Title: Using Past Eruptions (1980-2019) to Identify Optimal Spatial and Temporal Resolutions for Future Satellite Missions Studying Volcano Topography Change

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Abstract:

Updated topography datasets are necessary for forecasting volcanic hazards and monitoring deformation. Many hazard modeling programs are dependent on up-to-date digital elevation models (DEMs) to forecast the potential directions of lava flows, lahars, landslides, and pyroclastic density currents (PDCs). Furthermore, updated DEMs are essential to accurately process interferometric synthetic aperture radar (InSAR) data for surface deformation, and to quantify eruptive rates for physical eruption models. There are many ways to track topography change at volcanoes, including fieldwork, airborne instruments, and satellites. Satellites provide the greatest potential for global coverage. For future satellite missions we need to know the optimal horizontal and vertical spatial resolution and repeat intervals for topography change data for the science and application needs.

Despite the global availability of satellite topography data, we still do not know the number of volcanoes that have detectable topographic changes or the characteristics of those changes over a given time interval. We define the specific acquisition needs for topography data using topographic change detected from recent eruptions. We review existing literature and compile a dataset of eruptive products (lava flows, domes and PDCs) from eruptions between 1980 and 2019. We focus on eruptions VEI 3 or greater and magnitude 4.5 or greater because they make up over 80% of the erupted mass over those 40 years. Of the 383 erupted products (121 flows, 99 domes, 163 PDCs) surveyed, 45% do not have published spatial dimensions. Our results show that a vertical resolution of 2m would capture 82% of all eruptions studied and an acquisition rate of every week would capture 88% of lava flow and dome-forming eruptions. PDCs have the smallest average thickness with only 59% resolvable at 2m and occur on the order of minutes, indicating different sensing capabilities are required for different use cases.