

# A Proposal for **Interferometric Time Series Product** with Reduced Stochastic and Systematic **Phase Errors**

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Knowledge for Tomorrow

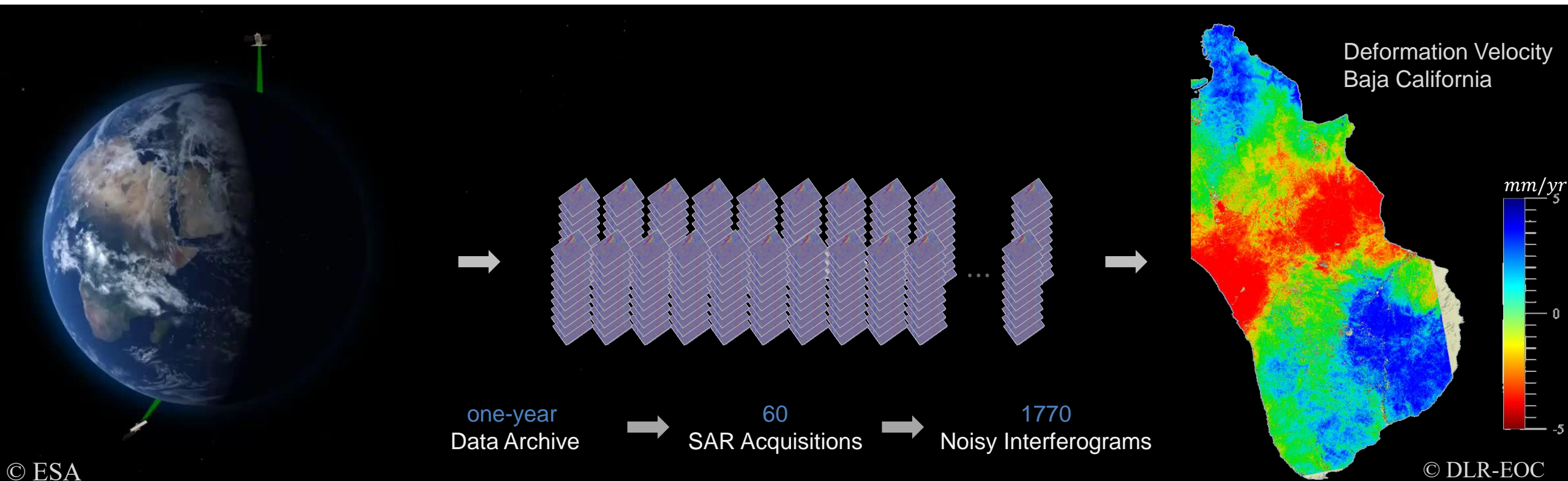


# Big Data from Sentinel-1

Unique Capability : high-precision **deformation** monitoring (mm/yr)

Challenge : **preserving** accuracy in Big Data processing

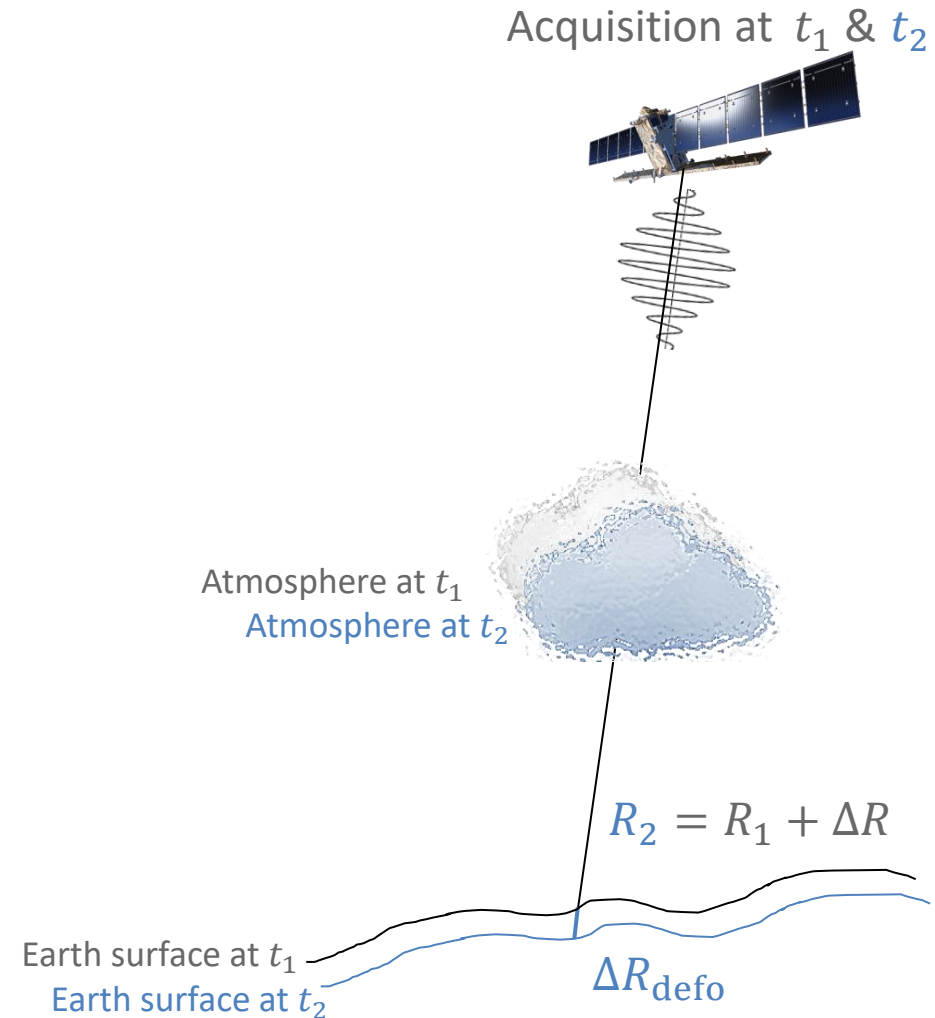
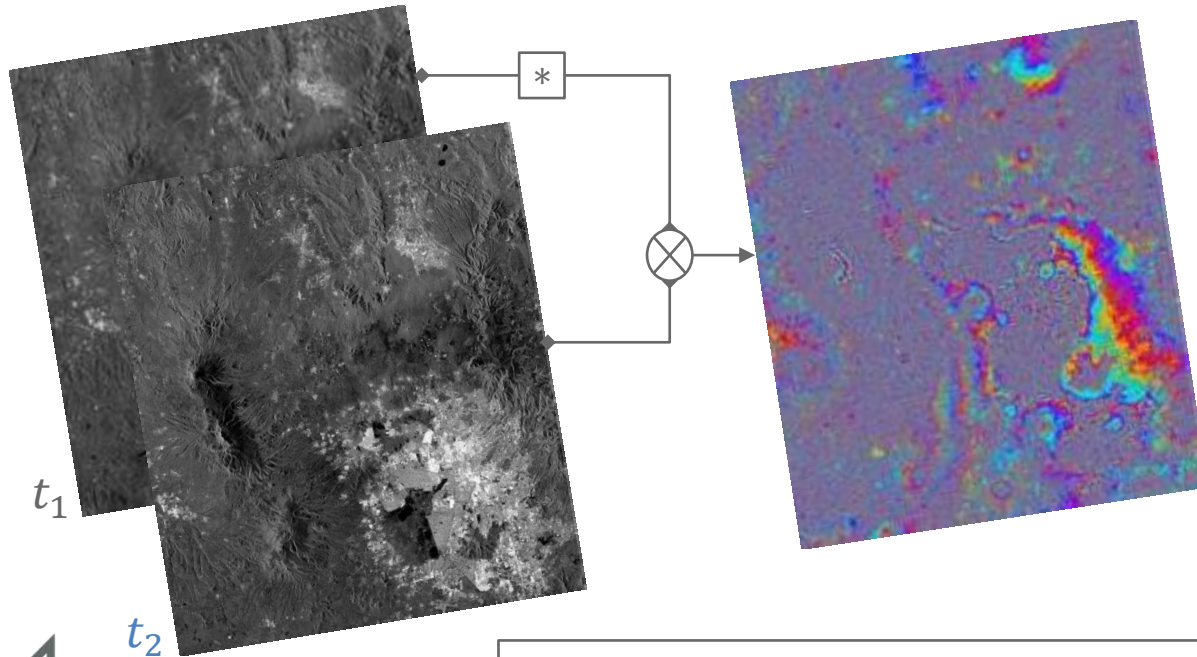
Our Solution : proposal of **an analysis-ready phase product** to overcome the challenge



# Systematic Error Sources in Interferograms

$$\Delta R = \frac{\lambda}{4\pi} \Delta\phi = \Delta\phi_{\text{atmo}} + \Delta\phi_{\text{defo}} + \Delta\phi_{\text{sct}} + \Delta\phi_{\text{system noise}}$$

$\Delta\phi_{\text{sct}} \rightarrow$  decorrelation noise  
 $\rightarrow$  systematic signal/error

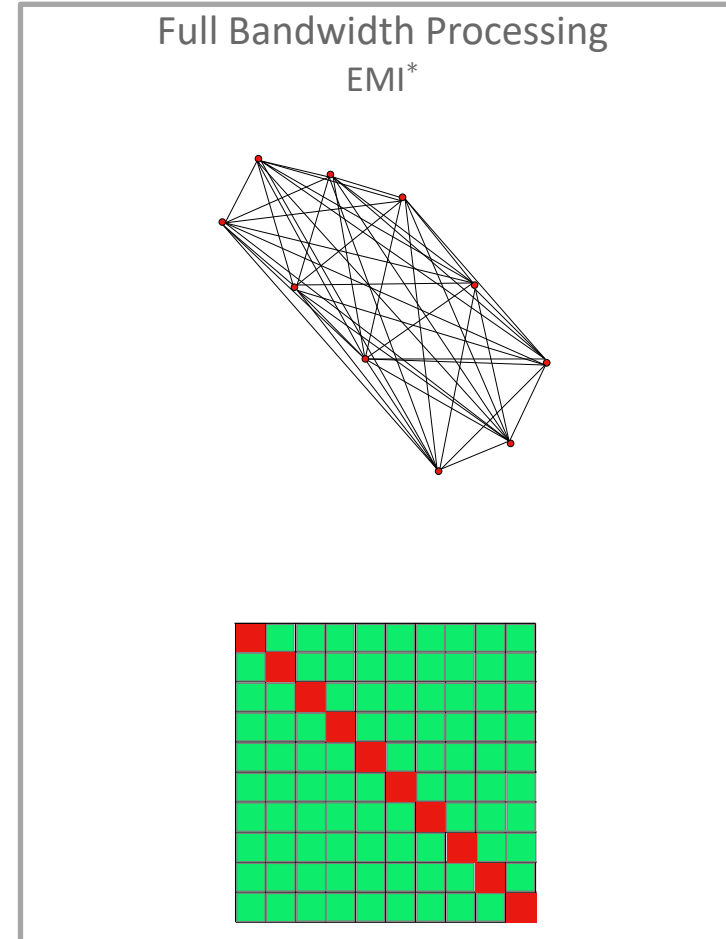
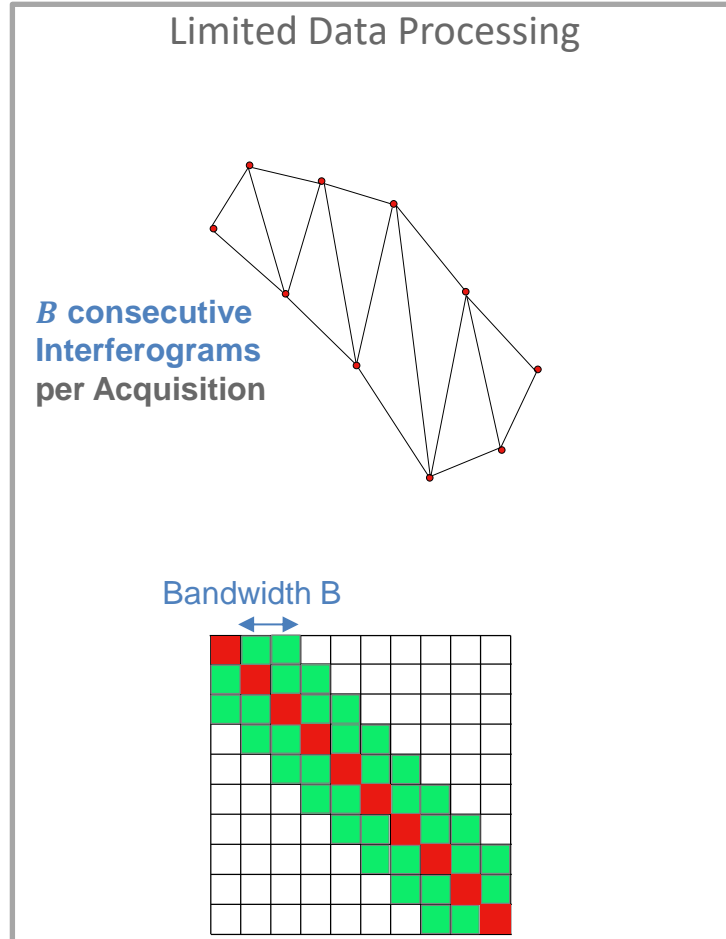


# Verification of Deformation Velocity Maps from Big Data Processing





# Different Schemes in Big Data Processing



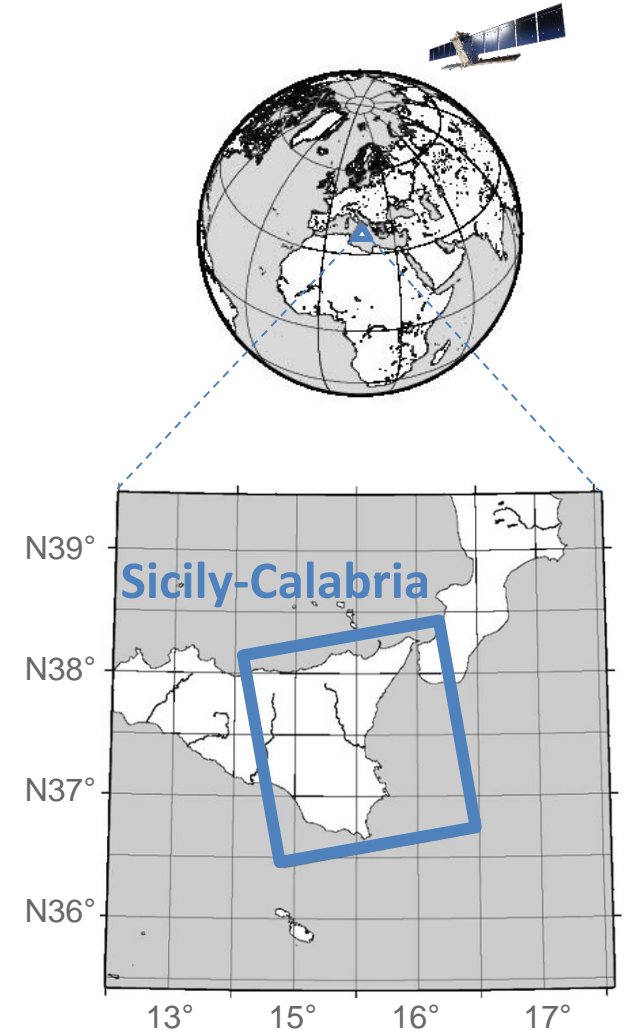
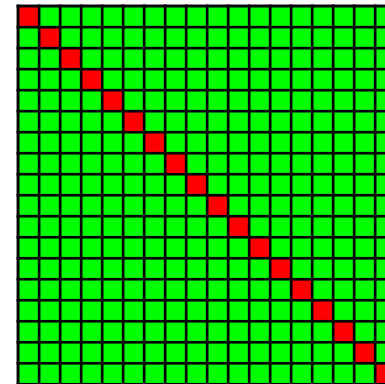
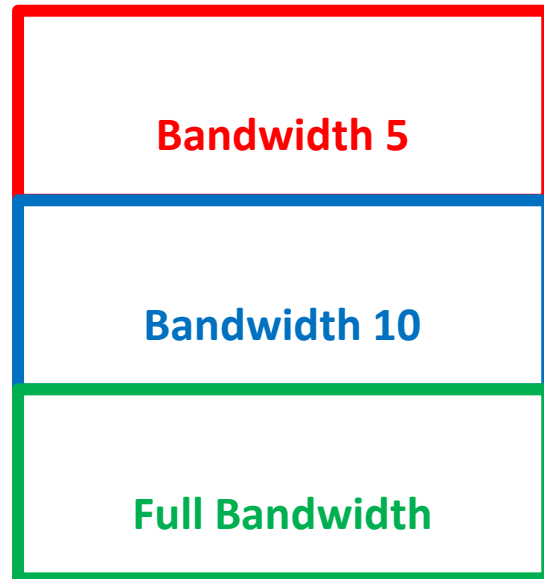
# Verification Scheme

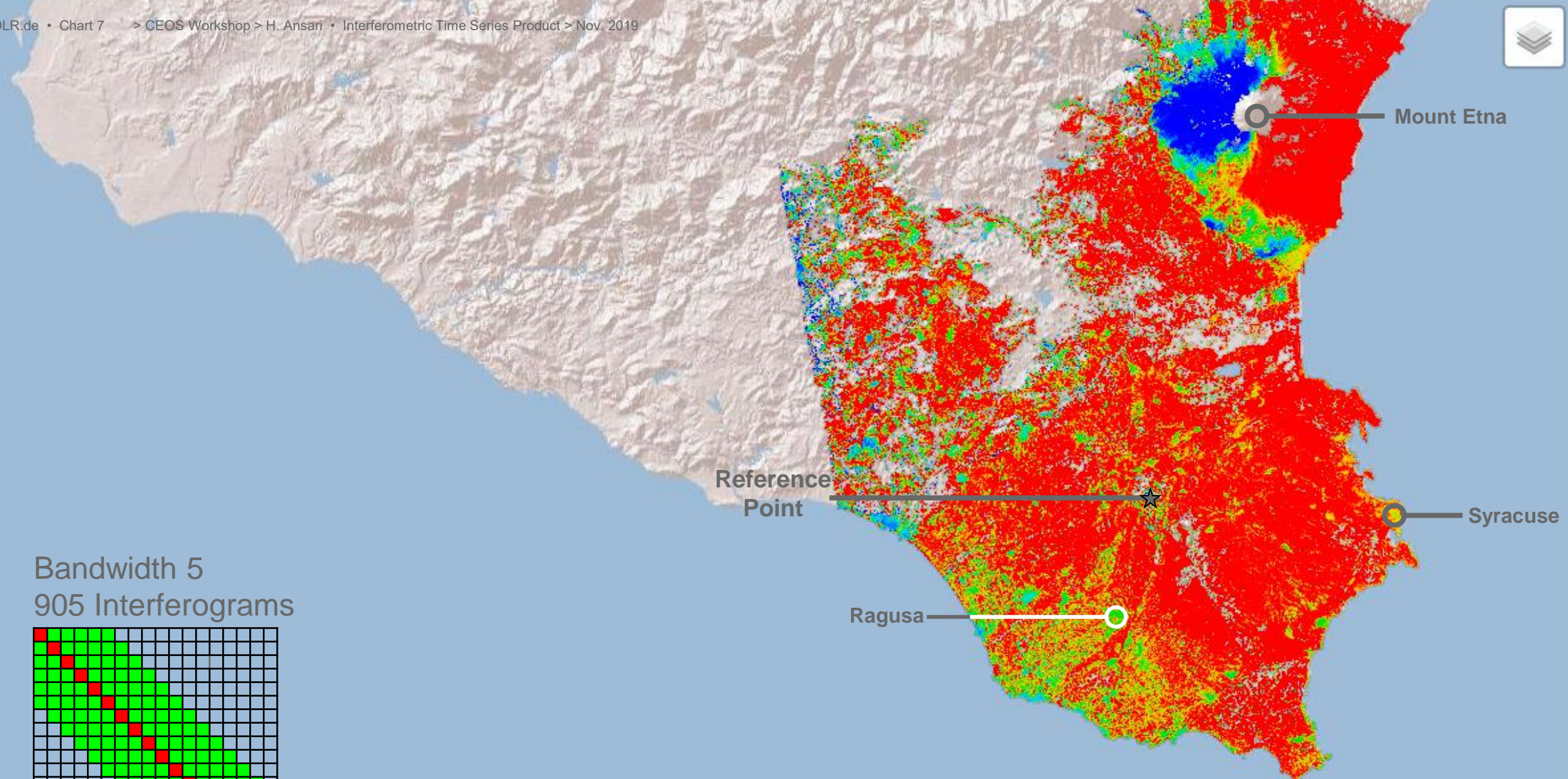
## Sentinel-1 A/B time series:

acquisition time span : 4 years (Oct. 2014-Sep. 2018)  
size of the time series : 184 SLCs  
extent of the chosen area  $\approx 30000 \text{ km}^2$   
number of processed bursts : 19

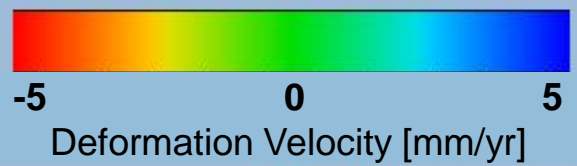
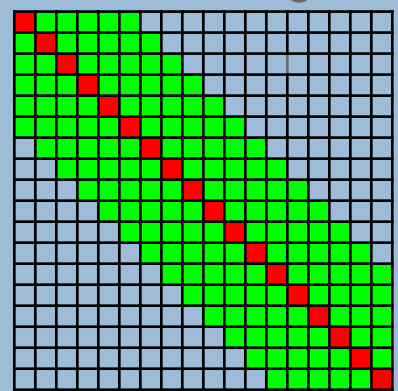
PSI

versus





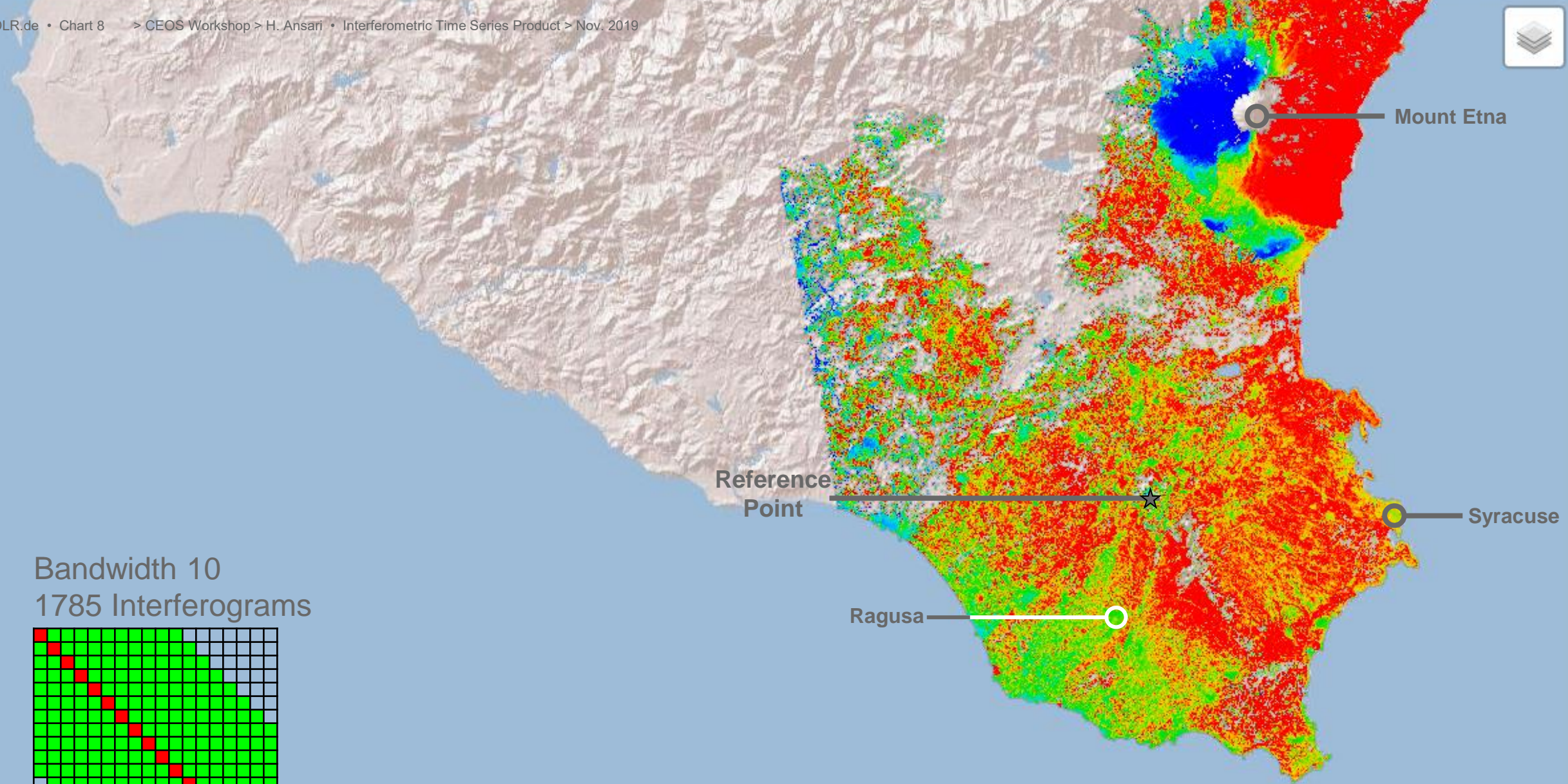
Bandwidth 5  
905 Interferograms



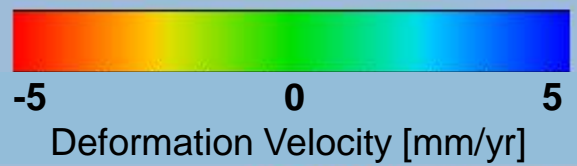
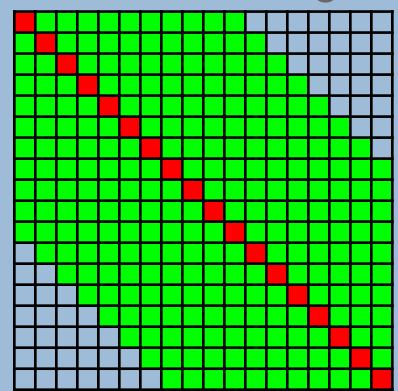
20 km

Lat: 36.62214 Lng: 18.94867





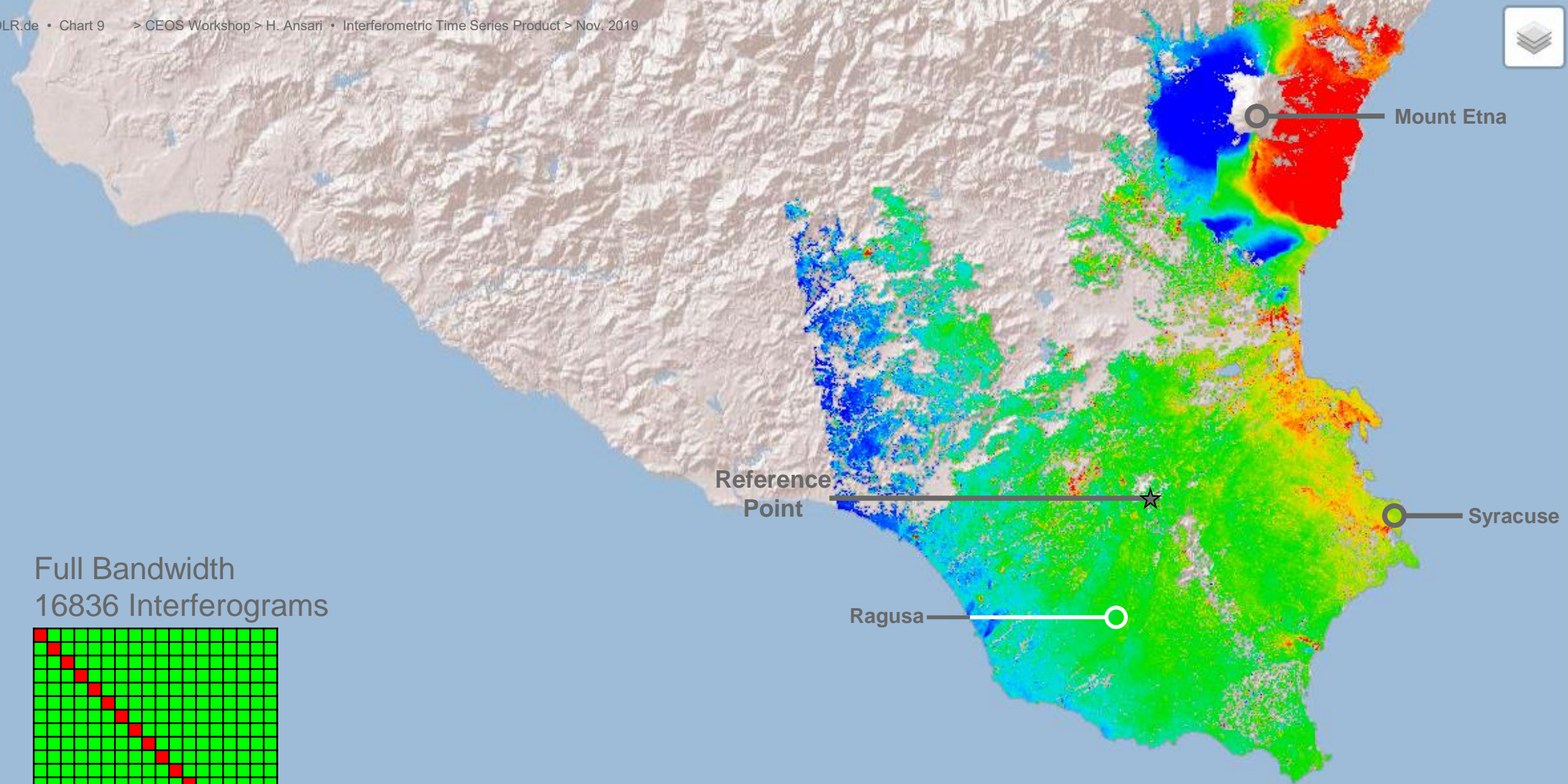
Bandwidth 10  
1785 Interferograms



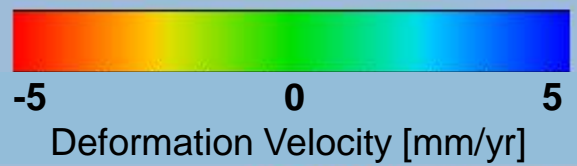
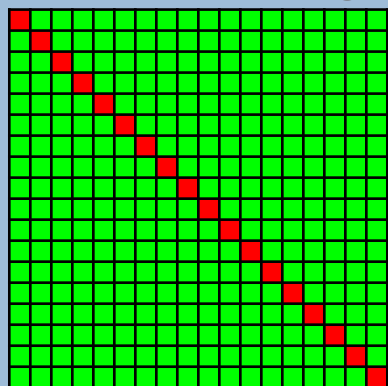
20 km

Lat: 36.62214 Lng: 18.94867





Full Bandwidth  
16836 Interferograms



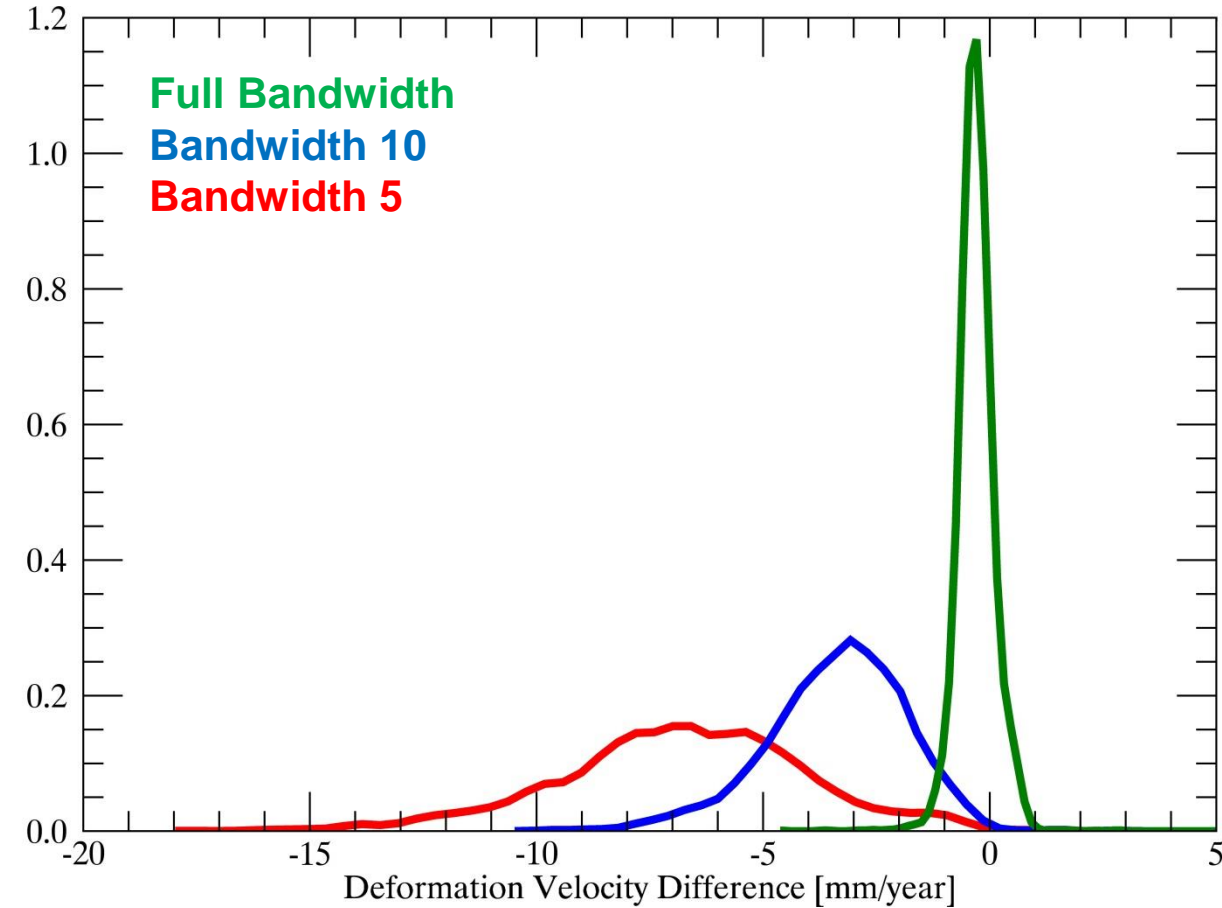
20 km

Lat: 36.62214 Lng: 18.94867

# Accuracy of Deformation Velocity Maps

- Comparison with PSI
- Persistent Scatterers (PS): free from systematic phase error

	Bias [mm/year]	Std. Deviation [mm/year]
Bandwidth 5	-6.50	2.58
Bandwidth 10	-3.05	1.55
Full Bandwidth	-0.24	0.70

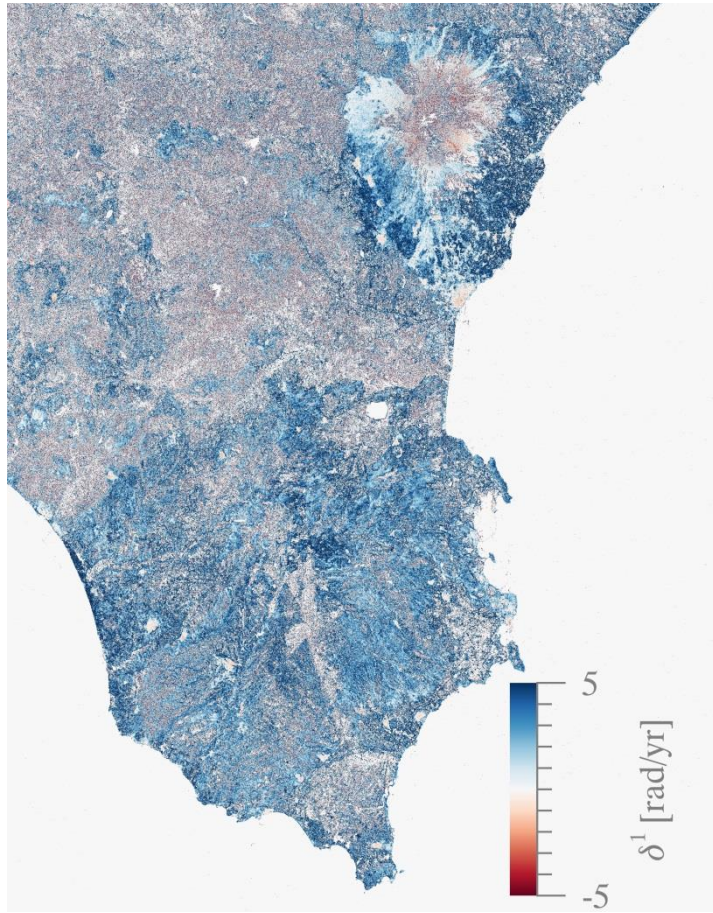


## The Origin of Deformation Error

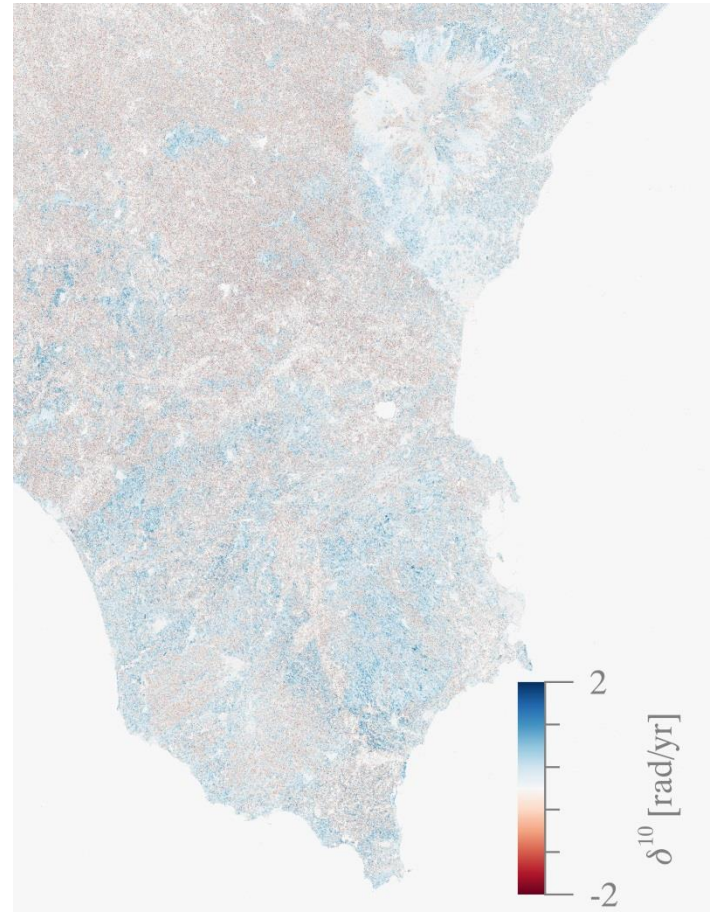




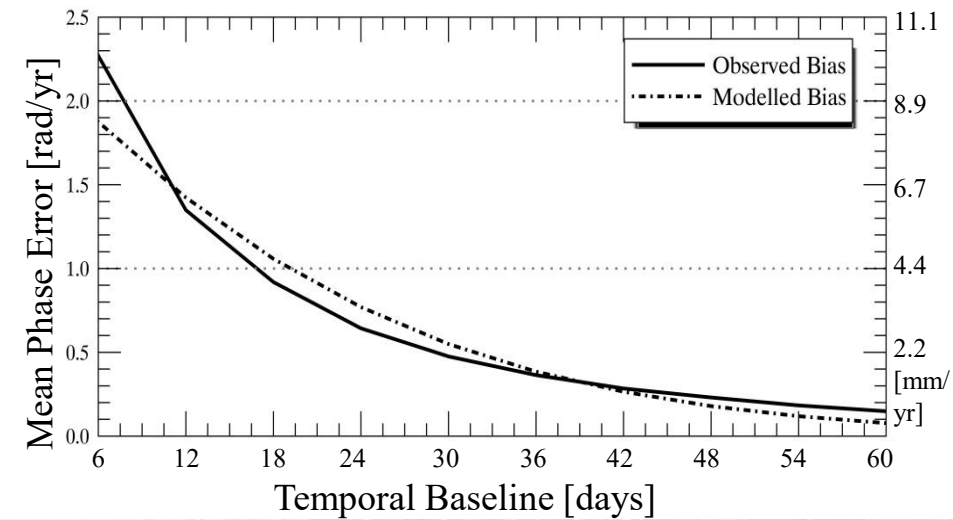
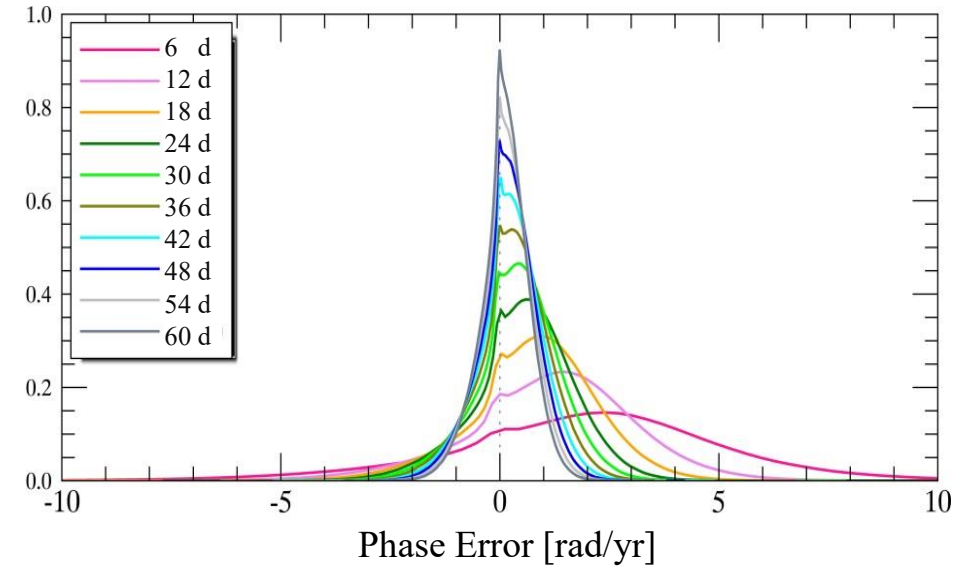
# Evaluation of Phase Error



**Error of 6-day Interferograms**



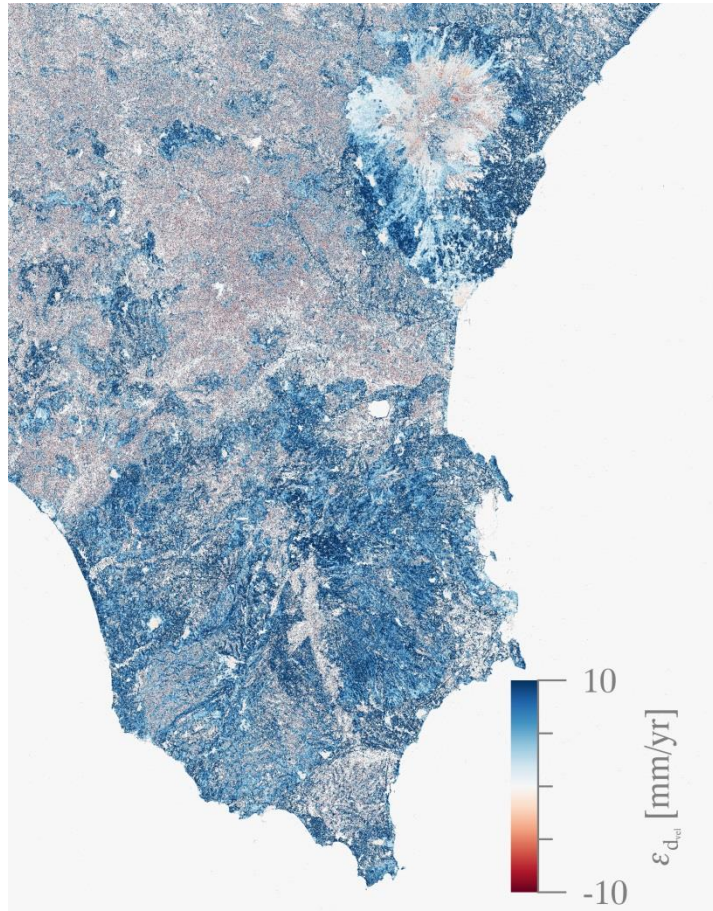
**Error of 60-day Interferograms**



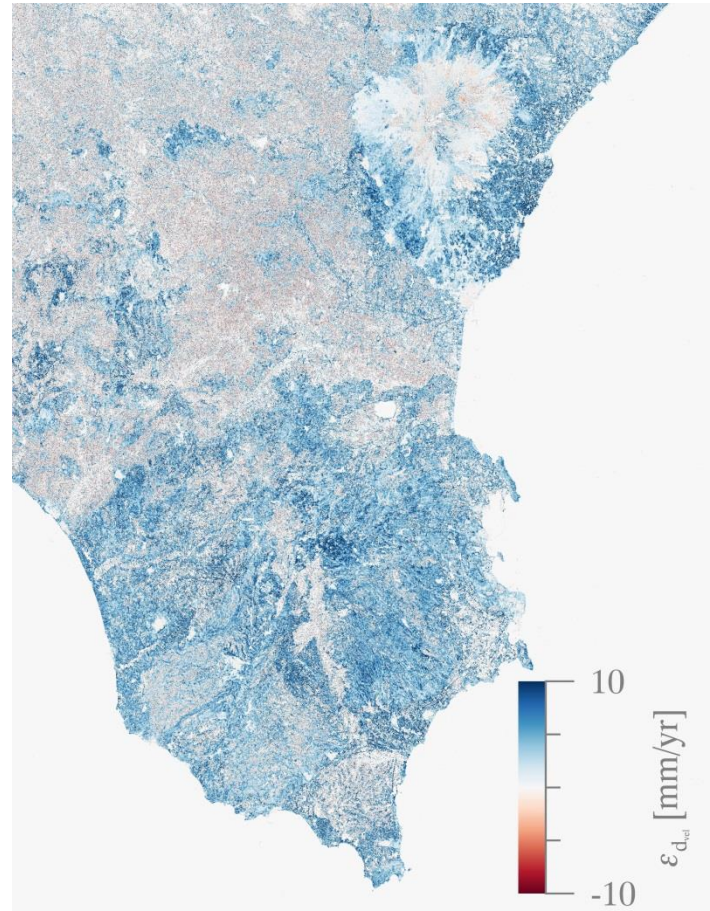


# Evaluation of Deformation Error

propagation of error from interferograms to deformation

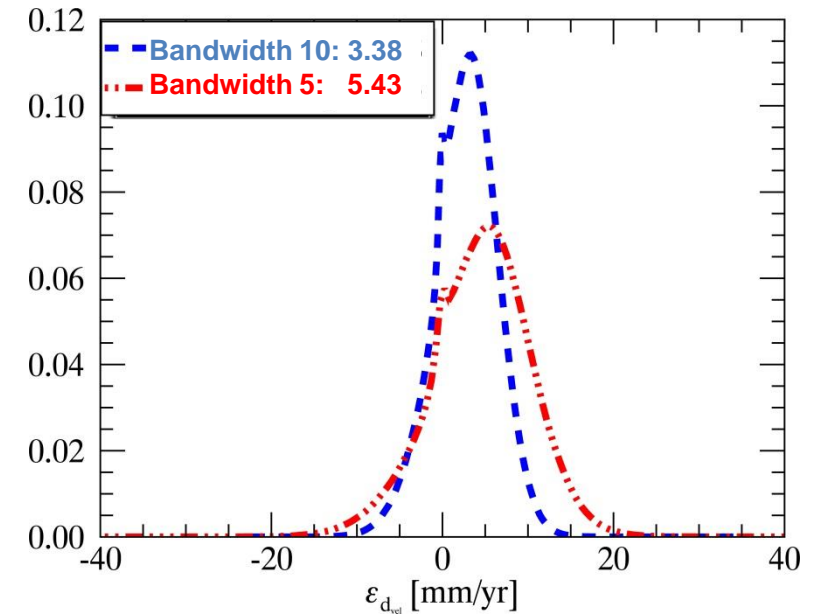


**Bandwidth 5 processing**



**Bandwidth 10 processing**

Empirical Deformation Error from Data:  
**Bandwidth 10 : 3.05 mm/yr**  
**Bandwidth 5 : 6.5 mm/yr**



# An Analysis-ready InSAR Product with Reduced Phase Errors





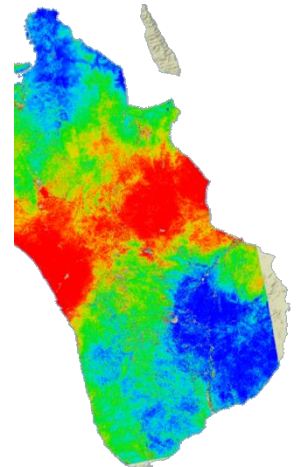
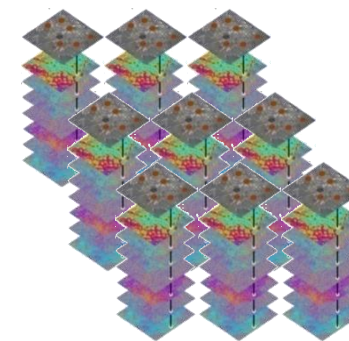
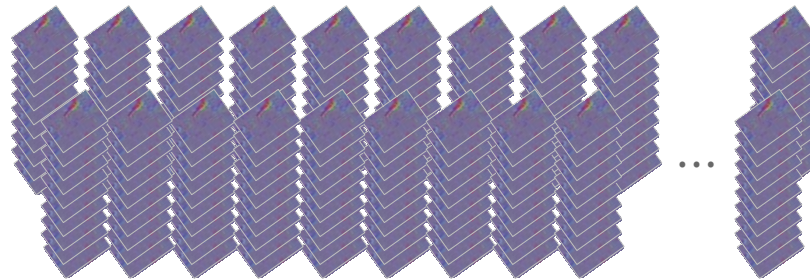
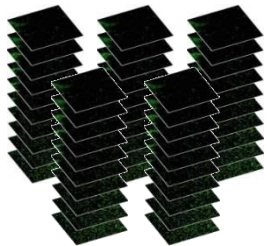
# Current Approach in Processing Big Data

Coregistration  
 $N$  SLCs

Choosing a subset of  
 $K$  interferograms  
 $K > N - 1$

Unwrapping the  
 $K$  interferograms

Deformation Map

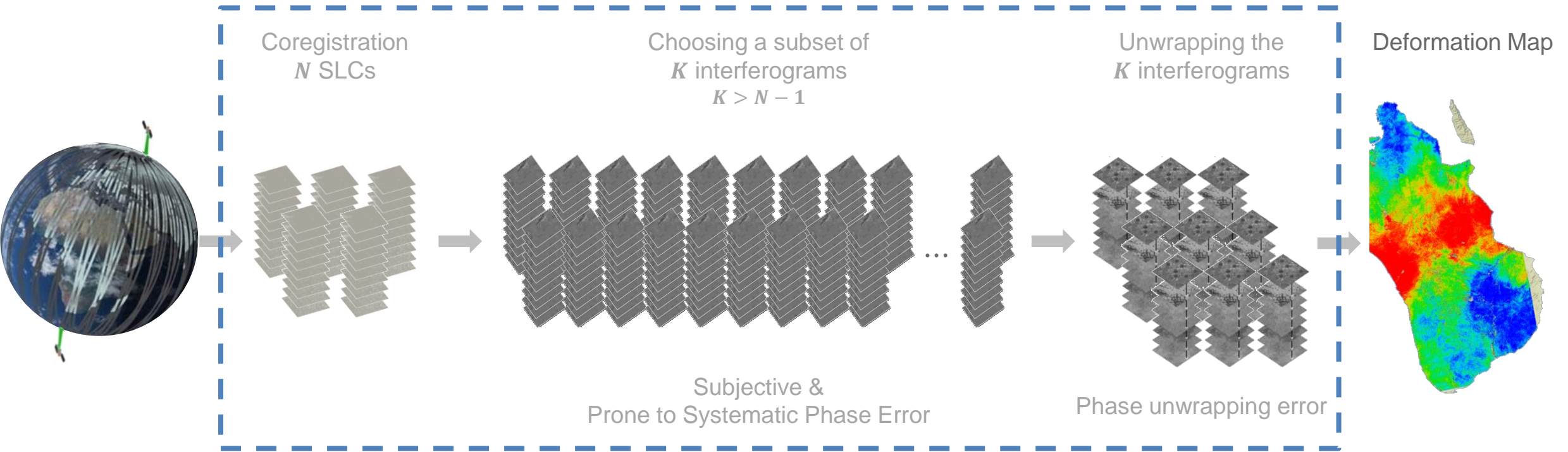


Subjective &  
Prone to Systematic Phase Error

Phase unwrapping error



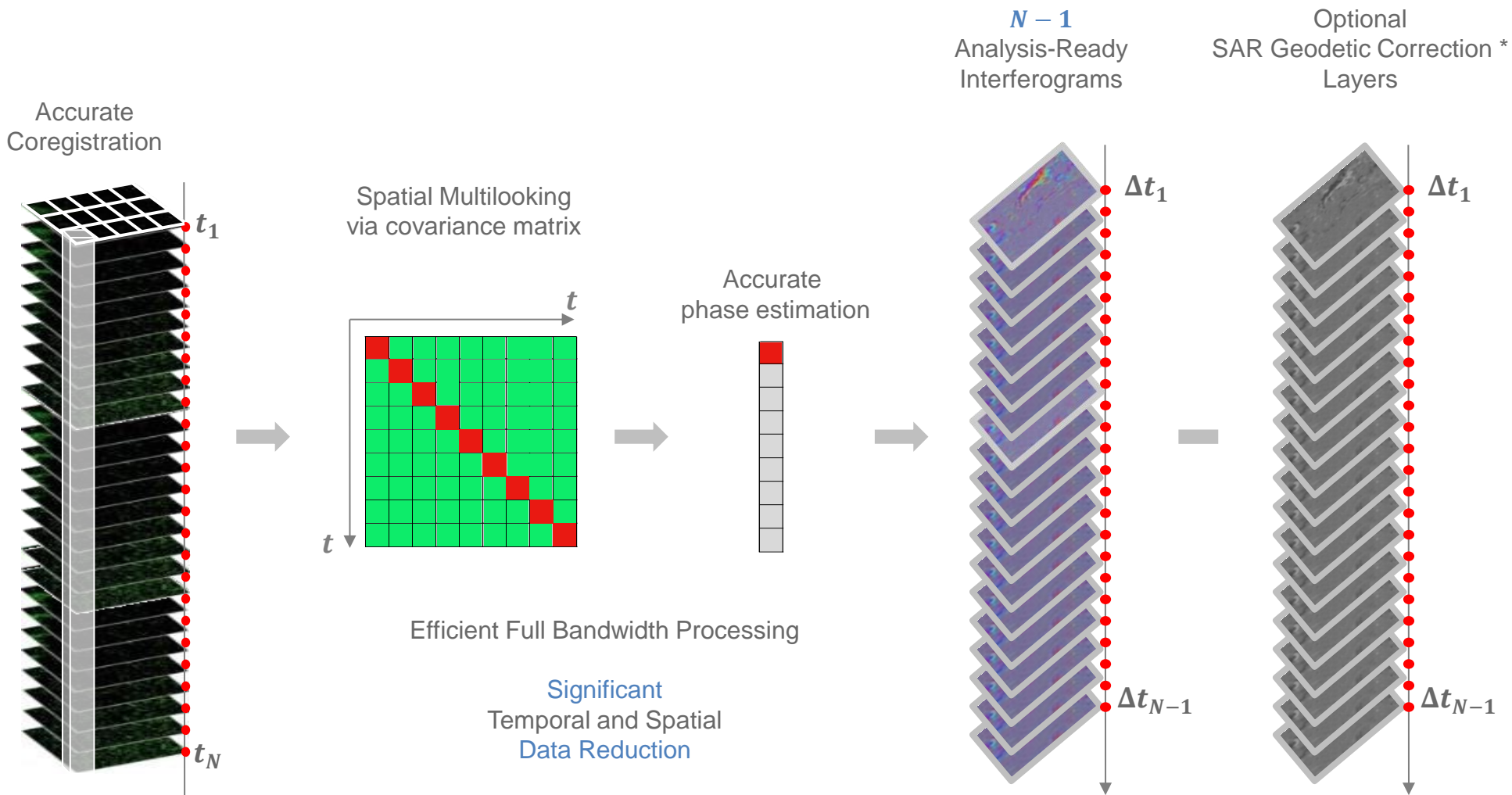
# Current Approach in Processing Big Data



Substitution with an [analysis-ready InSAR product](#)



# Analysis-Ready InSAR Product



Merits of the product:

- “Compressed”
- Reduced Error
- Wrapped
- Geocoded
- Optional correction layers



\* Towards Operational SAR Imaging Geodesy (Talk By Christoph Gisinger at 11:50)



# In Summary

- **Verification** of differential interferograms and deformation products is a **necessity**
- Big Data **processing** schemes can **compromise** mission capabilities
- An **analysis-ready accurate interferometric product** is a potential solution
- Computational complexity is not a concern. **Stream processing** is possible as well ...



# Our recipe for Big Data:

# Sequential Estimator: Toward Efficient InSAR Time Series Analysis

