Extreme events detection from the QUALAIR supersite in Paris

Location: LATMOS (Laboratoire Atmosphères, Observations Spatiales)
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Length in months: 4-6
Starting date: Marsch to June 2025
type of internship: data analysis, instrumentation

QUALAIR (https://qualair.fr/index.php/en/english/) is an experimental research platform dedicated to the observation of chemical and dynamic variability of the atmosphere. The QUALAIR platform is located in the heart of Paris on the roofs of Sorbonne University. It is equipped with a varied range of instruments to measure various variables of climatic, chemical and dynamic interest.

Motivation

climate change induced by human activity is significantly altering the chemical composition of the atmosphere, leading to extreme phenomena such as heatwaves, droughts and fires, which are now occurring at an increasing rate and are set to multiply in the future. As these extremes have an impact on the economy, society and health, it is essential to monitor them, on a local, regional and global scale. Fire events can be transported thousands of kilometers across the globe, carrying many pollutants (mainly carbon monoxide, CO) and aerosols, which can affect local air quality. Wildfires are a substantial but poorly quantified source of tropospheric ozone (O_3) and are known to significantly increase observed fine particles ($PM_{2.5}$, particles having aerodynamic diameter of less than 2.5 µm) until exceedances of national quality standard.
Dust plumes containing million tons of mineral-rich aerosols can also be transported far away from their sources (Sahara Desert), causing visibility reduction, and respiratory diseases. The influence of smoke and dust plumes on air quality and public health is still not well characterized.

Description of the internship work

In this work we will exploit the complementarity of measurements on QUALAIR (in situ, remote sensing and satellite). This is important because it provides information on the chemical composition and dynamics of the atmosphere at local and regional scales: in situ observations measure the atmosphere very precisely at the local scale, while profile measurements provide information at the regional scale and on the transport of pollutants. The platform's own infrastructure allows for the co-location of observation resources in order to promote instrumental synergies, which are a key element in the understanding of atmospheric processes. The objective of this internship is to explore the QUALAIR platform's instruments synergy to characterize fire and dust pollution events that occurred in Paris in the last few years. We will be using remote sensing instruments, such as LIDAR (active laser atmospheric sounding) and photometer (passive spectrometer) techniques, combined with satellite data (IASI, antenna on the platform). With this synergy of the different instruments, fire and dust events will be investigated, inventoried and analyzed in time and space to assess their impact on the local air quality. Air masses back trajectory simulations and chemical transport model outputs could be used in this work to better characterize the sources and transport of such extreme events. The details of the internship work are as follows:

- Examine and explore the aerosol LIDAR and photometer aerosol optical depth time series to characterize fire and dust plume events detected in Paris.
- Investigate the sources region and transport of such events using satellite data and simulations from back-trajectory and chemical-transport models.
- Study the effect of these dust and fire plumes on the Paris air quality focusing on atmospheric PM and tropospheric ozone concentrations (monitored from AIRPARIF for example).

Prerequisites and skills required

- Knowledge in meteorology or physics/chemistry, atmospheric or environmental sciences
- An interest in data analysis and visualization
- Skills in computer programming (Python, Matlab, other)