



Air quality real-time monitoring during volcanic crises with low-cost sensors: the Cumbre Vieja volcano study case

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Volcanic gases and particulate matter (PM) can be hazardous for population not only during an eruptive event, but also during the post-eruption phase, even at significant distances from the volcanic edifice. Volcanic plume dispersion can be affected by diverse factors, such as the weather conditions (e.g., wind speed and direction, rainfall) and/or the topography. Several studies have showed that gas concentrations and PM impacts on the quotidian life during a volcanic crisis can be significant, highlighting the importance of setting up permanent monitoring systems.

Instruments with carbon dioxide (CO₂), sulphur dioxide (SO₂) and particulate matter (PM_{2.5} and PM₁₀) low-cost sensors were developed in order to easily and continuously monitor any volcanic area, and the 2021 Cumbre Vieja eruption was chosen as test site to deploy and validate the instrumentation. A network of nine instruments was set up around the volcanic eruption site, covering both the north and south areas of the lava flows, at distances varying between 1.6 and 7 km from the volcano craters. Five instruments were designed to work autonomously in the field, powered by batteries, and the electrical network powered the other four sensors. All nine instruments broadcasted the recorded data via LoRa communication.

The network settled after the 9th December 2021, closer to the ending of the eruptive period, recorded maximum CO₂ concentrations of 1585 ppm at station named "Perm-2", located at about 4.8 km distance from the volcanic craters, on the 21st December 2021. Regarding particulate matter, even if the 24 hour-mean standards set by the World Health Organization (WHO) for the PM_{2.5} and PM₁₀ (25 mg/m³ and 50 mg/m³, respectively) were not exceeded during the monitored period, maximum concentrations were also recorded for these two parameters (470 and 874 mg/m³) at "Perm-2" in the 21st December. For the same period, the station located closer to the volcano craters measured maximum SO₂ concentrations of 1.11 ppm. Maximum PM values were recorded also at other two monitoring sites in the same day, suggesting spatial and temporal correlation between the different parameters. In this particular case, and considering that maximum concentrations were registered during the night in the exclusion zone, one can reject the potential association of the measured values with suspended ashes resulting from sweeping and cleaning activities. For other periods, particularly after the ending of the eruption, this association must be considered. The highest concentrations of particles post-eruption were measured in the 31st December 2021 and 3rd January 2022.

The installed instruments seem to be adequate for an easier and faster deploy during a volcanic crises, allowing recognizing the presence of hazardous gas and particulate matter concentrations, crucial to reduce potential health effects on the population, even after the end of the eruptive phase.

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