Quantification of tephra deposits from Tungurahua 2011 - 2013 eruption, Ecuador: implication on the evolution of a long-lasting eruption

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Since the beginning of the Tungurahua eruption in October of 1999, tephra has been the most frequent and widespread volcanic hazard. Ash clouds have perturbed the air traffic and fallouts have covered thousands of square kilometers on repeated occasions. Quantification of the fallout associated with each eruptive episode is critical in understanding the volcano's eruptive behavior and to assess consequent hazards. We used a network of ash collectors installed around the volcano to collect data on the tephra deposits in 2011 - 2013. Throughout 2012 the ash collectors were replaced with homemade ashmeters that allow for more accurate measurements by reducing error attributed to environmental factors. Eleven sampling missions have been carried out over the course of five fallout periods to assess the evolution of Tungurahua's recent activity: 1) 20 April - 27 May 2011; 2) 27 November - 8 December 2011; 3) 22 December 2011 - 24 July 2012; 4) 5 August - 02 September 2012; and 5) 14 December 2012 - 10 January 2013. The third fallout period is a 7 month span during which Tungurahua volcano developed a semi-continuous complex eruptive dynamism with a proliferation of gentle eruptions. Each of these lasted between one and four days separated by short rest periods. This contrasts with the other four fallout periods that correspond to more continuous eruptions. Both thickness and area density values were collected, however, due to the small amount of fallout during these periods, we used mostly area density to create isomass maps. The total mass of the tephra deposits was calculated using multiple empirical methods after each sampling mission and summarized for each eruptive period. Our results indicate a non-linear reduction of tephra emissions from April 2011 to January 2013. The daily fallout average for each eruption shows a similar pattern. This trend can be extrapolated since the largest eruption of the current active period, in August of 2006, and potentially suggests an approaching end to the volcano's long-lasting eruption. From April 2011 to August 2012 there was also a significant increase of the ratio of SO2 emission/fallout. Assuming that the mass of fallout is fairly proportional to the volume of erupted magma and that the amount of SO2 exsolved from the magma is globally constant, our data would show an increase of the intrusive versus extrusive component during this period. This hypothesis could be tested using seismoacoustic and geodetic data. Continuous quantification of tephra deposits is essential in understanding the evolution of long-lasting eruptions and is a necessary complement to the monitoring system.