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Sources of ultrafine particles at a typical rural site in Switzerland

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Atmospheric aerosol particles are known for their adverse effects on human health and Earth's climate. Among those, a class, namely ultrafine particles (UFPs), is critical given the particles' high number concentrations in the atmosphere and their capability to travel deep into the human body and to deposit onto sensitive body parts e.g. brain and heart [1]. Therefore, scientists dedicated a large fraction of research to advance the understanding of the chemical composition, source and sinks of UFPs.

UFPs are found to be more abundant close to source area, e.g. traffic and industry compared to more remote locations subject to limited anthropogenic activity. However, UFPs can also form in the atmosphere from gaseous precursors via a secondary process known as new particle formation (NPF).

Studies conducted in Switzerland have highlighted the presence of UFPs in urban areas, with transportation-related emissions being a significant primary source [2]. Additionally, Switzerland's proximity to various industrial regions in Europe underscores the role of transboundary pollution in contributing to UFP levels [3].

In this study, we will delve deeper into the outdoor sources of UFPs observed in Payerne, an ACTRIS (The Aerosol, Clouds and Trace Gases Research Infrastructure) and NABEL (National Air Pollution Monitoring Network) site at a typical rural location in Switzerland. We aim to quantify the primary and secondary fractions of UFPs.

Our results show comparable UFP levels throughout the year. Besides traffic (visible in Fig. 1 during rush hours) and residential heating, we explore the roles of airport emissions and long-range transport of black carbon aerosols from forest fires in increasing UFP concentrations. Besides primary emissions, we observe local NPF events evident from the increase in cluster ions and nucleation mode particles concentrations, especially in spring and summer (Fig. 1, Fig. 2). In this work, we further explore the contributions of ammonia and amines from agriculture in enhancing NPF rates in Payerne.

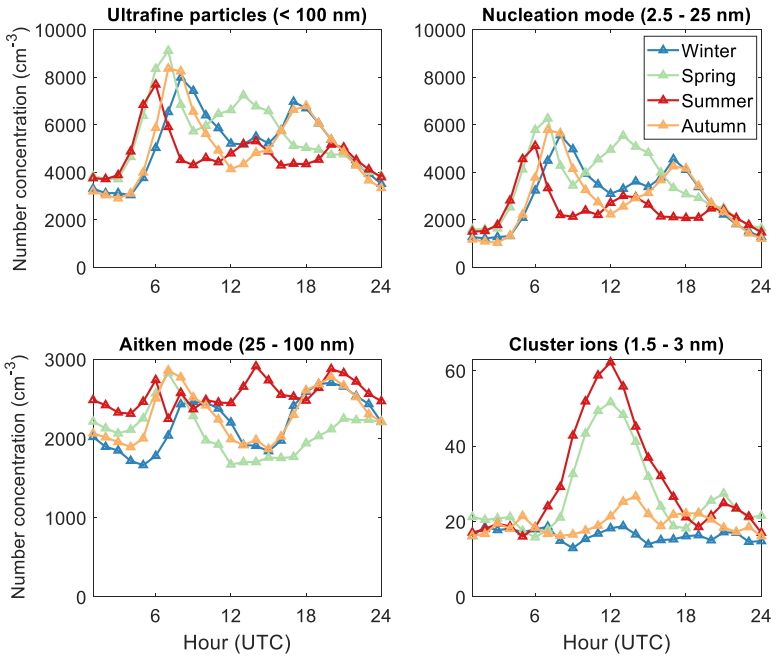

Figure 1. Hourly average seasonal variations of ultrafine, nucleation mode and Aitken mode particles and cluster ions (positive) in Payerne.

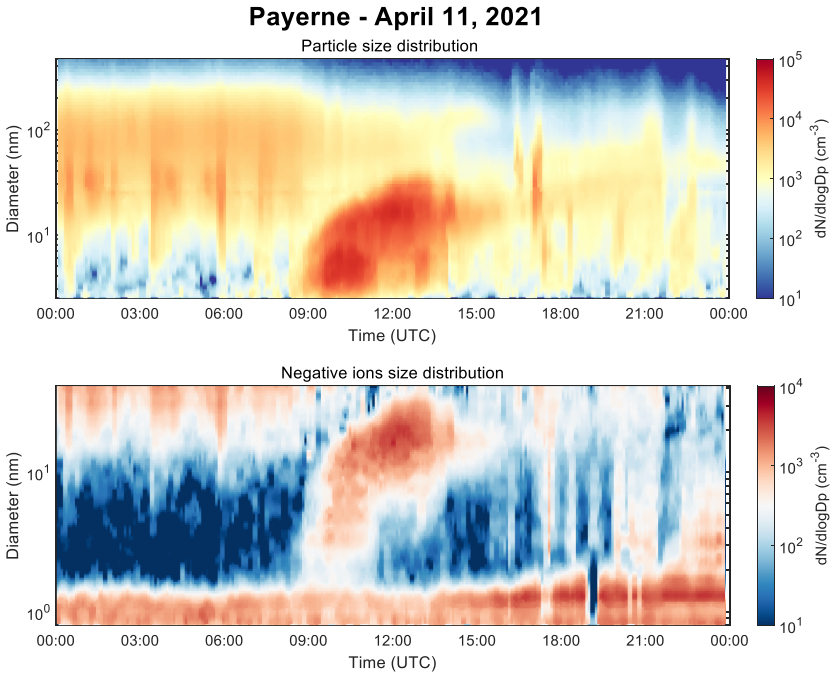

Figure 2. Particle (upper) and ion (bottom) number size distributions on April 11, 2021 in Payerne.

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