UNIVERSITÀ DEGLI STUDI
DI GENOVA

1st PhD Annual Report

PhD in Physics and Nanoscience - XXXVIII Cycle

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Preliminary title: "Optical characterization of natural and anthropogenic aerosols using an atmospheric simulation chamber."

Aerosols are tiny particles suspended in the air, coming from natural sources like dust storms and human activities such as burning fossil fuels. They play a significant role in climate change. Some aerosols reflect sunlight back into space, cooling the Earth, while others can absorb sunlight, leading to localized warming. They also affect clouds by changing their properties, impacting how much sunlight they reflect and how much rain they produce. Understanding aerosols helps scientists to predict how they affect our climate, but their complex effects make it challenging to precisely forecast their overall impact on global temperatures. Balancing efforts to reduce harmful aerosol emissions while understanding their role in climate change is crucial for better managing their influence on our planet's climate. In this respect, the aim of my PhD project is focused on: Identifying and particularization the chemical and physical behaviors of natural and anthropogenic aerosols within an atmospheric simulation chamber.

In my first year of pursuing a PhD, my research has explored the Optical Properties of Atmospheric Aerosols by using an Aerosol Simulation Chamber (ASC). Specifically, I want to set up advanced apparatus that will allow me to measure the absorption and scattering cross-sections of atmospheric aerosols with λ-resolution. Instruments such as Aerosol simulation Chamber for Atmospheric, Aethalometer-CASS, Nephelometer, Photoacoustic Extinction meter (PAXs), Organic Carbon/Elemental Carbon (OC/EC) Analyzers, Multi-Wavelength Absorbance Analyzer (MWAA), BLAnCA (Broadband Light Analyzer of Complex Aerosol), and particle counters will be utilized synergistically to achieve comprehensive insights into aerosol optical properties.

My involvement in the planned activity began in September due to the prolonged duration needed to obtain my visa. In the previous month, which ran from February to July, I mostly worked on study assignments that involved aerosol physics and the difficulties associated to use Aerosols Simulation Chamber.

Implementation of eDiluter Pro with ASC:

The initial phase was involved to implement the eDiluter at ChAMBRe to ensure precise measurements. When it comes to study of aerosol concentrations in aerosols simulation chambers and in combination with devices like PAXs (Photoacoustic Extinction meter) and OPS (Optical Particle Sizer), the eDiluter Pro is a necessary tool for atmospheric research. The precise control and adjustment of aerosol concentrations offered by the eDiluter Pro are crucial for conducting controlled experiments, improving the accuracy of measurements, and enhancing our understanding of aerosol behavior and its impact on atmospheric processes and climate change. Additionally, when the eDiluter Pro is paired with equipment like PAXs and OPS, it ensures that the levels of aerosols used for analysis are optimal. This partnership enables these instruments to precisely measure how aerosols absorb light, scatter it, and their various sizes.

The successful integration of the diluter within the ChAMBRe setup significantly improved accuracy in measuring aerosol properties. Recently we performed test with Gass Analyzer using Nitrogen dioxide (NO_2) for calibration of eDiluter Pro and another test was performed with optical particle sizer (OPS) using Ammonium sulfate (AMS) Particles to calibrate eDiluter. For this purpose, we set a study to get some useful results, and for these tests we set a constant time against each value. The scheme of study of 1st test and results are given below:

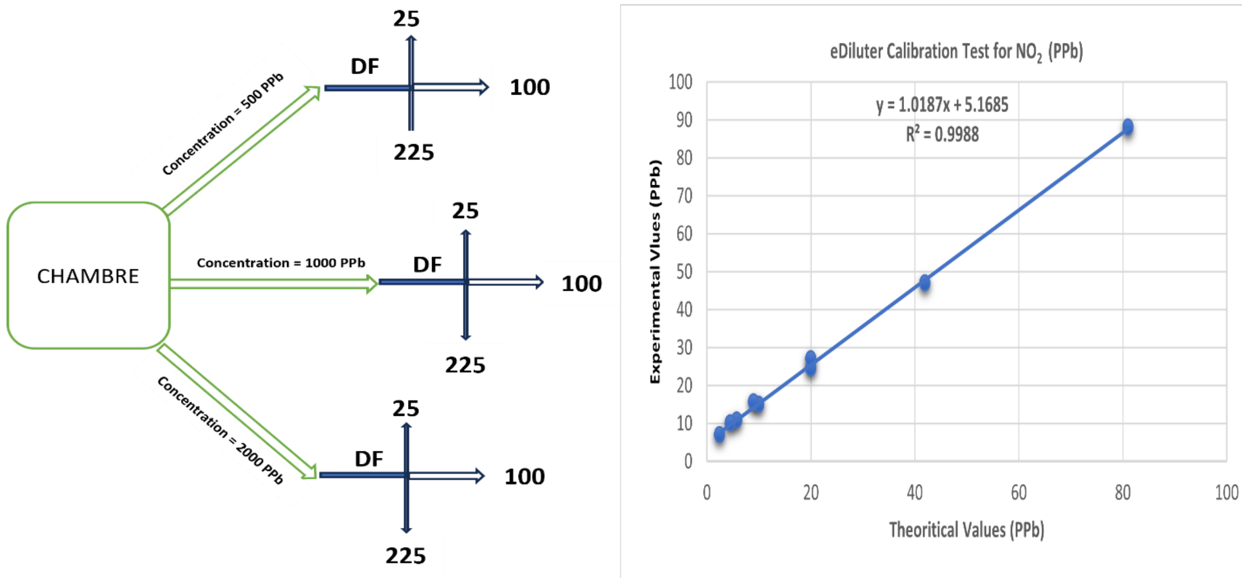

Figure: Schematic Study and results of experimental and theoretical validation

MWAA & BLAnCA Training:

Contributing for measurements at the Multi-Wavelength Absorbance Analyzer (MWAA) and the Broadband Light Analyzer of Complex Aerosol (BLAnCA) worked as valuable training for me to enhance the multi-lambda optical analysis. By utilizing the MWAA, I was able to explore the superior points of determining absorption characteristics at different wavelengths and obtain understanding of how aerosols react with individual wavelengths of light. Furthermore, working with the BLAnCA instrument gave me an interesting opportunity to investigate the aerosol particles' scattering phase function across a wide range of angles and wavelengths. My knowledge for aerosols scatter light at various wavelengths and angles has improved because of this training, which also helped me for better understanding to the complicated optical properties of atmospheric aerosols. Overall, the hands-on experience with MWAA and BLAnCA not only broadened my understanding for multi-lambda optical analysis, also boosted my essential key skills for optical studies to different kind of aerosols.

Attending Courses:

- Optical microscopy at the nanoscale: waiting for the end of the course.

Courses Selected for 2nd year.

- Microscopic and spectroscopic techniques for surface and interface analysis (PhD course).
- Physics of the atmosphere and dispersion of pollutants (Master's degree course – physics).
- Biosensing (PhD Course).