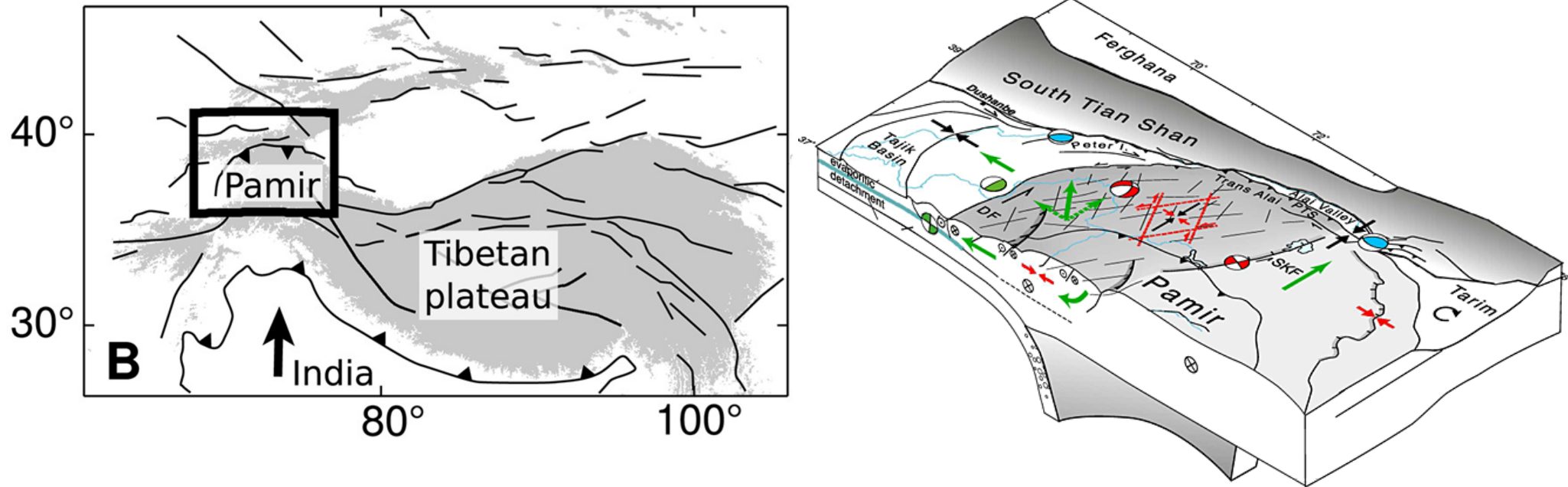


[Lindsey et al., 2015]

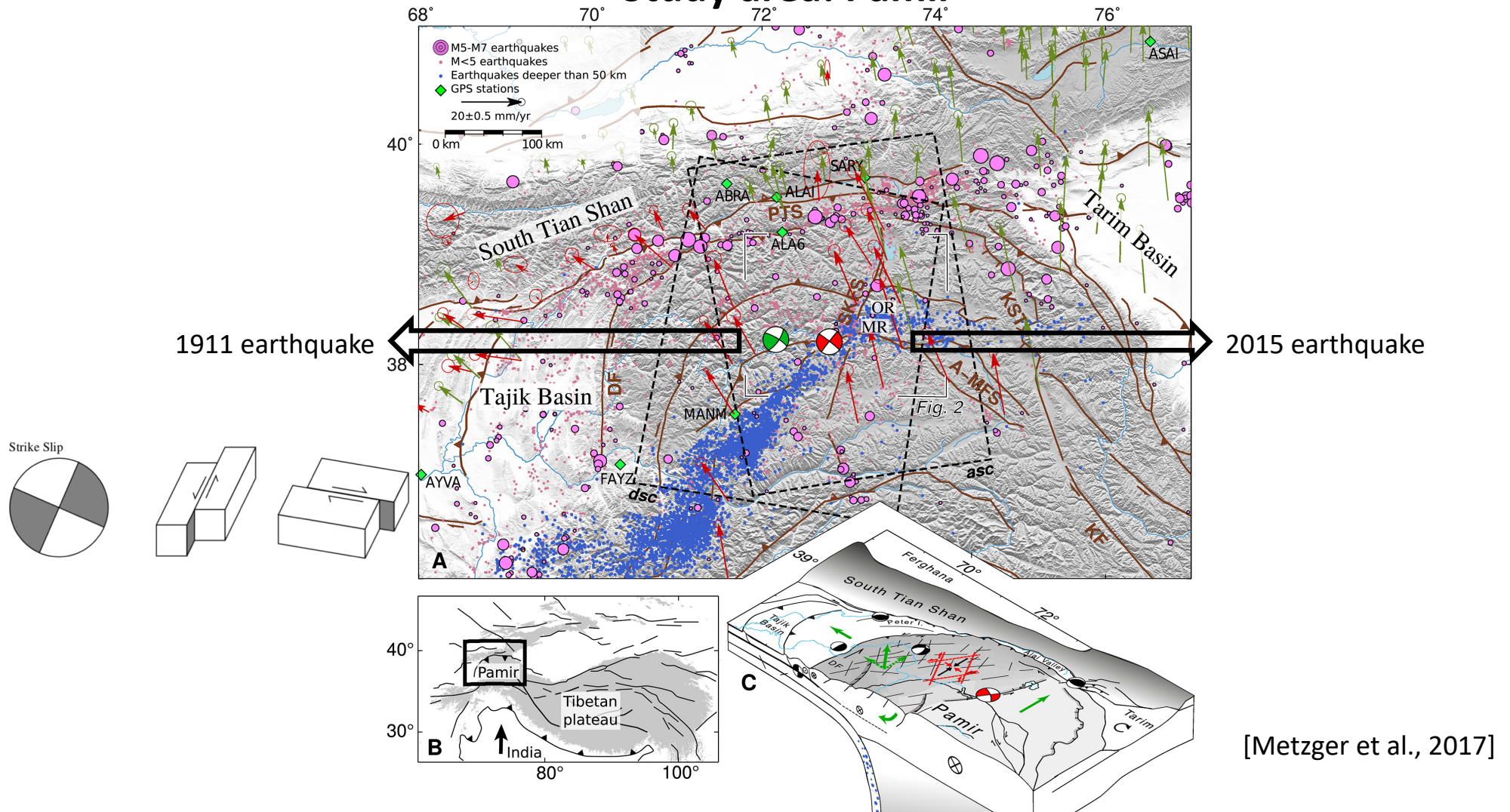
- **Tectonic settings**
- **Traditional Interferometry**
- **Sentinel TOPS-mode**
- **Persistent Scatterer Method**

Study area: Pamir



[Metzger et al., 2017]

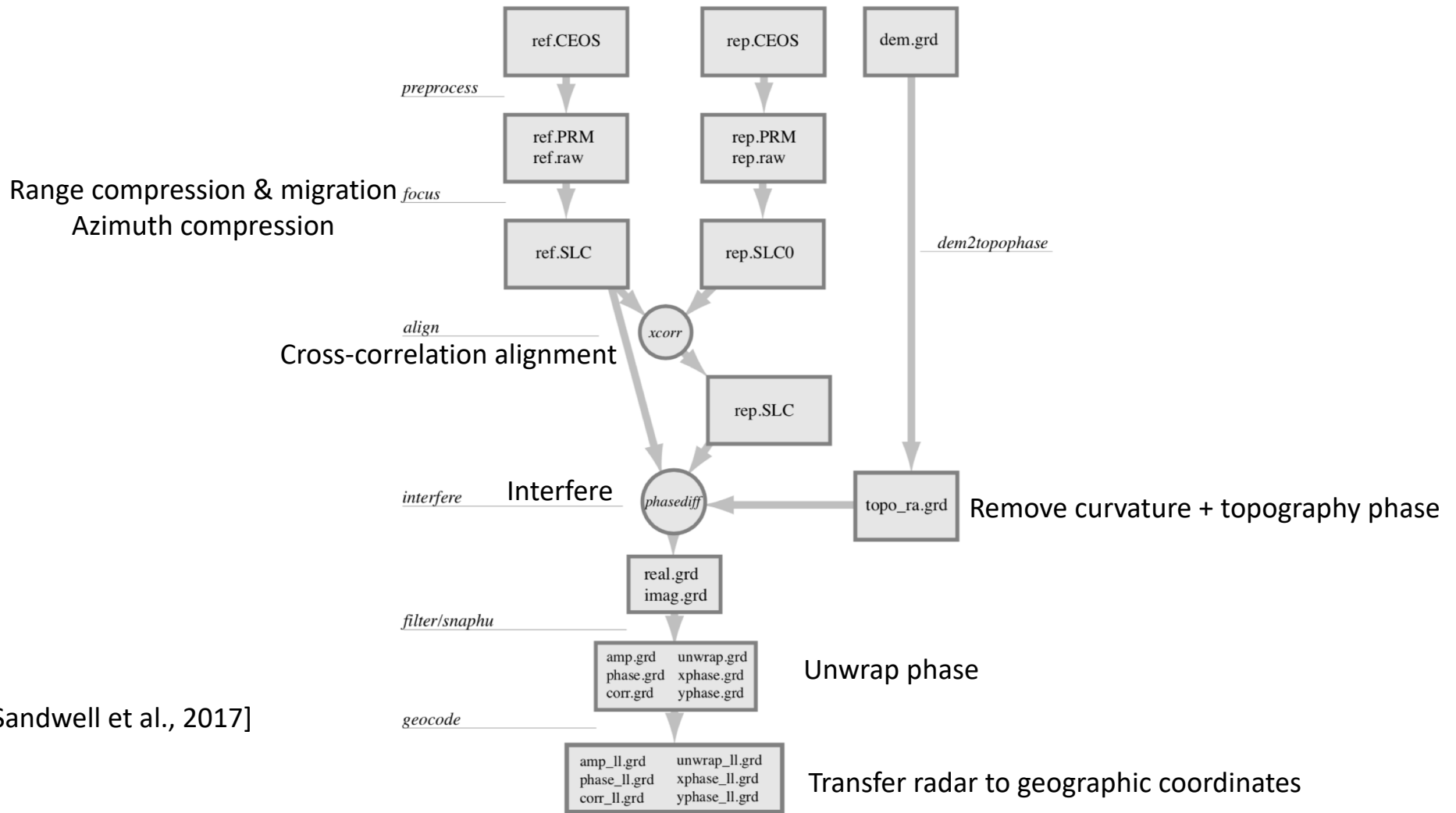
Study area: Pamir



[Metzger et al., 2017]

- **Tectonic settings**
- **Traditional Interferometry**
- **Sentinel TOPS-mode**
- **Persistent Scatterer Method**

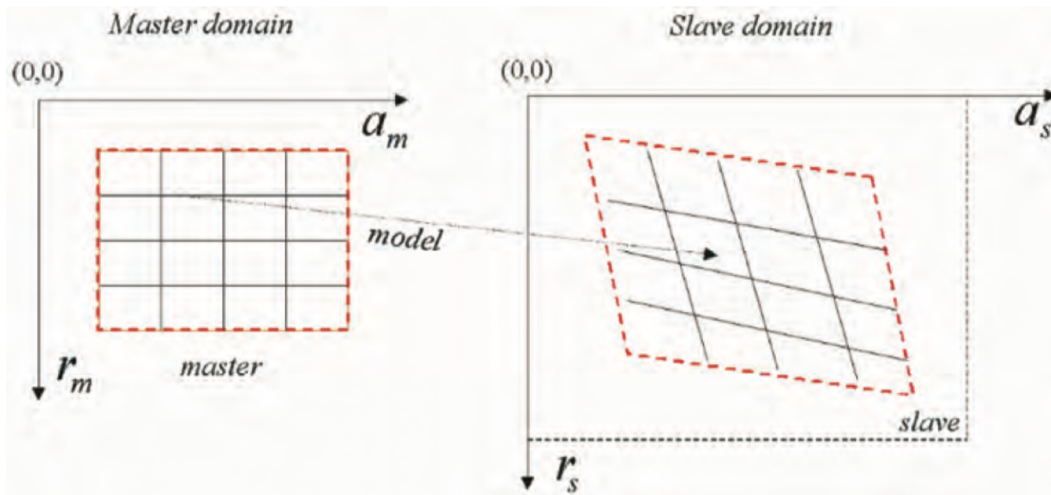
Work Flow of Interferometry



[Sandwell et al., 2017]

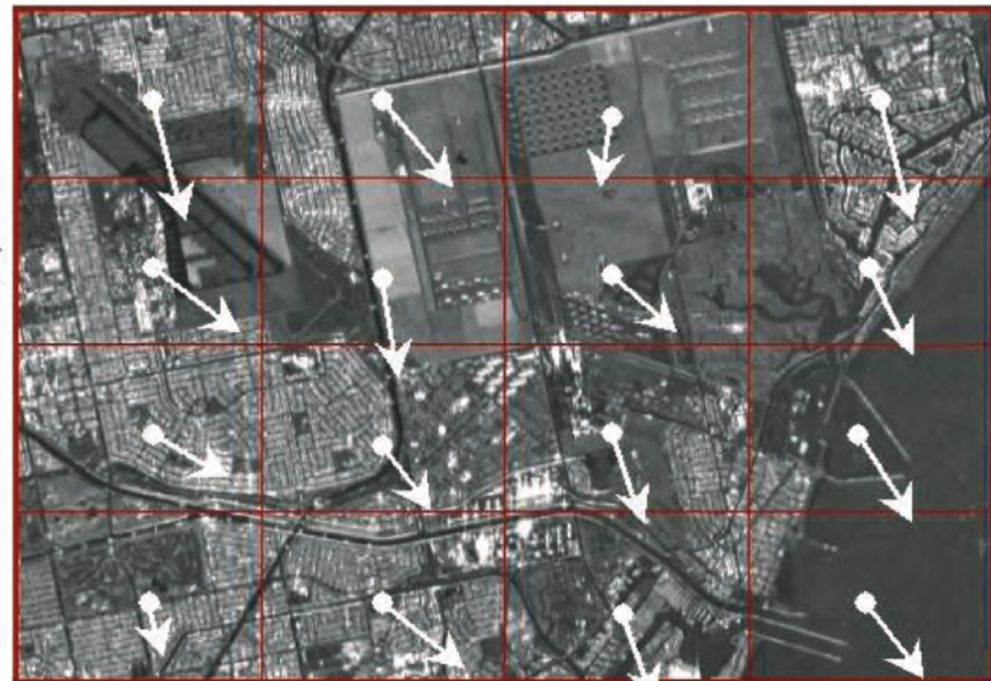
Cross-correlation alignment

$$\begin{cases} r_S = a \cdot r_M^2 + b \cdot r_M + c \cdot a_M + d \\ a_S = e \cdot r_M^2 + f \cdot r_M + g \cdot a_M + h \end{cases}$$



~ 1/10 pixel accuracy

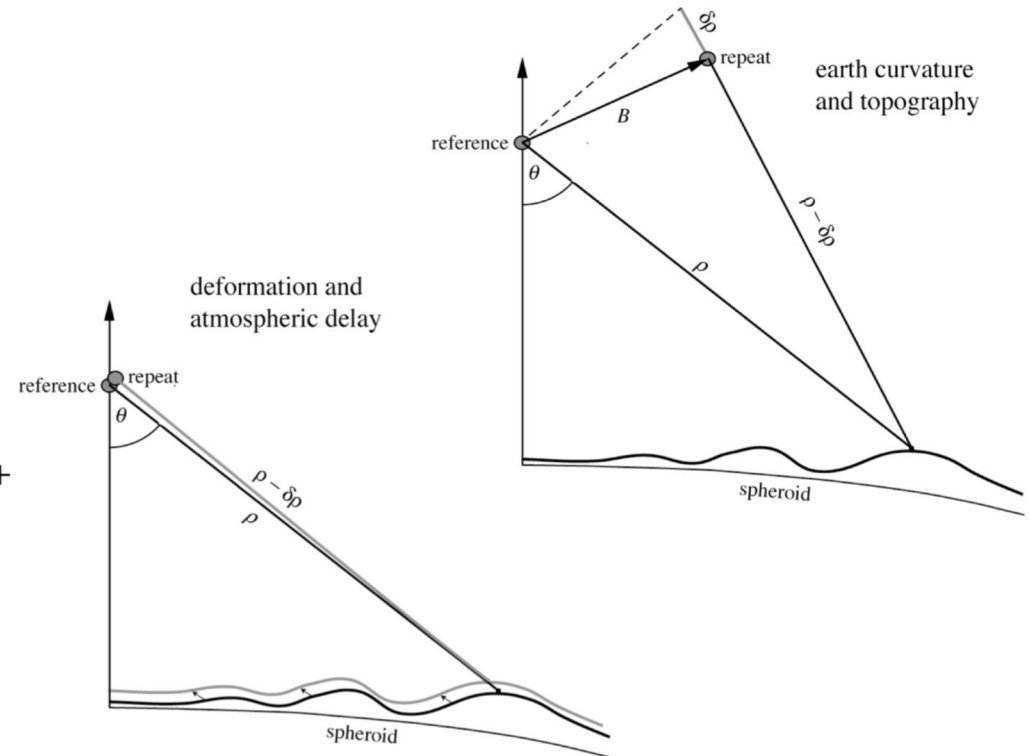
Estimate of co-register parameters



[Ferretti et al., 2007]

Contributions to Phase

phase = *earth curvature* (almost a plane, known) +
topographic phase (broad spectrum) +
surface deformation (broad spectrum, unknown) +
orbit error (almost a plane, largely known) +
ionosphere delay (a plane or 40-km wavelength waves) +
troposphere delay (power law, unknown) +
phase noise (white spectrum, unknown)

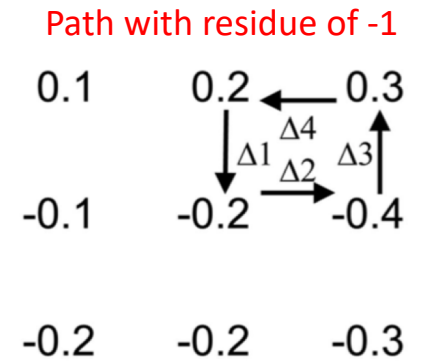
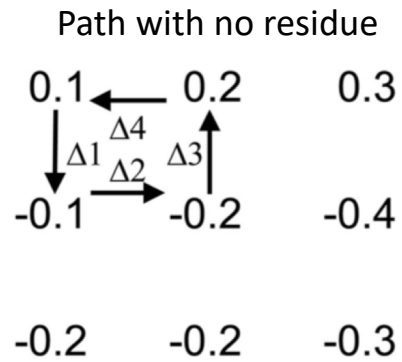


[Sandwell et al., 2017]

Two Dimensional Phase Unwrapping

Path-Following Method

Assume Nyquist frequency $F_s > 2F_0$ of signal
Phase change next less than π rad



(a)

Branch-cuts to prevent phase jumps more than π rad (b)

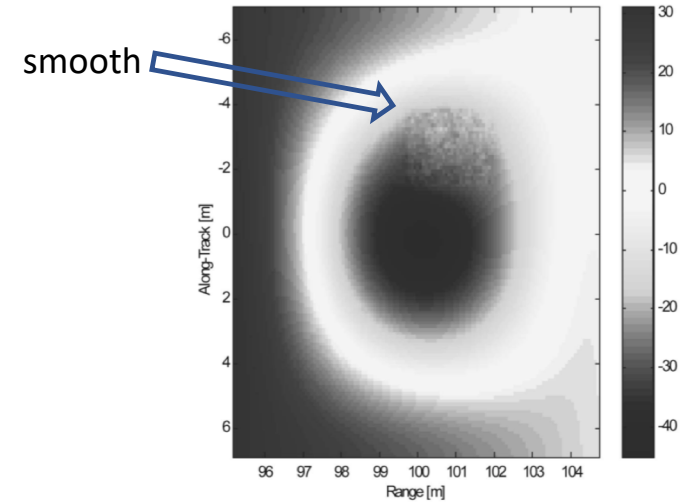
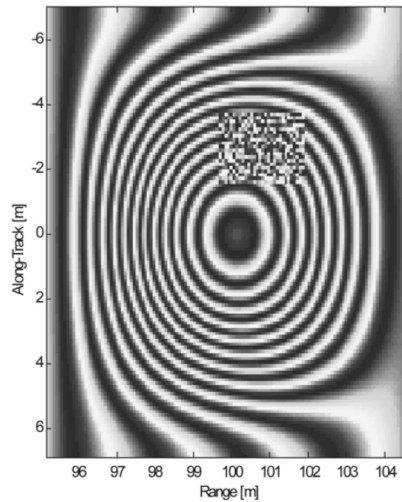
[Richards et al., 2005]

Least Square Method

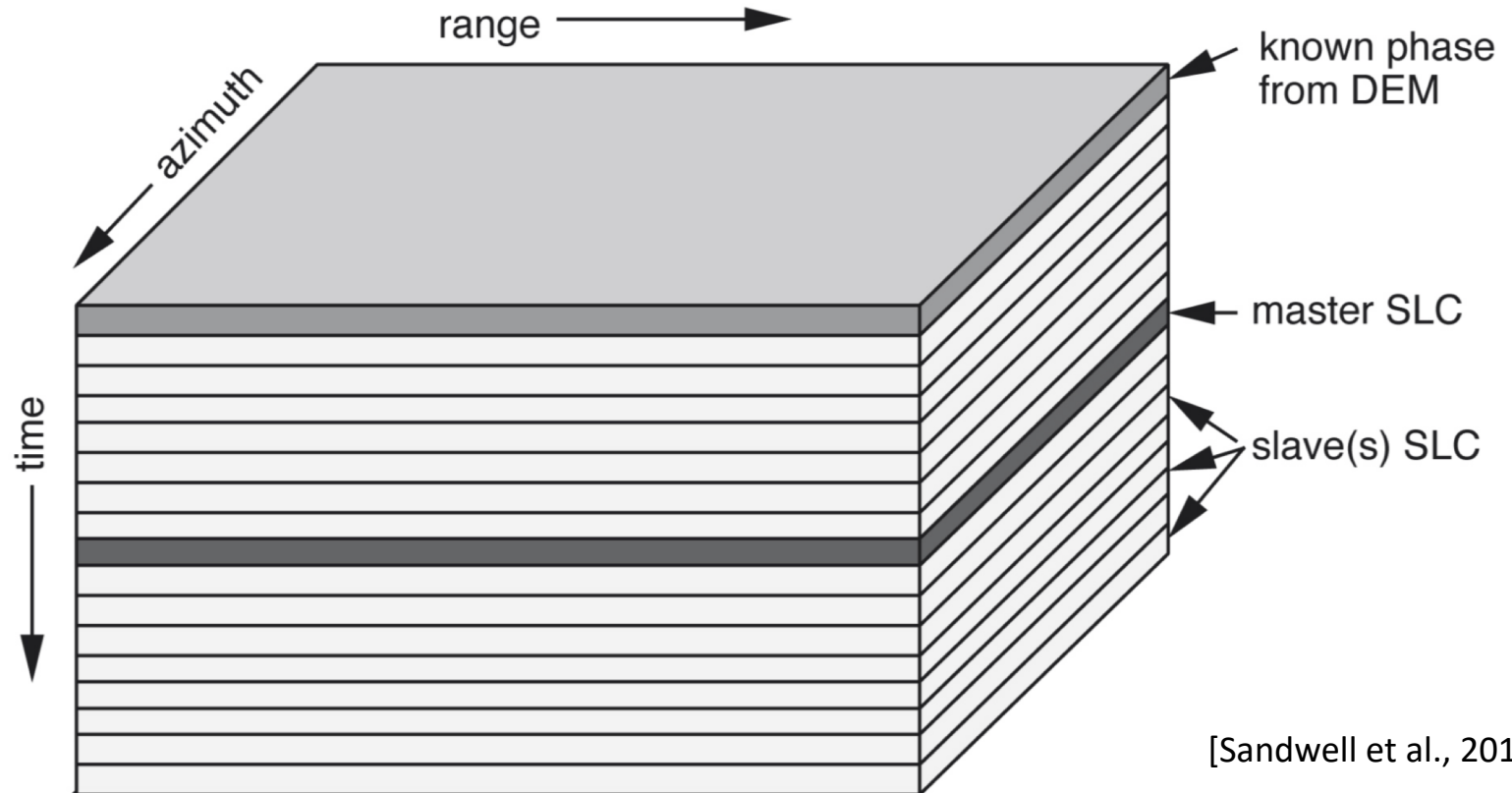
Minimize the error measure

Network Flow Method

snaphu: mostly used



Time Series Analysis

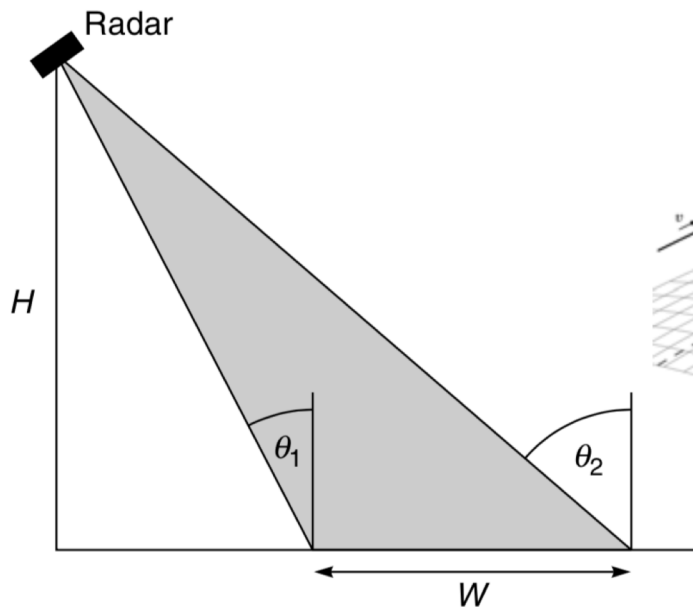


[Sandwell et al., 2017]

- **Tectonic settings**
- **Traditional Interferometry**
- **Sentinel TOPS-mode**
- **Persistent Scatterer Method**

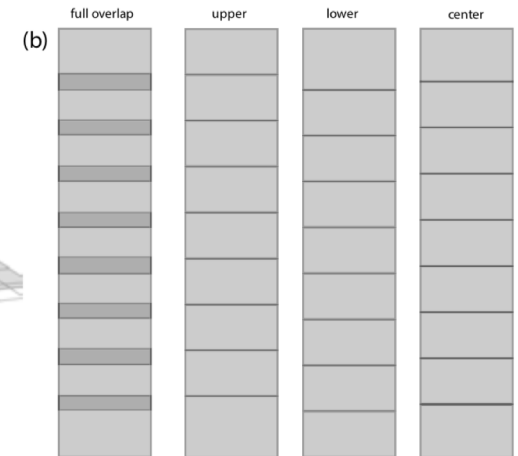
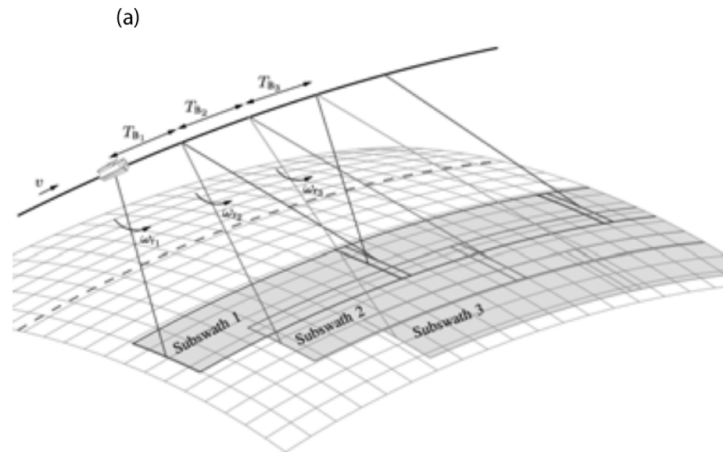
TOPS mode interferometry

Stripmap Mode



Restricted by antenna length
Maximum swath width ~80km

TOPS Mode



Three subswaths, each one 80 km wide and 20 km along track
Phase difference in overlap areas refining the image alignment

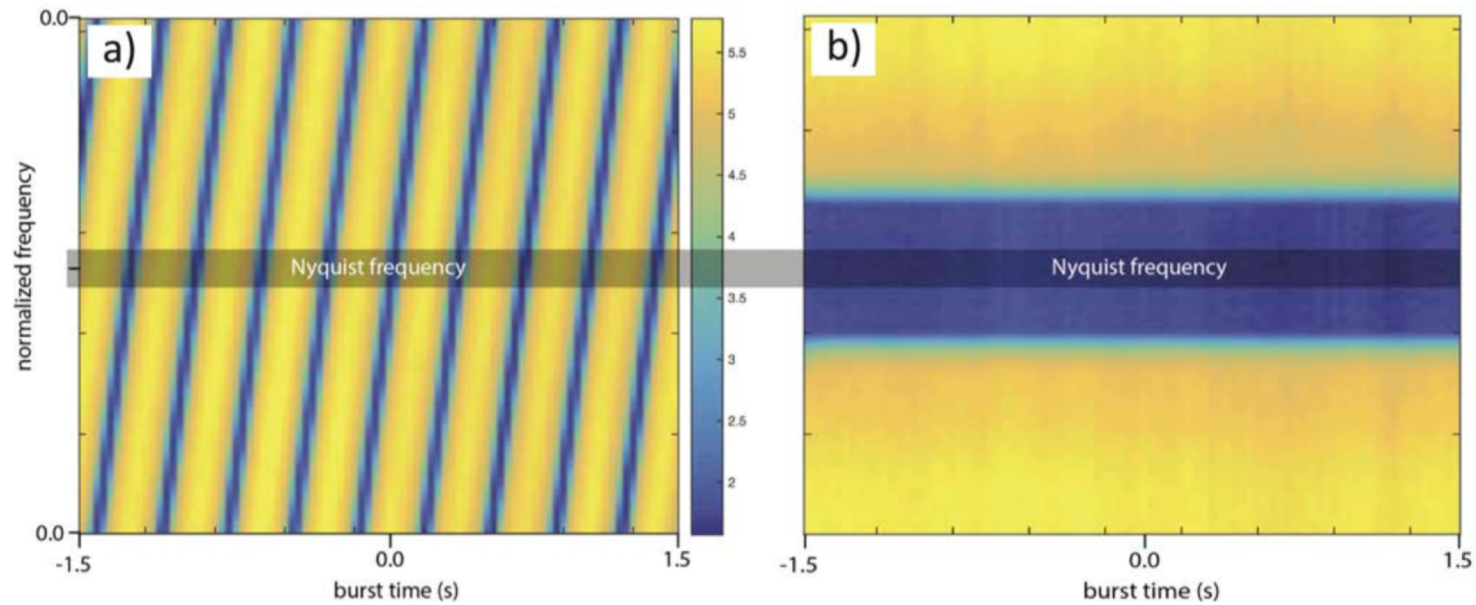
$$\Delta\alpha = PRF \frac{\phi}{2\pi(f_u - f_l)} \text{ (enhanced spectral diversity)}$$

[Sandwell et al., 2017]

TOPS mode interferometry

Central Doppler Variation: ~ 4.5 kHz
PRF: ~ 486 Hz

Deramp the spectrum and resample



mis-registration error: $\sim 1/200$ pixel
traditional accuracy: $\sim 1/10$ pixel

[Xiaohua et al., 2017]

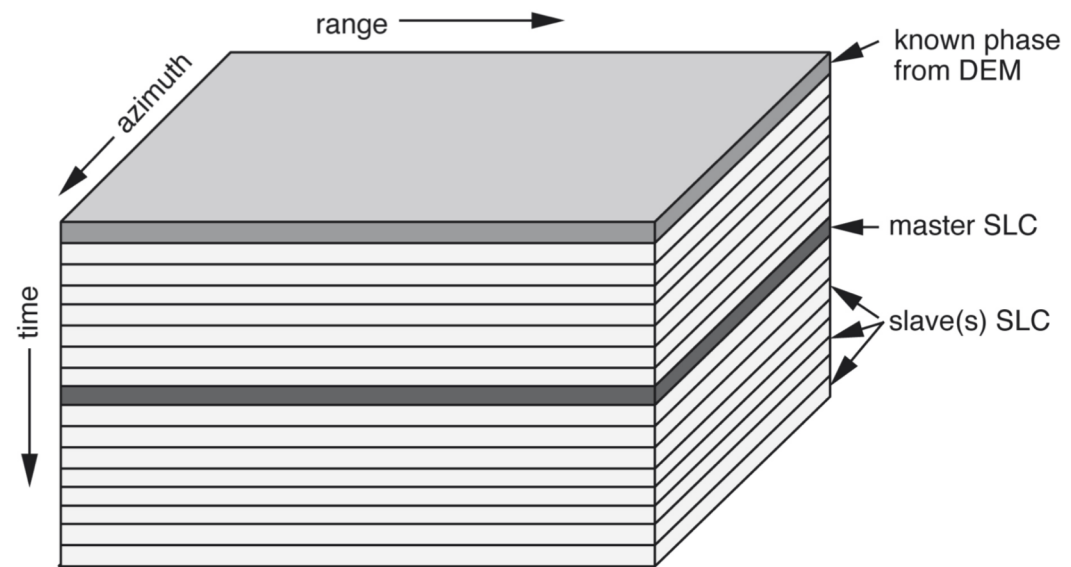
Geometric Image Registration

Cross-correlation method fail

- 0.1 pixel accuracy less than 0.01 pixel to match the phase
- TOPS high frequency well above Nyquist frequency of SLC

Geometric Alignment

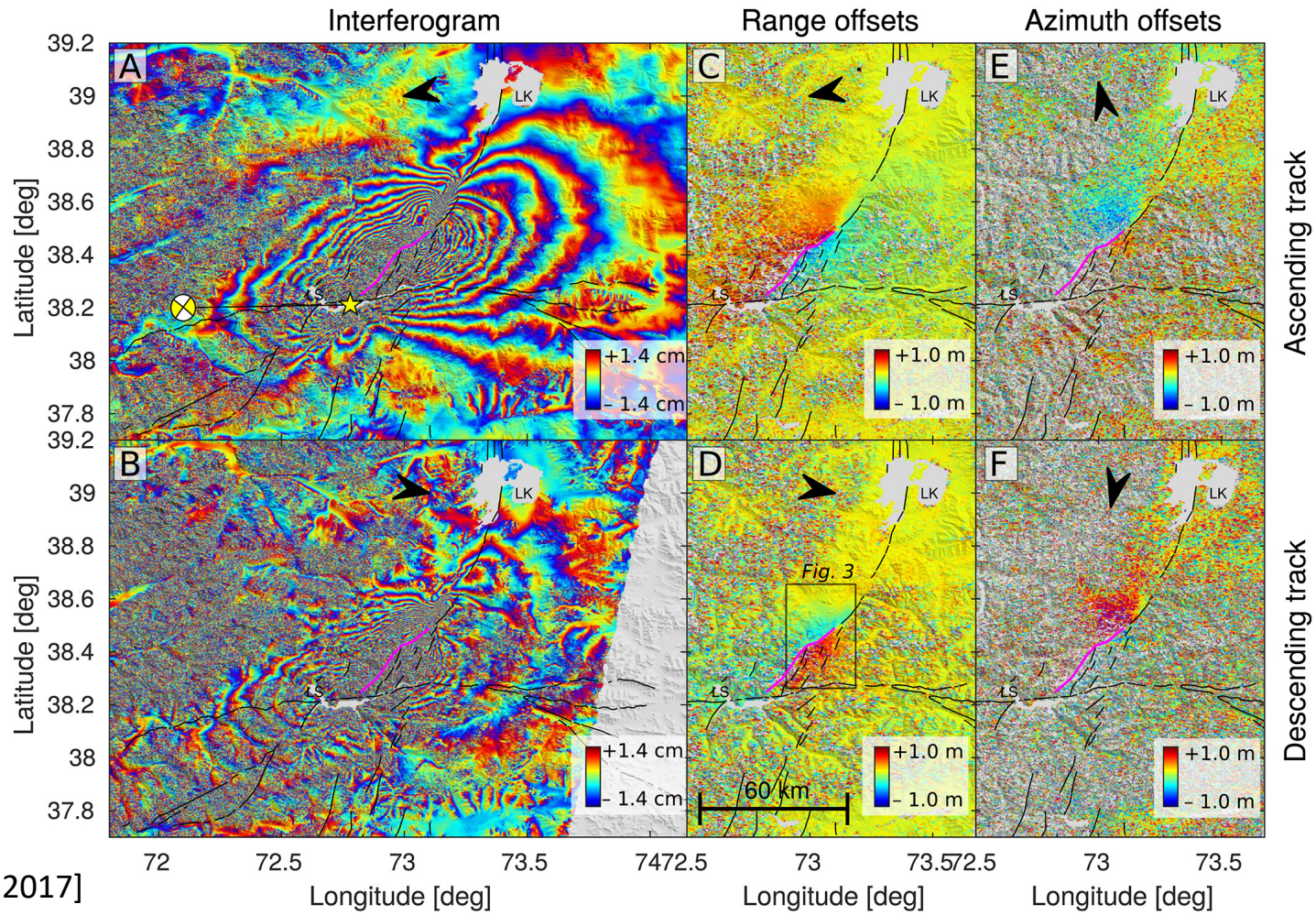
- Based on Sentinel 1A precise orbit
- remove almost phase mismatch



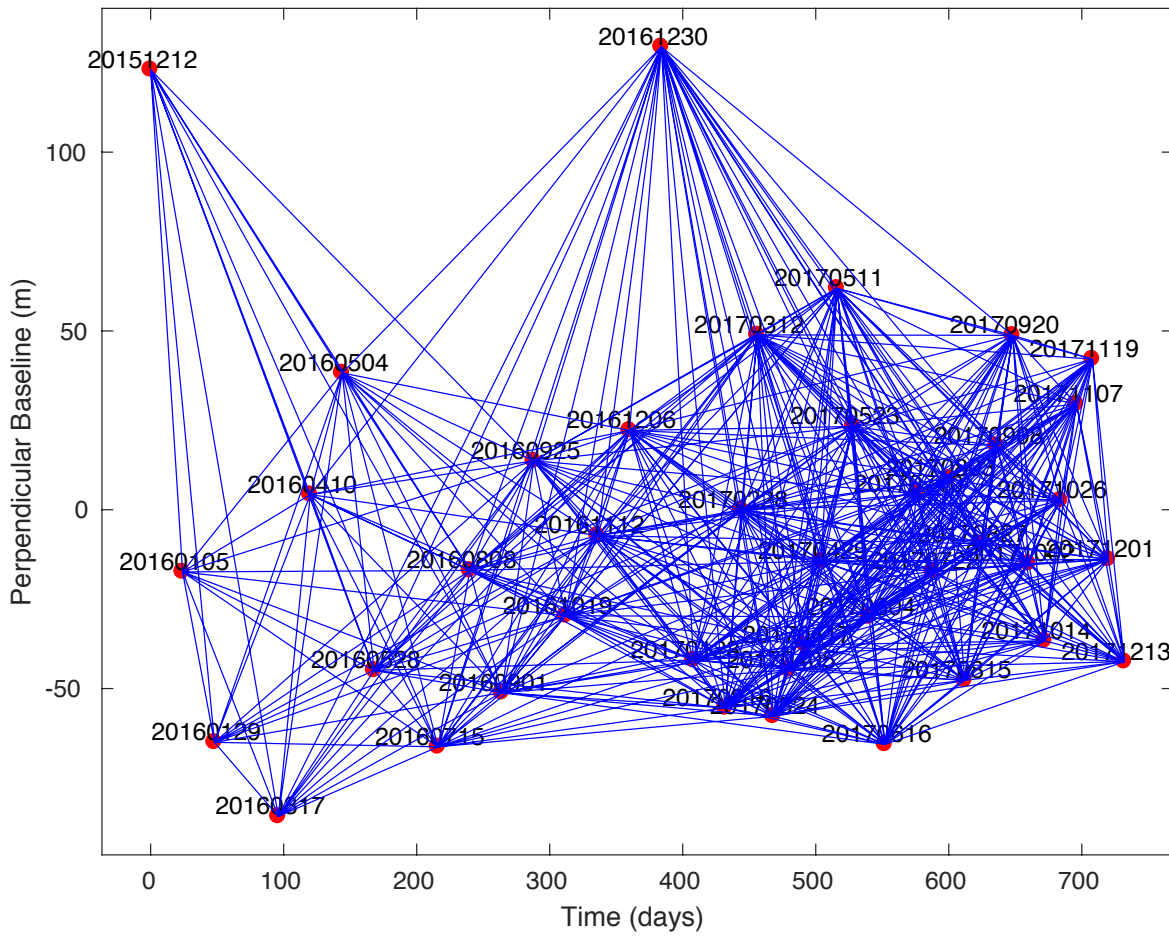
**Form interferograms with any two slave images
(reduce temporal decorrelation)**

[Sandwell et al., 2017]

Coseismic Interferogram

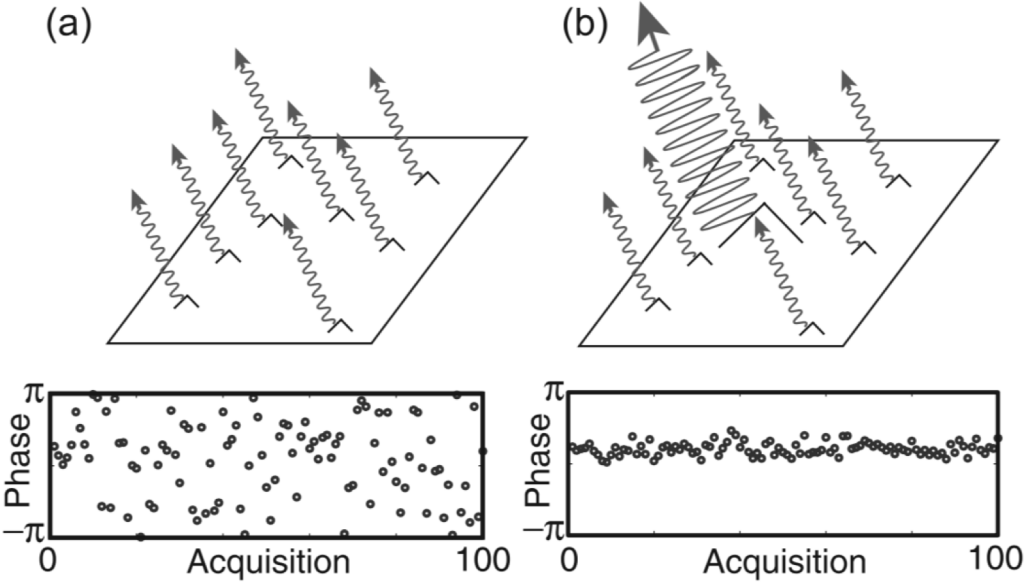
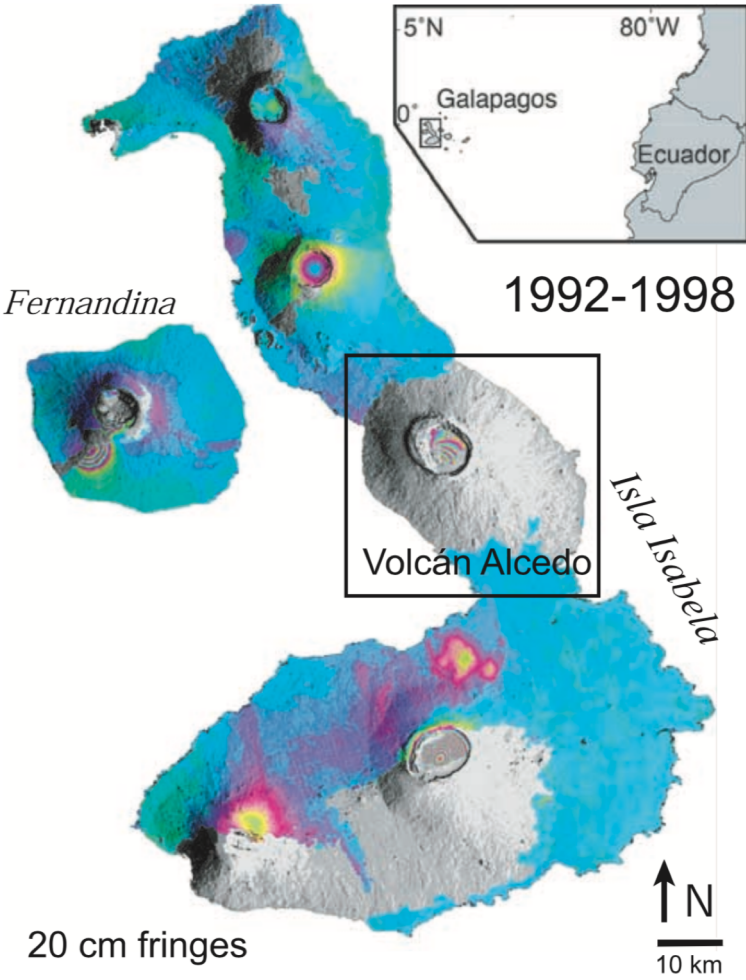


Time Series Postseismic Slip



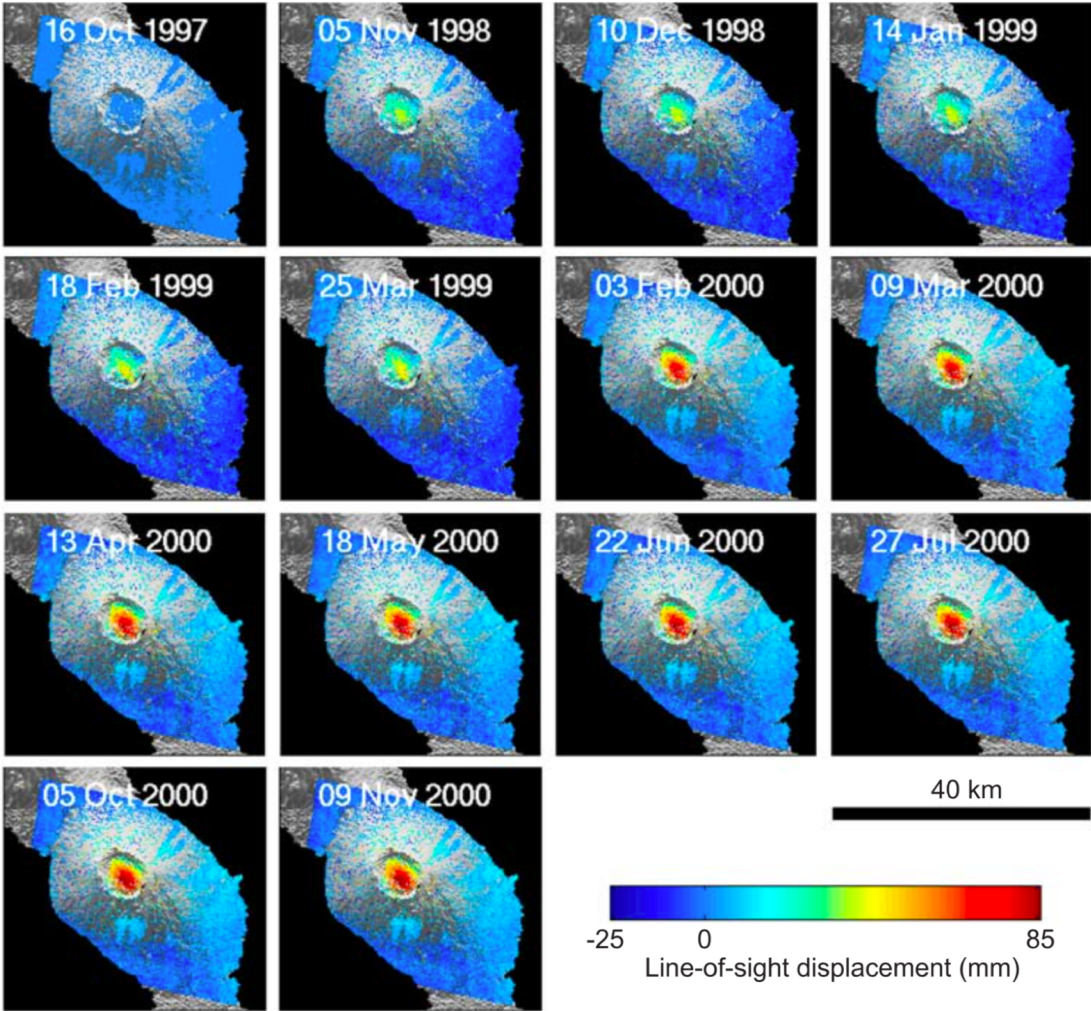
- **Tectonic settings**
- **Traditional Interferometry**
- **ScanSAR & Sentinel TOPS-mode**
- **Persistent Scatterer Method**

Persistent Scatterer Method



[Hooper et al., 2007]

Persistent Scatterer Method



- Make interferograms from master to each slave images
- Phase Stability Analysis
- Amplitude Analysis $D_A = \frac{\sigma_A}{\mu_A}$
- Phase Analysis
- PS selections
- Phase unwrapping

[Hooper et al., 2007]

Unfortunately...

Questions?