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The influence of local particles on classifier performance for pollen monitoring

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Pollen detection through automatic instruments has significantly improved over the recent years. Hirst-type traps start to be complemented with automatic instruments throughout Europe. Instead of the traditional identification of airborne pollen particles using light microscopy, data of the particles is collected and subsequently analysed by an AI-classifier. As an airflow-cytometer, SwisensPoleno instruments capture a fingerprint of each particle in-flight. Holography images, as well as fluorescence spectral data, as for SwisensPoleno Jupiter, are collected to classify measured pollen grains flowing through the device in real-time. Labelled datasets of each pollen-type of interest are required for the training of a new classifier. These are generated by collecting fresh and pure pollen from plants and aerosolizing it directly into a SwisensPoleno instrument under controlled conditions.

New classifiers are evaluated by correlating concentrations determined by the automatic instrument with daily concentrations of co-located Hirst-type traps. To evaluate the performance of classifiers throughout Europe, multiple sites in different countries are assessed. Using results of the latest pollen classifier "Swisens (2025)", based on holography images and fluorescence spectra, we show here how different locations of the SwisensPoleno and different input data can affect the resulting correlations to Hirst data, as well as the Mean Absolute Error (MAE). Differences in performance are expected between sites which are far apart, due to many factors such as differing geography, local climatic conditions and flora. Bad performance may arise from unknown interfering particles, only abundant at one specific site, and thus not included in the training datasets.

Our results demonstrate that this effect can also occur at a sub-regional scale, in sites only 30 km apart (Figure 1A), installed with the same instrument, and analysing data with the same classifier. *Fraxinus* pollen concentrations for P48 (Bolzano, Italy) correlate very well with a co-located Hirst (Figure 1B); that isn't true for P46 (San Michele all'Adige, Italy), where strong interference from other particles is present during late May and beginning of June (Figure 1C). Interfering particles, similar to the target taxa, require site specific fine-tuning, e.g. in form of additional filters

specifically excluding the interfering particles. In conclusion, while automatic pollen detection instruments show great promise in improving accuracy and efficiency, our findings highlight the importance of site-specific adaptations to address geographic and environmental variability, ensuring reliable performance across diverse locations.