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Preliminary analysis of InSAR displacements for the Tonga 2022 eruption

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British Geological Survey

Area of interest - Tonga archipelago

Area of interest

- We investigated InSAR time series between June-19 and Dec-21 and interferograms between November 2021 and January 2022
- Interferograms processed through the Alaska Satellite Facility InSAR on demand service (https://search.asf.alaska.edu/#/)

Interpreting the Line of Sight (LOS) displacement maps

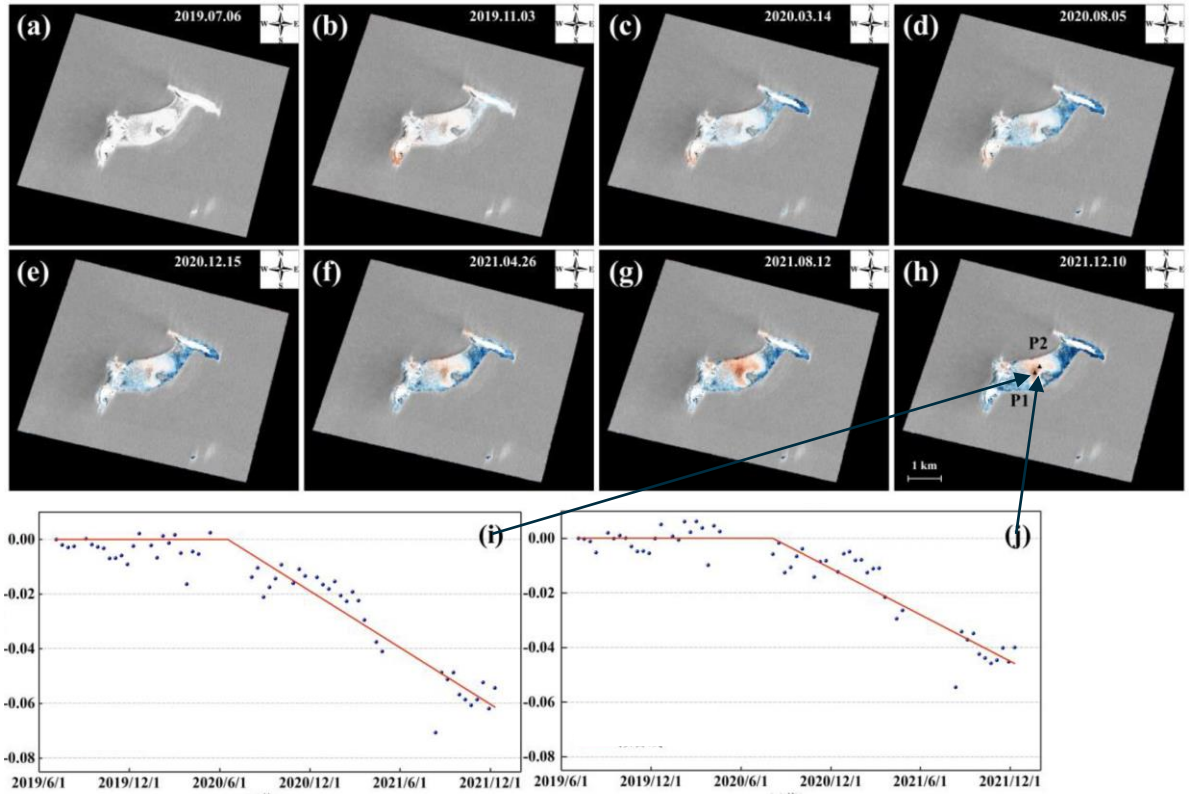
- SAR (Synthetic Aperture Radar) imagery for Sentinel-1 IW scenes is acquired at an oblique angle to the Earth's surface (from 29 to 46 degrees). The phase difference measurements are calculated along that look angle, and the LOS displacement also quantifies movement in that direction.

- SAR is relatively insensitive to movement that occurs in the same direction as the path of the sensor. Motion can be detected in the range direction (perpendicular to the orbit direction) but poorly captured in the azimuth direction (parallel to the orbit direction).

- LOS measurements can (and often do) have elements of both vertical and horizontal movement, and it is not possible to determine their relative contributions from a single interferogram.

- Pixel resolution of the Displacement maps is ~80x80m

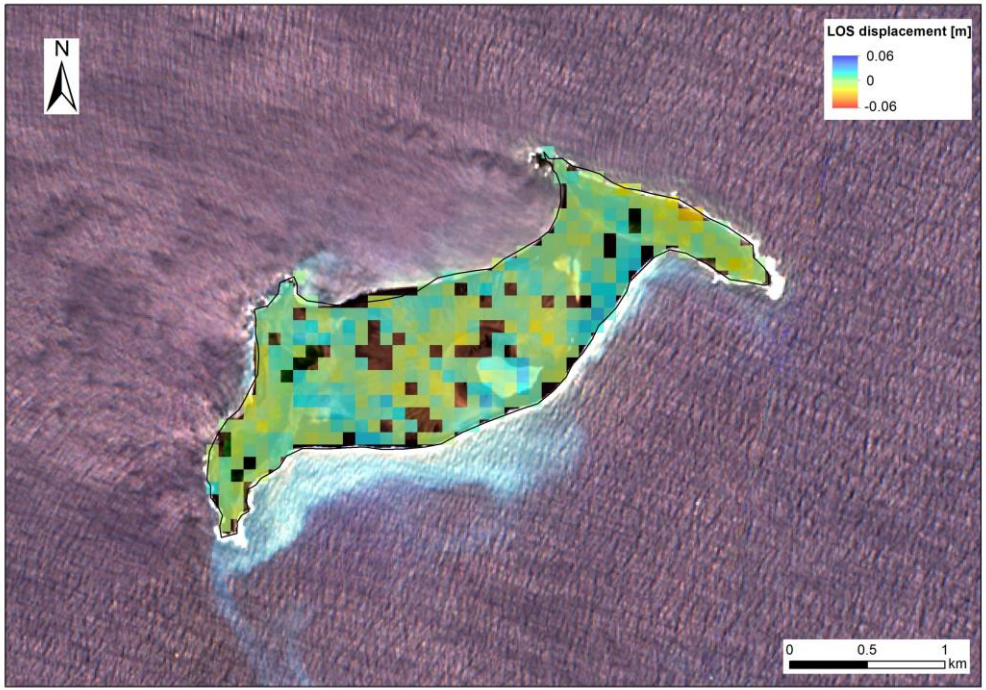
Line of Sight (LOS) displacement maps



- HT-HP shows ground surface stability from Jun-19 to Jun-20
- Cumulative negative movements (down to -6cm) are observed in the center of HT-HP between Jun-20 and Dec-21

Time series analysis from Yufeng et al., 2022 (10.13203/j.whugis20220050)

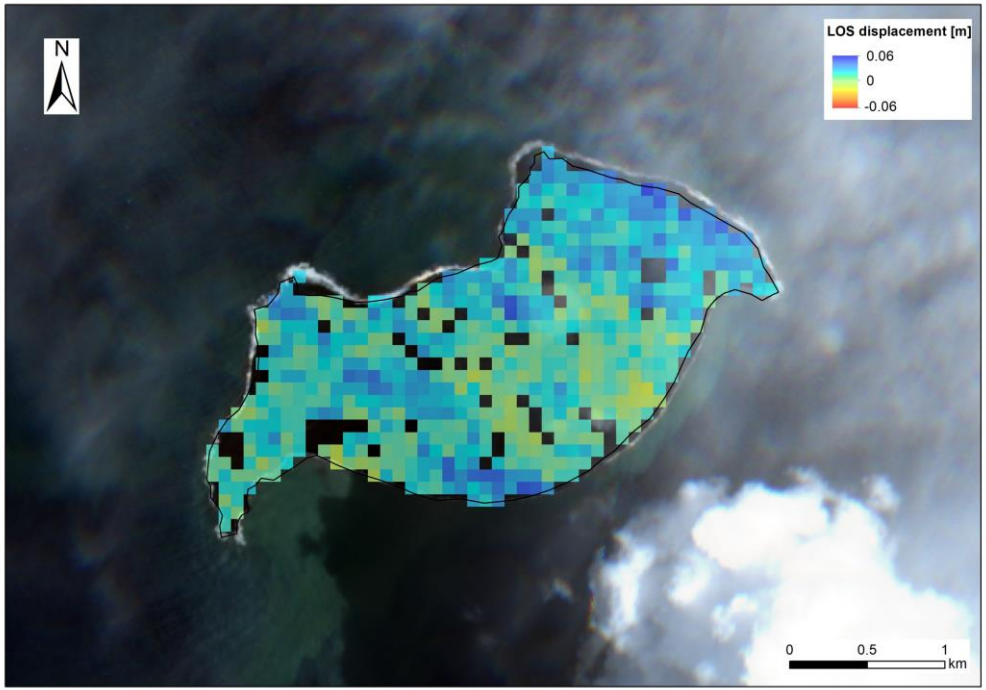
HT-HP, 10-12-2021 vs 22-12-2021 LOS displacement



- Poor coherence (<0.2 on average) across the whole island so displacements rates look unreliable

HT-HP = Hunga Tonga Hunga Ha'apai
Basemap is represented by the RGB Sentinel-2 image acquired on 28/11/2021

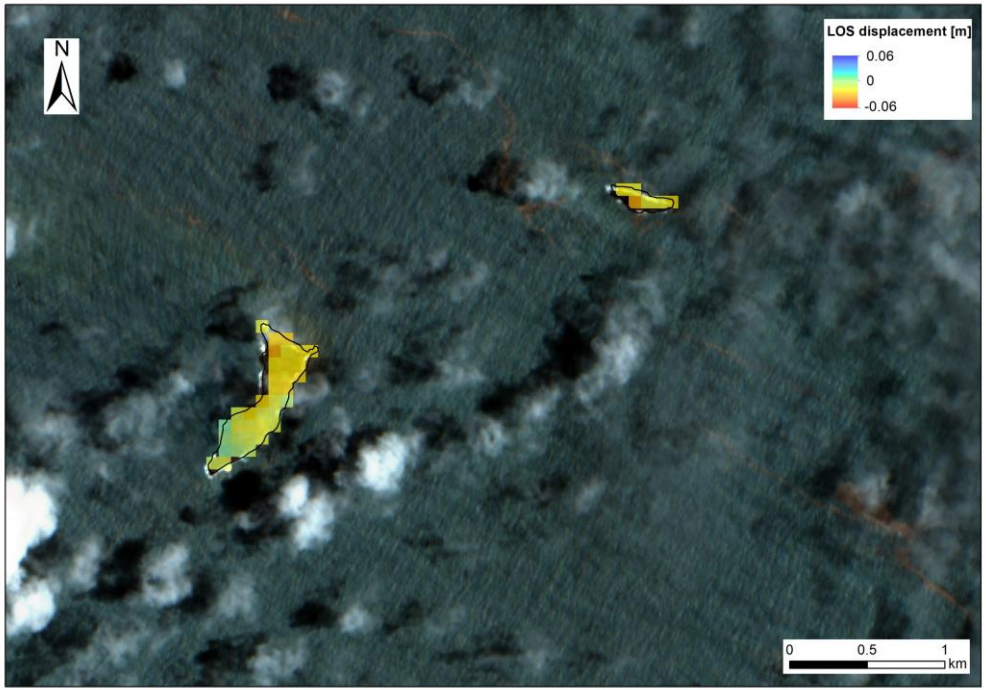
HT-HP, 22-12-2021 vs 3-1-2022 LOS displacement



- Poor coherence (<0.2 on average) across the whole island so displacements rates look unreliable
- Decorrelation reflects the intense reshaping of the HT-HP island

HT-HP = Hunga Tonga Hunga Ha'apai
Basemap is represented by the RGB Sentinel-2 image acquired on 2/1/2022

HT-HP, 15-1-2022 vs 27-1-2022 LOS displacement



- Reduced rates of deformations and mainly concentrated in the central part of HT-HP.
- Minimum displacements (in the range of -0.03m) show movements on the SW island.

HT-HP = Hunga Tonga Hunga Ha'apai
Basemap is represented by the RGB Sentinel-2 image acquired on 17/1/2022

Summary of findings & Disclaimer

- HT-HP volcano showed LOS displacements up to 6.0cm between June 2020 and December 2021
- The poor coherence of the interferograms from December 2021 prevent any further analysis of the deformation at HT-HP.
- These displacement maps are provided as a convenience, to help users interpret what is happening in the image. They are not intended to be authoritative, and displacement values from a single interferogram should not be used to draw conclusions.