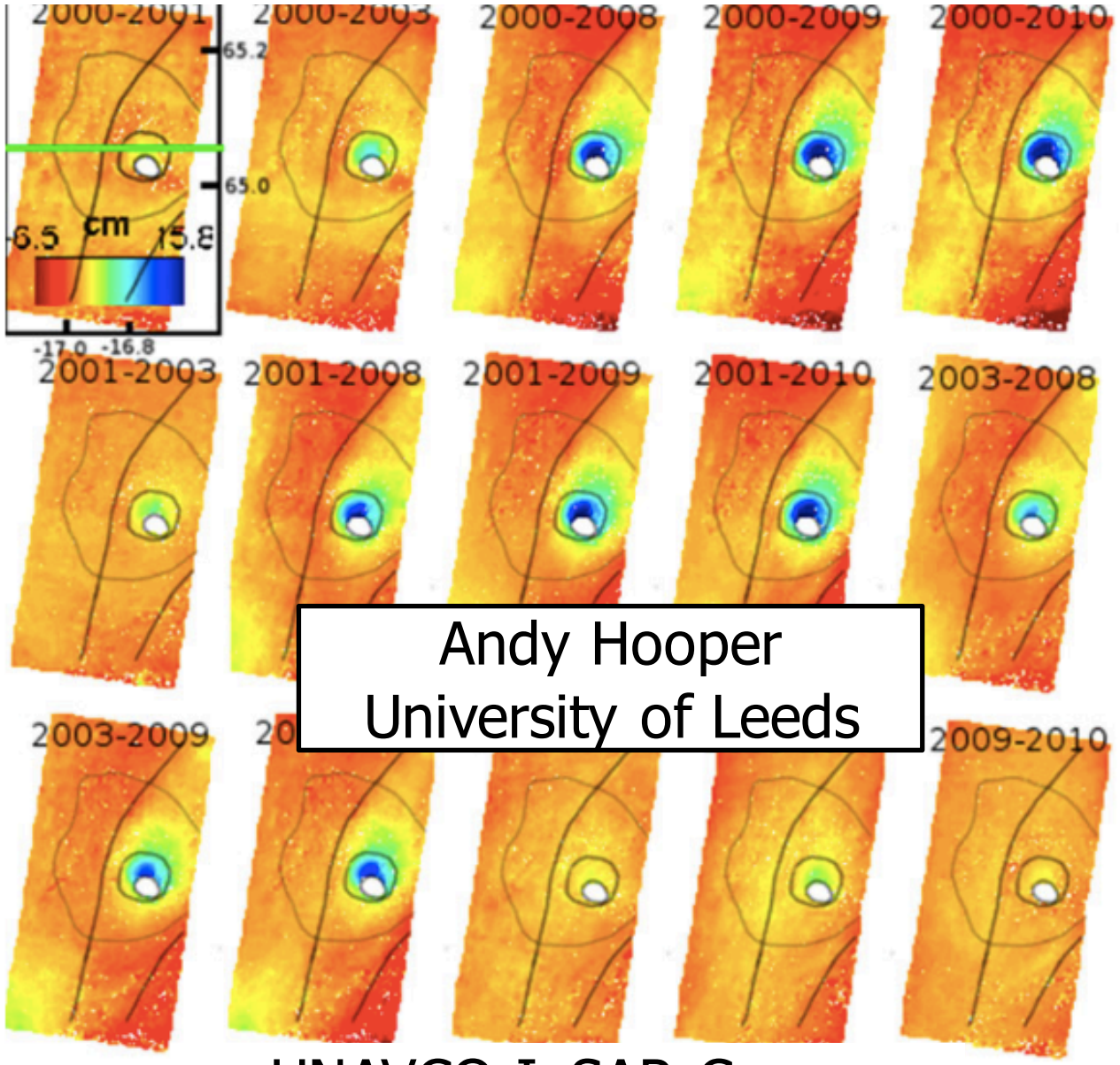
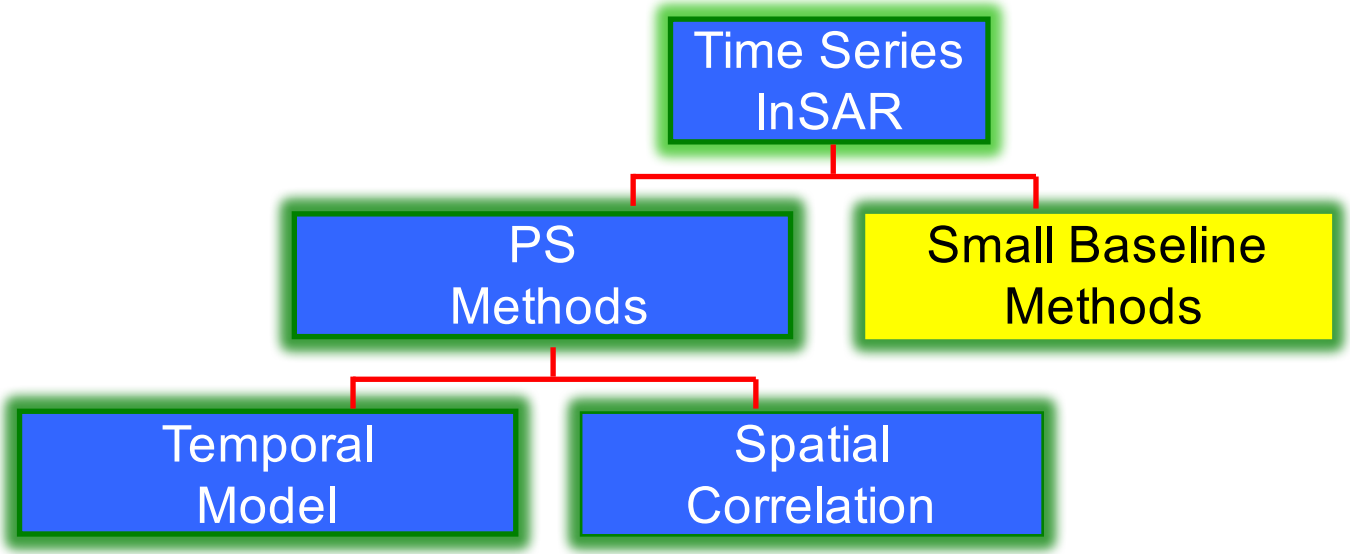
Small Baseline InSAR and StaMPS



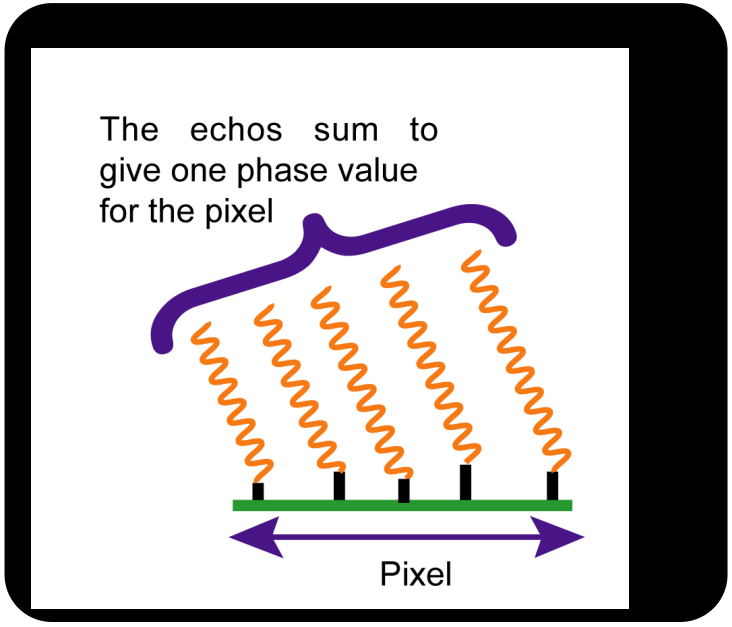
Andy Hooper
University of Leeds

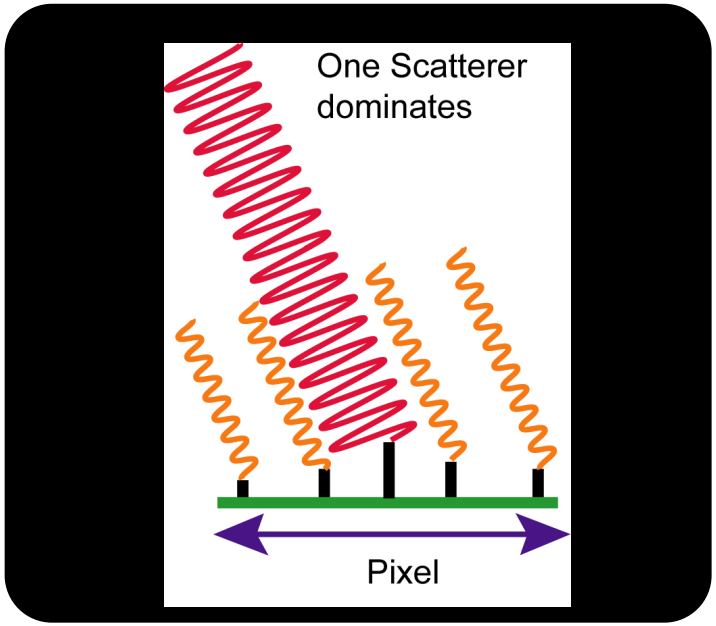
Part 2

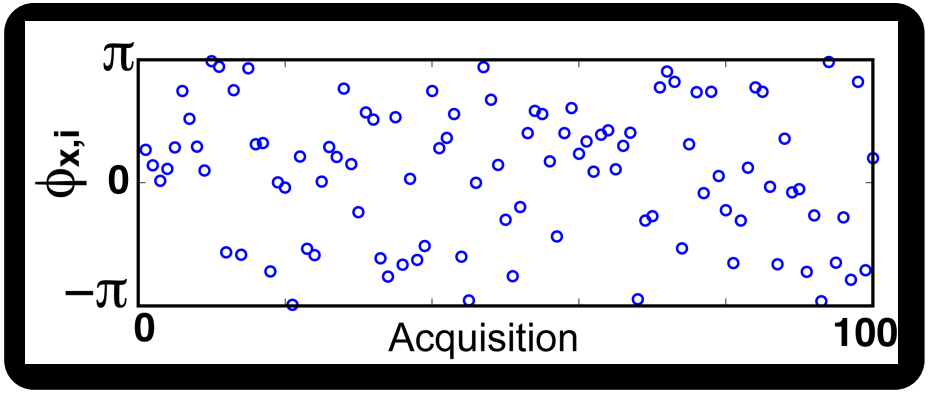

Time Series InSAR
PS Methods
Small Baseline Methods
Temporal Model
Spatial Correlation

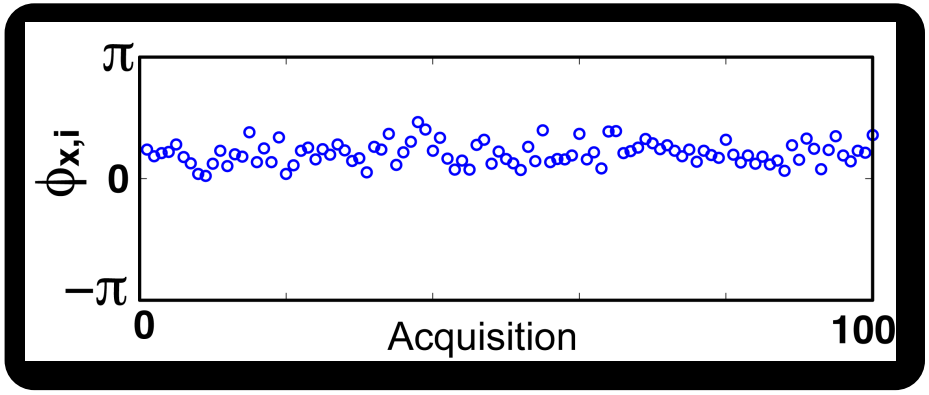
RECAP

Persistent Scatterer Pixel





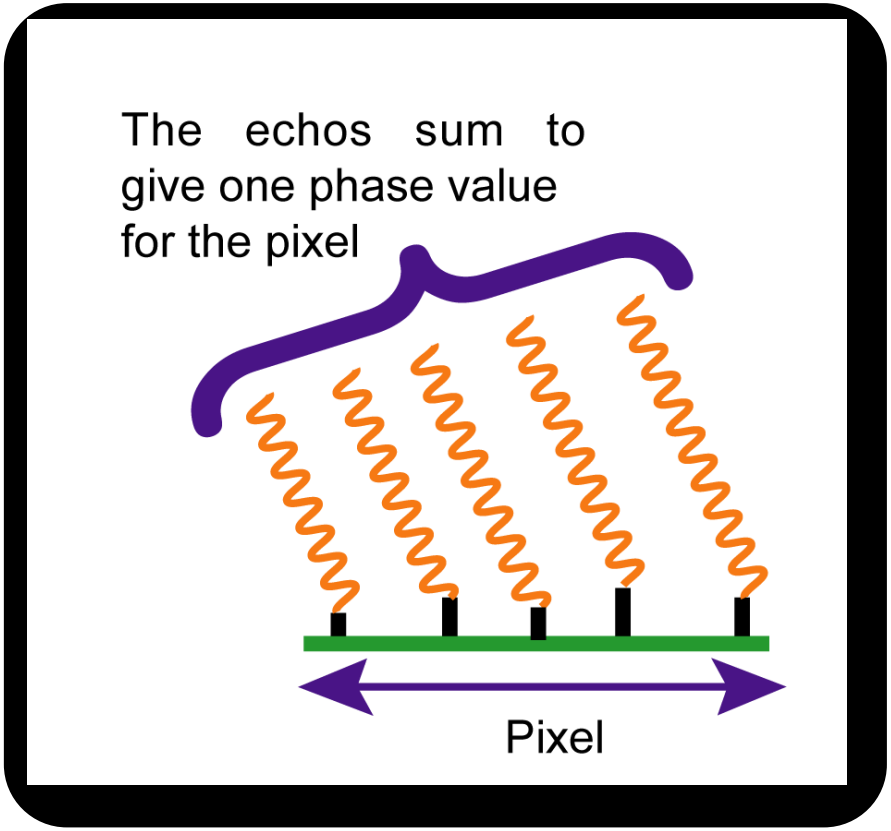




Distributed scatterering pixel

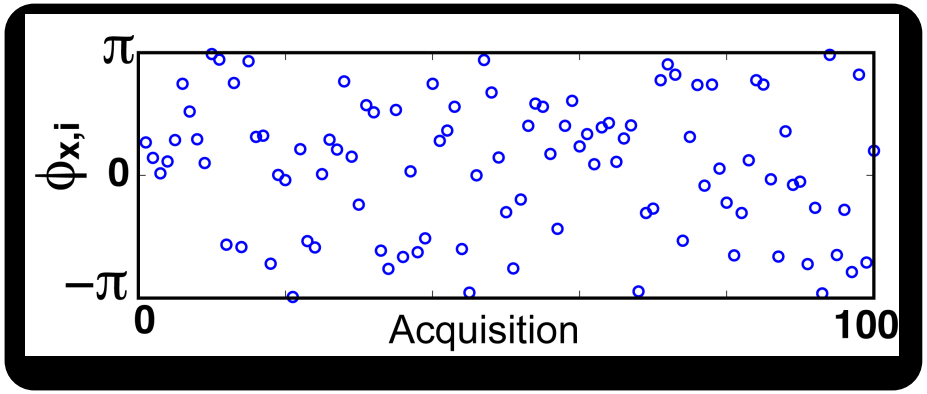
“Persistent scatterer” (PS) pixel

Using Distributed Scatterer Pixels



Distributed scatterer pixel

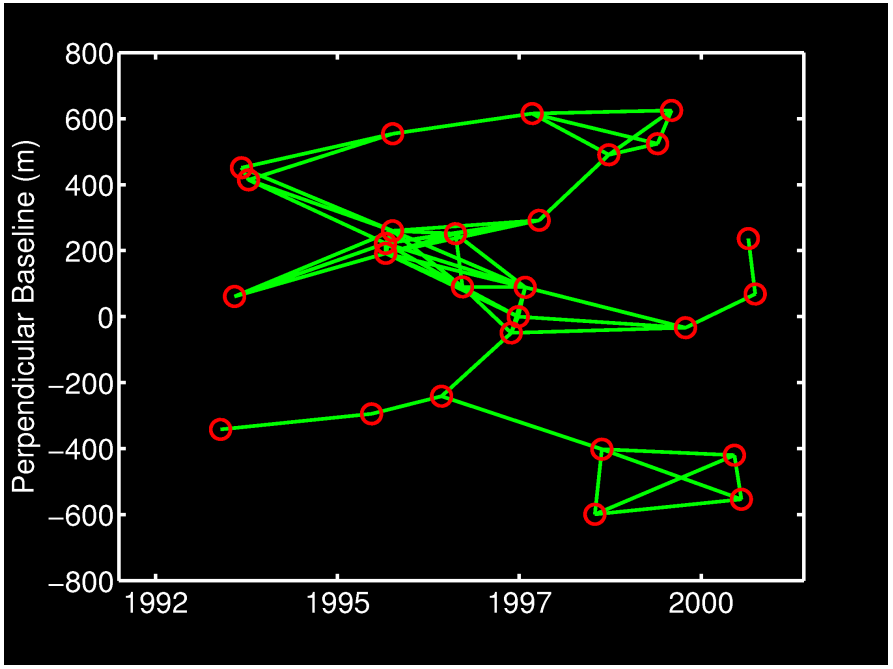
If scatterers move with respect to each other, the phase sum changes



Multilooked small baseline approach

e.g. SBAS (Berardino et al., 2002) or Schmidt and Bürgmann, (2003)

1. Interferograms formed between image pairs that have small perpendicular, temporal and Doppler baselines



- Spectral filtering is used to discard non-overlapping bandwidth

Multilooked small baseline approach

1. Interferograms formed between image pairs that have small perpendicular, temporal and Doppler baselines

2. "Multilook" each interferogram to increase signal to noise ratio

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4. Find pixels which are spatially coherent in most interferograms and invert in some way for the temporal displacement

Multilooked small baseline approach

1. Interferograms formed between image pairs that have small perpendicular, temporal and Doppler baselines
2. "Multilook" each interferogram to increase signal to noise ratio
3. "Phase-unwrap" each interferogram in 2-D

Conventional InSAR

4. Find pixels which are spatially coherent in most interferograms and invert in some way for the temporal displacement

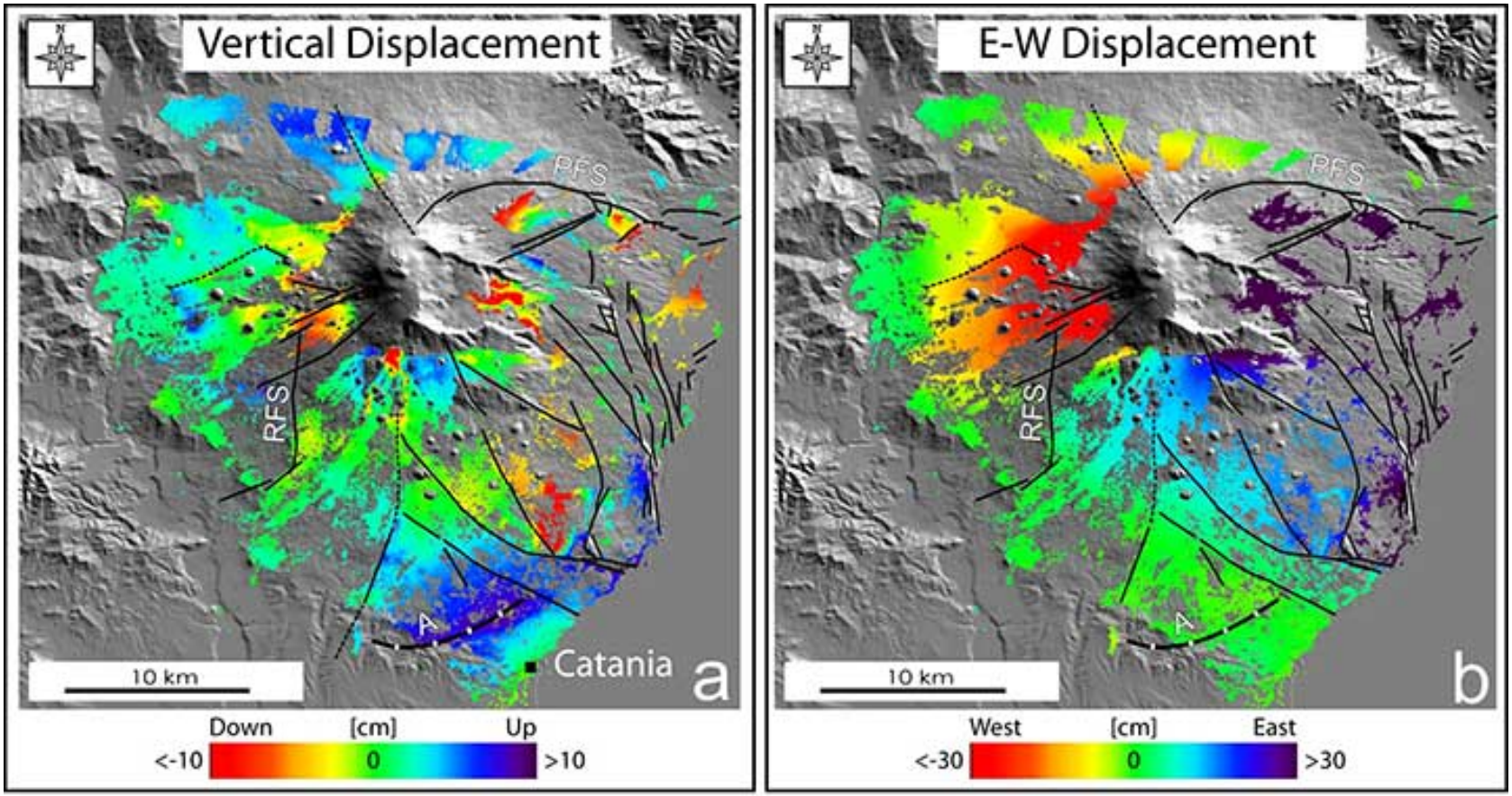
Multilooked small baseline approach

….invert in some way for the temporal displacement:

- Singular value decomposition (SBAS, Beraradino et al. 2002)
- Least squares (Schmidt and Burgmann, 2003, Biggs et al, 2007)
- Constrained least squares (NSBAS, Doin et al.)
- L^1-norm minimisation (Lauknes et al, 2007)

Redundancy in small baseline network allows checking for unwrapping errors

Example

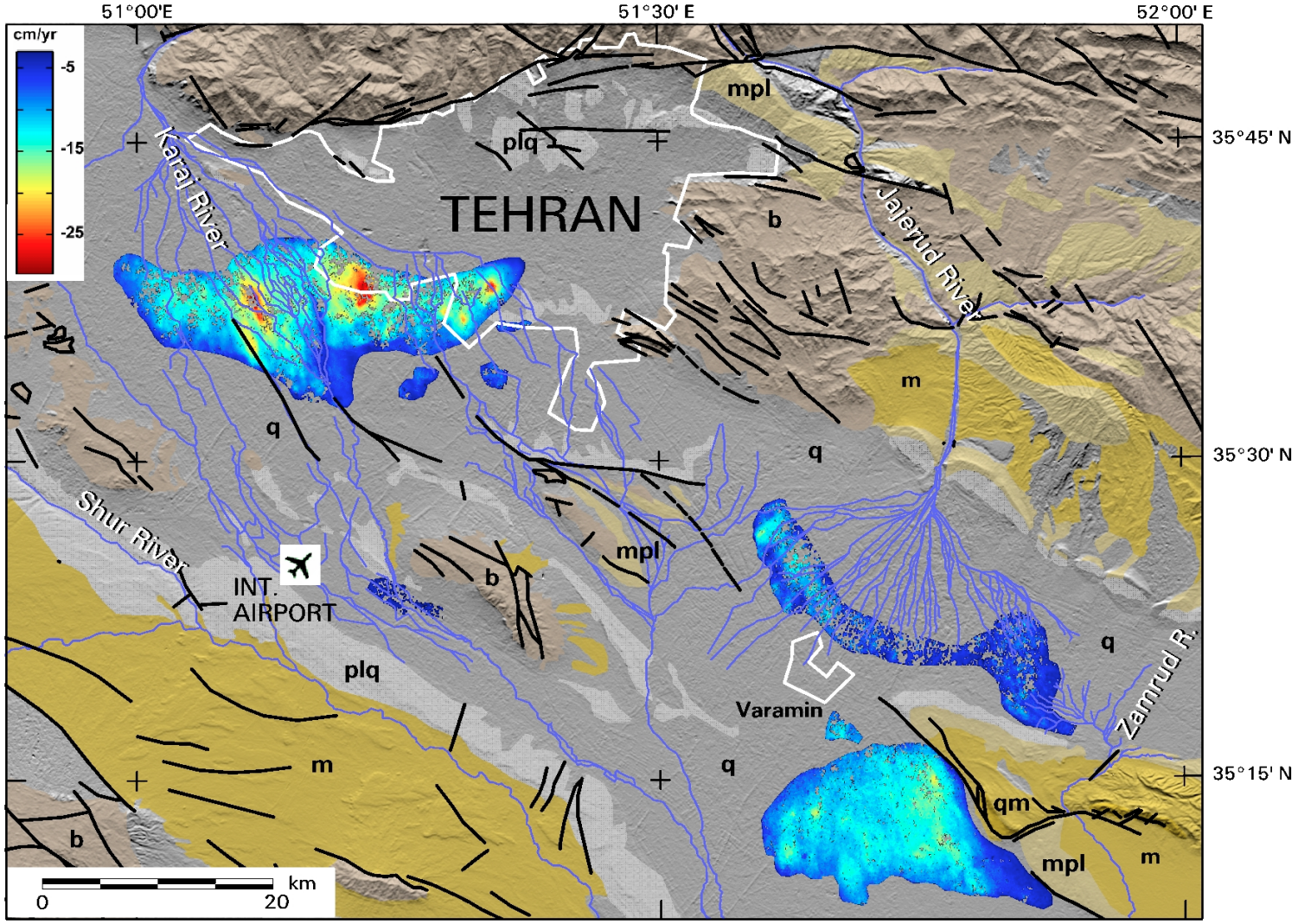


Mt Etna displacement 1992-2006 (Lanari et al)

Other variations

1. Phase-unwrapping in ~3-D (Pepe and Lanari, 2006, Hooper 2010).
   - Improves accuracy

Using 3-D phase unwrapping



Alipour et al, in prep

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Other variations

1. Phase-unwrapping in ~3-D (Pepe and Lanari, 2006, Hooper 2010).
   - Improves accuracy

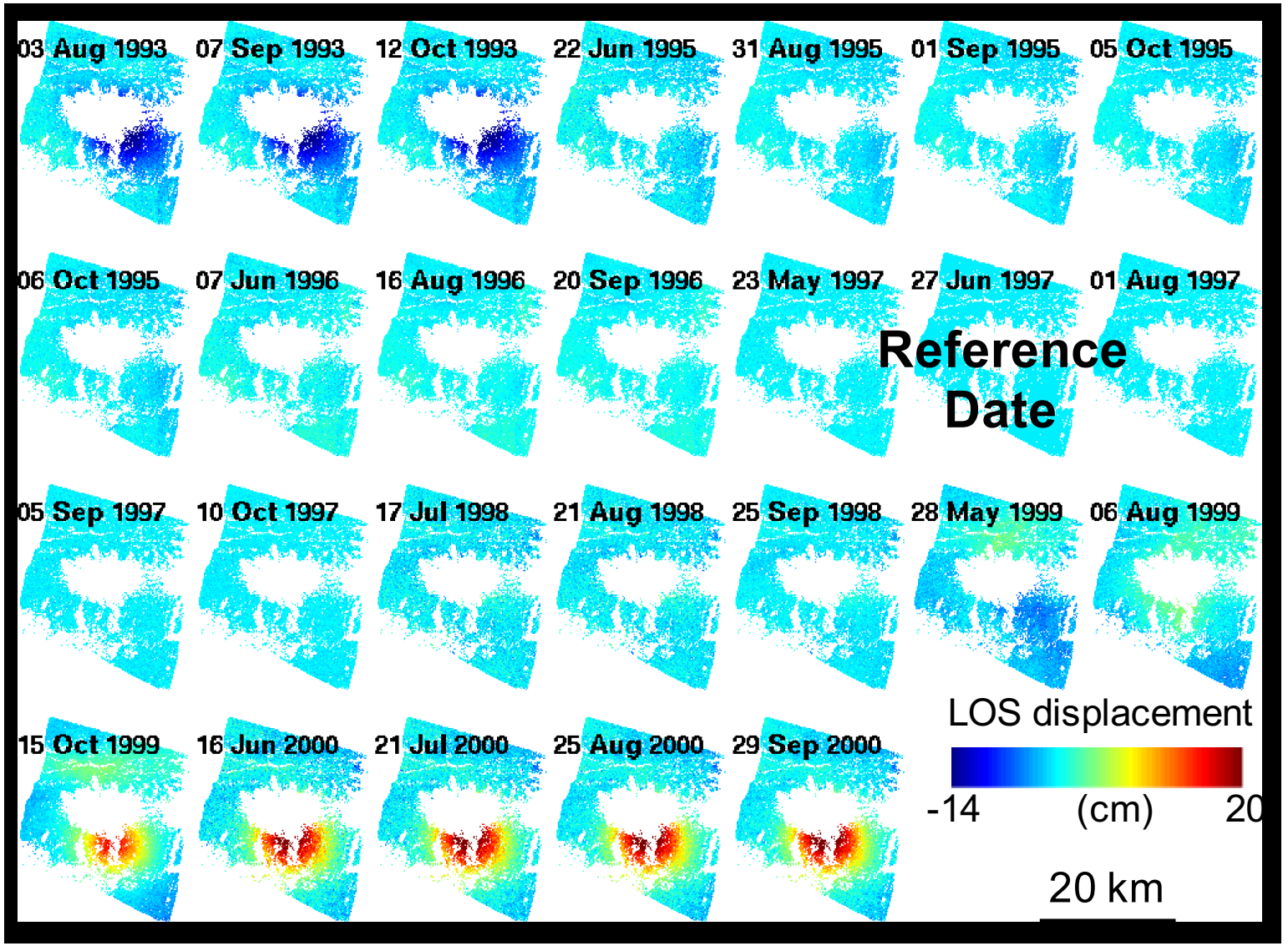
2. Processing single-look images (Lanari et al 2004, Hooper 2008).
   - Increases resolution
   - Can find isolated stable pixels (Hooper 2008)

Single-look small baseline method

1. StaMPS approach (Hooper 2008) basically applies same algorithm as PS processing to filtered small baseline interferograms.

2. These are then unwrapped using ~3-D algorithm and inverted using least-squares.

Single-look small baseline method



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Eyjafjallajökull 1993-2000

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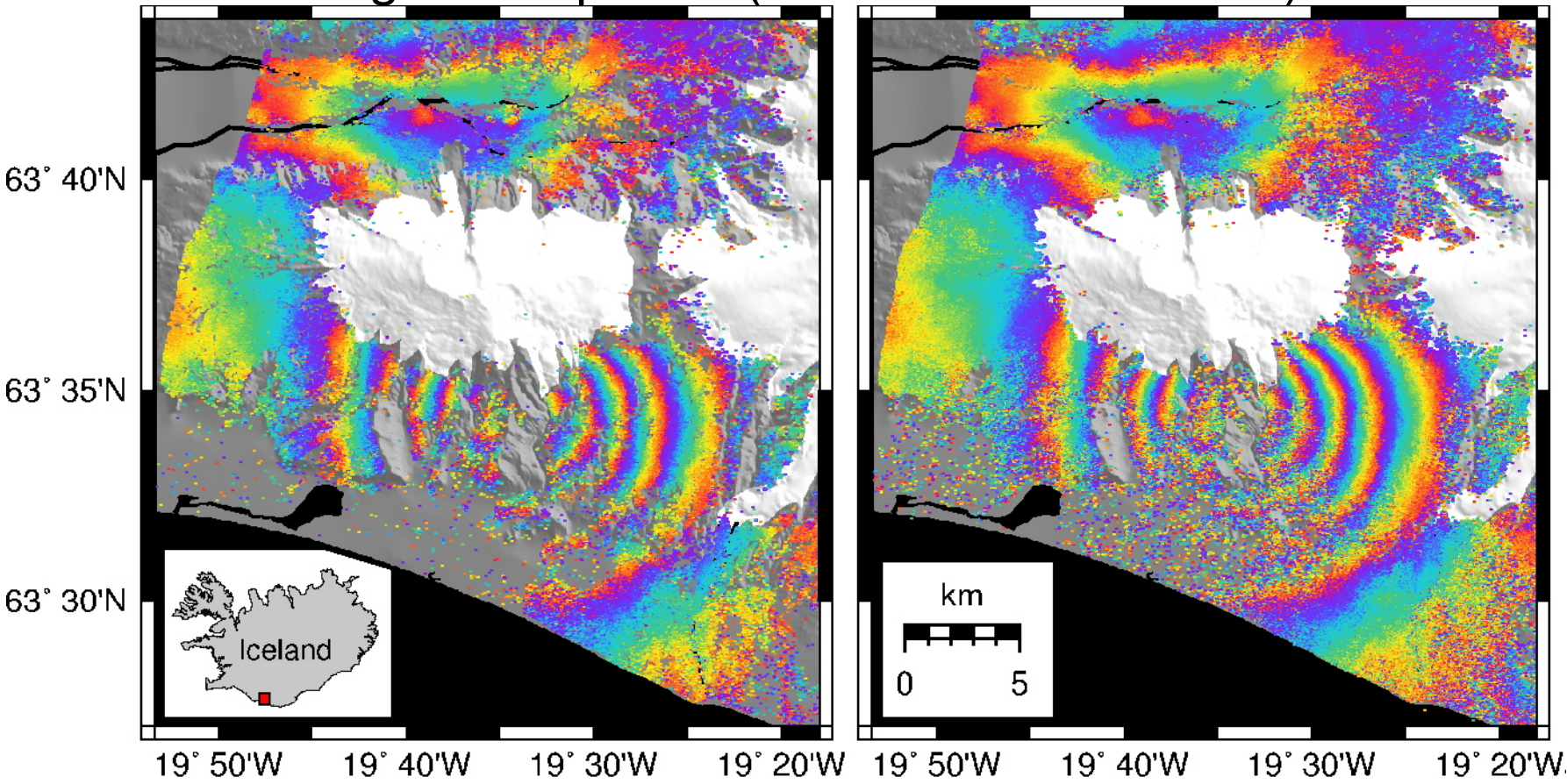
Comparison of PS and Small Baseline Pixels

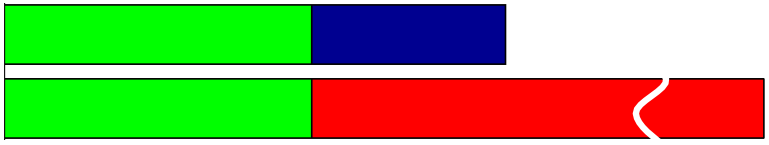
Single time period (Jun 1997 to Oct 1999)



Persistent Scatterer pixels

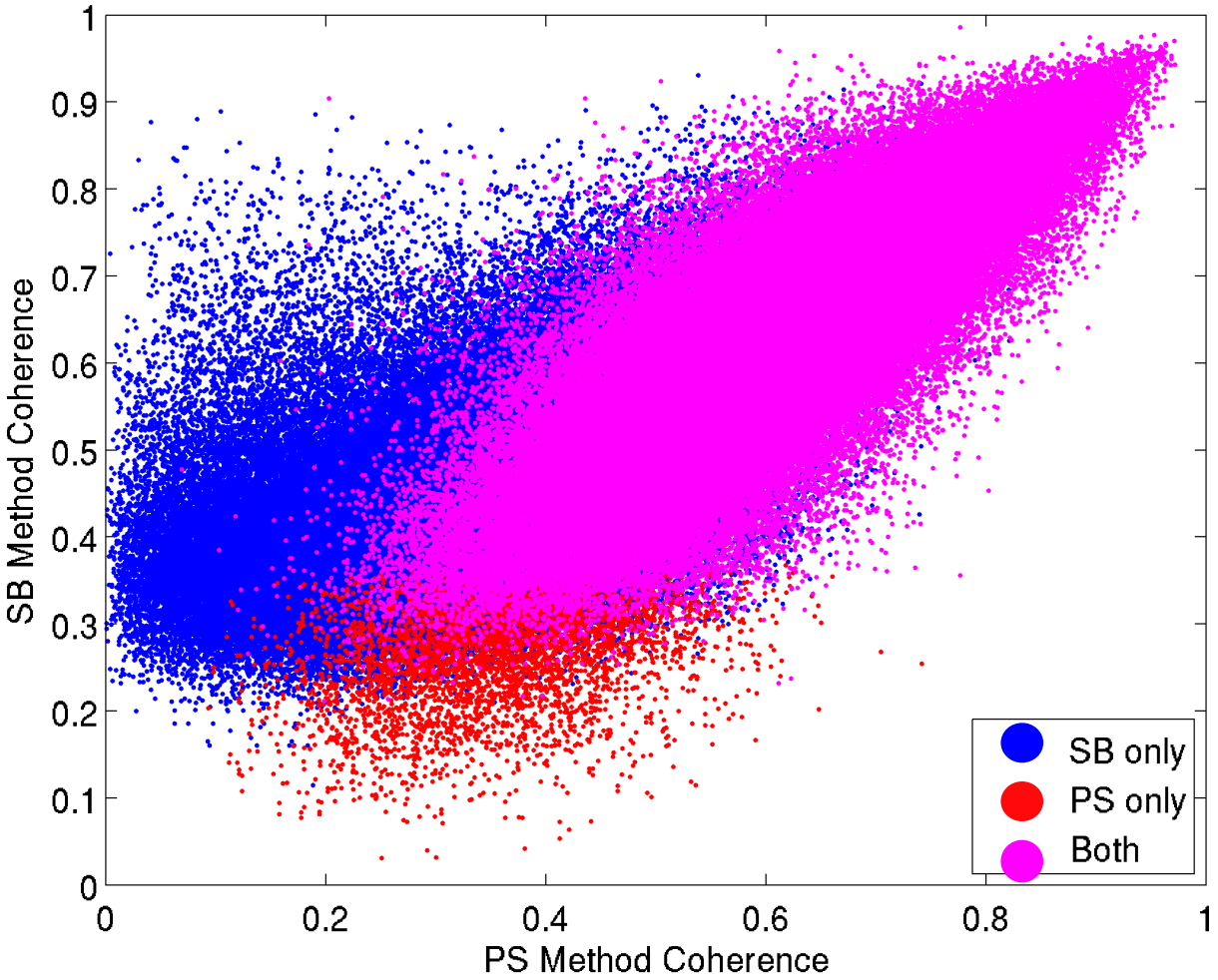
Small Baseline pixels

Both:
91,000



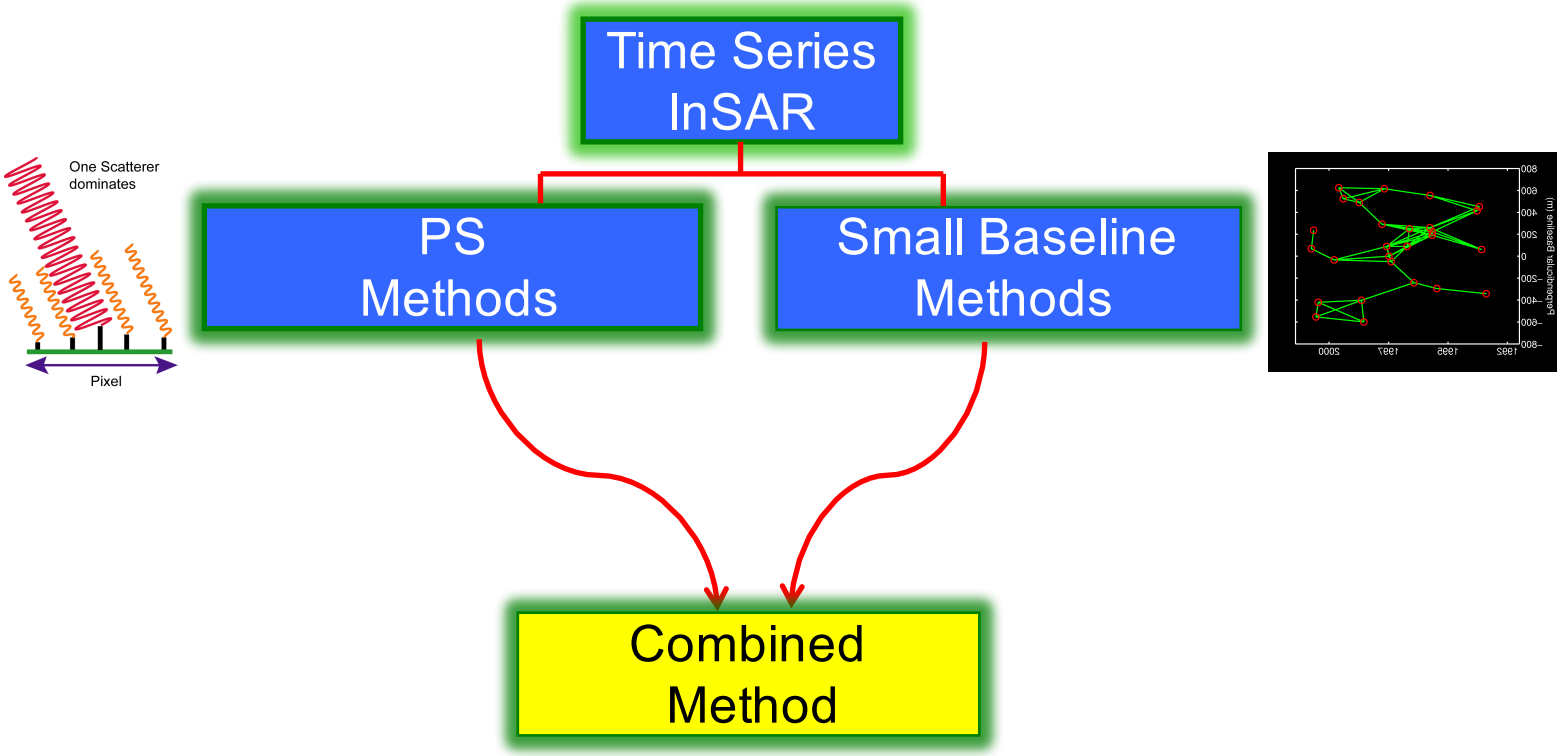
PS pixels: 139,000
SB pixels: 675,000

Comparison



Differences in estimated coherence due to filtering in SB case, and differences in estimation of spatially correlated phase.

Time series INSAR



StaMPS (Hooper 2008), SQUEESAR (Ferretti et al, 2009)

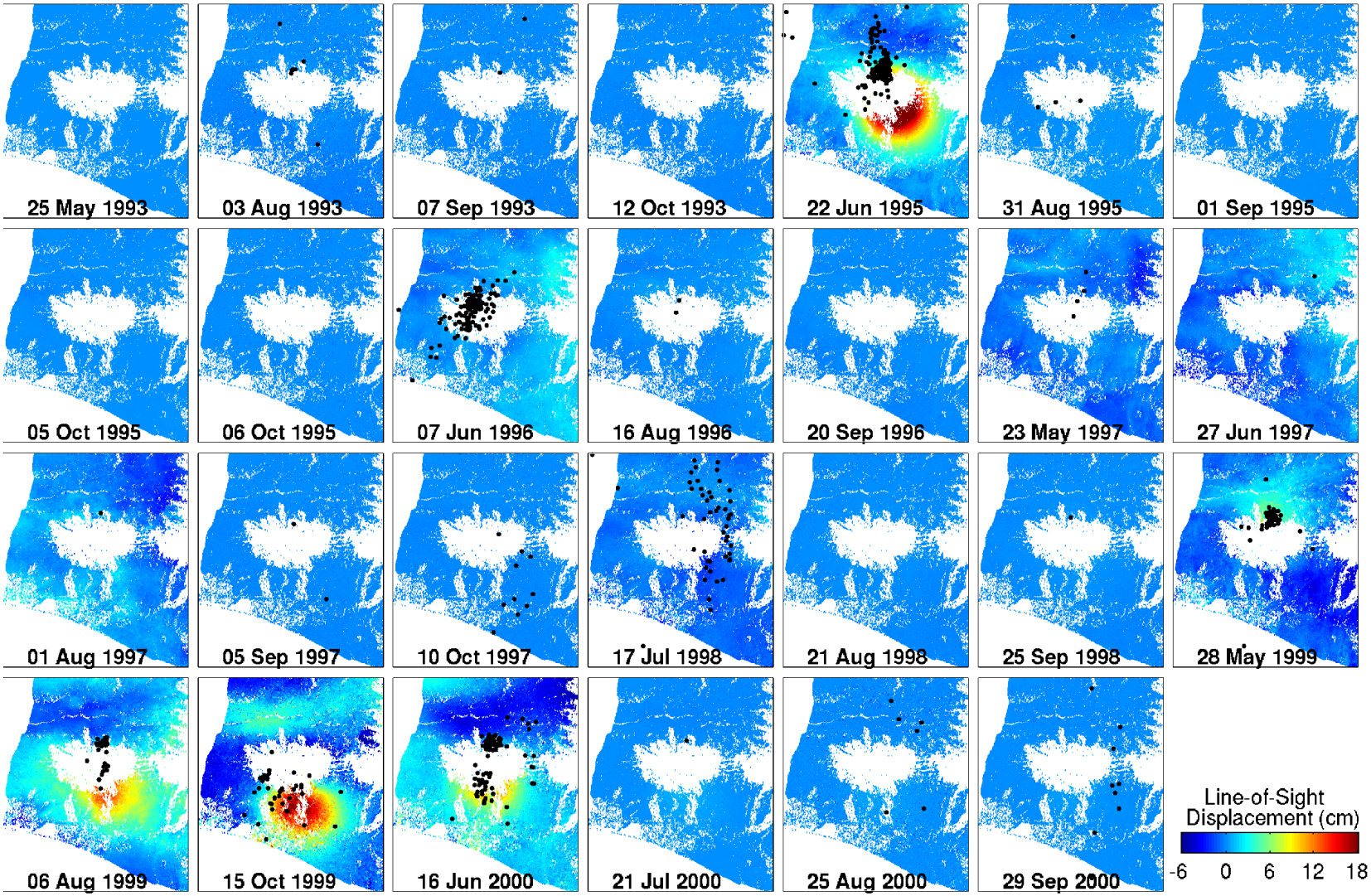
Combined Time Series InSAR (StaMPS)

- PS and SB pixels are combined before phase-unwrapping

Combined Time Series InSAR (StaMPS)

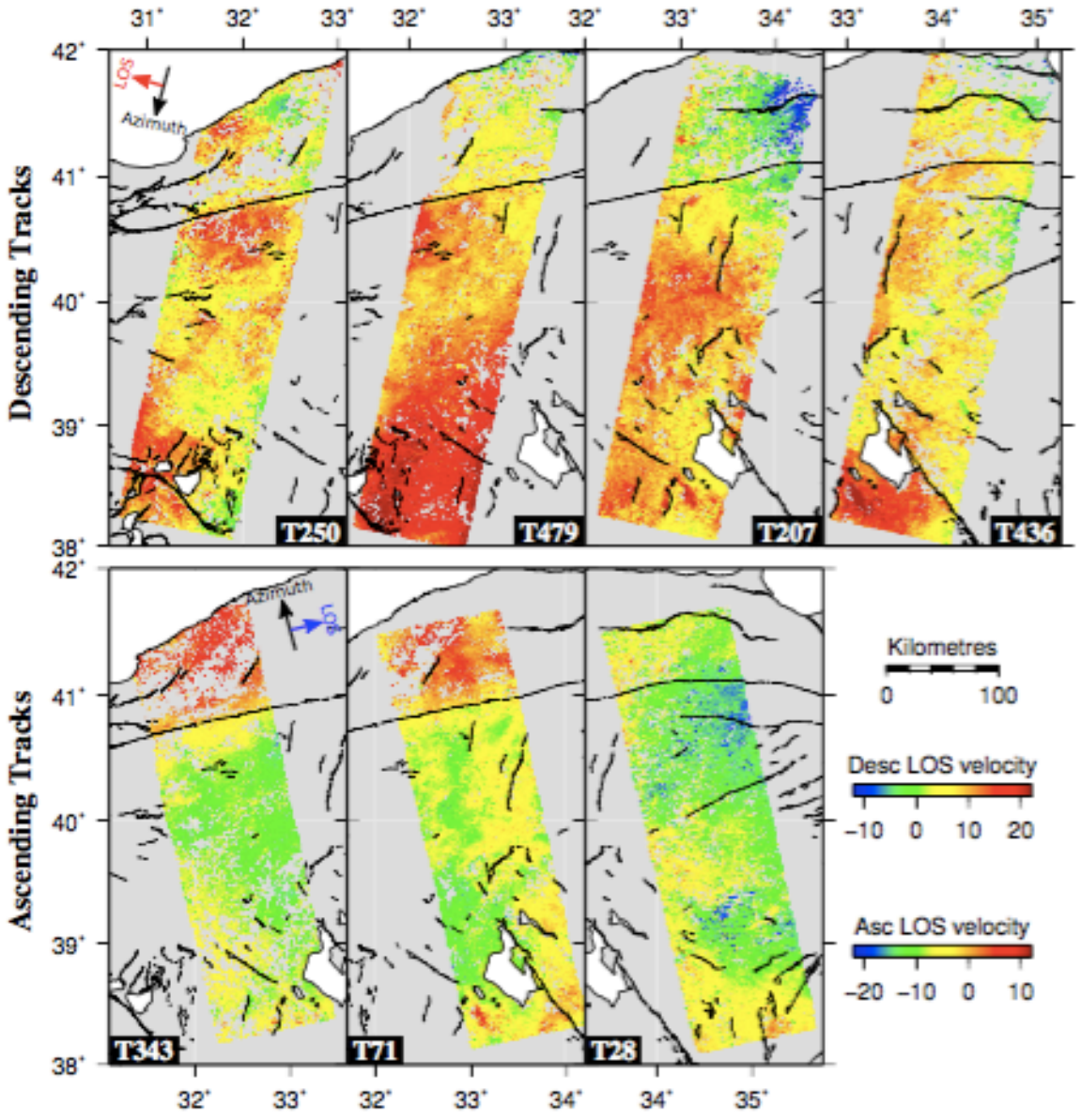
- PS and SB pixels are combined before phase-unwrapping
- Pixels that are in both data sets are weighted according to their signal-to-noise ratio (estimated from γ_x)

Example: Eyjafjallajökull



- Each image shows change since previous image

Example: Northern Turkey 2003-2010



Hussain et al, JGR, 2016

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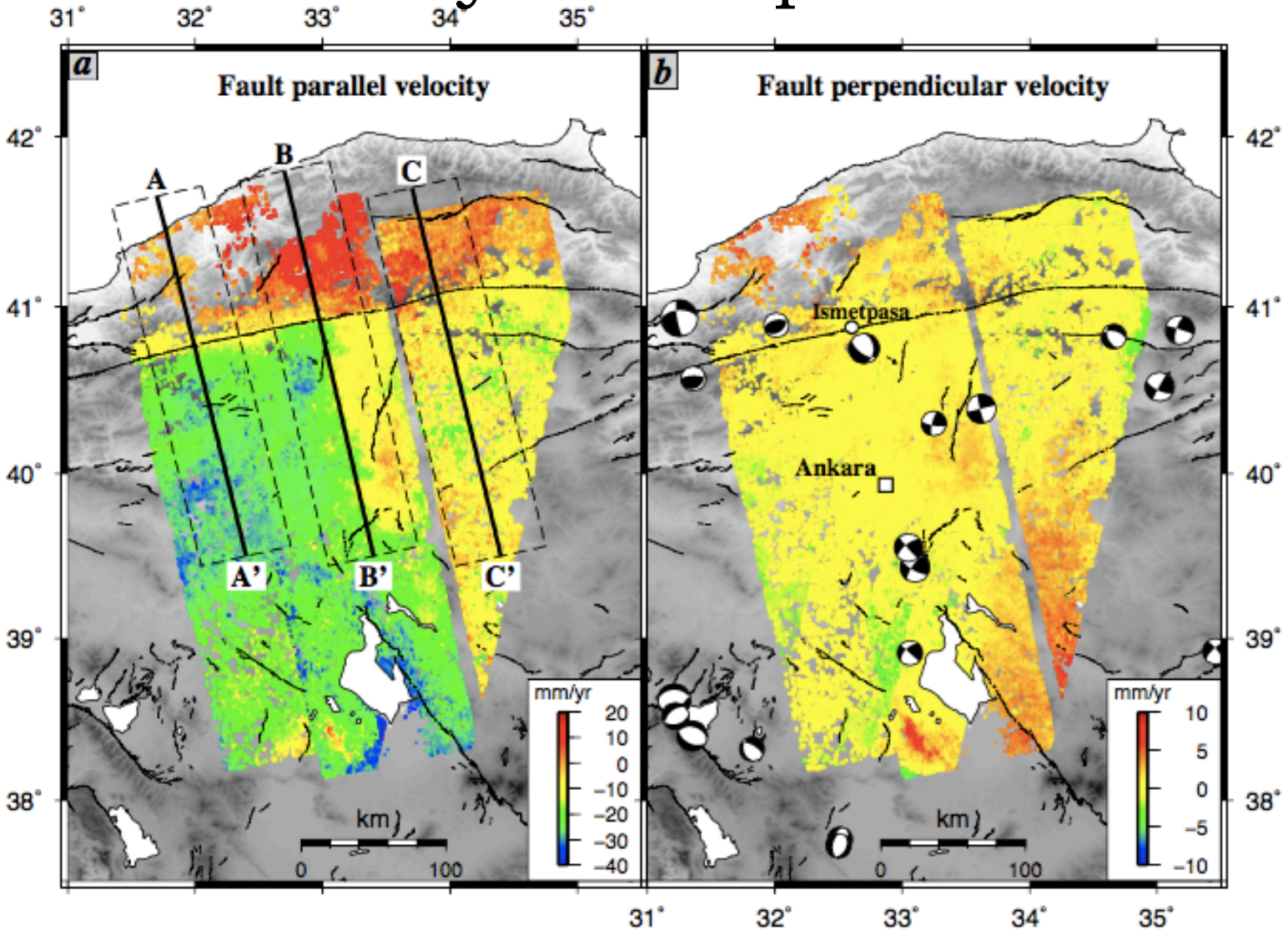
Northern Turkey, 2003-2010
Velocity Decomposition



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Hussain et al, JGR, 2016

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