Source models for the March 5-9, 2011 Kamoamoa fissure eruption, Kilauea Volcano, Hawaii, constrained by InSAR and in-situ observations

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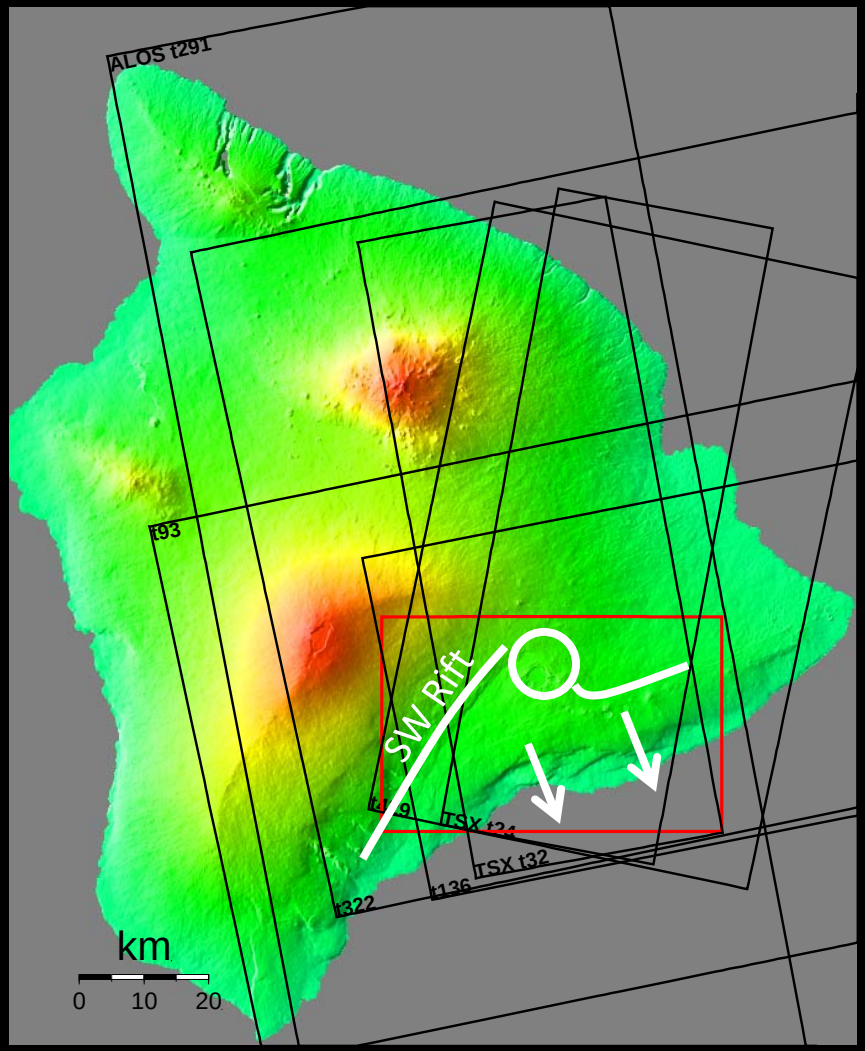
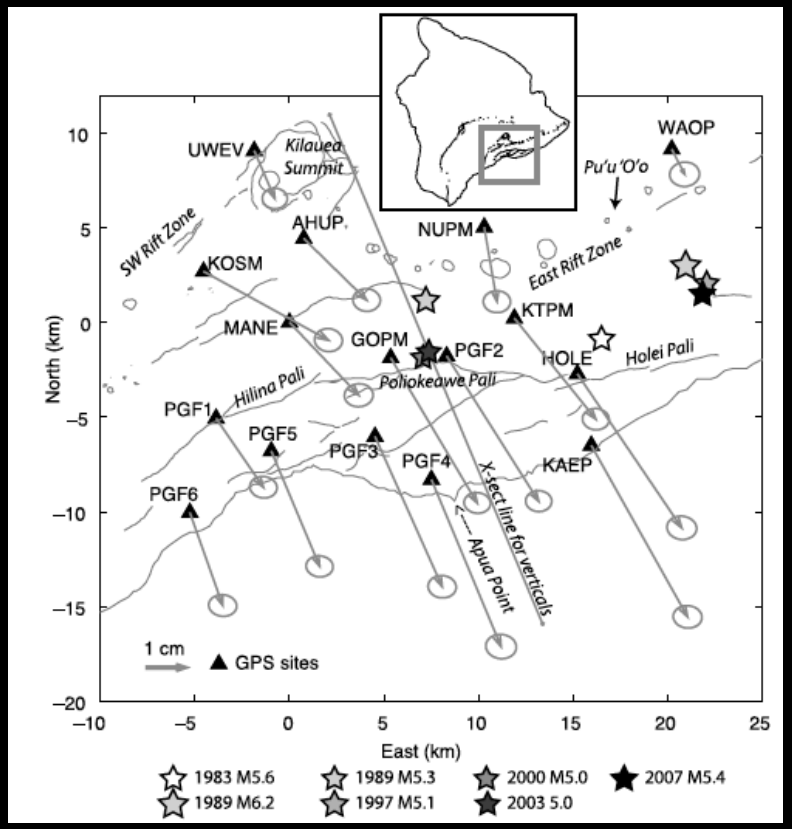
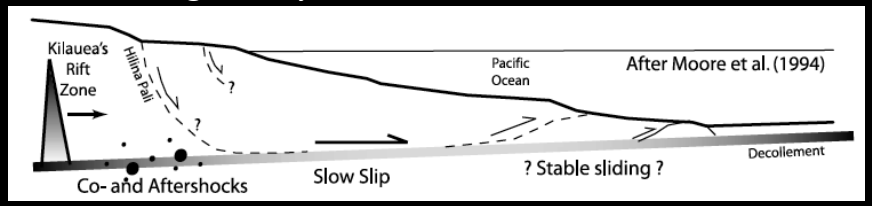
[3]Geological Survey of Japan, AIST, Tsukuba, Ibaraki, Japan

Kilauea, Hawaii



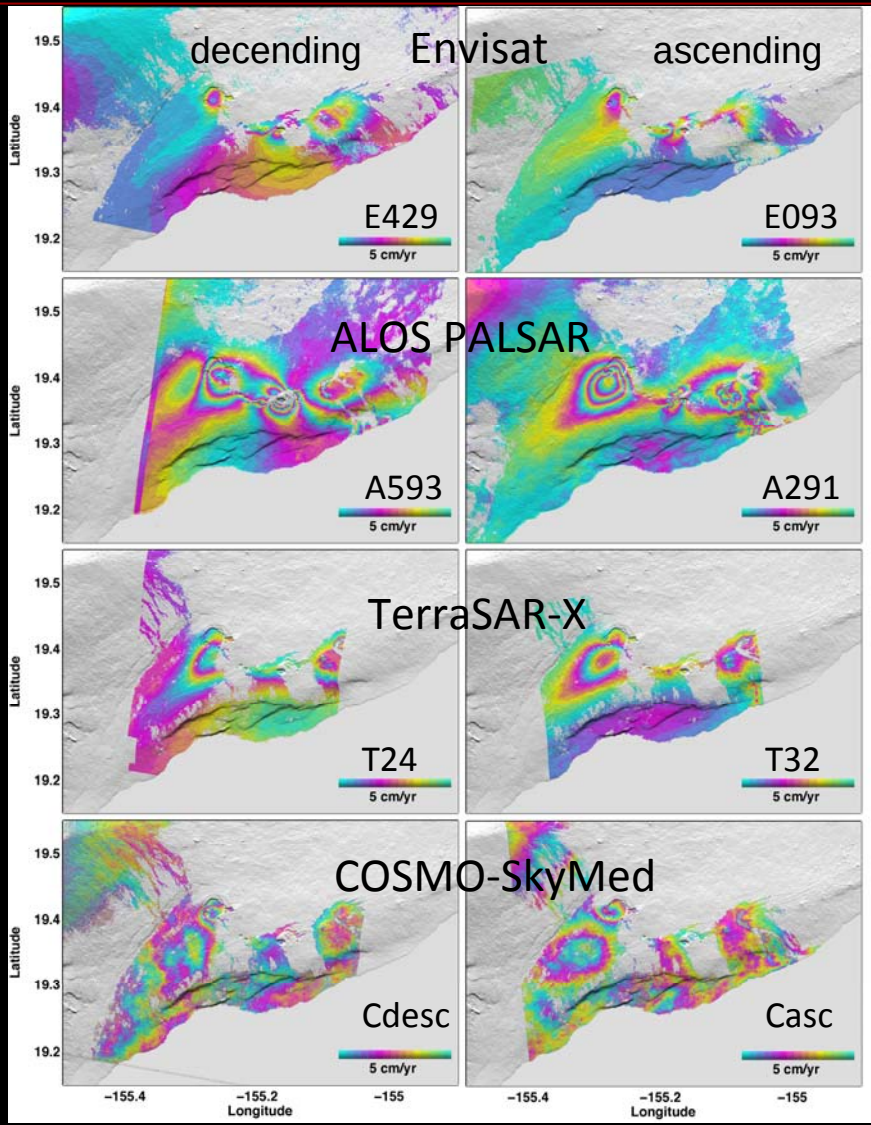


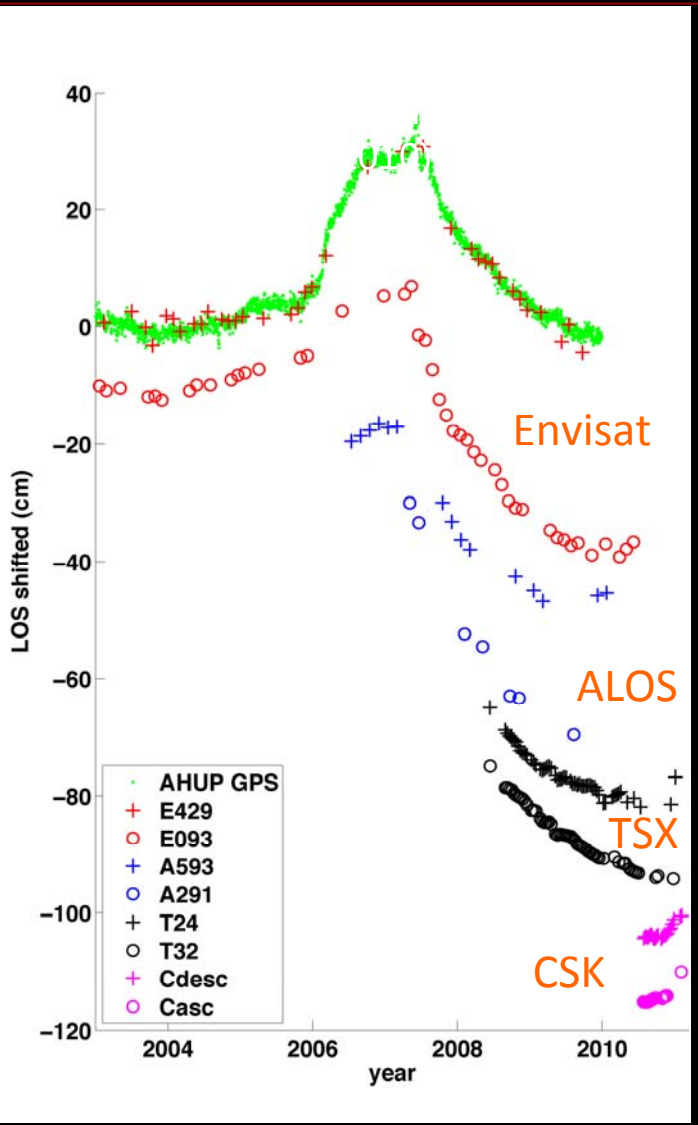
Montgomery-Brown et al., JGR, 2008



Hawaii InSAR tracks and Kilauea/E Rift context

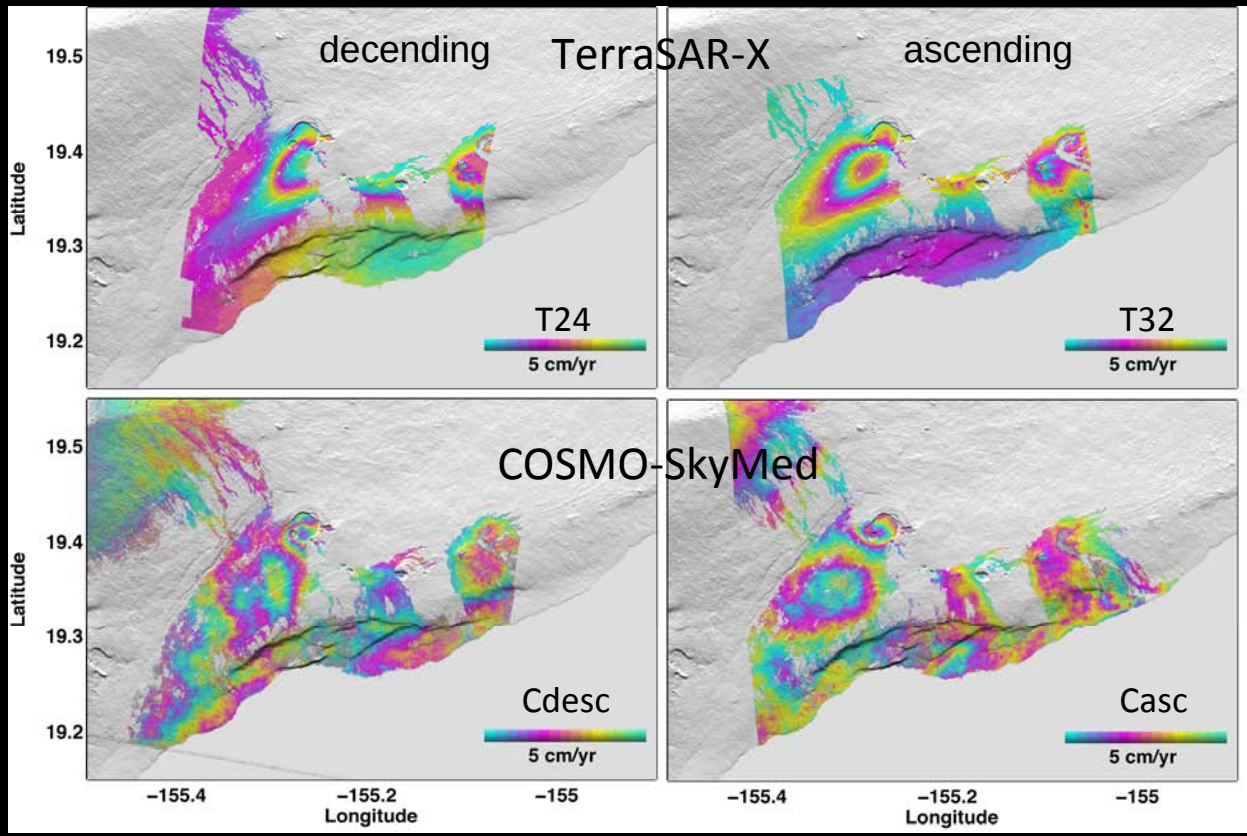
Kilauea InSAR time series



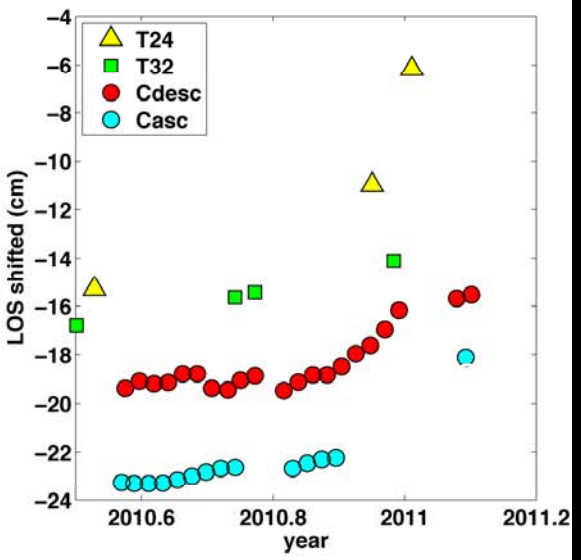


Future Activity (from Feb 2011 talk)

Late 2010-2011 Kilauea Caldera: accelerated uplift and increased seismicity suggest new eruption in near future



Kilauea caldera time series

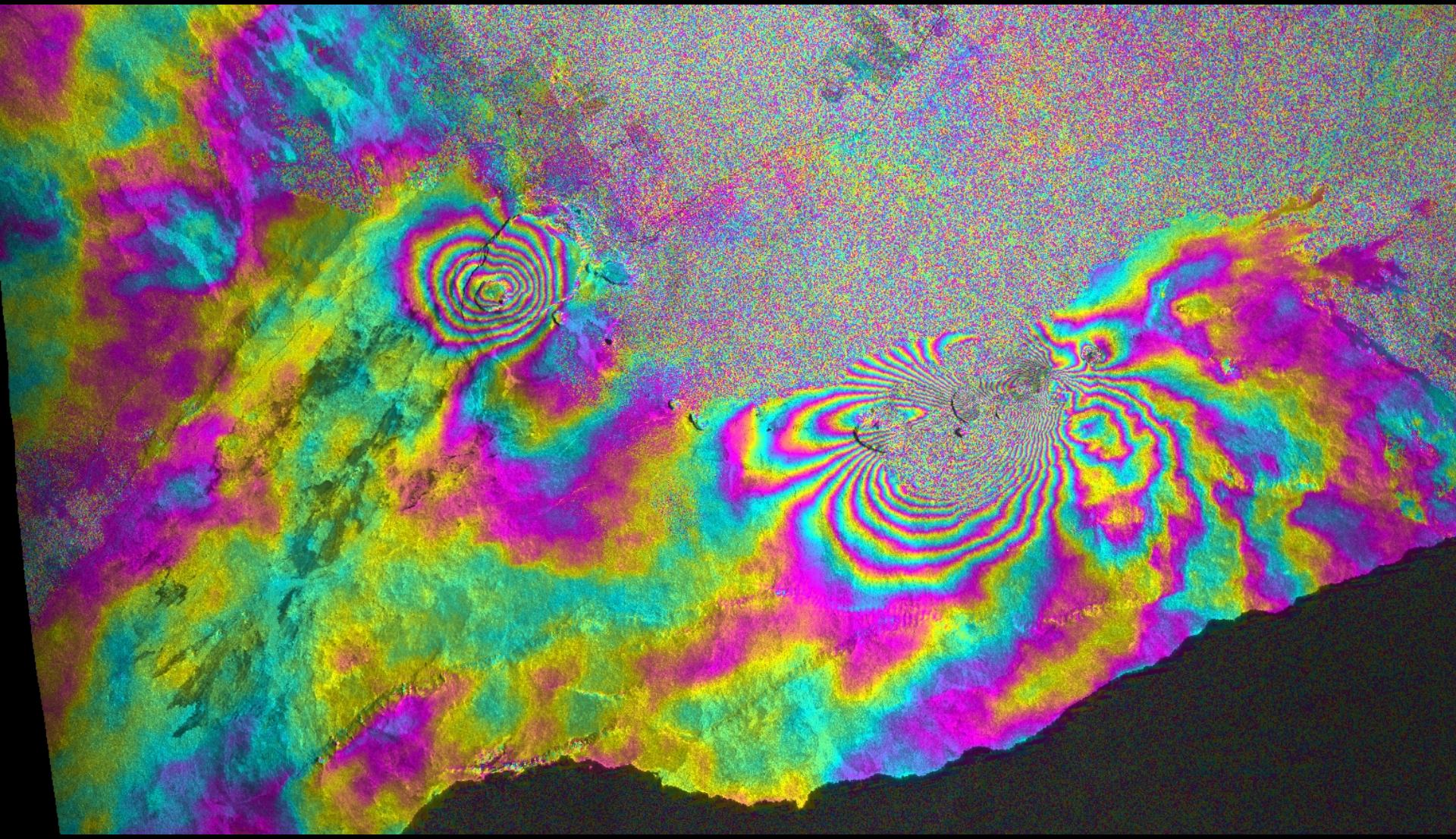


Continued TerraSAR-X and COSMO-SkyMed data should lead to unprecedented temporal resolution of future eruption

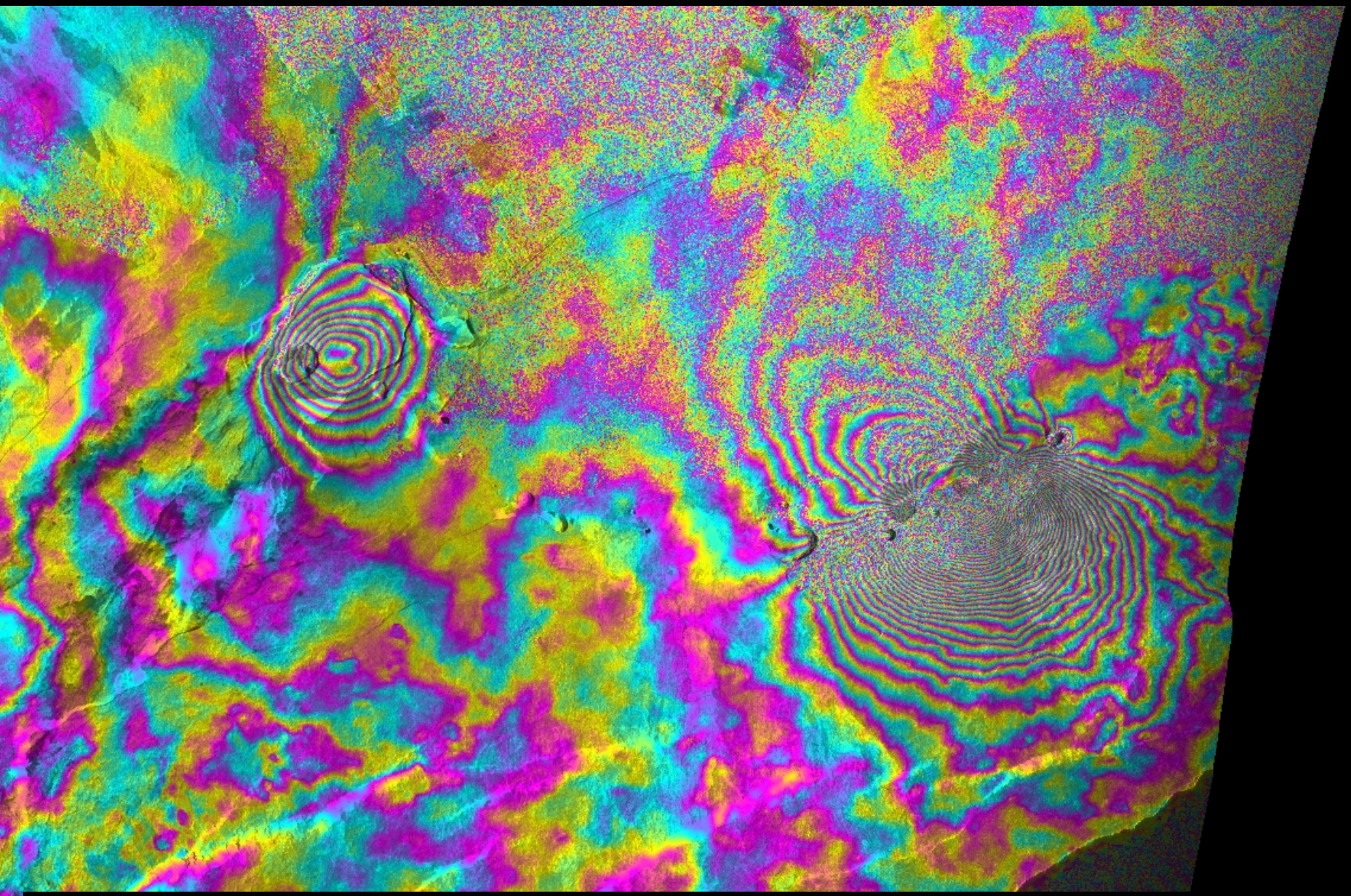
March 5-9, 2011 Kamoamoa eruption

Courtesy Tim Orr, HVO

Near-real time COSMO-SkyMed data



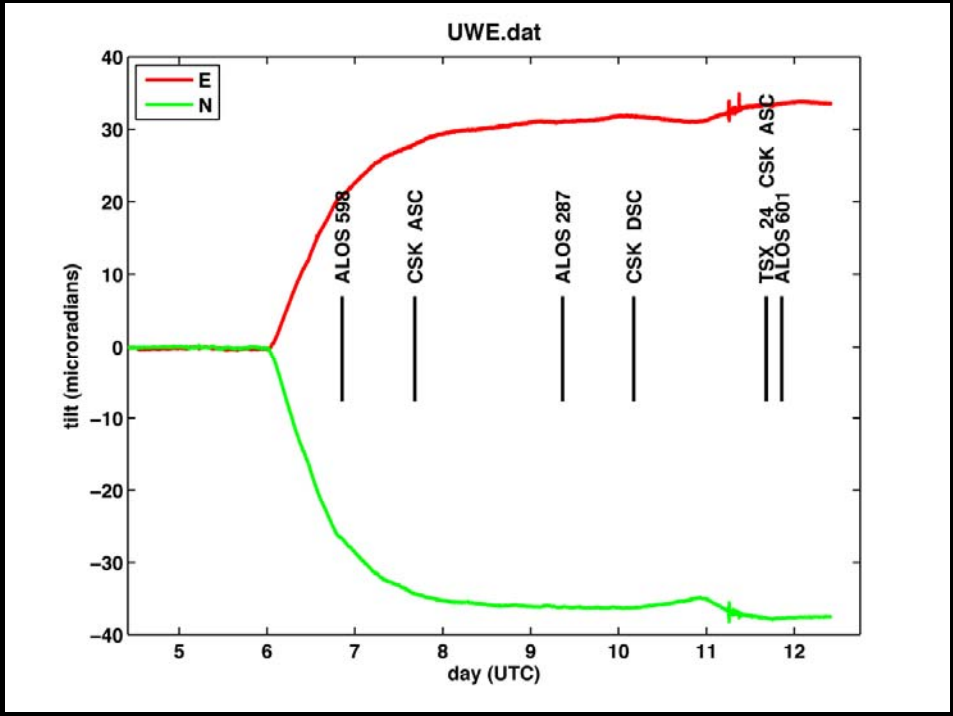
1st interferogram on March 7, ~12 hrs after acquisition



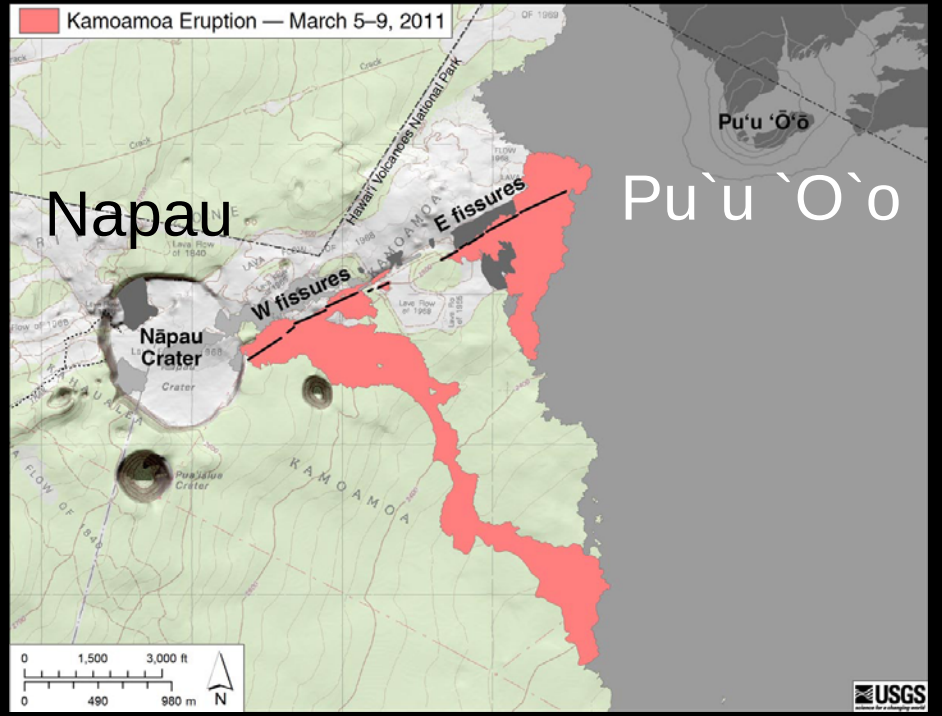
2nd CSK interferogram (DESC) on March 10, w/ repeat ASC on 11th, all with rapid delivery from ASI (Luigi Dini) and eGEOS

Eruption

Kilauea summit tilt

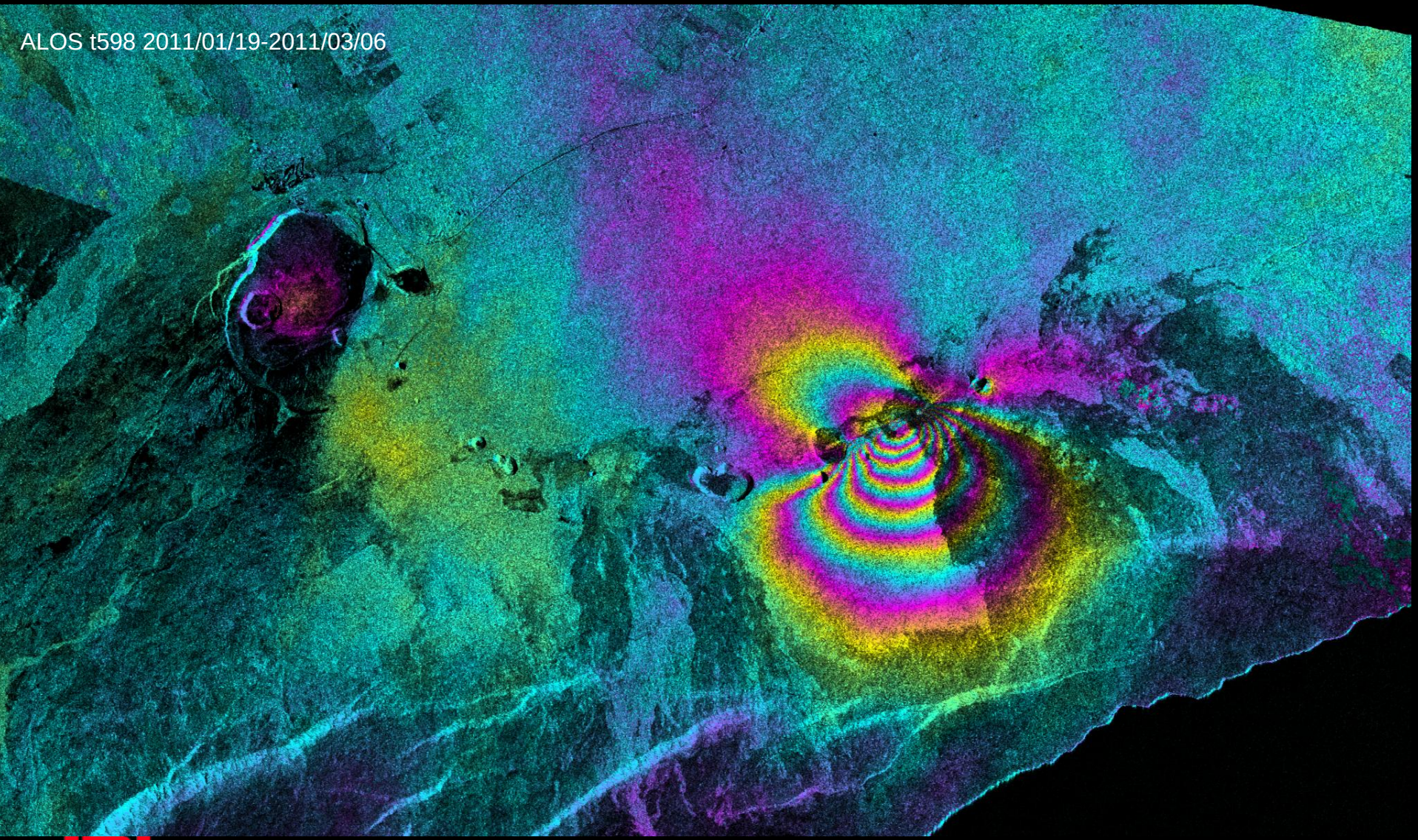


ERZ Fissure eruption



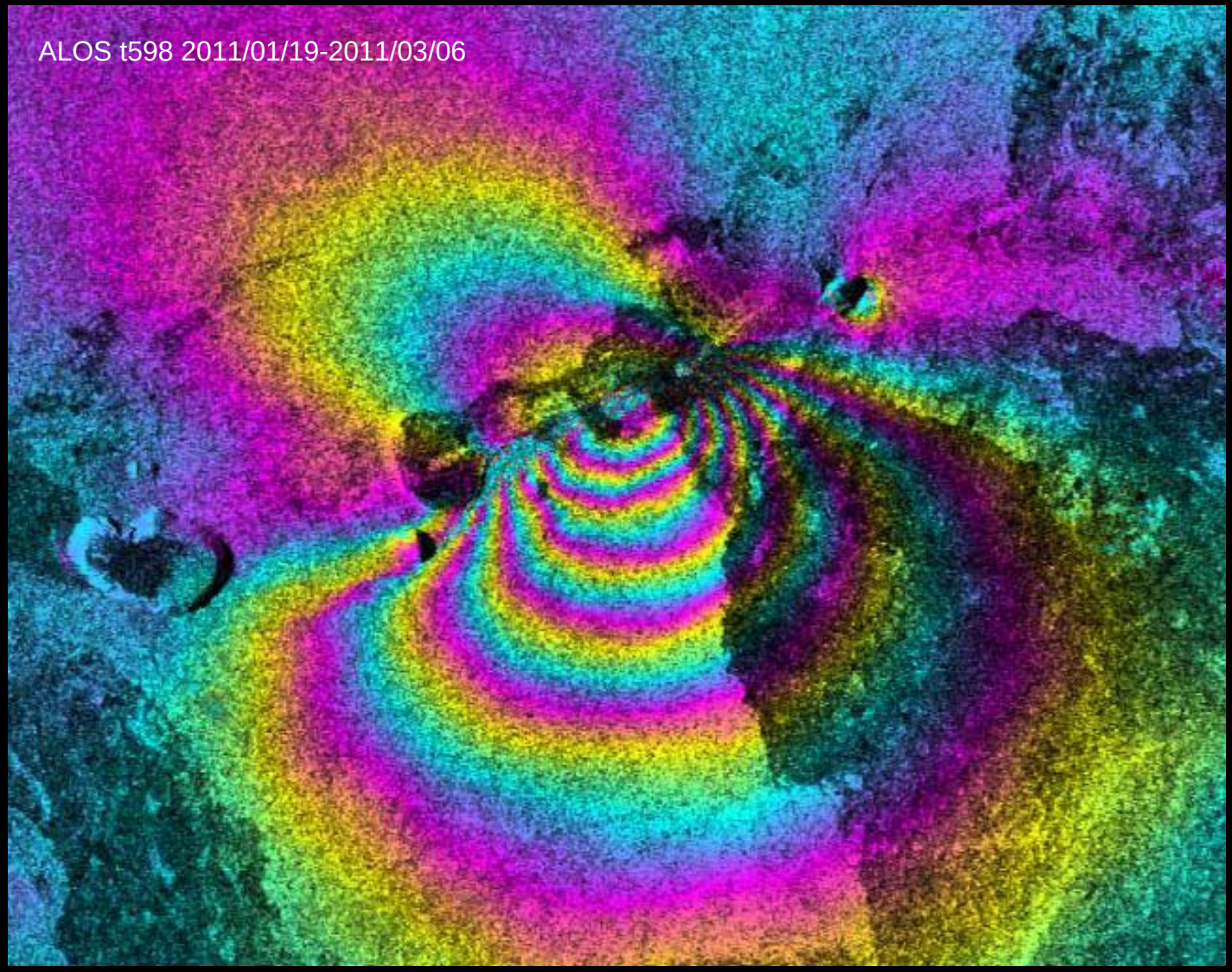
Eruption started late afternoon March 5 (HST) with Pu`u `O`o tilt (deflation) starting 30 min prior to Kilauea tilt (deflation)

ALOS Interferogram ending March 6



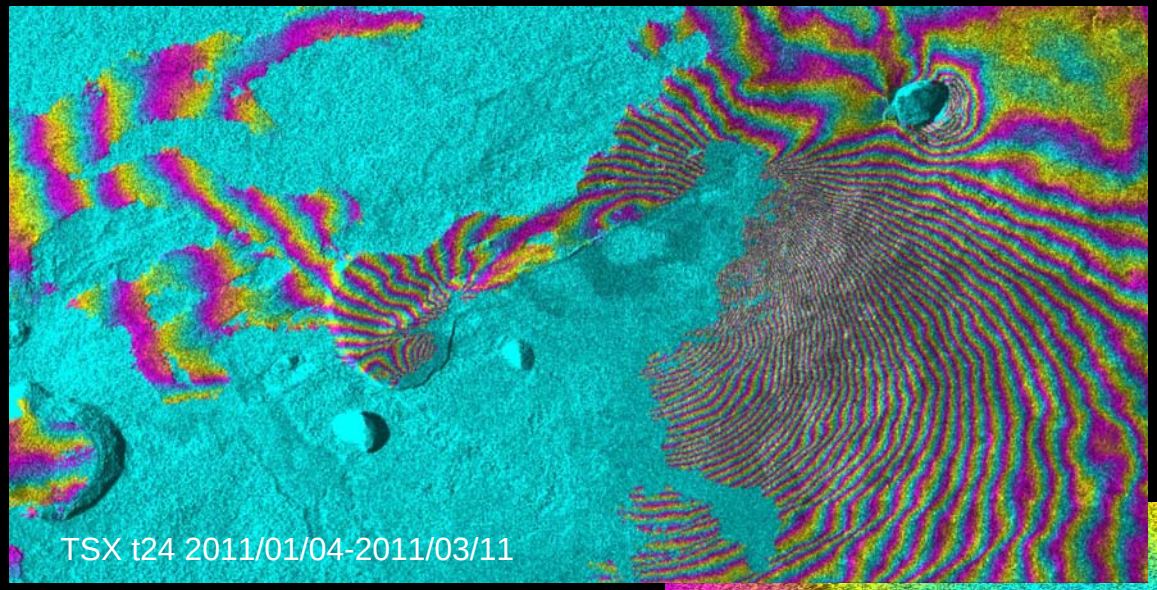
12 cm/cycle ALOS

ALOS Interferogram ending March 6

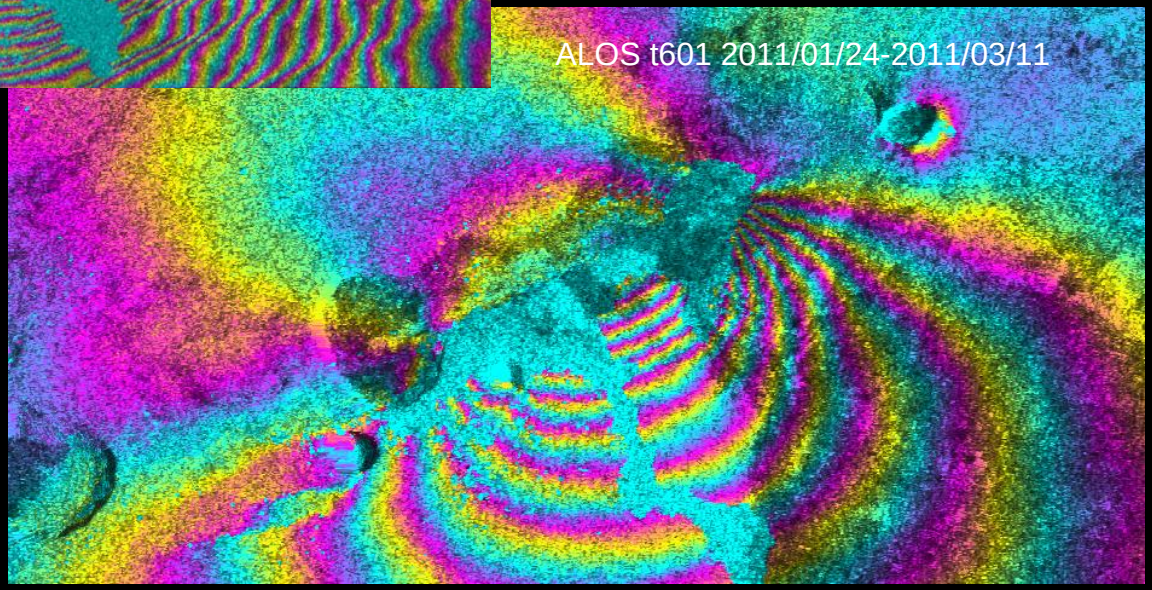


12 cm/cycle ALOS

Comparison X- vs L-band

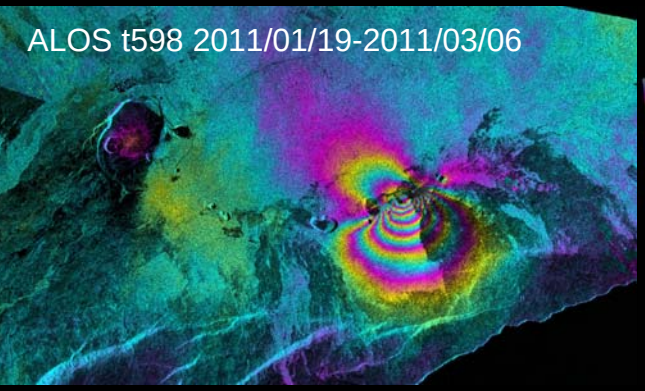


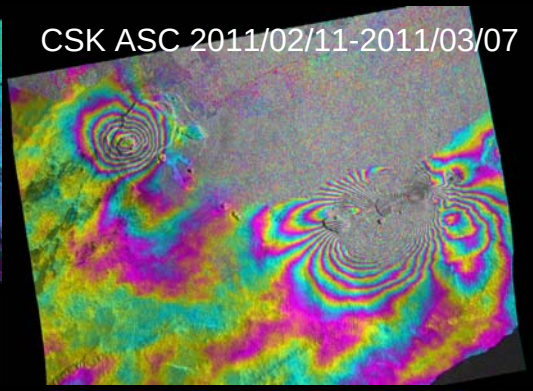
1.5 cm/cycle TSX

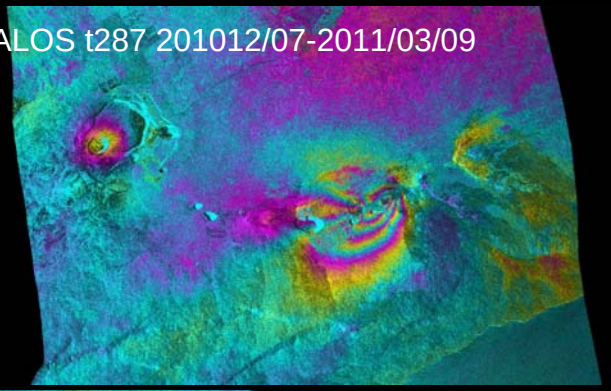


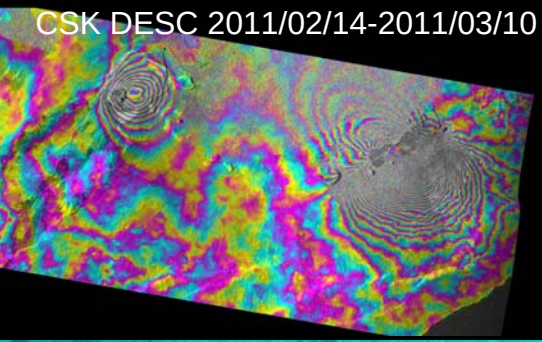
12 cm/cycle ALOS

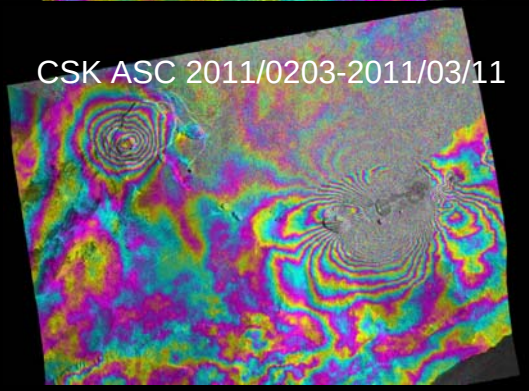
Interferograms ending March 6-11

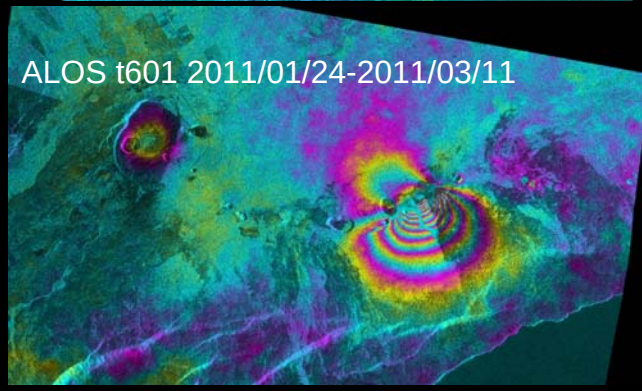


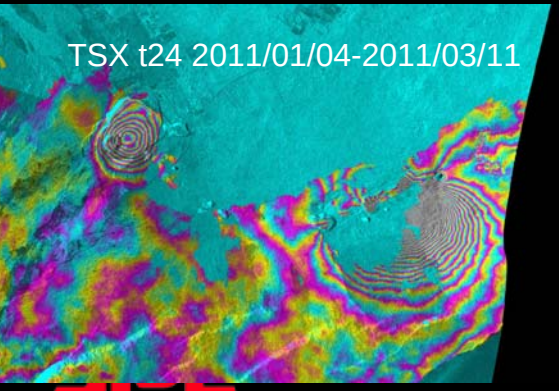




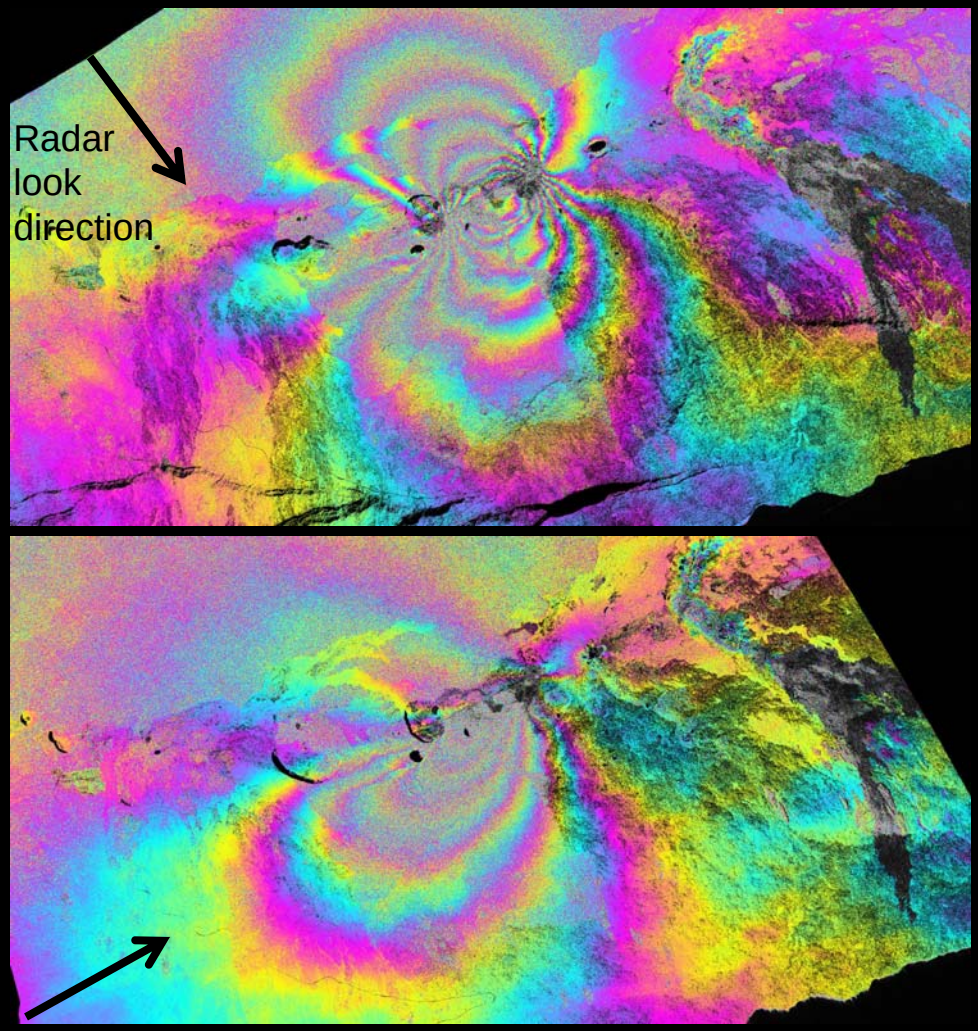






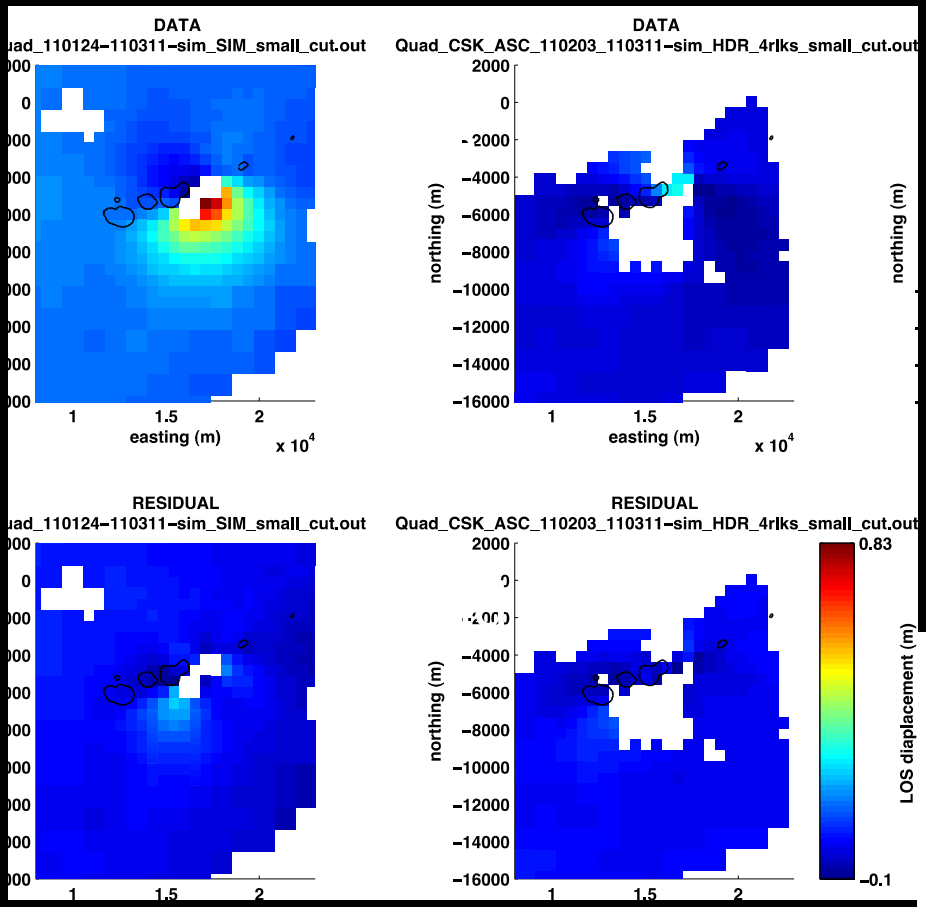


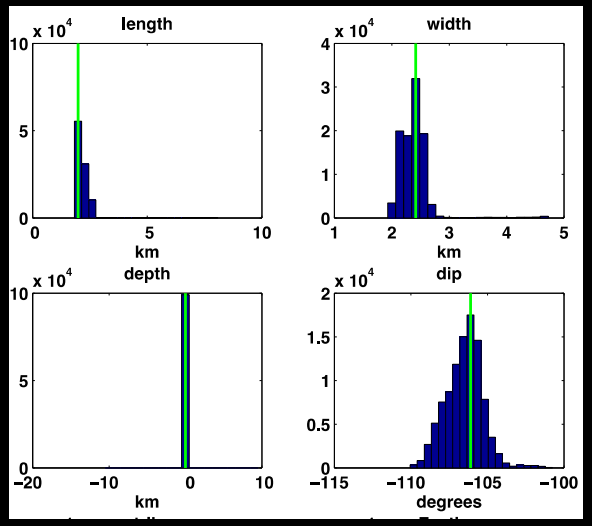
Unwrapped interferograms displayed at their natural wrap rates:
12 cm/cycle ALOS
1.5 cm/cycle TSX and CSK

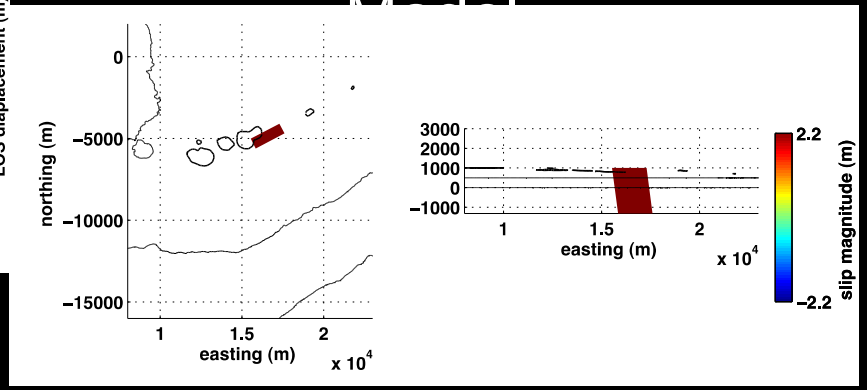


UAVSAR interferograms,1.4 years spanning the March 5-9, 2011 Kamoamoa eruption

MCMC solution for dike dip angle (74° to SE)

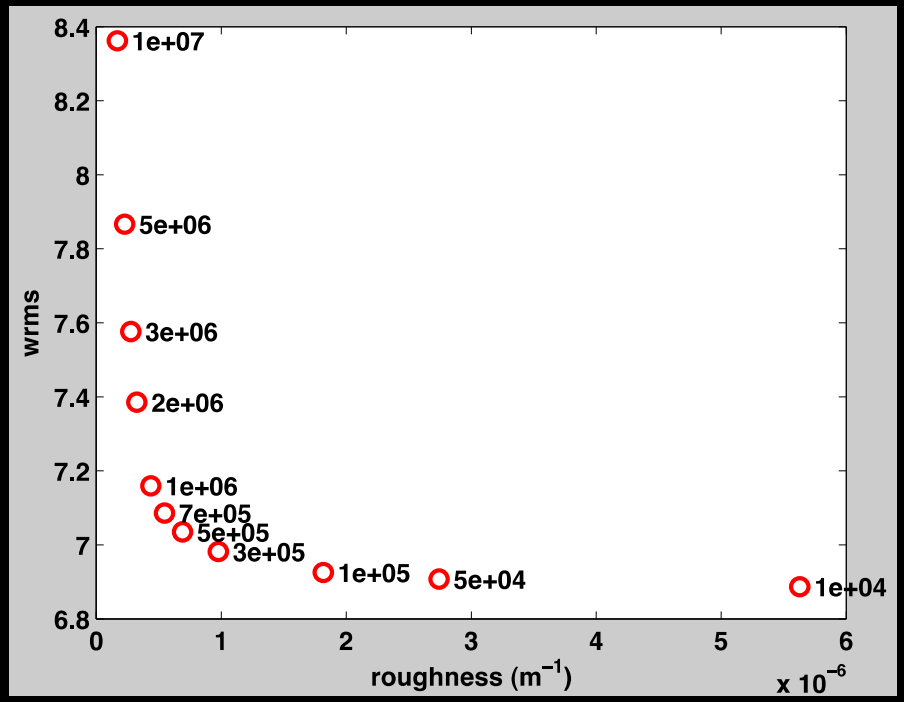




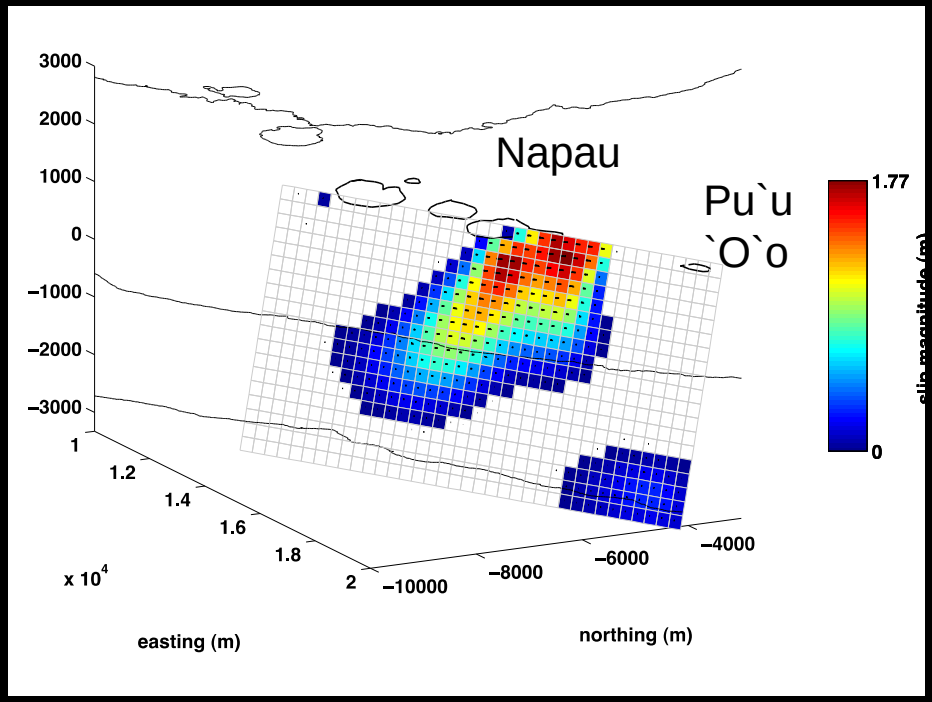


Distributed slip dike modeling after MCMC

Laplacian smooting vs wrms and roughness

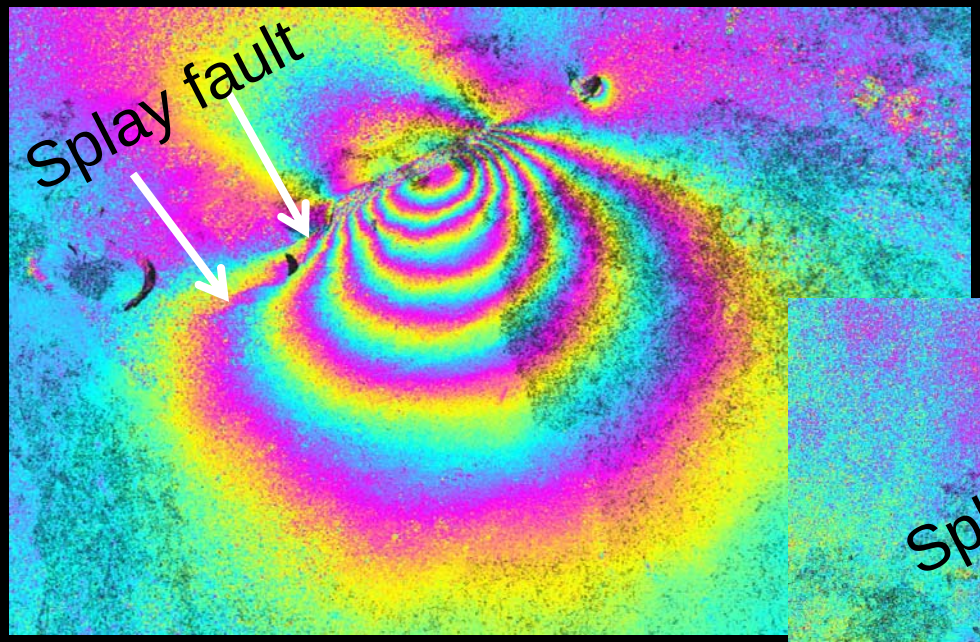


Dike plane geometry from MCMC solution



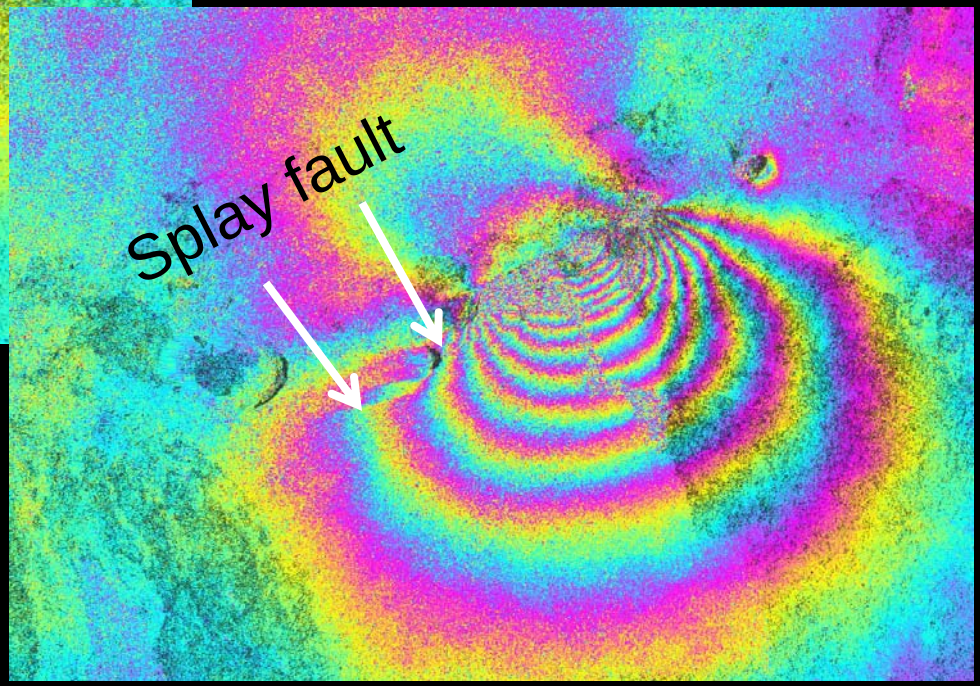
Dike tensile opening for ALOS t297 March 9 data

Dike is not enough when fitting GPS

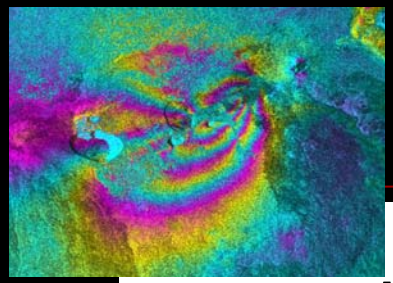


March 6 ALOS t598

ALOS descending track data show a splay fault that increases in displacement



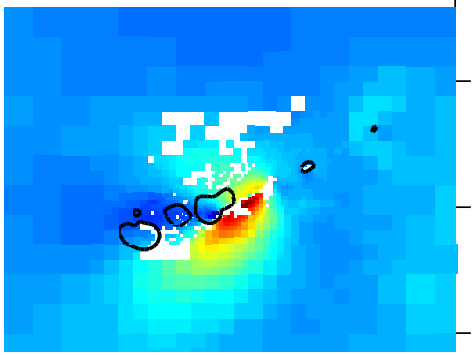
March 11 ALOS 601



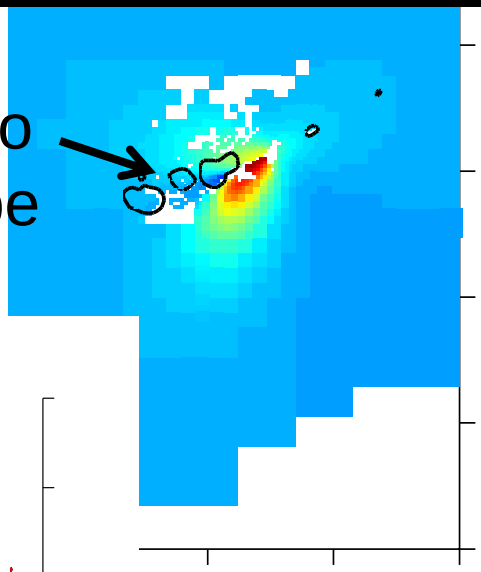
InSAR sensitivity: dike only

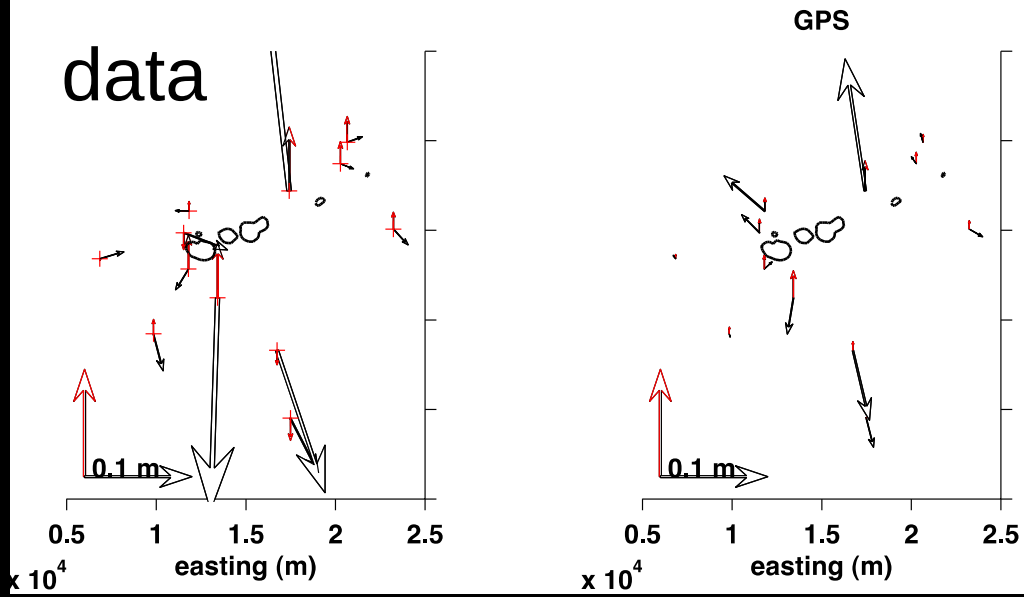
Poor fit to both InSAR and GPS

ALOS t287 asc.



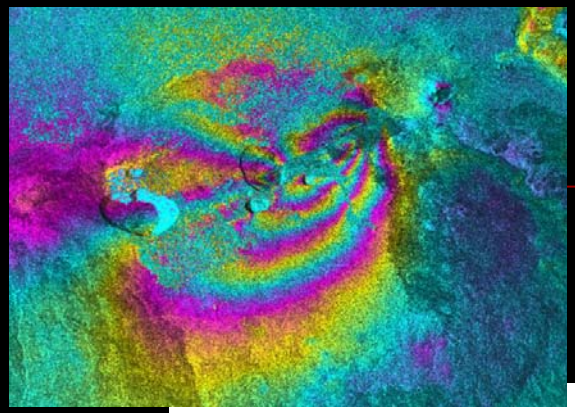
Poor fit to shape





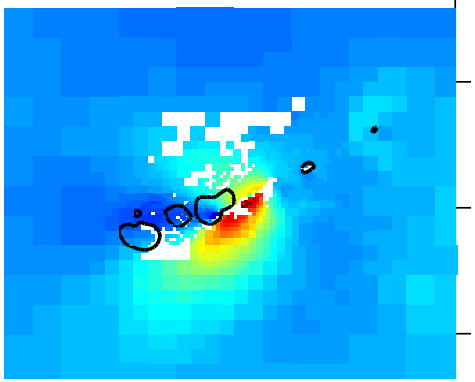
synthetic

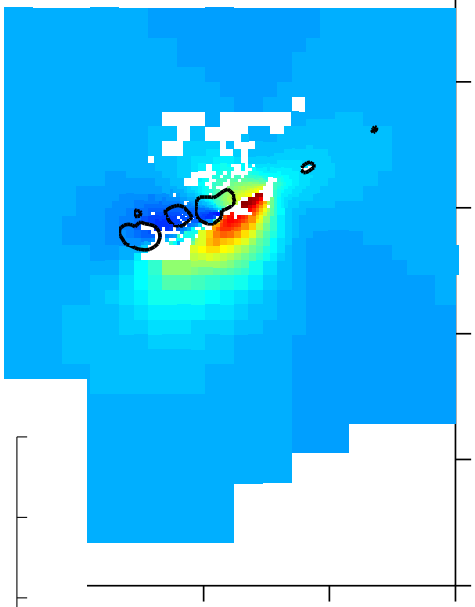
GPS weighting: 1



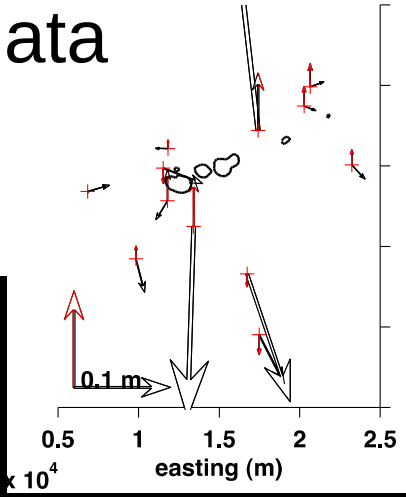
dike + splay fault

Improved fit to both InSAR and some GPS

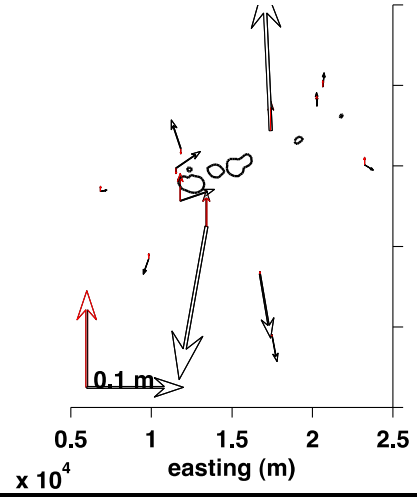




data



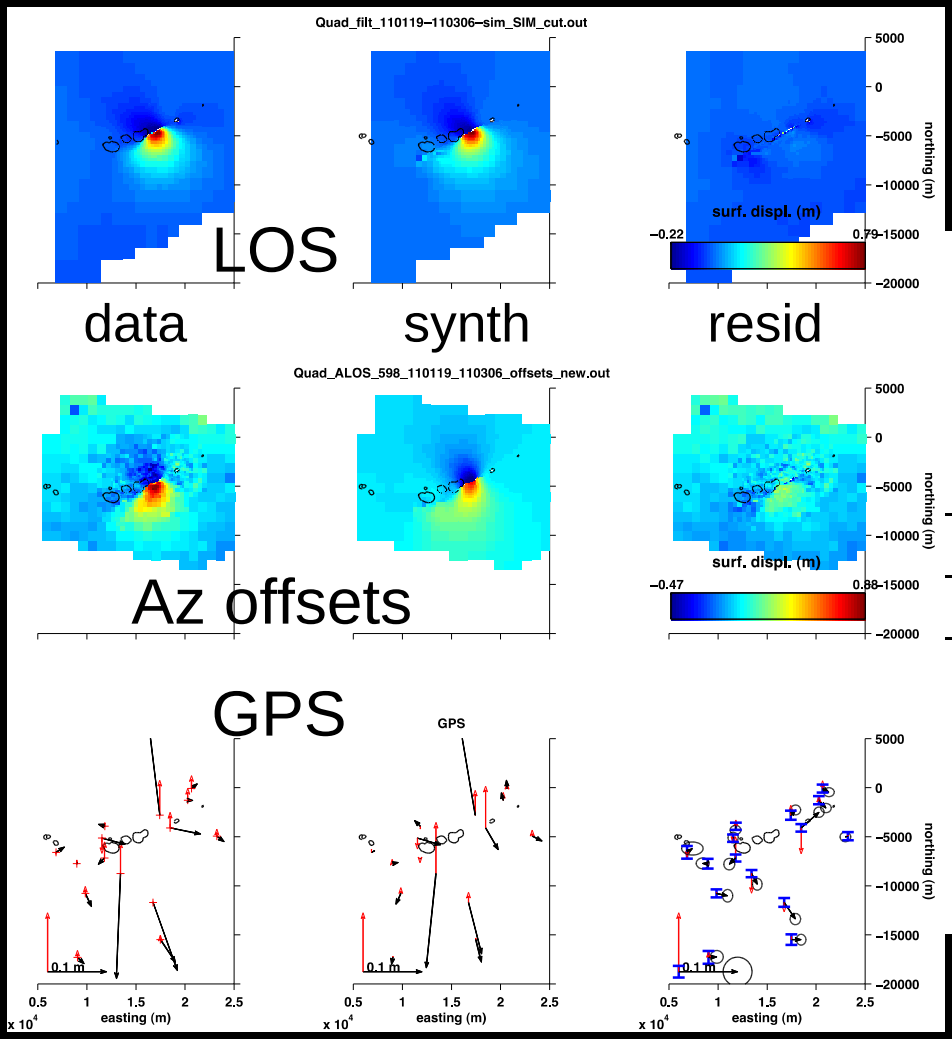
GPS



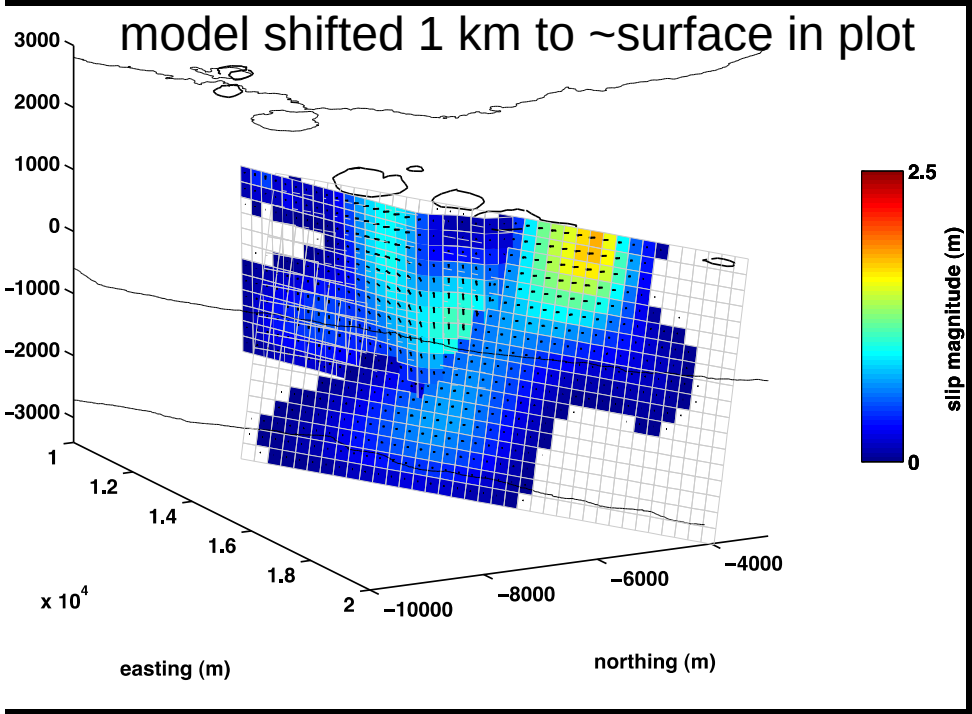
synthetic

GPS weighting: 1

Dike model: March 6

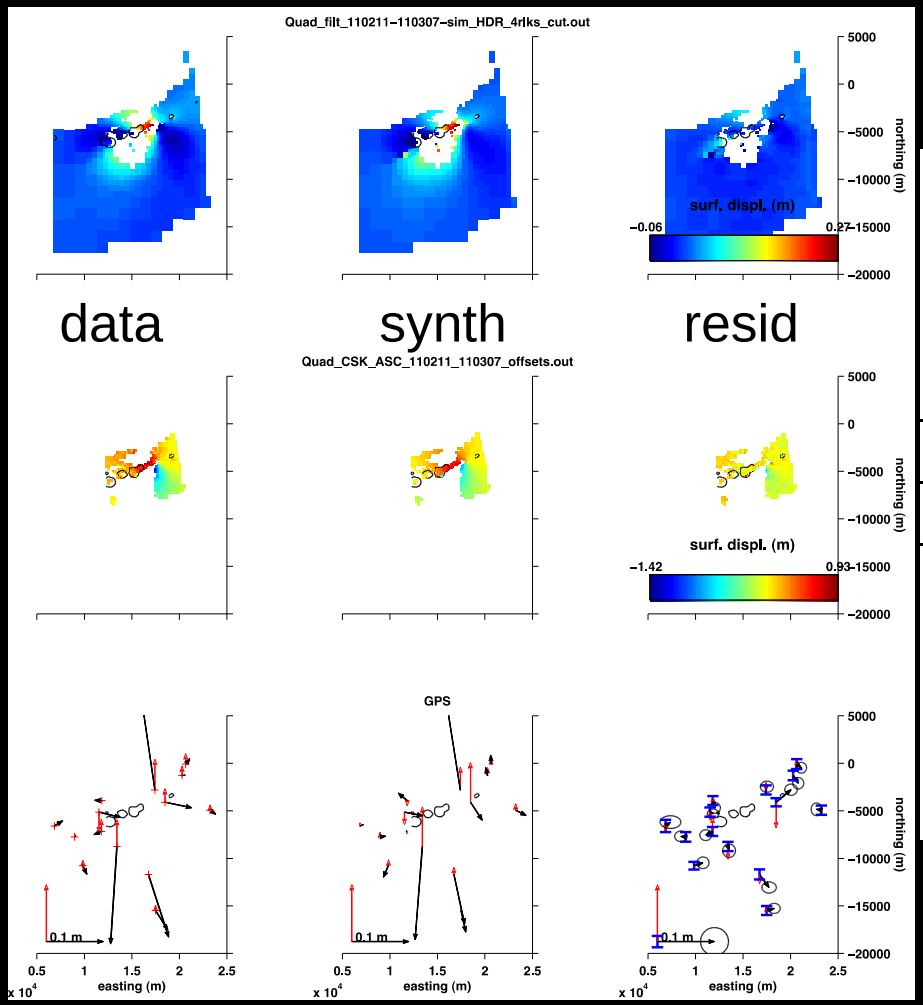


ALOS LOS + azimuth offsets
GPS 3 components

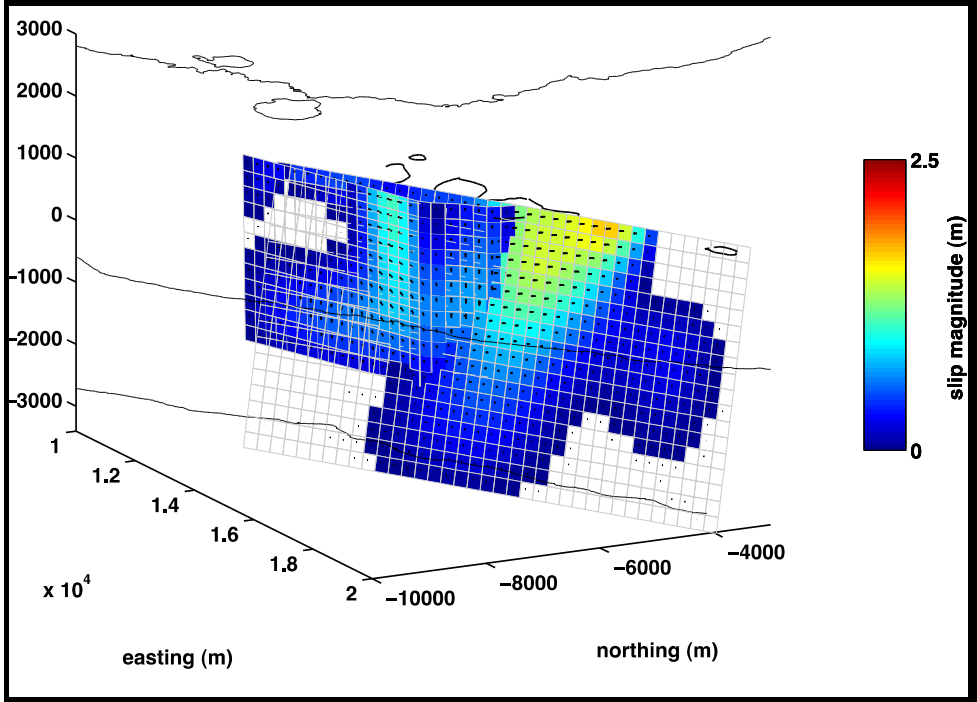


Dike volume = 9.5 x 10^6 m^3

Dike model: March 7

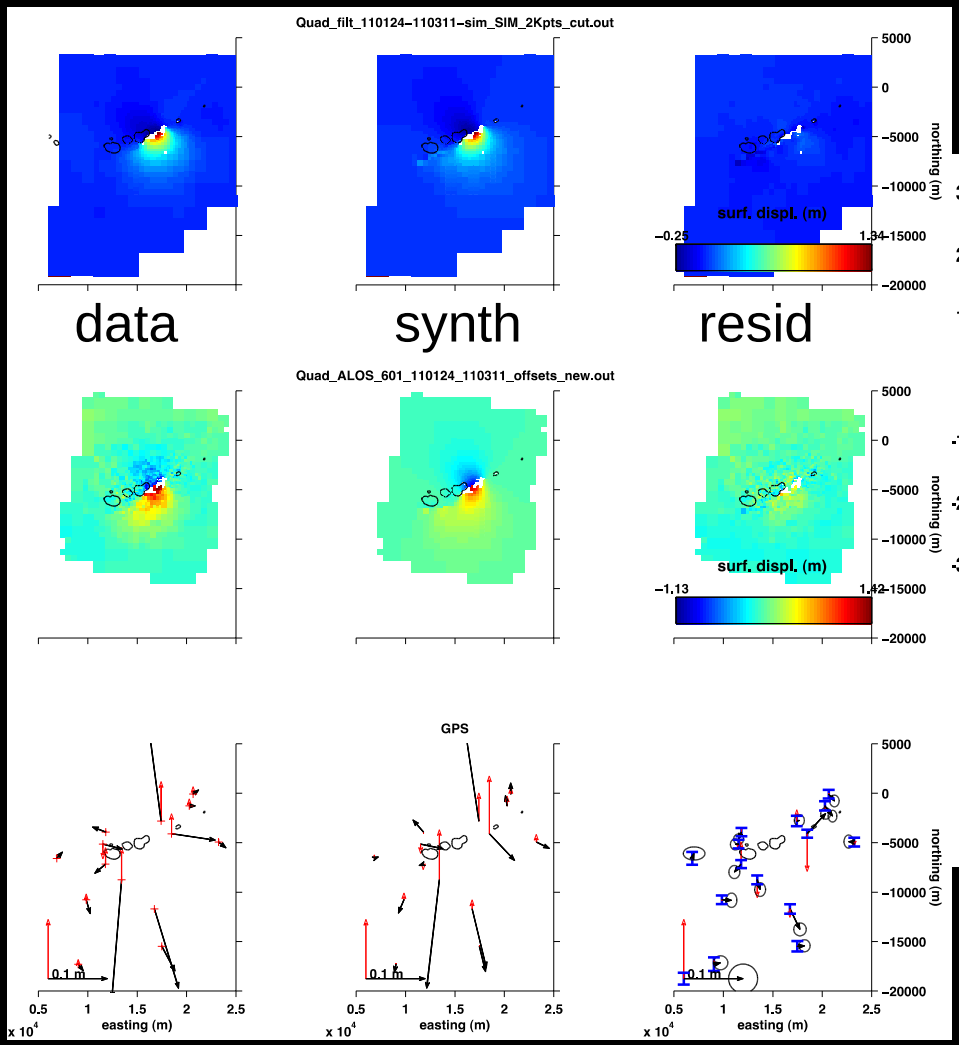


CSK ASC ascending

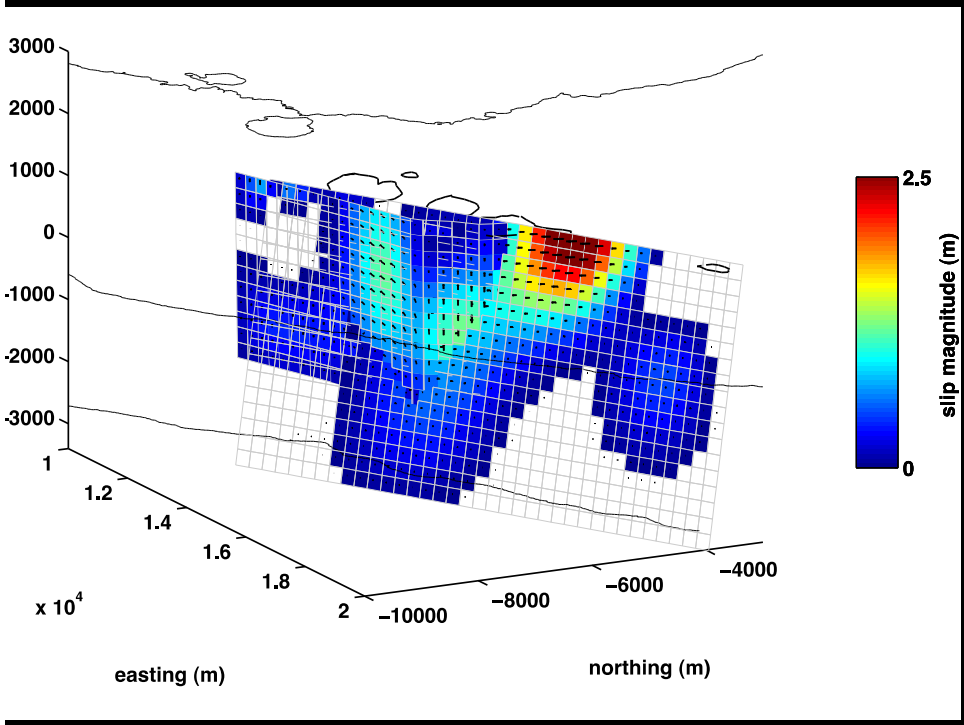


Differences in asc. vs desc. InSAR models

Dike model: March 11



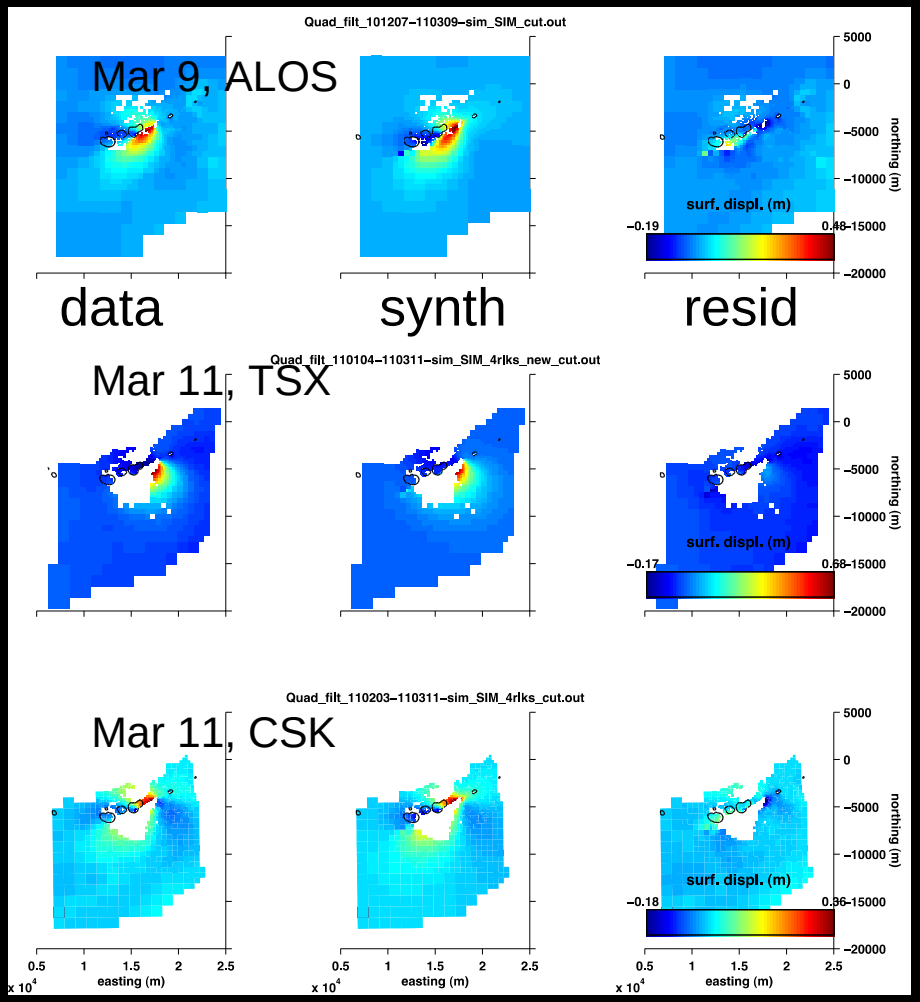
ALOS t601 descending

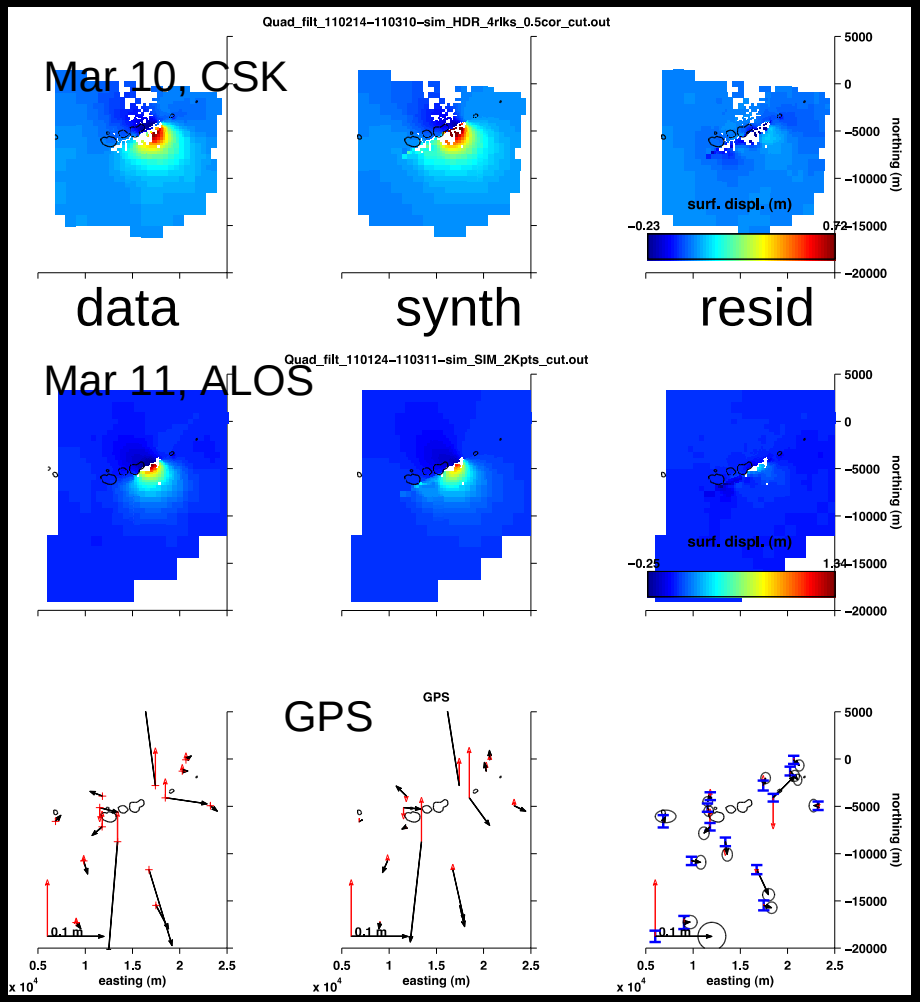


Dike volume = 11 x 10^6 m^3

Dike shows ~ 1 m additional opening+ lesser splay increase

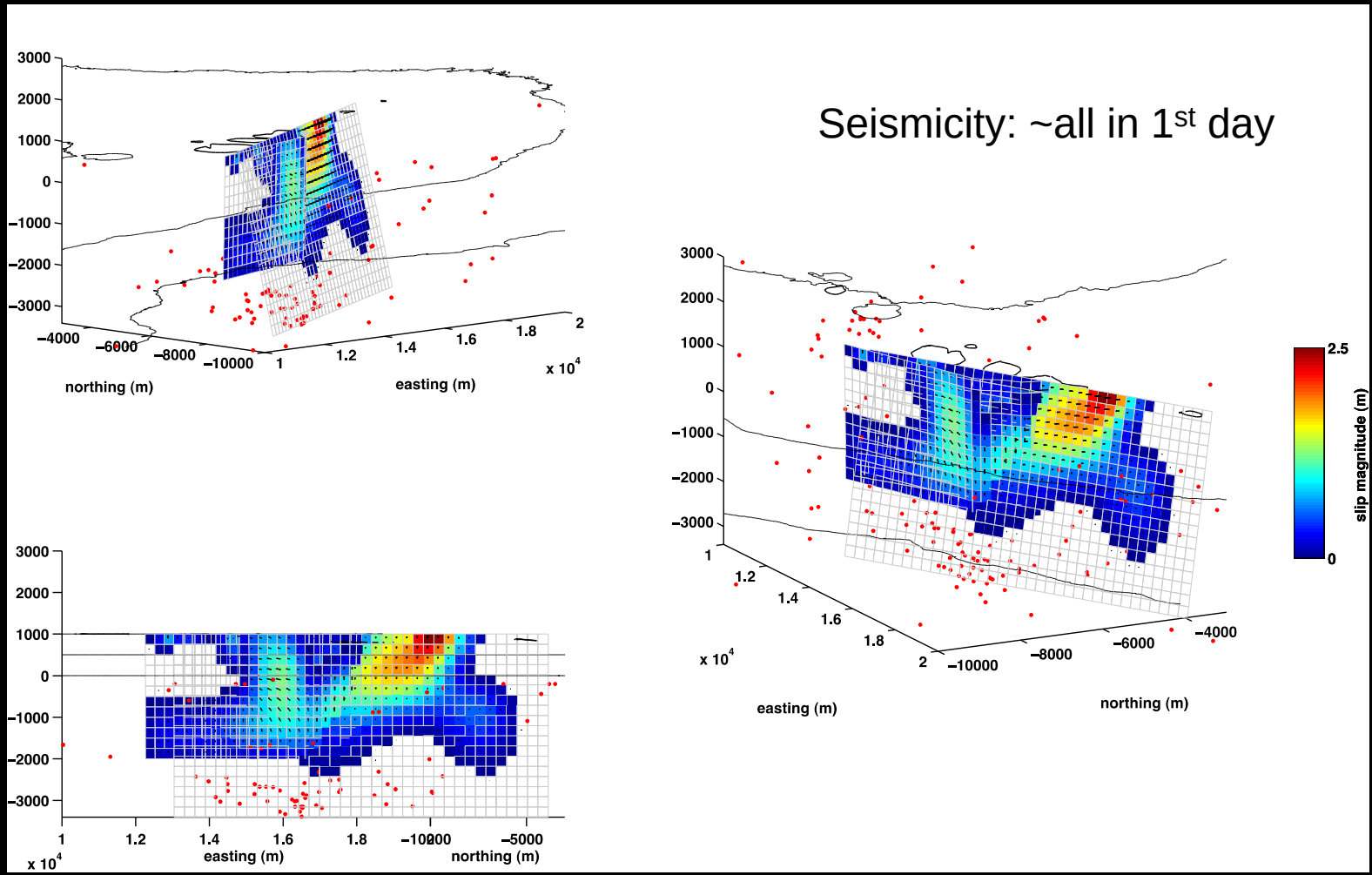
Dike model: March 9-11 all InSAR +GPS





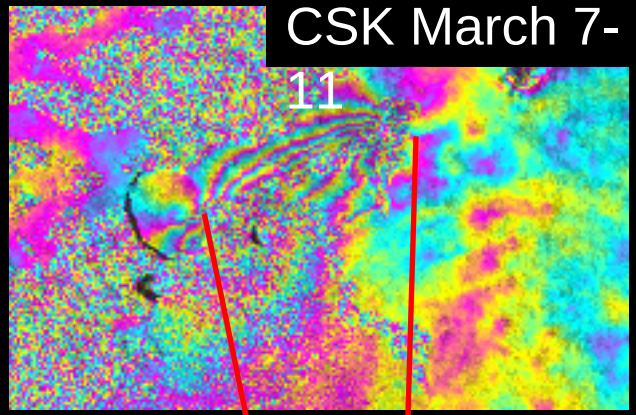
Five InSAR LOS data (TSX, CSK, ALOS) + GPS

Dike model: March 9-11 all InSAR LOS+GPS

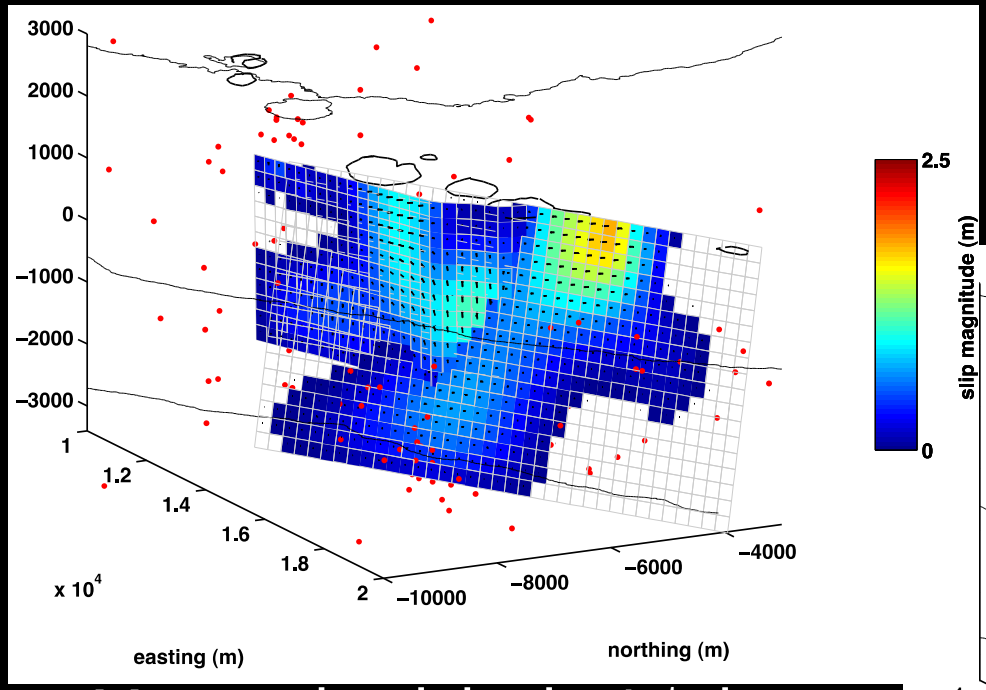


Dike model reflects a compromise between ASC and DESC models;
Model shifted up by 1 km in plot (seismicity not shifted!)

Dike model: March 6 vs March 11

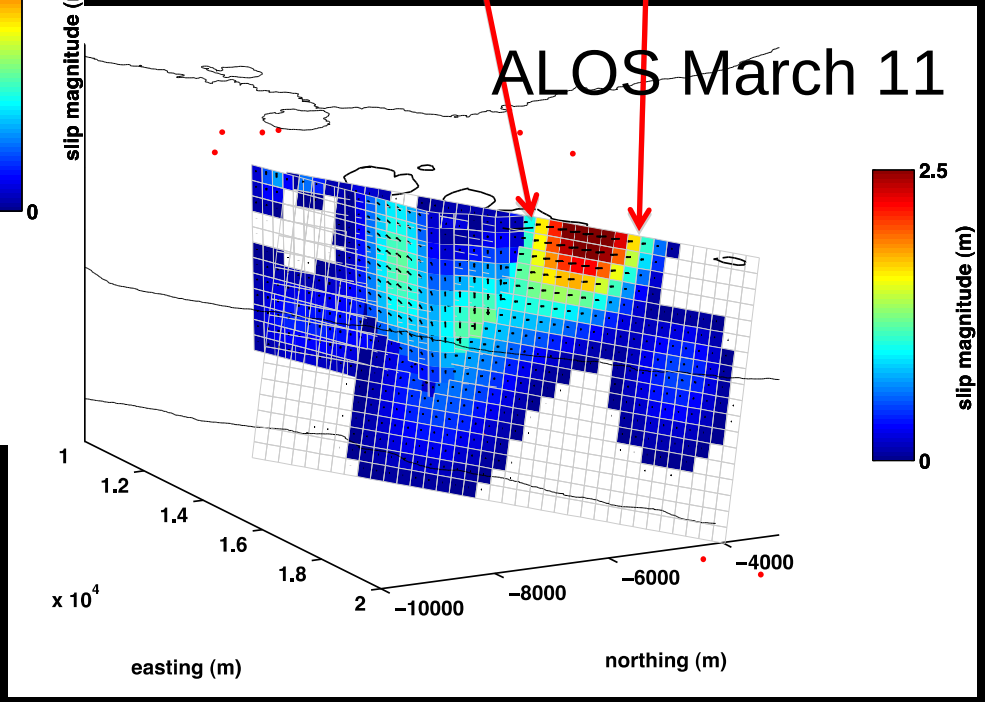


March 6



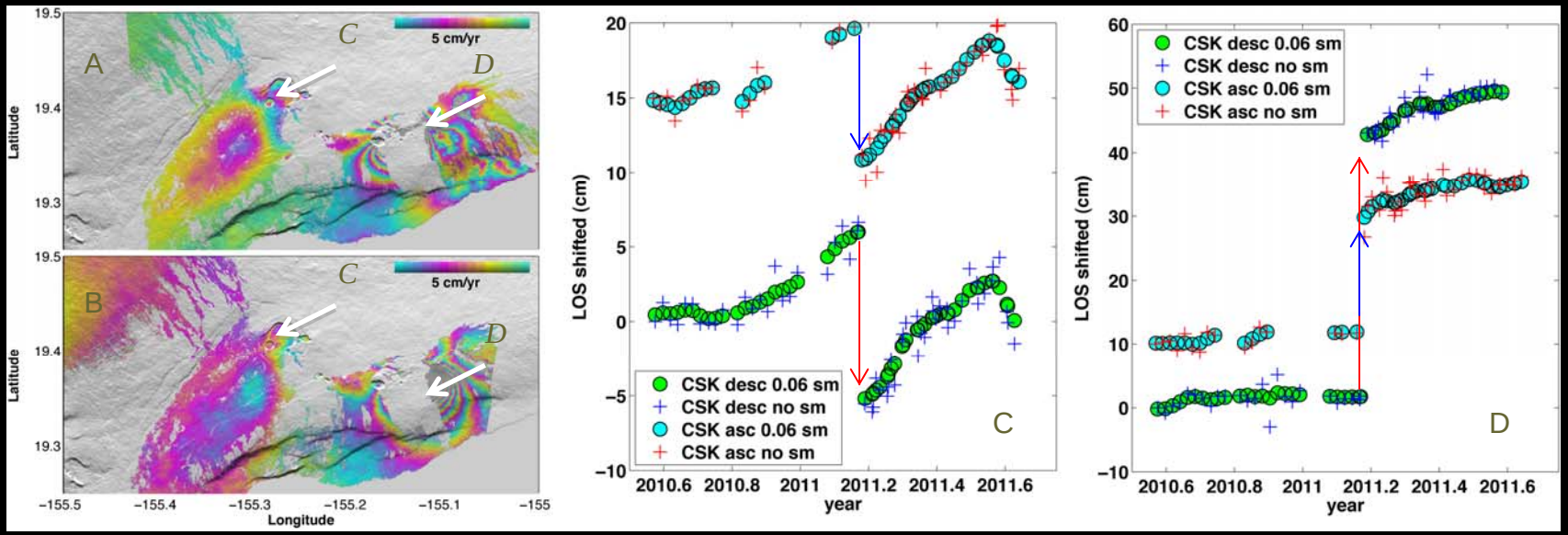
Most seismicity in 1st day

ALOS +GPS models



Seismicity March 7-11

CSK ~1 year time series

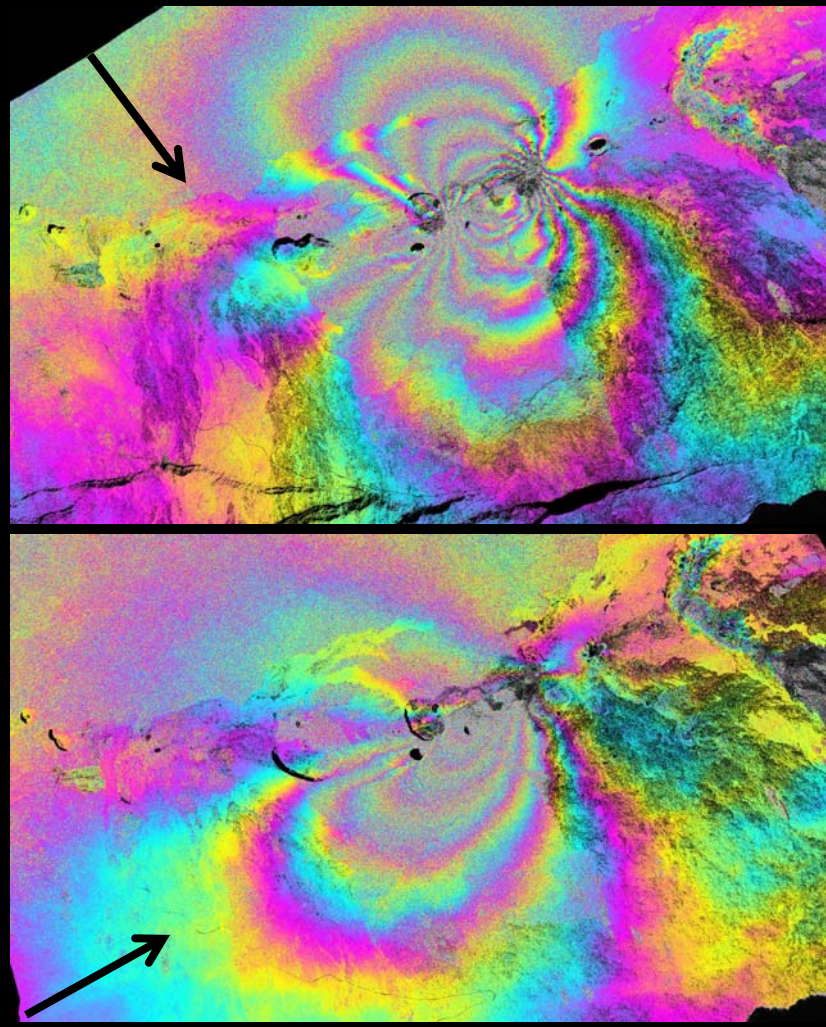


InSAR time series for one year (late July 2010 – August 2011) of COSMO-SkyMed data. (A) Ascending track mean velocity (5 cm/yr color cycle). Arrows indicate approximate locations of time series shown in (C) and (D). (B) Descending track mean velocity. (C) Point time series for Kilauea caldera and (D) for points near the Kamoamoa dike eruption. The March 2011 fissure eruption shows sharp deflation at Kilauea until mid-2011, whereas (D) shows post-dike transient. Plus (+) signs are unsmoothed time series, circles are time series with a temporal triangular filter width of 3 weeks. Ascending data time series are shifted relative to the descending data. ***A*** and ***B*** in (C) and (D) refer to series from (A) and (B).

Future work will model Kilauea sources and move toward kinematic models

Summary

- CSK data provided low-latency (< 12 hrs) InSAR of the Kamoamoa eruption
- L-band data identified splay fault which helps explain some GPS data
- Dike models suggest feeding from both Pu`u O`o and Kilauea in accordance with tilt time series
- Opening increased in accordance with field observations
- Future work to use CSK time series and UAVSAR data to constrain post-diking processes



Thank You

SAR data courtesy:

COSMO-SkyMed – ASI

TerraSAR-X – DLR, Hawaii Supersite

ALOS – JAXA, through PIXEL