Using Local and Remote Infrasound Recordings to Detect and Characterize Explosive Volcanic Activity

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Remote infrasound arrays have become increasingly useful in detecting and characterizing explosive volcanic activity. The explosive phase of the 2009 Redoubt Volcano eruption produced predominantly short duration, high amplitude infrasound signals recorded up to 4500 km away. All 19 numbered explosive events were recorded at a local microphone (DFR, 12 km), as well as at an infrasound array in Fairbanks, Alaska (I53US, 547 km), most with high signal to noise ratios. The local microphone provides an estimate of the source parameters, and comparison between the two datasets allows the unique opportunity to evaluate acoustic source term estimation at a remote array. High waveform similarity between DFR and I53US occurs during much of the explosive phase due to strong stratospheric ducting, permitting accurate source constraints inferred from I53US data. Cross-correlation analysis after applying a Hilbert transform to the I53US data shows how the acoustic energy has passed through a single caustic, as predicted by ray theory. Similar to previous studies, significant low frequency infrasound from Redoubt recorded at I53US is coincident with high altitude ash emissions. The largest events also produced considerable energy at greater than 50 s periods, likely related to the initial oscillations of the volcanic plume or jet. Many of the explosive events have emergent onsets, somewhat unusual for explosive, short-duration eruptions. Comparison of the satellite-derived SO_2 emissions with the relative amount of acoustic energy at I53US shows a very high, statistically significant correlation. We also present volcano infrasound recordings from the I44RU (Petropavlovsk-Kamchatsky, Russia) infrasound array, and discuss future infrasound monitoring in Kamchatka and the North Pacific region. This study reiterates the utility of using remote infrasound arrays for detection of hazardous emissions and characterization of large volcanic eruptions, and demonstrates how, under typical meteorological conditions, remote infrasound arrays can provide an accurate representation of the acoustic source.