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On the transition from strombolian to fountaining activity: a thermal energy-based driver

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Since 1999, Mount Etna's (Italy) South-East crater system has been characterised by episodic lava fountaining. Each episode is characterised by initial strombolian activity followed by transition to sustained fountaining to feed high effusion rate lava flow. Here, we use thermal infrared data recorded by a permanent radiometer station to characterise the transition to sustained fountaining fed by the New South-East crater that developed on the eastern flank of the South-East crater starting from January 2011. We cover eight fountaining episodes that occurred between 2012 and 2013. We first developed a routine to characterise event waveforms apparent in the precursory, strombolian phase. This allowed extraction of a database for thermal energy and waveform shape for 1934 events. We detected between 66 and 650 events per episode, with event durations being between 4 and 55 s. In total, 1508 (78%) of the events had short waxing phases and dominant waning phases. Event frequency increased as climax was approached. Events had energies of between 3.0×106 and 5.8×109 J, with rank order analysis indicating the highest possible event energy of 8.1×109 J. To visualise the temporal evolution of retrieved parameters during the precursory phase, we applied a dimensionality reduction technique. Results show that weaker events occur during an onset period that forms a low-energy "sink". The transition towards fountaining occurs at 107 J, where subsequent events have a temporal trend towards the highest energies, and where sustained fountaining occurs when energies exceed 109 J. Such an energy-based framework allows researchers to track the evolution of fountaining episodes and to predict the time at which sustained fountaining will begin.