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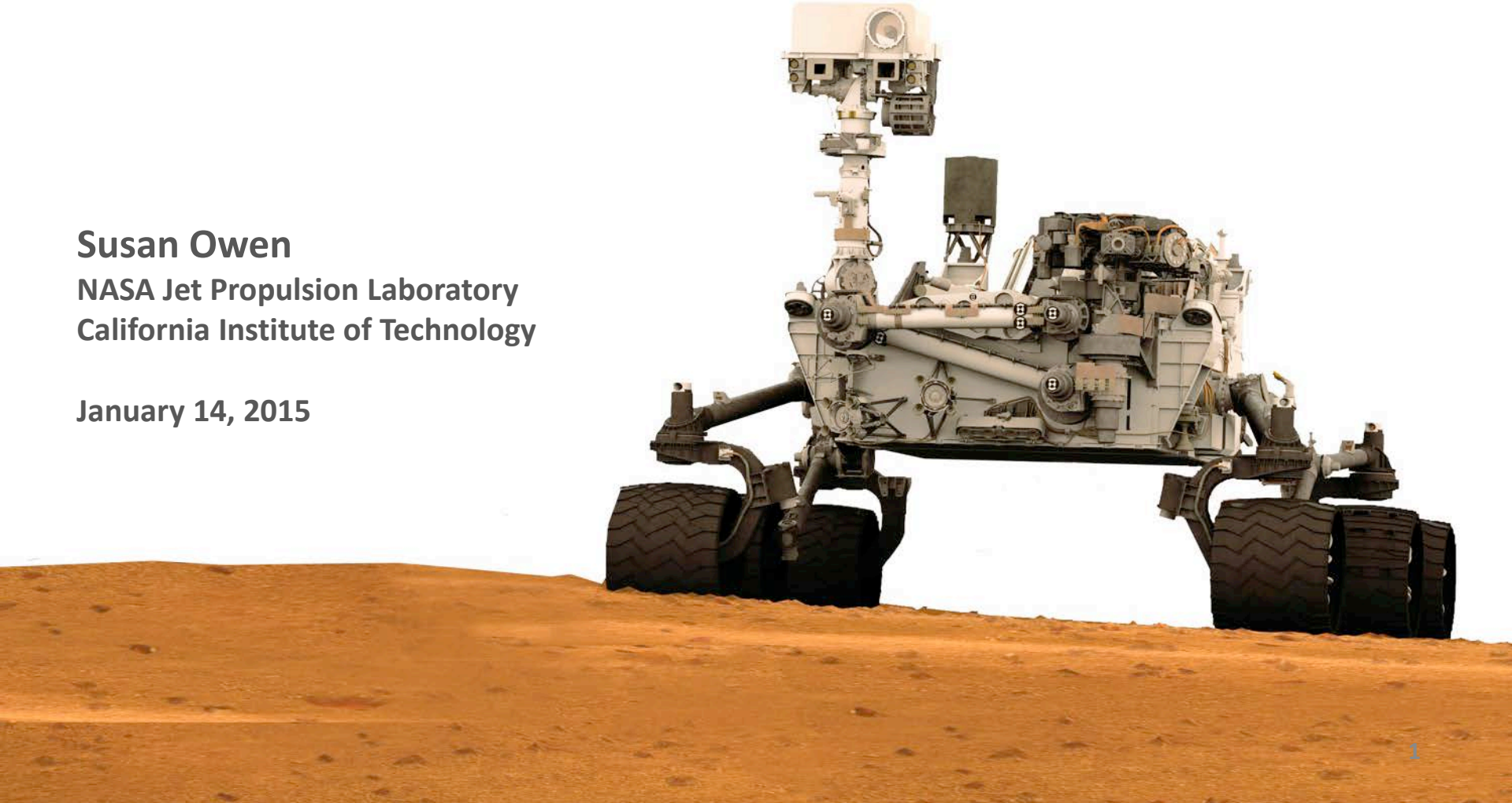
NASA/JPL Capabilities and California Earthquake Resiliency



Susan Owen
NASA Jet Propulsion Laboratory
California Institute of Technology

January 14, 2015

JPL expertise in Technology, Earthquake Imaging

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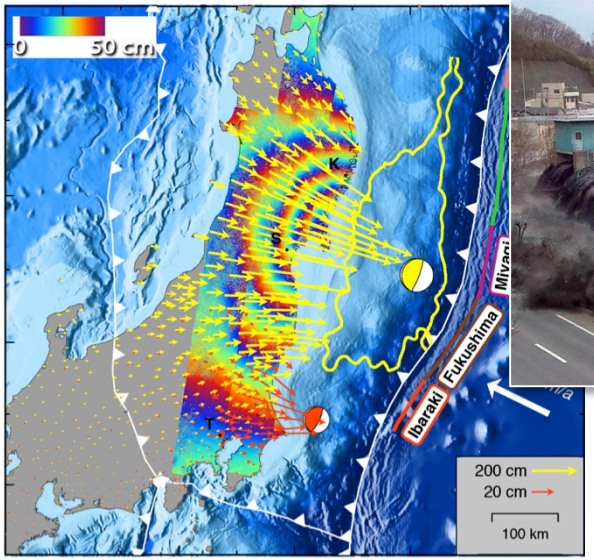
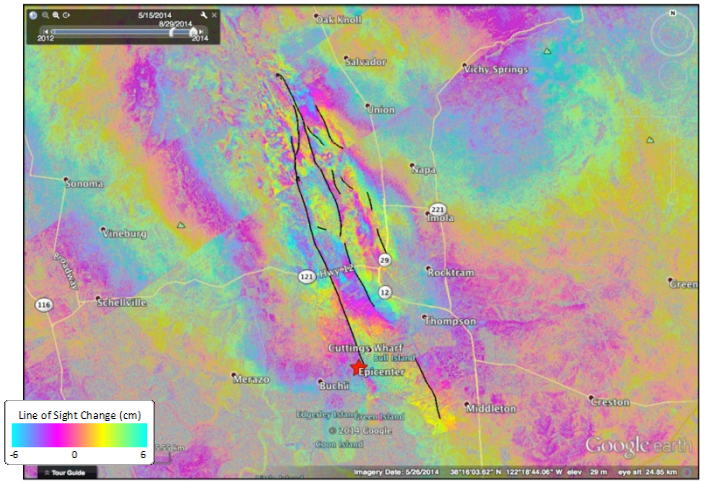
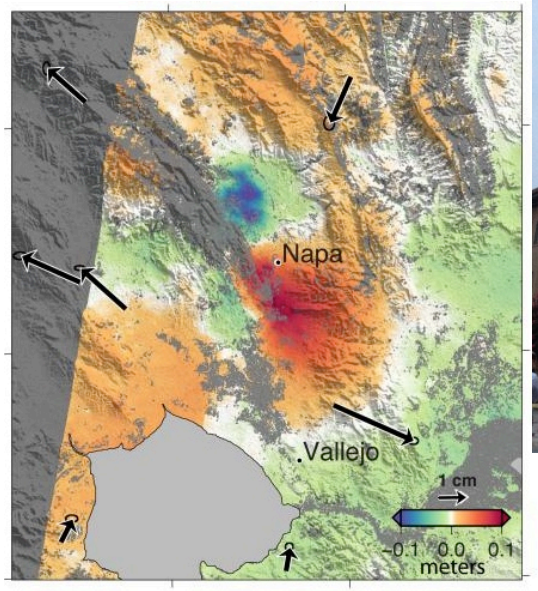
- **Expertise in developing new technology to solve difficult problems**
- **JPL expertise in**
  - **Radar Imaging**
  - **GPS technology**
  - **Scientific applications**
- **Have been working on earthquake observations and science since 1980's**



2011 M9 Tohoku earthquake and tsunami





M6.0 South Napa earthquake

JPL: A Resource for California

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- **Pilot Project to partner with Seismic Safety Commission**
- **Partner with Seismic Safety Commission on post-event report on JPL's response to the Napa earthquake.**
  - **Summarize impact of data sets**
  - **Set goals for future response efforts**
- **Explore JPL technology capabilities and how they can best be used to increase California's resiliency to earthquakes**
  - **Search & Rescue with FINDER**
  - **Damage Assessment with Radar**
  - **Earthquake characterization/fault identification with radar**
- **Identify future partnerships**

Napa earthquake response

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Day 3: Space-based radar results were provided to field teams looking at faults on the ground

Original COSMO-SkyMed Data © ASI 2014

Napa Earthquake Response

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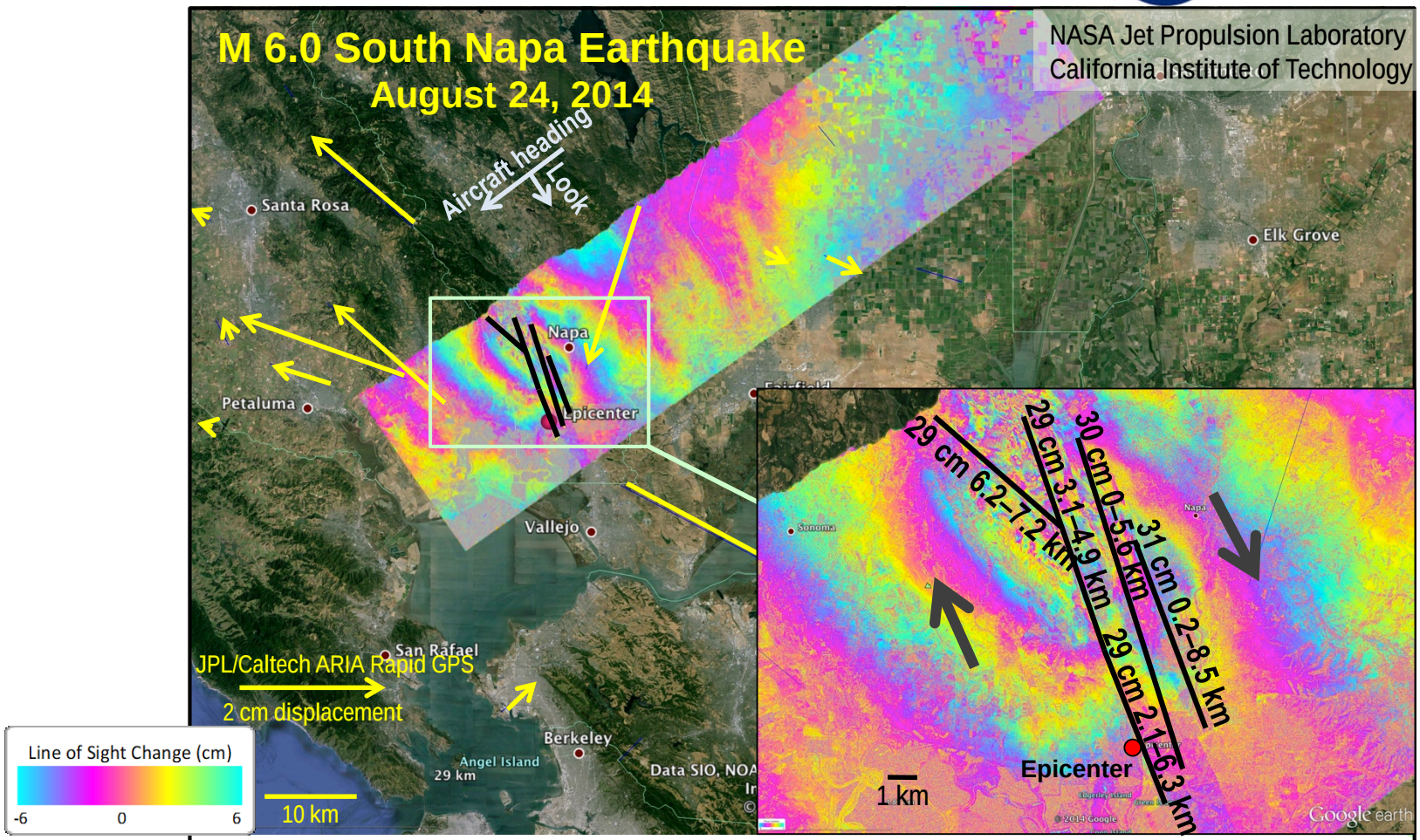

JPL UAVSAR results showing multiple fault offsets from the earthquake
Each color band fringe is 12 cm displacement toward the instrument

- **Day 6: UAVSAR data was acquired to aid rapid response activities in determining faulting and levee/aqueduct status.**

Napa Earthquake Response

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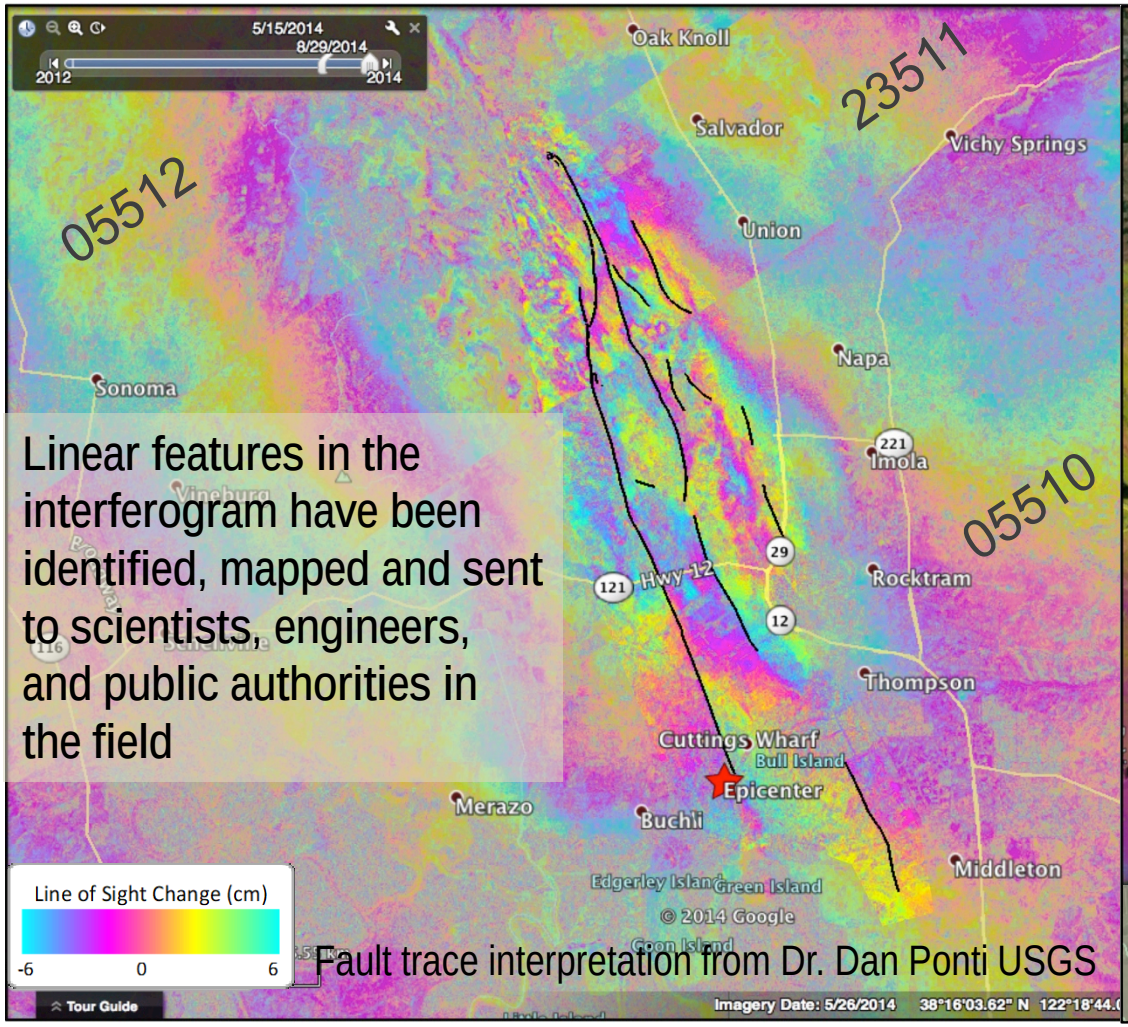
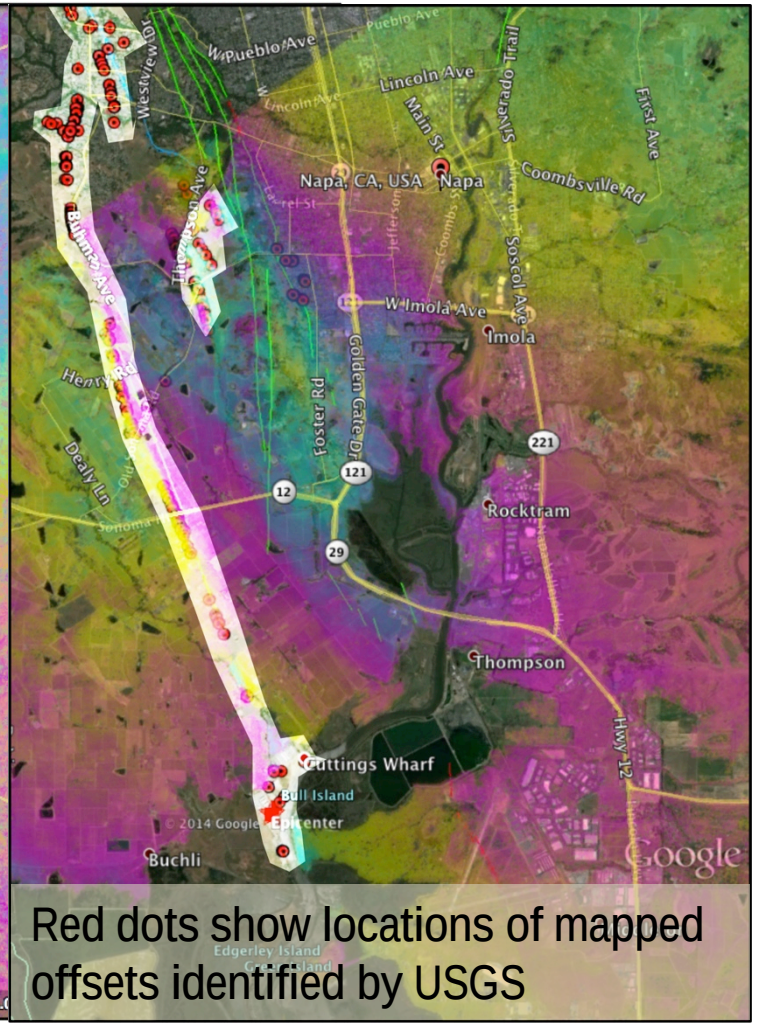


Linear features in the interferogram have been identified, mapped and sent to scientists, engineers, and public authorities in the field

Fault trace interpretation from Dr. Dan Ponti USGS



Red dots show locations of mapped offsets identified by USGS

- **UAVSAR data was provided to field teams looking at faults on the ground to support identification of faults**

Levee Assessment with NASA UAVSAR – Day 8

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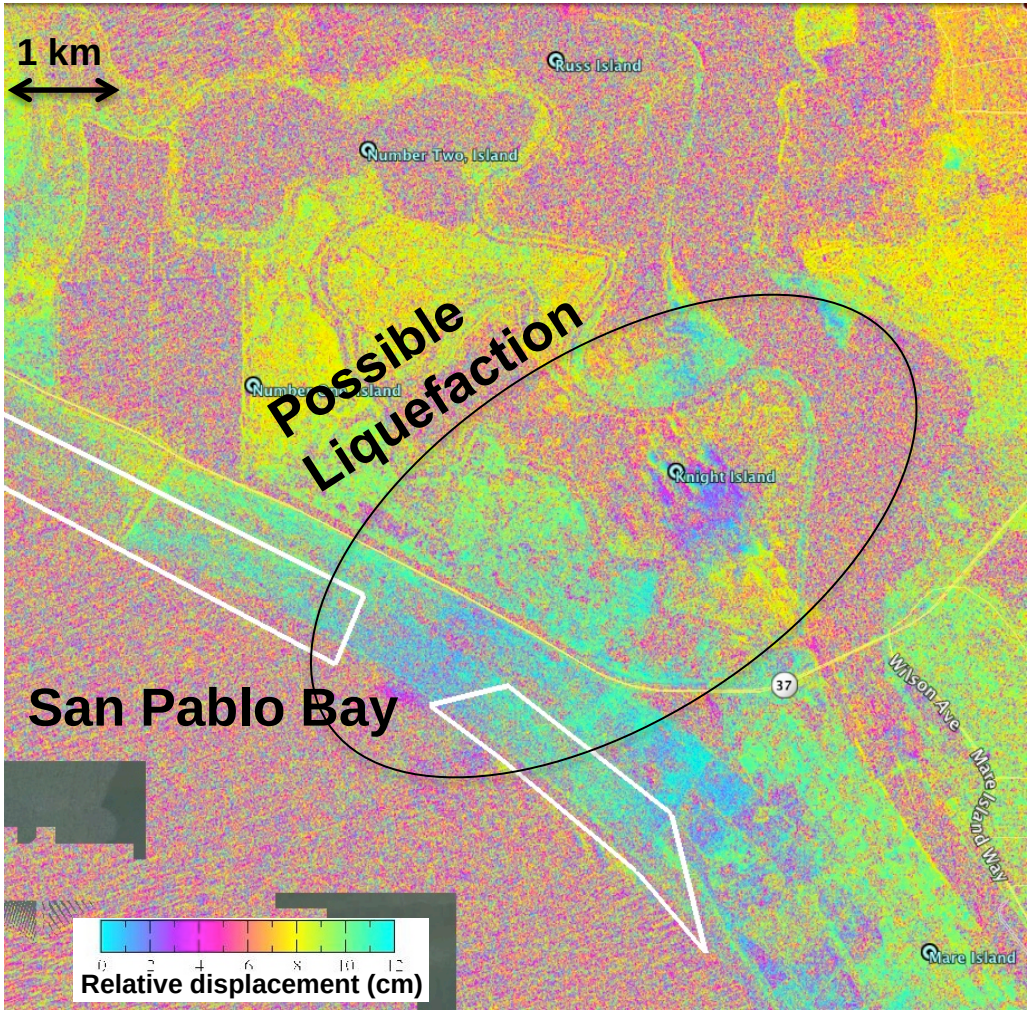

- **UAVSAR data was provided to CDWR to support targeting of Lidar assets investigating liquefaction along the San Pablo Bay shoreline.**
- **UAVSAR data was used to determine the north Sacramento Delta levees to be stable during the main quake and aftershocks.**

Lessons Learned from Napa Response & Capstone Exercise for future earthquakes

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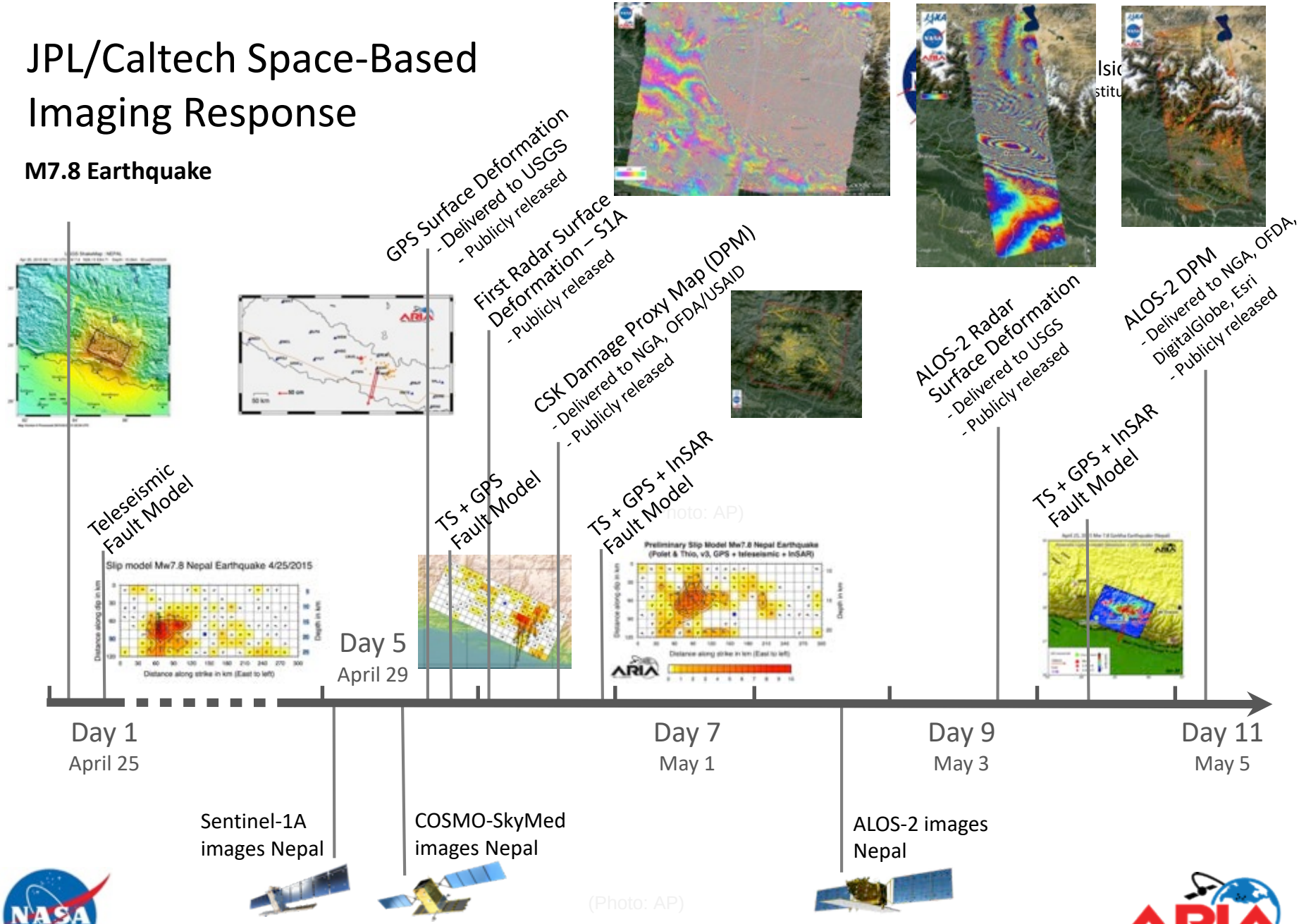
- **Radar imagery from both space and airborne platforms are valuable**
- **Damage assessment based on imagery, models can help direct efforts in the field, and field workers can provide important ground-truthing and validation for assessment and models**
- **Federal, state and local agencies are interested in the information but have different systems and capabilities for inge and working with the data.**

JPL/Caltech Space-Based Imaging Response

M7.8 Earthquake



Damage Assessment from Radar

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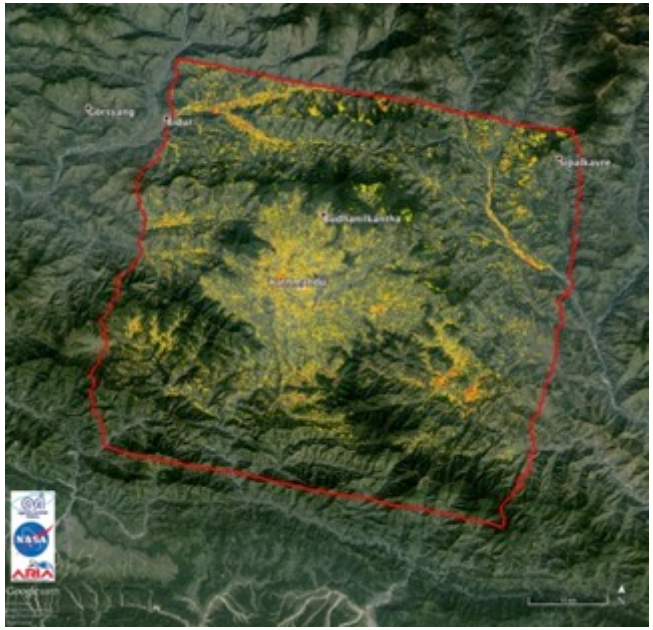

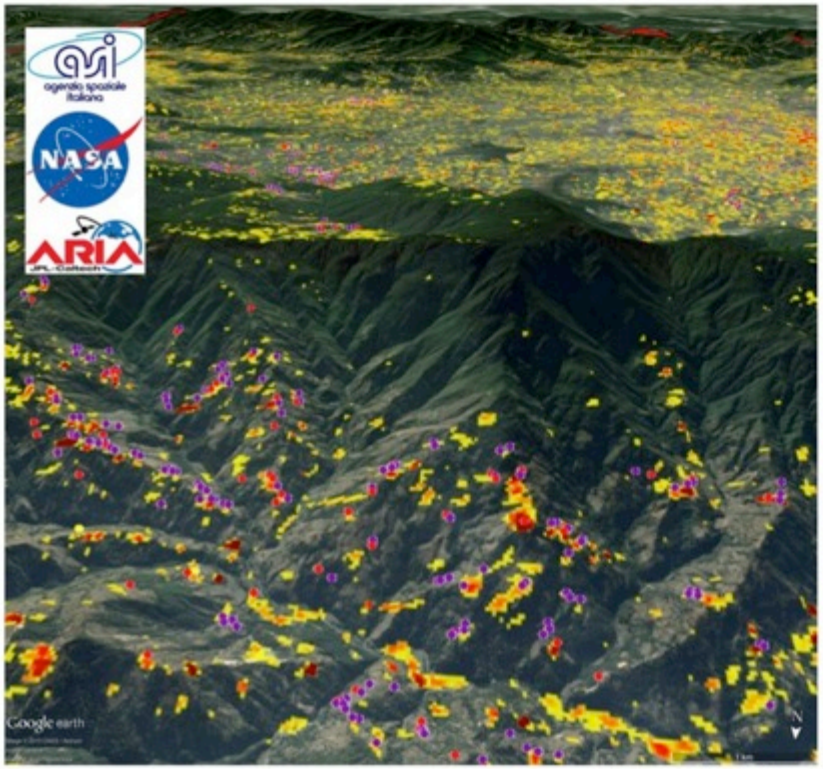

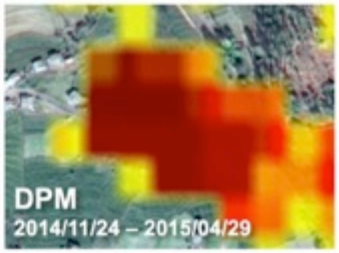

For more information about ARIA, visit: http://aria.jpl.nasa.gov

- **Highlighted areas of potential damage (25 mi x 31 mi, or 40 km x 50 km footprint) from ASI COSMO-SkyMed Synthetic Aperture Radar (SAR) data.**
- **Validated with NGA optical analysis of collapsed buildings in more remote regions.**
- **Delivered to NGA, GEER, OFDA, ICIMOD for their damage assessment efforts in support of humanitarian response**

(Photo: AP)

Damage Assessment from Radar

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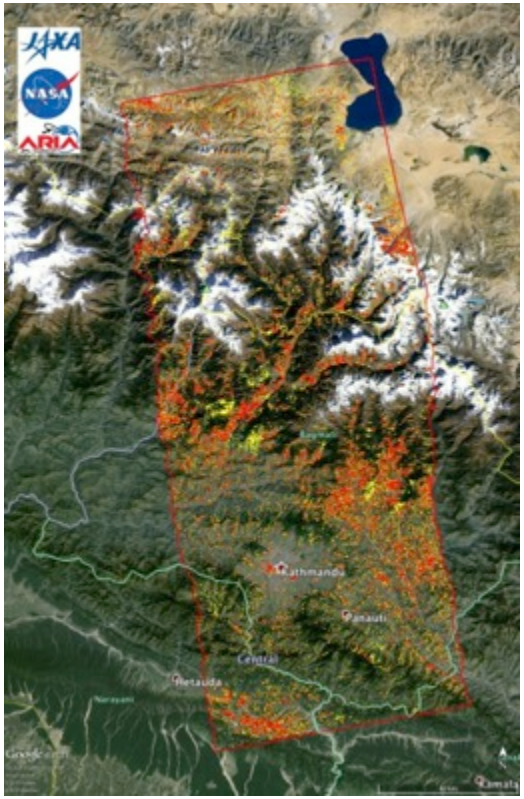

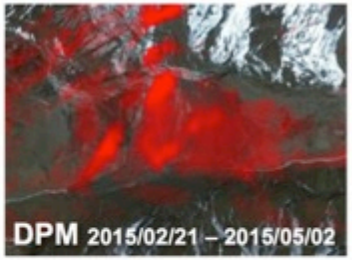

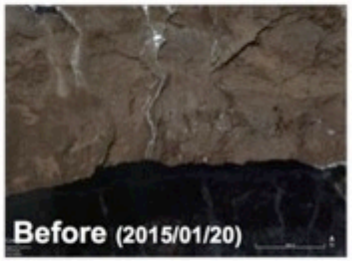

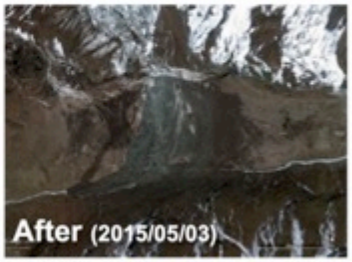

For more information about ARIA, visit: http://aria.jpl.nasa.gov

- **Highlighted areas of potential damage (43 by 112 mi, or 70 km x 180 km) by SAR data from JAXA ALOS-2 data.**
- **Delivered to NGA, GEER, OFDA, ICIMOD for their damage assessment efforts in support of humanitarian response**

(Photo: AP)

Radar-based Damage Proxy Map Imagery Used for Response, Prioritizing Analysis

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Users	How they are being used
World Bank	Damage assessment for economic loss
NGA	Determine priority areas for analysis
USGS	Search for land damage and surface rupture in their fieldwork
OFDA/USAID	Damage assessment for ground response
ICIMOD	Search for land damage, landslides, and river blockage
GEER	Guidance for geotechnical engineer reconnaissance fieldwork
DigitalGlobe	Determine priority areas for high-resolution image acquisition
ESRI	Post on their interface for community access

For Nepal earthquake: 650+ downloads worldwide in May 2015

Lessons Learned from Nepal Response for California

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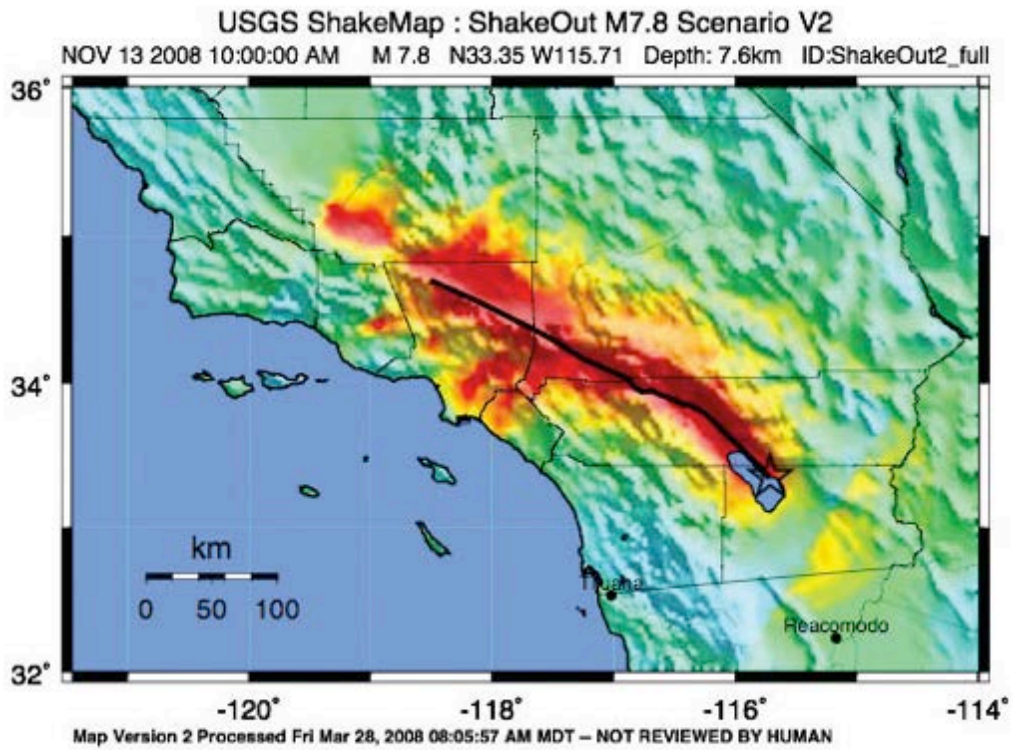
- **FINDER field test was successful**
- **Coordination amongst group improved response – important to have plan ahead of time**
- **Damage assessment with radar is valuable – need to work with organizations that provide damage assessment beforehand to make most use of data during disaster**
- **Newly launched SAR missions will allow JPL to provide rapid, regional scale image of earthquakes**



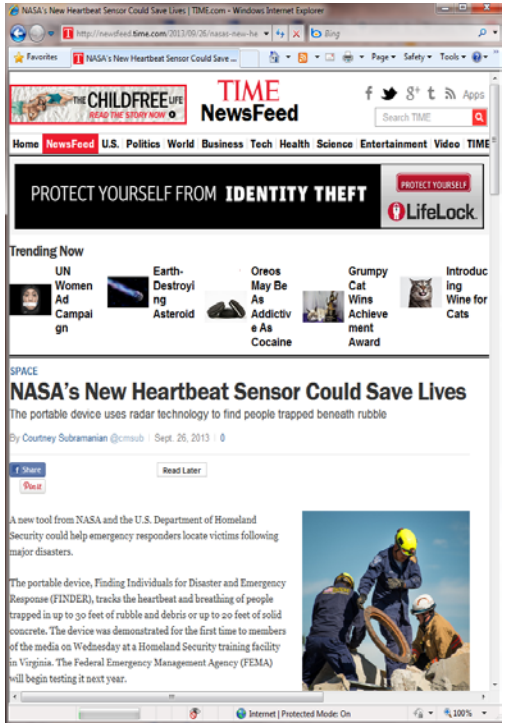
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

(Photo: AP)

FINDER

FINDING INDIVIDUALS FOR DISASTER AND EMERGENCY RESPONSE

- "Golden hours" in Search & Rescue (S&R)
  - FINDER microwave radar detects heartbeat of live victims trapped under rubbles.
- Successfully tested by FEMA Virginia Task Force one from Fairfax County (shown in picture).
- FINDER has been demonstrated to detect human heartbeat through:
  - 30 feet of rubble
  - 20 feet of concrete
  - 100 feet in woods
  - Variety of other construction materials
  - Can separate human vs animal



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SPACE

NASA's New Heartbeat Sensor Could Save Lives

The portable device uses radar technology to find people trapped beneath rubble

By Courtney Subramanian | Sept. 26, 2013

A new tool from NASA and the U.S. Department of Homeland Security could help emergency responders locate victims following major disasters.

The portable device, Finding Individuals for Disaster and Emergency Response (FINDER), tracks the heartbeat and breathing of people trapped in up to 30 feet of rubble and debris or up to 20 feet of solid concrete. The device was demonstrated for the first time to members of the media on Wednesday at a Homeland Security training facility in Virginia. The Federal Emergency Management Agency (FEMA) will begin testing it next year.

FINDER

FINDING INDIVIDUALS FOR DISASTER AND EMERGENCY RESPONSE

- First generation FINDER technology has been licensed to two companies – R4 and SpecOps
- R4 president took prototype to Nepal, successfully field tested to help save 4 lives
- Larry Collins, LA County Fire Dept, runs team that regularly field tests new technology that then becomes part of standard equipment
  - SearchCam
  - Thermal imaging
- JPL has made initial connection between LA County Fire Dept, including a search and rescue team, and the president's of both R4 and SpecOps. Both have contacted Larry Collins to field test their prototype instruments with their team
- JPL will be meeting with Larry Collins to discuss field testing the next generation technology, which will include better location resolution

Partnering for Earthquake Response

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- **Path Forward for improving partnerships**
  - **Workshop with CGS, USGS, CalOES, JPL to strengthen parterships**
    - **Have key personnel meet prior to event, understand roles of each organization.**
  - **Workshop between JPL, and state and local emergency personnel who work geospatial information**
    - **Discuss needs at different levels, prioritize next steps**
    - **Bring in visualization expertise on how to best to communicate information contained in complex radar imagery for emergency personnel**
  - **Work with LA County Fire Dept on technology development for next generation FINDER**