InSAR and GPS Study of “Slow” Moving Landslides

2013 JPL UAVSAR Workshop , March 26-27

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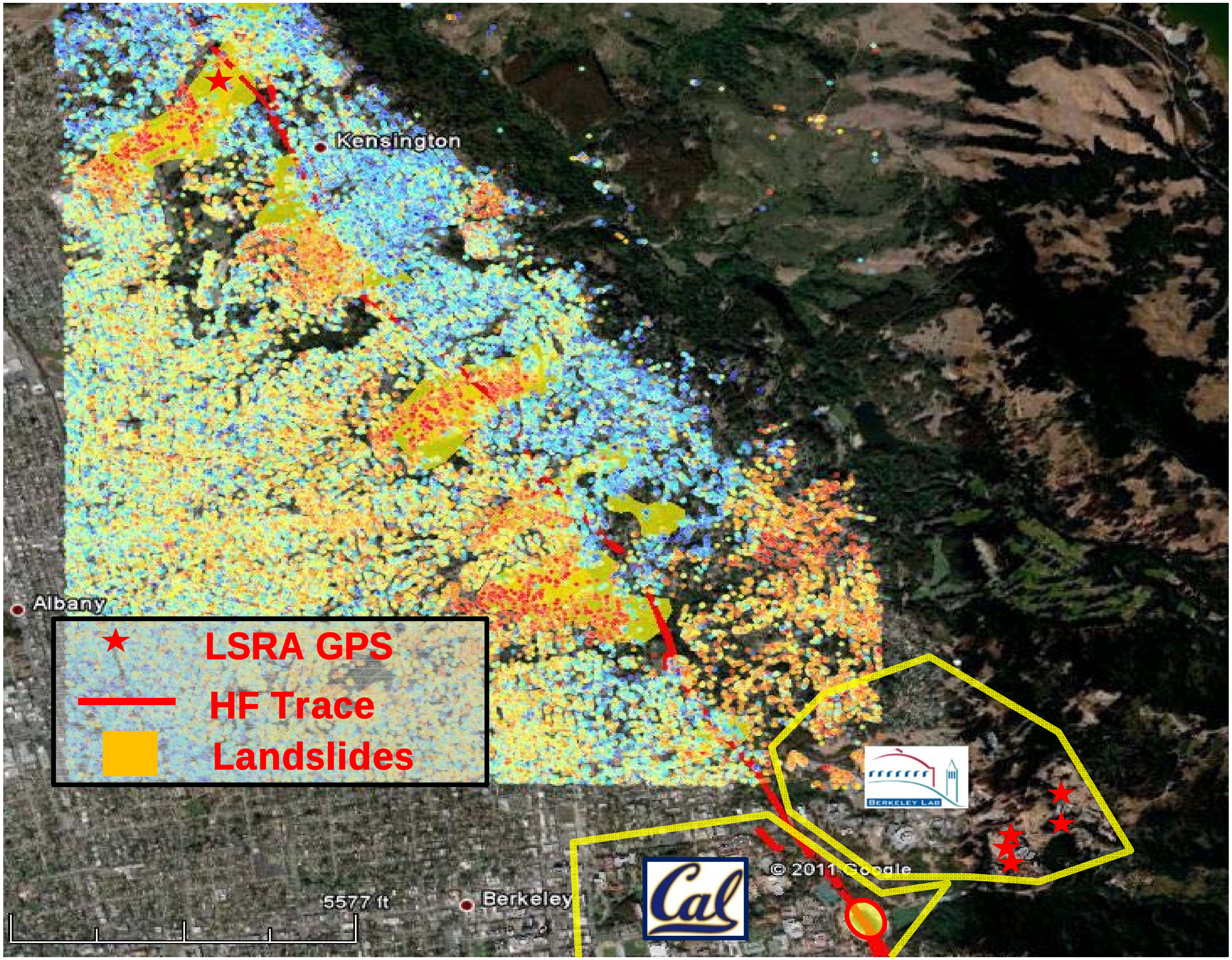

2008-2010 TerraSAR-X InSAR time series (Lei and Burgmann 2010)

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Summary

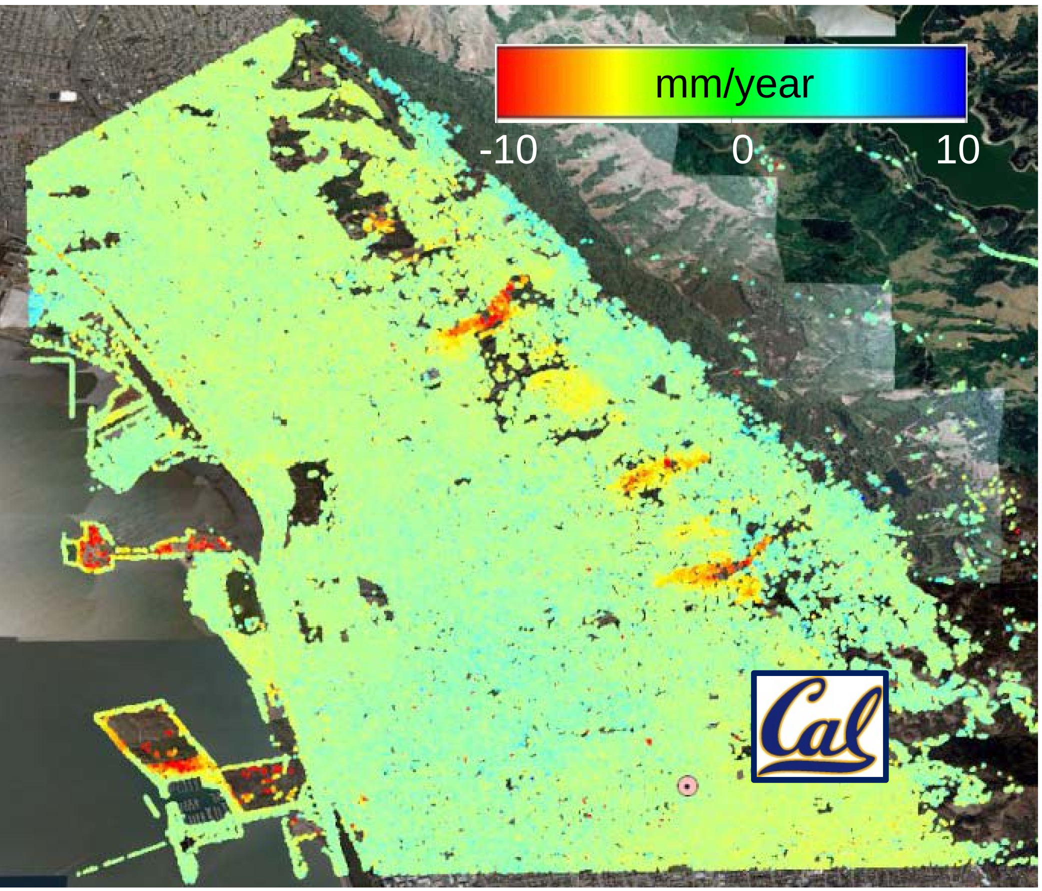
- **Objective:** Spatial characterization and temporal analysis of deformation related to slow moving (cm/year – m/year) earth flows.
- **Methods:**

Continuous GPS Network (unique ground displacement measurements)

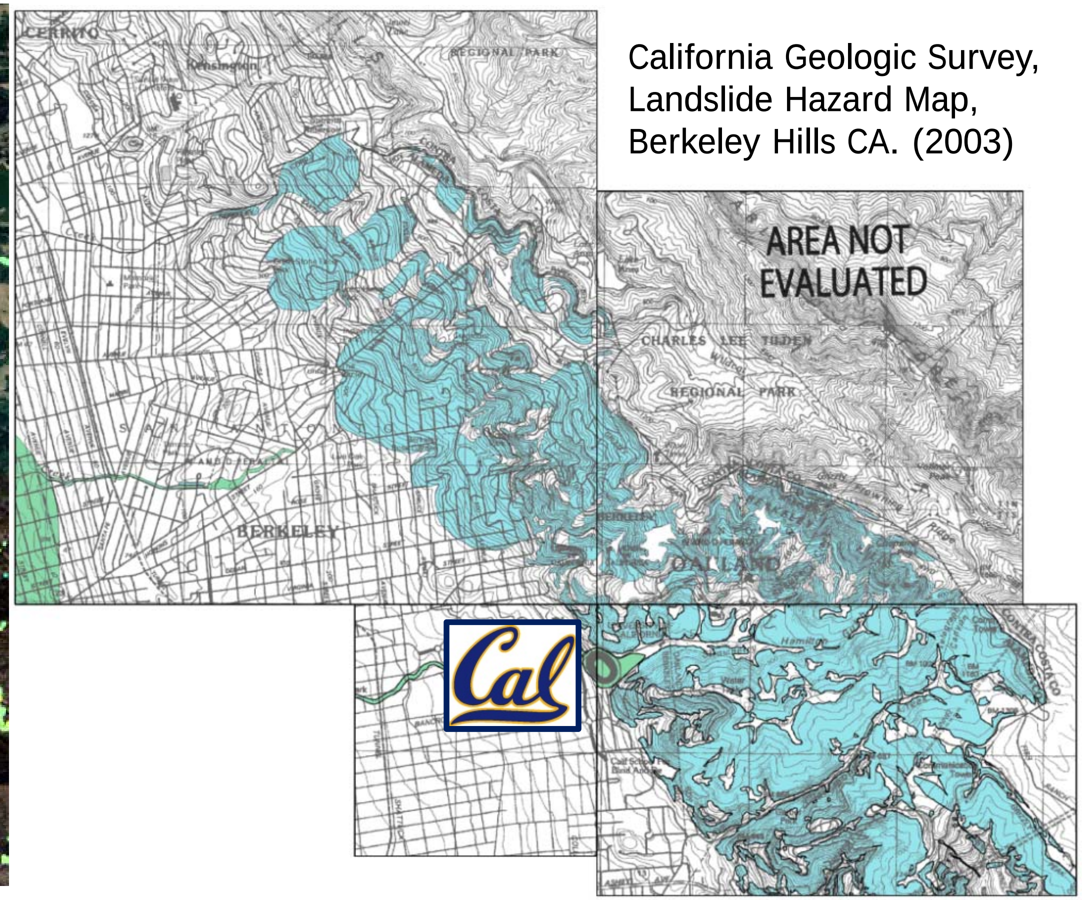
Satellite InSAR Time Series Analysis (higher spatial resolution)

UAVSAR (Flexible flight lines and repeat passes)

- **Motivation:** Model slide mechanisms, refine current landslide hazard mapping.



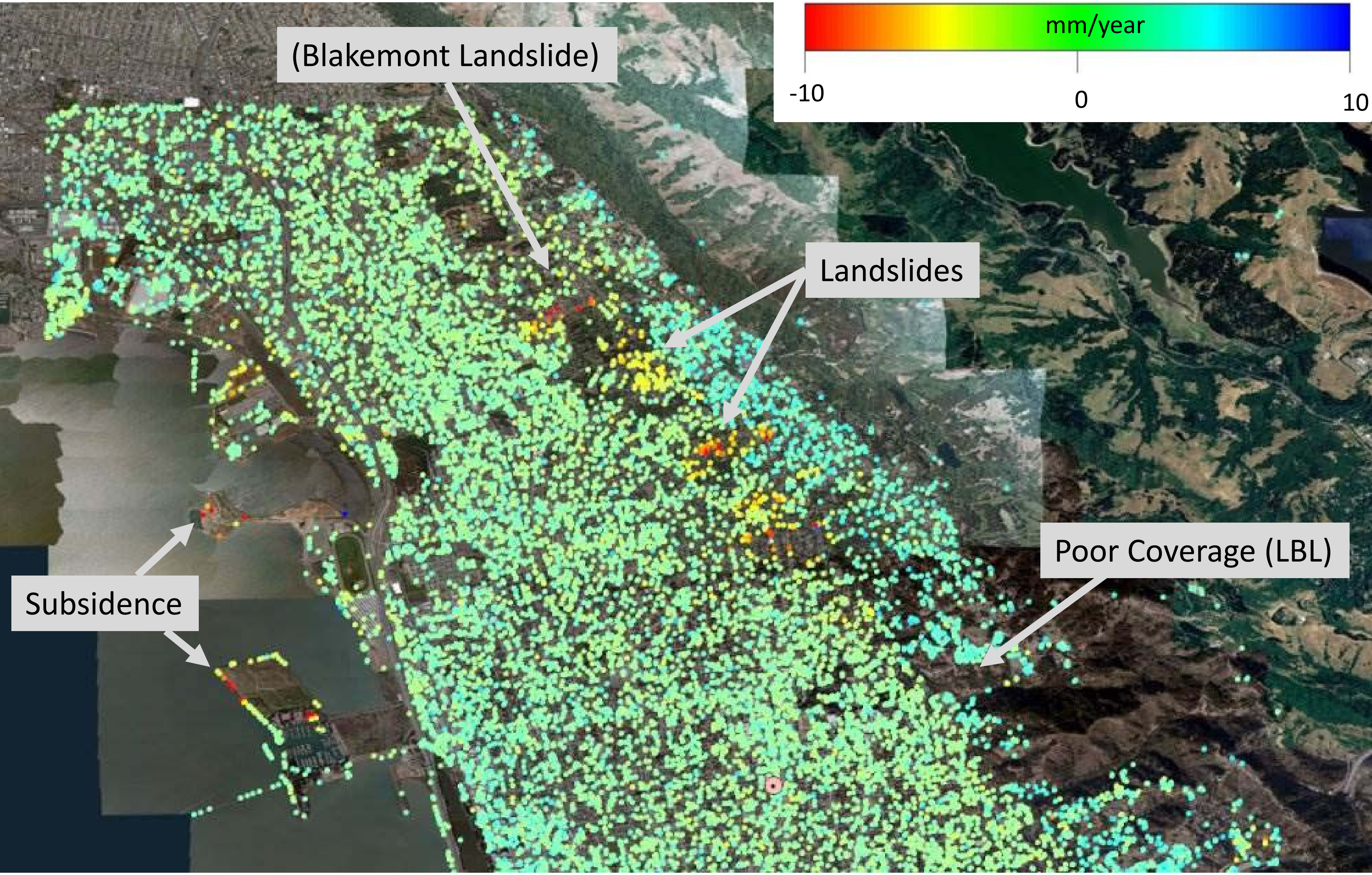
2009-2011 TerraSAR-X Velocity map, SqueeSAR™ , TRE (2011)



California Geologic Survey, Landslide Hazard Map, Berkeley Hills CA. (2003)

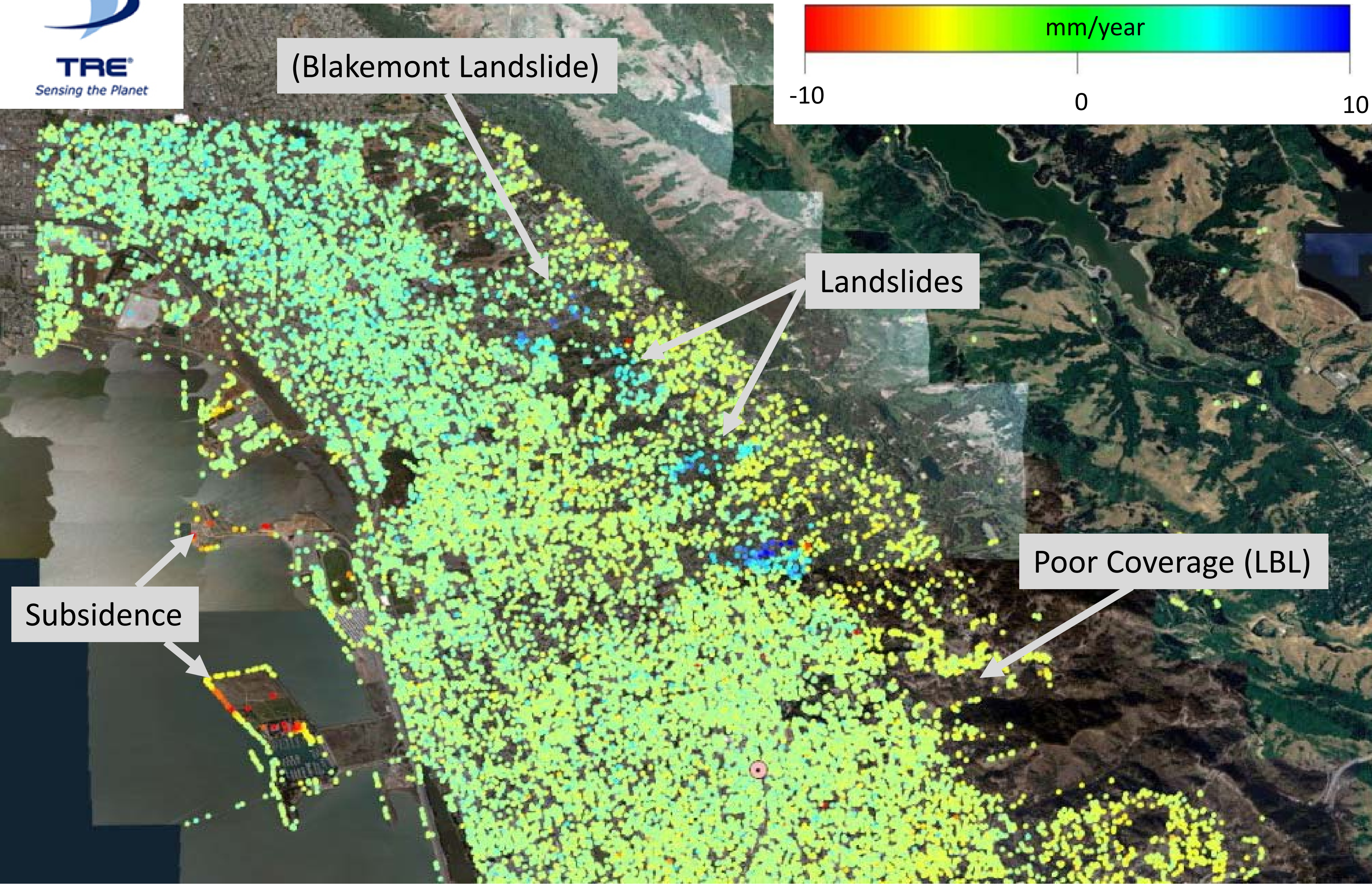
ERS Velocity map 1992-2000

Hilley et al. (2004): using PS-InSAR



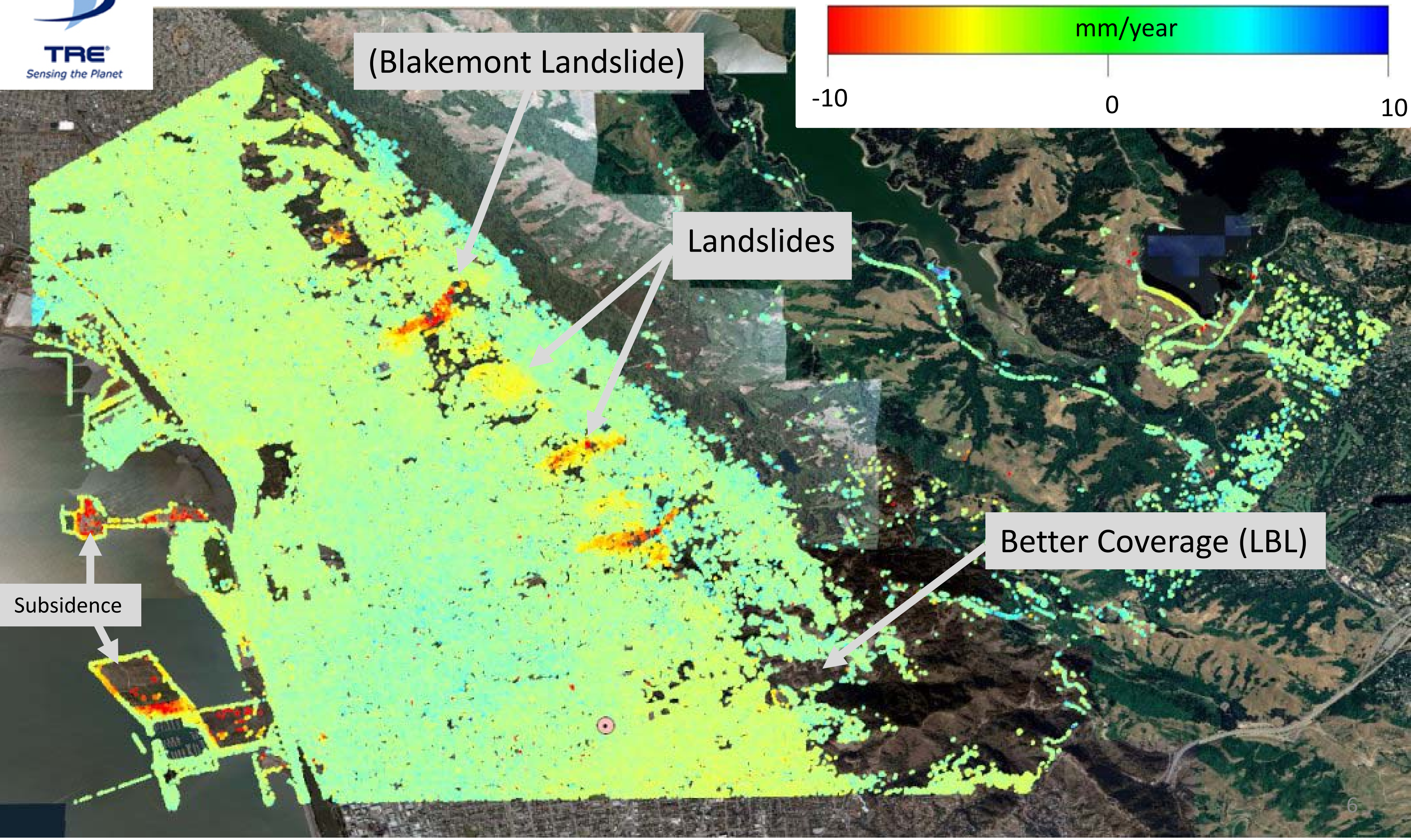
Radarsat-1 Velocity map 2001-2006

TRE: Improved PS-InSAR coverage



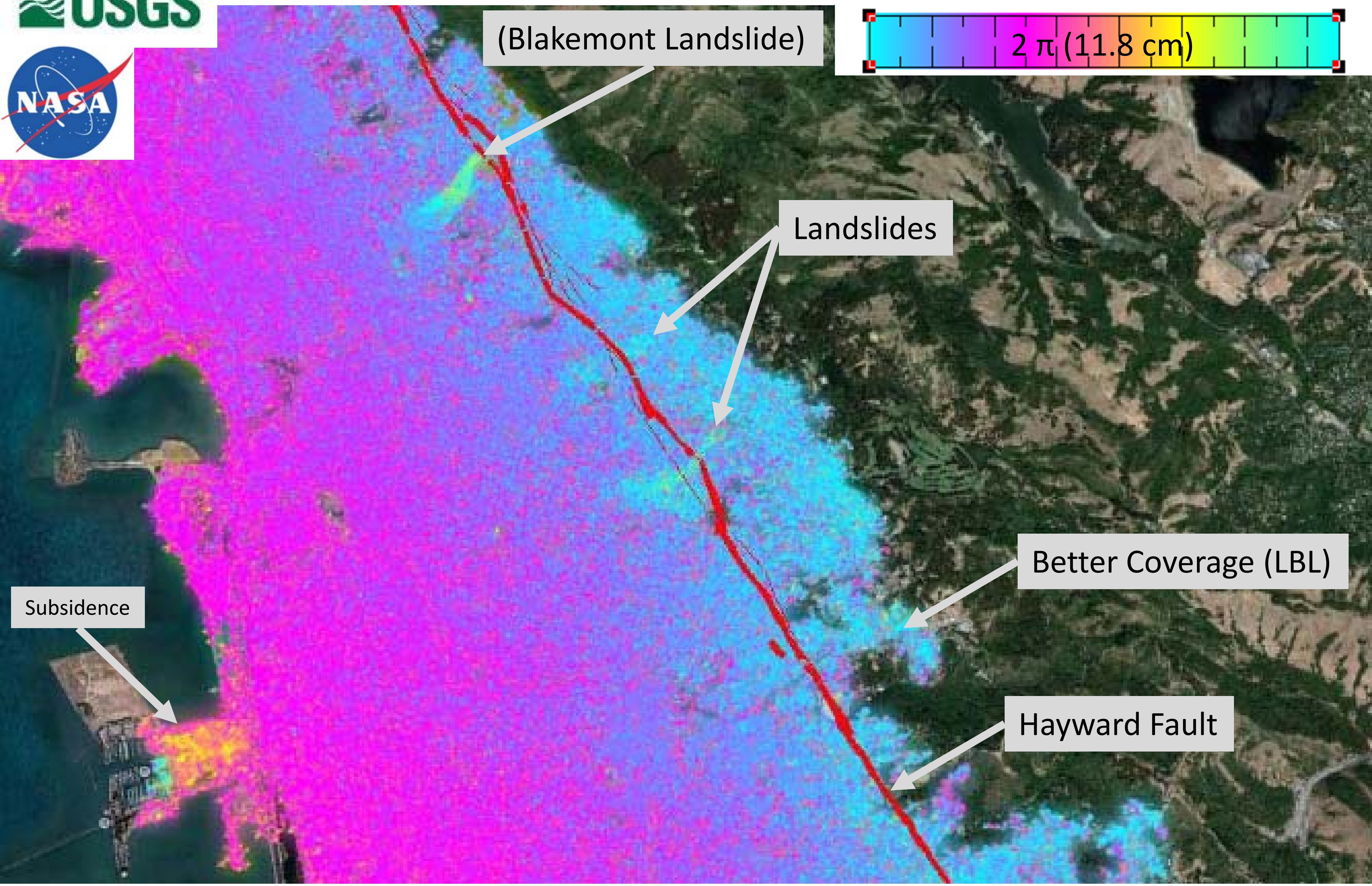
TerraSAR-X - Velocity map 2009-2011

TRE (2011): SqueeSAR™ improved coverage using PS and DS InSAR method



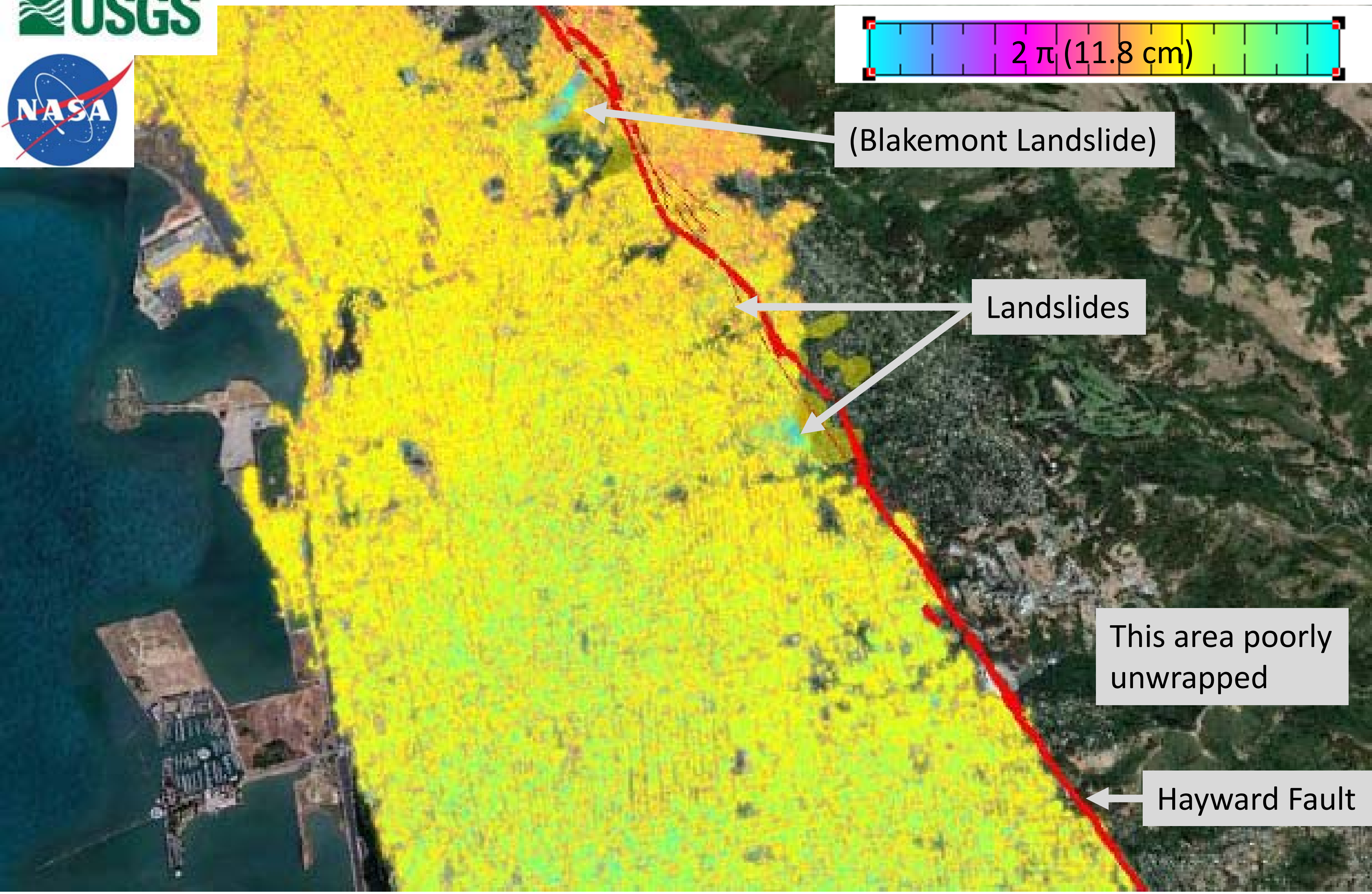
UAVSAR April 2010 – July 2011

JPL: 15302 Fault Parallel (153°) Unwrapped



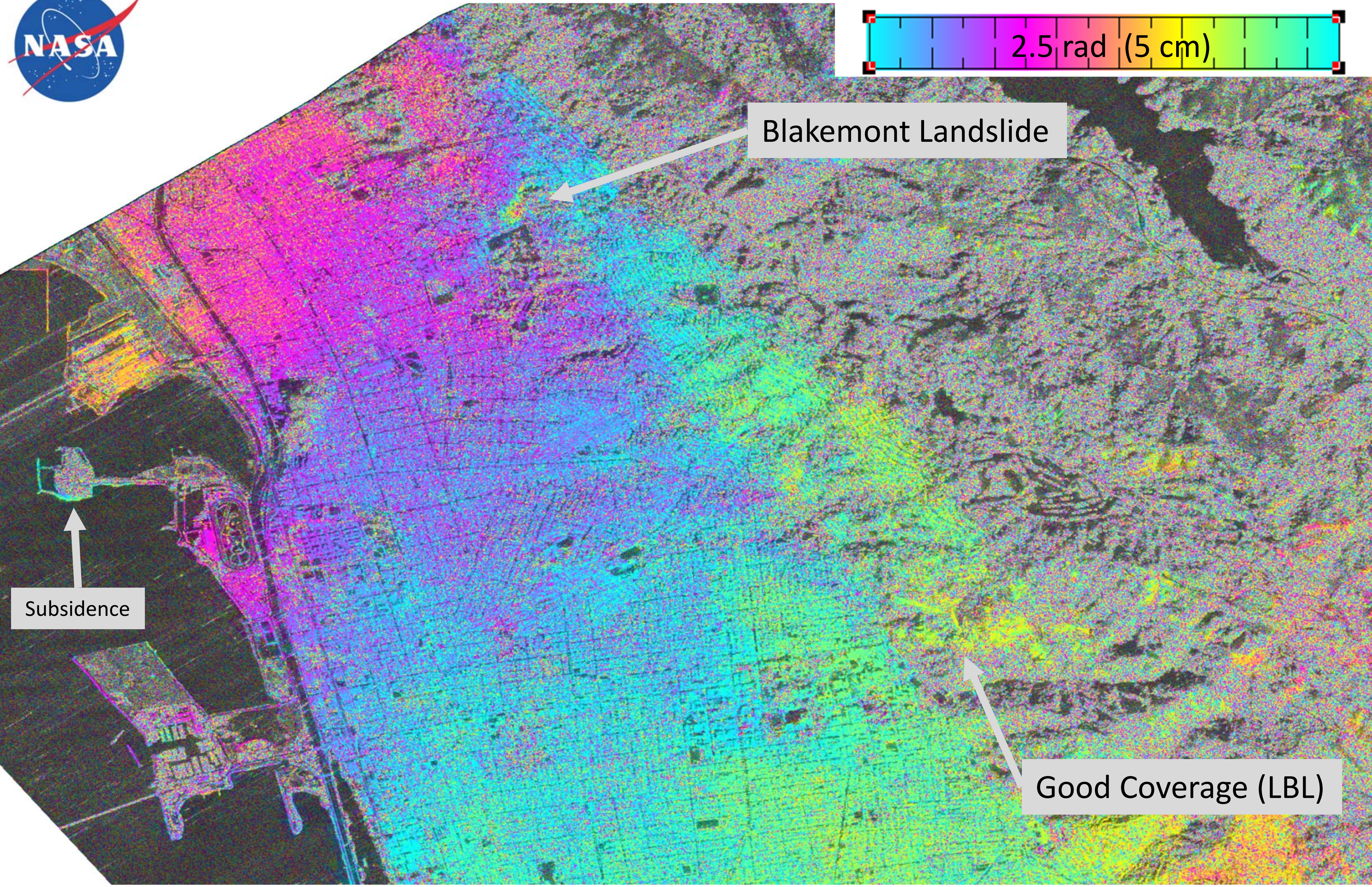
UAVSAR April 2010 – July 2011

JPL: 34001 Fault Parallel (340°) Unwrapped



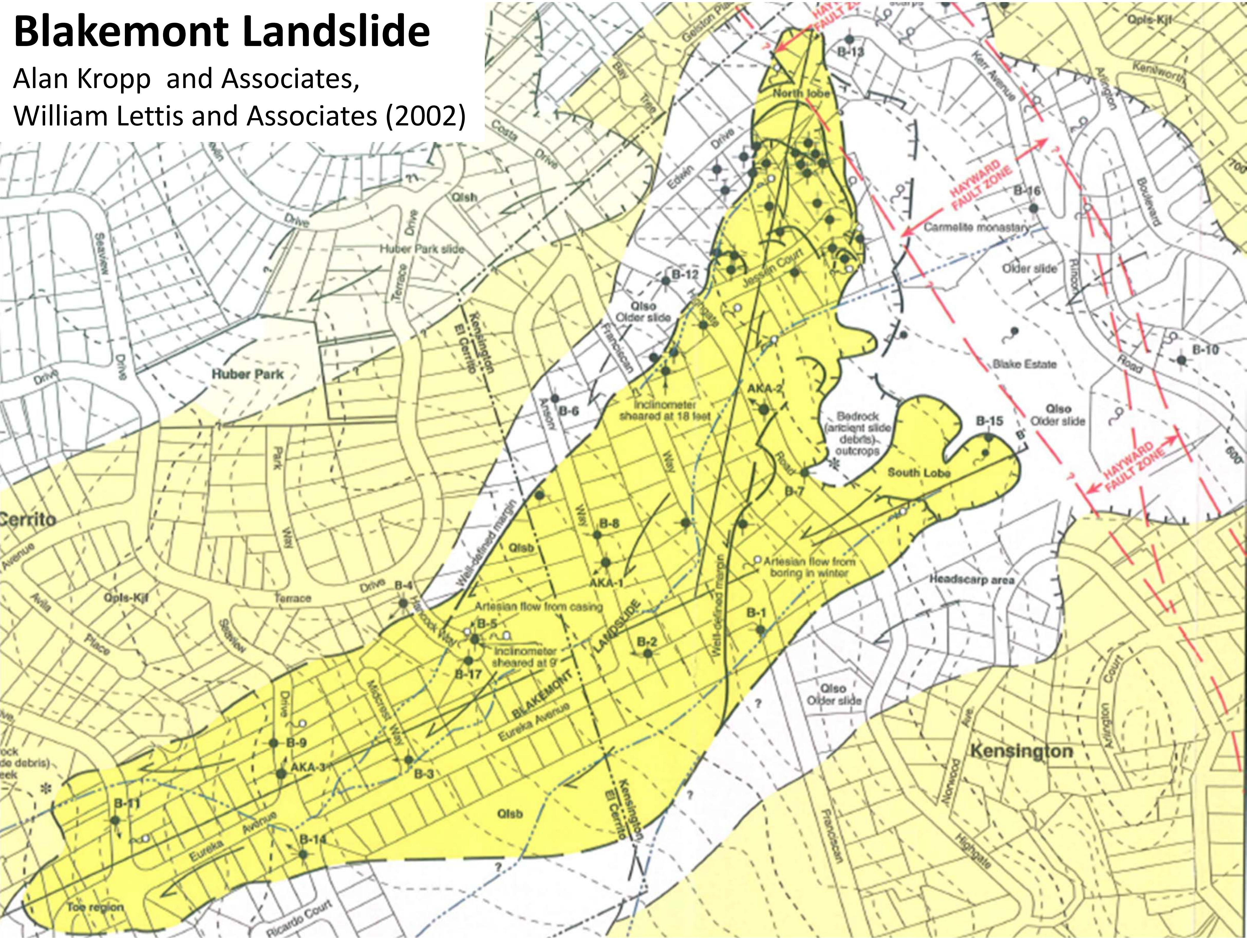
UAVSAR April 2010 – July 2011

JPL: 05524 Fault Normal Rewrapped

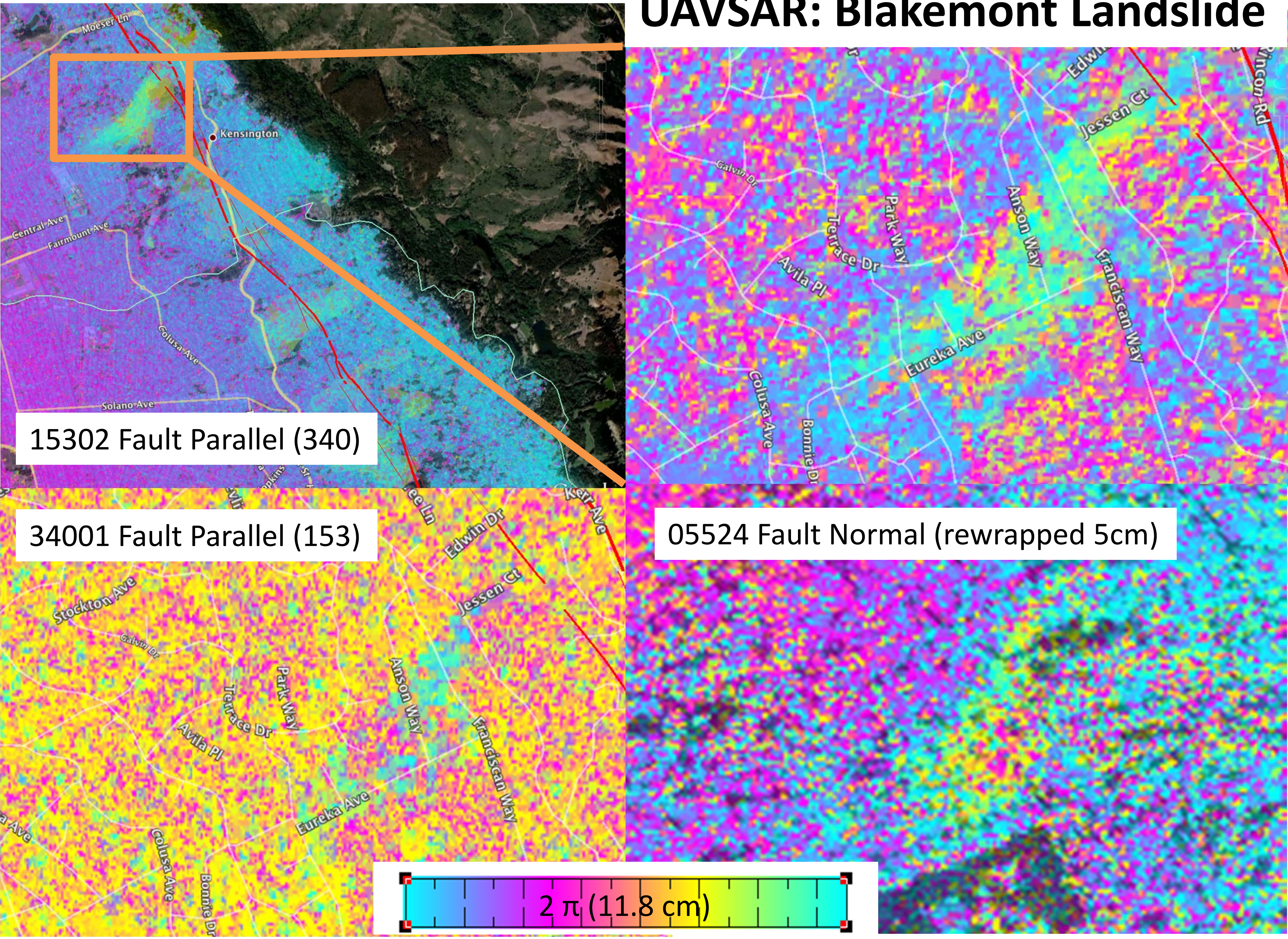


Blakemont Landslide

Alan Kropp and Associates,
William Lettis and Associates (2002)



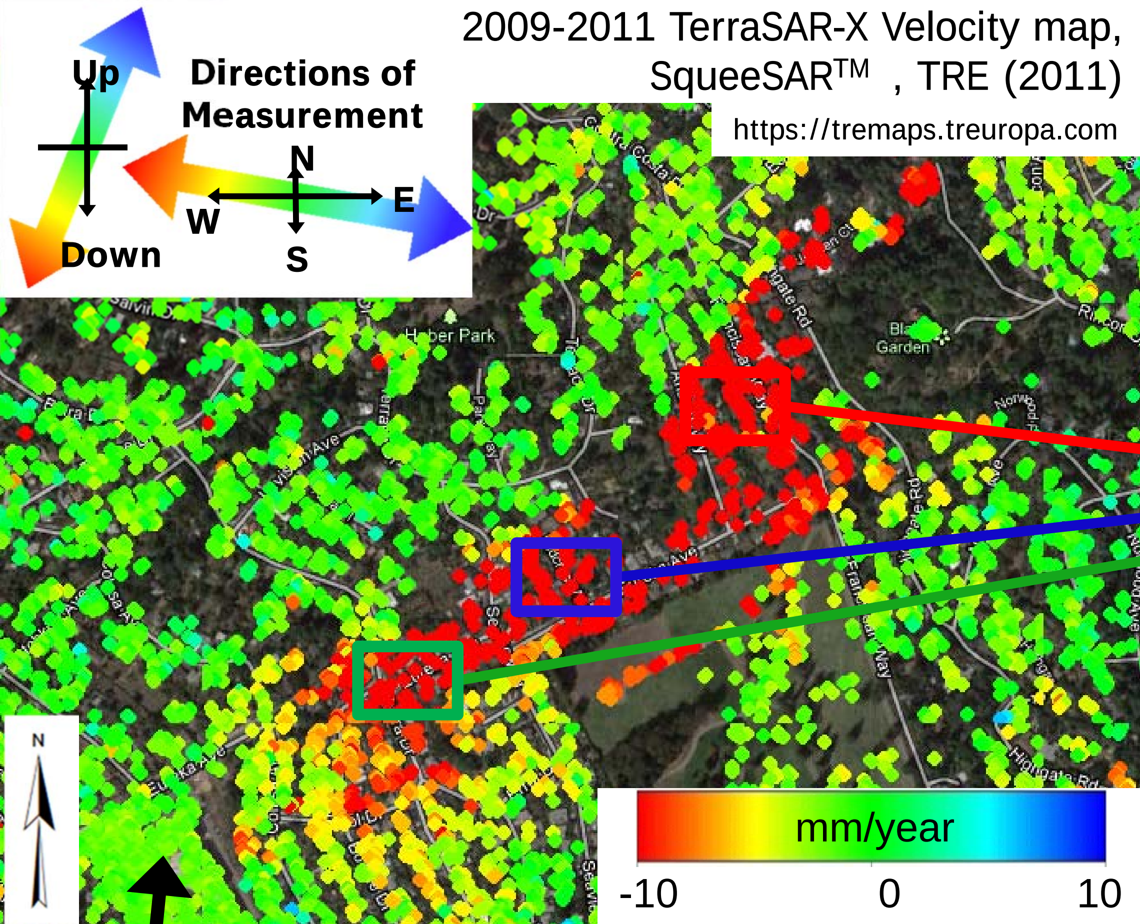
UAVSAR: Blakemont Landslide



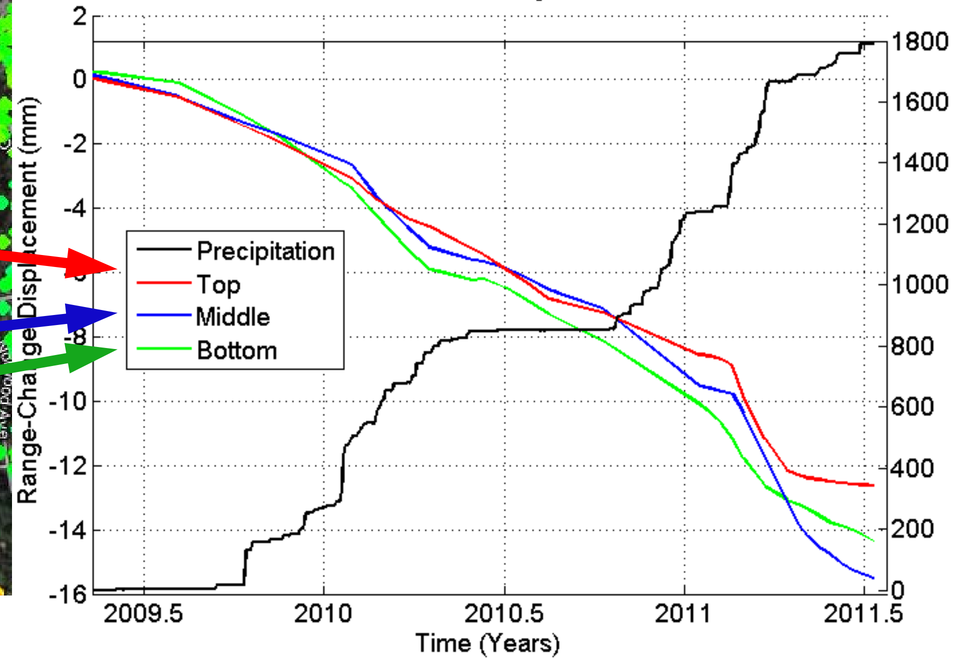
Landslide Behavior

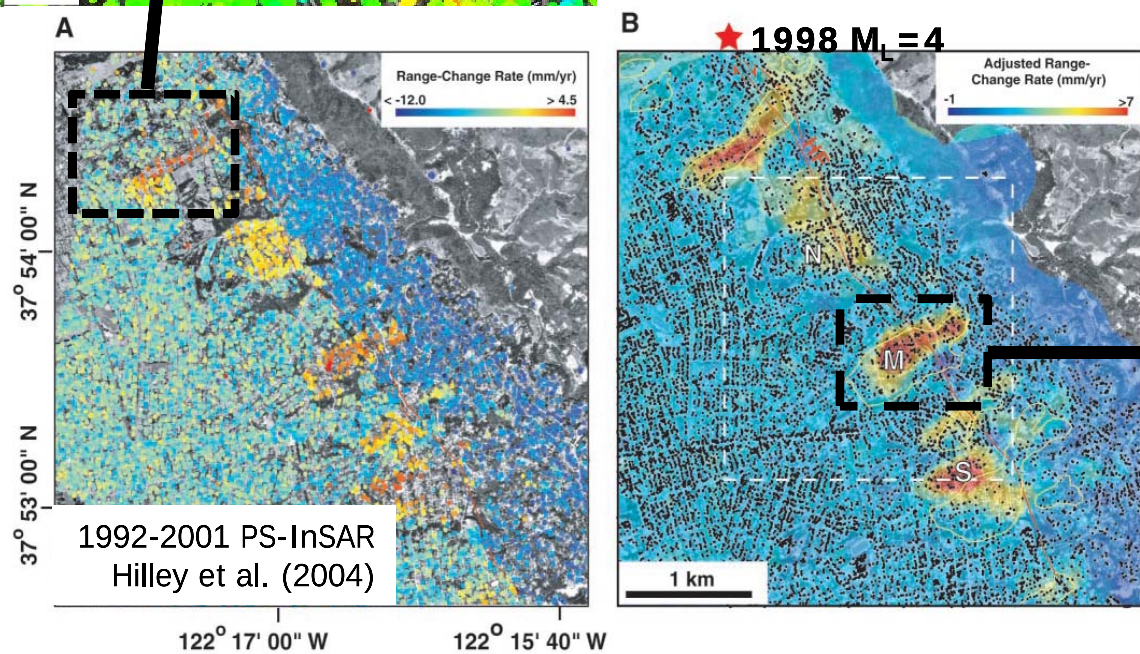
2009-2011 TerraSAR-X Velocity map, SqueeSAR™ , TRE (2011)

https://tremaps.treuropa.com



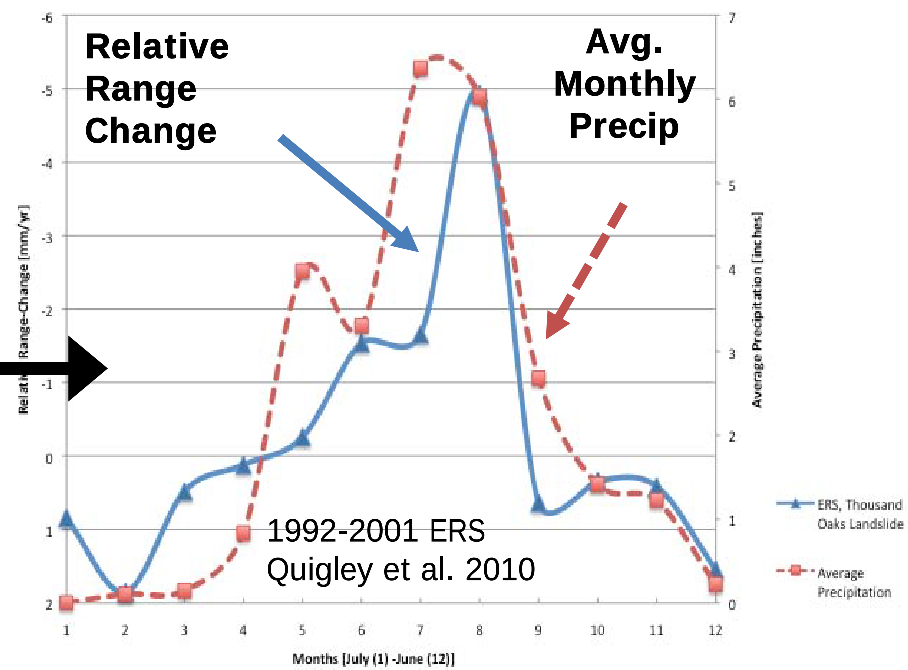
Blakemont Landslide Range-Change Displacement
TSX InSAR Time Series by TRE 05/09-07/11





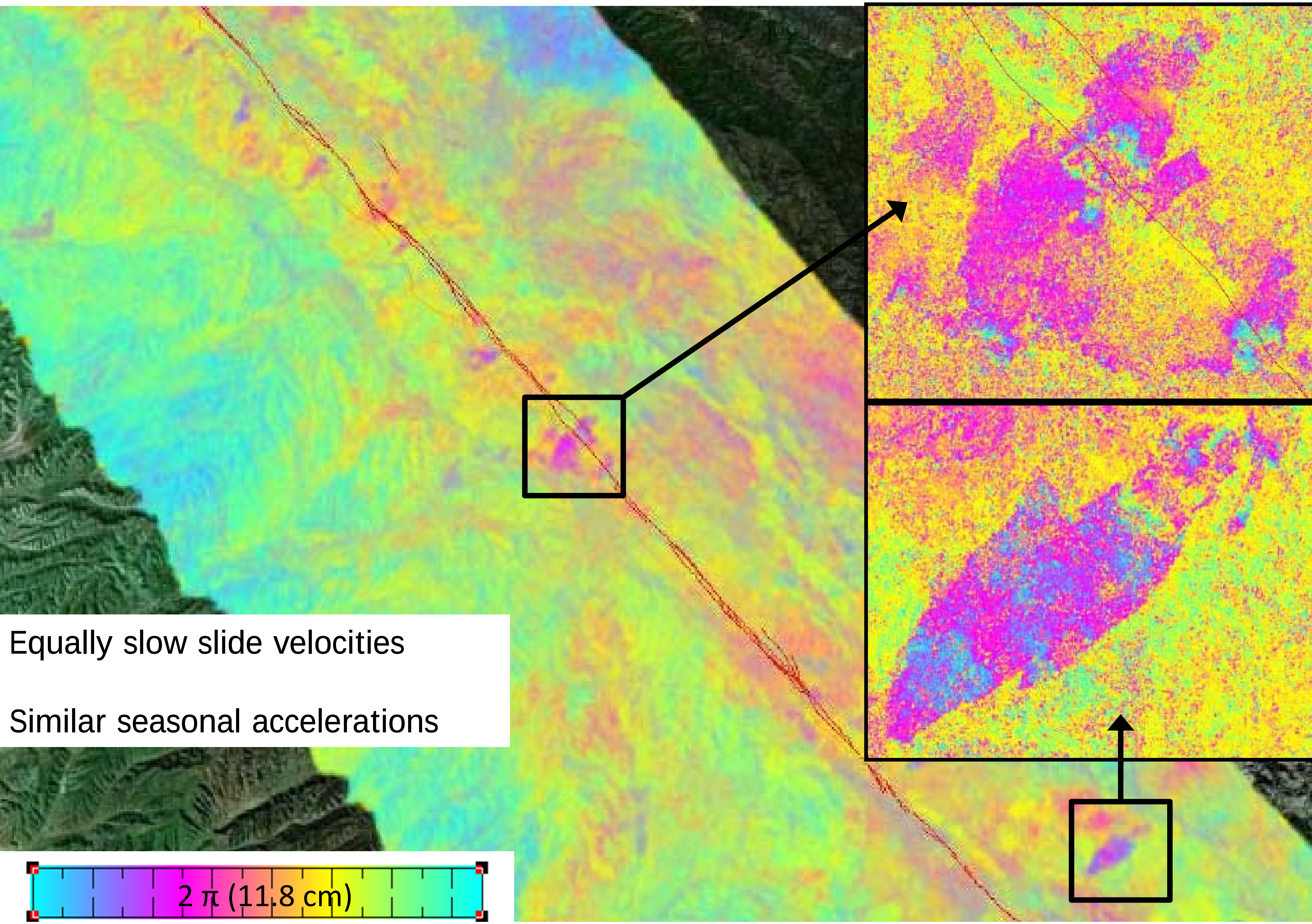
1992-2001 PS-InSAR
Hilley et al. (2004)

Range-Change Detrended and Stacked by Month 1992-2000 Thousand Oaks Landslide, ERS



1992-2001 ERS
Quigley et al. 2010

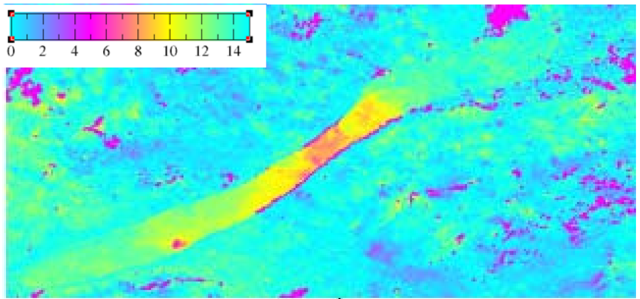
UAVSAR: Central San Andreas, Nov. 2010 – July 2011



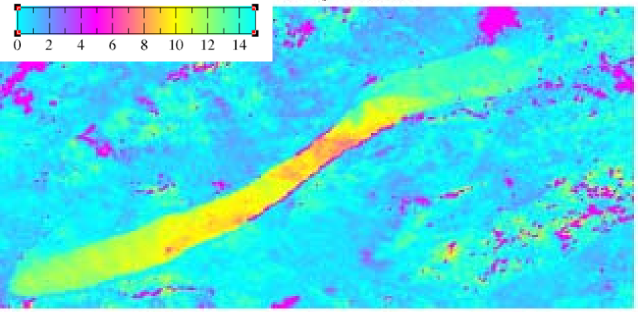
Slumgullion Landslide

(2 orders of magnitude faster)

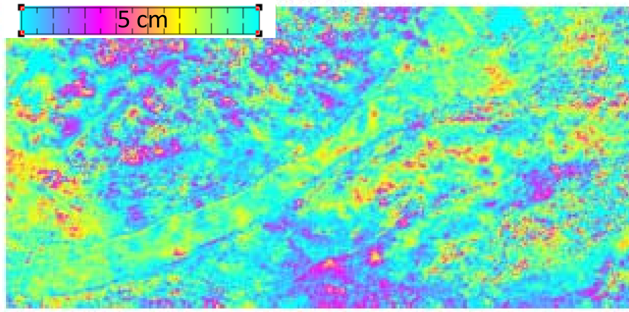
H035 amplitude



North



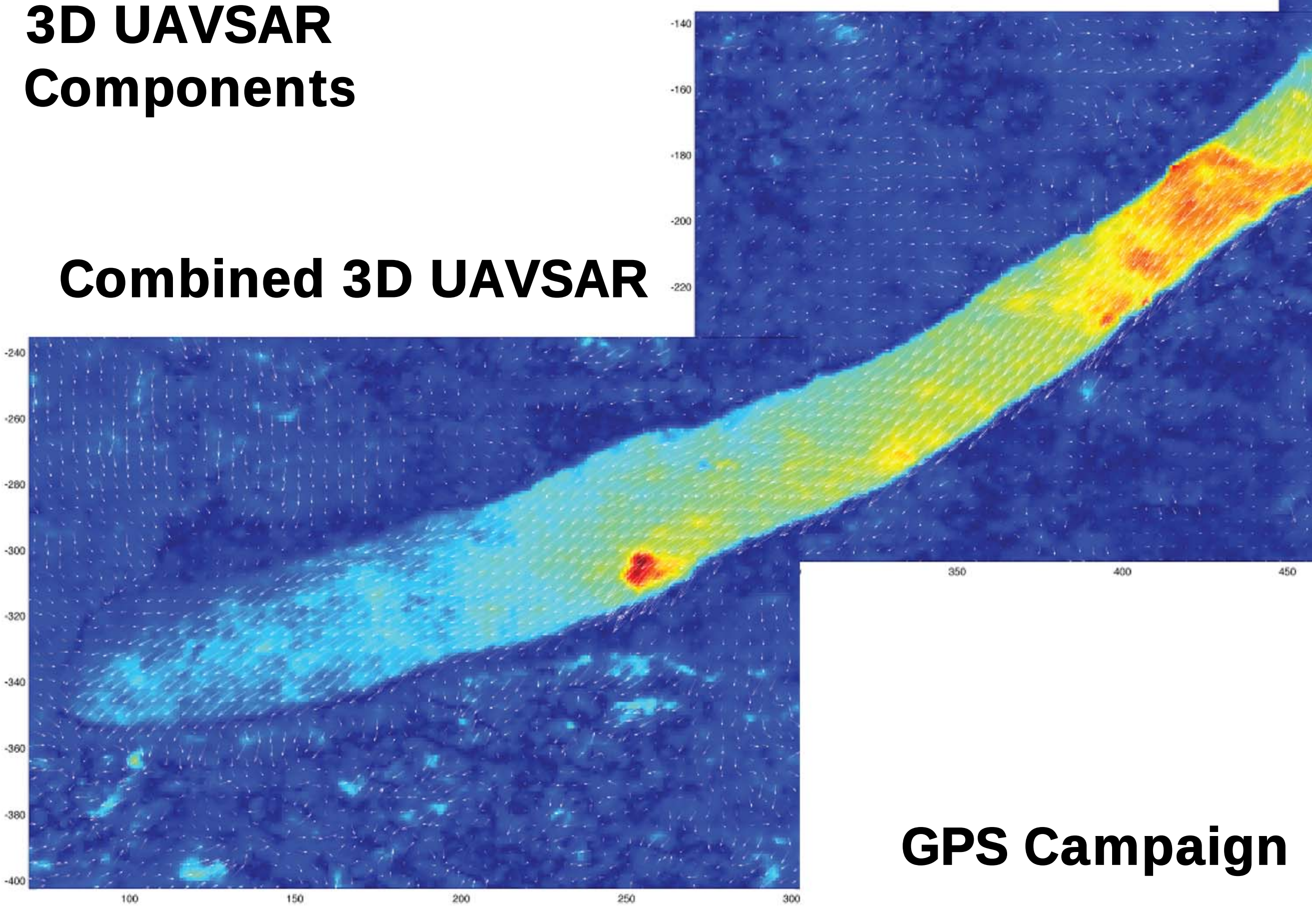
East



Up

3D UAVSAR Components

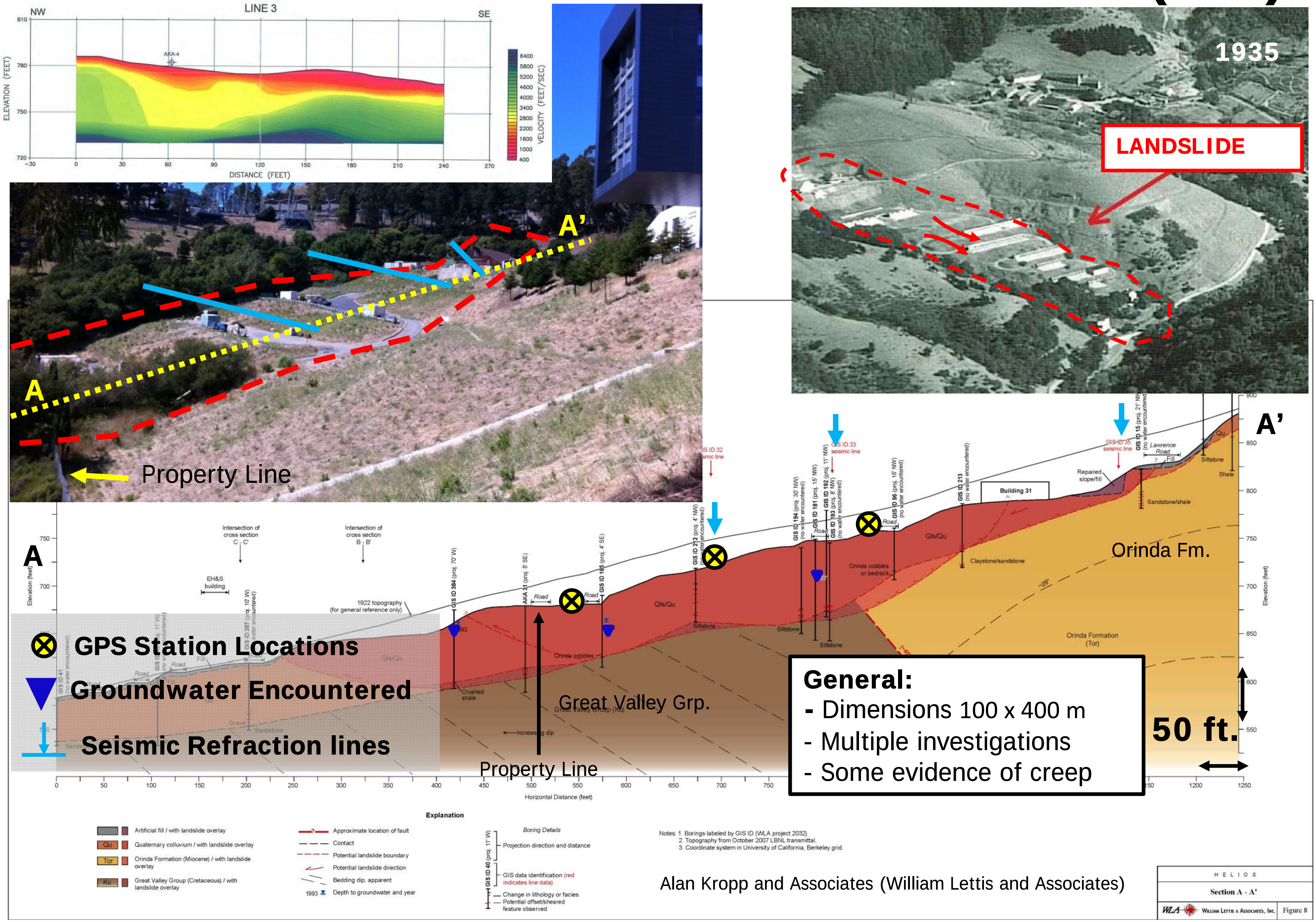
Combined 3D UAVSAR



GPS Campaign

GPS Monitoring of Slow Moving Landslides

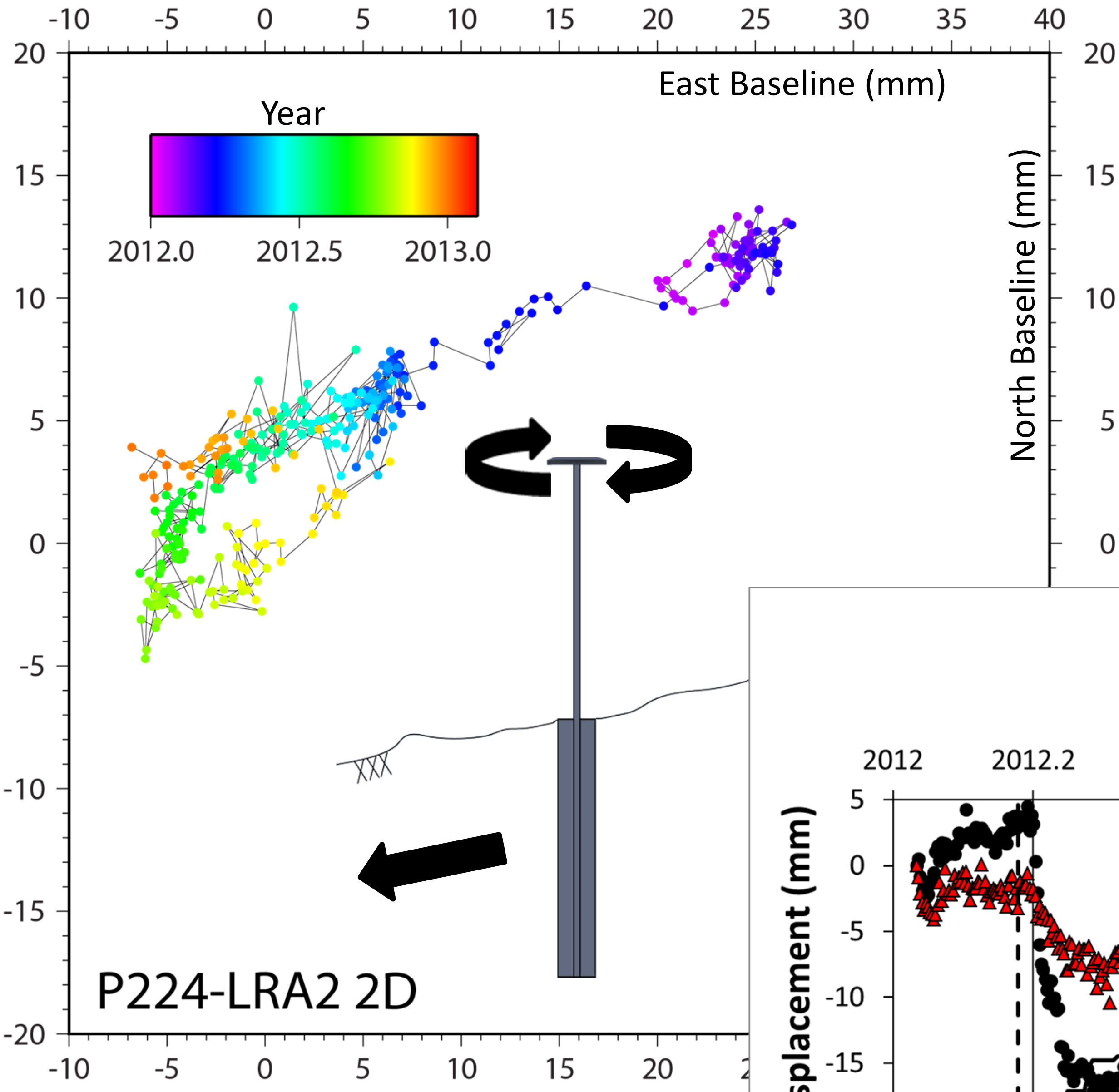
GPS Stations 1-3: Chicken Creek Landslide (LBL)

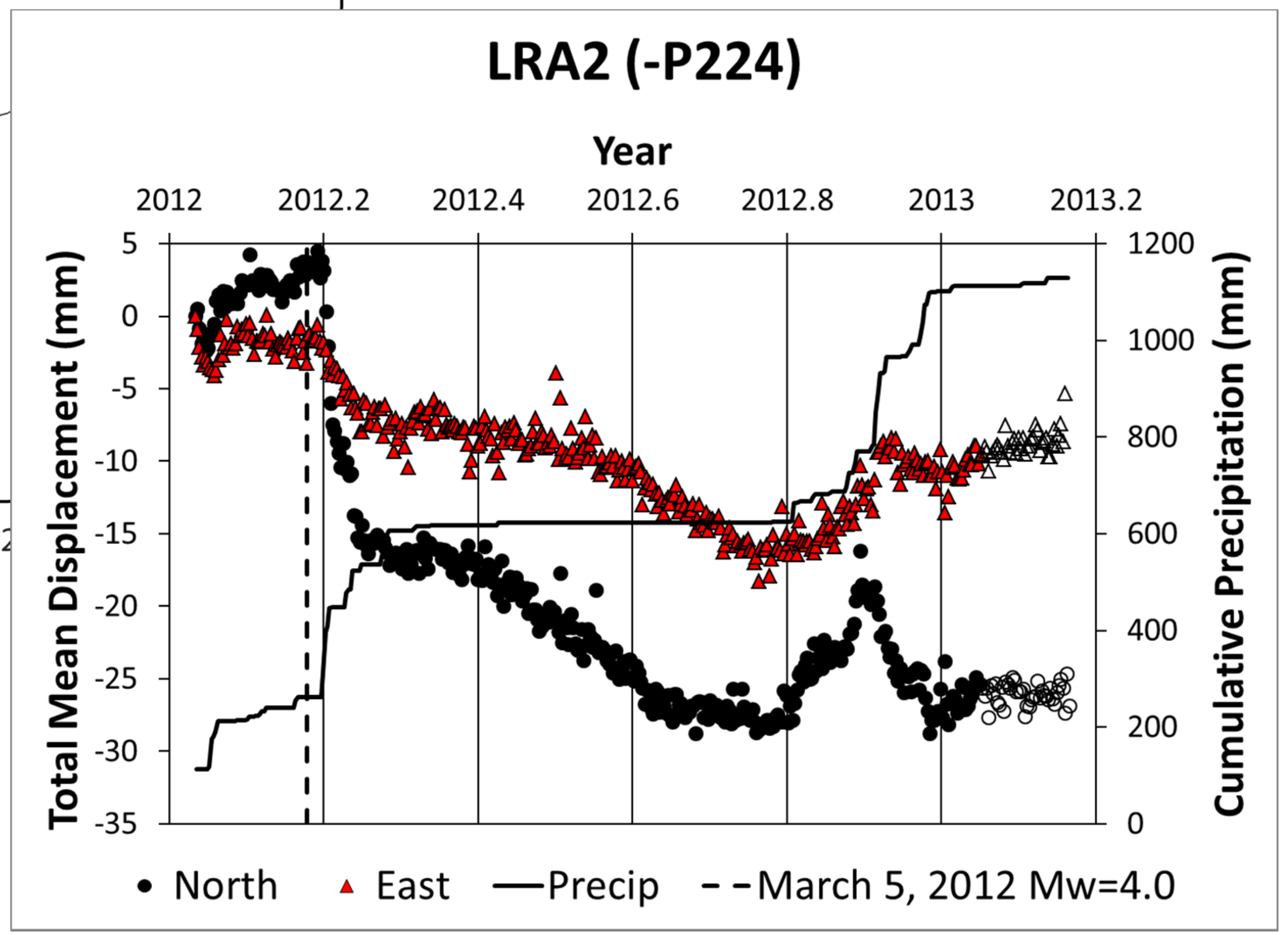


Station 2: Middle of Chicken Creek Landslide

Differential signal tracking with Station P224 at ~5km

Clear sensitivity to precipitation



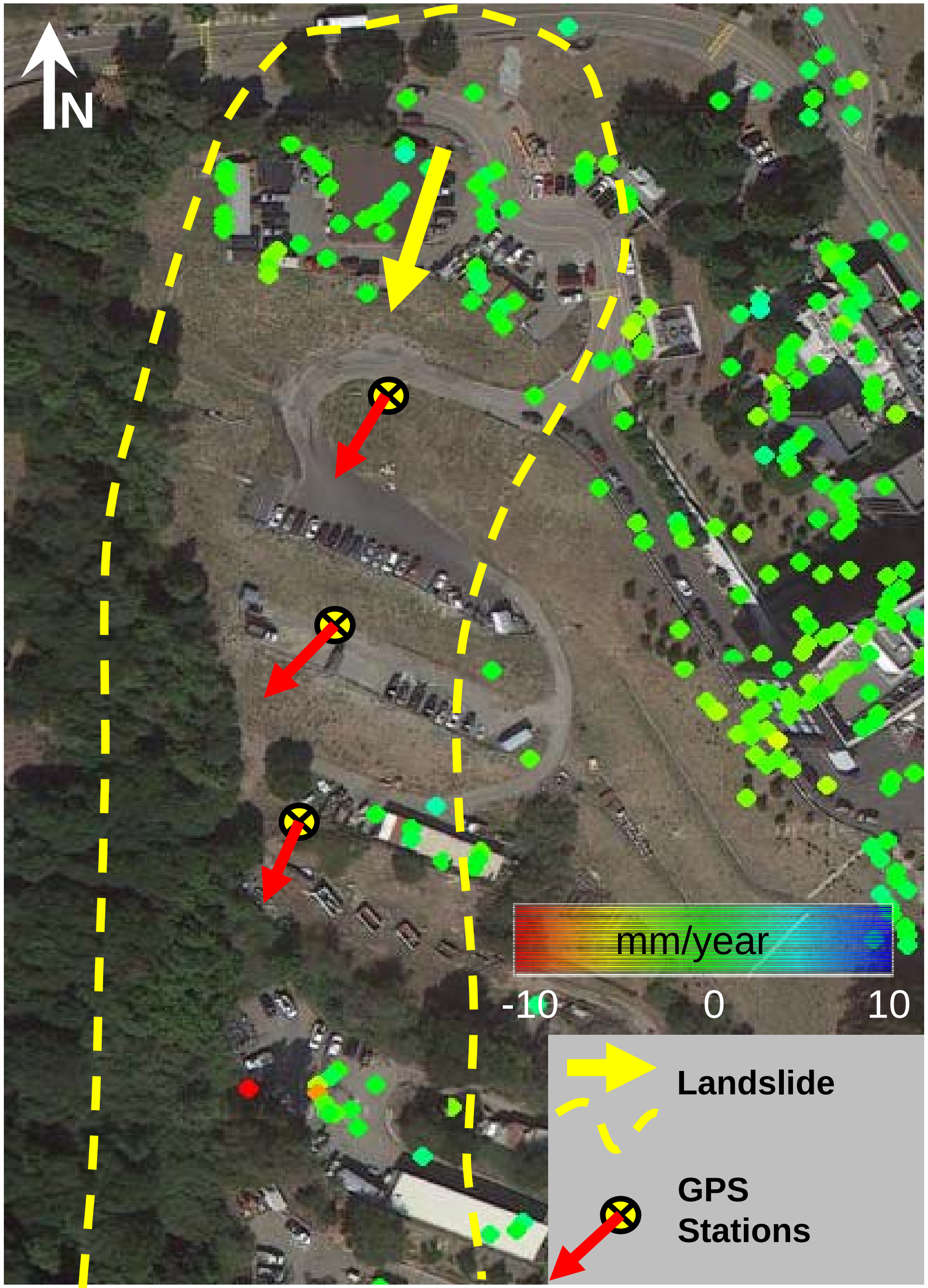


Unclear sensitivity to 03-05-12 M_w = 4 event @ <10km.

~3 cm down slope displacement.

Antenna Wobble?

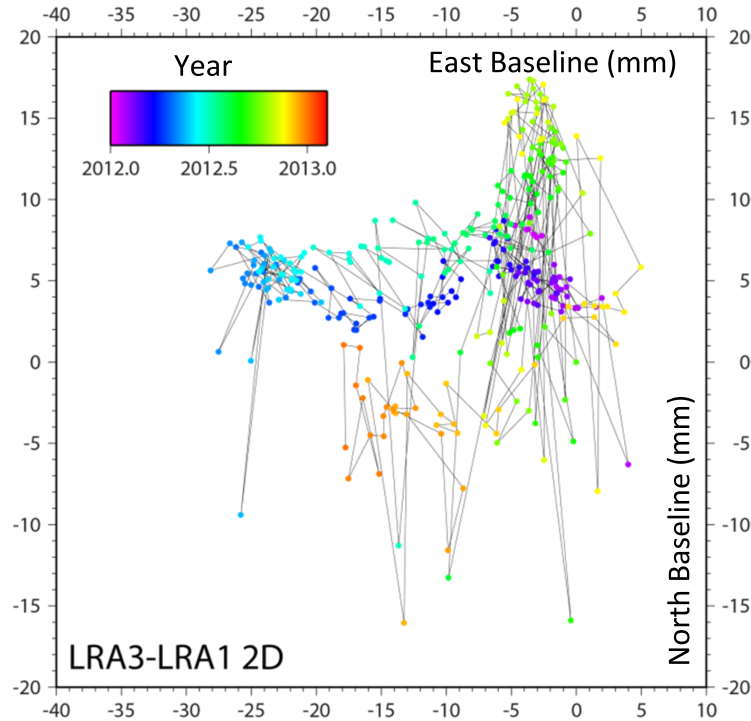
Differential Displacement at Chicken Creek Landslide

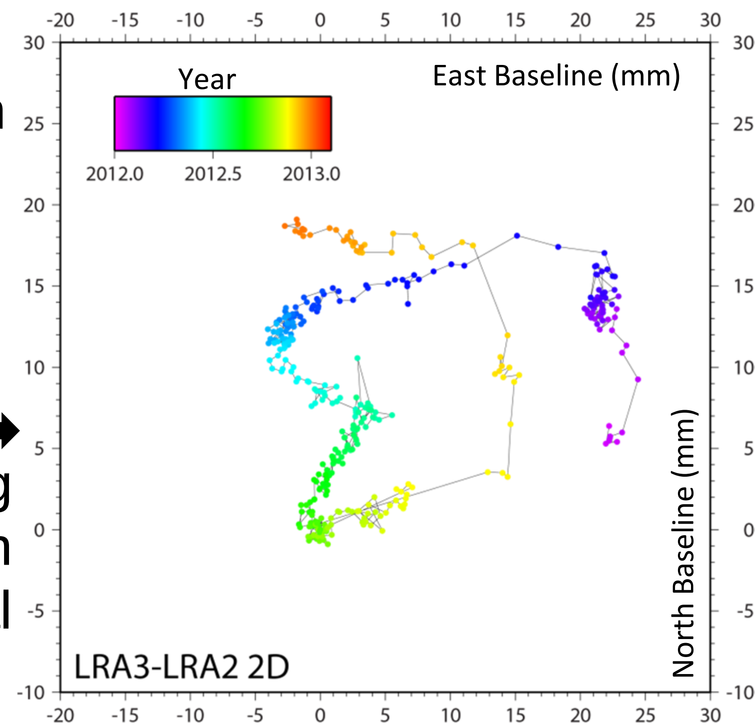


Generally uniform relative displacement of GPS stations

Poor InSAR coverage (TSX 2009-2011) but some suggestion of movement

Stations moving together with slight differential





Conclusions

- **InSAR**
  - X- and C- Bands give good coverage of Permanent Scatteres.
  - New algorithms for better ground coverage (SqueeSAR Version 2).
  - Expand TerraSAR-X series to overlap GPS study and focus on LBNL.

- **UAVSAR**
  - Offers flexibility in flight lines and scene takes.
  - Provides good 3D vector solutions of downslope movement.
  - L-band provides coherence over larger areas.
  - Does not require SqueeSAR type algorithms to extract motion.
  - Unwrapping may give low correlation in areas of high relief.

- **GPS**
  - Offers better time history of movement.
  - Useful tool to proof 3D displacements.


THANK YOU
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