Investigating Azimuth Direction Displacements from Sentinel-1 TOPS

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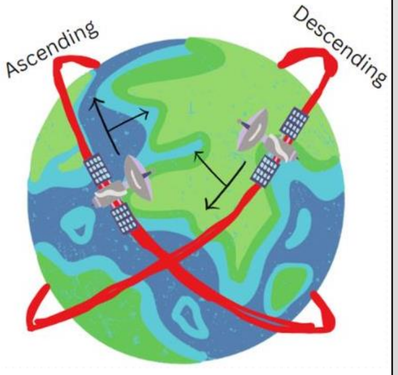
1. Introduction and Motivation

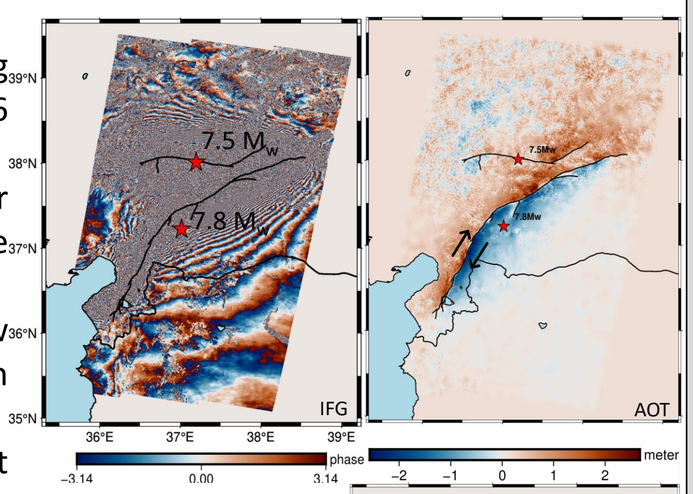
- Although InSAR techniques and measurements are getting popular for Earth Science applications, the lower precision in the North-South direction compared to Vertical and East-West directions hinders researchers to decompose deformation and modelling tectonic events.
- The causes of lower precision in the N-S direction are being in the polar orbit ($\pm 98°$ inclination for S-1) and tracking with side-looking geometry.

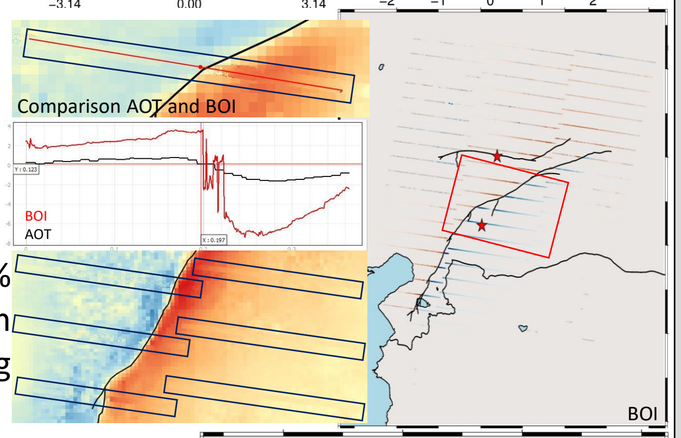


- Enhanced Spectral Diversity (ESD) method is originally utilized for the coregistration step by exploiting the burst overlaps which provide much greater spectral diversity due to a steering angle of around 1 ° (Scheiber and Moreira, 2000; Prats-Iraola et al. 2012).
- Grandin et al. (2016) showed that the method can be used for coseismic displacement to extract N-S displacement with cm accuracy. Following year, the method also has been used for postseismic (Martinez et al. 2019) and interseismic events (Li et al. 2021, Piromthong et al. 2021) as called Burst Overlap Interferometry (BOI).
- Our aim is to improve decomposition models for coseismic deformation and velocity models of the inter-seismic deformations on a continental scale by extracting the N-S component of displacements through ESD and BOI.

2. Coseismic Displacement from Burst Overlap Interferometry

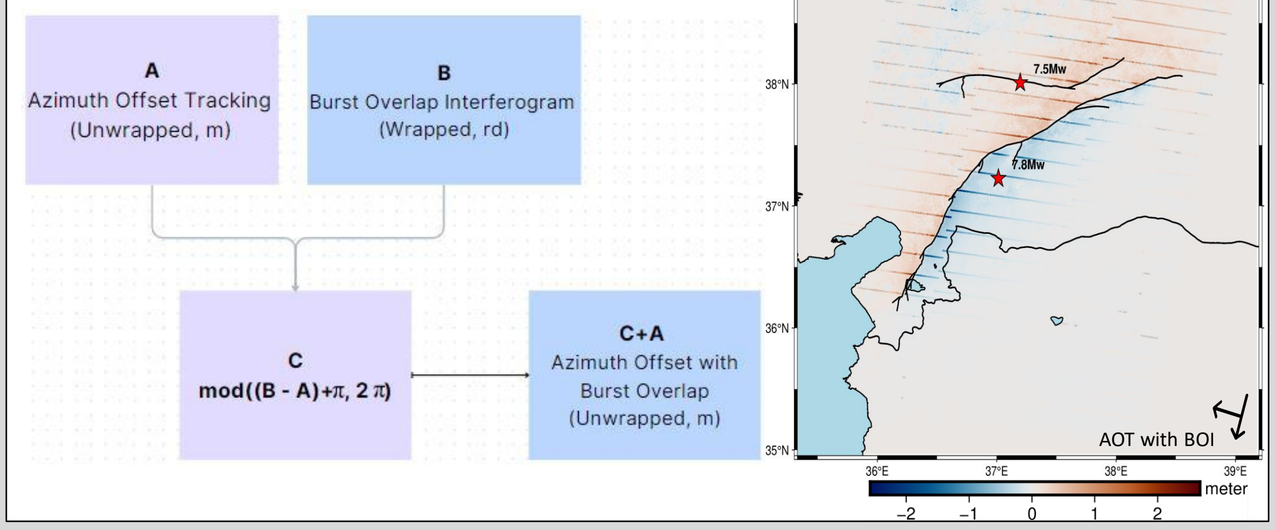
- Turkey experienced two devastating earthquakes within 10 hours on 6 February 2023.
- Such big earthquakes hinder determining the fault trace on the ground through InSAR.
- Offset tracking methods can show faults clearly in this kind of situation albeit with poor accuracy.
- BOI method also catches the fault trace with higher accuracy but is only limited in the burst overlap regions (about 10% of the whole frame).





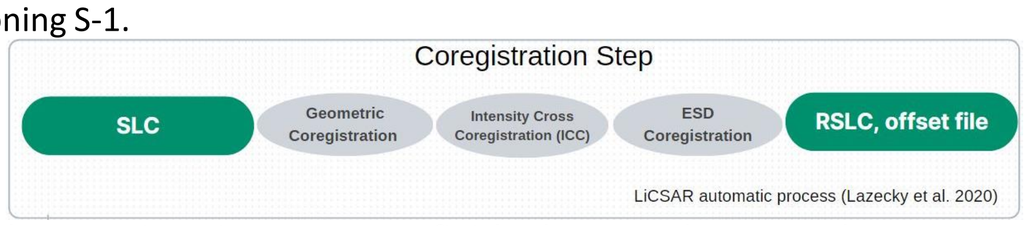
Key Study:

- Besides being only available in 10% of the whole frame, another problem is to unwrap the BOI in such big earthquakes.
- To deal with these problems, we merged AOT and BOI as below

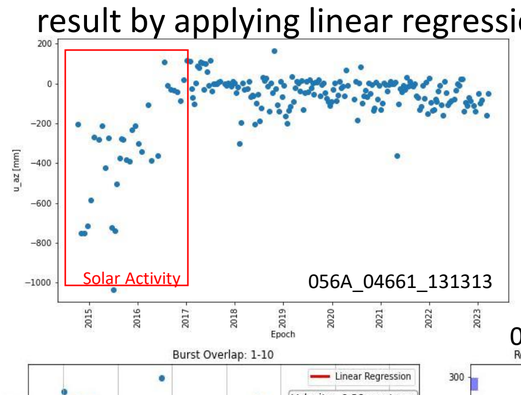


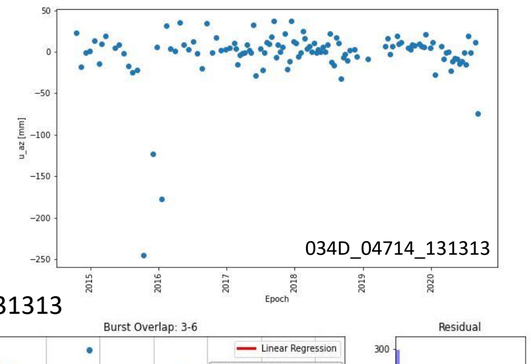
3. Enhanced Spectral Diversity Time Series Analysis

- We choose the Tien Shan region to observe N-S displacements by coregistering secondary epochs to master epoch with ICC and ESD (Lazecky et al. 2023).
- We prefer this method for extracting N-S displacements because it has a lower computational load compared to burst overlap interferometry. Furthermore, the method provides the absolute measurement because of the GNSS-based positioning S-1.



- Once the coregistration steps are finished, ICC and ESD results are stored in LiCSAR system.
- These results and other necessary extra metadata are extracted to calculate the azimuth offset u_{az}. The calculated u_{az} for each epoch is converted to velocity result by applying linear regression.





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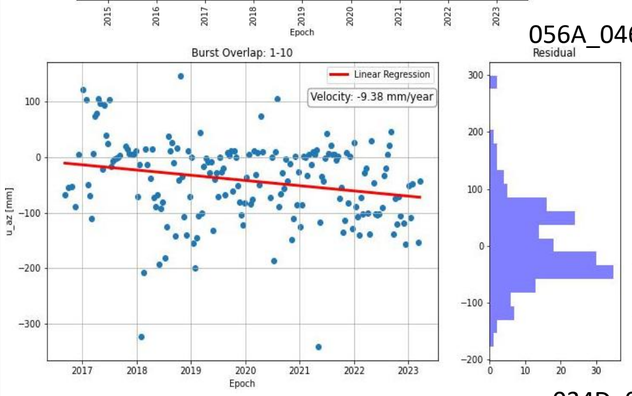

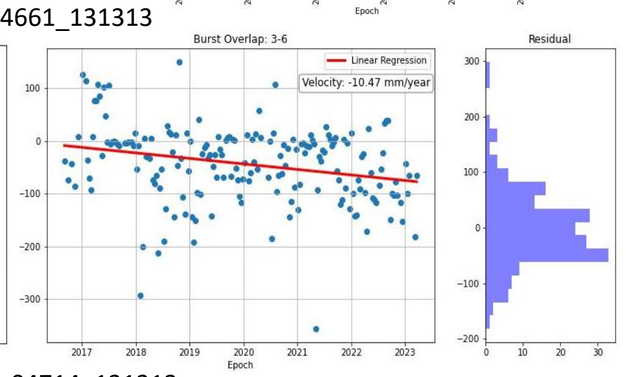

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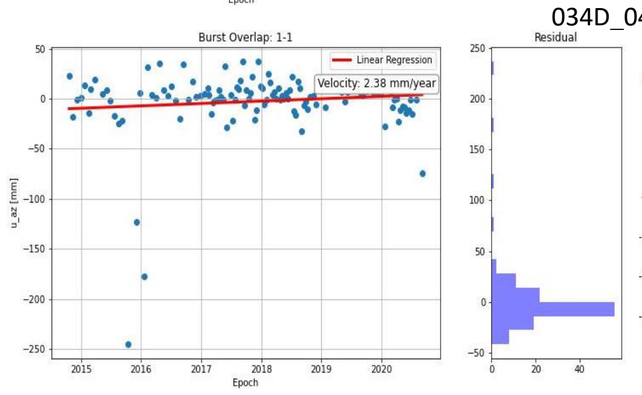

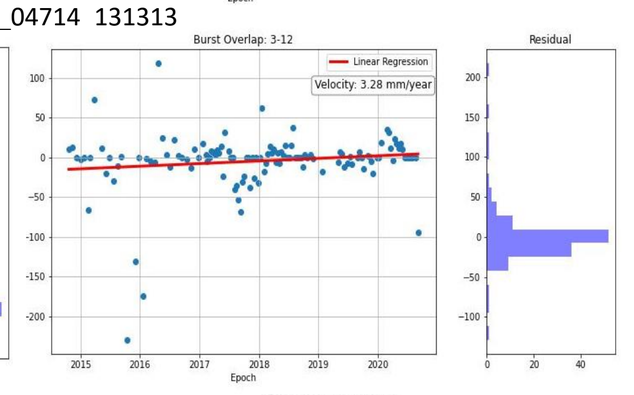

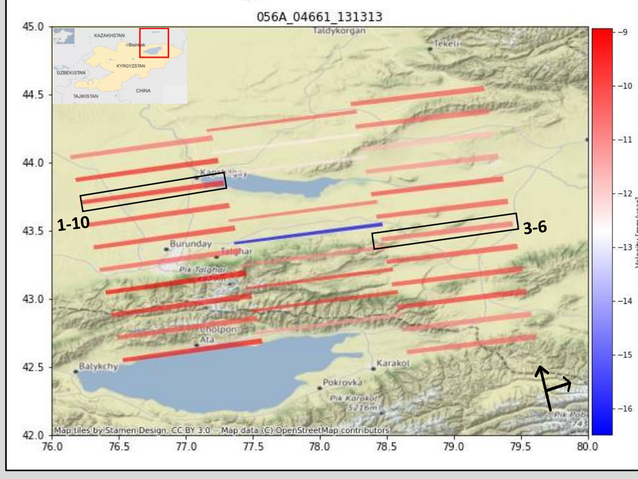

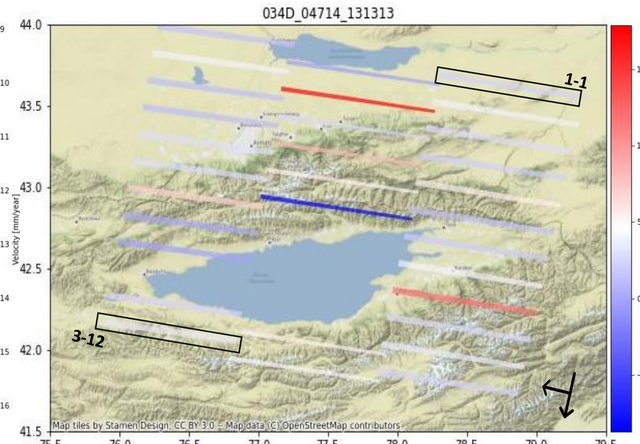

4. Next Steps

- Raw azimuth offset results include some distorting parameters which should be removed. They are ionospheric and Solid-earth tides contributions.
- After removing distorting contributions, We reprocess the velocity estimation through linear regression. Before the regression, outliers will be eliminated in order to make a more correct assumption.
- We will compare the result with GNSS values and plate motion models.

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