PhD Second Year Report

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Summary of scientific activity

During the second year of my PhD, I further developed what I started in the first year. In particular, I continued working on both the hardware and software sides of the development of a new broadband light analyzer of particulate matter (PM), nicknamed BLAnCA (Broadband Light Analyzer of Complex Aerosol). Below are the details of the different branches of my work.

- **Hardware development:**
  I assembled and started testing the second version of the prototype instrument, BLAnCA 0.2. The new setup was built at the INFN mechanical workshop at DIFI. This prototype version features a rotating detector which spans 165 degrees around the PM sample, form $\alpha = 0°$ (transmission) to $\alpha = 165°$. Furthermore, the sample is now illuminated with a small diameter (≈ 1 cm) collimating lens. The detector itself is another small diameter collimating lens which feeds the scattered light into a 200 μm fiber optic cable which in turn channels it to the spectrometer. At the same time, I worked on a LabView virtual instrument (VI) to automate BLAnCA measurements. The VI integrates the driver for the motor, which moves the detector, with the spectrometer interface, allowing a fully automatic measurement including dark spectrum saving and pixel-strip integration time calibration for each angle. The testing and validation for BLAnCA 2.0 are ongoing.

- **Measurements:**
  To characterize the prototype and explore its features, I carried out several measurements on different aerosol samples. In particular, I measured the spectrally resolved absorption of desert dust samples coming from various locations around the world. The dust had been collected by LISA-CNRS personnel, and I resuspended and sampled it using the atmospheric simulation chamber CESAM located in Paris. Furthermore, I carried out measurements of absorption of brown carbon samples provided by dr. Vaios Moschos (UNC, USA). Brown carbon is a category of carbonaceous compounds originated mainly through biomass burning. Finally, to test the efficacy of the new rotating detector setup, I measured the scattering phase function of several types of filtering supports used for PM sampling, namely quartz, Nuclepore^{TM}, Cyclopore^{TM} and PTFE filters.

- **Software development:** I updated the data analysis software that performs the minimization to retrieve absorption values from raw measurements to account for the rotating detector setup. In addition to this necessary task, I also took up a second coding project. This project entailed devising an upgrade to an existing mathematical model for source apportionment of carbonaceous aerosol (as found in [1]), writing an accompanying Python toolkit and releasing it into the public domain. The model upgrade consists in a key pre-processing step whereby several parameters, which were fixed by the user in previous versions of the model, are now automatically retrieved by the algorithm by a correlation analysis between optical measurements and some other type of measurement (e.g. levoglucosan concentration for biomass burning aerosol). This work and the related software toolkit (MWAAMT - MWAA Model Toolkit), in addition to being useful to the scientific community, are also directly related to my PhD project. In fact, the same software toolkit can be used to analyze absorption data with a high spectral resolution such as is measured by BLAnCA. This task resulted in an article which has recently (late August 2023) been submitted for revision.

Attended courses

- Advanced computational physics;

Summer schools

- AGORA aerosol training school, Granada, 12-16 June 2023 (face-to-face), 19-23 June 2023 (online)

Conferences

- Poster presentation at the 13^{th} International Conference on Carbonaceous Particles in the Atmosphere (ICCPA), Berkeley CA, USA, 9-12 July 2023;
- Talk at the 109^{th} national conference of the Italian Physical Society (SIF), 11-15 September 2023.

Publications

- T. Isolabella et al., *A new instrument prototype for aerosol light absorption measurements*, Il Nuovo Cimento C, 46 (2023) 145;
- V. Vernocchi et al., *Airborne bacteria viability and air quality: a protocol to quantitatively investigate the possible correlation by an atmospheric simulation chamber*, Atmos. Meas. Tech., under revision;
- T. Isolabella et al., *A new software toolkit for optical apportionment of carbonaceous aerosol*, submitted for revision.

References

[1] D. Massabò et al. "Multi-wavelength optical determination of black and brown carbon in atmospheric aerosols". In: *Atmospheric Environment* 108 (2015), pp. 1–12. DOI: https://doi.org/10.1016/j.atmosenv.2015.02.058.