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Explosive activity at Mt. Yasur volcano: characterization of acoustic signals

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Mt. Yasur (Vanuatu Islands) is an active volcano characterized by persistent Strombolian to mild Vulcanian explosive activity, well known to generate a broad variety of air pressure waves. Between 9 and 12 July 2011, we recorded explosive activity from the three active vents of Mt. Yasur by means of a multiparametric station, comprising thermal and visual high-speed cameras and two ECM microphones recording both infrasonic and sonic signals at 10 kHz sampling frequency. A total of 106 major acoustic events, lasting on average 5 seconds (up to 20 in some ash-rich explosion), correspond to visually recorded explosions at the vents and exhibit a surprisingly broad waveform variability. Major events intervene between minor transients with strongly repetitive waveforms typical of puffing activity. Spectral analyses have been computed on both major events and whole traces. Analysis of major events, carried out using a 5.12 s long window, reveals peak frequencies mostly beneath 5 Hz, only a few events displaying a notable energy content in the sonic band (up to 100 Hz ca). Peak-to-peak amplitude as well as RMS values (evaluated from event start to end) were computed on both raw and filtered (above and below 20 Hz) signals. Spectrograms of the whole traces, carried out using 1.28, 2.56, and 5.12 seconds long windows with 50% overlap, outline clearly the frequency content of major events and the occurrence of puffing ones. We also evaluated the peak frequency of each spectrum of the spectrogram, in order to detect spectral variation of the puffing signal. Considering their great variability, we classified the major events on the base of their spectral content rather than on waveform, grouping together all events having similar spectra by cross-correlating them. Three spectral families cover most of the dataset, as follows: 1) variable and irregular shaped spectra, with energy mainly below 4 Hz; 2) monochromatic events, with simple spectra corresponding in the time domain to very regular sinusoids; 3) spectra with a relatively widespread energy content below 5 Hz and an abrupt amplitude decrease above this value. Despite the high waveform variability and spectral complexity, likely related to multiform eruptive activity at several vents, our robust spectral classification outlines the occurrence of three broad groups of source mechanisms (and correspondent eruptive dynamics), to be further assessed by comparing acoustic and visual/thermal features of explosive events.