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Analysis of volcanic plume detection on Mount Etna through GPS

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A permanent and continuous GPS network developed by Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Etneo (Italy) was used to study its capability in detecting volcanic plumes produced during Etna explosive eruptions. Indeed, the electron plasma and neutral atmosphere, water vapor, hydrometeors and particulates induce propagation path delays in the GPS signal. The existing GPS network consists of 35 permanent stations located on the volcano flanks and is currently used to detect ground displacements of the volcano. We processed the GPS data coming from the Etna network using the GAMIT package developed by Massachusetts Institute of Technology. We used the undifferenced post-fit phase residuals as input in testing for the presence of a volcanic plume. Four robust cross-statistics were applied to assert the plume detection by GPS signals with 99% of confidence. The GPS network was able to detect the volcanic plume occurred on 4 September 2007. Here, we extend the proposed method to the lava fountains of Etna recorded in 2012. During this period Mount Etna produced more than twenty lava fountain episodes, forming volcanic plumes from few to tens kilometers of altitude. Starting from the previous experiences in which we considered a simplified paraboloid model to represent the geometry of the volcanic plume in atmosphere to evaluate the GPS satellite-station paths that crossed the plume, here we improve the method taking into account the results of simulations of volcanic ash dispersal in order to have a more realistic volcanic plume representation.