

# **InSAR Imaging of White Island from 2014 to 2020: Insights into the 2019 Phreatic Eruption**

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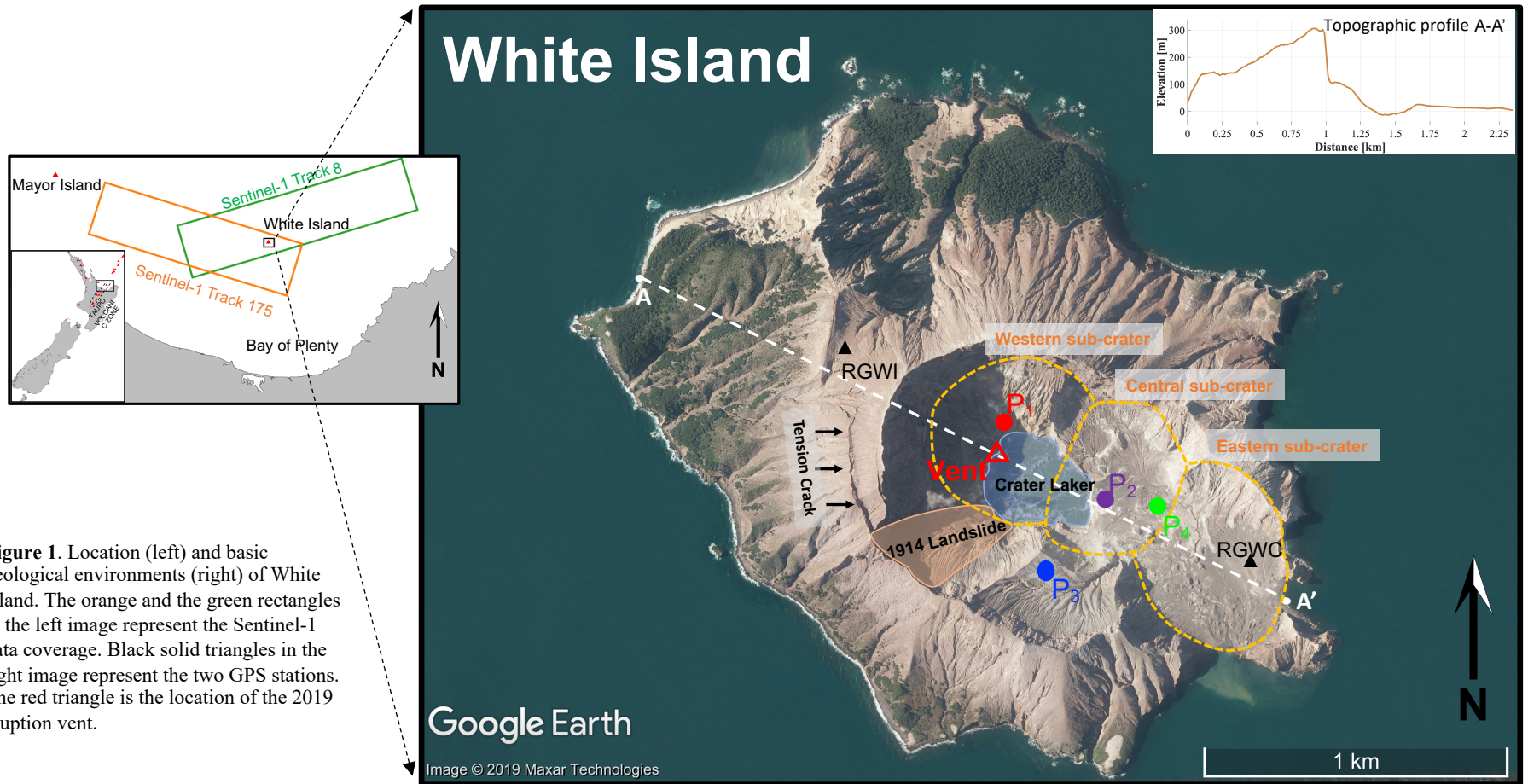
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# 1. Backgrounds



**Figure 1.** Location (left) and basic geological environments (right) of White Island. The orange and the green rectangles in the left image represent the Sentinel-1 data coverage. Black solid triangles in the right image represent the two GPS stations. The red triangle is the location of the 2019 eruption vent.

## The 2019 eruption:

- Phreatic
- VEI = 2
- Claimed 21 lives

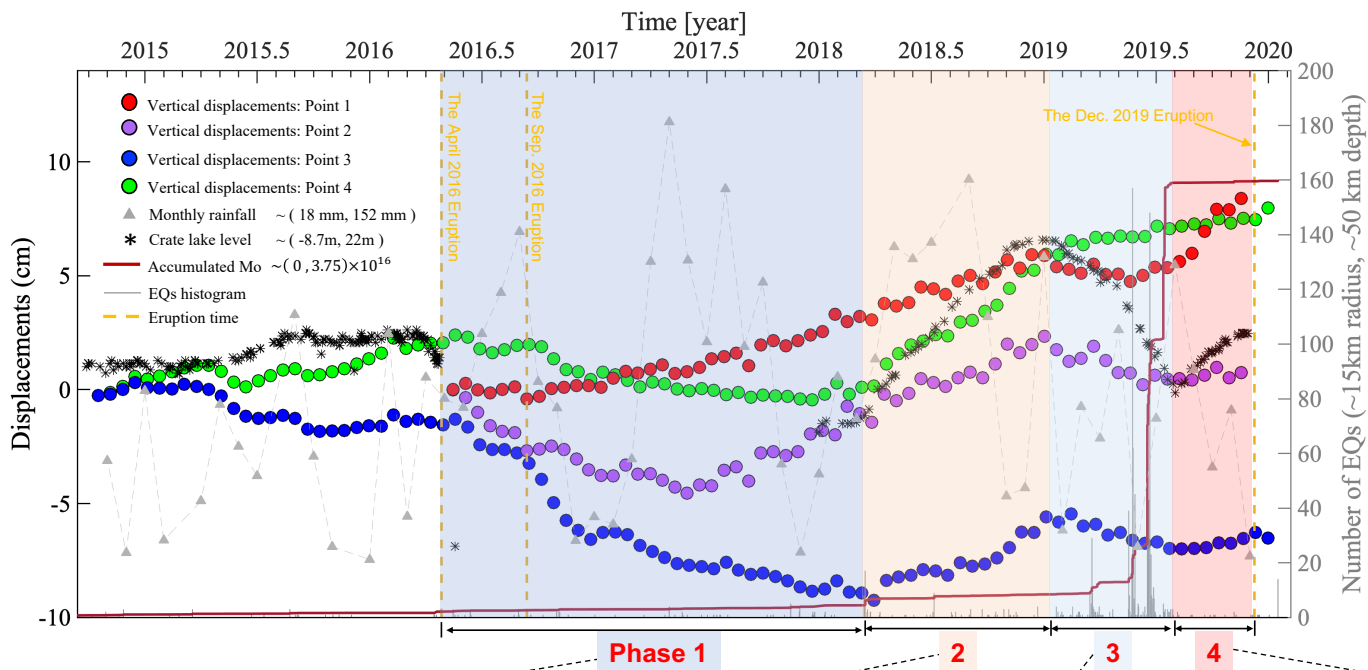
## Geodetic data:

- Sentinel-1 radar images
- August 2014 ~ January 2020
- Ascending Track 8 (122 images)
- Descending Track 175 (123 images)

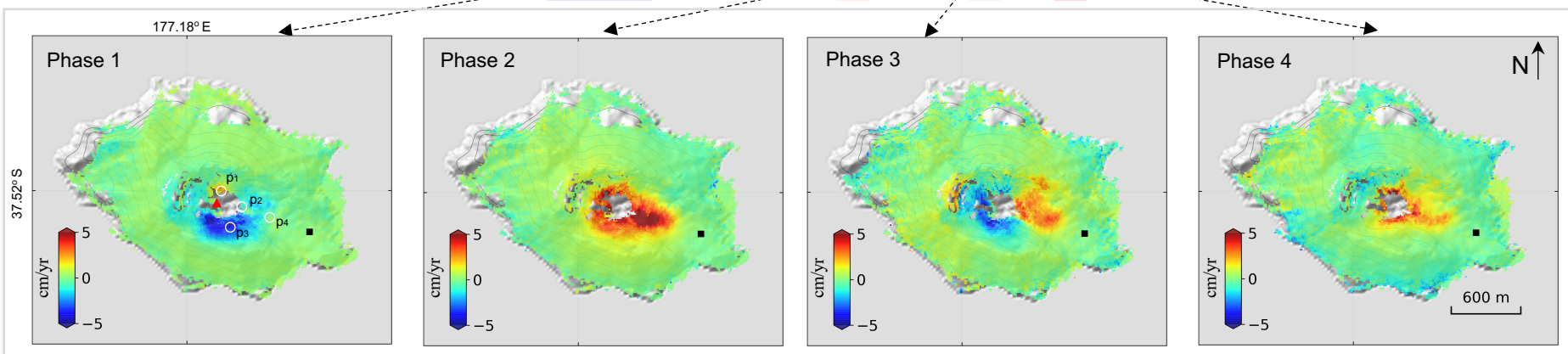
## Research points:

- White Island surface displacements (2014 - 2020) ?
- Any short-term precursor before the 2019 eruption?

## 2. Results



**Figure 2.** Time-series analysis of InSAR derived vertical displacements evolution at the four location (colored points in Fig. 1) along with rainfall (gray triangle), water level of the crater lake (dark star), the number of earthquakes (gray histogram), and the cumulative seismic moment (red line).



**Figure 3.** InSAR-derived velocity maps of the vertical displacements during different phases. Positive value means uplift and negative value means subsidence. White circles in the first map are the locations of the same colored points presented in Fig. 2, and the red triangle is the location of the 2019 eruption vent.

- Four phases with different behavior are observed
- Correlation between displacements and crater lake level
- No clear correlation between displacement and seismicity/rainfall

### 3. Discussion and Conclusions

- Subsidence in 2016-2017, within the crater area of White Island, changed to rapid uplift ( $\sim 8$  cm/yr) in early 2018.
- Uplift east of the crater lake continued into 2019, albeit at a slower rate ( $\sim 3$  cm/yr), while the area near the lake returned to subsidence ( $\sim 4$  cm/yr).
- The area near the lake started uplifting again ( $\sim 3$  cm/yr) in early July 2019 and until the Dec. 2019 eruption, possibly due to pressure increase in a shallow sub-surface source. Northwest of the lake, close to the 2019 vent, the uplift rate is even higher ( $\sim 8$  cm/yr), although the uplift rate does not appear to accelerate towards the eruption.
- Together, the results indicate that complex inflation/deflation patterns occurred at White Island in the 2-3 years before the Dec. 2019 eruption with a change from local subsidence to uplift in the crater lake area, occurring 4 months before the Dec. 2019 eruption.

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#### References:

- Moon, V., et al. (2009). "Geomorphic development of White Island Volcano based on slope stability modelling." *Engineering Geology* 104(1-2): 16-30.
- Hamling, I. J. (2017). "Crater Lake Controls on Volcano Stability: Insights From White Island, New Zealand." *Geophysical Research Letters* 44(22): 11,311-311,319.