Black carbon and aerosol optical property measurements at a midsize city in Po valley, Italy

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Methods

During the UPUPA measurement campaign in Piacenza in September 2011, black carbon was measured by a Multi Angle Absorption Photometer (MAAP 5012), an Aethalometer AE31 and a Micro Aethalometer AE51 and inter-comparisons were conducted. Optical columnar properties of aerosols were also measured by Ocean Optics S2000 radiometer. Aerosol Optical Depth (AOD), Angstrom extinction parameter (alpha) and aerosol components were analyzed to investigate particles optical and microphysical properties and their origin, supported by back trajectories calculation.

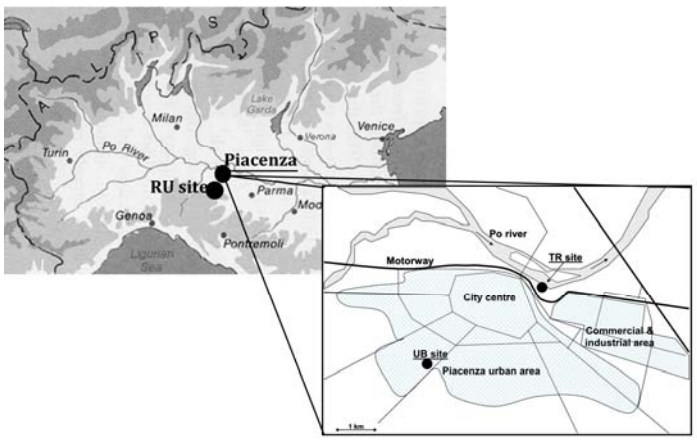


Figure 1. Measurement site at Piacenza, Italy (TR site - 45.056570° N, 9.706234° E).

Conclusions

Comparison of black carbon measurements obtained by two methods was performed at Piacenza Italy using an absorption photometer (MAAP) and two Aethalometers (AE31, AE51). The results show that equivalent black carbon (EBC, Petzold et al., 2013) concentrations recorded by the three instruments follow a similar trend with pronounced morning and evening peaks during rush hours. The regression analysis shows that the EBC raw levels measured by MAAP and AE51 are quite similar, whilst AE31 overestimated EBC about 10-15% compared to MAAP and AE51 records. Apart from local emissions, air mass origins also have a detectable effect on the black carbon and particle optical properties in Piacenza.

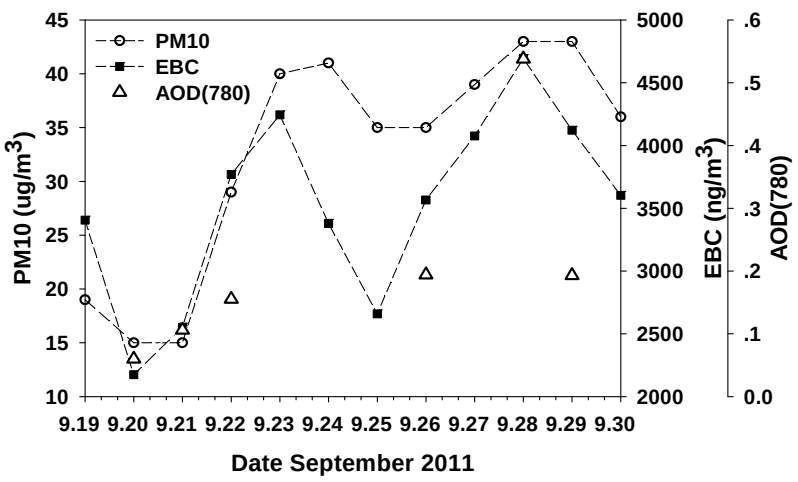


Figure 2. Temporal variations of PM10 (daily average), EBC (daily average by AE31), AOD (aerosol optical depth, daily averaged columnar data from 8 AM to 3 PM*).*

EBC and optical properties

Figure 2 shows that the lowest levels of PM10, EBC and AOD on September 20th and 21st, when the air masses were from the Atlantic Ocean, as shown in Figure 4, with high loading of water soluble ions. Maximum values observed on September 28th correspond to air masses from Eastern Europe, with higher particle loading of aged urban emissions and increased fraction of BC. The different aerosol origin has also been reflected by the relationship between AOD and Angstrom extinction parameter.

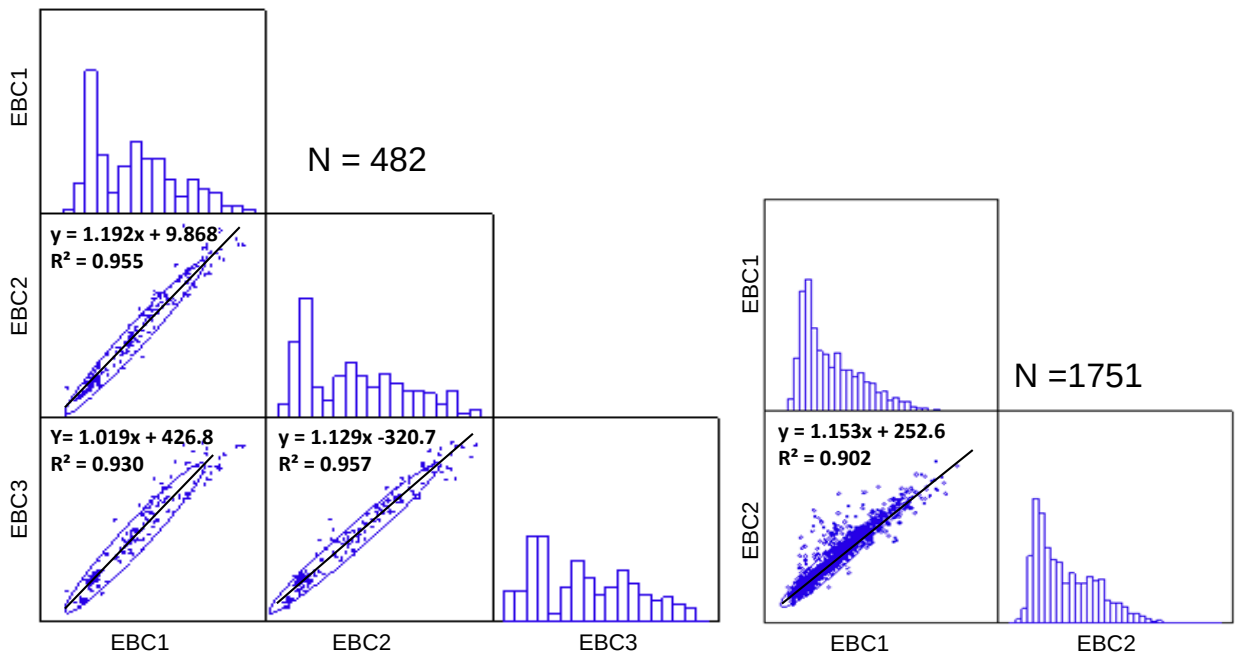
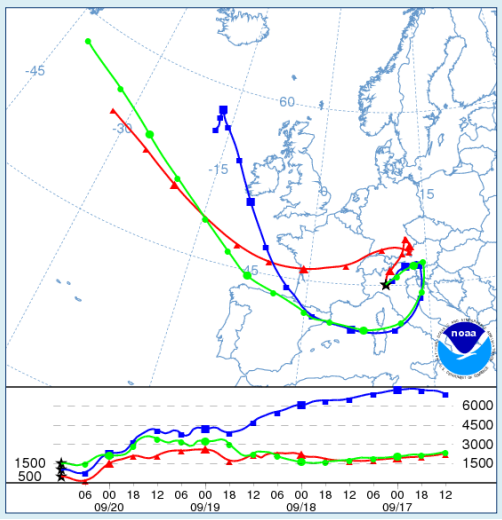


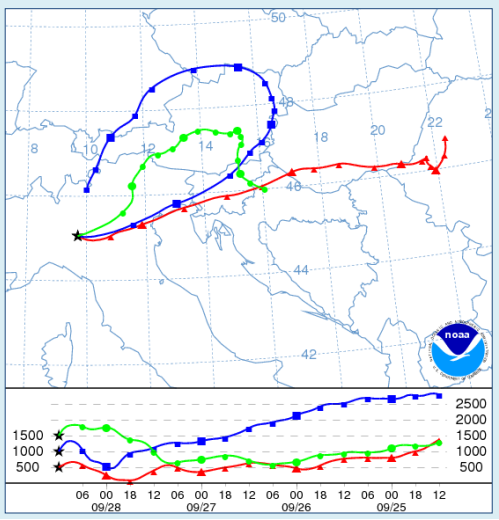
Figure 3. Scatter plots, linear regressions and EBC 5-min raw concentration distributions for the simultaneous datasets. (EBC1: MAAP, EBC2: AE31, EBC3: AE51)

Relationship of EBC levels by MAAP, AE31 and AE51

The average EBC raw concentrations are 3686±136 ng/m^3 by MAAP, 4404±166 ng/m^3 by AE31 and 4185±144 ng/m^3 by AE51. Scatter plots show correlations between the 3 instruments higher than 0.9, and not influenced much by the size of the dataset. The regression indicates that AE31 overestimates EBC concentration about 10-15% compared to MAAP and AE51. When the EBC concentration is lower than 1st quartile or higher than 3st quartile more difference are recorded by MAAP and AE31. For the larger dataset (N = 1751), R^2 is 0.305 when EBC concentration is less than 2 µg/m^3. R^2 is 0.708 when EBC is larger than 5 µg/m^3.

Figure 4. Backward trajectories ending at Piacenza measurement site or Sept. 20th 2011 (left) and for Sept. 28th 2011 computed by NOOA Hysplit Model





References

Petzold et al., Atmos Chem Phys, (2013) 13: 8365-8379.