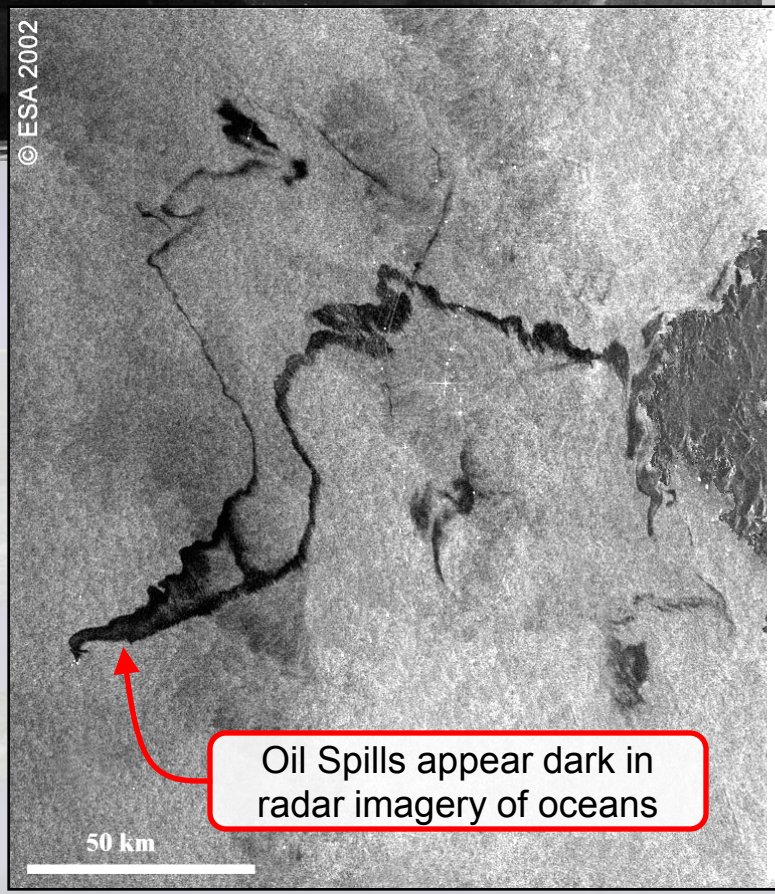
Oil Spills





Monitoring of Oil Spills

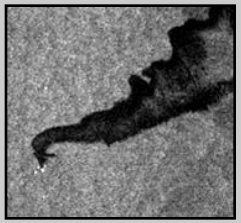




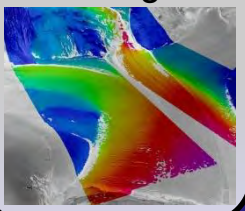
Spaceborne Radar Image of Prestige Spill, 2002

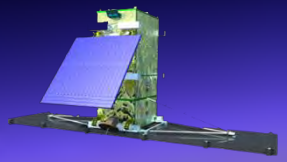
Applications of Remote Sensing for Alaska

Oil Spills



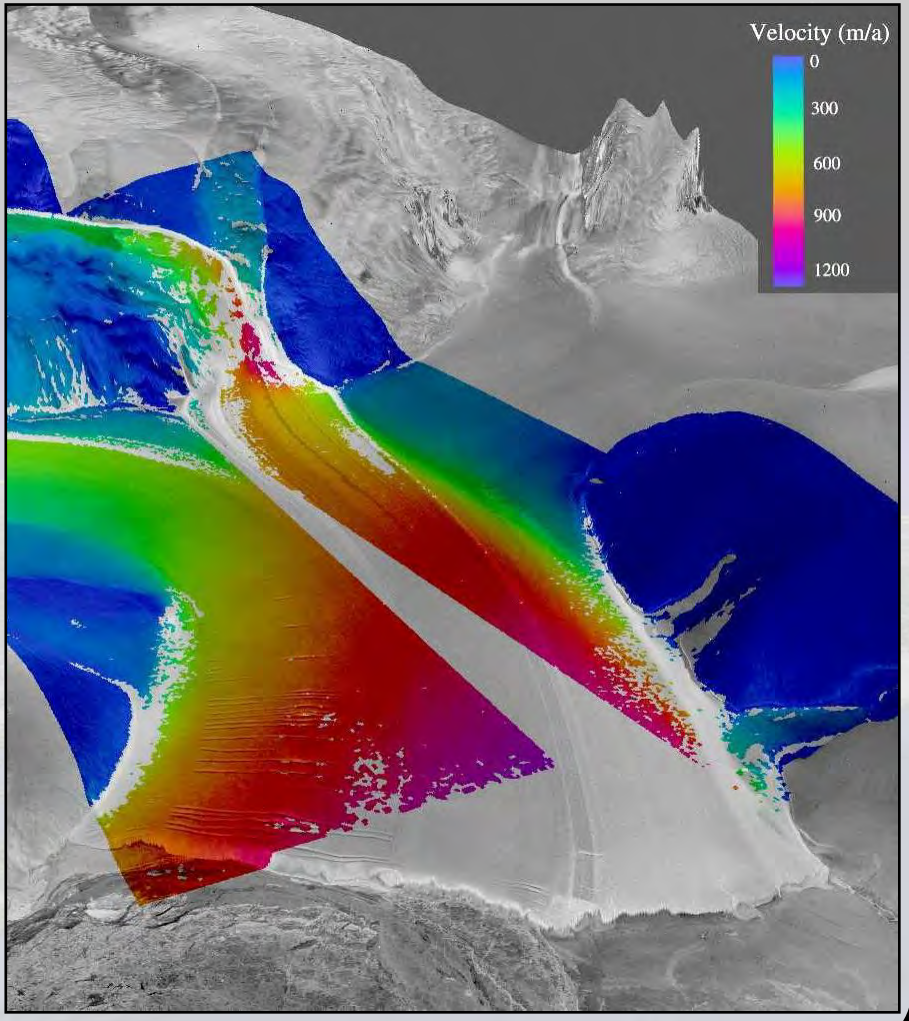
Cryospheric Change





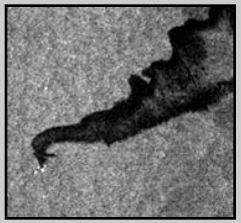
Monitoring Cryospheric Change

Measuring centimeter-scale ice motion from Space



Applications of Remote Sensing for Alaska

Oil Spills



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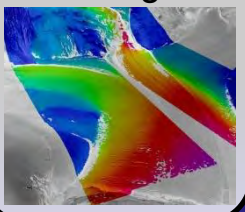
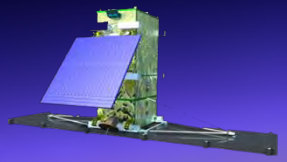
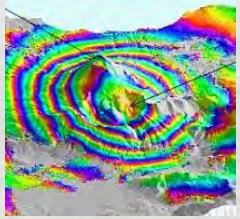




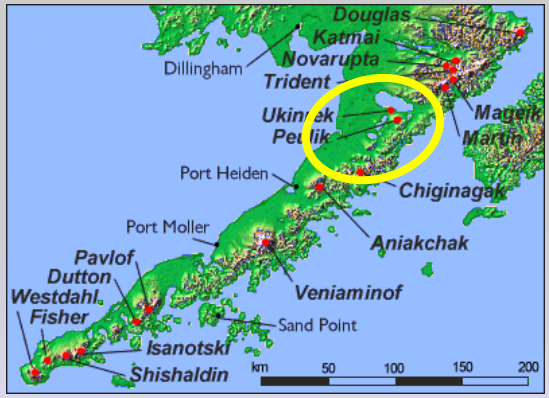
Volcanoes



Bristol Bay

Volcanoes

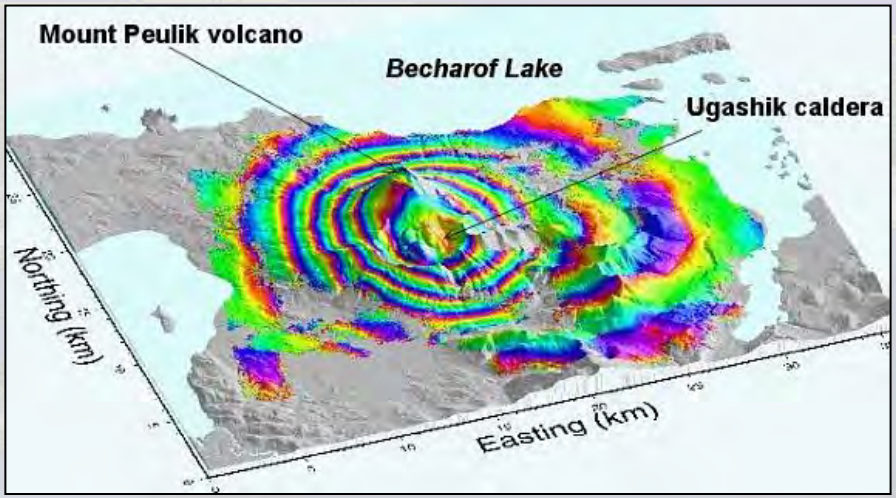
Watching Volcanoes "Breath" from Space



Mt. Peulik, AK

observed from space:

17-cm inflation
9/1996 – 11/97



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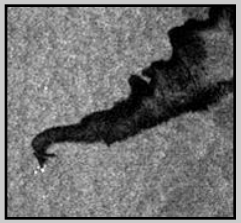

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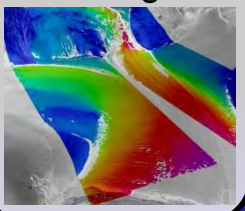

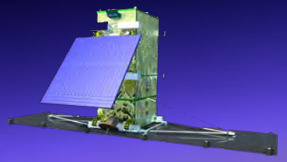

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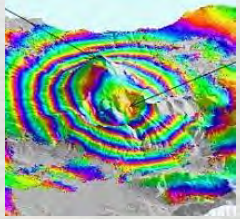
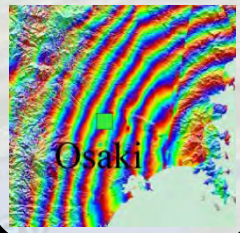


Earthquakes



Bristol Bay

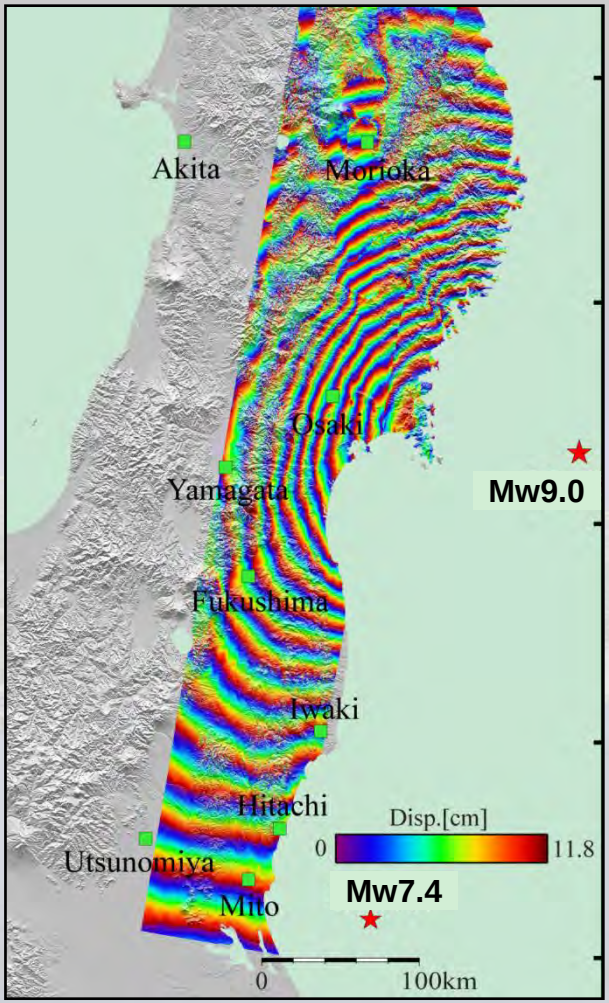
Earthquakes

Mapping the Motion of Japan, 2011

Processed by:

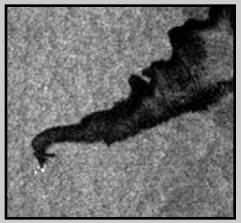
LSGI/PolyU, Hong Kong Polytechnic University

Near Sendai:
~ 2.5m total motion



Applications of Remote Sensing for Alaska

Oil Spills



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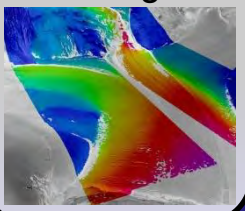
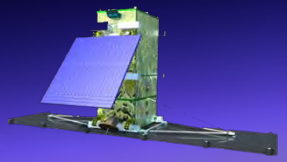
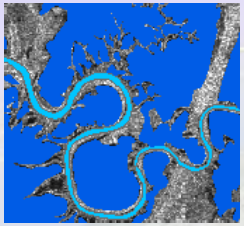




Weather



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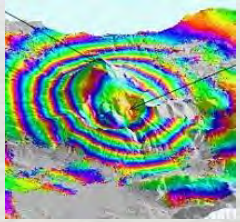

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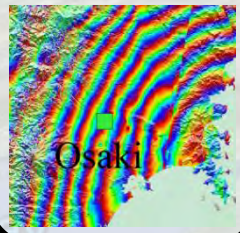
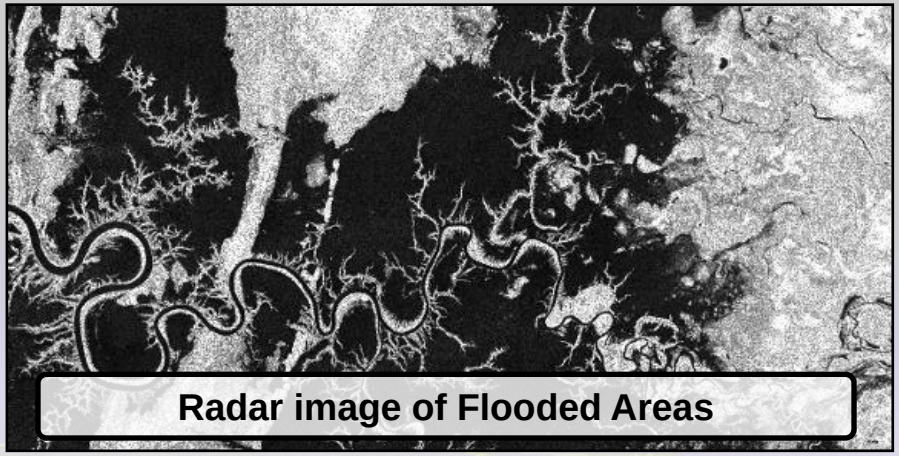


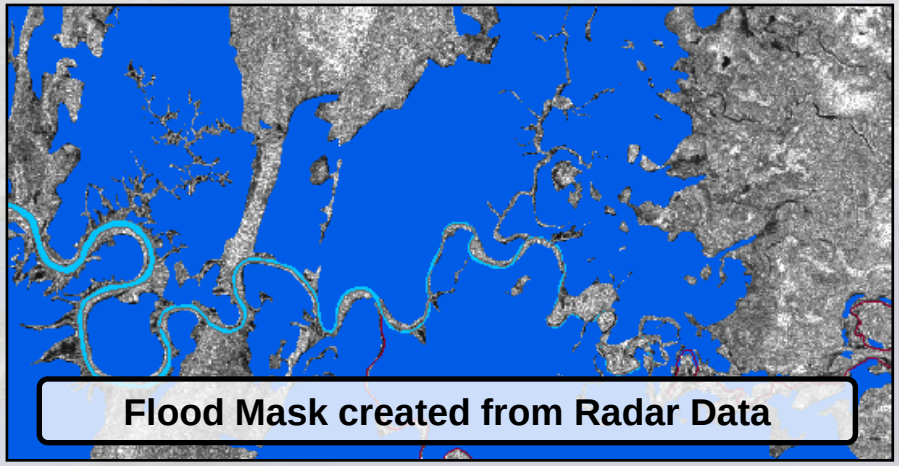
Bristol Bay

Flood Mapping

Mapping Flooded Regions in Australia, 2010



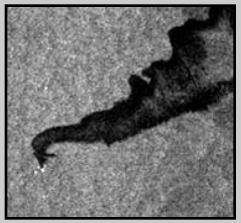
Radar image of Flooded Areas



Flood Mask created from Radar Data

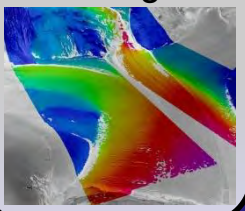
Applications of Remote Sensing for Alaska

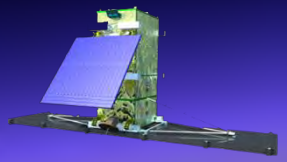
Oil Spills



Sea Ice

Cryospheric Change





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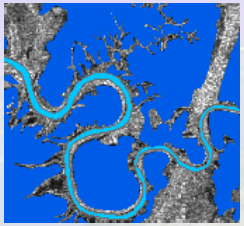

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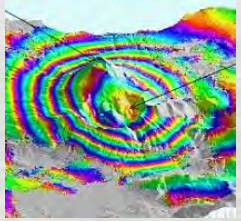

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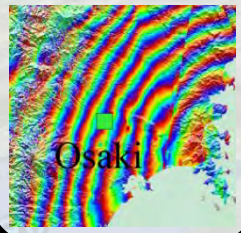
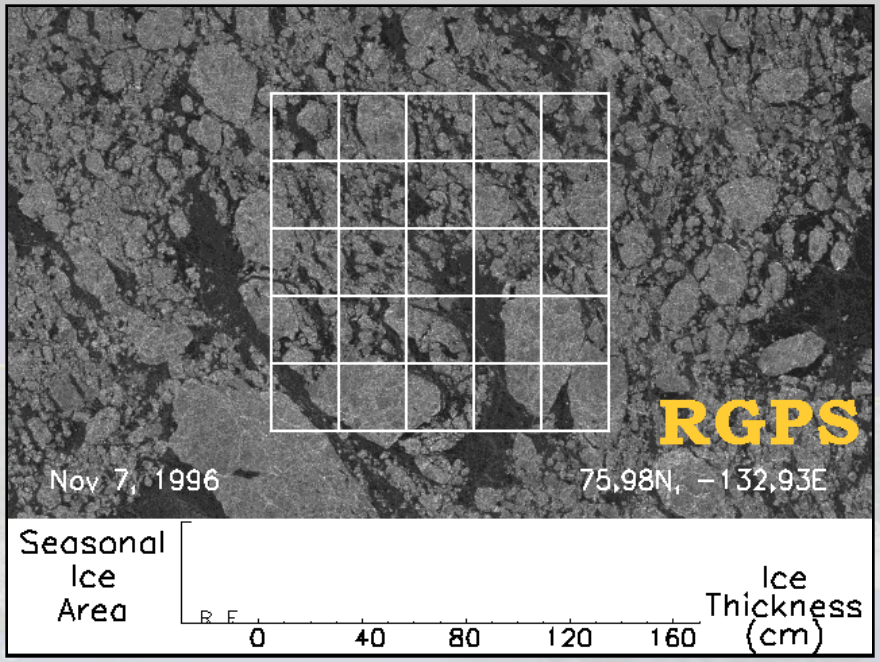


Sea Ice Monitoring

Monitoring Sea Ice Motion with Radar



Sea Ice motion in the Beaufort Sea

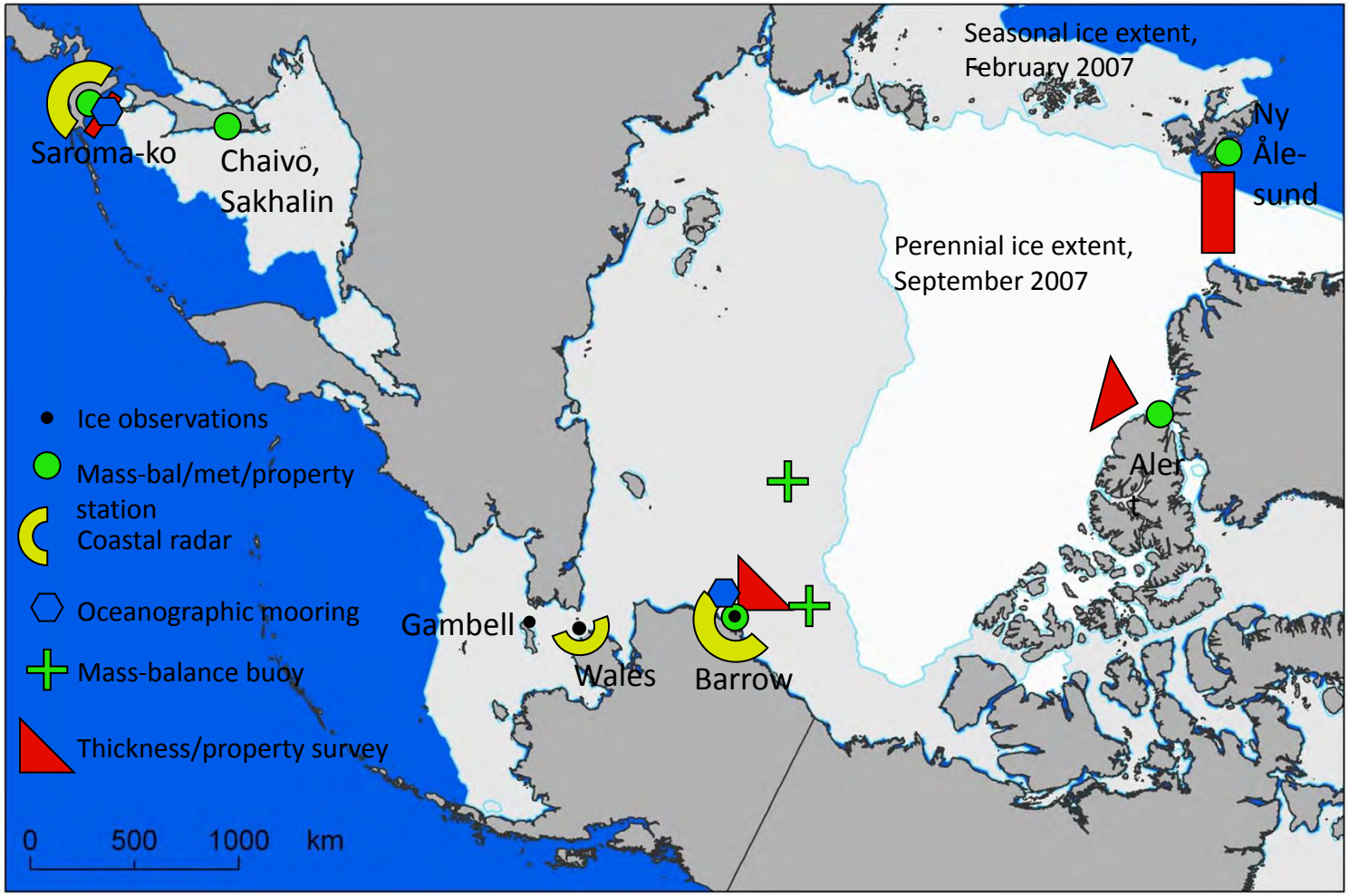
Remote Sensing Assets in Alaska

Alaska's Remote Sensing Assets

- Alaska hosts world class assets in (1) spaceborne, (2) airborne, and (3) ground-based remote sensing

Example of Ground-Based Remote Sensing Tools

Contributions to SIZONet (Seasonal Ice Zone Observing Network)



NSF funded observing network with international collaborators from Germany, Canada, Norway and Japan (www.sizonet.org)

Example of Ground-Based Remote Sensing Tools

Contributions to SIZONet (Seasonal Ice Zone Observing Network)

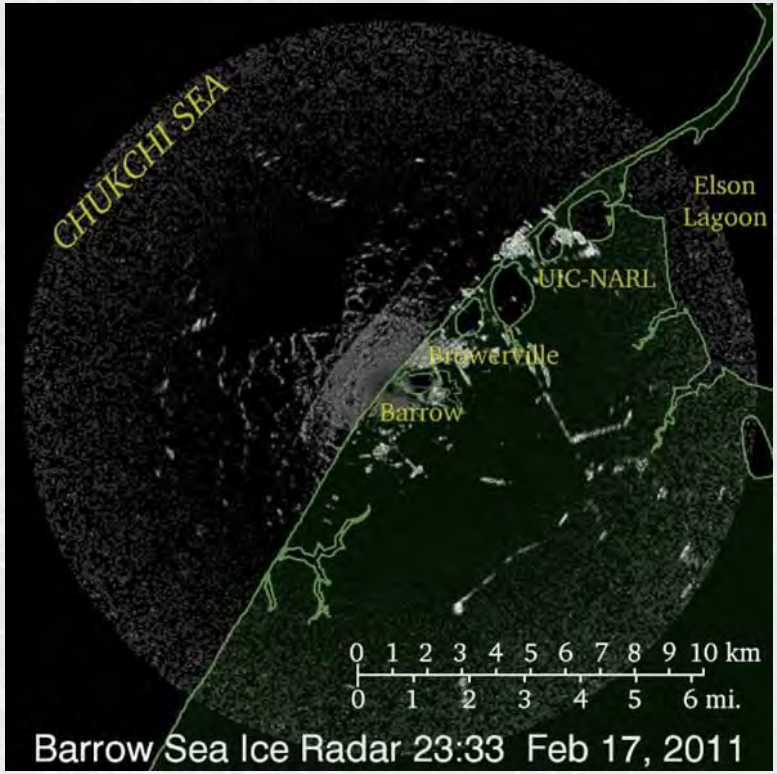
- Barrow Coastal Sea Ice Observatory
  - Webcam and sea ice radar
  - Mass balance site
  - Ocean moorings
  - Local ice observations

Barrow Sea Ice Cam Thu May 17 2007 14:00:07

Barrow Sea Ice Cam 2010-08-05 09:34:59

Ground-based Remote Sensing for Near-Shore Ice Analysis

- Winter Ice Shove, Feb 17/18, 2011
  - Simultaneous observations by webcam and radar imagery



Alaska's Unmanned Aerial Vehicle Program

- Managed by the Poker Flats Research Range, University of Alaska Fairbanks (manager: Greg Walker)
- Large number and variety of UAVs operated and tested in Alaska

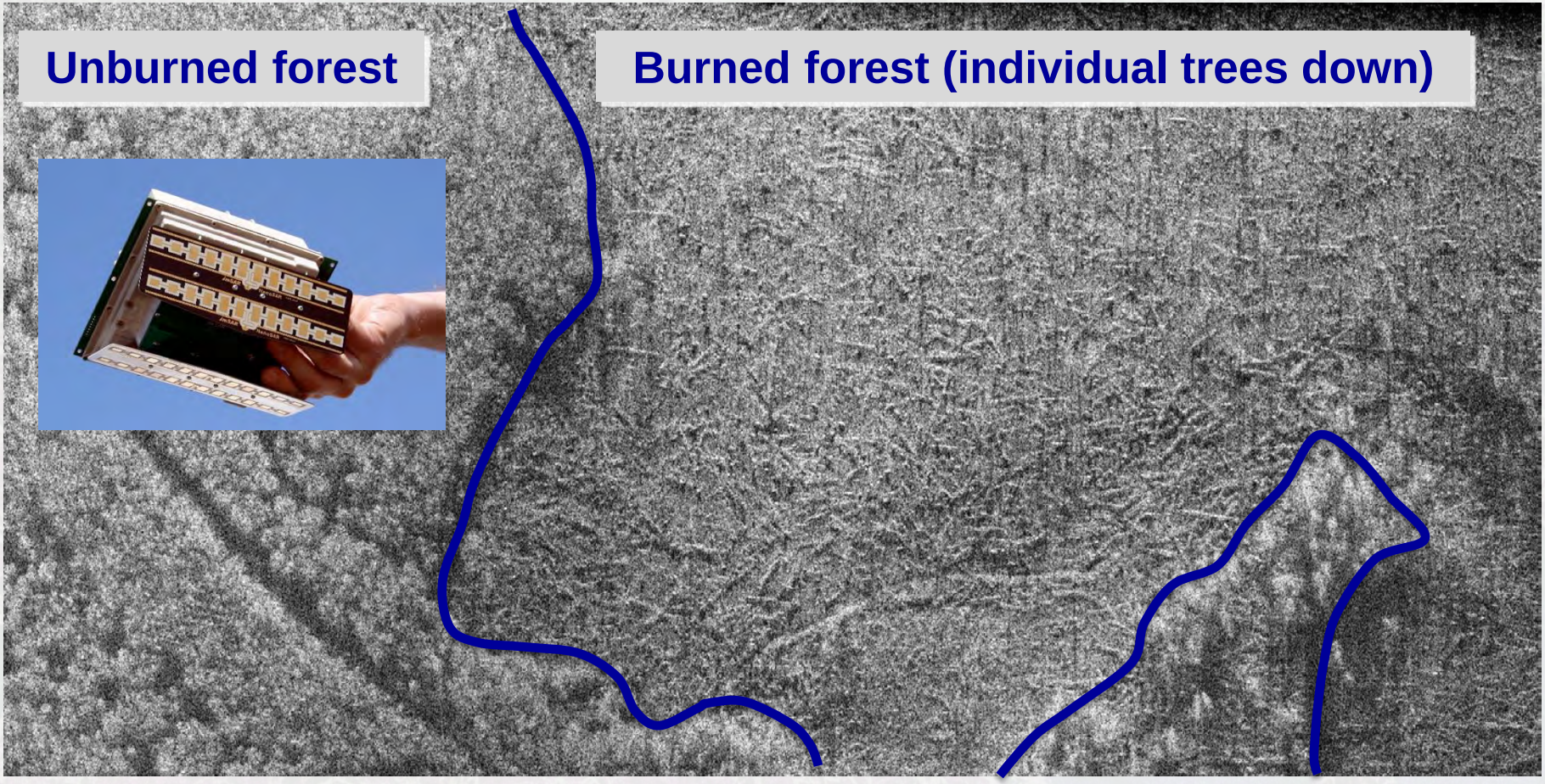
Example UAV Platforms in Alaska

Gatewing X100 (3 foot wingspan)

INSITU ScanEagle (10 foot wingspan)

- Large number of remote sensing sensors are currently tested on these platforms

Application of UAVs for Wildfire Mapping



The Alaska Satellite Facility – Largest Data Center for Spaceborne Radar Remote Sensing Data in the US

Alaska Satellite Facility (ASF)

- Operated by Geophysical Institute of University of Alaska Fairbanks since 1991
- NASA SAR Data Center: member of NASA DAAC Alliance
- ASF Satellite Tracking Station
- **Main SAR data processing, archiving, and distribution center of the US**
- Support of US SAR science community in processing and data analysis

ASF Satellite Tracking Station

ASF operates two antennas:

- 10m X-band
- 11m X- and S-band

ASF Radar Remote Sensing Mission Portfolio:

ERS-1: ESA-owned C-band
supported for NASA 1991-2000

JERS-1: JAXA-owned L-band
supported for NASA 1992-1998

ERS-2: ESA-owned C-band
supported for NASA 1995-present

AIRSAR & UAVSAR: NASA-owned airborne SAR archive data

R-1: CSA-owned C-band
supported for NASA 1995-2008

ALOS: JAXA-owned L-band supported 2006-now.
ASF is the Americas ALOS Data Node

Other Supported Systems:

Quikscat; AIM; COSMIC; SAMPEX; CHAMP; GRACE-1,2; SCISAT

Geographic Information Network of Alaska

3.6-meter Antenna

SeaSpace X-band Ground Station

MODIS on NASA Terra and Aqua

1.2-meter Antenna

SeaSpace L-band Ground Station

AVHRR on NOAA polar orbiters

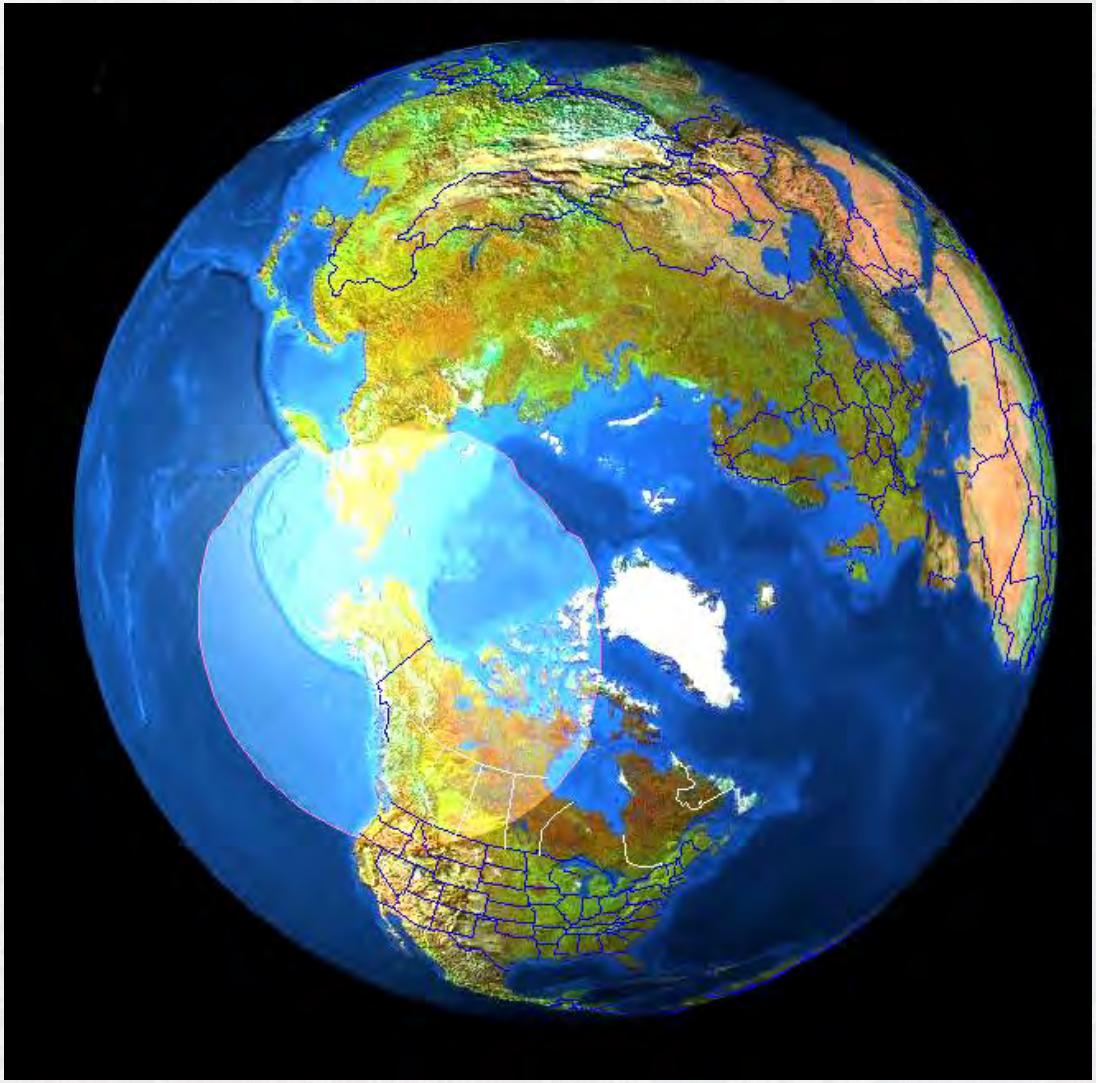
GINA Capabilities:

- Satellite data reception
- Real-time product generation
- Geospatial data management
- Rapid, large-scale data distribution
- Web interfaces

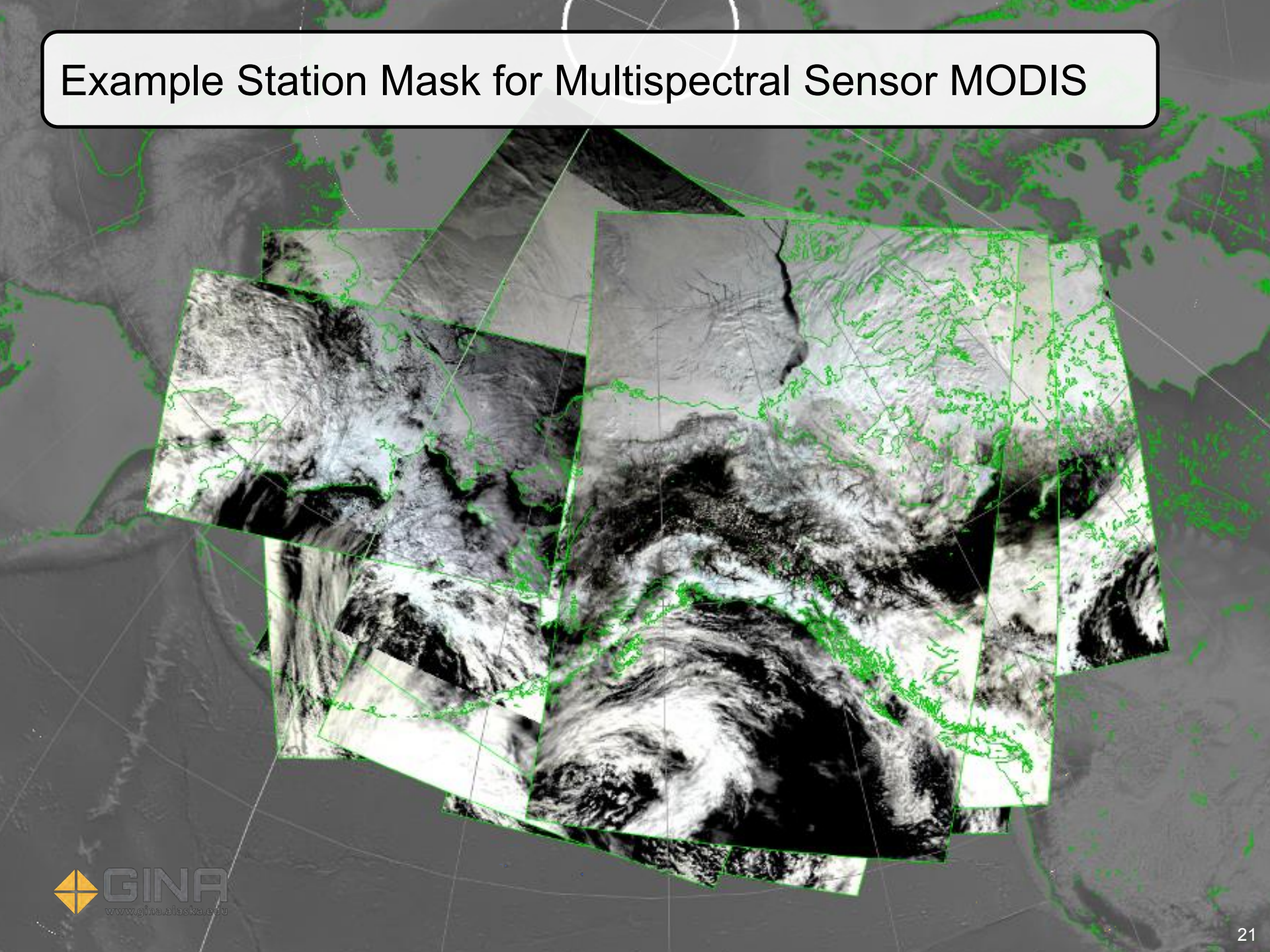
www.gina.alaska.edu

Station Masks of Alaska's Remote Sensing Data Centers

- Unique access to spaceborne remote sensing data over Arctic Regions
- Near real-time coverage of Alaska as well as large parts of Canada and the American North West



Example Station Mask for Multispectral Sensor MODIS



Example Remote Sensing Applications for Alaska

Remote Sensing-Based Volcano Monitoring – The Alaska Volcano Observatory (AVO)

A collaborative program of the USGS, the ADGGS and the UAF/GI

AVO Remote Sensing Data Center

http://avo.images.alaska.edu/tools/datacenter/

June 14, 2011

Geophysical Institute

UAF

Monitoring
AM - Dehn
PM - Steensen

Duty
RS: Peter Webley
DS: Kristi Wallace

RS Reports
2011-06-14 AM
2011-06-13 PM
2011-06-13 AM

Links
Image Flipper
Weekly Report
Observation DBase

Web Tools
Contacts

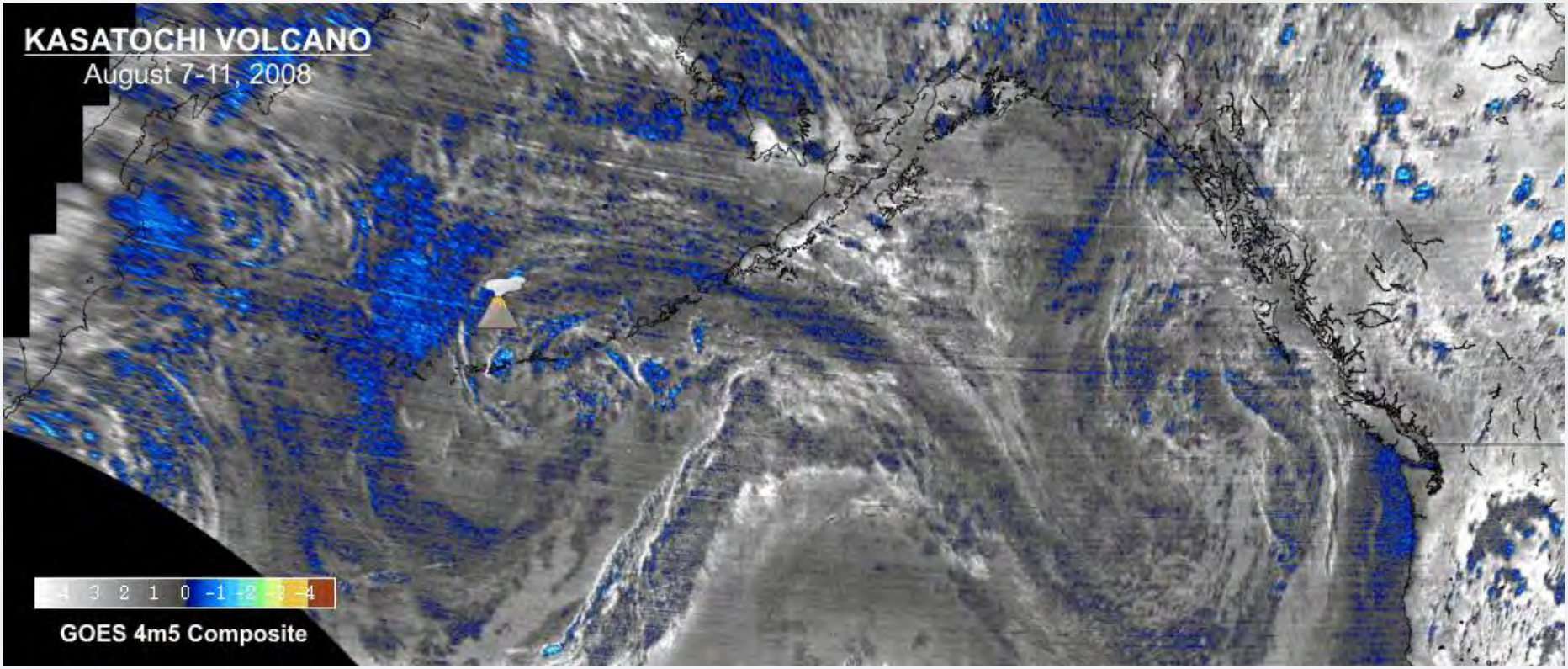
Sat. Report
Auto Hotspot
Auto Plume
Auto Aster
Possible Auto Aster
E-mail
Cellphone SMS

Current | Activity | Future | Color Codes

DATE	AVHRR	MODIS	GOES	MTSAT	HS	AA	DBASE
20:00 UTC 06/14/2011			g11.11165.2000				
16:00 UTC 06/14/2011	n16.11165.1948 n19.11165.1827 n16.11165.1807 n15.11165.1722 n18.11165.1653 n16.11165.1626	a1.11165.1828 t1.11165.1802 a1.11165.1648	g11.11165.1945 g11.11165.1930 g11.11165.1930 g11.11165.1915 g11.11165.1900 g11.11165.1900 g11.11165.1845 g11.11165.1830 g11.11165.1830 g11.11165.1800 g11.11165.1745 g11.11165.1730 g11.11165.1730 g11.11165.1715 g11.11165.1700 g11.11165.1700 g11.11165.1645 g11.11165.1630 g11.11165.1630 g11.11165.1615 g11.11165.1600 g11.11165.1600	m1.11165.1901 m1.11165.1832 m1.11165.1732 m1.11165.1714 m1.11165.1701 m1.11165.1632 m1.11165.1601			jdehn pwebley
12:00 UTC 06/14/2011	n18.11165.1512 n15.11165.1403 n19.11165.1326	a1.11165.1507 a1.11165.1329	g11.11165.1530 g11.11165.1530 g11.11165.1500 g11.11165.1445 g11.11165.1430 g11.11165.1430 g11.11165.1415 g11.11165.1400 g11.11165.1400 g11.11165.1345 g11.11165.1330 g11.11165.1330 g11.11165.1315 g11.11165.1300 g11.11165.1300 g11.11165.1245 g11.11165.1230 g11.11165.1200 **g11.11165.1200**	m1.11165.1532 m1.11165.1501 m1.11165.1432 m1.11165.1401 m1.11165.1332 m1.11165.1301 m1.11165.1232		Pavlof (12:00)	

Example of Remote Sensing-Based Volcano Monitoring

Kasatochi Volcano, Alaska: 2008, Air Traffic issue



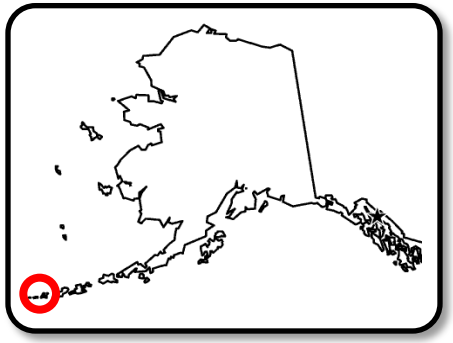
Ash was caught in a gyre, but enough passed over southeast to disrupt air traffic.

Slides courtesy of Peter Webley, UAF-GI and AVO; pwebley@gi.alaska.edu

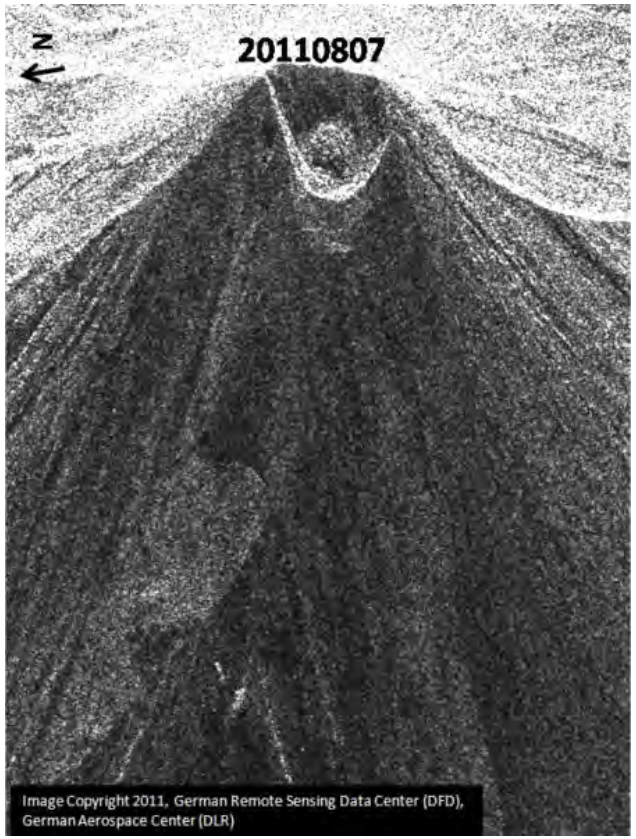
The Importance of Radar Remote Sensing

Radar observations of current activity at Mount Cleveland

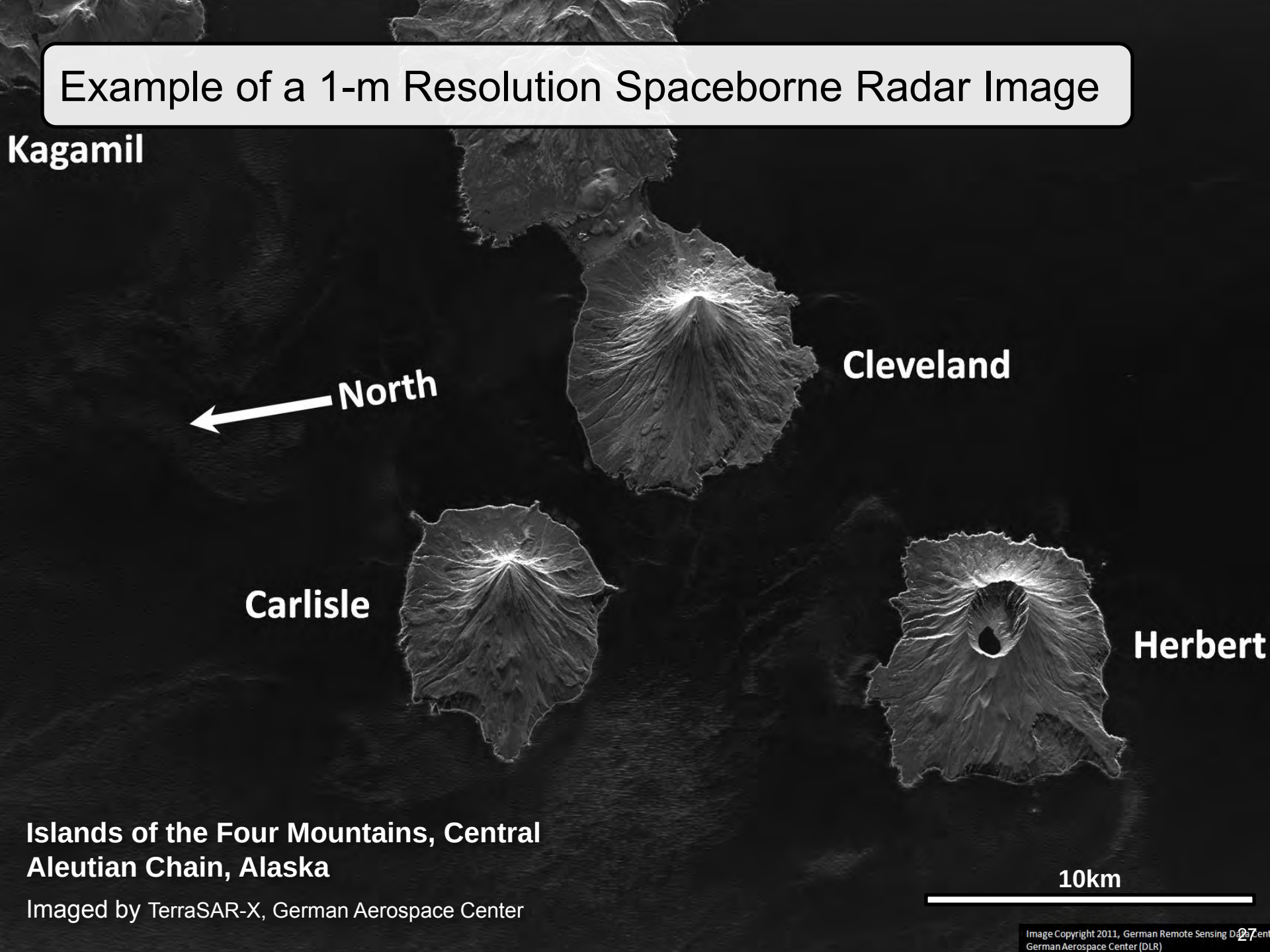
- Optical sensors yield little information due to cloud cover
- Radar data can see through clouds, ash, and smoke
- Active radars can operate day and night



2011 Dome Growth of Mount Cleveland from SAR



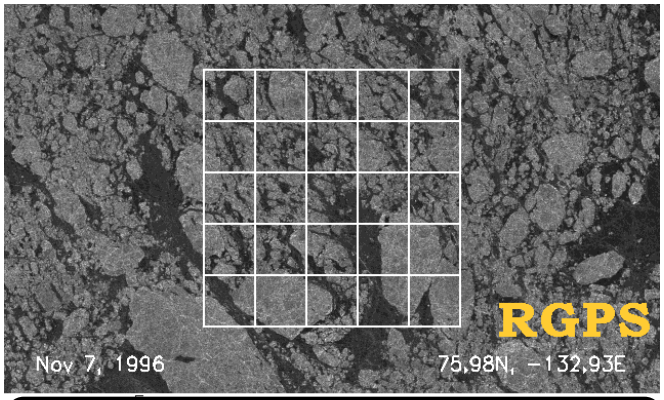
Example of a 1-m Resolution Spaceborne Radar Image



Islands of the Four Mountains, Central Aleutian Chain, Alaska

Imaged by TerraSAR-X, German Aerospace Center

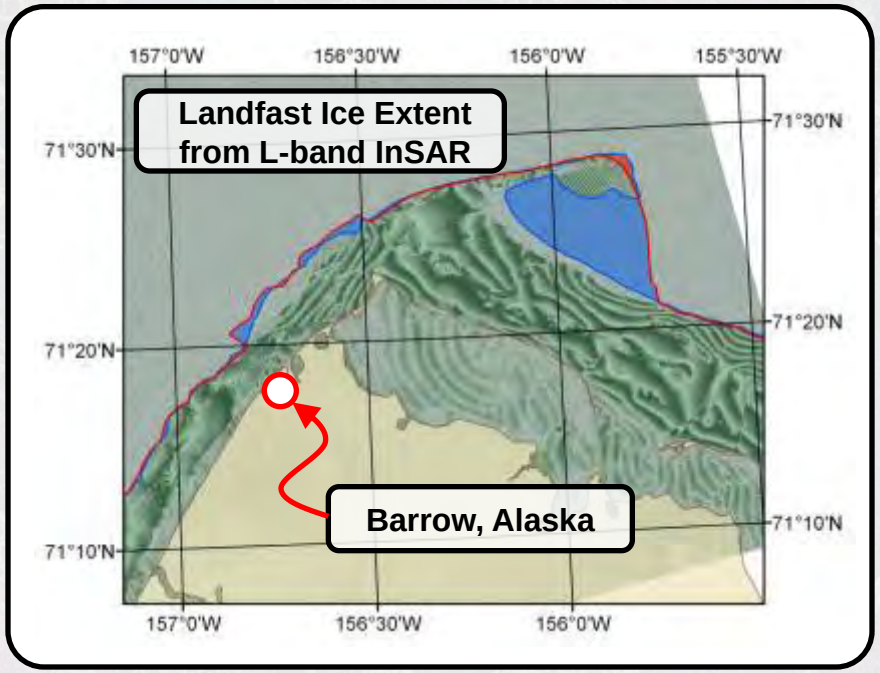
Sea Ice Dynamics from Radar Remote Sensing Data



Ice dynamics from multi-temoral Synthetic Aperture Radar Data

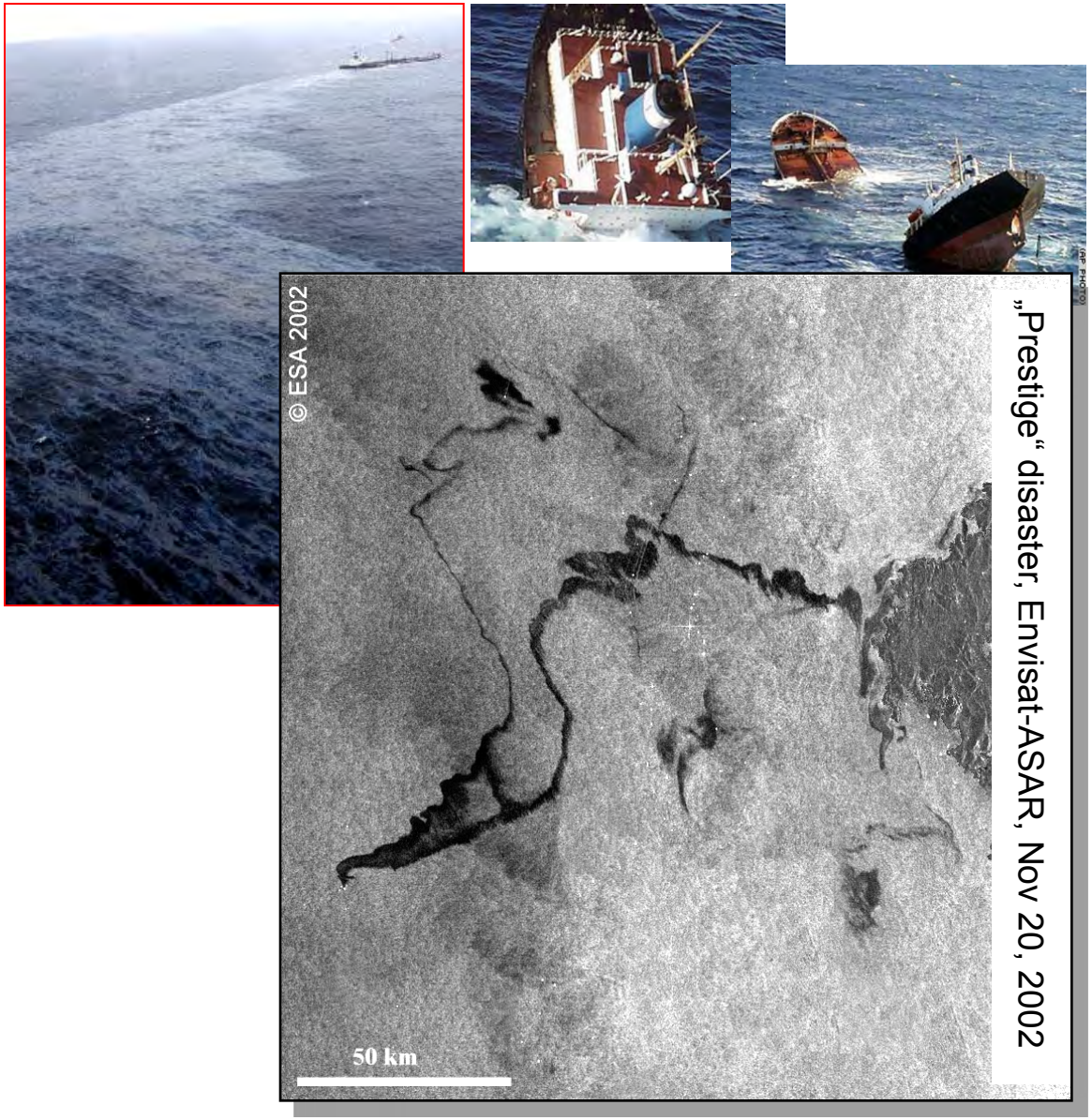
- Ice Dynamics from Multi-temporal Radar Images:
  - Large coverage Radar data (500km swath)
  - Cooperation with JPL

- Landfast Ice Monitoring:
  - Mapping and monitoring landfast ice from C-band SAR and L-band InSAR data
  - Cooperation with BOEMRE, Shell, Conoco Phillips



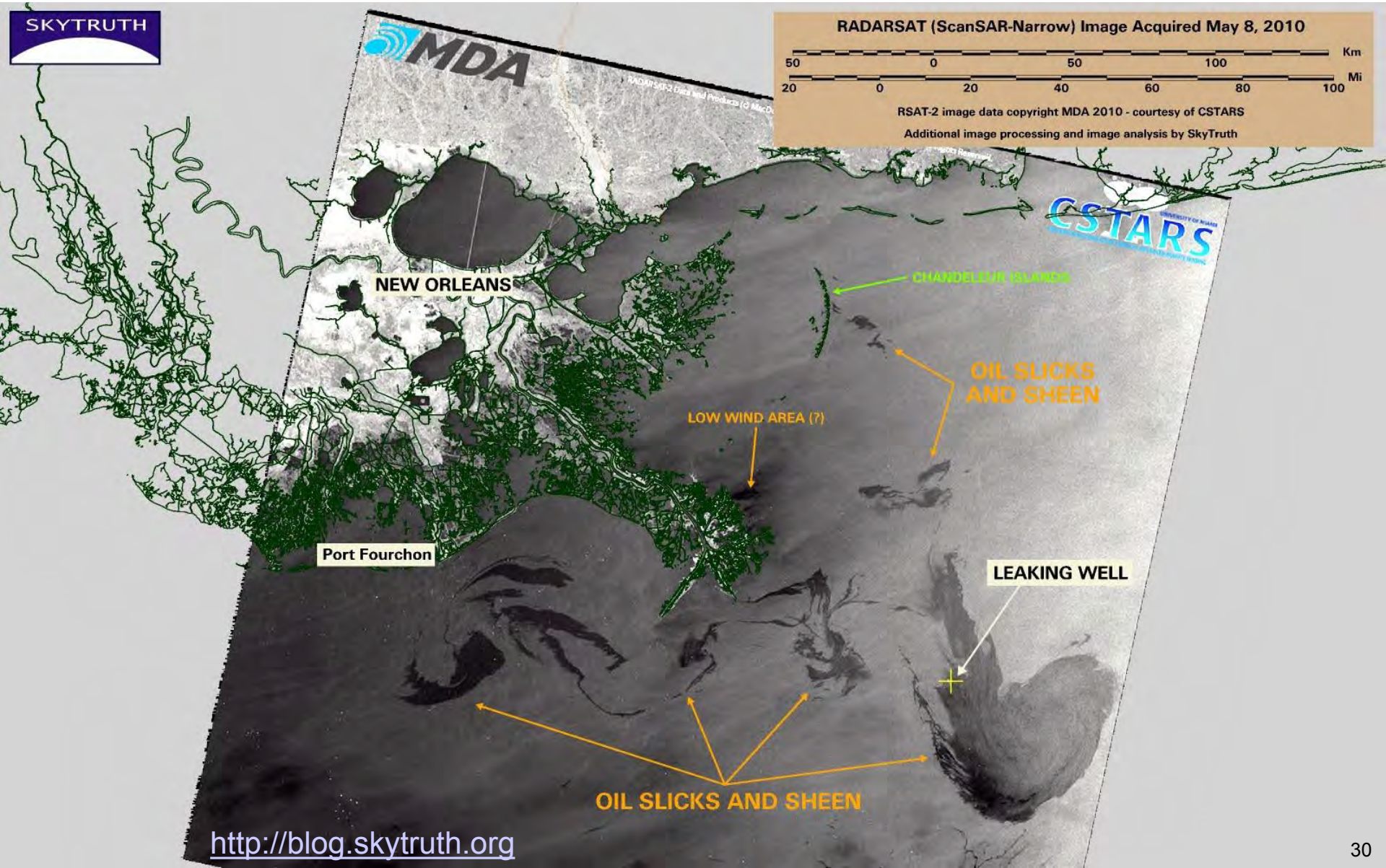
Oil Spill Monitoring with Spaceborne Radars

- Brightness of oceans in Radar images driven by roughness of ocean surface
- Wind-driven oceans appear bright in radar
- Oil spills change roughness of water surface and show up dark in SAR images
- SAR tool for detecting and tracking of spill



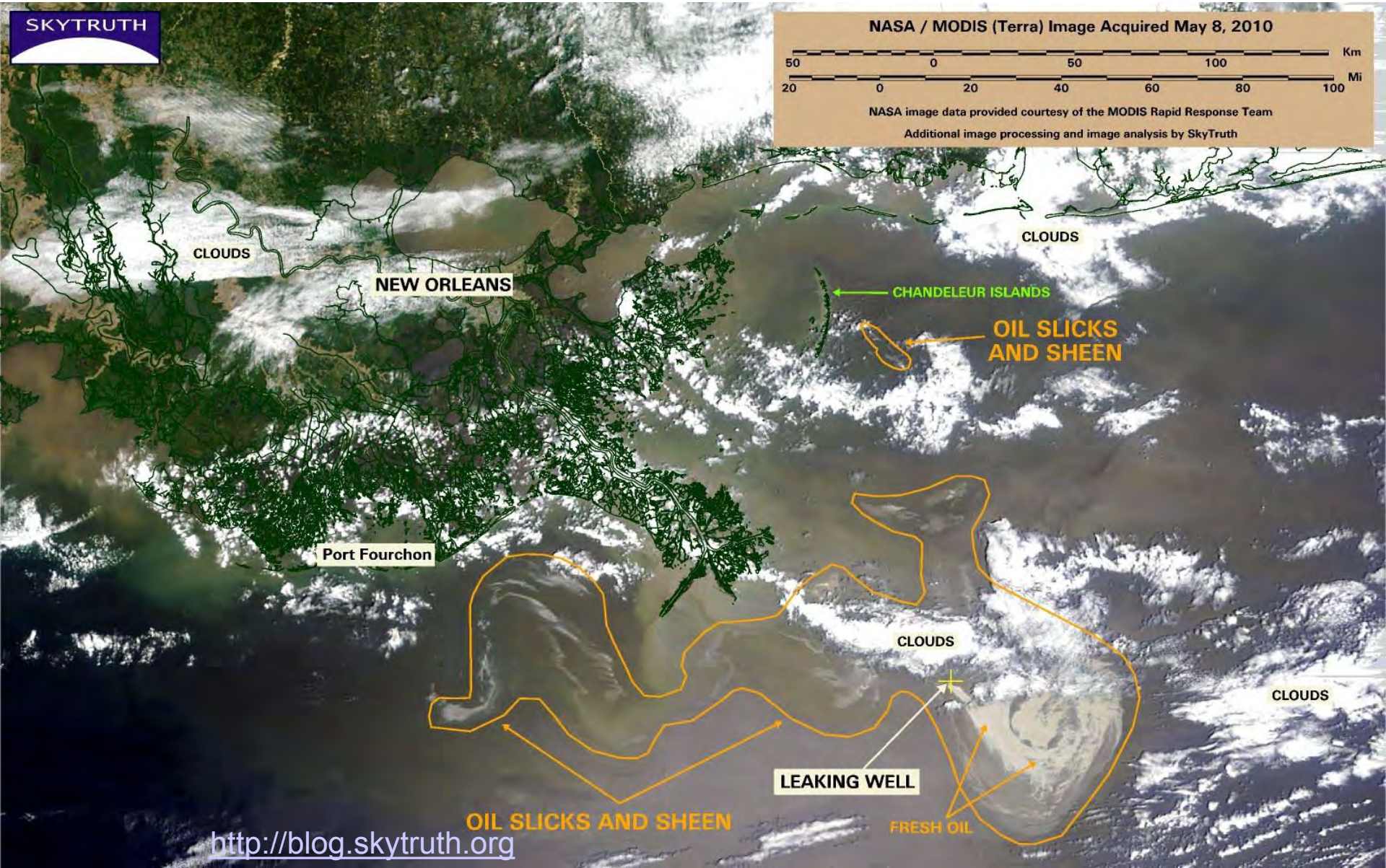
„Prestige“ disaster, Envisat-ASAR, Nov 20, 2002

Deep Water Horizon Spill Mapping with Spaceborne Radars



http://blog.skytruth.org

Deep Water Horizon Spill Mapping with Spaceborne Optical Imagery

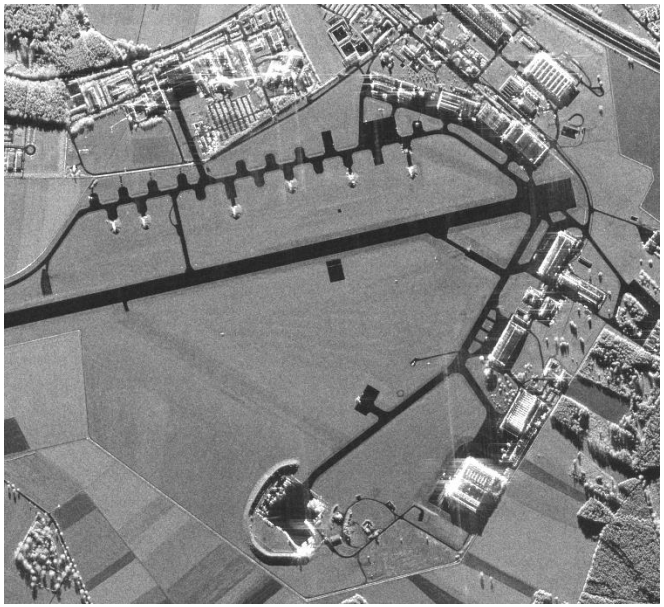


http://blog.skytruth.org

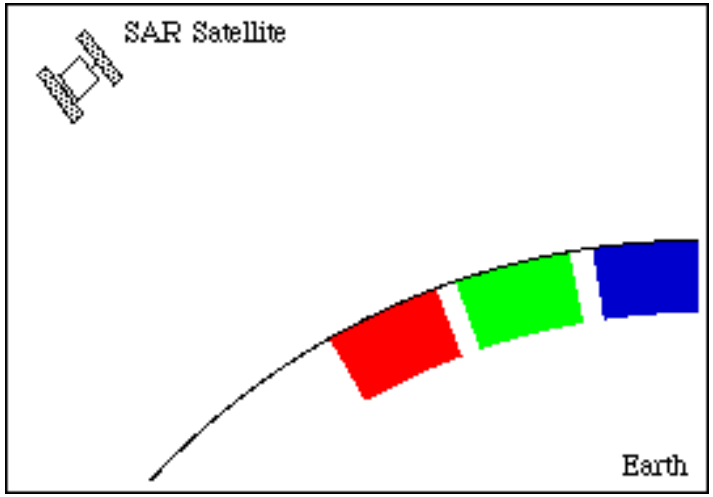
A SAR Acquisition …

- … records both **Amplitude** and **Phase** of the reflected microwave signals

Amplitude forms SAR Image

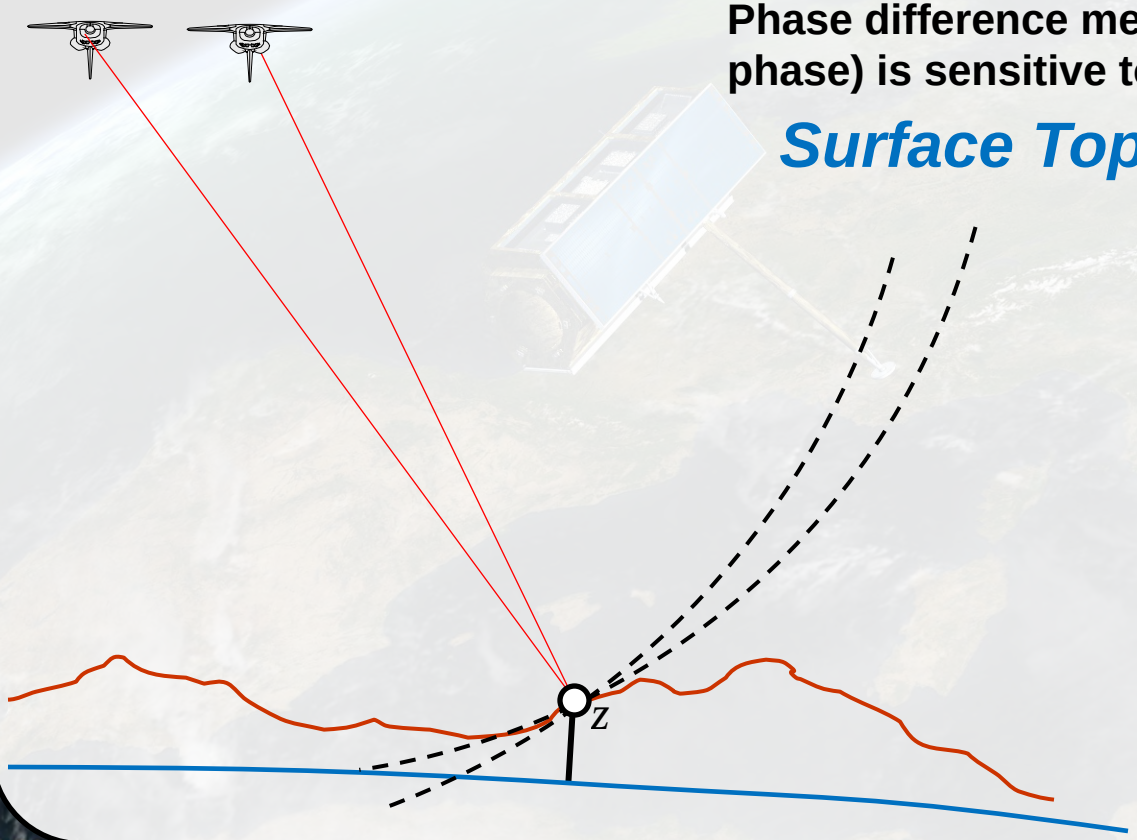


Phase measures the range to objects on ground



The Concept of Interferometric SAR (InSAR)

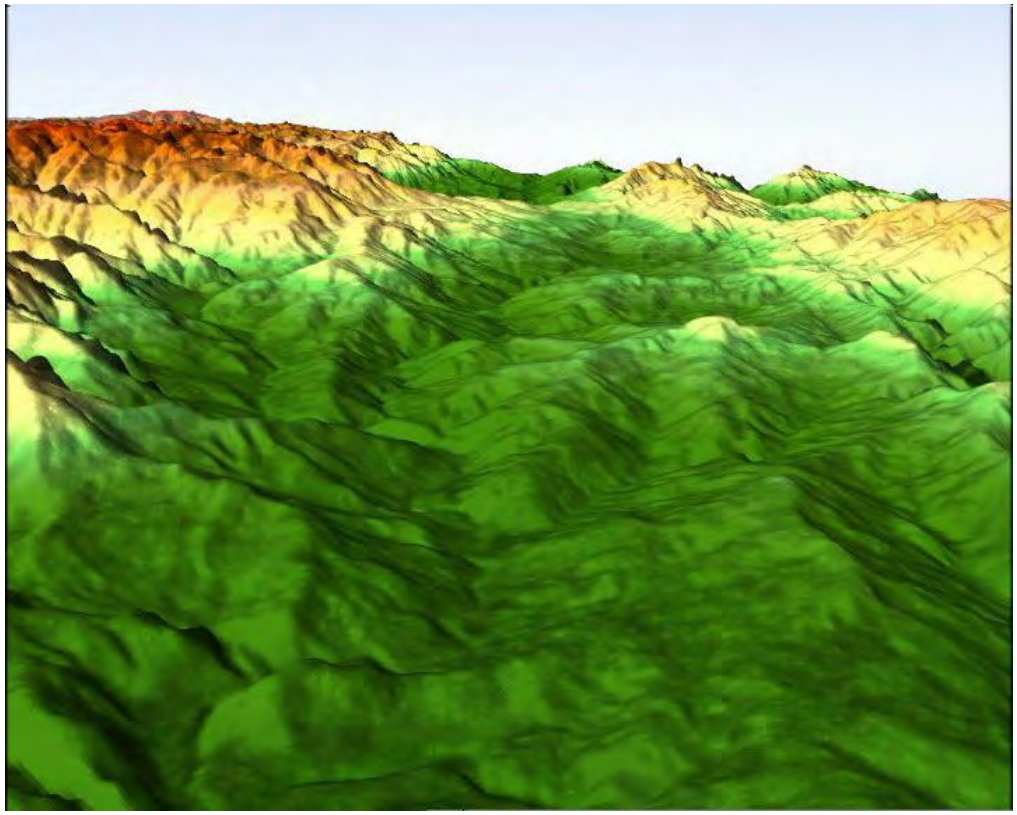
- Calculation of Phase Difference between Pairs of Radar Remote Sensing Images acquired from similar vantage points



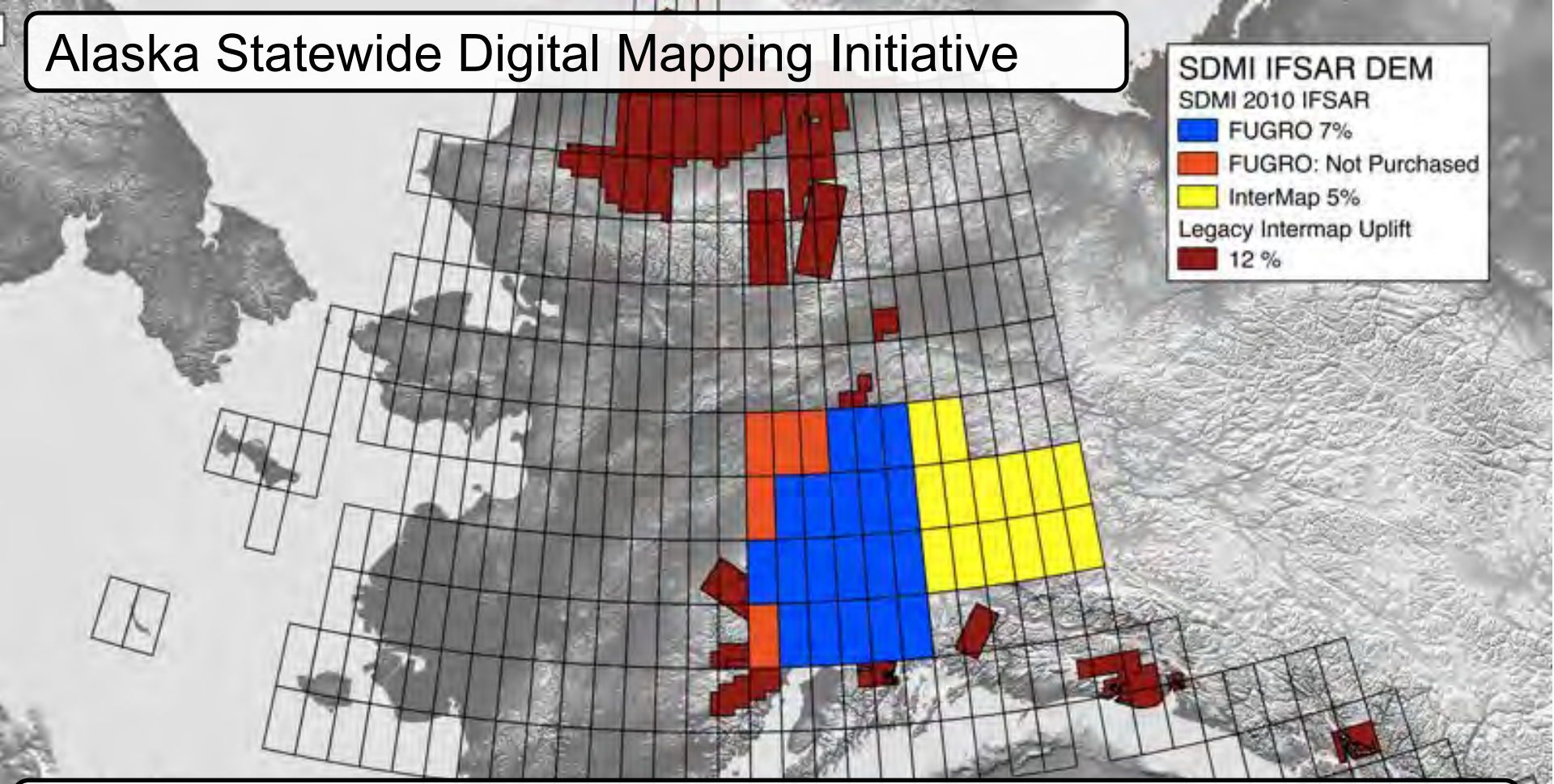
Phase difference measurement (interferometric phase) is sensitive to:

Surface Topography

InSAR-derived DEM, Cotopaxi Volcano, Ecuador

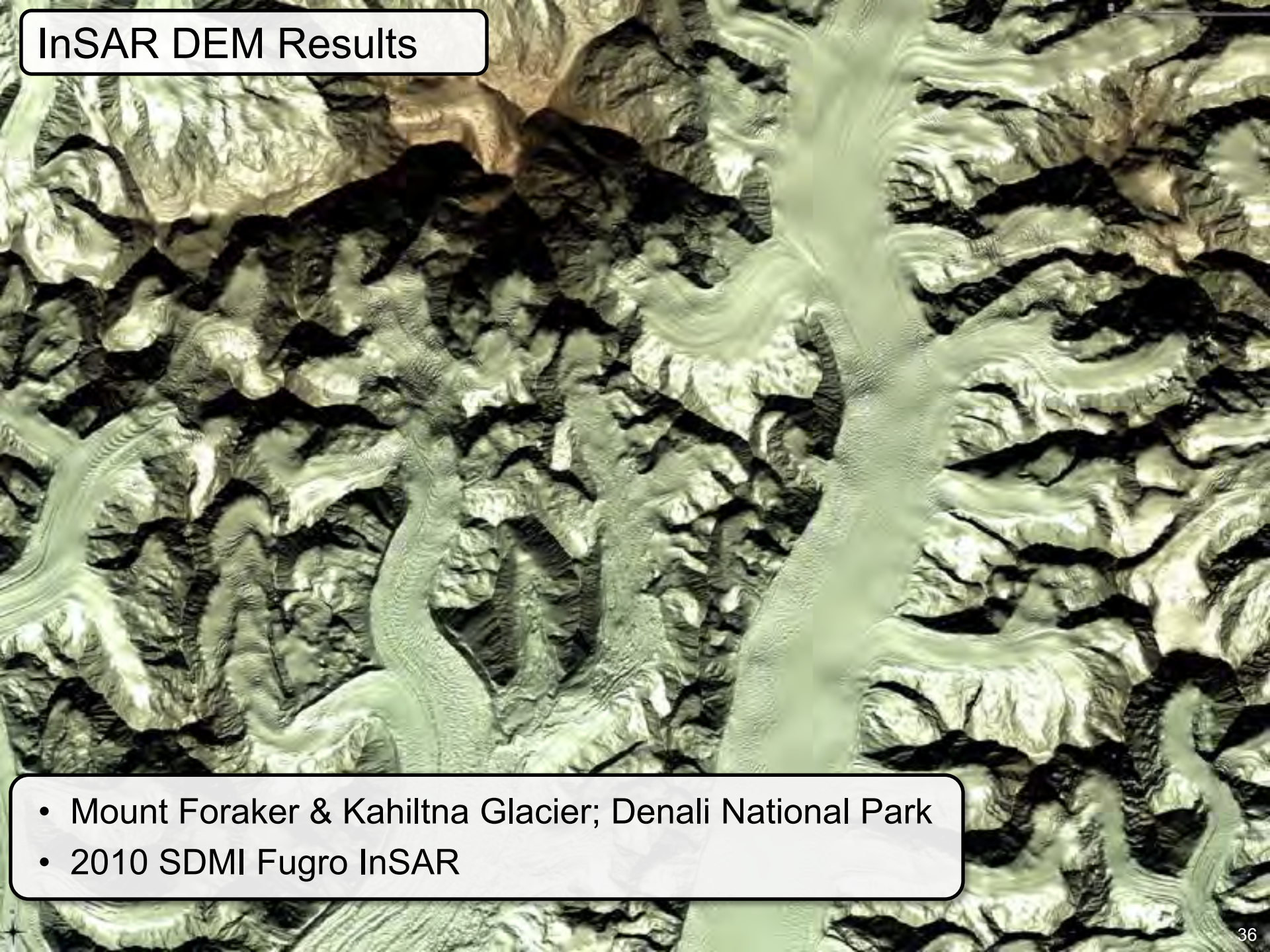


Alaska Statewide Digital Mapping Initiative



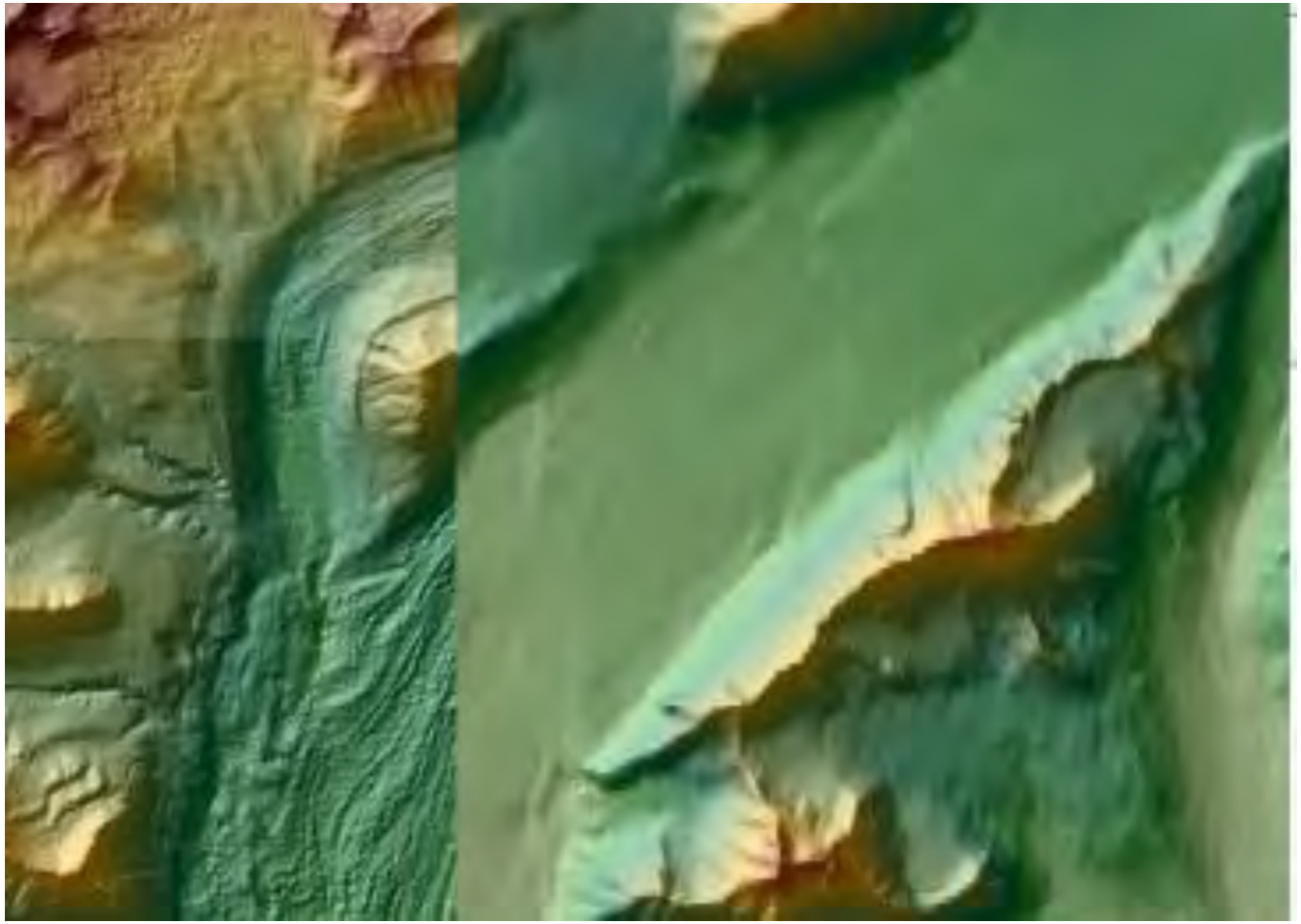
- Create high-quality digital elevation models (DEMs) for the state using InSAR and stereo-photogrammetry
  - Areas for InSAR (IfSAR) coverage are shown

InSAR DEM Results



- Mount Foraker & Kahiltna Glacier; Denali National Park
- 2010 SDMI Fugro InSAR

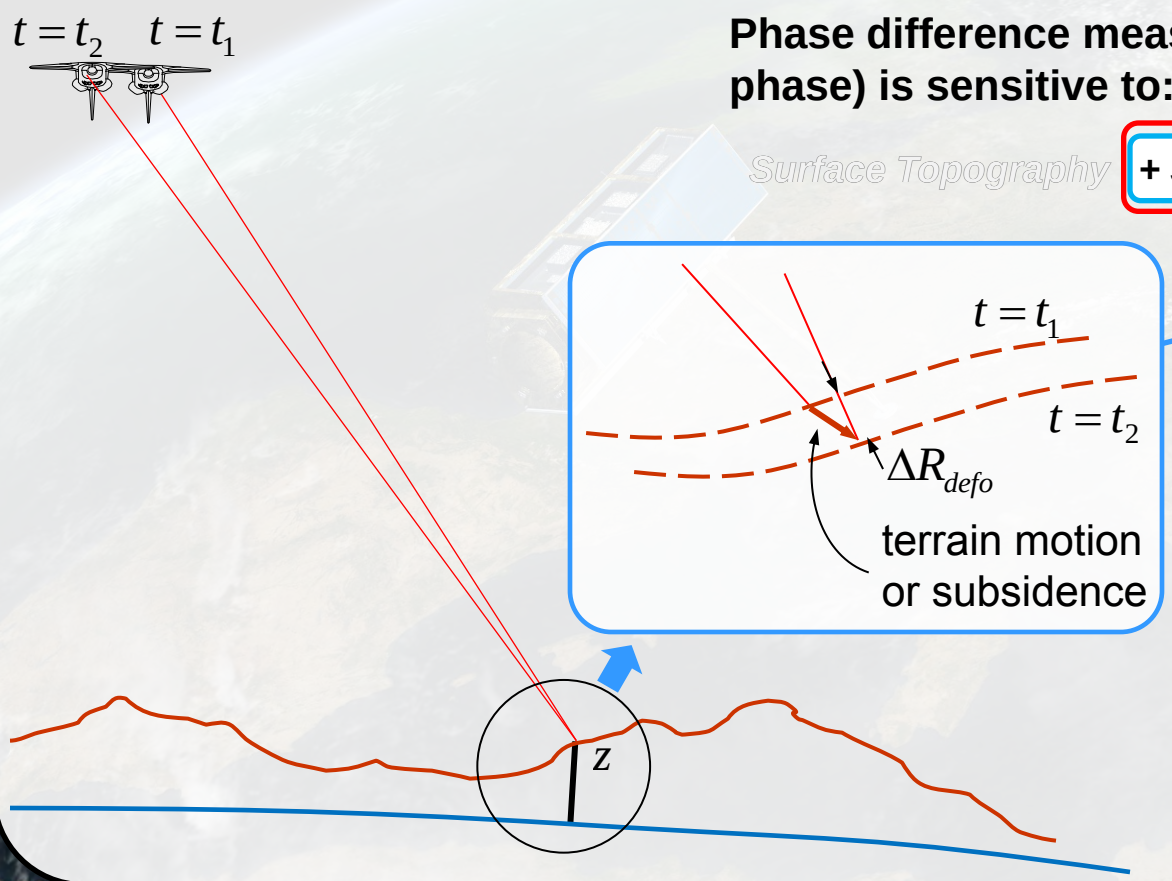
Resolution/content significantly better than the National Elevation Dataset (NED)



InSAR (left) and NED (right)

The Concept of Differential InSAR (d-InSAR)

- Calculation of Phase Difference between Pairs of Radar Remote Sensing Images acquired from similar vantage points



Phase difference measurement (interferometric phase) is sensitive to:

Surface Topography

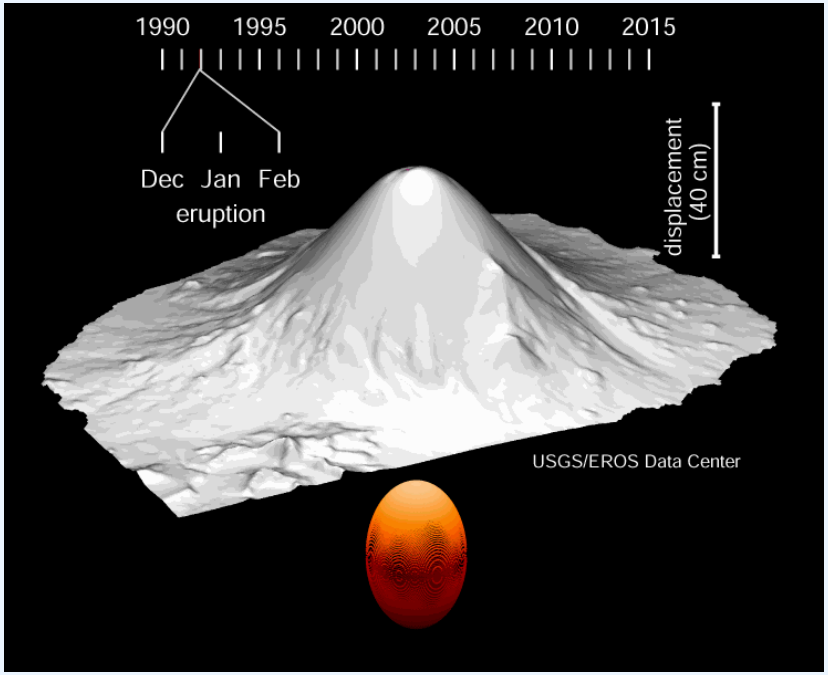
+ Surface Deformation

d-InSAR:

extraction of deformation signal from interferometric phase

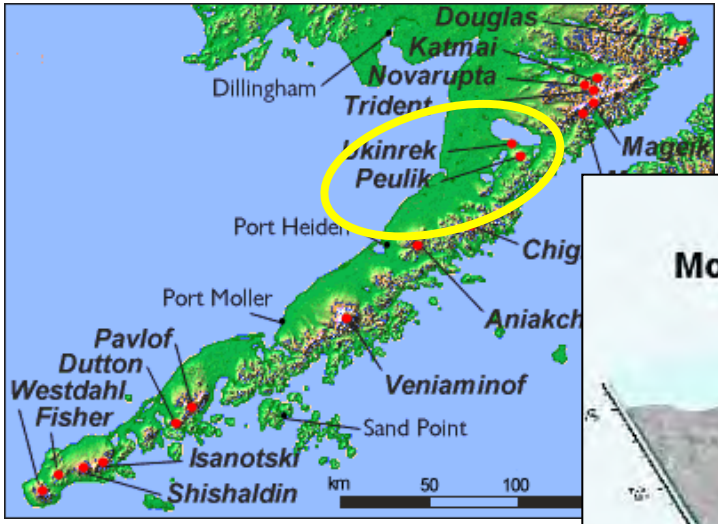
Monitoring Volcanoes with d-InSAR

- Surface inflation and deflation with changes of magma pressure
- Surface deformation often precedes volcanic eruptions
- Surface deformation observable with d-InSAR

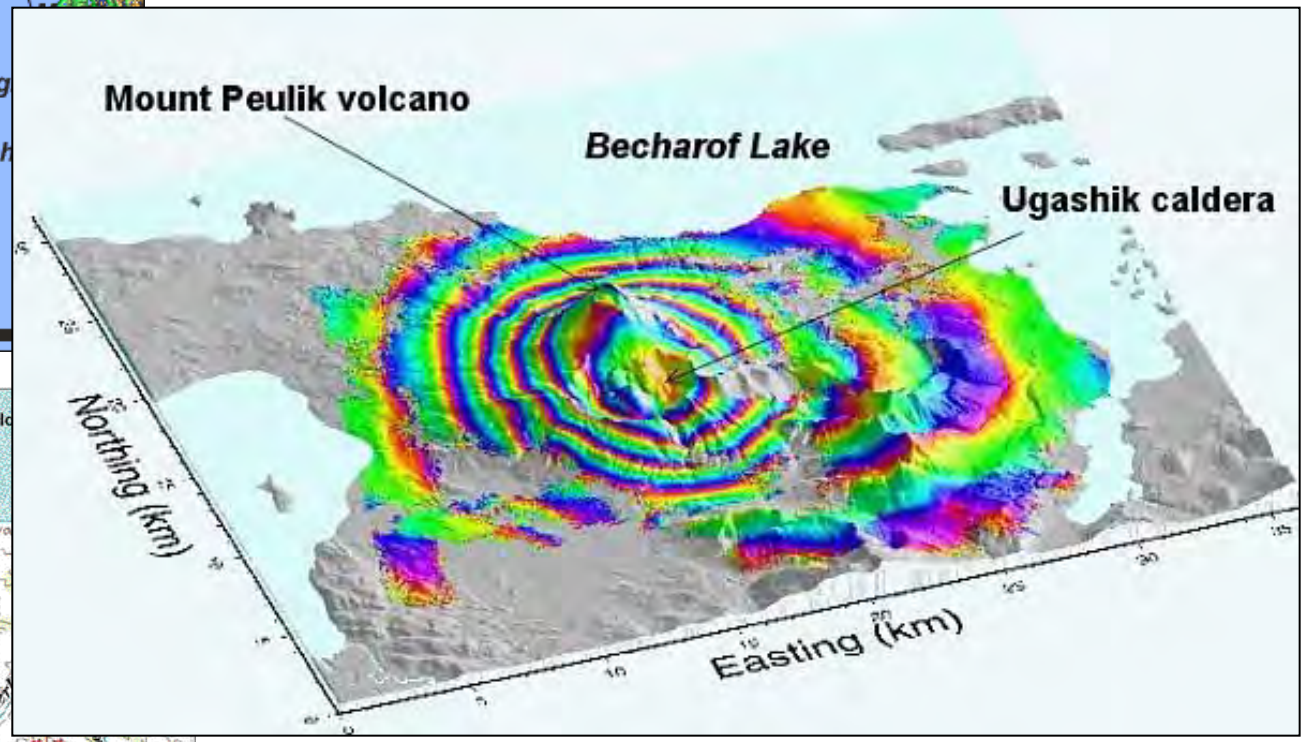


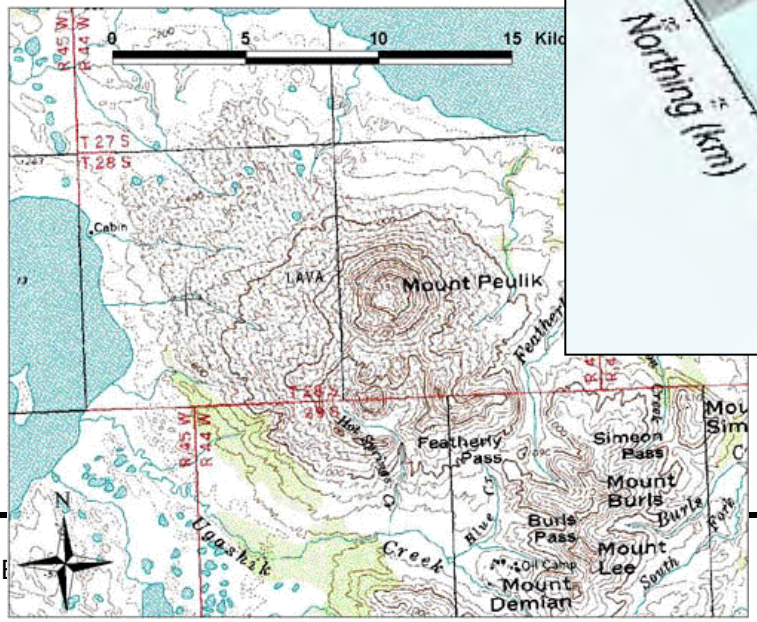
Westdahl Volcano Deformation Movie

Deformation of Mount Peulik, AK from d-InSAR



17-cm inflation, Sept. 1996 to Oct. 1997





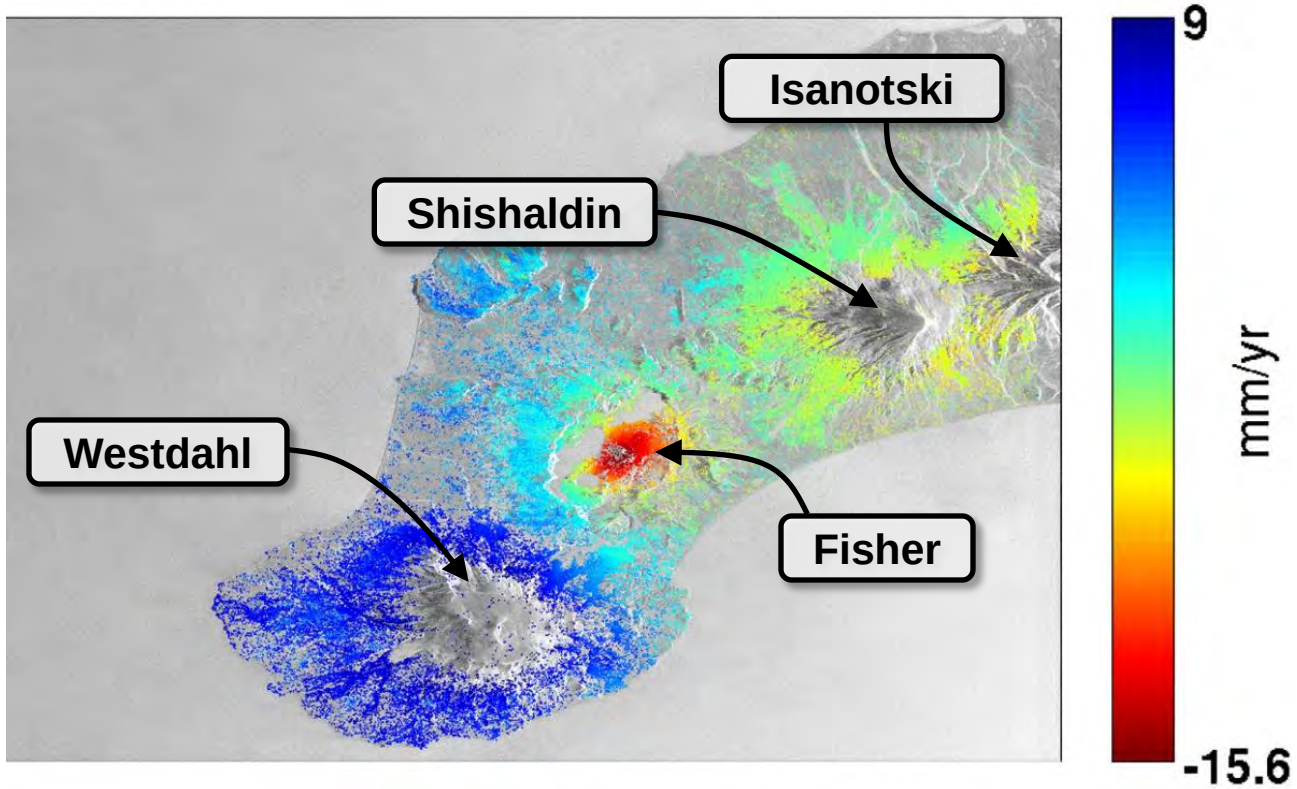
Z. Lu, C. Jr. Wicks, D. Dzurisin, J.A. Power, S. Moran, W. Thatcher, (2001)

Volcanic Deformation on Unimak Island, Alaska

Advanced Processing

Mean Surface Motion: SAR Time Series Analysis

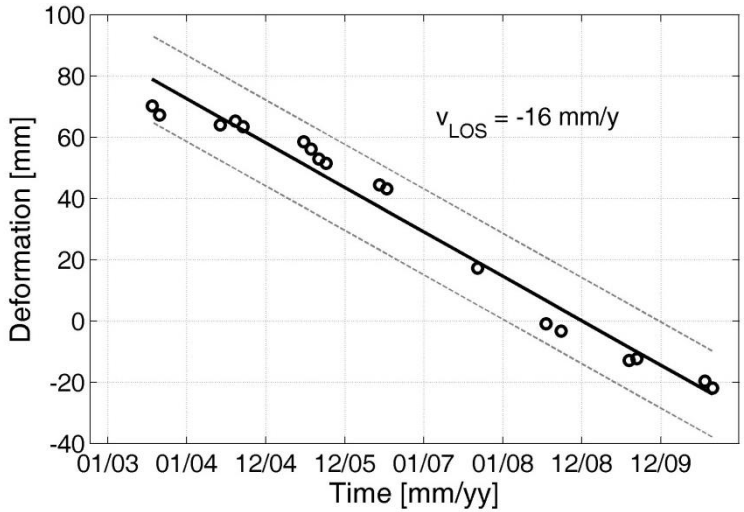
(2003 – 2010)



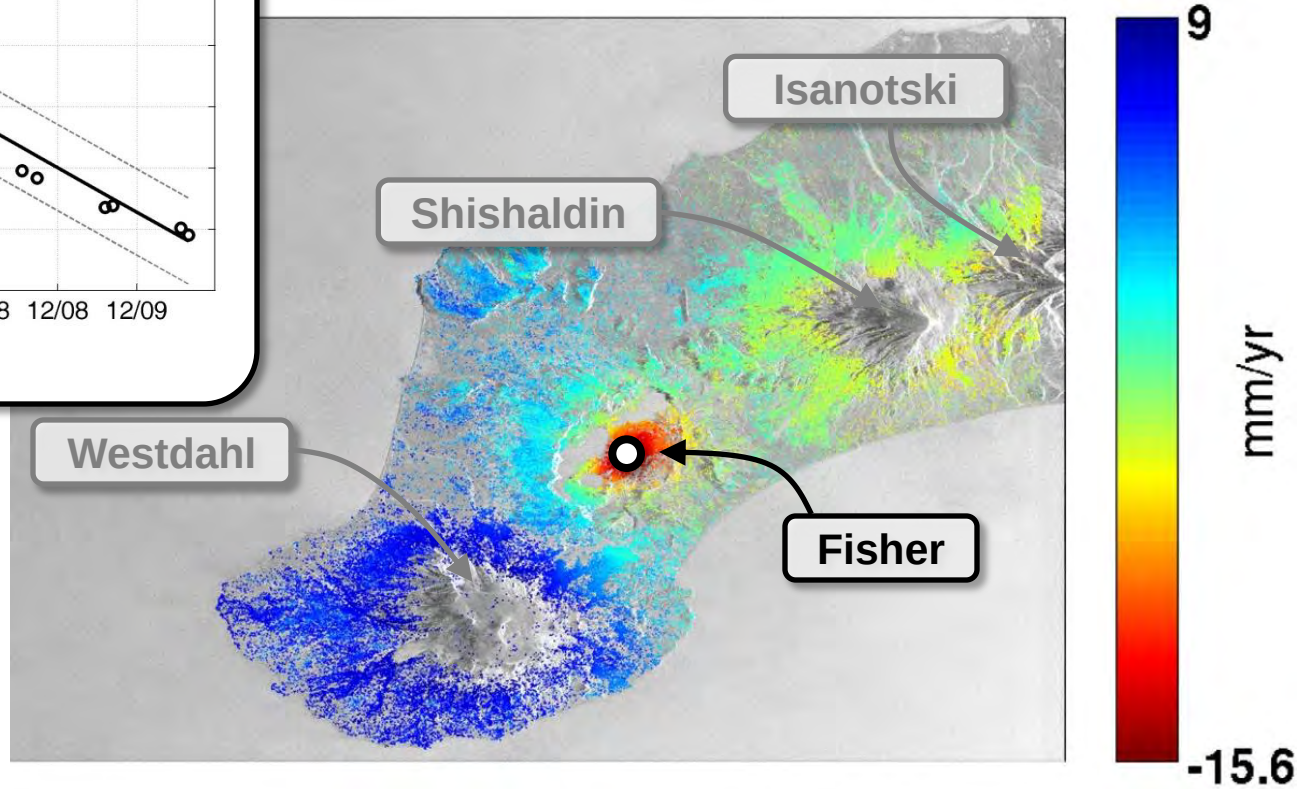
Optical Image: Courtesy of AVO

Volcanic Deformation on Unimak Island, Alaska
Advanced Processing

Deformation Time Series - Fisher



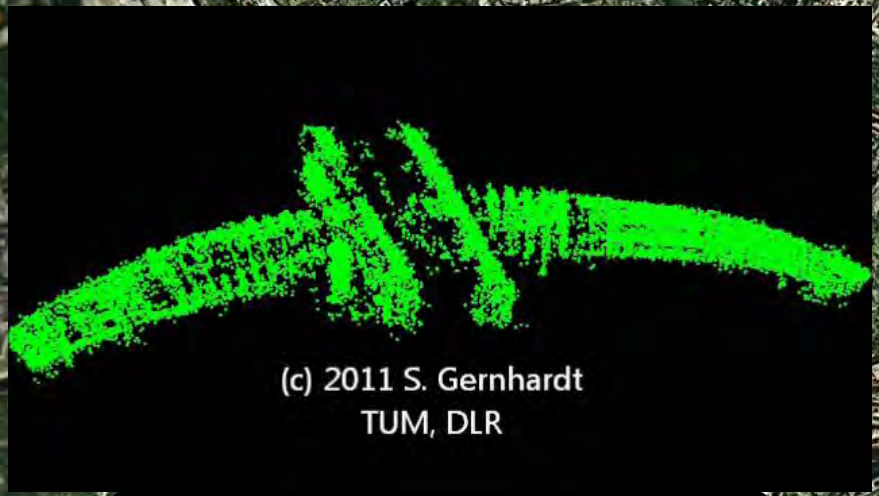
urface Motion: SAR Time Series Analysis
(2003 – 2010)



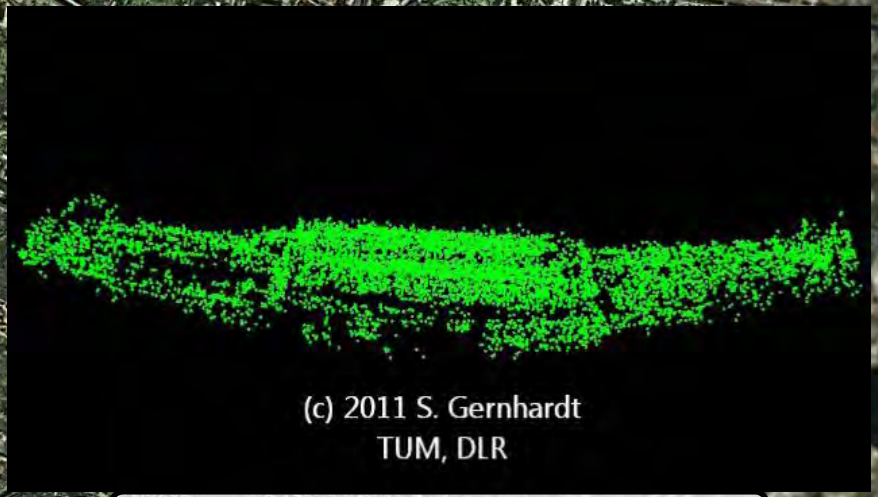
Optical Image: Courtesy of AVO

Sub-Milimeter Surface Analysis

Building Deformation in Berlin, Germany



Central Railway Station Berlin



Railway Station Berlin

Summary

- Remote Sensing Technology Development and Application essential for ecologic and economic development of Alaska
- Alaska hosts a wide range of world class remote sensing assets and
- Alaska can assume a national leadership role in the application of remote sensing in management and decision making
- The IEEE Alaska Section Geoscience and Remote Sensing Society (GRSS) Chapter is working on increasing the remote sensing activities in the state

Image from: http://www.astrium-geo.com