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Investigating the 3D distribution of GEM (Gaseous Elemental Mercury) in the lower atmosphere via a UAV (Unmanned Aerial Vehicle) - Lumex® assemblage

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The occurrence of gaseous mercury pollution has to be identified and monitored through innovative methods and techniques, which would serve as a step toward strengthening the knowledge of the mechanisms of mercury dispersion in the atmosphere, in accordance with the provisions of the Minamata Convention on Mercury. Consequently, the aim of this work is to present the very first data obtained by directly and continuously measuring GEM (Mercury Elemental Gas) in the lower atmosphere through an original assembly of a UAV (Unmanned Aerial Vehicle, a heavy-lift octocopter) and a Lumex® RA-915M (a portable spectrometer for gaseous mercury). A few sites pertaining to both the mining facilities of the former Hg-mining area of Abbadia San Salvatore (Mt. Amiata, Italy) and the surrounding urban zones were selected to test the performance and effectiveness of the UAV-Lumex® combination at different heights. The octocopter agility and directional versatility, able to stop at selected altitudes, and the Lumex® great sensitivity made it possible to shed light on the variability of GEM concentrations and to represent its distribution via dot-map graphical visualization, providing a tridimensional picture of GEM profiling during the flights. This approach allows checking in near real-time whether the guideline concentrations are eventually exceeded. More specifically, the acquisition system was optimized through: i) the use of a stand-alone GPS as a synchronization tool for Lumex® and UAV GPS data; ii) the connection of a vertical sampling tube to the Lumex® inlet to overcome the strong airflows of the UAV rotors; iii) the use of batteries for power supply to avoid the release of exhaust gases. Moreover, all flights were standardized based on previously acquired data thanks to the method accuracy and the UAV pilot experience, allowing reprogramming and repeating the routes in different times. The results showed significant concentration variations between the urban and the most contaminated mining area, and highlighted the differences when the flight was repeated at a later date.