

Investigation of Low-Cost Sensors for Particulate Matter and Gases for the Application in Measuring Ambient Air Quality

Introduction

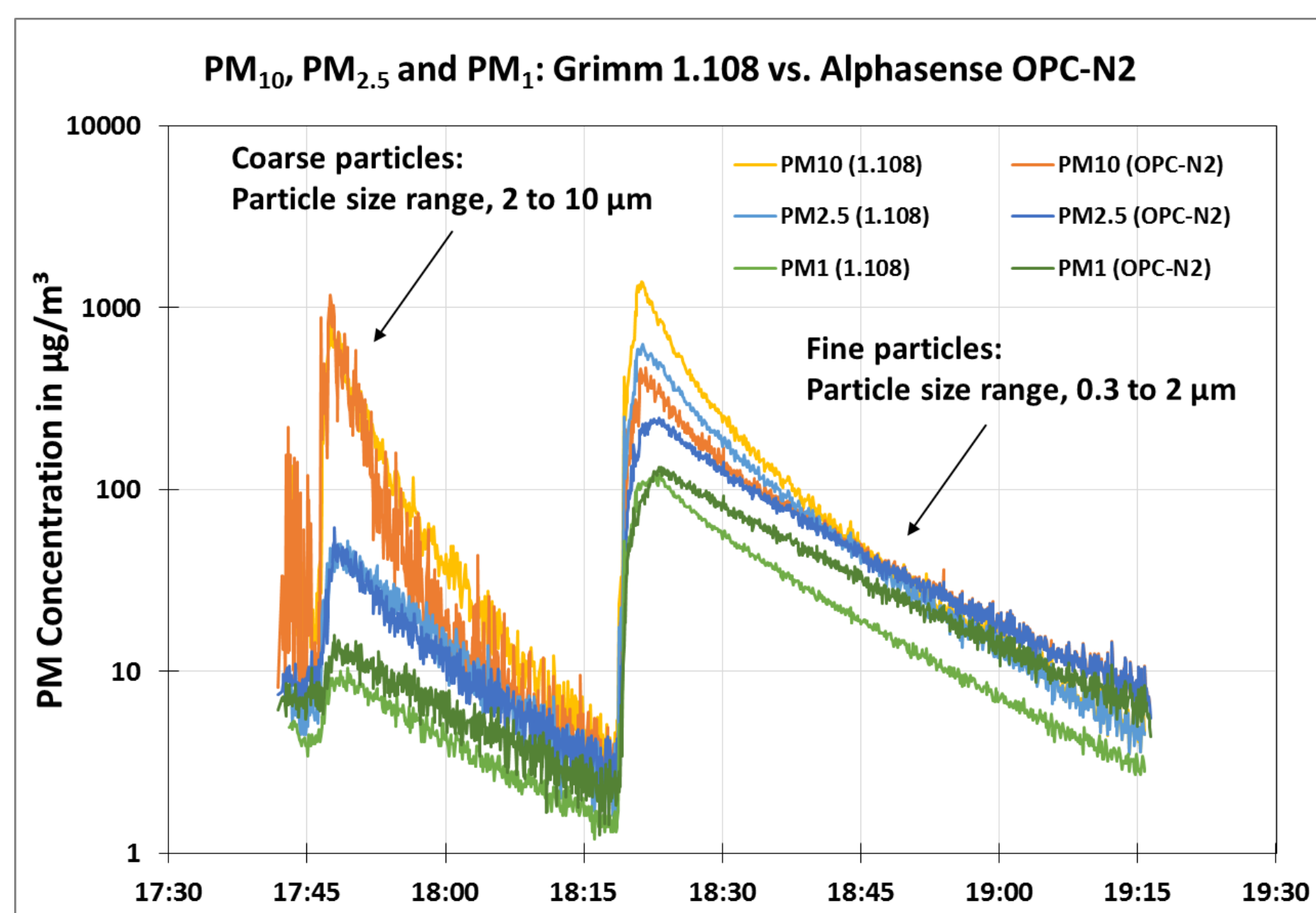
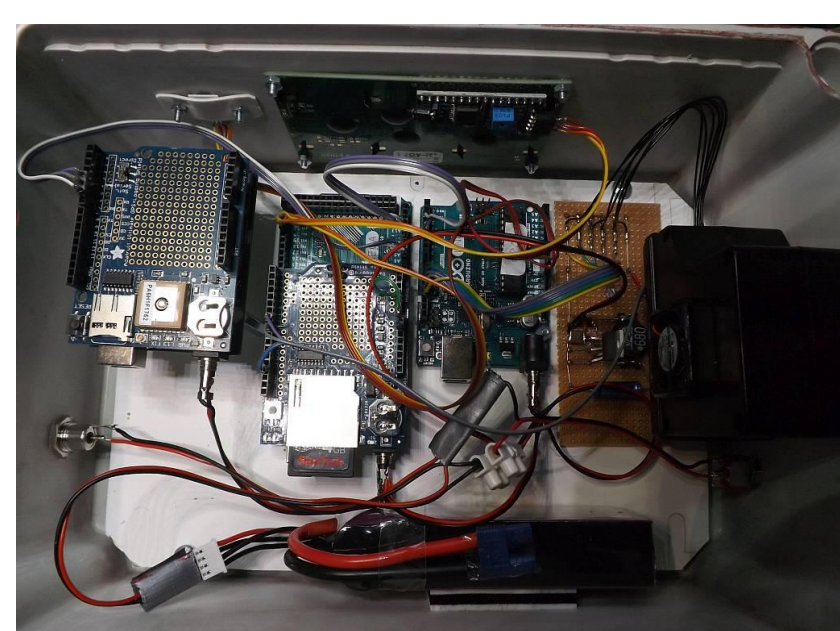
- Low number of air quality monitoring stations available due to expensive measurement devices and high maintenance
- Few monitoring stations do not provide information on the spatial distribution of air pollutants
- Low-Cost sensors can prove the solution to measure the spatial and temporal variability of air pollution
- Small, mobile and cost-effective measuring sensors are offered
- These sensors could be used to map cities with the spatial distribution of air pollutants
- These sensors may not be as accurate as professional equipment, however, the quality of these sensors is constantly being improved
- Potential low-cost sensors available for air quality monitoring were investigated for their data quality

Sensor	PM	PM	Gas
Model	SDS011	OPC-N2	CO-B4, NO-B4, NO ₂ B43F, O ₃ B431
Company	Nova Fitness	Alphasense	Alphasense Membrapor
Measurement principle	Light scattering	Light scattering	Electrochemical
Output	PM10, PM2.5 output 0.3 to 10 µm	PM10, PM2.5, PM1 output 16 channels from 0.37 to 17 µm	NO ₂ , NO, O ₃ , CO
Weight	~ 70 g	~ 105 g	~ 13 g
Temperature range	-10 to +50 °C	-10 to +50 °C	-30 to +40 °C
Humidity range	0 to 95 % RH	0 to 99 % RH	15 to 85 % RH
Cost	~ 25 €	~ 300 €	~ 50 € per sensor



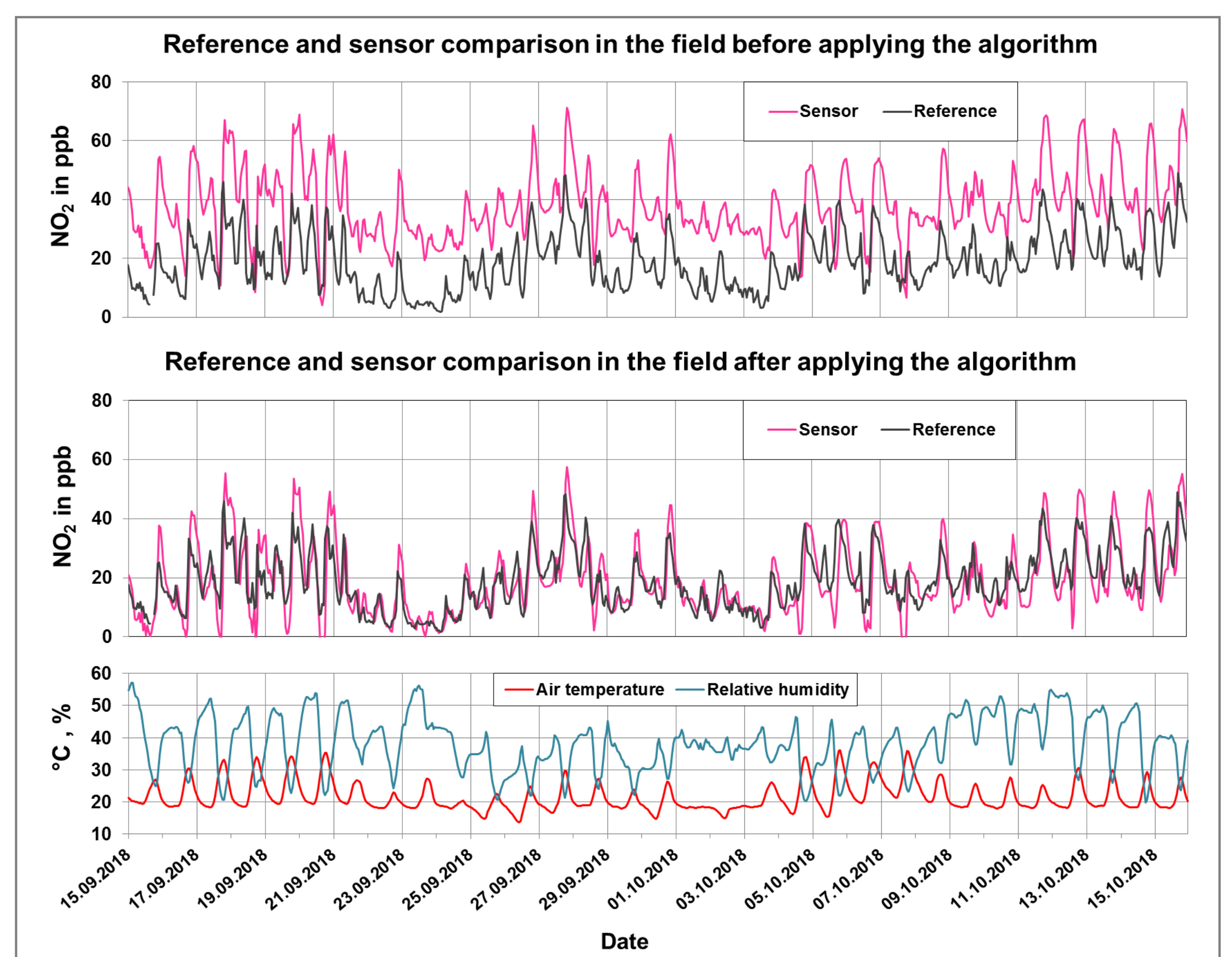
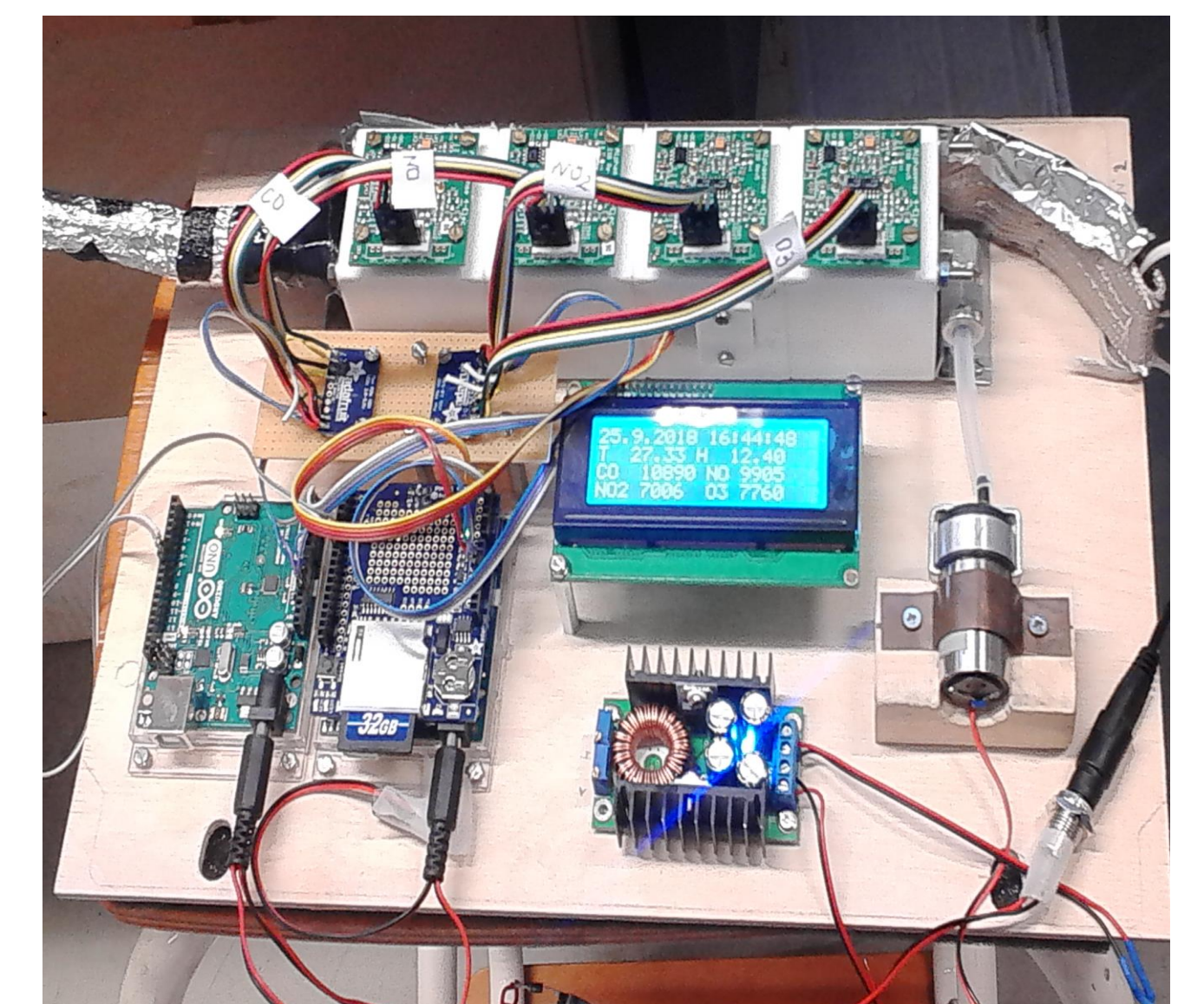
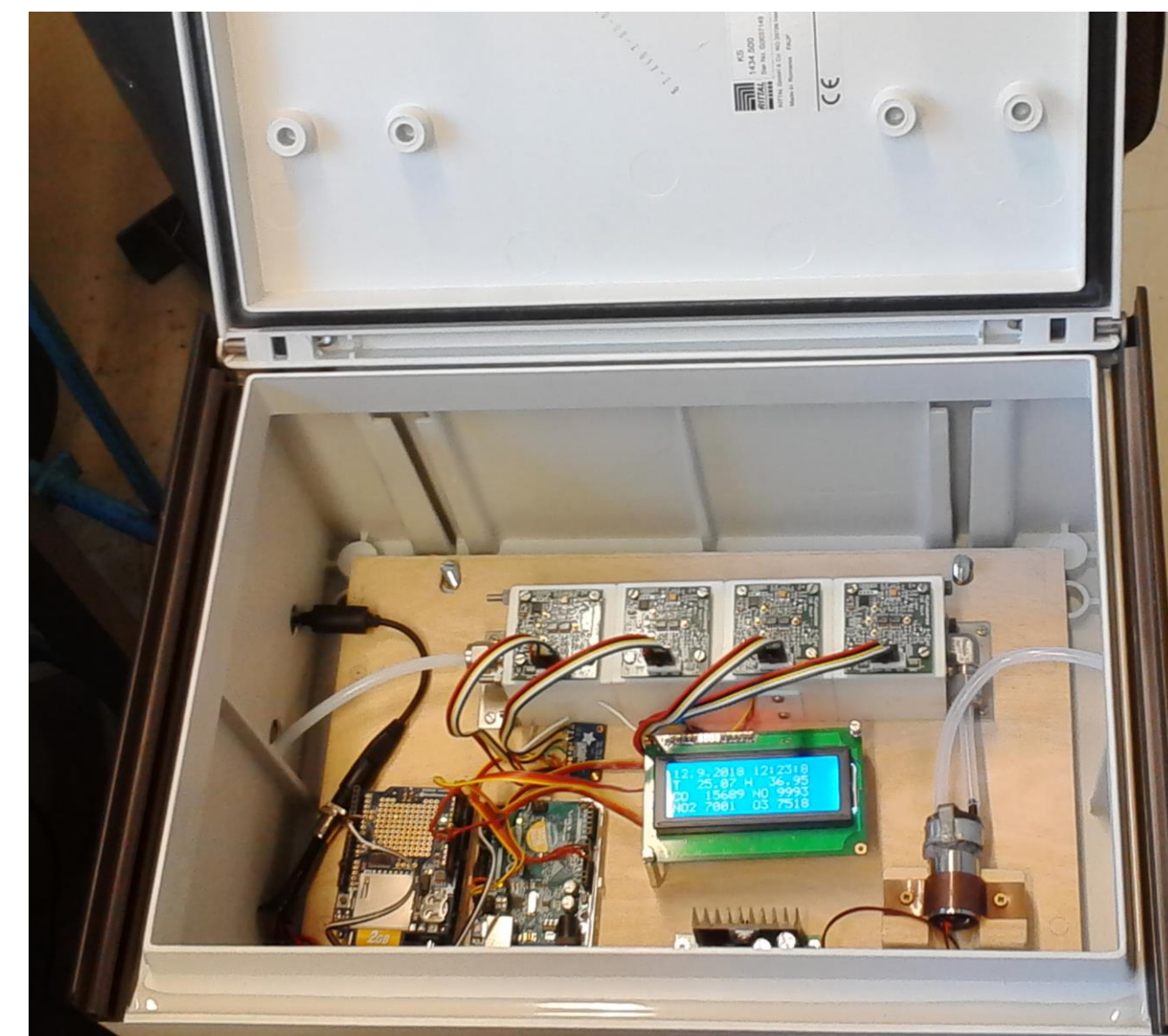
Results: Low-Cost PM sensors

- Investigation and comparison of different low cost PM sensors that were available on the market with aerosol spectrometers was done
- Experiments were performed in the laboratory in order to identify the sensor with the best properties
- Low cost sensor OPC-N2 showed same temporal course as shown in the example but needs to be corrected by comparing to aerosol spectrometer
- It is a well known fact that humidity has an enormous influence on the results, therefore a low cost heater was built and tested together with low cost PM sensors
- The PM sensors box equipped with OPC-N2 was also tested for mobile measurements



Results: Low-Cost Gas sensors

- The low cost gas sensors were tested in the laboratory as well as in the field and the results obtained were compared to the reference devices for each parameter
- The factors influencing the quality of the data obtained by the low cost gas sensors were mainly meteorological parameters such as humidity and temperature
- Cross sensitivities of the low cost gas sensors against other gases was also investigated
- The possibility to use statistical analysis and laboratory experiments in order to correct the data taken by measurements in the field to enhance the accuracy of the low cost gas sensor results was analyzed
- Good agreement was seen after applying the algorithm developed to compensate humidity and temperature as shown in the example



Conclusions

PM sensors: The low cost dryer seems to be a good solution to solve the problem of the influence of moisture on particle concentration

Gas sensors: The quality of data can be improved by quantifying the effect of the parameters affecting the reliability of results obtained by the low cost gas sensors and applying the correction to the raw data

