



E-DECIDER Data System and Decision Support Technology

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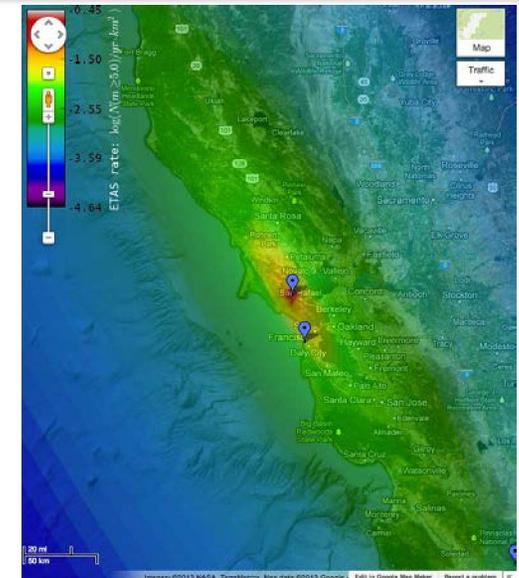
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What is E-DECIDER?



- ❖ E-DECIDER = **E**arthquake **D**ata **E**nhanced **C**yber-**I**nfrastructure for **D**isaster **E**valuation and **R**esponse
- ❖ Provides decision support for earthquake disaster management and response utilizing remote sensing data and NASA modeling software
- ❖ Delivers web-based infrastructure designed for ease-of-use by decision makers, including:
 - Rapid and readily accessible remote sensing and derived data products both pre- and post- earthquake
 - Standards-compliant map data products
 - Deformation modeling and earthquake forecasting results
- ❖ Provides both long-term planning information for disaster management decision makers as well as short-term information following earthquake events, such as identifying areas where the greatest deformation and damage has occurred and emergency services may need to be focused



Simulated aftershock forecast for May 2013 Golden Guardian Exercise

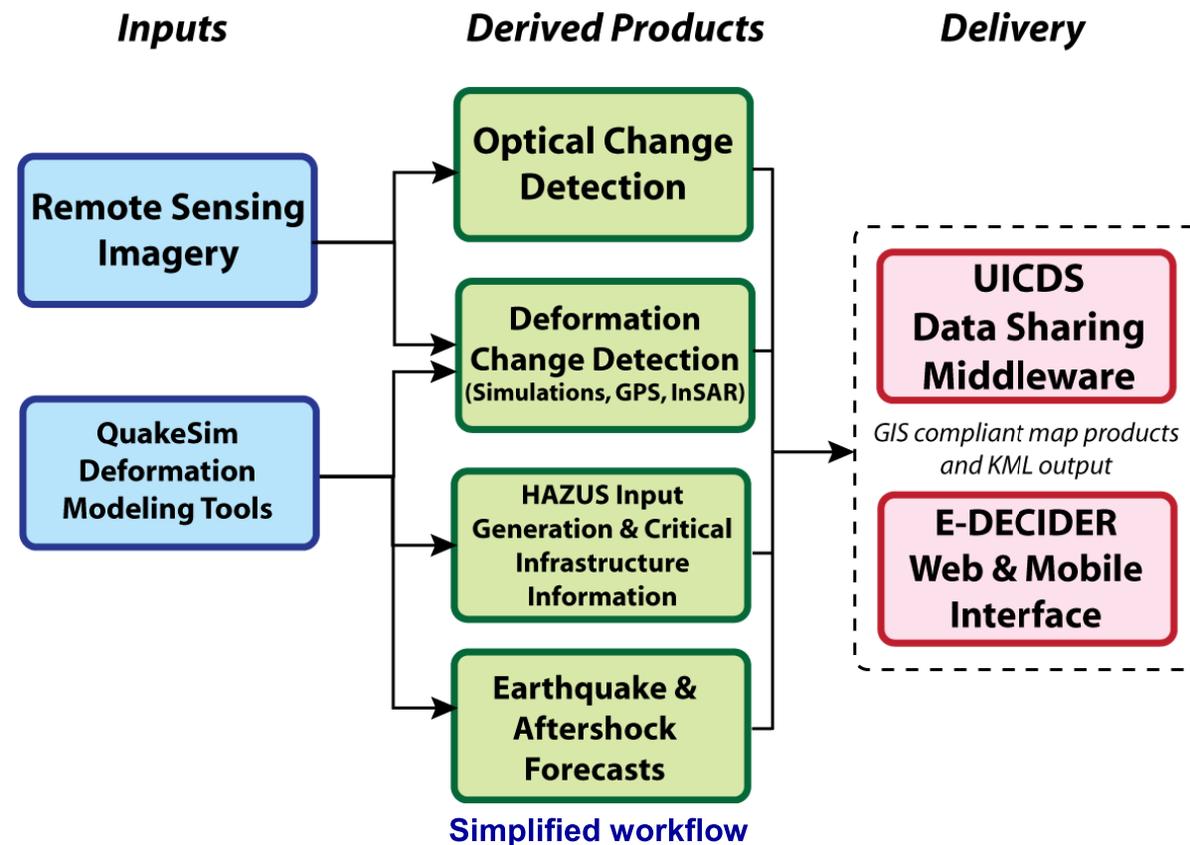
What is E-DECIDER? (2)



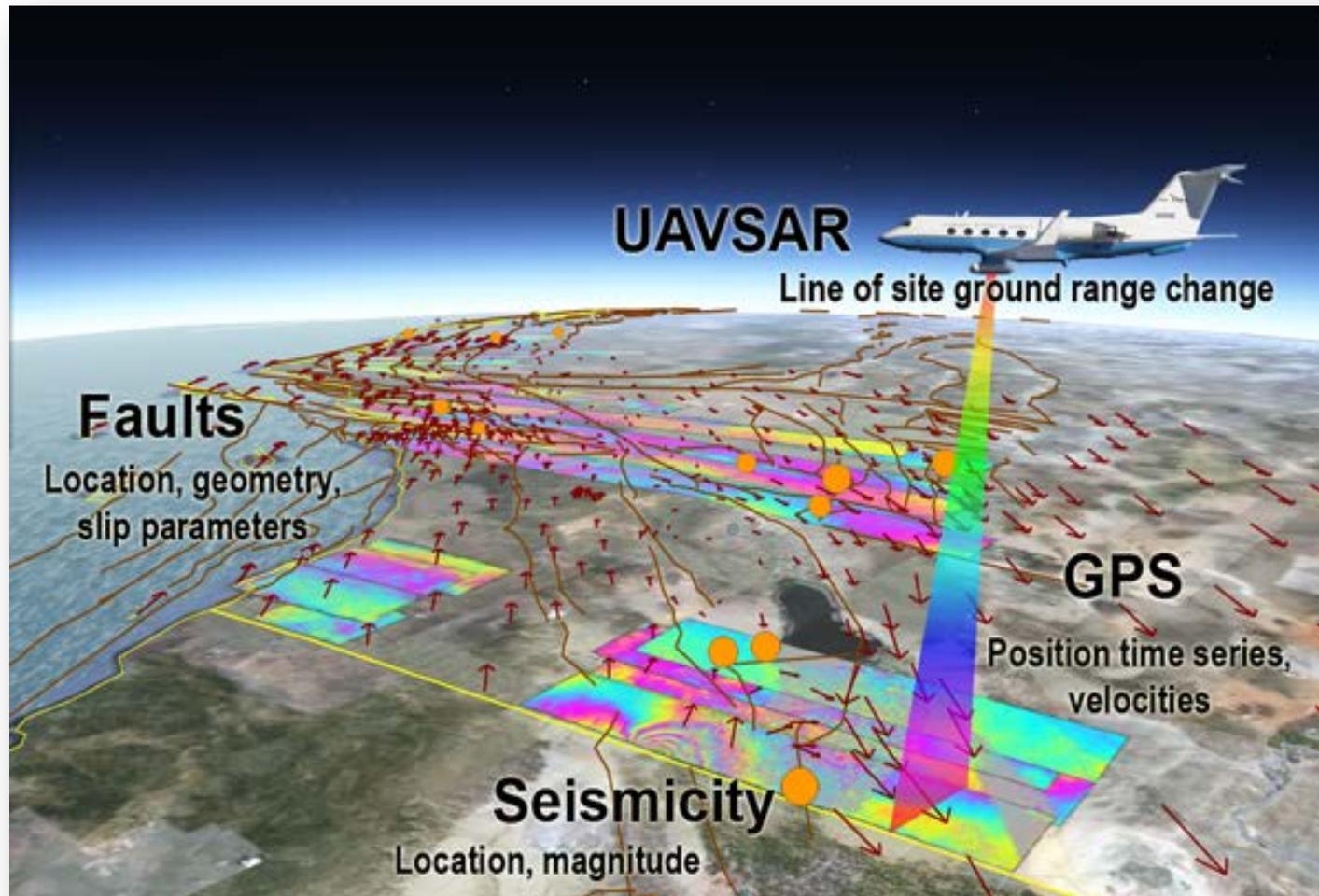
Goals

- ✧ E-DECIDER Project Goals: Transform and Distribute NASA Earth Science Data in support of Earthquake Mitigation and Response
- ✧ Facilitate coordination of decision support for earthquake disaster response

- ◇ Analysis
 - ◇ Remote sensing imagery – UAVSAR, InSAR, MODIS, LandSAT, high res optical; geophysical modeling
 - ◇ Distribution of products
 - ◇ Web, mobile, UICDS
- ✦ Identify standards
 - ◇ Data formats
 - ◇ Distribution methodologies
 - ◇ These need to be compatible with the state of the art IT infrastructure



- ✦ How to produce results that have immediate utility for disaster response?



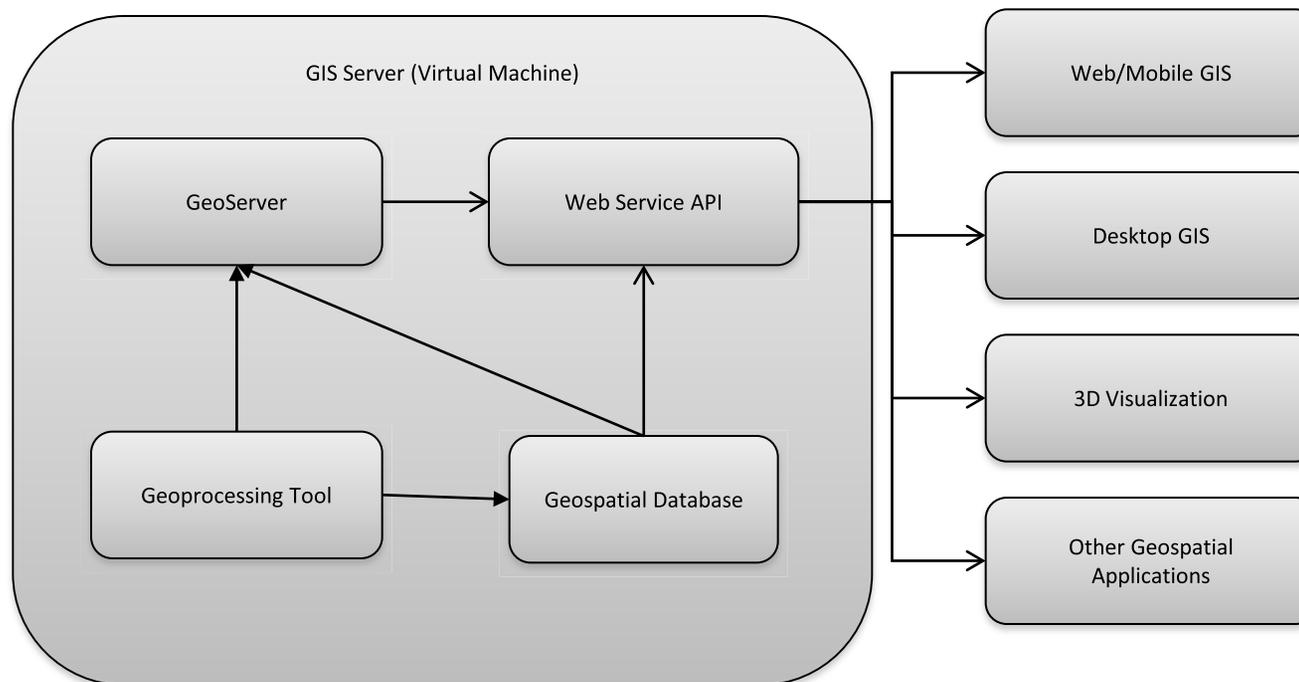
E-DECIDER uses data from a number of sources, including fault and seismic data (to generate deformation models) and various remote sensing data (like UAVSAR and GPS) in order to refine these models and to generate decision support products.

- ✧ Same infrastructure supports multiple projects:
 - ✧ QuakeSim (<http://quakesim.org>)
 - ✧ E-DECIDER (<http://e-decider.org>)
- ✧ More than 2Tb Images and millions of vector and time series data
- ✧ Open Source solution, easy to distribute among multiple partners
- ✧ Cloud computing ready: tested on Amazon cloud and FurtureGrid research cloud (<https://portal.futuregrid.org/>)

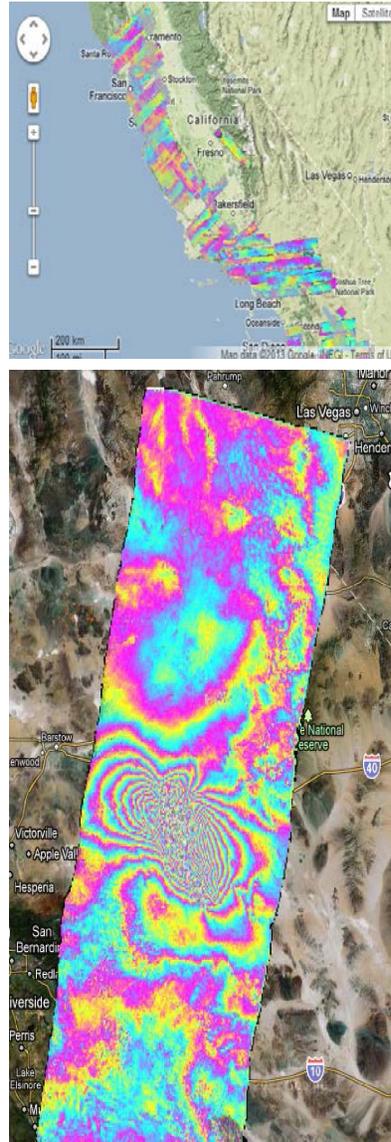
- ✧ Data distribution service: produce more standard-compliant GIS products for different types of user groups with multiple service protocols, such as KML, WMS (Web Map Service), WFS (Web Feature Service) and WCS (Web Coverage Service).
- ✧ Software as a Service: make complex GIS processing and domain-specific analysis tools more accessible for general users.
- ✧ Infrastructure as a Service: provide system sustainability and reusability for related projects.

Components of GIS Server

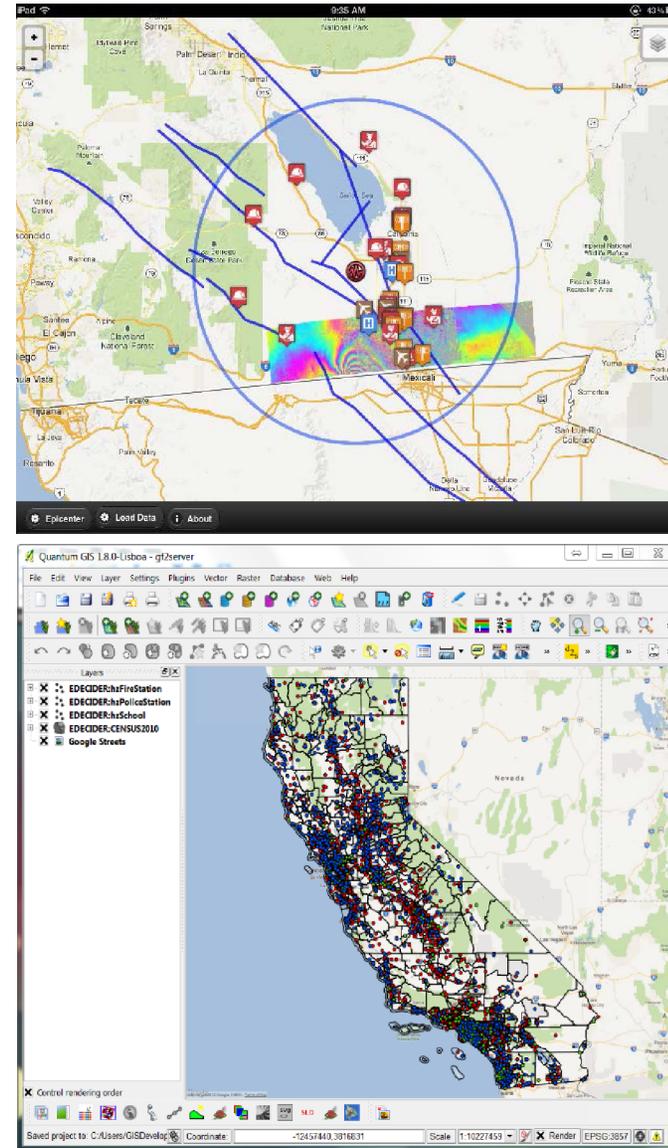
- ❖ GeoServer: thematic mapping and data distribution
- ❖ Geospatial Database: storage and spatial analysis
- ❖ Web Service API: simple use REST API for complex GIS functionalities
- ❖ Geoprocessing Tool: Python scripts to produce standard-compliant data products



Data Distribution Examples



QuakeSim



E-DECIDER

Automatically generated earthquake products



- ❖ E-DECIDER delivers automated deformation products through web services in conjunction with QuakeSim
- ❖ Forward models are triggered from the USGS earthquake feed and vector displacements, synthetic interferograms, slope change (tilt) maps, and strain magnitude maps are generated and posted to an RSS feed.
- ❖ An automated web service will soon be available on the E-DECIDER website that will make these results available along with an on-demand KML generator that will allow overlay of census and infrastructure data.
- ❖ Example results have been posted to the E-DECIDER website.

RSS Disloc | e-decider.org

e-decider.org/content/rss-disloc

RSS Disloc | e-decider.org

E-DECIDER

Earthquake Data Enhanced Cyber-Infrastructure for Disaster Evaluation and Response

Home Services Media E-DECIDER Workshop 2011

RSS Disloc

Disloc Results Map

This map shows results of surface deformation calculations for earthquakes from the USGS RSS feed for M_s>5. See <http://earthquake.usgs.gov/earthquakes/catalogs/7day-M5.xml>.

Four different scenarios are calculated for each event.

1. Dip Angle=90 degrees, Strike Angle=0 degrees, strike slip, no dip slip
2. Dip Angle=90 degrees, Strike Angle=45 degrees, strike slip, no dip slip
3. Dip Angle=45 degrees, Strike Angle=0 degrees, dip slip, no strike slip
4. Dip Angle=45 degrees, Strike Angle=90 degrees, dip slip, no strike slip

Interferograms are calculated with elevation angle=60, azimuth=0, and frequency 1.26 GHz.

Usage Instructions

- Click the "+" or "-" icon to expand or contract the listings for an event.
- Click the earthquake name link to go its location.
- Click the checkbox next to "InSAR Plot" or "Surface Displacement" to toggle results display on/off.
- Click the "InSAR Plot" or "Surface Displacement" links to download the source KML.

[Refresh Page](#)

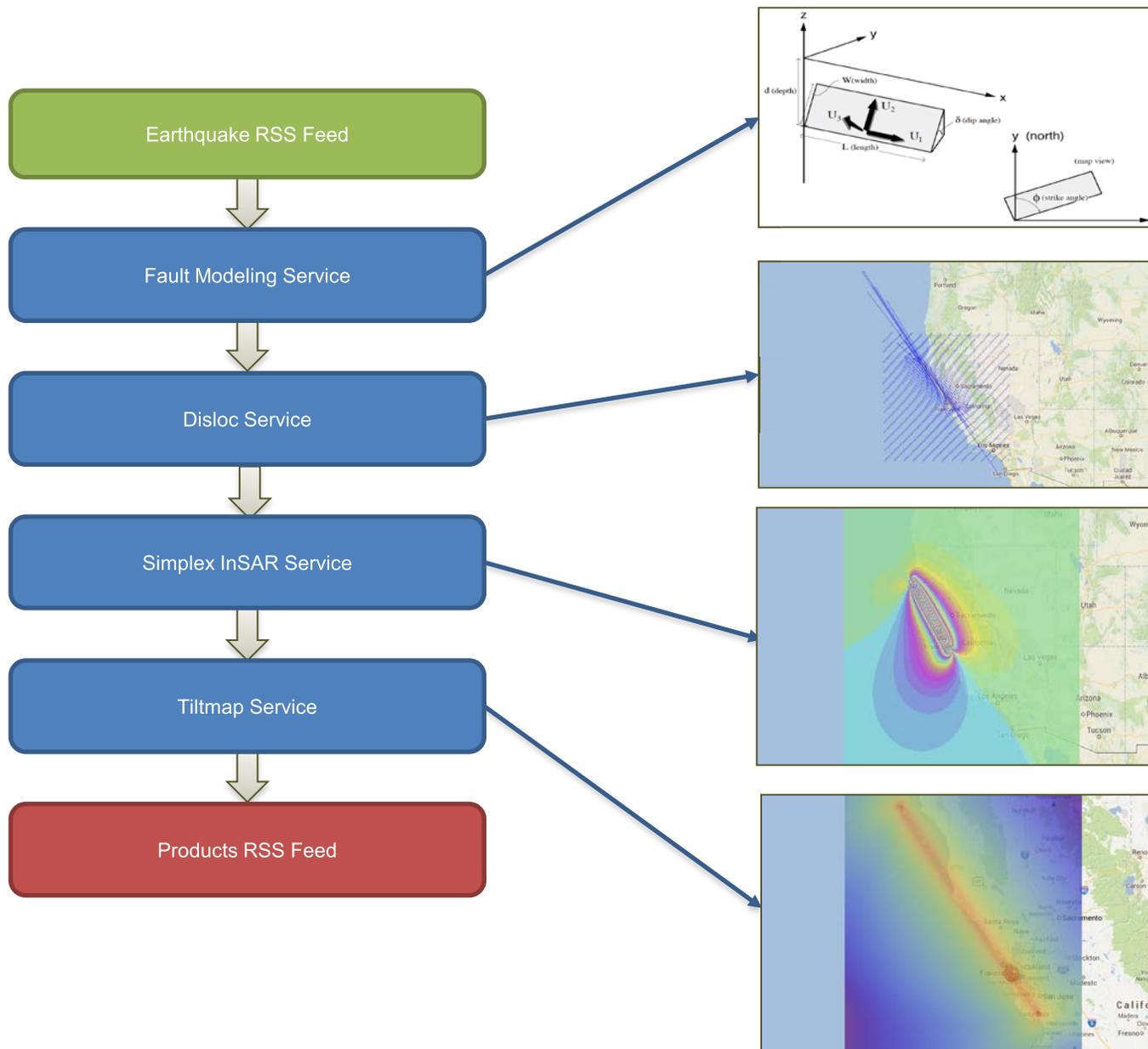
- * M6.4.BallenysIslandsregion(c000d4)
- * M5.5.nearthenorthcoastofPapua.In
- * M5.2.nearthenorthcoastofPapua.In
- * M6.3.BandaSea(c000d3rv)
- * M6.0.GulfofCalifornia(c000d3ne)
- * M5.8.Antofagasta_Chile(c000d3lf)
- * M5.3.Azerbaijan(c000d3ex)
- * M5.3.NewBritainregion,PapuaNew
- * M5.6.Luzon,Philippines(c000d3bv)
- * M5.0.GulfofCalifornia(c000d2jc)
- * M5.4.offthecoastofGuatemala(c00
- * M5.0.BandaSea(c000d2fa)
- * M5.0.northeastofTaiwan(c000d23

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Map Satellite Hybrid Terrain

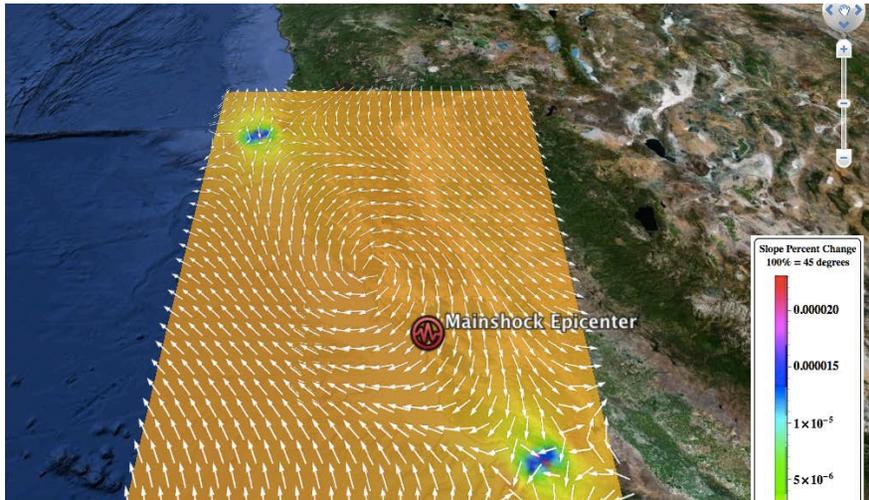
A collaboration between the Jet Propulsion Laboratory, the US Geological Survey, Indiana University, and UC Davis
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RSSDisloc web service on E-DECIDER webpage

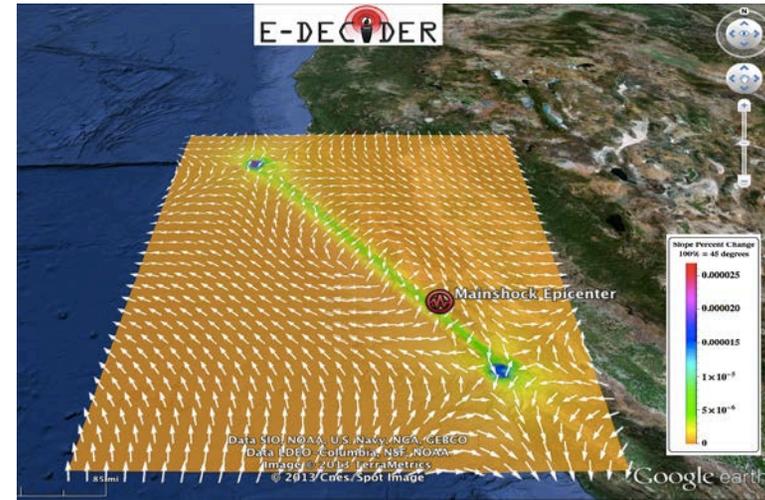


- ✧ Golden Guardian 2013 Exercise is a scenario based on a major earthquake in the San Francisco Bay Area.
- ✧ Deformation modeling products were generated for different fault and displacement setups: mainshock, mainshock (v2), aftershock, aftershock (v2) and DWR scenario
- ✧ <http://e-decider.org/content/e-decider-golden-guardian-resources>

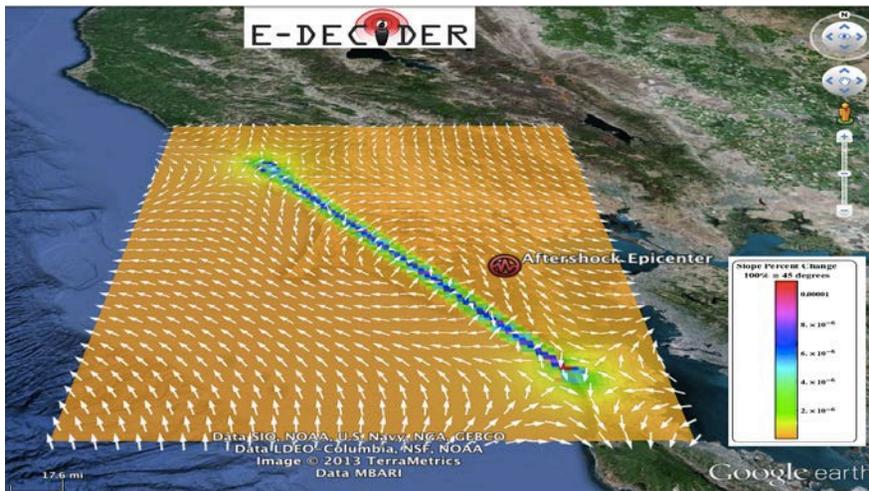
Tiltmap: Slope Percent and Direction



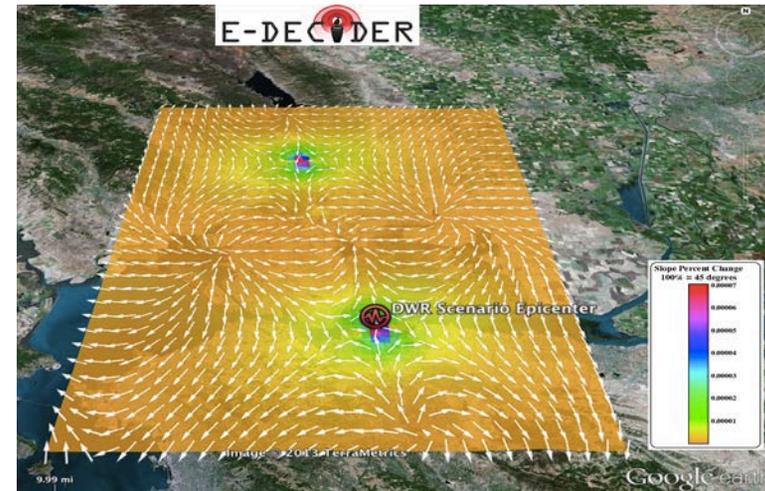
Mainshock



Mainshock v2

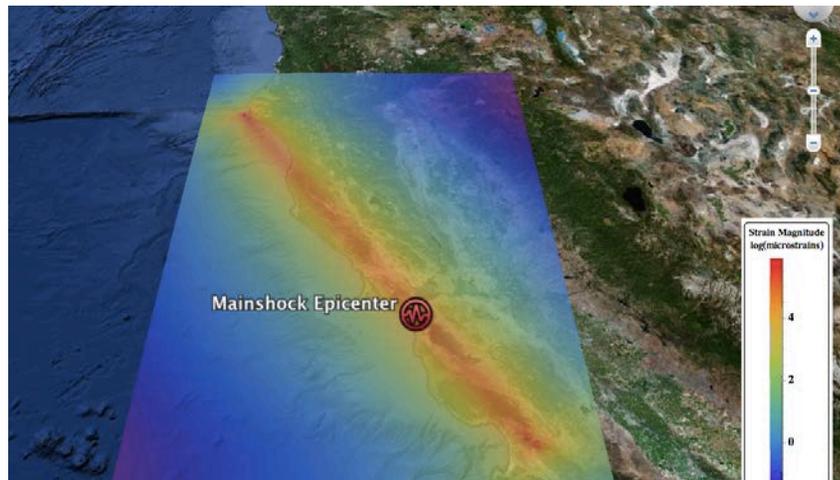


Aftershock

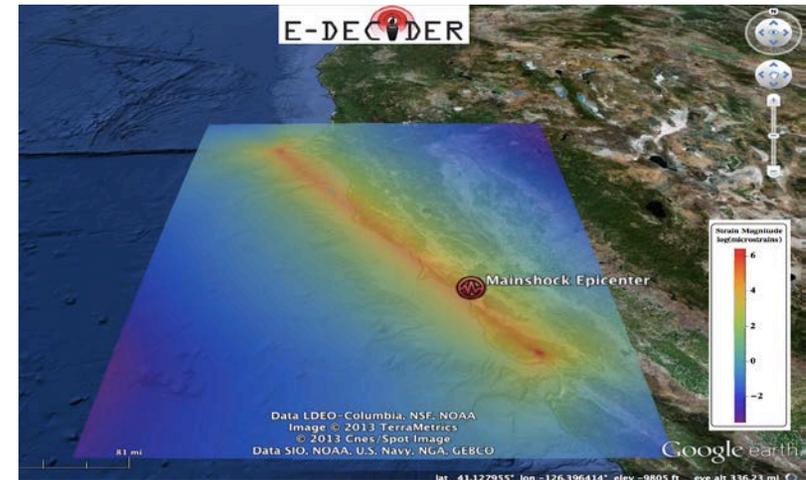


DWR scenario

Strain Magnitude Maps



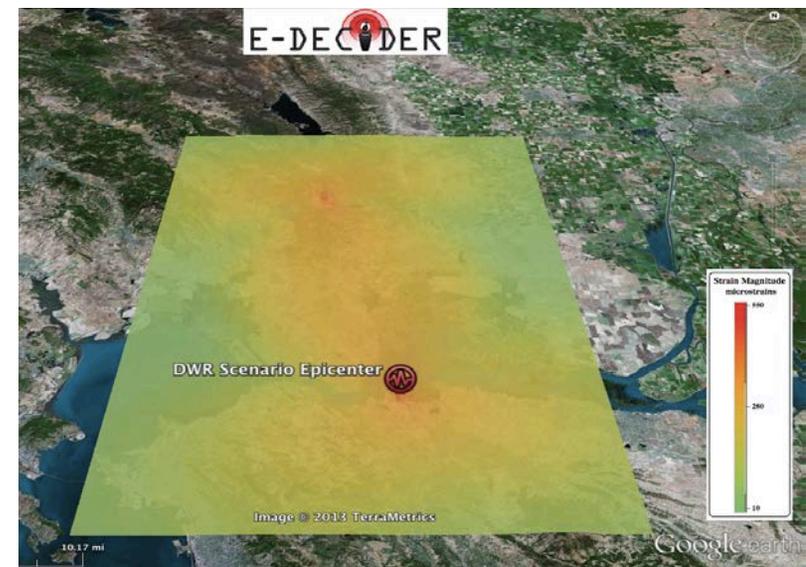
Mainshock



Mainshock v2



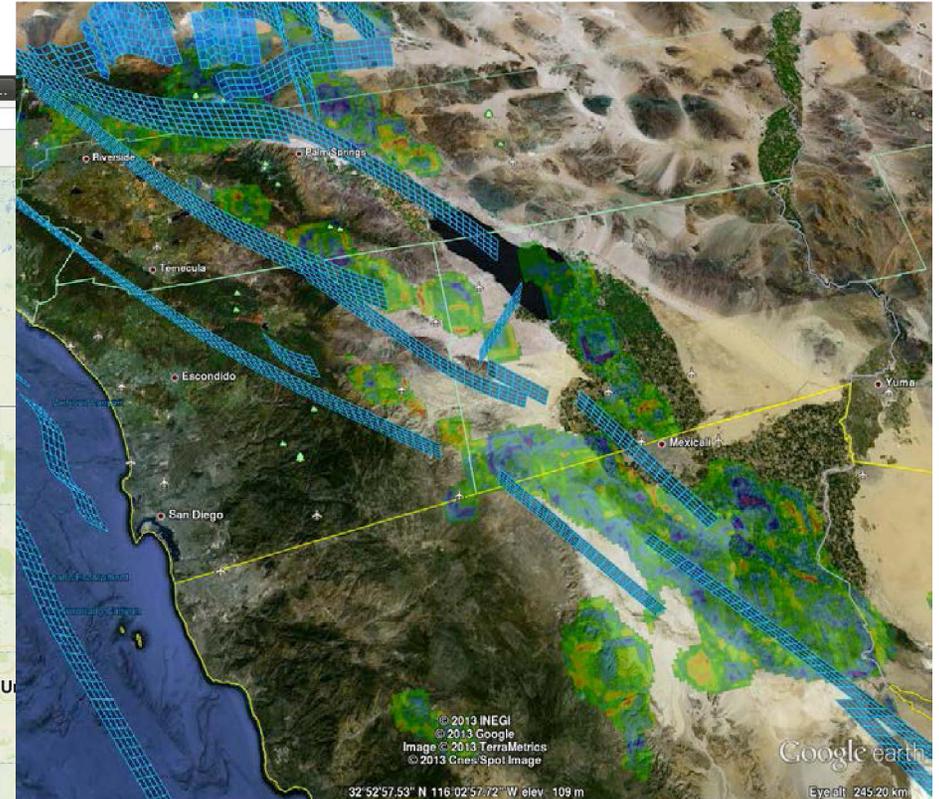
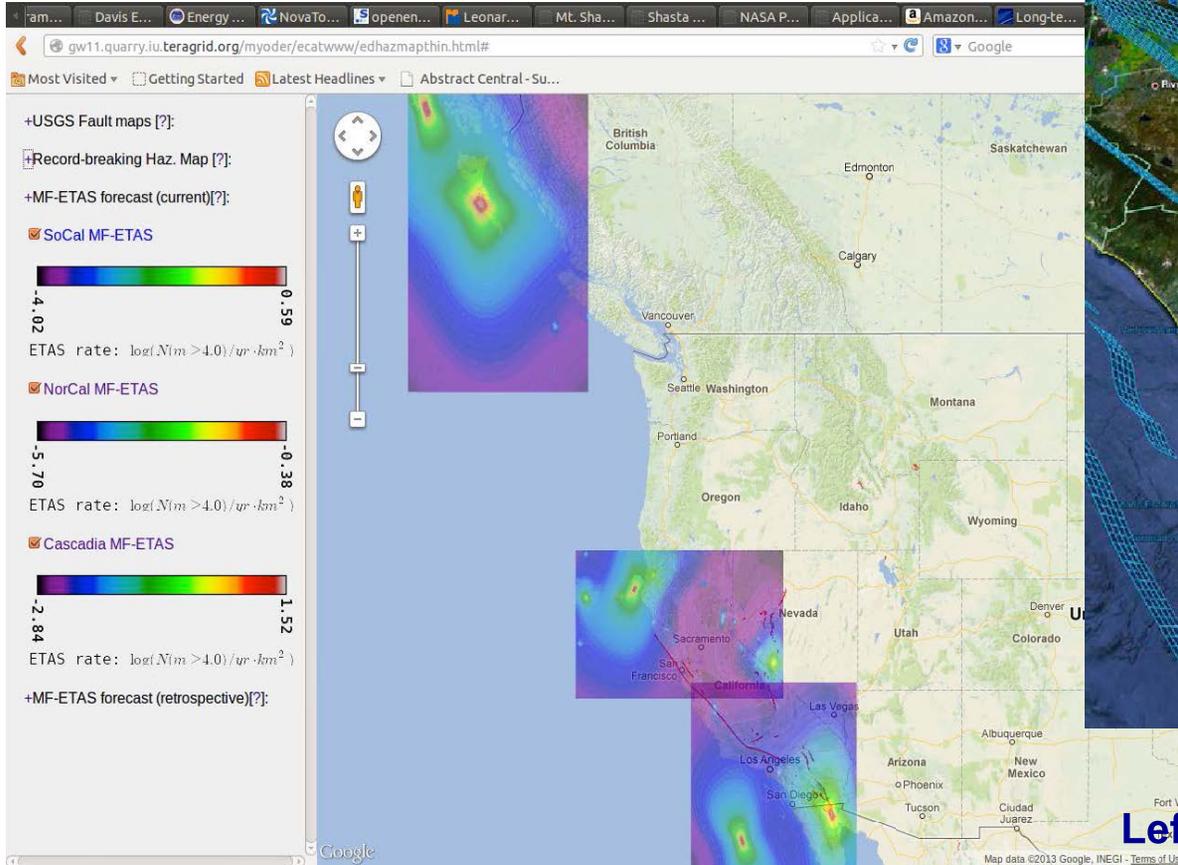
Aftershock



DWR scenario

- ✧ Two types of forecast models
 - ✧ Based on epidemic type aftershock sequence (ETAS) forecasts
- ✧ First forecast type
 - ✧ Provides an estimate of aftershock activity following a large mainshock
 - ✧ E-DECIDER forecast webtool
- ✧ Second forecast type
 - ✧ Bins earthquake catalog and uses record breaking statistics to detect local seismicity trends (acceleration or deceleration) in order to assess seismic hazard.

Earthquake forecasting tool

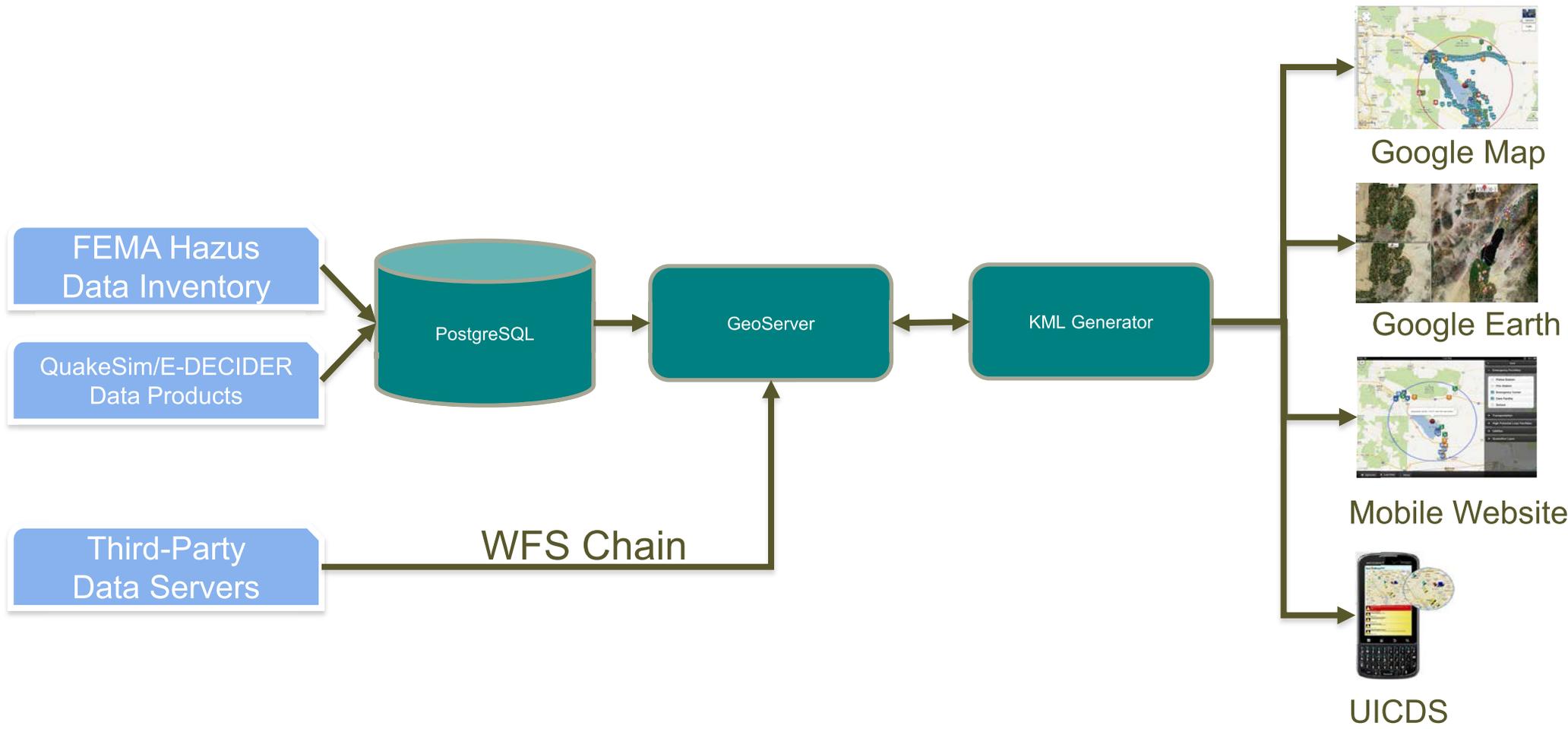


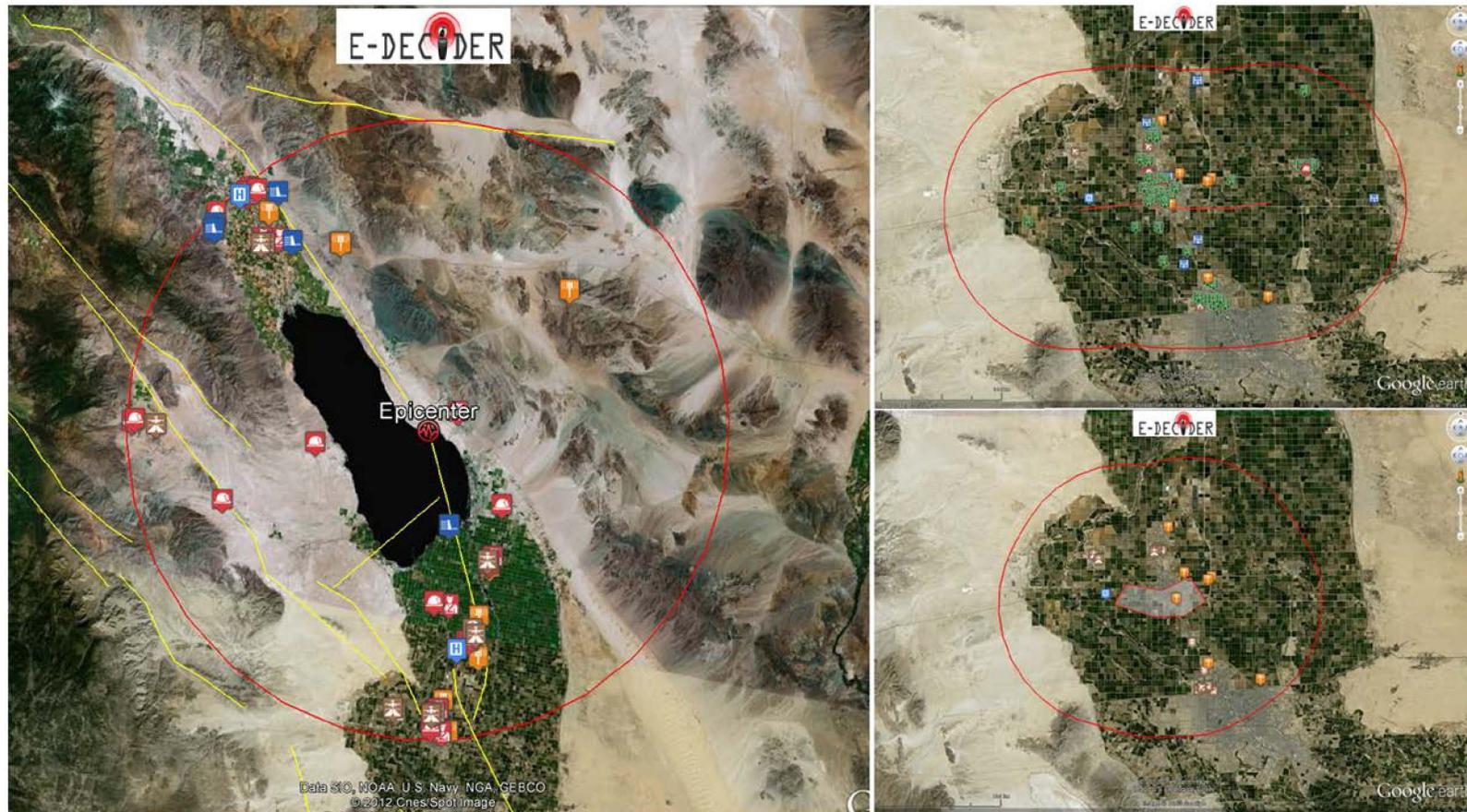
Left: E-DECIDER ETAS Webtool. Right: KML overlay of local seismic rate trends in Google Earth. Warm colors indicate elevated seismicity and cool colors indicate Omori relaxation (aftershocks). Gridded faults are from the Virtual California simulation.

✧ Key features

- ✧ Enables user to access near 30 FEMA critical infrastructure information layers and data products from E-DECIDER and QuakeSim
- ✧ Supports spatial query for broader range of emergency situations: point (e.g. earthquake), line (e.g. tornado), and polygon (e.g. flood, wildfire), and user-specified search distance
- ✧ Supports KML output for Google Earth and Google Map, GeoJSON output for mobile web applications, and UICDS event adaptor is under development
- ✧ Data inventory hosted on third-party GIS server can be added through WFS chain service
- ✧ The system and data is packaged into one virtual machine, and can be deployed on Amazon Cloud as on-demand service.

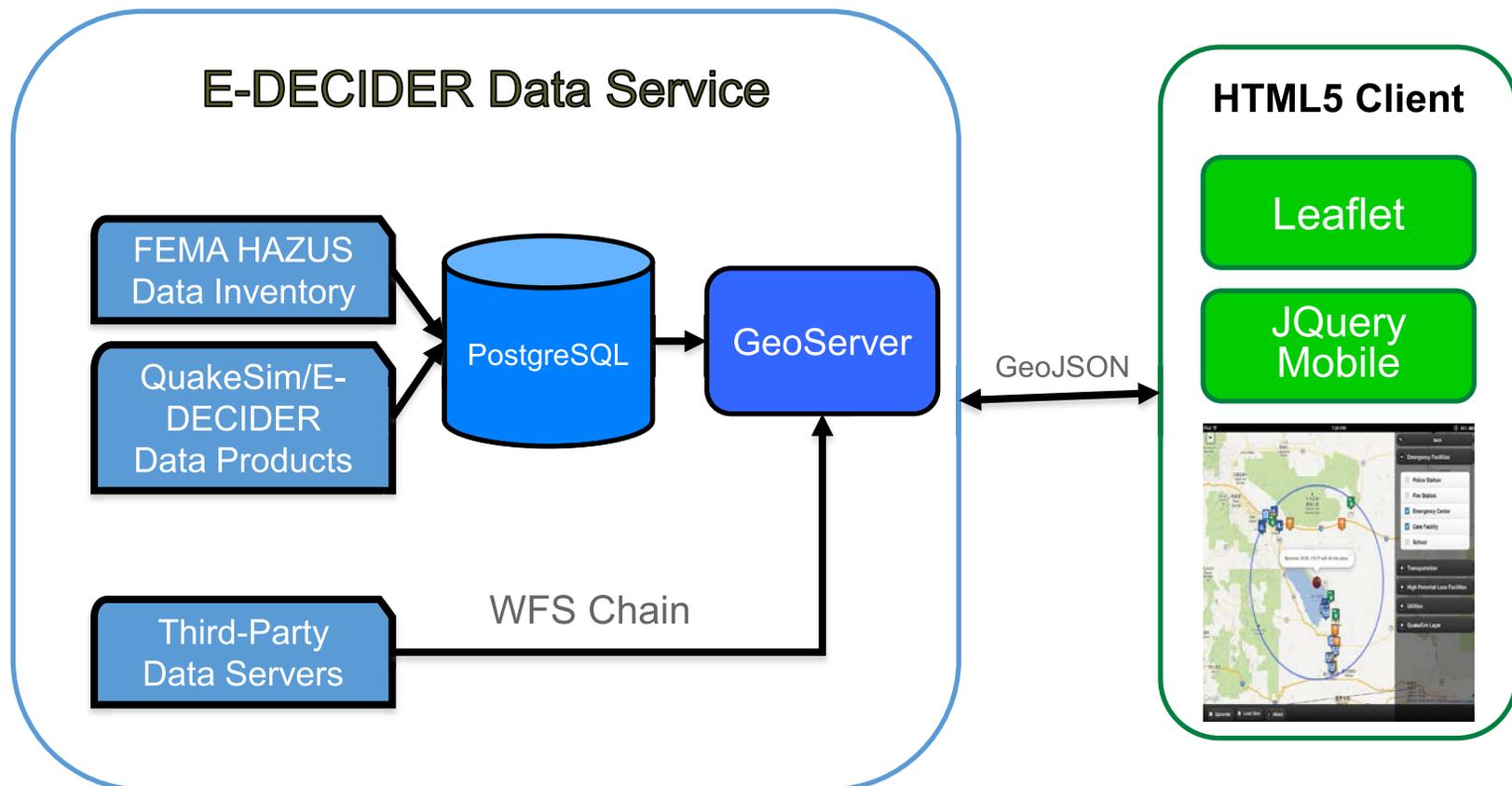
KML Generator Service Architecture



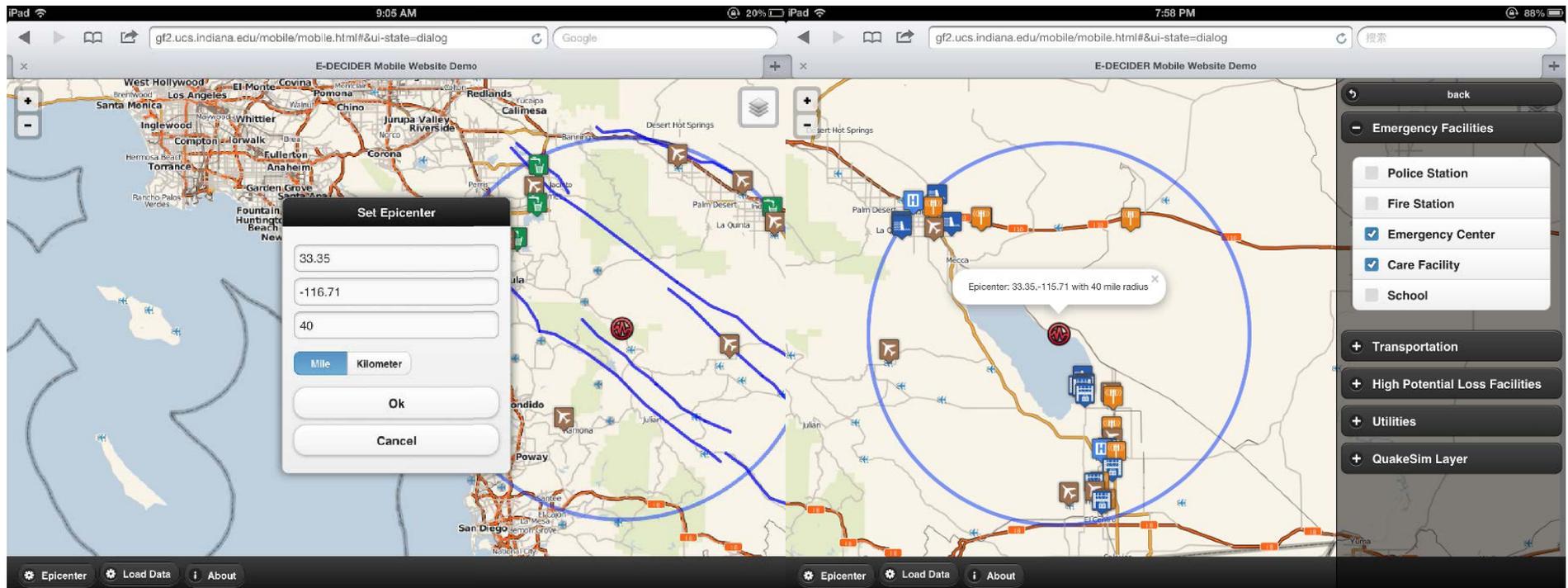


Example queries, including earthquake epicenter (left), line source (e.g. tornado) and polygon (e.g. fire or flood) with search distance (circle) and key infrastructure of interest.

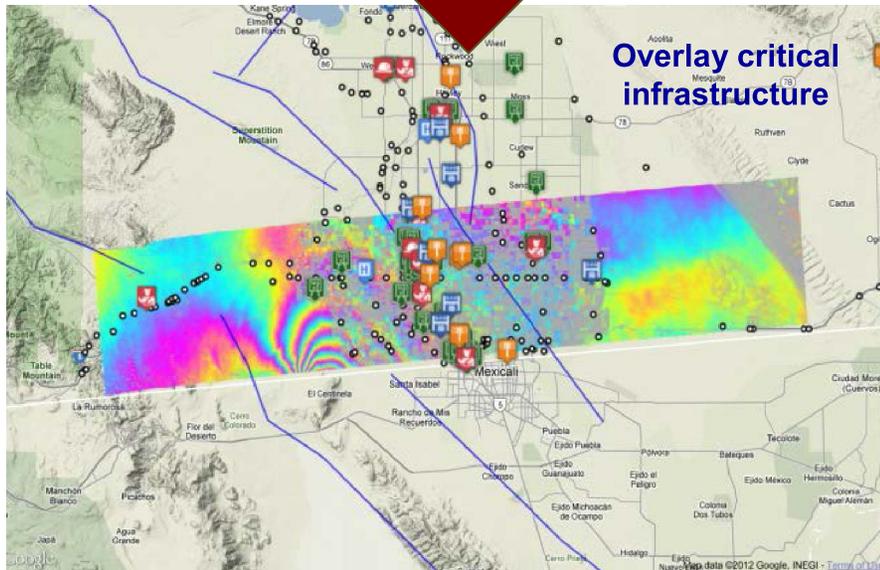
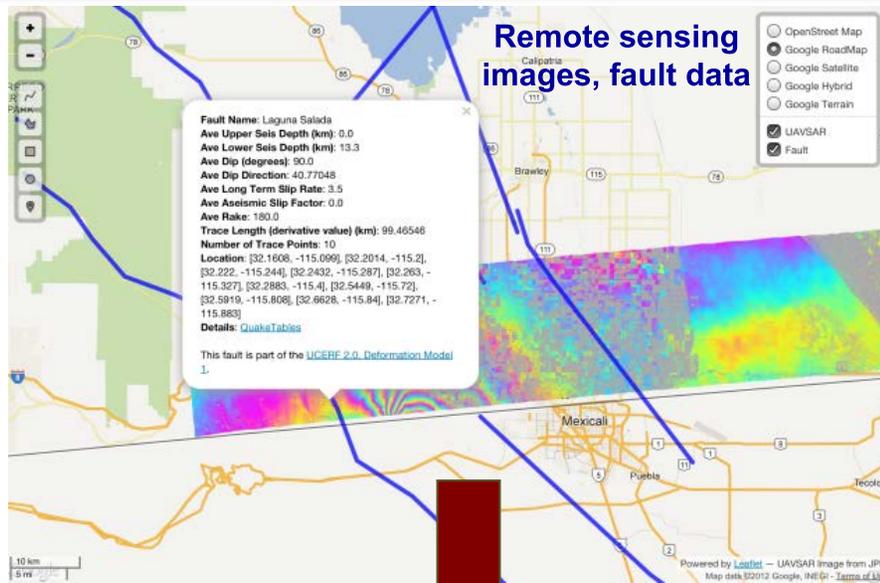
- Mobile GUI: JQuery mobile web framework (<http://jquerymobile.com/>)
- Mobile Mapping Library: Leaflet (<http://leafletjs.com/>)
- GeoJSON is used to exchange data between server and client



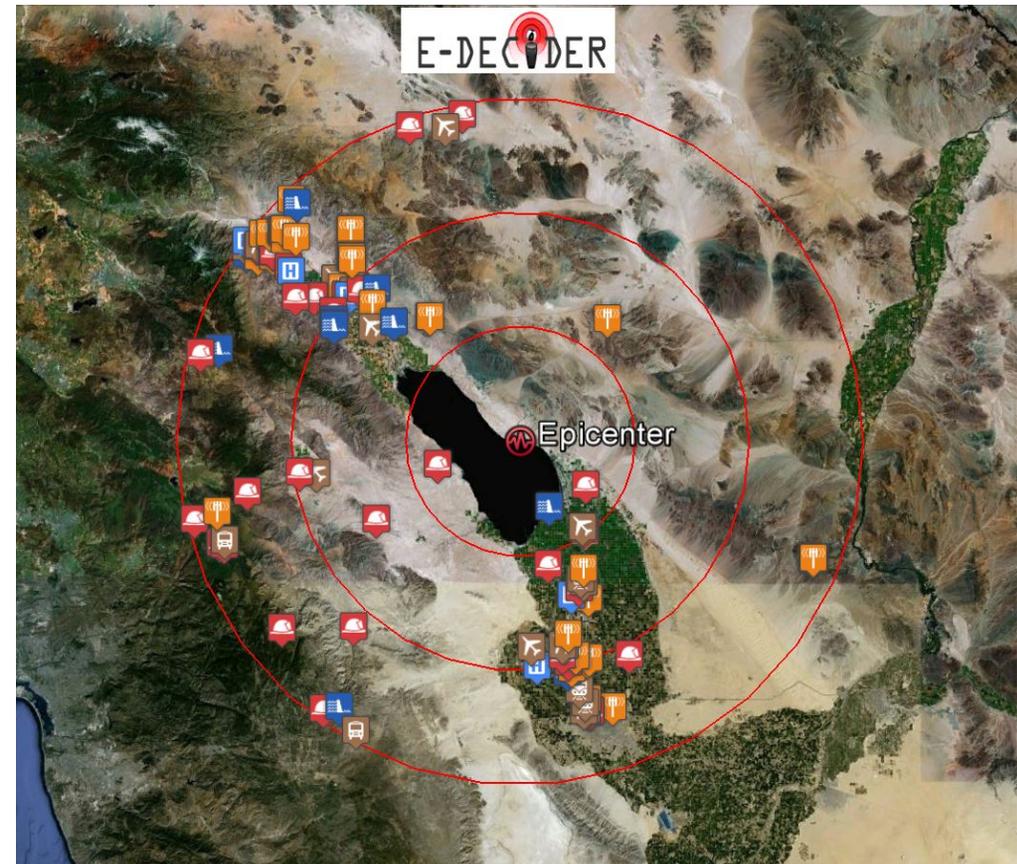
Mobile Service Examples



E-DECIDER mobile interface with epicenter and search distance (circle) with selected infrastructure of interest.



Earthquake epicenter, critical infrastructure with circles denoting various radii distances



Key requirements for products



- ✧ Disaster response operates on a number of timelines
 - Immediate (crucial first minutes to hours following the event) – rapid results to focus initial response efforts
 - Intermediate (hours to days following the event) – continued response, refining initial results and assessments
 - Longer term (weeks to months) – identify areas where repair of infrastructure needs to be addressed



- ✧ Must identify where deformation is greatest and likely damage has or is likely to occur
 - This will allow decision makers and responders to focus response efforts
- ✧ Format and distribution
 - Standards compliant, georeferenced data products
 - Standards compliant distribution services
- ✧ How data is currently represented may not be easily understandable or interpreted by users
 - Must move beyond science products to decision support/response products

- ✧ Need better coordination
 - Analysis efforts
 - Distribution of high and low level data products
- ✧ Agreement on standards
 - Data formats (OGC)
 - Distribution methodologies (DHS-UICDS, web services, mobile services)
 - These need to be compatible with the state of the art IT infrastructure
- ✧ **Data sharing!**
- ✧ How can scientists produce results that have immediate utility for disaster response?

Questions?

<http://e-decider.org>

<http://quakesim.org>

<http://www.californiaeqclearinghouse.org>

<http://www.uicds.us>

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