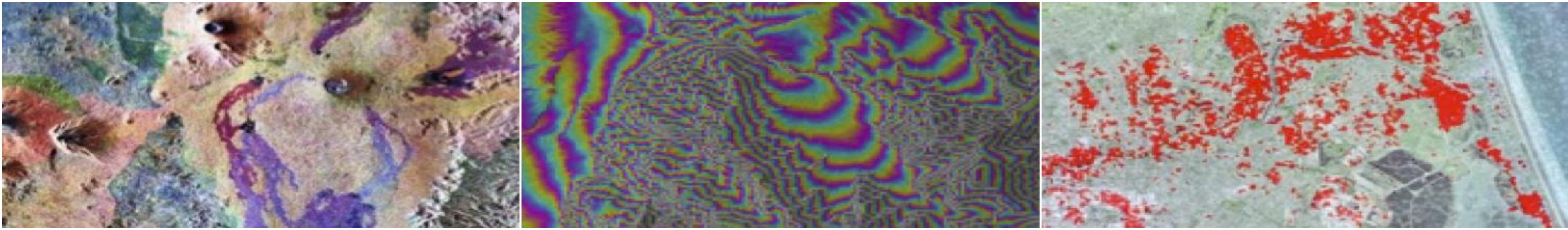

# InSAR Timeseries Analysis: theory and overview

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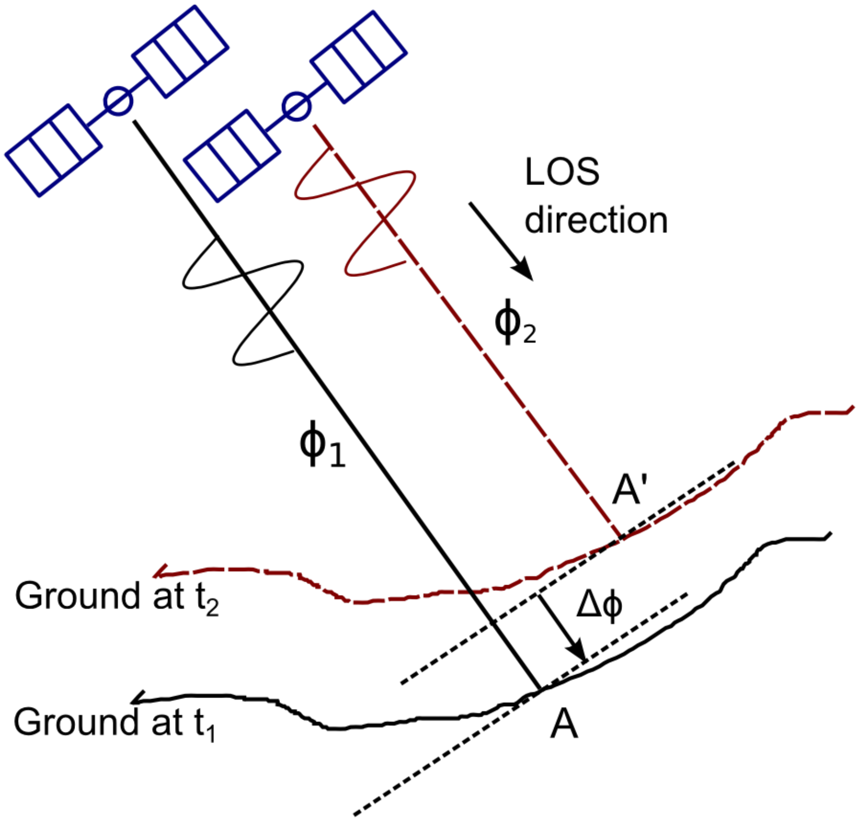
# Interferometric Synthetic Aperture Radar (InSAR)



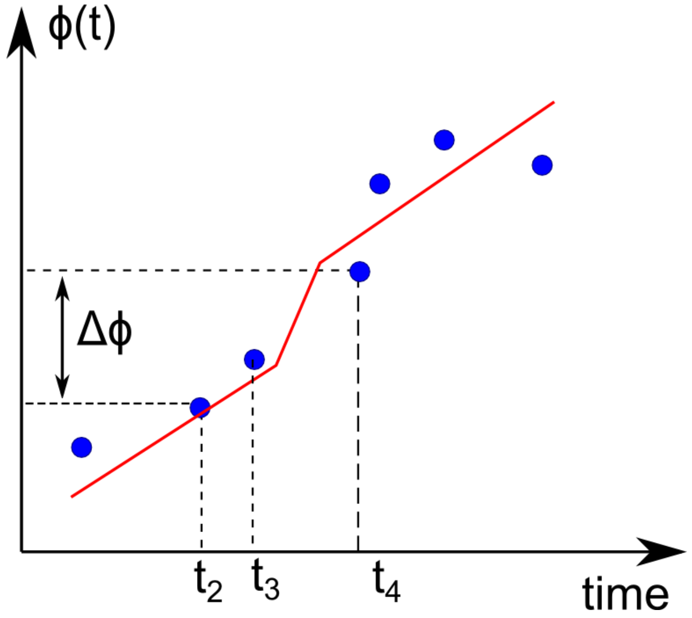

- We can measure any small ground deformation $\Delta d$ along LOS direction occurring between $t_1$ and $t_2$ using the InSAR phase difference $\Delta\phi$:

$$\Delta\phi = \frac{4\pi}{\lambda}\Delta d$$

- Temporal and Spatial Baselines

# InSAR time series analysis

*LOS InSAR phase history of a pixel in the interferogram:*




Define $v_k$ as the average velocity between $t_k$ and $t_{k+1}$, we have:

$$(t_3 - t_2)v_2 + (t_4 - t_3)v_3 + \Delta\phi_{noise} = \Delta\phi$$

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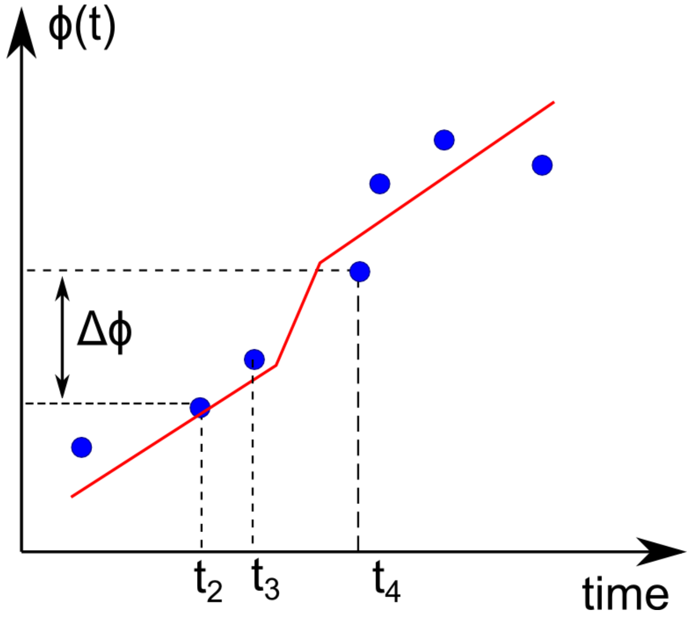


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We use 7 SAR data to form M small baseline interferograms. The matrix form of the SBAS system is:

$$B_{M\times 6}v_{6\times 1} = \Delta\Phi_{M\times 1}$$

# The impact of noise terms

- The accuracy of the SBAS time series results depends on the quality of the input data!

- InSAR measurement noise:

$$\Delta\phi = \frac{4\pi}{\lambda}\Delta d_{LOS} + \Delta\phi_{orb} + \Delta\phi_{decor} + \Delta\phi_{unwrap} + \Delta\phi_{dem} + \Delta\phi_{iono} + \Delta\phi_{tropo} + \Delta\phi_{n}$$

  – InSAR time series analysis can reduce the impact of noise that are random in time (e.g. tropospheric turbulence noise) through the use of temporal filtering and deformation models.

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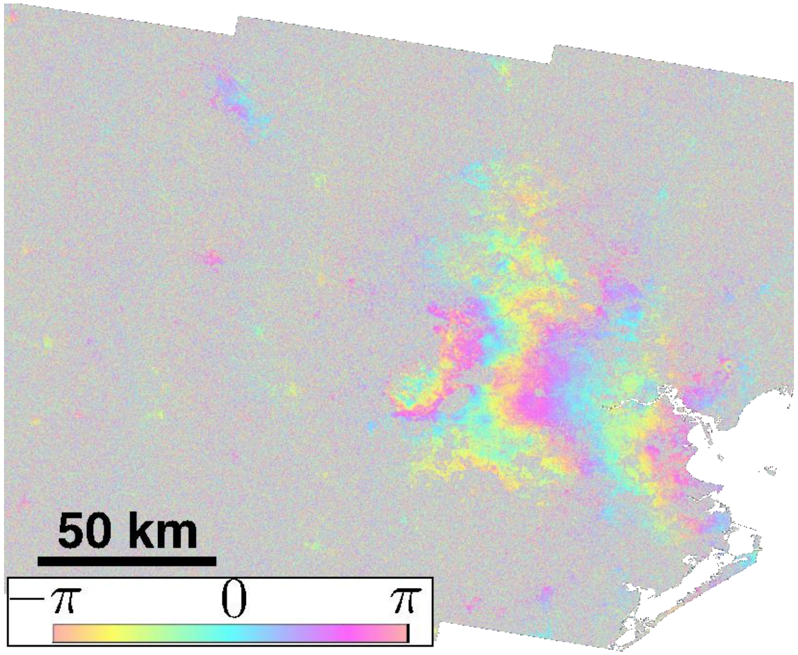
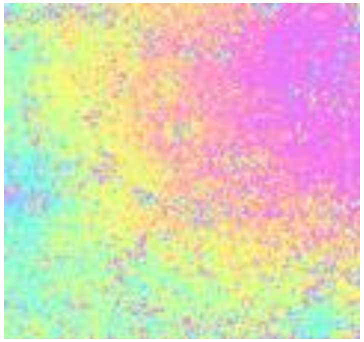
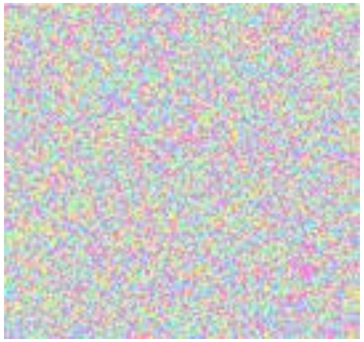
  - In many cases, the dominant errors are tropospheric noise and decorrelation noise and the associated unwrapping errors.

# Decorrelation noise



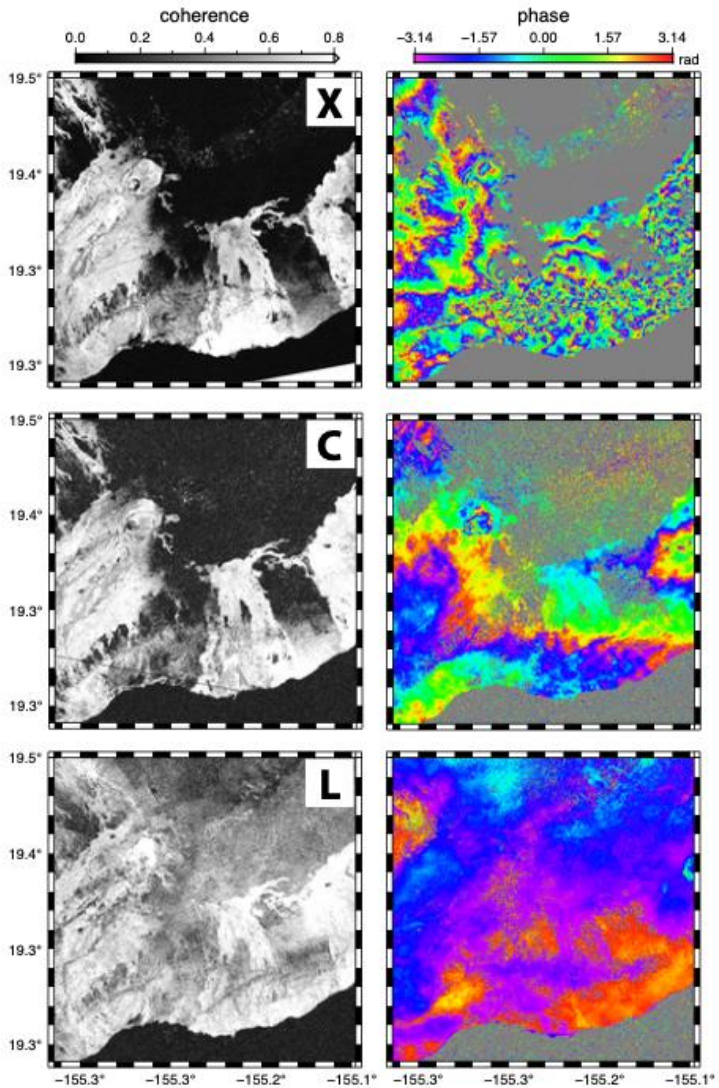
Without severe decorrelation, phase measurements are spatially coherent.



With decorrelation, phases are random and not predictable.

Sentinel-1 Interferogram over the Greater Houston area (Jan. 03, 2018 – Nov. 06, 2019)

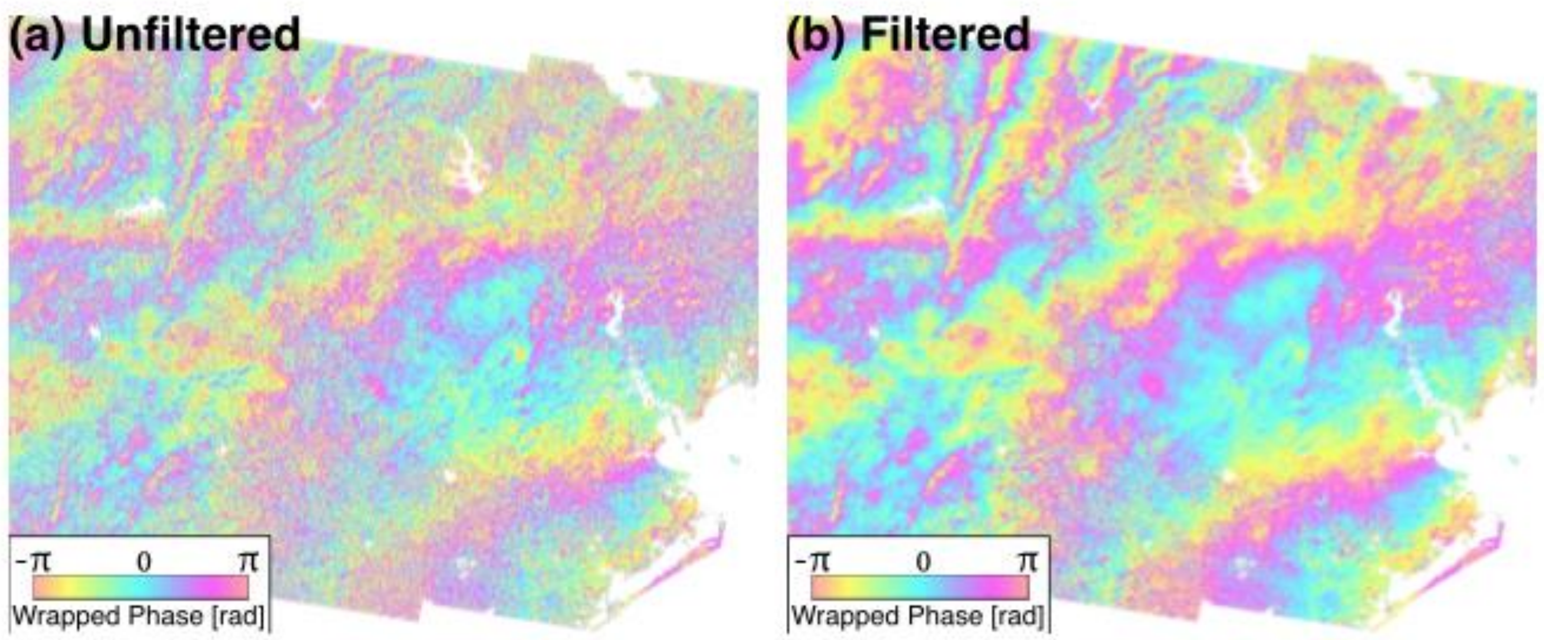
# Decorrelation Noise Characteristics




- A major issue over densely vegetated terrain
- Radar sensors with shorter wavelengths are more prone to decorrelation noise.

# Mitigation Strategies

- Spatial Filtering or Multi-looking



## Mitigation Strategies

- Using a subset of interferograms with small baselines
  - Works well if your study site suffers from minimal or moderate decorrelation
  - In vegetated regions, the SBAS solutions may be unreliable (e.g., different temporal thresholds lead to very different solutions).
- Persistent Scatterers