National Aeronautics and Space Administration

# Satellite observations of volcano topography change: A critical but immature measurement for eruption forecast models

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Program: FY22 SURP

Strategic Focus Area: Land and solid earth processes

## Objectives (Year 1)

1. How frequently do volcanoes have **topographic change** that could be measured from space?
2. What are their spatial and temporal characteristics?

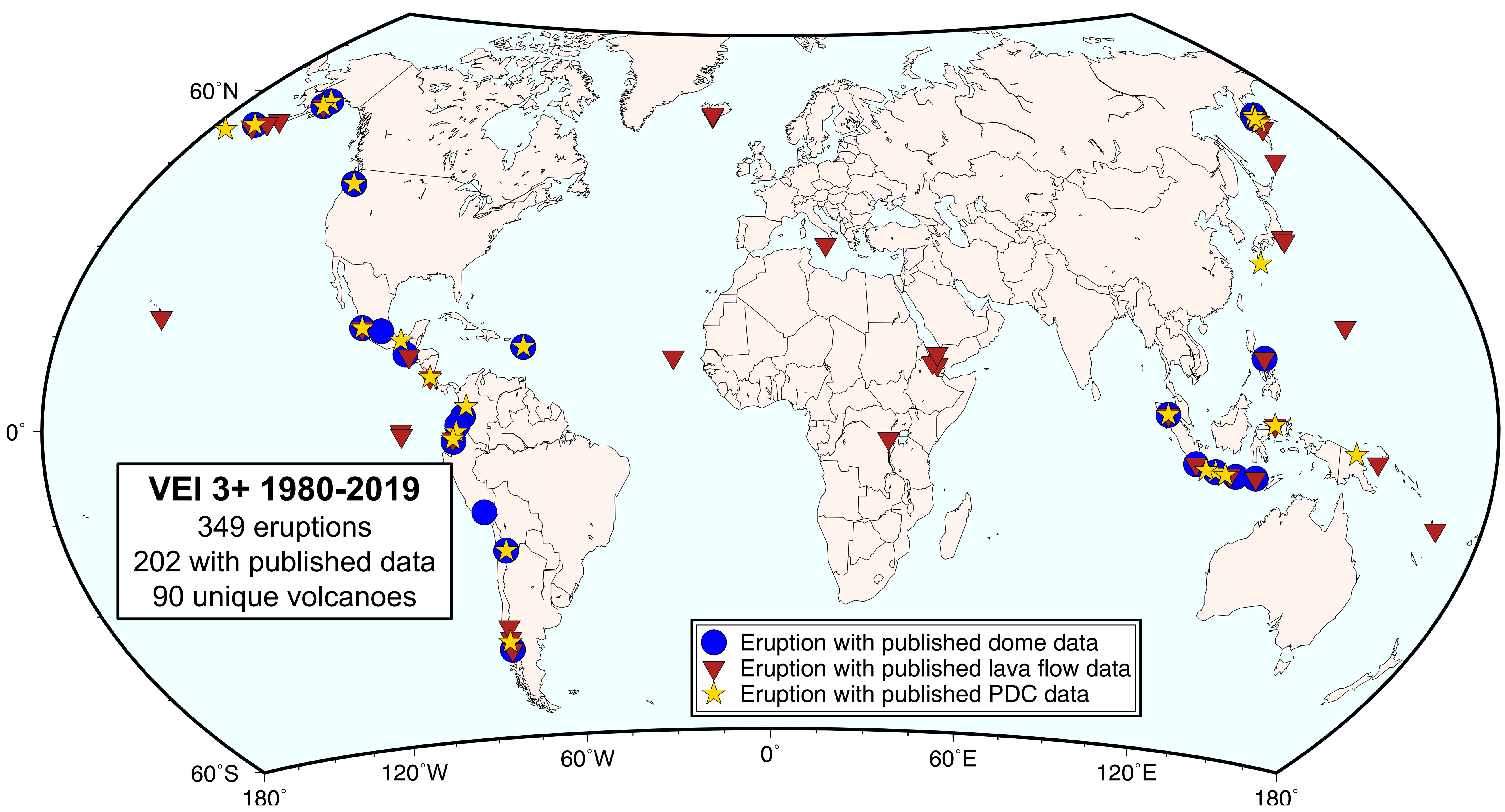


**Fig 1.** Global map of eruptions Volcano Explosivity Index (VEI) 3+ with topographic data. Eruptions that produced lava domes, lava flows, or pyroclastic density currents (PDCs) and had published spatial dimensions topography change are shown here.

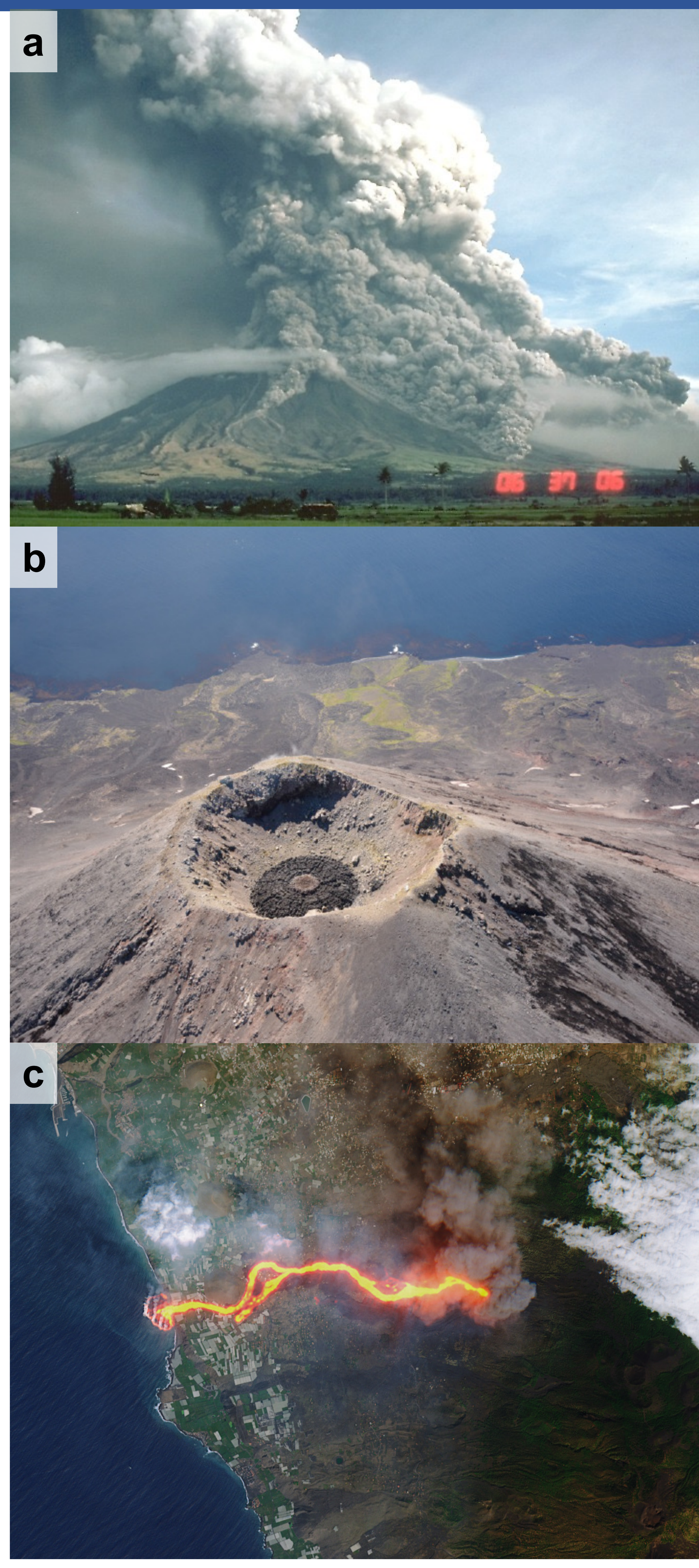


**Fig 2. (a)** PDC at Mayon volcano, Philippines[1]. **(b)** Lava dome at Mt. Cleveland volcano, Alaska[2]. **(c)** Lava flow at La Palma volcano, Canary Islands[3].

## Background

- Topography and how topography changes over time are critical datasets for developing **physical models of volcanic eruptions**.
- Measurements of topographic change with sufficient spatial and temporal resolution to constrain numerical eruption models are currently limited.
- Eruptions VEI 3 or greater make up over 75% of the erupted mass from 1980 – 2019[4]; this review focuses on those eruptions.

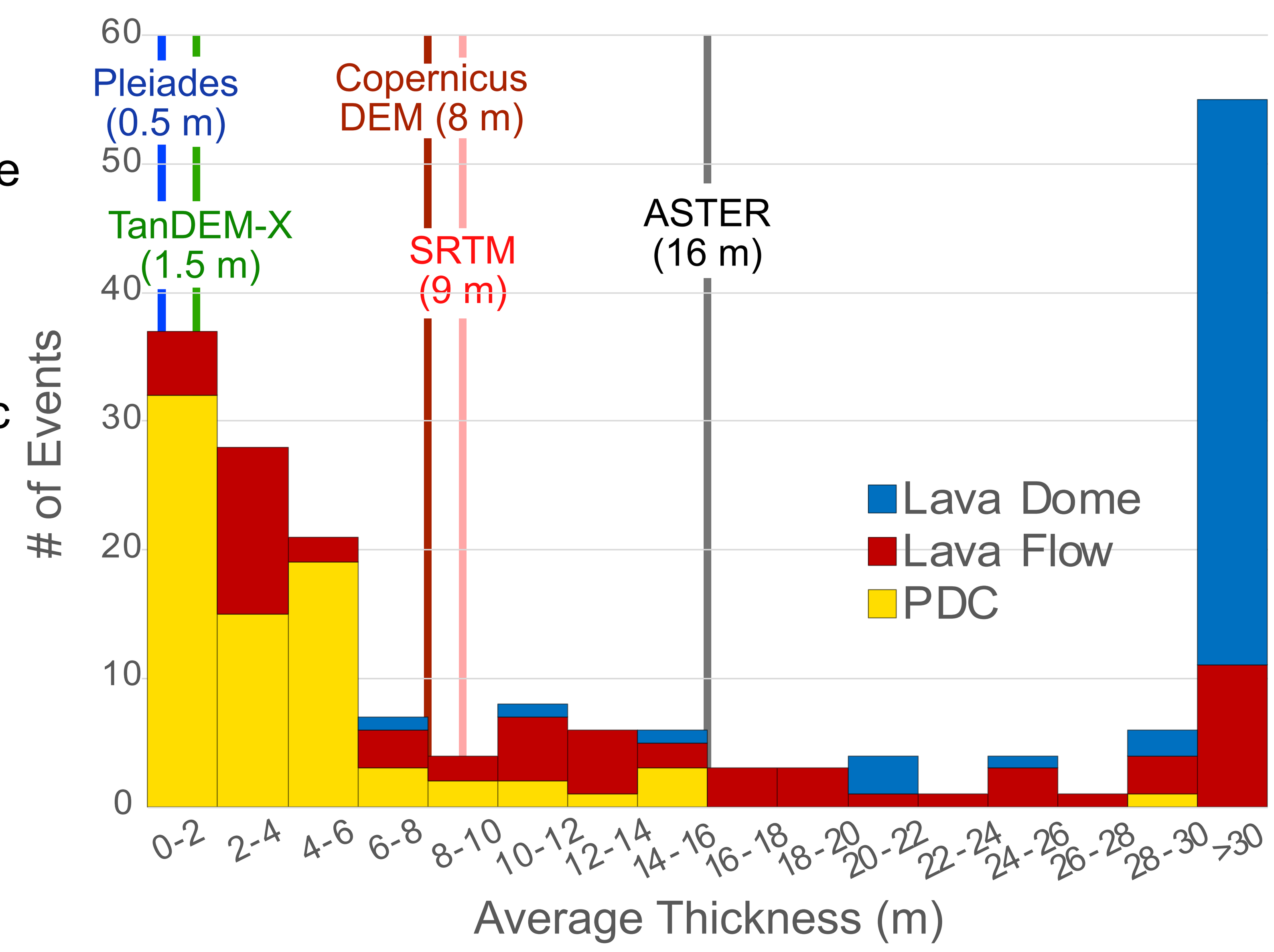


**Fig. 3.** Histogram of published average thickness measurements of eruptive products. The vertical resolutions of common satellite instruments used to measure topography from space are shown with vertical bars.

## Approach

1. Review existing literature and compile a database of eruptive products (lava flows, domes and PDCs) from eruptions VEI 3+ between 1980 and 2019.
2. Define spatial and temporal acquisition needs for future topography-change missions.

## Preliminary Results

1. Vertical resolution of 1 m would capture 89% of eruptive products (Fig. 3).
2. Many current topographic datasets do not have sufficient vertical resolution.

## Benefits to JPL and NASA

The deliverables from this project will be directly relevant for Surface Topography and Vegetation (STV) future mission proposals. The global analysis of available satellite topography data will provide guidelines for optimal spatial and temporal resolutions for future missions. The DEM and physics-based modeling capabilities developed in the second phase of the project will be implemented as part of the Advanced Rapid Imaging and Analysis project.

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### References

**[1]** Newhall, C. G. 1984. "Pyroclastic flows descend the south-eastern flank of Mayon Volcano." https://volcanoes.usgs.gov/Imgs/Jpg/Mayon/32923351-020_caption.html, **[2]** Lyons, J., 2015. "Mt. Cleveland Lava Dome." https://www.flickr.com/photos/usgeologicalsurvey/20659644801, **[3]** Sentinel-2. 2021. "La Palma lava flows into the sea." https://www.flickr.com/photos/europeanspaceagency/51564701938., **[4]** Galetto, F., and M. E. Pritchard. 2021. "A global database of erupted mass: an important tool for the spatial and temporal quantification of volcanism from 1980-2020." *AGU Fall Meeting 2021*. AGU.

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