



Discriminating icequakes from volcanic seismicity at Cotopaxi volcano (Ecuador)

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Cotopaxi volcano (5,897 m) is located in Central Ecuador, 50 km south of Quito. It has a long eruptive history including more than 70 eruptions with an estimated VEI between 2 and 4 since 1534. Its last low magnitude eruption occurred in 2015. The summit of the volcano is covered by a glacier down to about 5000 m elevation. The volcano is monitored by the Instituto Geofísico (IG) whose monitoring network includes permanent seismic stations. The closest station to the summit (BREF) is located 1 km below the summit (2.2 km distance), about 400 m from the base of the glacier. It is used as a reference station by the IG to characterize the seismicity. The station records transient events related to volcanic activity such as Long Period (LP) and Volcano Tectonic (VT) events, as well as icequakes (IQ) issued from the neighboring glacier. IQs may have various origins including fracture propagation or opening, collapse of ice blocks, basal friction or forced water flow within the glacier. These signals may be difficult to distinguish from VTs or LPs.

We examined data from station BREF recorded between January 2013 and October 2018, with the aim of identifying families of characteristic similar events. We applied a 3-step procedure including: (1) an automatic detection of transient events, (2) a classification of the detected events into families of similar events and (3) a re-composition of the temporal evolution of the largest families using matched-filtering. This procedure outlines the presence of numerous families and points out 4 characteristic temporal evolutions with respect of the 2015 eruption. These evolutions allow to distinguish precursory LP events from background seismicity and outline the presence of long lasting families which may persist for years. We use amplitude ratios calculated between BREF and a station more distant from the summit to distinguish shallow families from deeper ones. We also locate sources of long-lasting families with a seismic antenna installed at the foot of the glacier from April to September 2018. Locations indicate shallow sources below the glacier corresponding to IQs. These results confirm that background seismicity close to the summit of Cotopaxi is dominated by IQs. Temporal evolutions of these families also suggest that the large ($M_w=7.8$) subduction earthquake which occurred near Pedernales on April 16, 2016, 250 km from the volcano, had a stronger influence on the glacier or its shallow substratum than the 2015 eruption.

