

Capturing the Surface Deformation of the 112 km Deep M_w 6.8 2020 Earthquake, Chile, using InSAR time series analysis

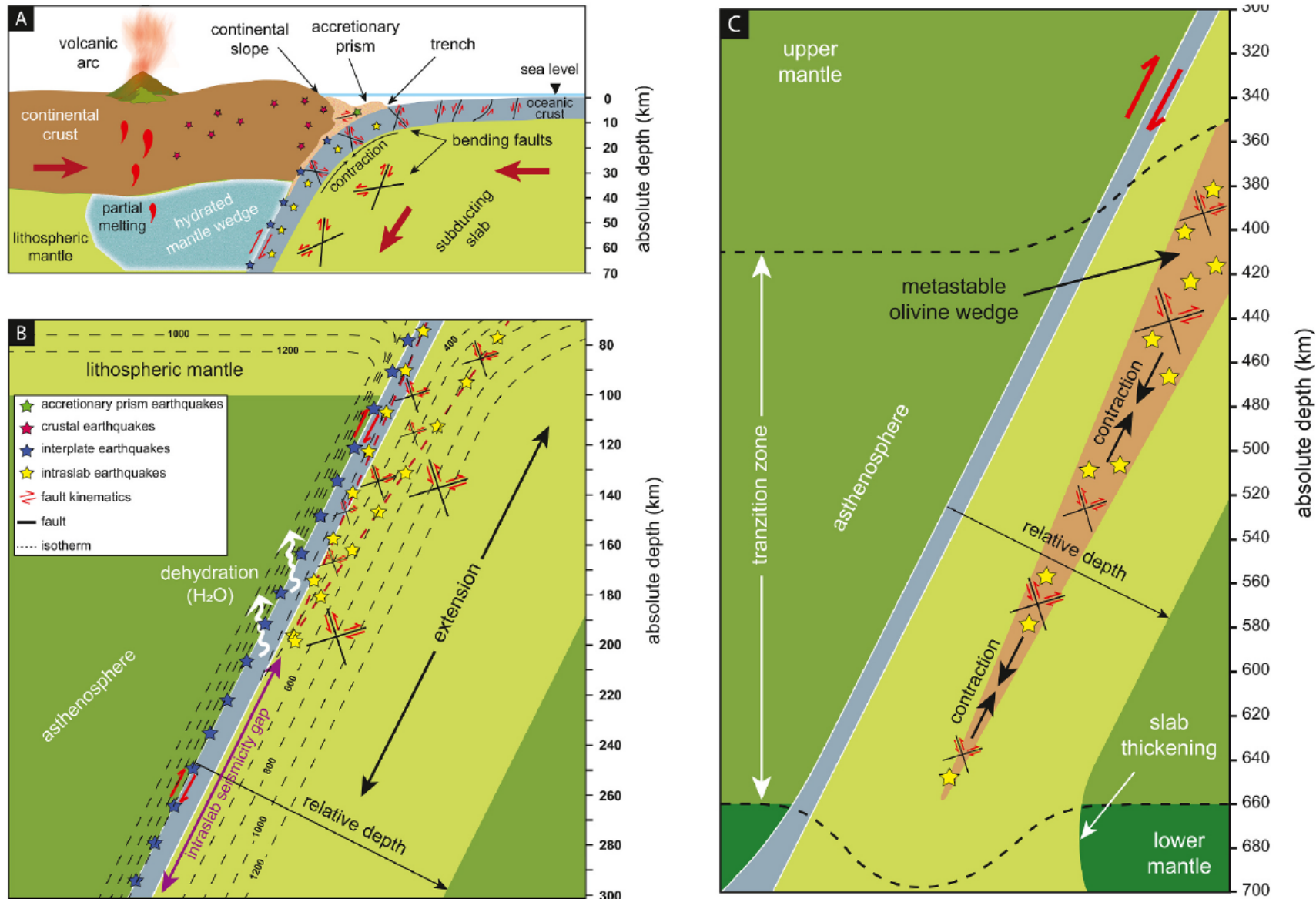
Fei Liu¹,

John Elliott¹, Tim Craig¹, Susanna Ebmeier¹,

Milan Lazecky¹, Yasser Maghsoudi Mehrani¹, & Reza Bordbari¹

¹*COMET, University of Leeds, UK*

- Background
- Study Area: Northern Chile
- InSAR Processing
 - Tropospheric Correction
 - Ionospheric Correction (Split Spectrum & CODE)
- Earthquake Study
 - Coseismic Deformation Field Retrieval (ICA)
 - Source Modelling
 - Intraslab Earthquake Detectability & Velocity Structure

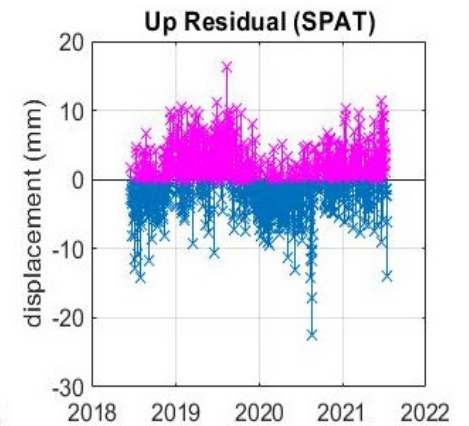
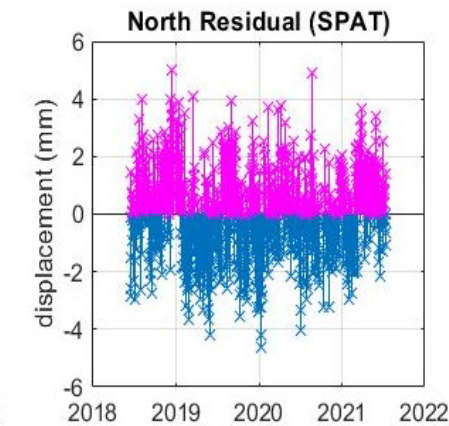
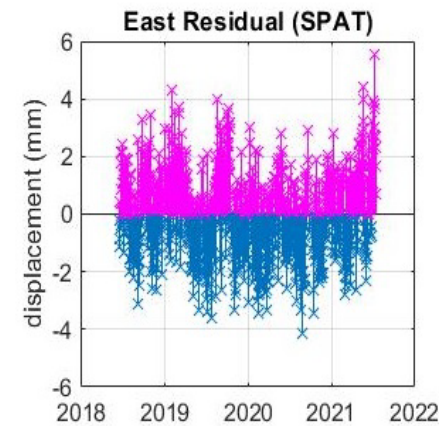
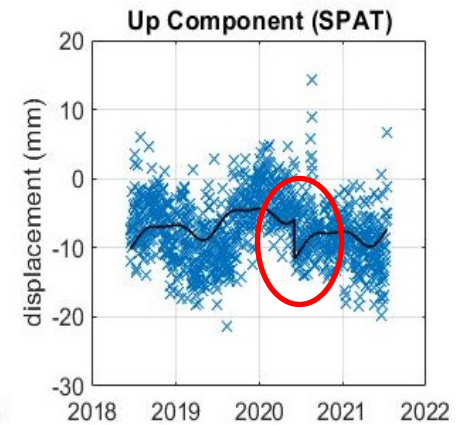
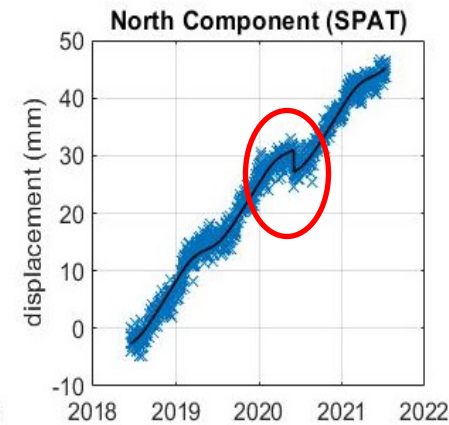
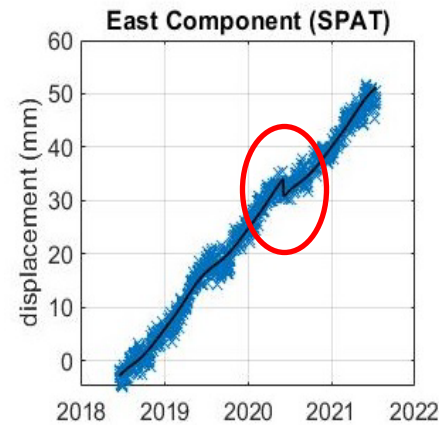
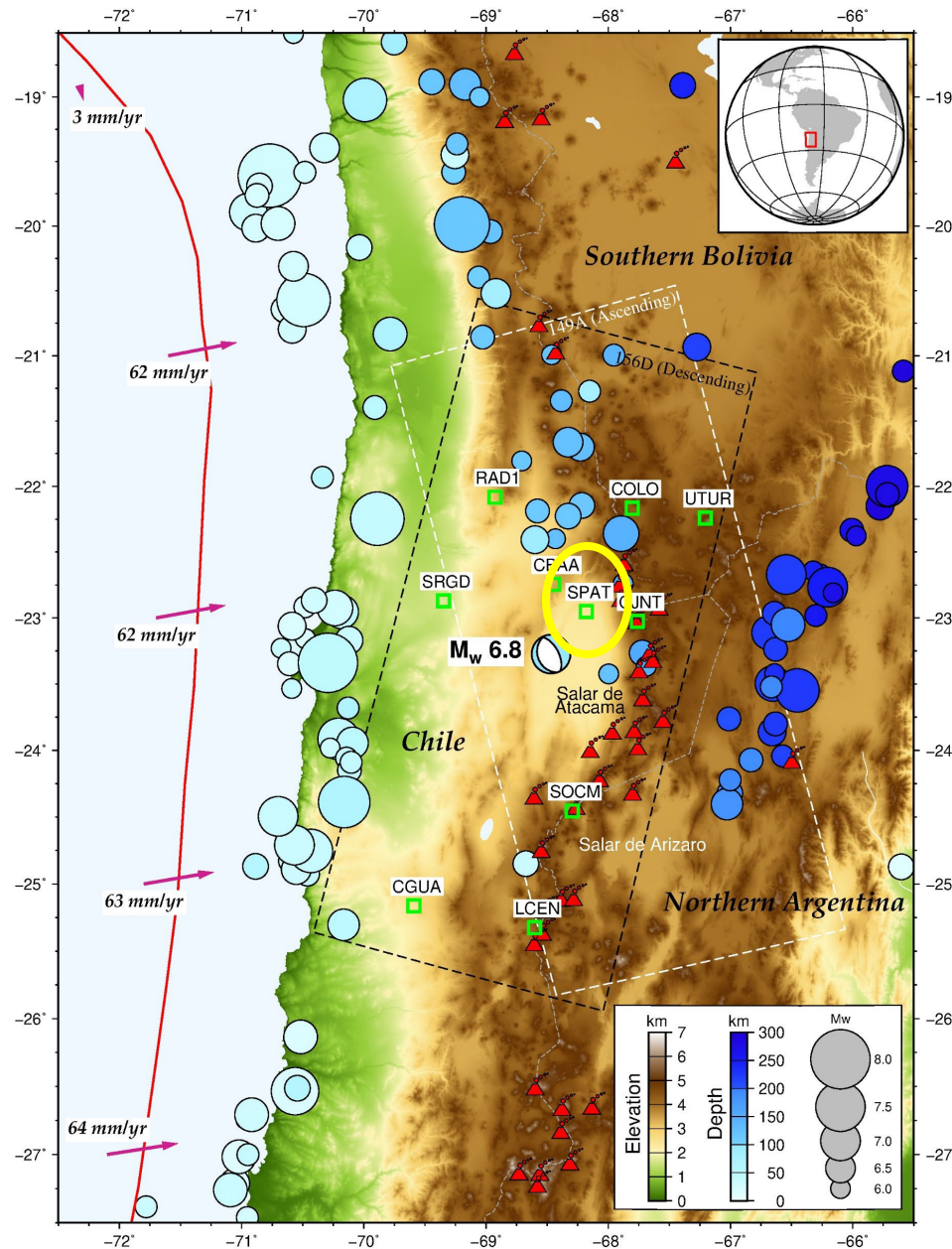


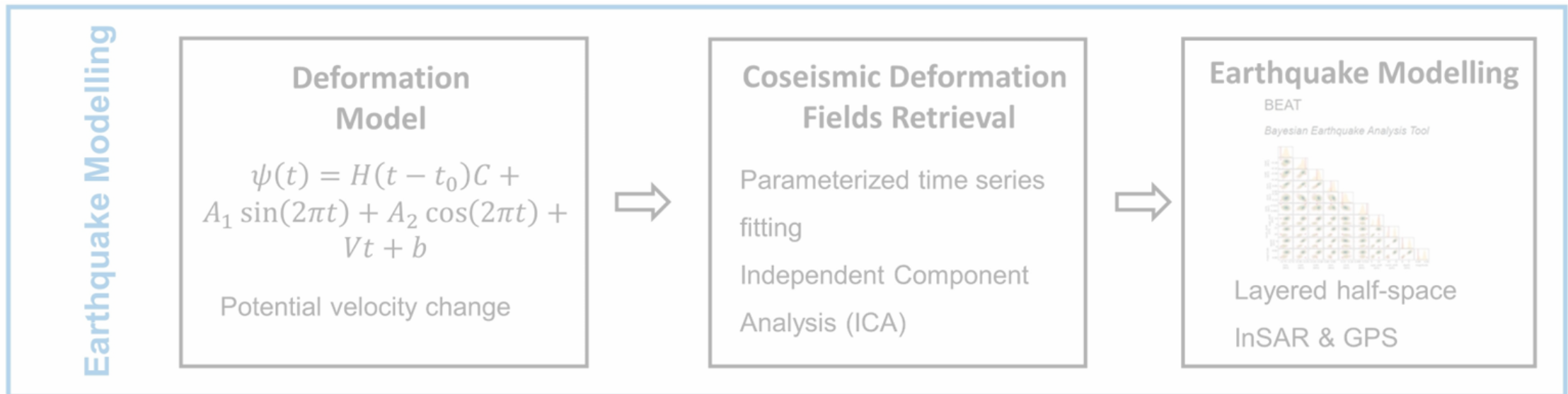
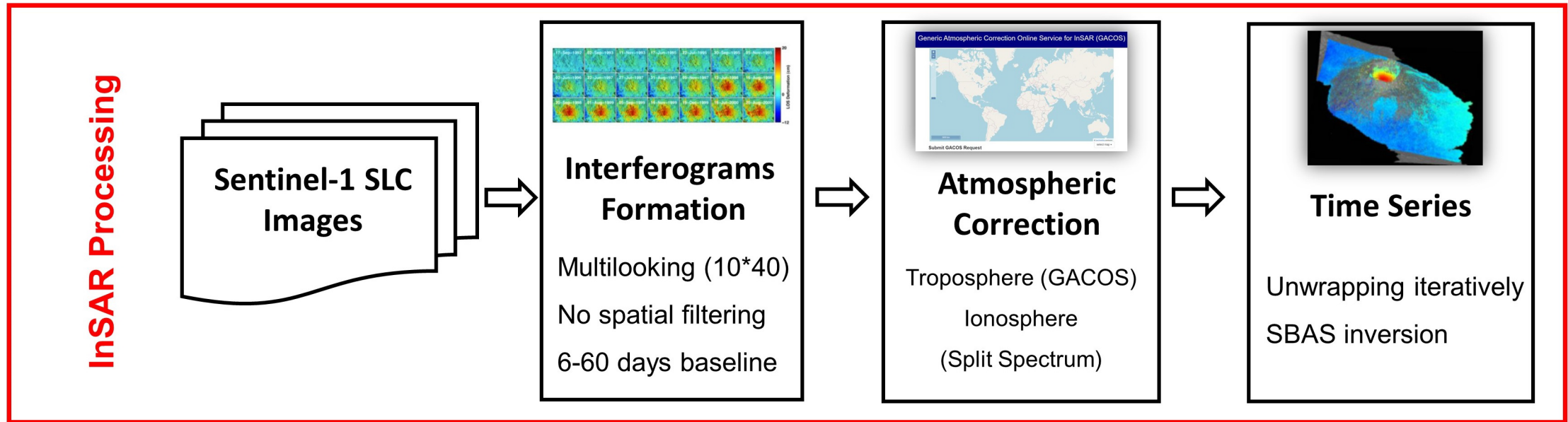
Why do we care about the intraslab earthquake?

Study Case: Northern Chile



Can we observe the coseismic deformation of this intraslab earthquake from InSAR?

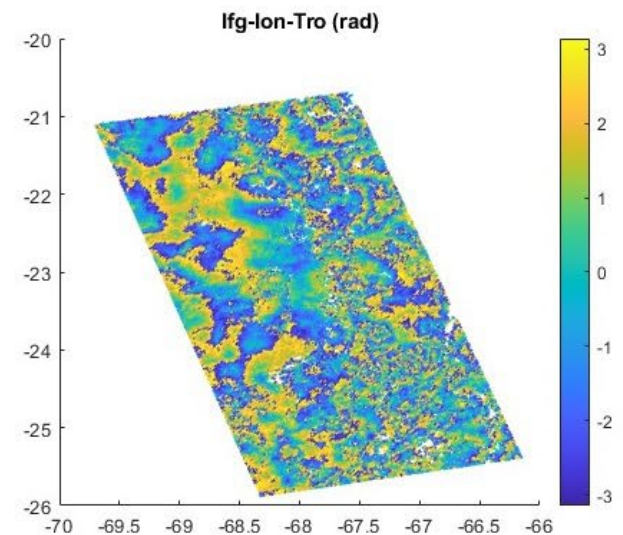
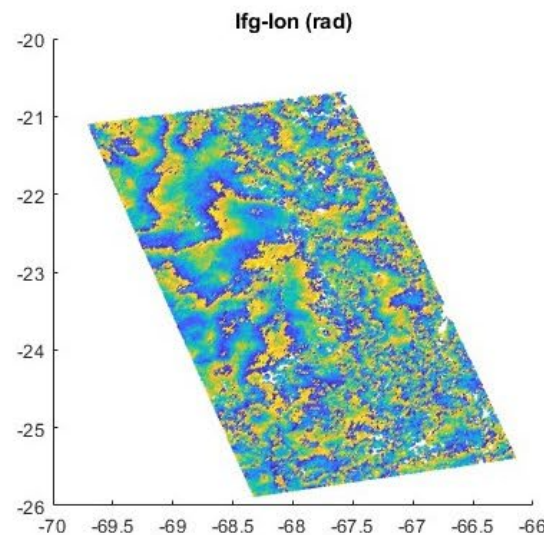
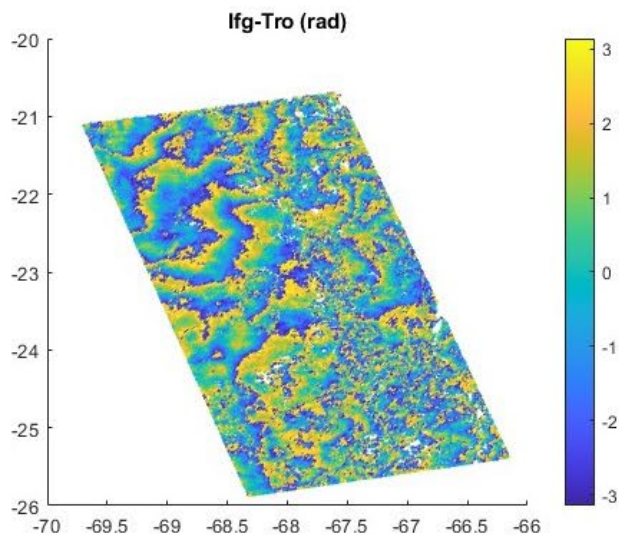
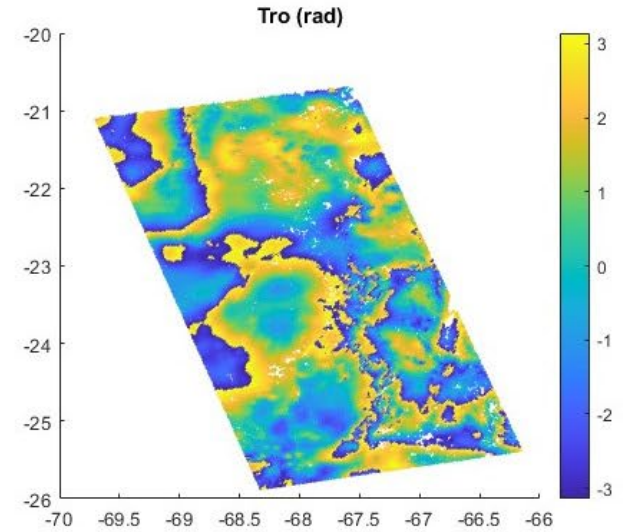
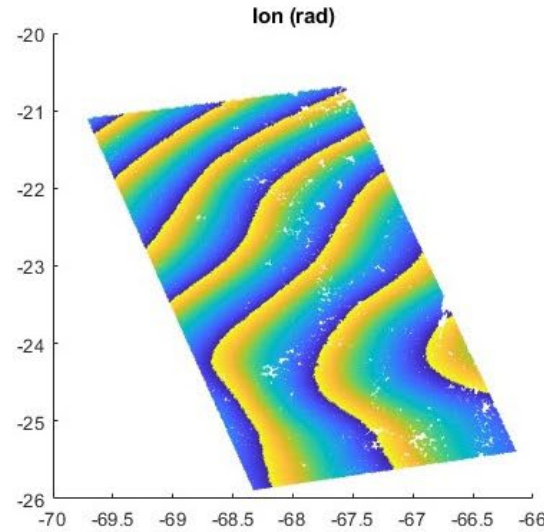
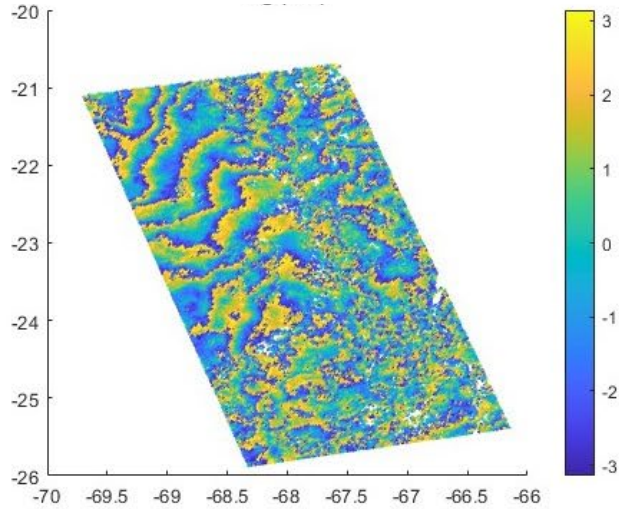


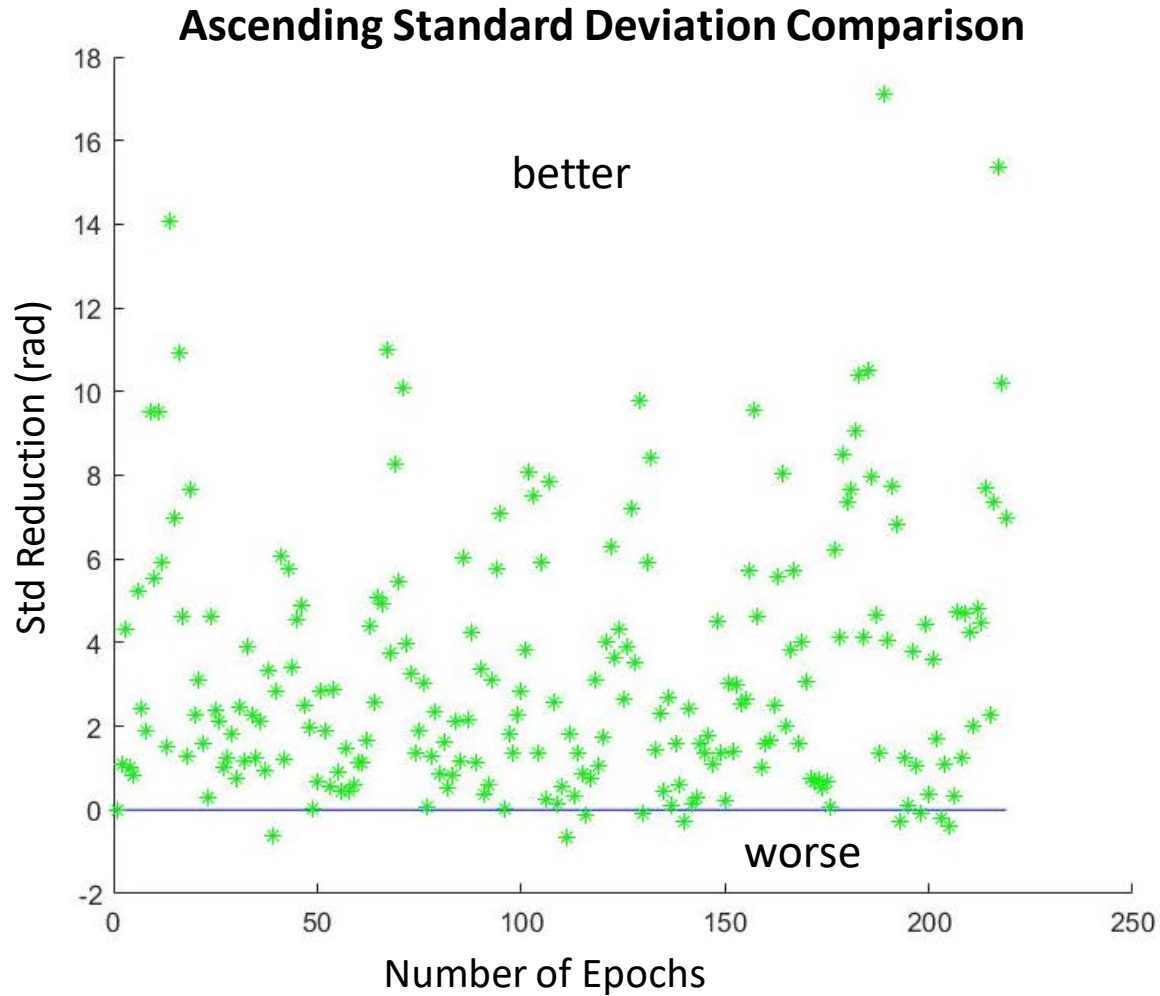


Atmospheric Correction: Example

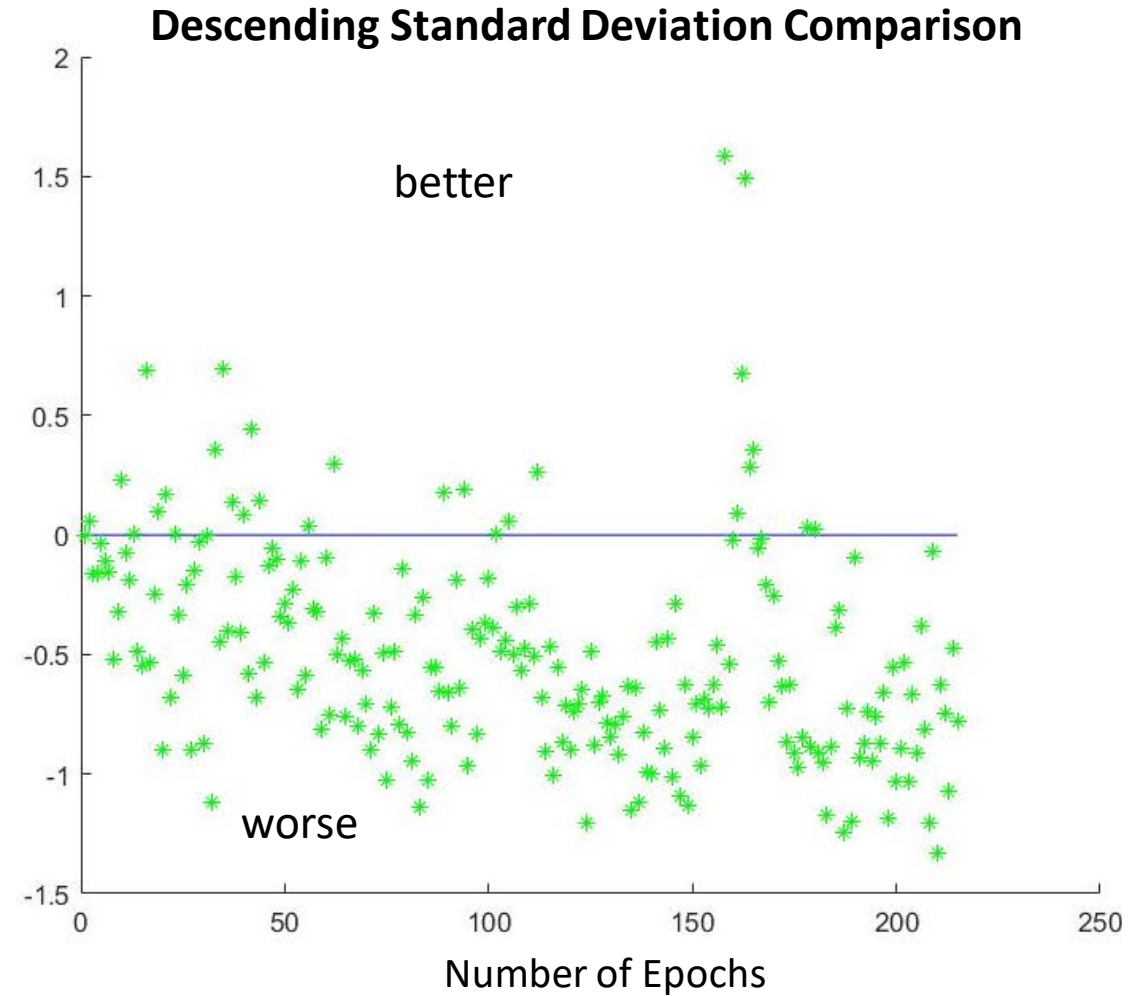


Ifg 20210306-20210312 on Ascending





Average 33% std reduction



Average -5% std reduction

**Mainly due to the different acquisition time
(6 pm for ascending and 6 am for descending, local time)**

Atmospheric Correction: Overall Improvements



Ascending	Average Standard deviation (mm)	Average RMSE for time series fitting (mm)
ifg	6.54	17.49
ifg-tropo	6.21 (5.11%)	14.25 (18.49%)
ifg-ion	4.34 (33.70%)	10.20 (41.64%)
ifg-tropo-ion	2.86 (56.20%)	8.10 (53.67%)

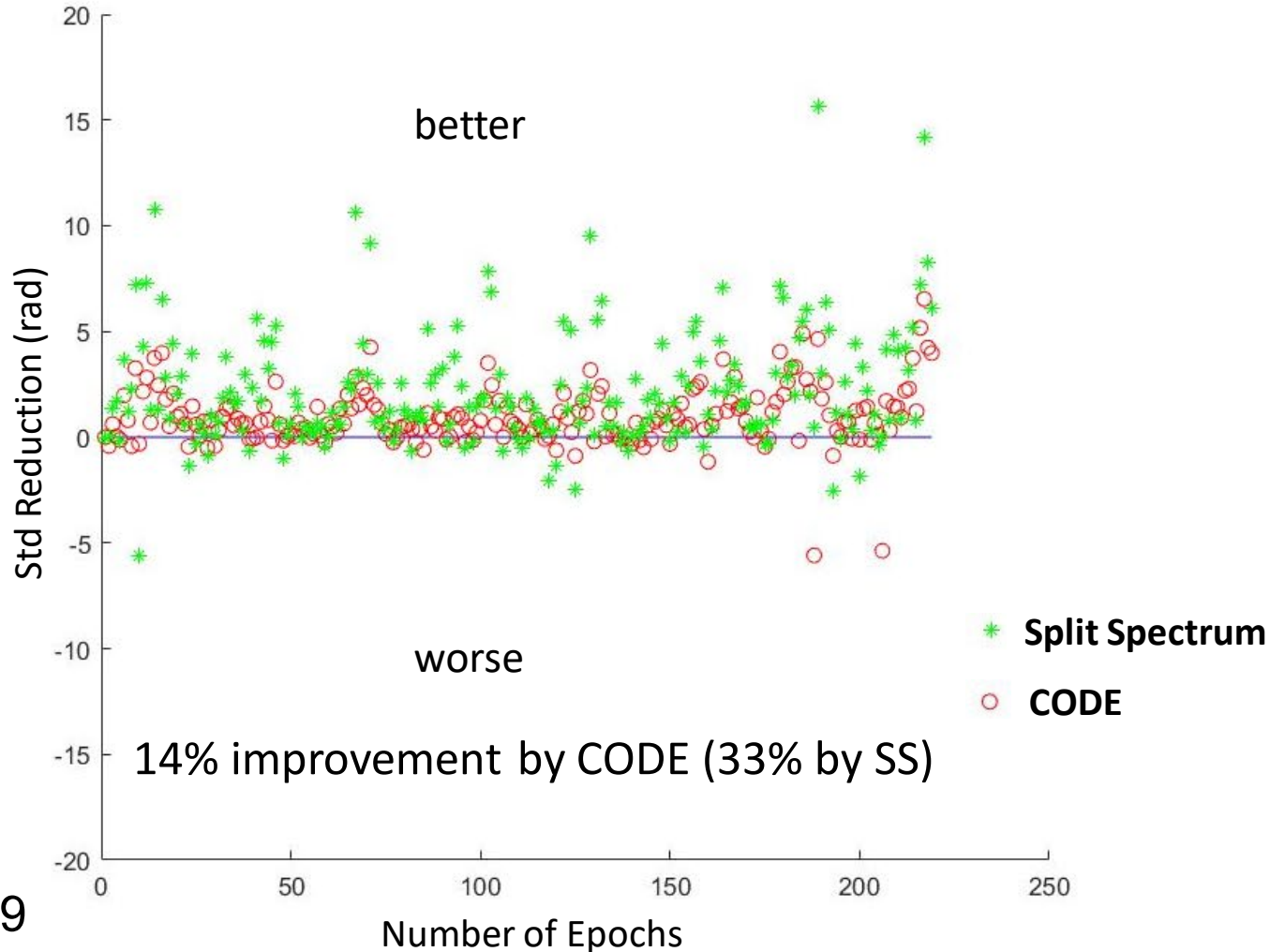
Descending	Average Standard deviation (mm)	Average RMSE for time series fitting (mm)
ifg	5.90	18.26
ifg-tropo	3.42 (42.04%)	8.42 (53.89%)
ifg-ion	6.20(-4.96%)	17.85 (2.25%)
ifg-tropo-ion	3.92(33.47%)	8.27 (54.71%)

Ionospheric Correction: Split Spectrum vs CODE

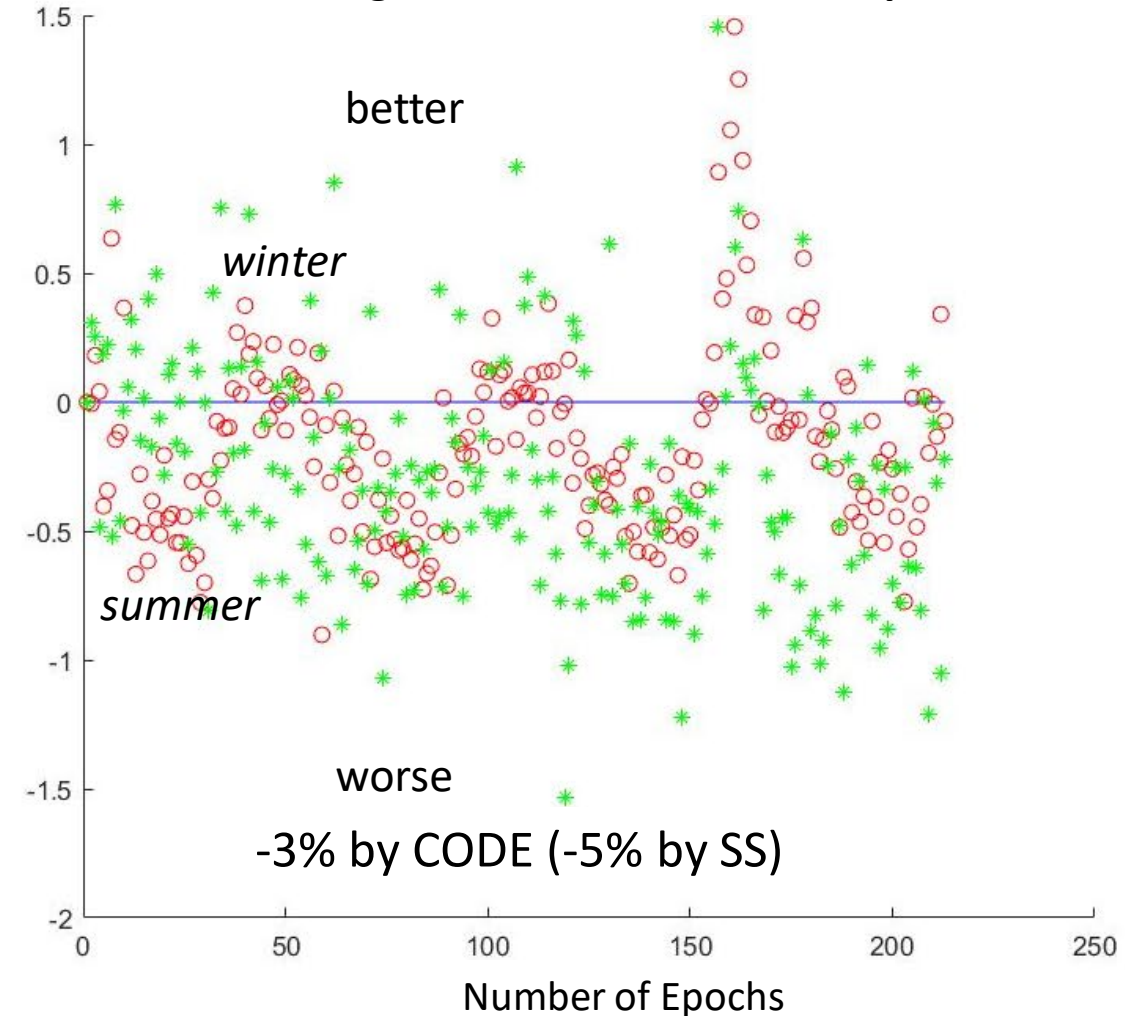


Vertical Total Electron Content (vTEC) product of Center for Orbit Determination in Europe (CODE), which is also used for ETAD ionospheric correction.

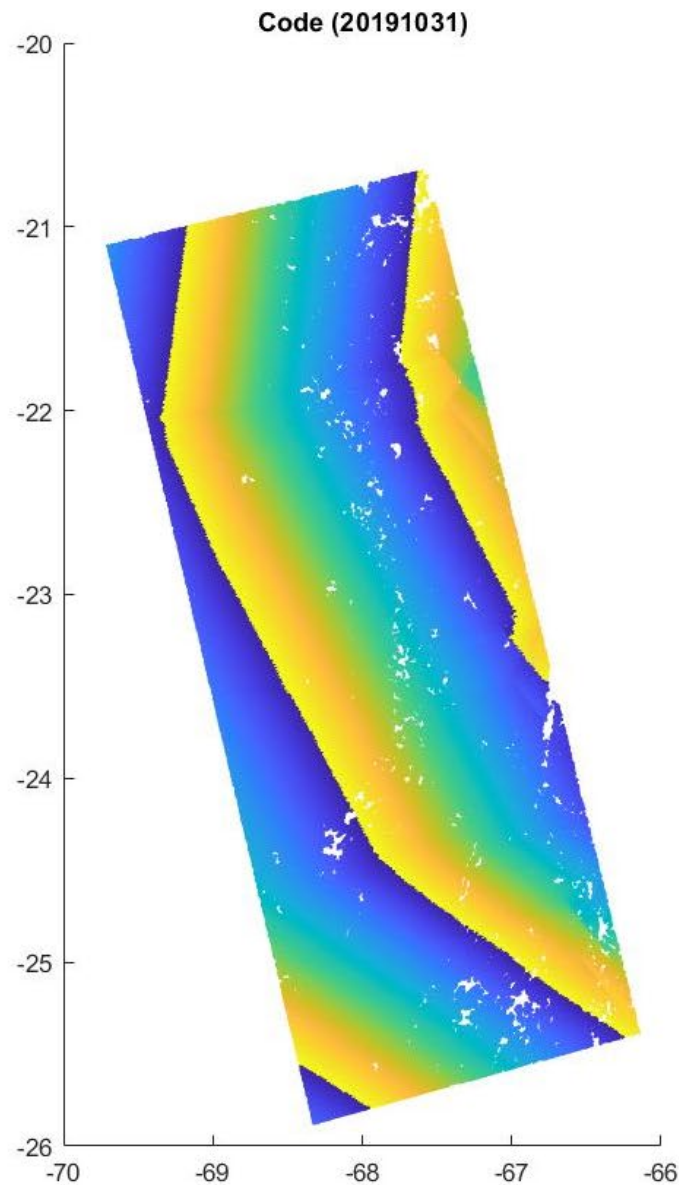
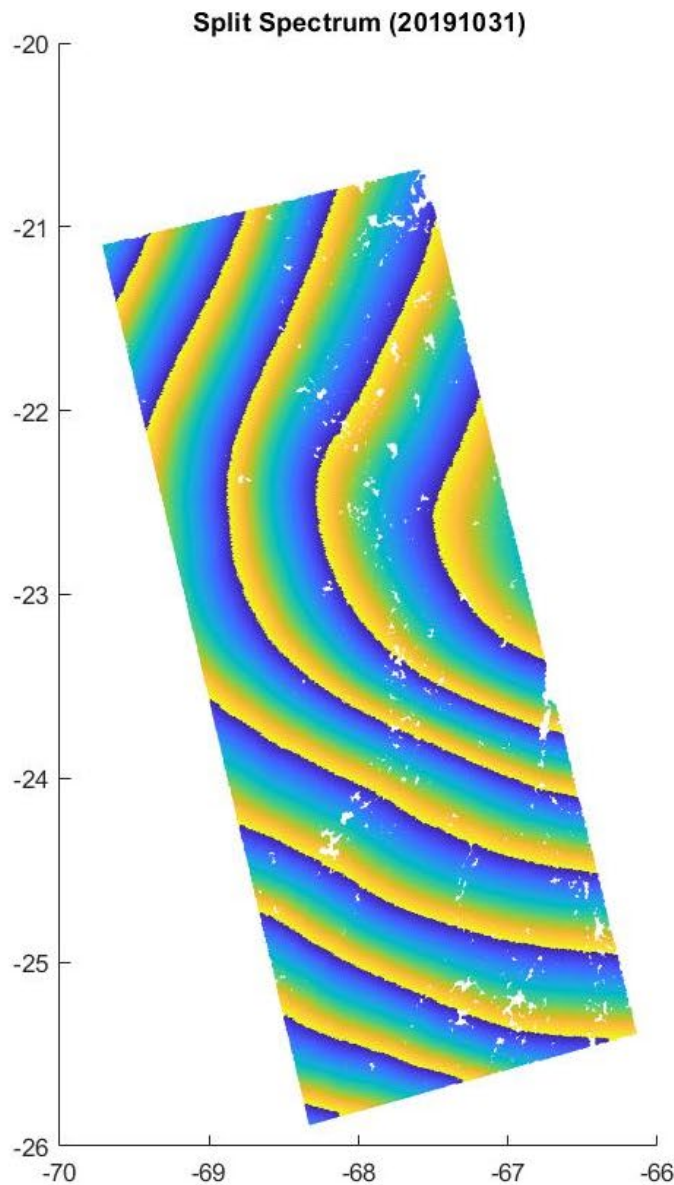
Ascending Standard Deviation Comparison



Descending Standard Deviation Comparison



Ionospheric Correction: Split Spectrum vs CODE



Check Reza's poster (ID 140)!

Measuring Ice-loss Associated Uplift in Antarctic Peninsula Using SAR Interferometry

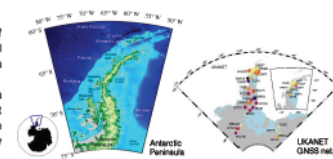
¹Reza Bordbar, ¹Andrew J. Hooper, ²Pippa Whitehouse, ²Grace Nield, ³Alex Briabourne
¹COMET, Institute of Geophysics and Tectonics, School of Earth and Environment, University of Leeds, UK
²University of Durham
³British Antarctic Survey (BAS)

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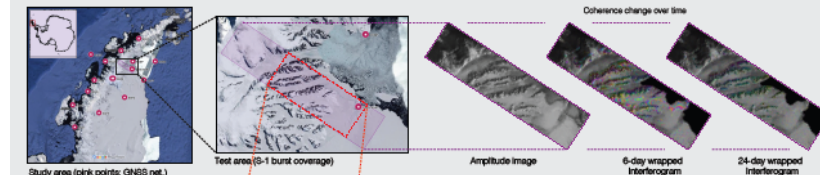
Abstract

Over the last two decades, the glaciers of the Antarctic Peninsula have experienced thinning of tens to hundreds of meters, and several ice shelves have collapsed. These changes in glacial loading, coupled with the millennial-scale glacial isostatic adjustment (GIA) have resulted in a viscoelastic response of the solid earth in the area.

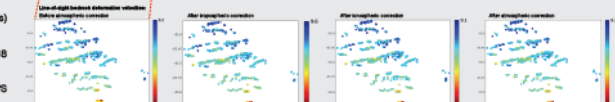
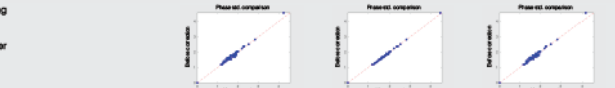
To date, studies of Antarctic bedrock deformation have focused on velocities obtained from a sparse network of continuous Global Navigation Satellite System (GNSS) stations. In this project we aim to apply InSAR in Antarctic Peninsula to increase the spatial sampling of deformation measurements and further understand both spatiotemporal ice mass change and the rheology of the solid Earth in the region.



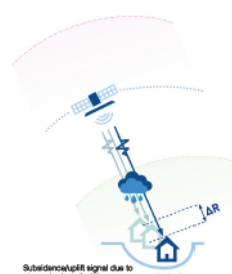
Interferograms and InSAR-detected Velocities



- A total of 59 Sentinel-1 scenes (bursts) utilized
- Data were collected between Oct 2018 and Mar 2020 (summer time)
- InSAR analysis performed using StaMPS software
- Topographic contribution removed using Cop 30 DEM
- 1914 Persistent scatterers identified over rock outcrops

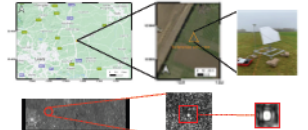
Atmospheric Path Delay Mitigation



- Ionospheric Correction**
 - Center for Orbit Determination in Europe (CODE) VTEO maps
 - Resolution: $6^\circ \times 2.6^\circ$ (longitude, latitude), 1h
 - VTEO computation: VTEO solution of CODE (University of Bern)
- Tropospheric Correction**
 - Vienna Mapping Function 5 (VMF5) product
 - Resolution: $1^\circ \times 1^\circ$ (longitude, latitude), 6h

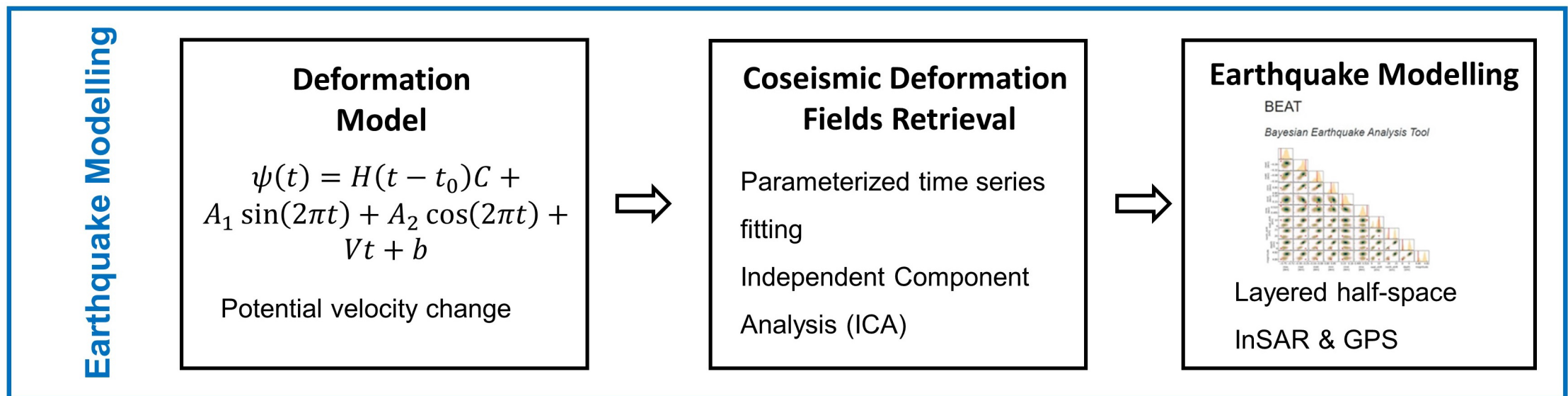
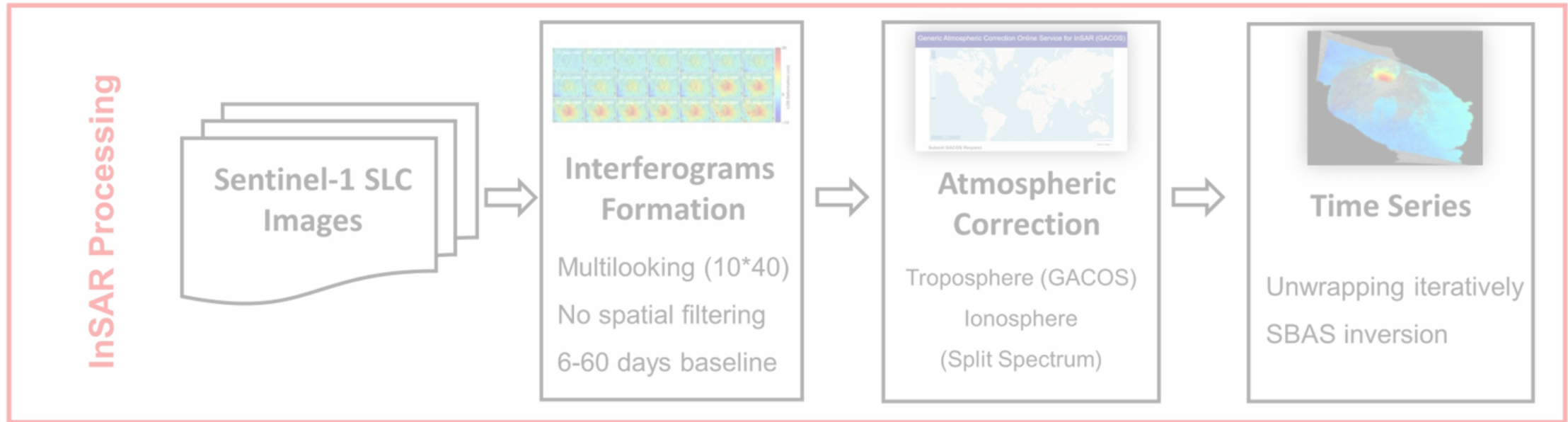
Comparison with ESA ETAD Product

Used a corner reflector as a point target

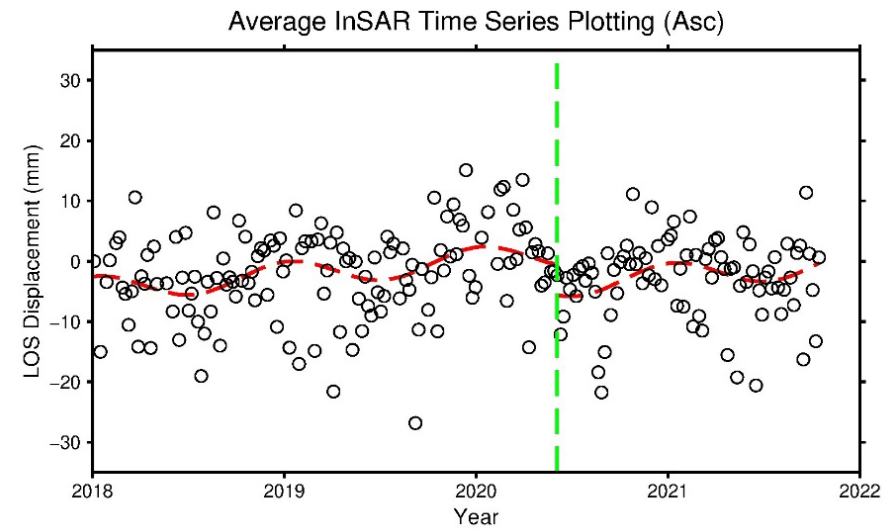
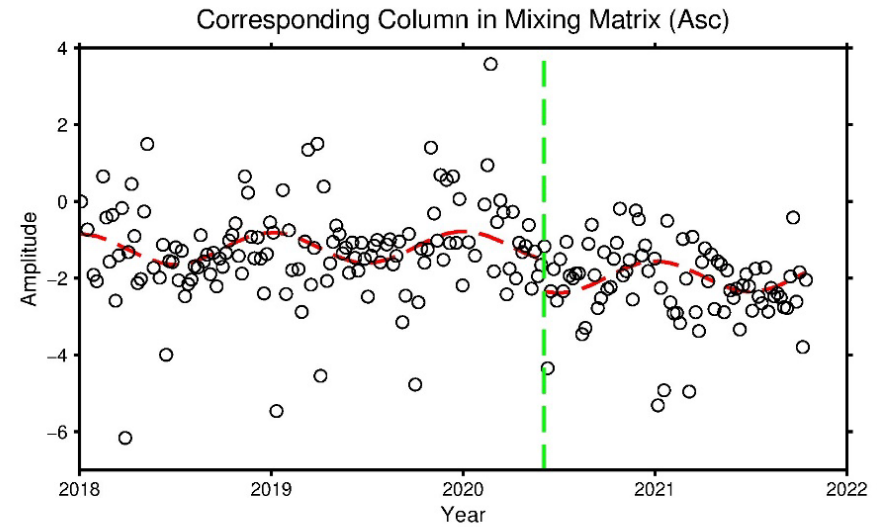
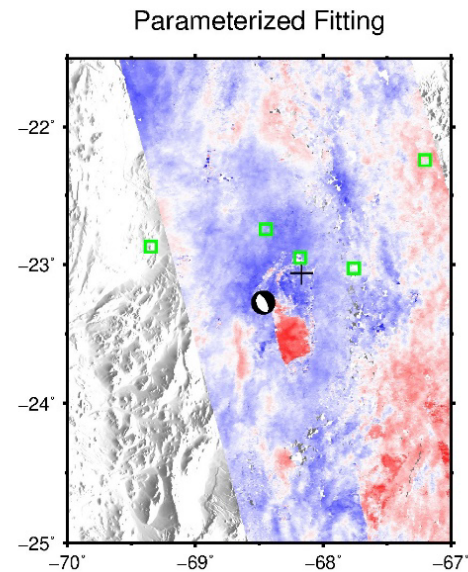
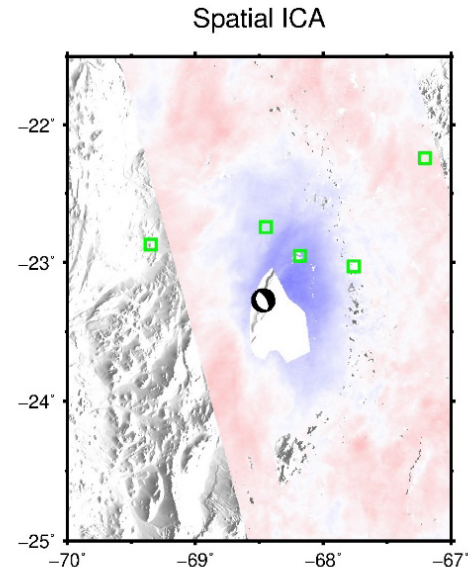
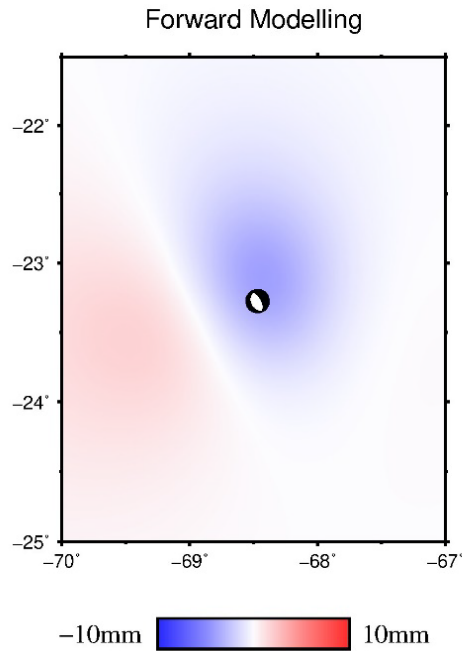


Comparison results

epoch	ETAD	CODE	ETAD	VMF5
2020-12-29	0.10636 (m)	0.10636 (m)	6.8211 (m)	6.8196 (m)
2020-08-07	0.22089 (m)	0.22089 (m)	6.2721 (m)	6.2816 (m)
2021-05-10	0.40363 (m)	0.40363 (m)	5.9253 (m)	5.8936 (m)

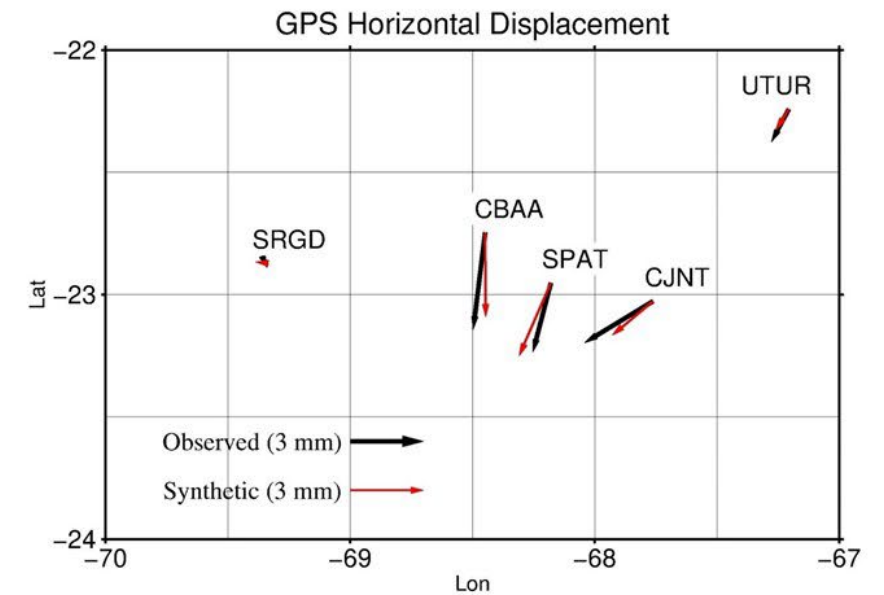
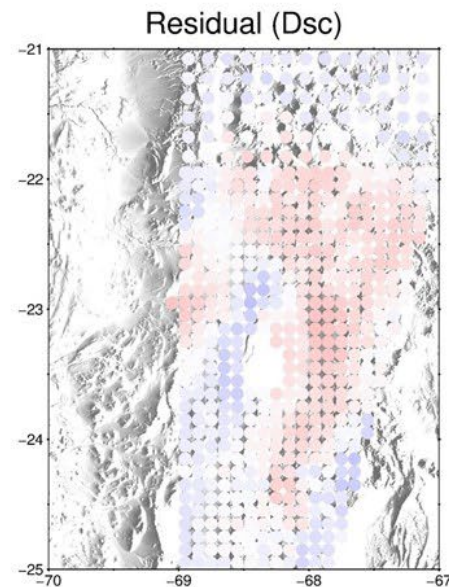
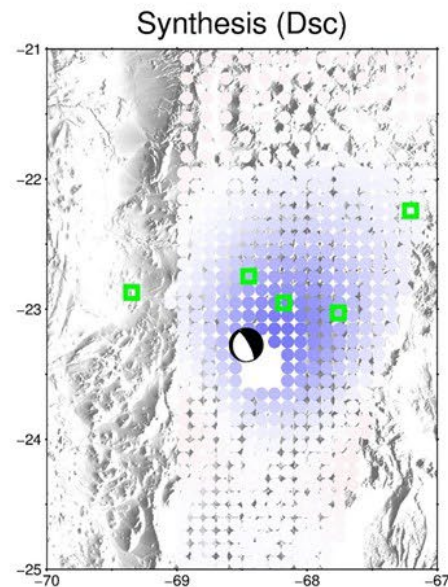
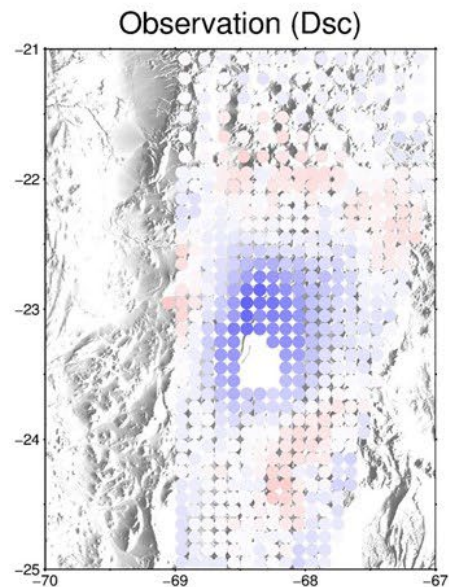
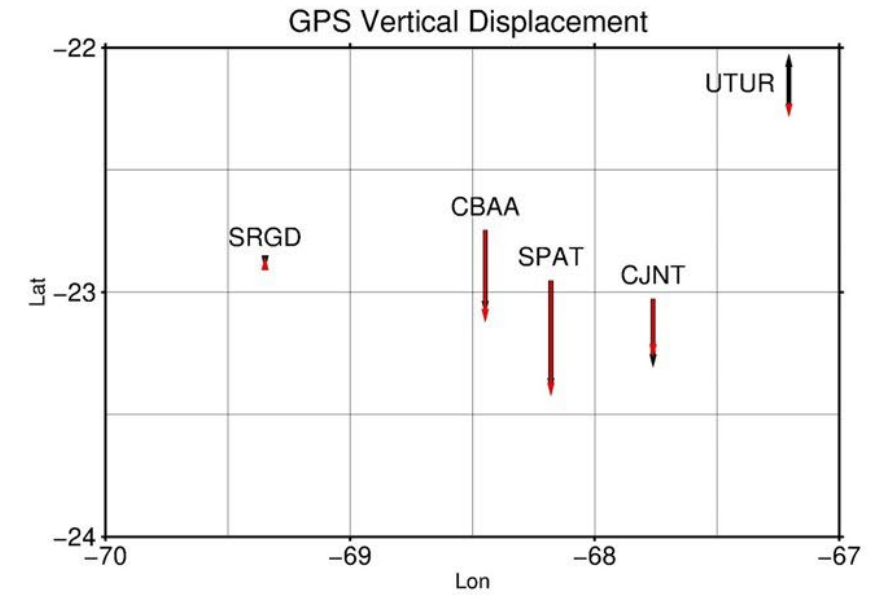
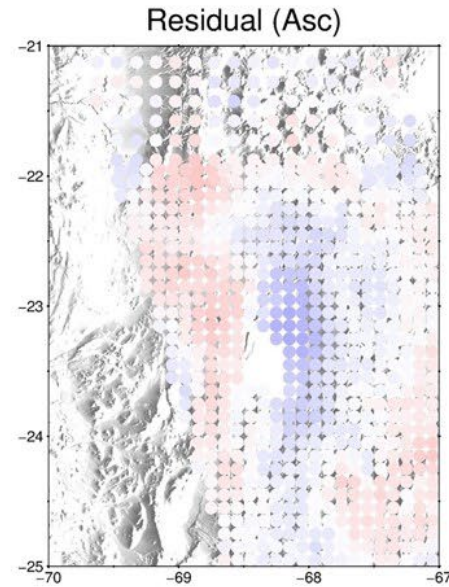
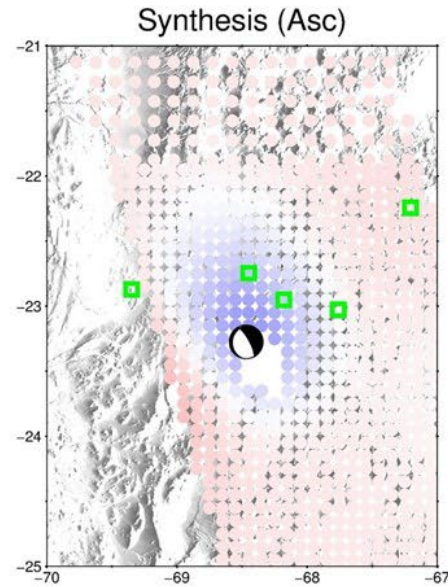
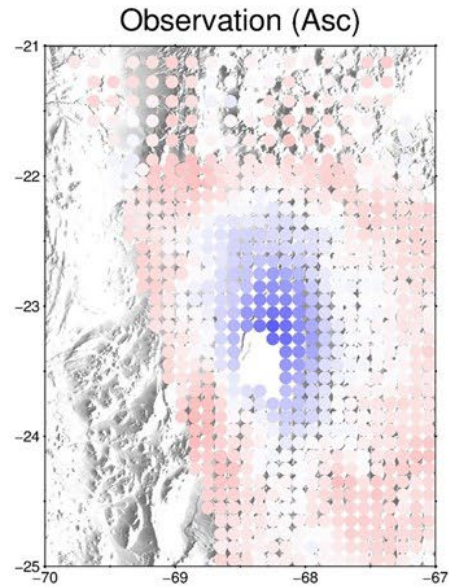


Parameterized Fitting & ICA

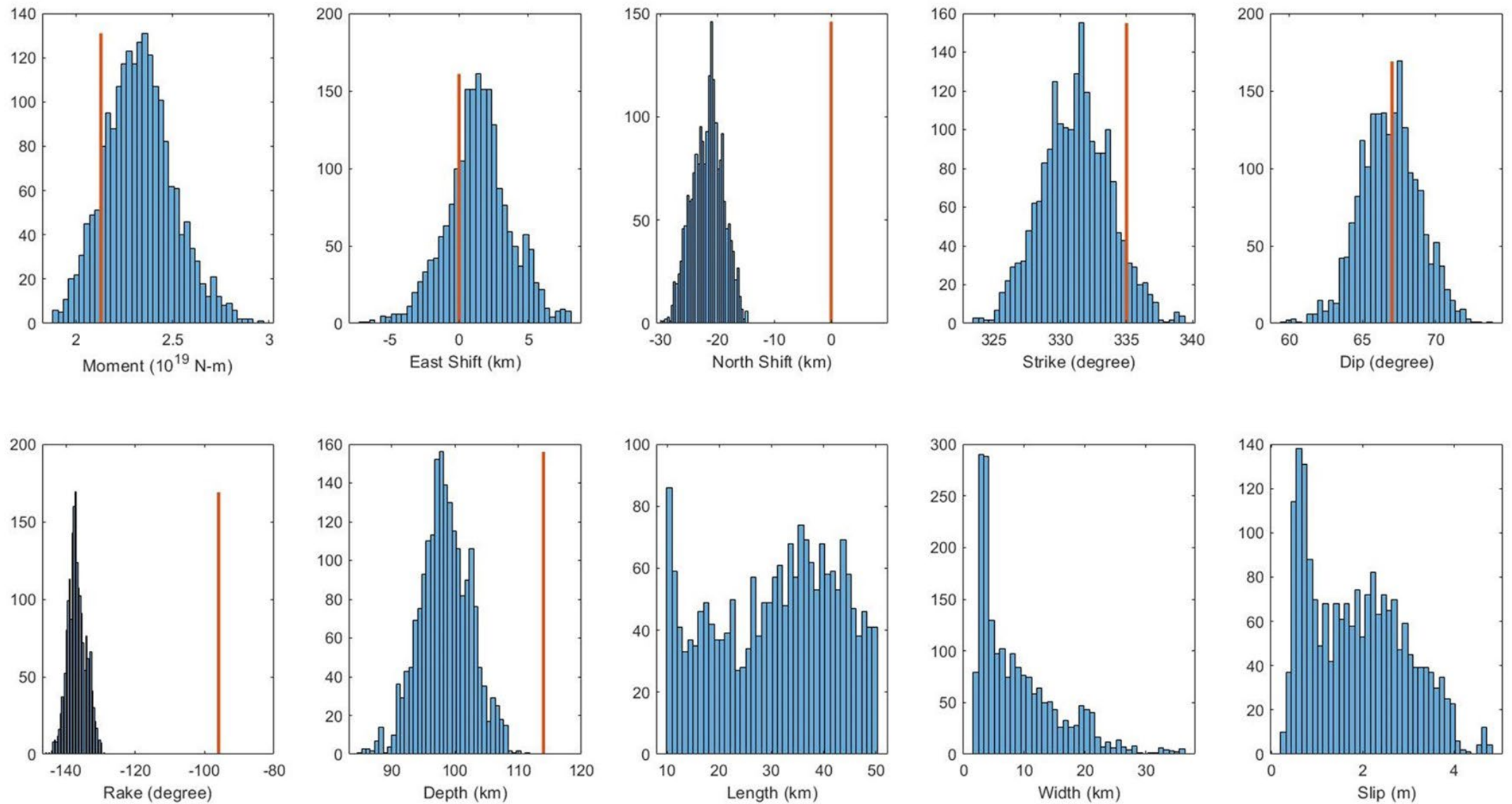


○ Observations - - - Fitting - - - Earthquake event time

Modelling: InSAR & GPS



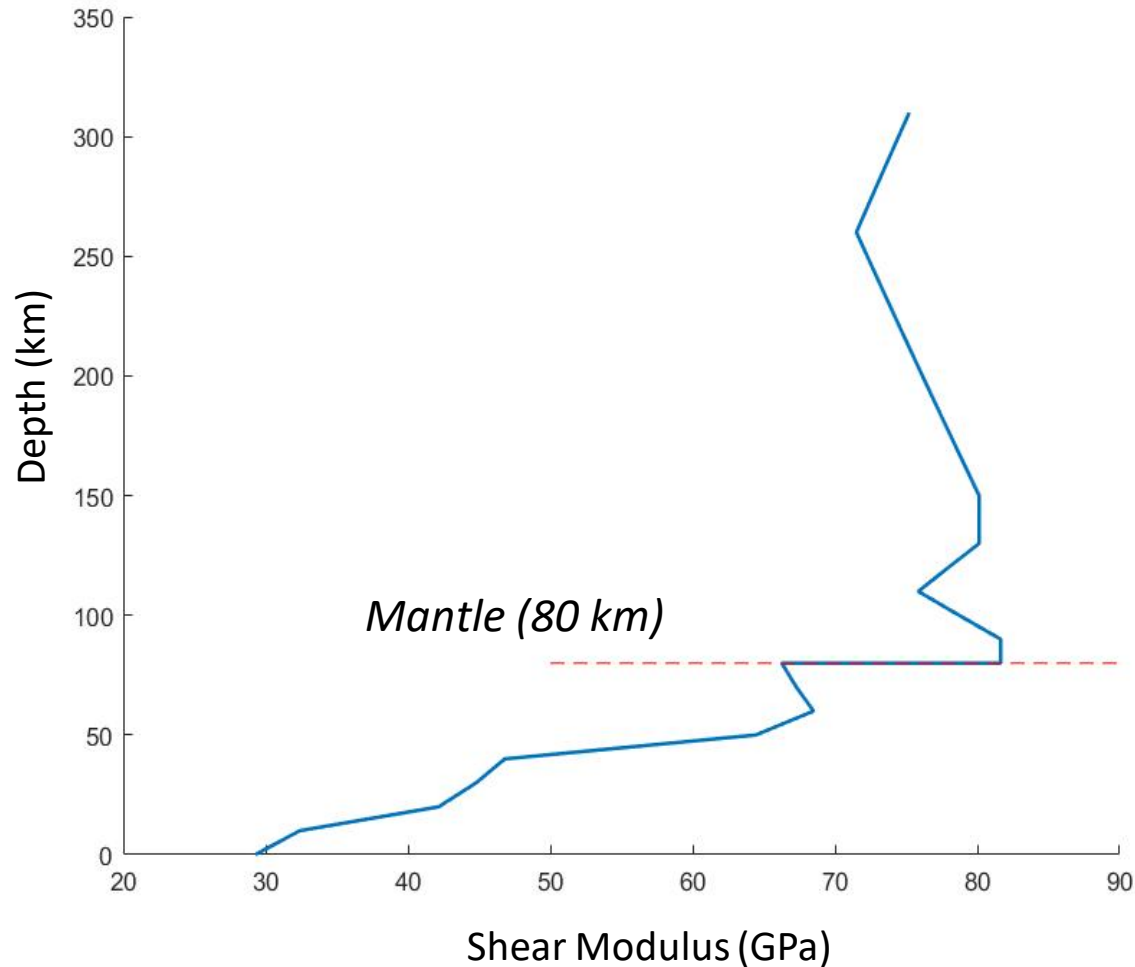
Modelling: Posterior Distribution



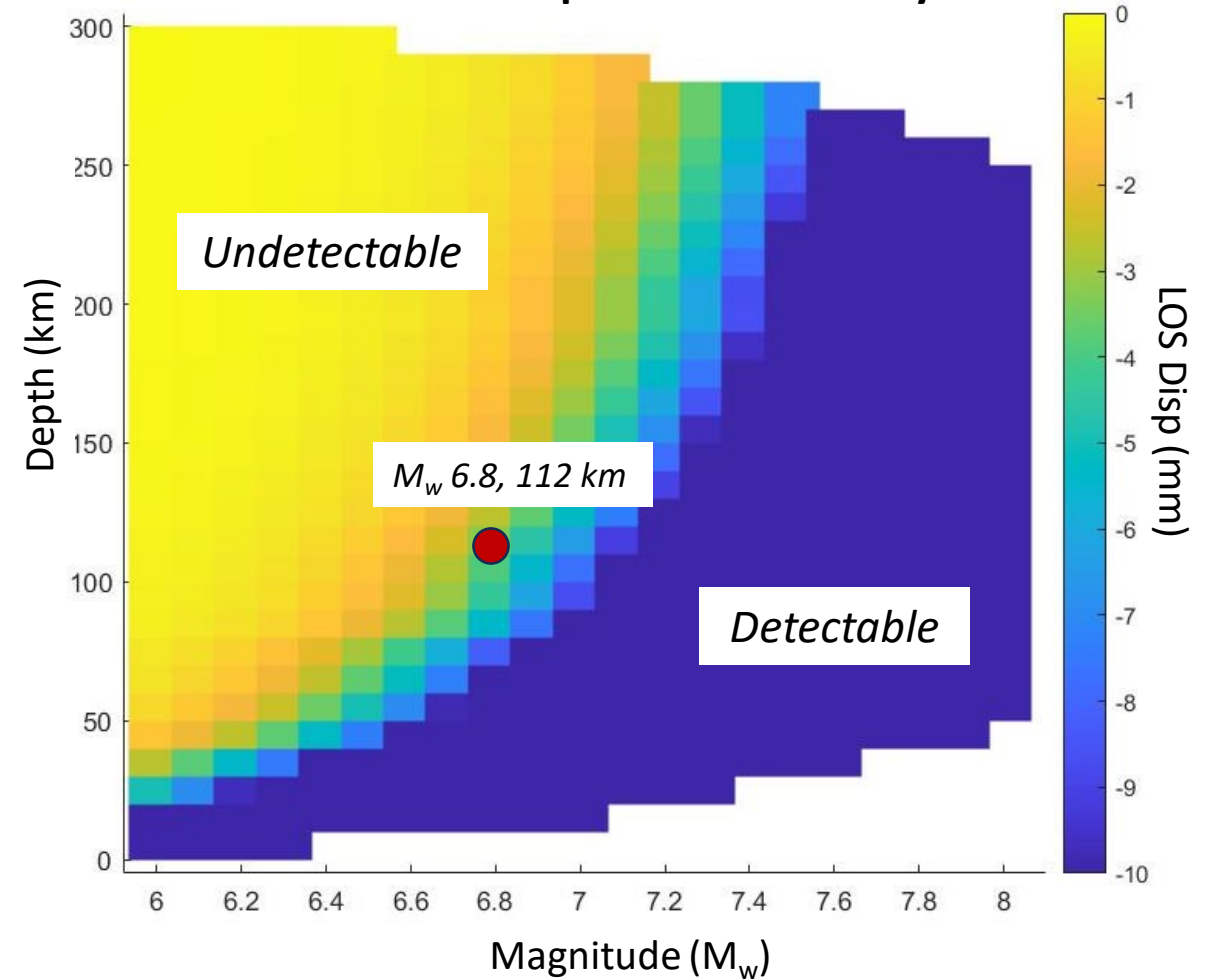
USGS
solution

$$M_0 = \mu \cdot D \cdot A$$

Shear Modulus Change with Depth

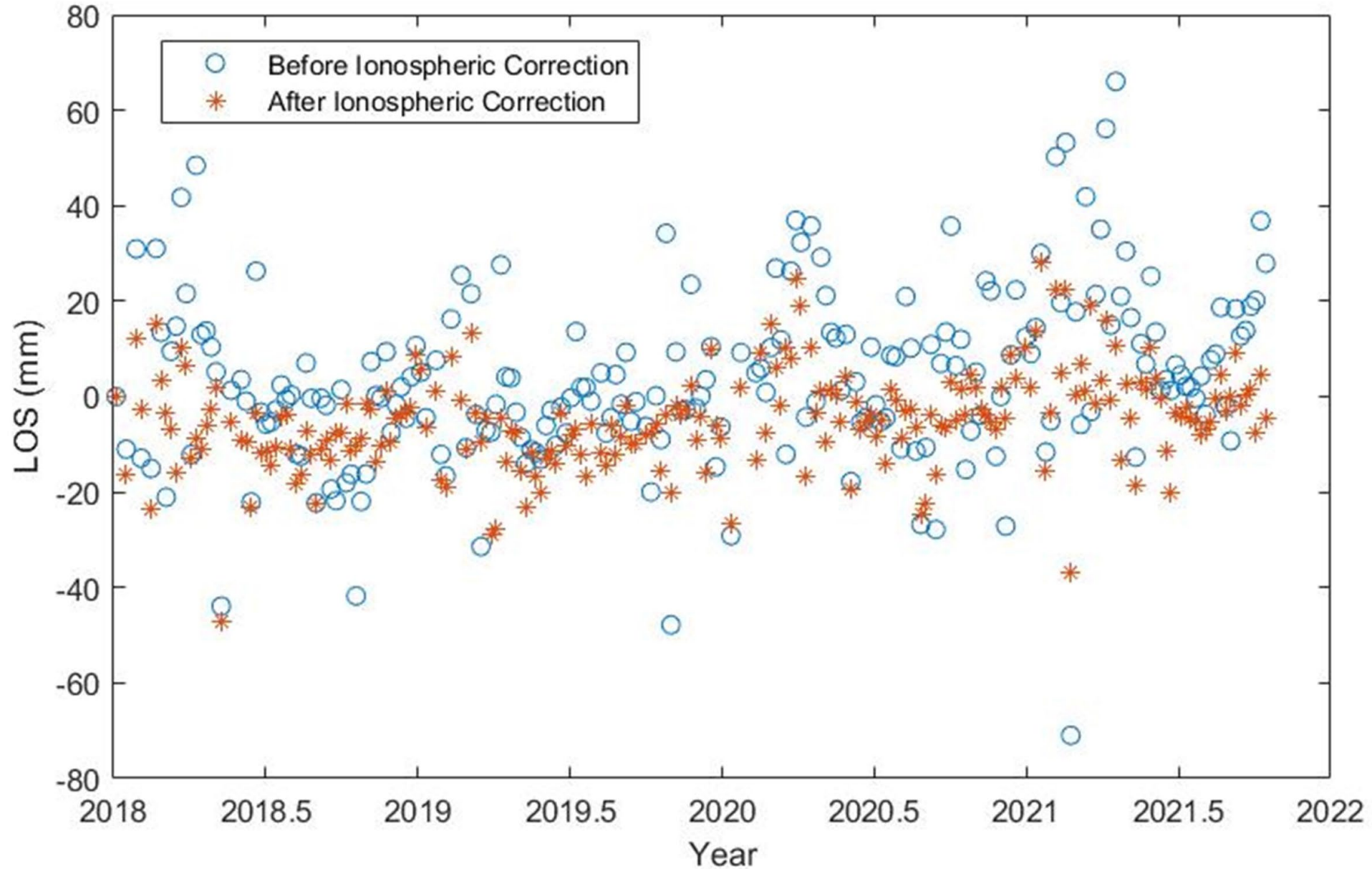


Intraslab Earthquake Detectability



- Ionospheric correction on Sentinel-1 ascending data can greatly improved the data quality in low latitude region, but is probably not worth doing on descending data.
- We retrieve coseismic deformation of an intraslab earthquake (M_w 6.8, 112 km depth), with peak displacement ~ 6 mm, using InSAR time series data.
- InSAR could help to constrain the fault geometry of intraslab earthquakes and compensate seismology for future study.

Supplementary: Ascending Time Series Example



Supplementary: Descending Correction Example



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