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Chemical characterization of volcanic plumes with multifunction UAVs and extra-lightweight drones: Concepts and first applications

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Investigating the chemical composition of volcanic plumes is an important method for obtaining geochemical information of volcanic systems, determining the environmental impact of volcanic outgassing and providing indications of impending activity of the volcano under investigation. However, sampling is not easy, particularly because of immediate meteorological influences on volcanic plume dispersion, but also, of course, because of potential hazards associated with sampling immediately at the rim of volcanic craters.

When remote sensing methods are not available, UAVs offer the possibility of bringing measurement systems to the scene. Standard parameters that are commonly measured are SO_2 and CO_2, as well as a number of atmospheric state parameters such as pressure, temperature, and relative humidity. In flight data transmission via radio telemetry plays a significant role, as of course both orography and current meteorology make it otherwise difficult to locate the volcanic plume from several kilometers away. In addition to key components such as SO_2, CO_2, and water, there are also a number of other components of interest to geoscientists, such as H_2S, CO, H_2, and halogen compounds. Larger drones, such as the DJI Matrice M210 or the DJI M300, can be used to fly those research based measurement systems in parallel. This allows for the chemical characterization of highly transient plume structures simultaneously at two locations or at large distances from the source including the free troposphere. Results of such measurements carried out at Mt Etna and Vulcano Island, Italy during the last two years are presented in this contribution. Larger drone systems (with the DJI Matrice M210, DJI M300) have the disadvantage that they have a comparatively high weight and therefore make it difficult to bring to the sampling site which might not be accessible by car. Smaller drones like the DJI Mavic 3 significantly reduce the weight one has to carry. In addition, the relatively high cost of the larger drone systems prevents their use for daily monitoring tasks. Therefore, we have equipped a comparatively small drone (DJI Mavic 3) with suitable radio telemetry and sensors to gather basic chemical information in volcanic plumes with an extra-lightweight system. We will introduce this new miniaturized instrumentation and present first results of measurements with the new setup.