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Decrease in Volcano Jet Noise Peak Frequency from Crater Expansion

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Volcanic jet noise is the sound, often below the human audible range (<20 Hz and termed infrasound), generated by momentum-driven fluid flow through a volcanic vent. Assuming the self-similarity of jet flows and audible jet noise extends to infrasonic volcanic jet noise, the Strouhal number, $St=D_j f/U_j$, connects frequency changes, f, to changes in the jet length (expanded jet diameter, D_j) and/or velocity scale (jet velocity, U_j). We examine the infrasound signal characteristics from the June 2019 VEI 4 eruptions of Raikoke, Kuril Islands and Ulawun, Papua New Guinea volcanoes with changes in crater geometry. We use data from the International Monitoring System (IMS) infrasound network and pre- and post-eruption satellite data (RADARSAT-2 and PlanetScope imaging for Raikoke and Ulawun, respectively). During both eruptions we observe a decrease in infrasound peak frequency during the transition to a Plinian phase, which remains through the end of the eruptions. The RADARSAT-2 data show a qualitative increase in the crater area at Raikoke; quantitative analysis is limited by shadows. At Ulawun, however, we estimate an increase in crater area from ~35,000 m^2 on May 25, 2019 to ~66,000 m^2 on July 17, 2019. We assume a constant Strouhal number and use the crater diameter as a proxy for expanded jet diameter. Our analysis suggests that the increase in crater diameter alone cannot account for the decrease in peak frequency during the Ulawun eruption. This suggests that the jet

velocity also increased, which fits satellite data, and or the fluid properties (e.g. particle loading, nozzle geometry and roughness, etc.) changed. This is reasonable as the Ulawun eruption went Plinian, which likely involved an increase in jet velocity and erosion of the crater walls. This is the first study to corroborate the decrease in infrasound peak frequency with documented increase in crater area. The fortuitous satellite overpass timing, clear skies, and high spatial resolution enabled the quantitative examination of the Ulawun eruption.