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Z_GIS

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Radio Detection & Ranging

Generation of a Displacement Map

Advance Remote Sensing
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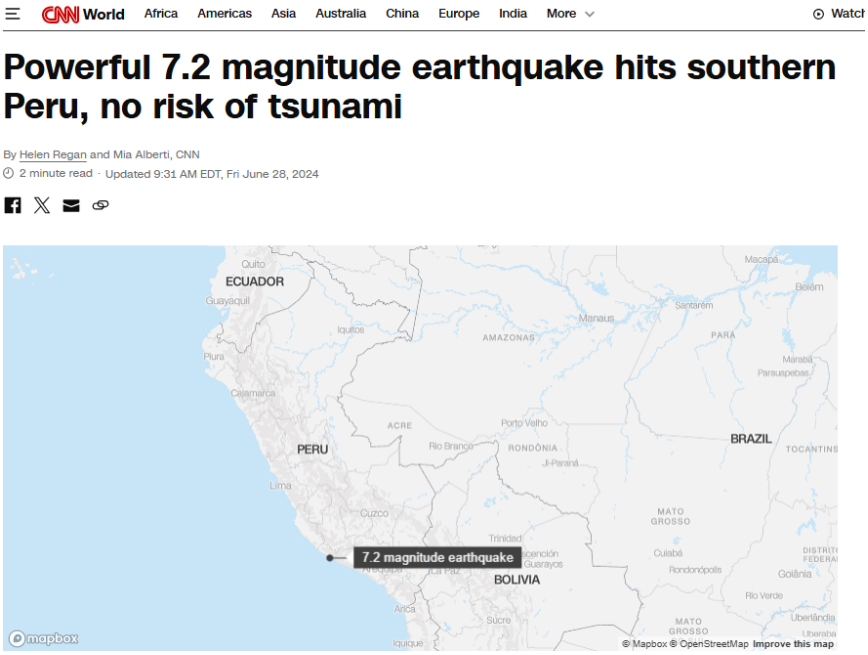
Dec 19, 2024

Area of Study

An offshore earthquake of 7.2 magnitude and depth of 24.0 km, west of Arequipa, Peru, was reported on July 28th, 2024. The seismic activity occurred at the coordinates 15.828°S 74.454°W about 8 km from the coastline.

Figure 1. CNN new about the earthquake



Data Input

The event was localized on the USGS earthquake resource, and subsequentially, the Sentinel-2 images were downloaded from NASA EOSDIS. Since the event happened on July 28th, 2024, results convenient to select imagery from both before and after the earthquake, ensuring they overlapped to effectively calculate the displacement.

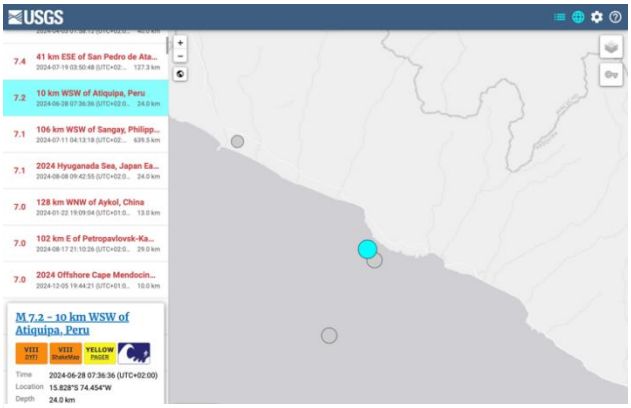


Figure 3. Selection of the event in USGS portal.

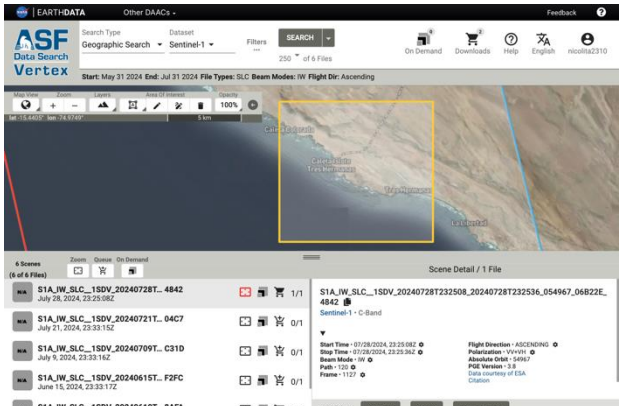


Figure 2.Download of the satellite images (before and after)

Data preparation

The data preparation process involves localizing the area of interest within the split section in SNAP to confirm that the event's location falls within the swath area (Image 5.). Once the previous step has been defined, the area of interest is narrowed down to 3 to 2 bursts.

Figure 4. Overlapping of the USGS portal map and S-1 Tops Split view.

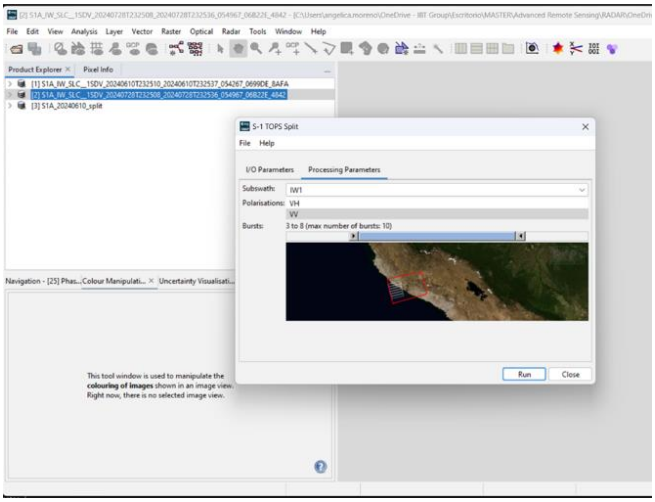


Figure 5. S-1 Tops Split process.

Data Processing

1. Apply-Orbit-Fil

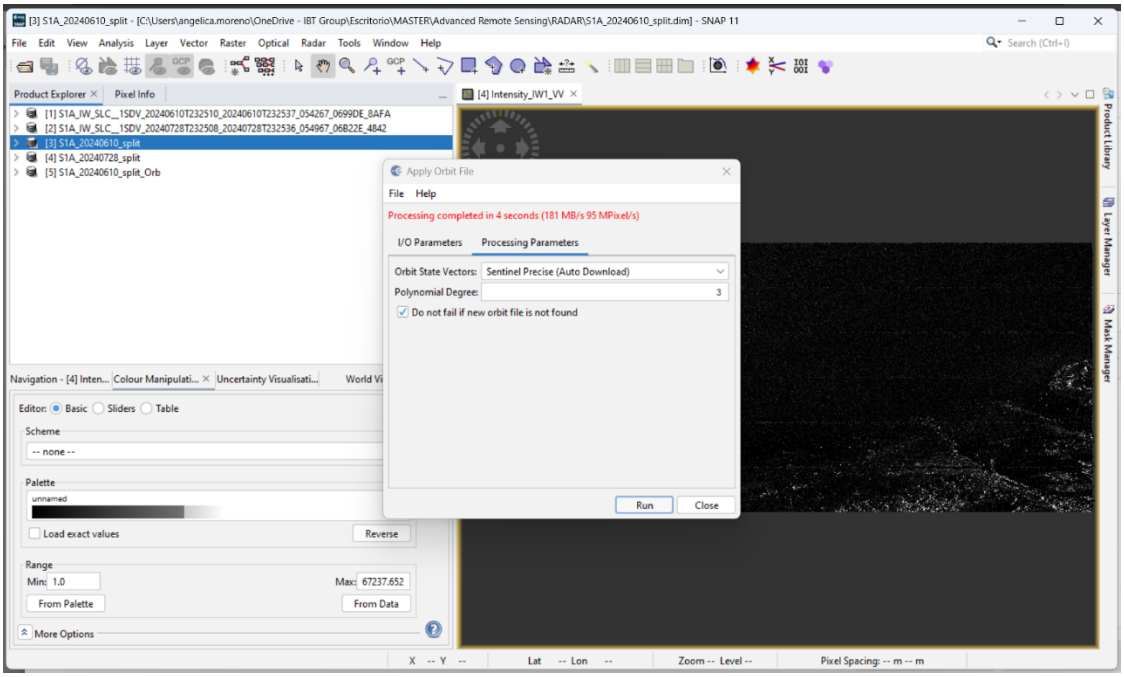


Figure 6. Use of the tool Apply-Orbit-File to correct satellite positioning errors.

2. Generation of Topographic Interferogram

In this process, the differences in phase caused by terrain elevation are corrected. Steps 2.1 and 2.2 are referred to as co-registration; the first is mandatory, while the second is optional.

2.1. S-1 Back-Geocoding

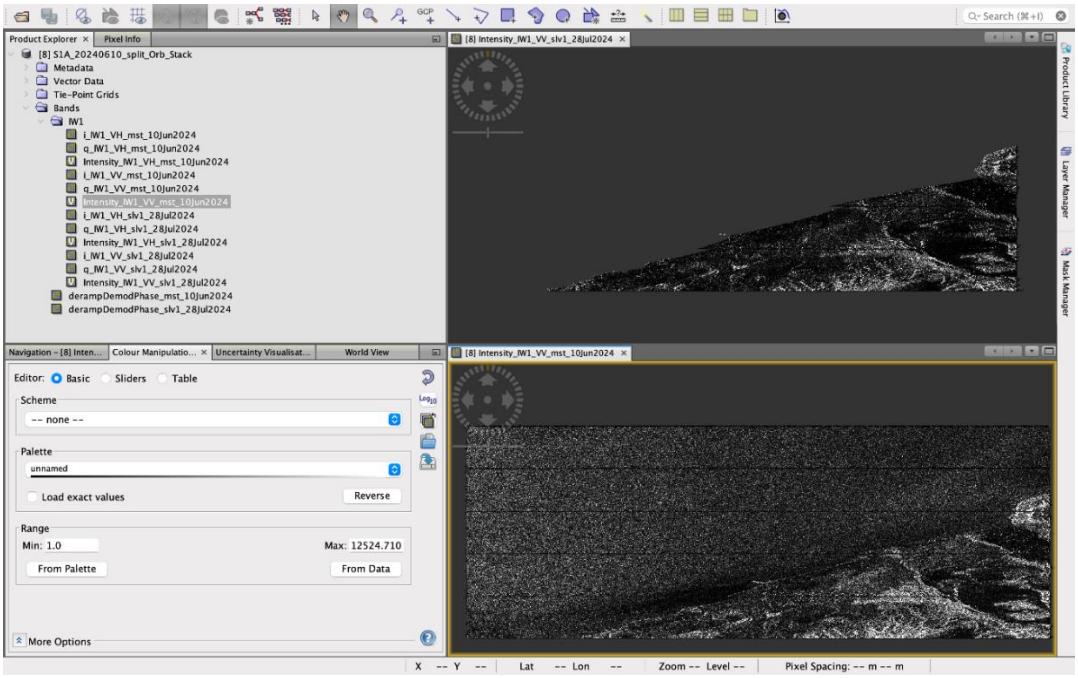


Figure 7. Application of S-1 Back-Geocoding as part of the co-registration process.

2.2. Enhanced Spectral Diversity

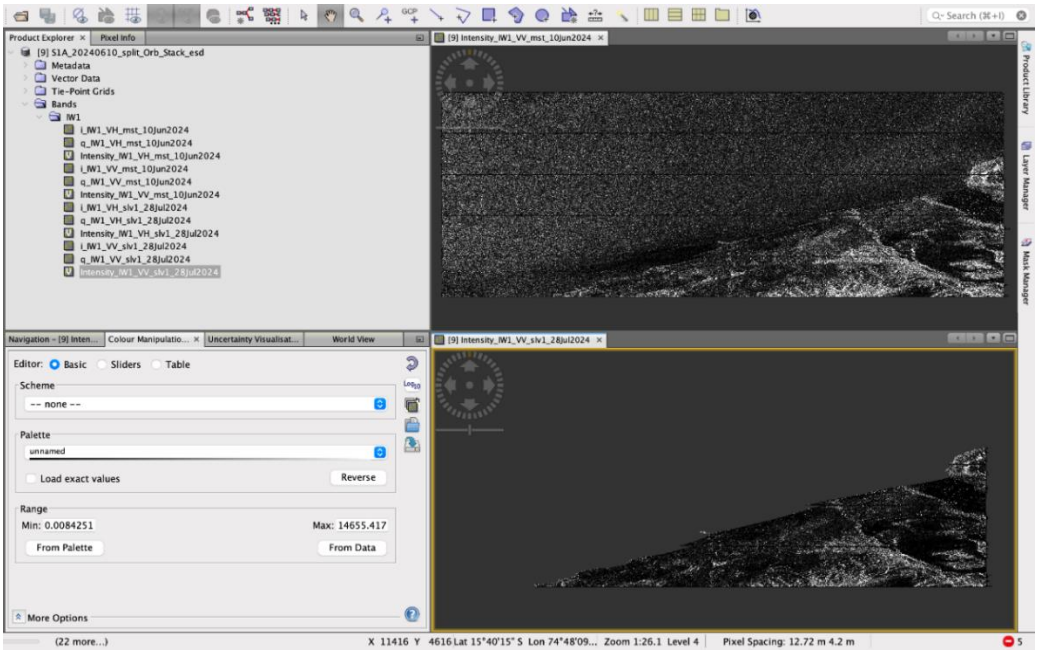


Figure 8. Application of Enhanced Spectral Diversity as part of the co-registration process.

2.3 Interferogram Formation

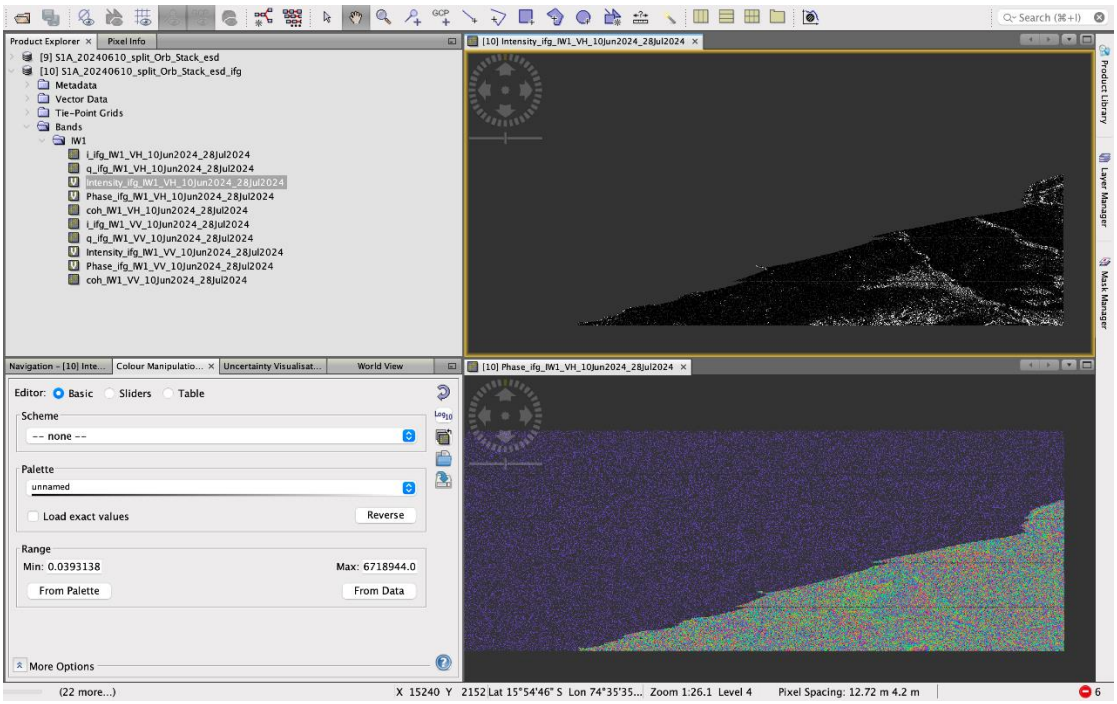


Figure 9. Creation of the interferogram

2.4 S-1 TOPS-Deburst

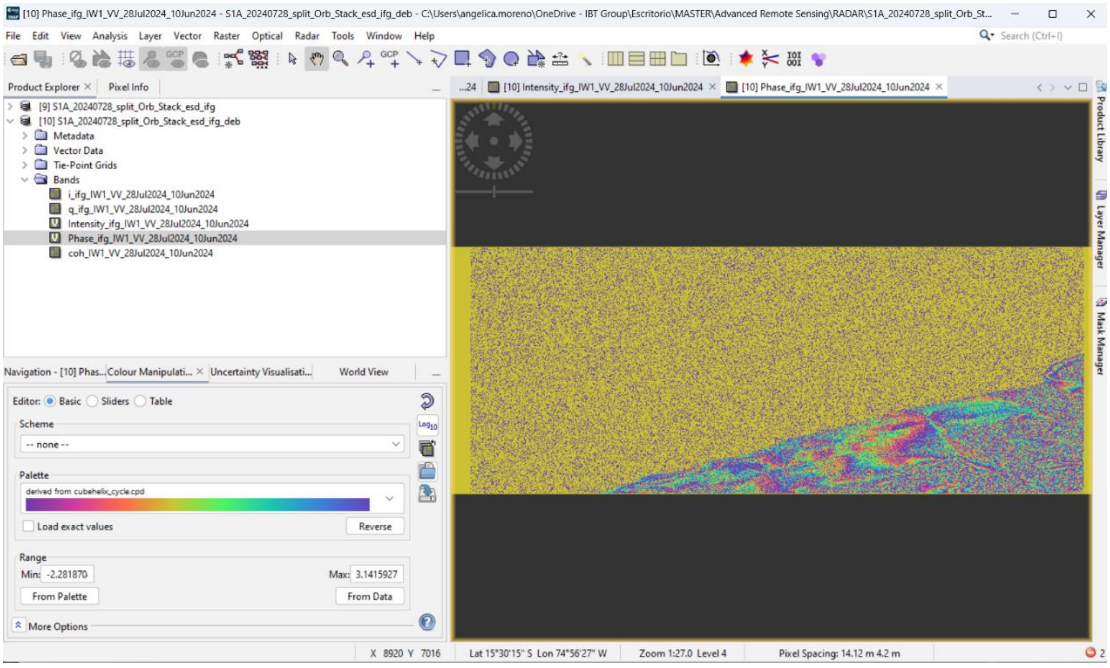


Figure 10. Application of TOPS-Deburst to remove the burst boundaries.

3. Generation of Differential Interferogram

3.1 Topographic Phase Removal

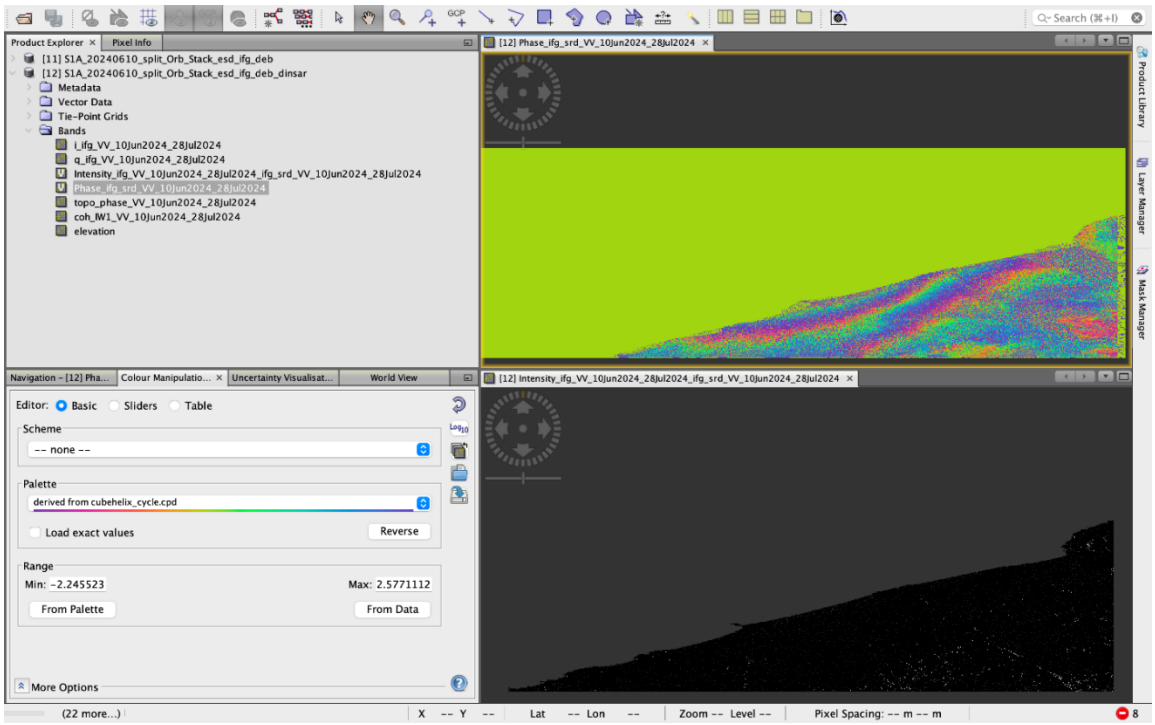


Figure 11. Results of the removal of topographic effects in a phase view.

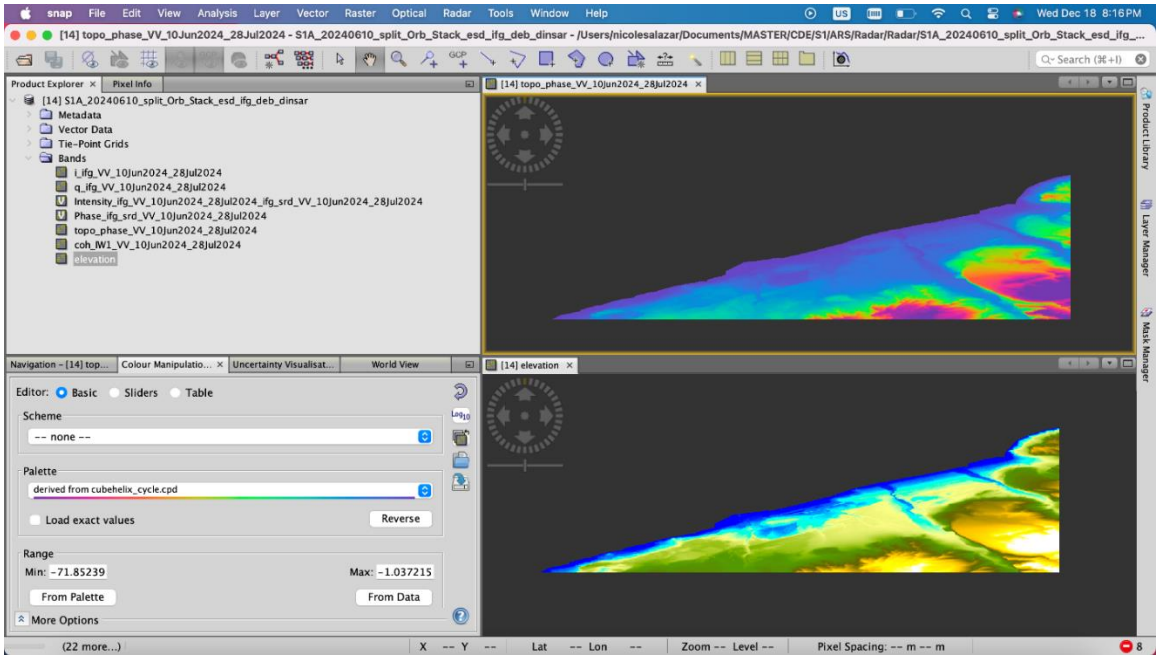


Figure 12. Results of the removal of topographic effects in the elevation view.

3.2 Multilooking

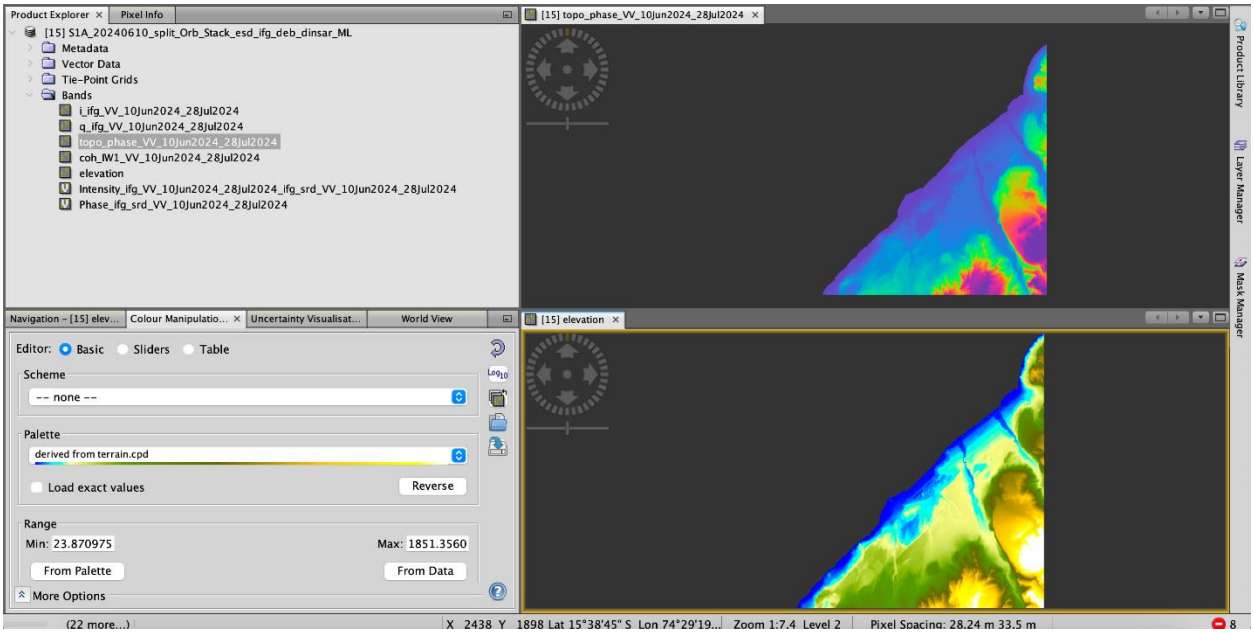


Figure 13. Results of the application of Multilooking to reduces noise and get square pixels

3.3 Goldstein Phase Filtering

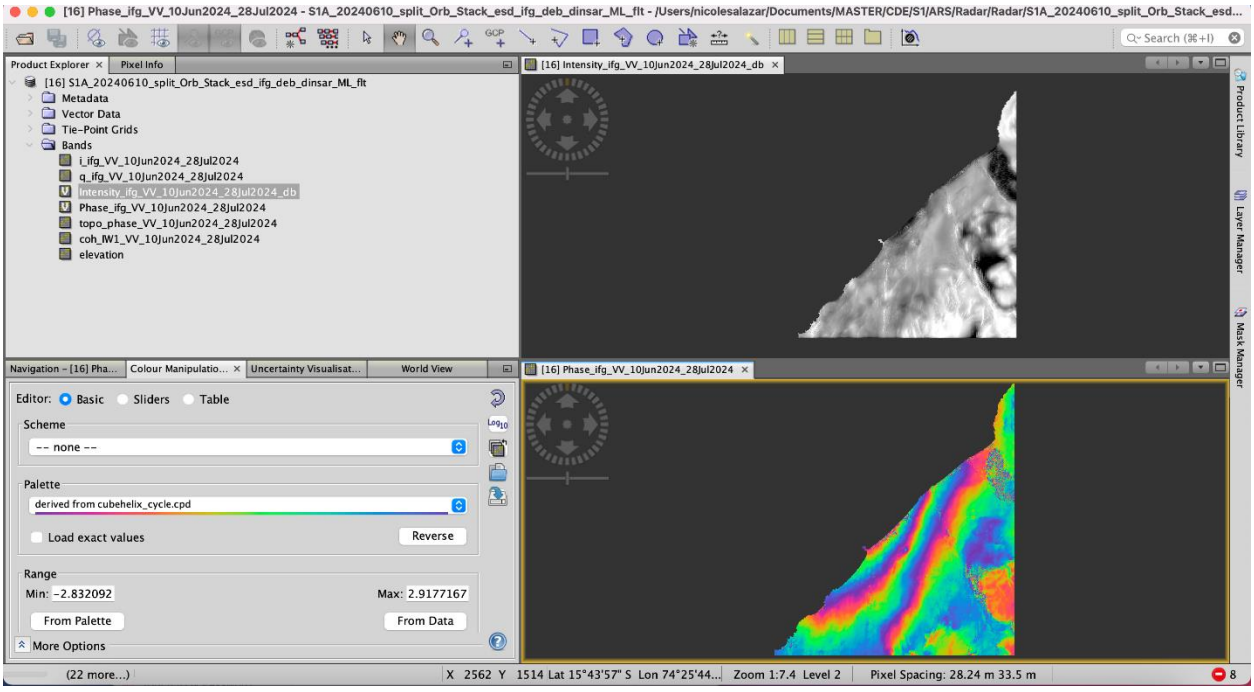


Figure 14. Result of the application of Goldstein Phase.

Snaphu

After the downloading and setting of snaphu, the export was made It and the tool was running getting as is showed in the next image:

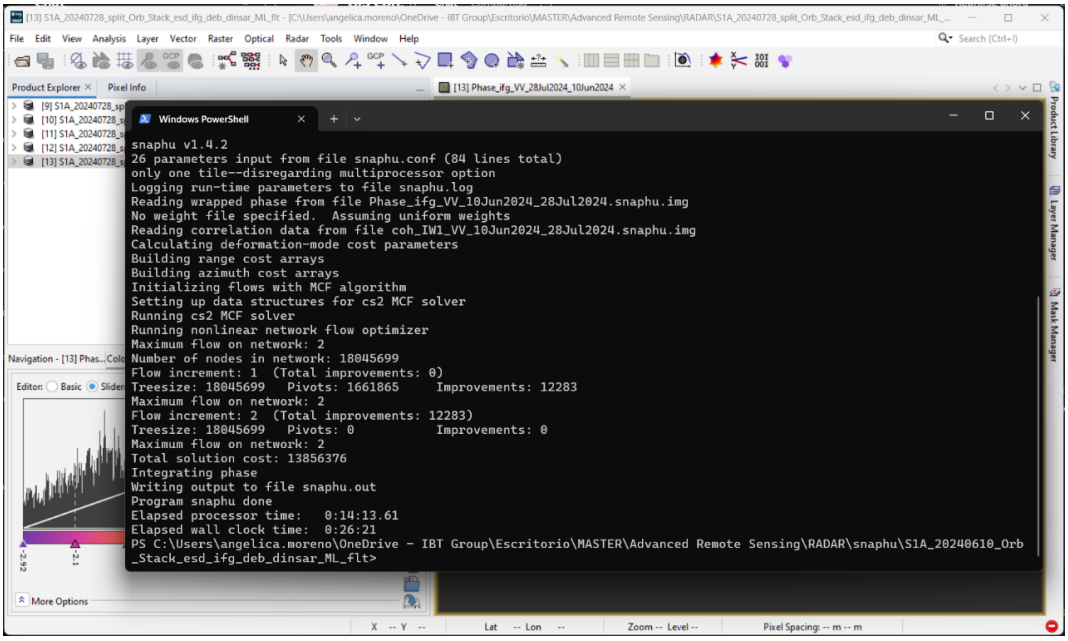


Figure 15. snaphu running result.

Output

Displacement Map Creation

1. Phase to displacement and displacement map

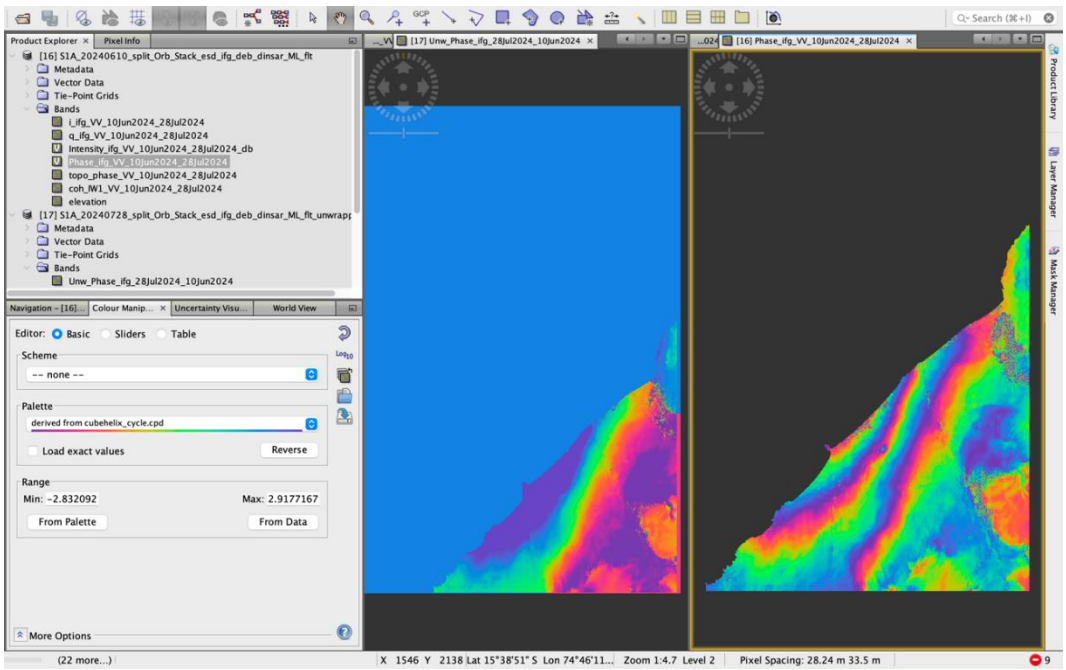


Figure 16. Result after import the snaphu result and apply phase to displacement.

2. Terrain Correction

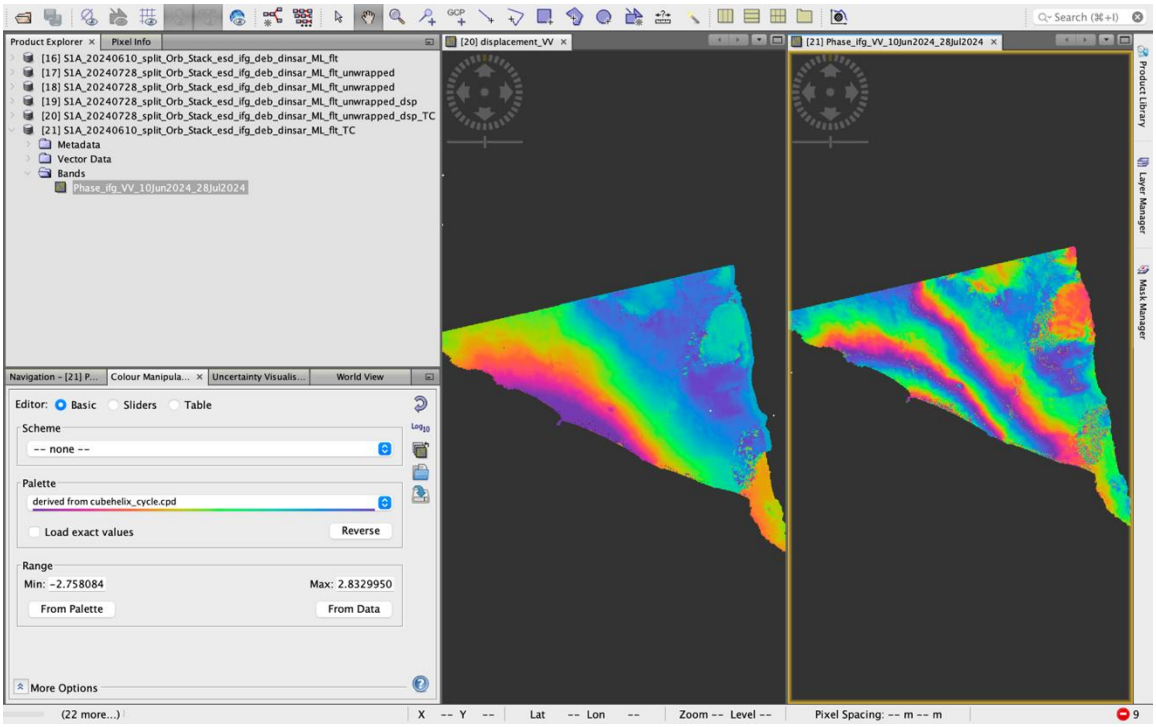


Figure 17. Result of terrain correction.

Analysis

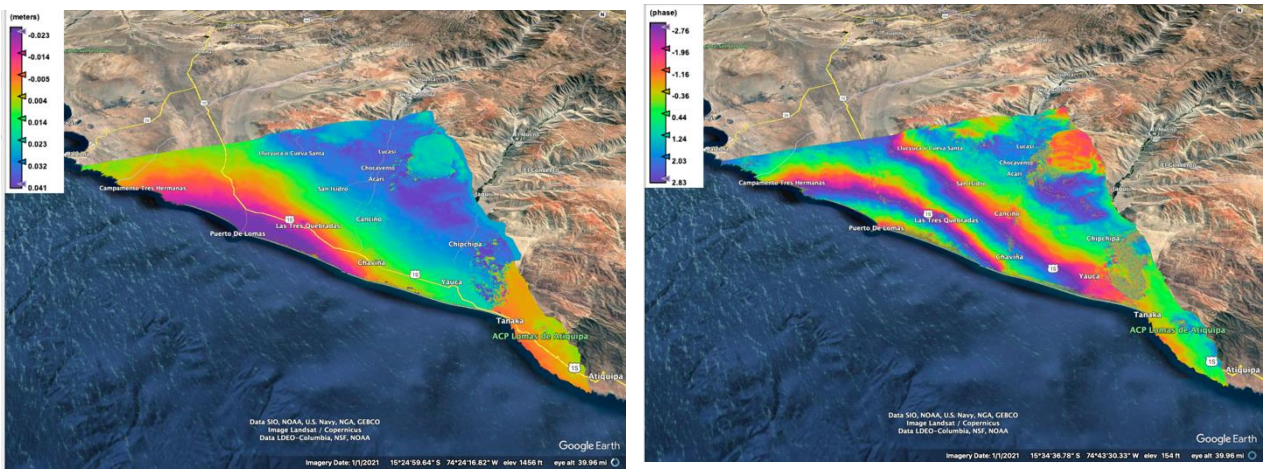


Figure 18. Result with graphic of the displacement in meters.

Despite the seismic event occurring offshore, factors such as the proximity to the coastline and the depth of the hypocenter will influence whether surface displacement is observed. In this case, the hypocenter was located at a depth of 24.0 km, and the displacement map revealed a range from -4 cm to +8.5 cm. Brighter areas on the map indicate uplift caused by the event, while the blue areas represent subsidence in the affected region.

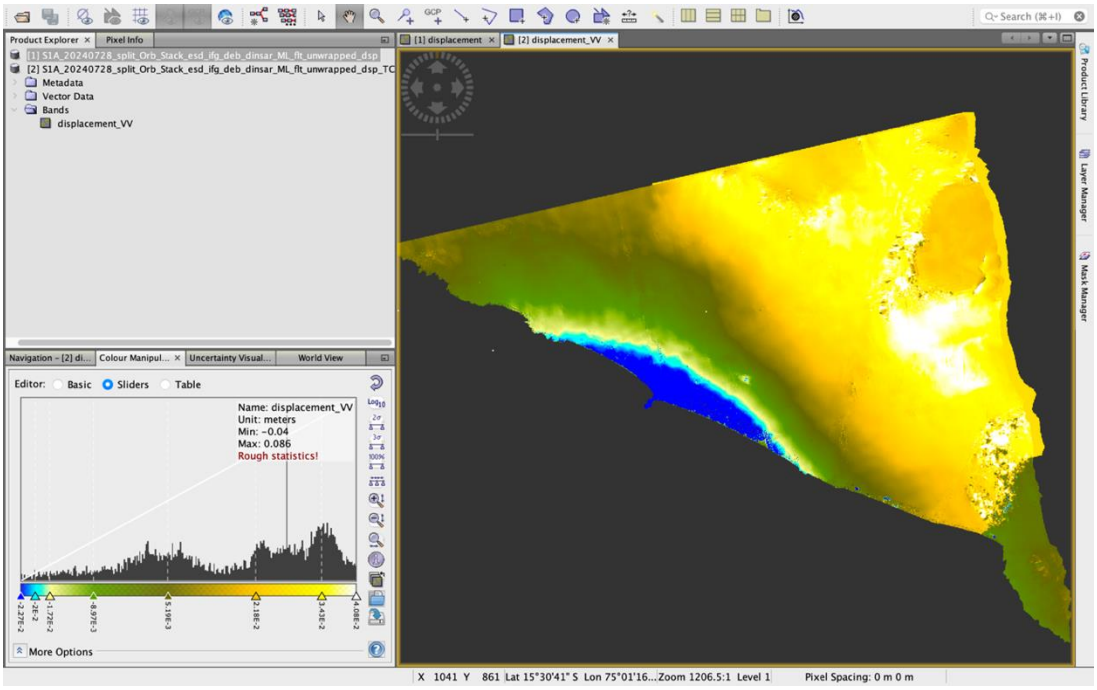


Figure 19. Result export to Google Earth.

References

1. Trevoho, I., Chetverikov, B., Babiy, L., & Malanchuk, M. (2020). Monitoring of displacements and deformations of the earth's surface near the Stebnyk city using radar images of Sentinel-1. *Geodesy and Cartography*, *69*(1), 85-96.
2. Hadj-Rabah, K. (2024, December). *Lab session: Generation of Displacement Map document*
3. Hadj-Rabah, K. (2024, November 23). *Génération d'une carte de déplacement à partir des images SAR - SEED4NA USTHB*. https://www.youtube.com/watch?v=ZPMRaztNbVU&t=393s
4. Sharma, K. (2024, December 13). *Working with RADAR : Case Study in Jajarkot EarthQuake.* https://kshitijrajsharma.com.np/blog/radar-image-tutorial/