Realization of a network of electronic noses for real-time monitoring of odour emissions: focus on calibration transfer

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In recent years, electronic noses, or more generally Instrumental Odor Monitoring Systems (IOMS), have aroused increasing interest in the field of environmental monitoring. In the last years, permanent installations of such instruments at plant fenceline have been required to monitor odor emissions, especially where regulations are issued form local authorities, in order to prevent odor events at sensitive receptors. With this purpose the realization of networks of multiple IOMS units becomes fundamental, but it points out some critical challenges related to the IOMS training. The scarce reproducibility of such instruments is a well-known issue strictly correlated to the poor reproducibility of the MOX chemical sensors as well, which are the most implemented in electronic nose sensors' arrays. Consequently, the transferability of the training model developed for an instrument (i.e., primary unit) to other nominally identical units (i.e., secondary units) is quite hard and challenging. On the other hand, the development of reliable and fit-for-purpose classification and quantification models for odour monitoring requires the collection of several samples representatives of the plant emissions variability (i.e., different working conditions and seasonal variations) to be characterized by dynamic olfactometry (EN13725:2022) in terms of odour concentration [ou_E/m^3]. Thus, the development of a specific training model for each unit is extremely expensive and time consuming. In this context, this work demonstrates the effectiveness of calibration transfer approaches, focusing on standardization approaches (e.g., direct standardization), on environmental real samples. The efforts are focused on removing the instrumental dissimilarities between nominally identical devices without affecting the intrinsic variability associated with the variability of the plant sources emissions. A network of two electronic noses has been installed at the fenceline of a waste treatment plant where each instrument has been trained analysing more than 100 samples collected from the emission sources previously identified (i.e., biofilter, landfill gas, waste storage and treatment sheds) in 5 olfactometric campaigns carried out along a year. 50 samples, analysed from both units, have been identified as potential transfer samples. Different algorithmic methods for the selection of transfer samples have been tested and their performance has been compared. In this way the minimum number of transfer samples required to reach the target accuracy has been identified. Based on the results obtained, the feasibility of such multiple IOMS networks for environmental monitoring has been proved by proposing a methodology, including also specific calibrant mixtures analysis, that aims to standardize protocols for training, reducing time and costs.