A Comparison of Aerosol Inlet Configurations at Storm Peak Laboratory

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Introduction

Storm Peak Laboratory has been a key mountain site measuring aerosol optical properties continuously since 2011. During this time, two different inlet configurations have been used to collect aerosol data , using a variety of instrumentation. The first inlet was installed in 2001 (to present), and the second inlet was installed in 2012. To ensure that these instruments are performing correctly while on these different inlet setups, this study makes comparisons of the two arrangements. In this study we present hypotheses as to why discrepancies exist between the two inlet setups (specifically size cuts), and why not all hypotheses presented can be rejected.

Methods

During the time of January 2013 to July 2013, both the SPL and GMD instrument racks were on the SPL inlet (different ports, displaced horizontally). From September 2014 to June 2015, the GMD rack was placed on the GMD Inlet, while the SPL rack remained on the SPL inlet. These two time periods were used for comparison. Below are the instruments used in this study, and the variables used are found in Table 1:

- 3-Wavelength Integrating Nephelometer (TSI 3563)
- Condensation Nuclei Counter (CNC, TSI 3010)
- Continuous Light Absorption Photometer (NOAA CLAP)

A description of the sampling methods, data processing, and quality assurance can be found in Sherman et al., 2015. It should be noted that from October 2013 to May 2014, the GMD nephelometer was not working properly (leak, shutter fault, etc.). It was replaced in August 2014 during annual maintenance.

Variable Abbreviation	Variable	Wavelengths	Size Cut
BsB	Scattering coefficient	[BGR]	PM1, PM10
BaB	Absorption coefficient	[BGR]	PM1, PM10
ZRsp	Submicron scattering fraction	[BGR]	PM1, PM10
ZAng	Ångström exponent	[BG, BR, GR]	PM1, PM10
N	Number concentration	-	-

Table 1: Variables used in this study, and their attributes.

Results: Linear regressions and PDFs

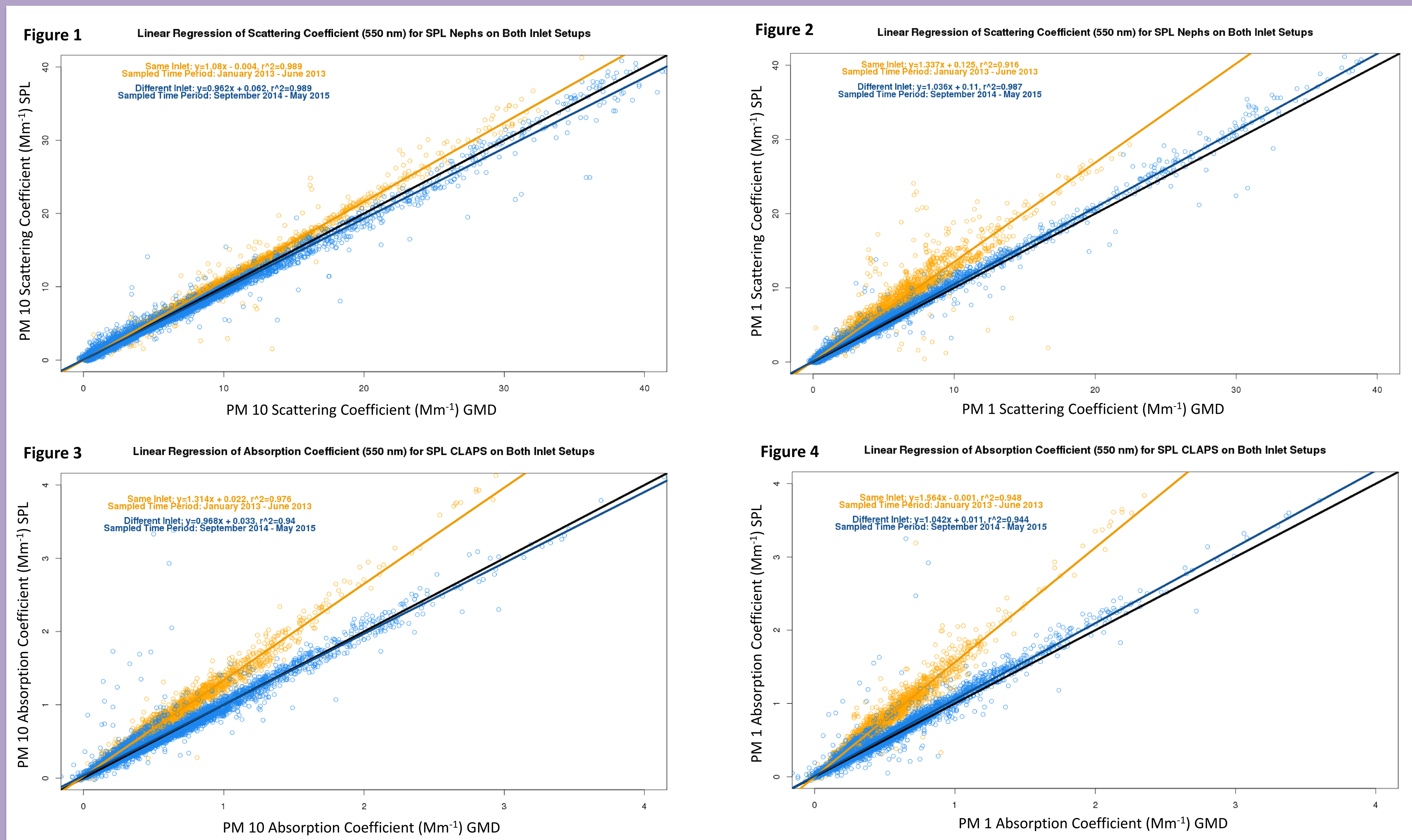

Figure 1: Linear regression for the PM10 scattering coefficient (550 nm wavelength) for two nephelometers on both inlet setups. The same inlet setup appears in orange, while the different inlet setup appears in blue. The black line is the 1/1 line for reference (top left). Figure 2: Same as Figure 1, but for PM1 (top right). Figure 3: Linear regression for the absorption coefficient (550 nm wavelength) from two CLAPS on both inlet setups (bottom left). Figure 4: Same as Figure 3, but for PM1 (bottom right).

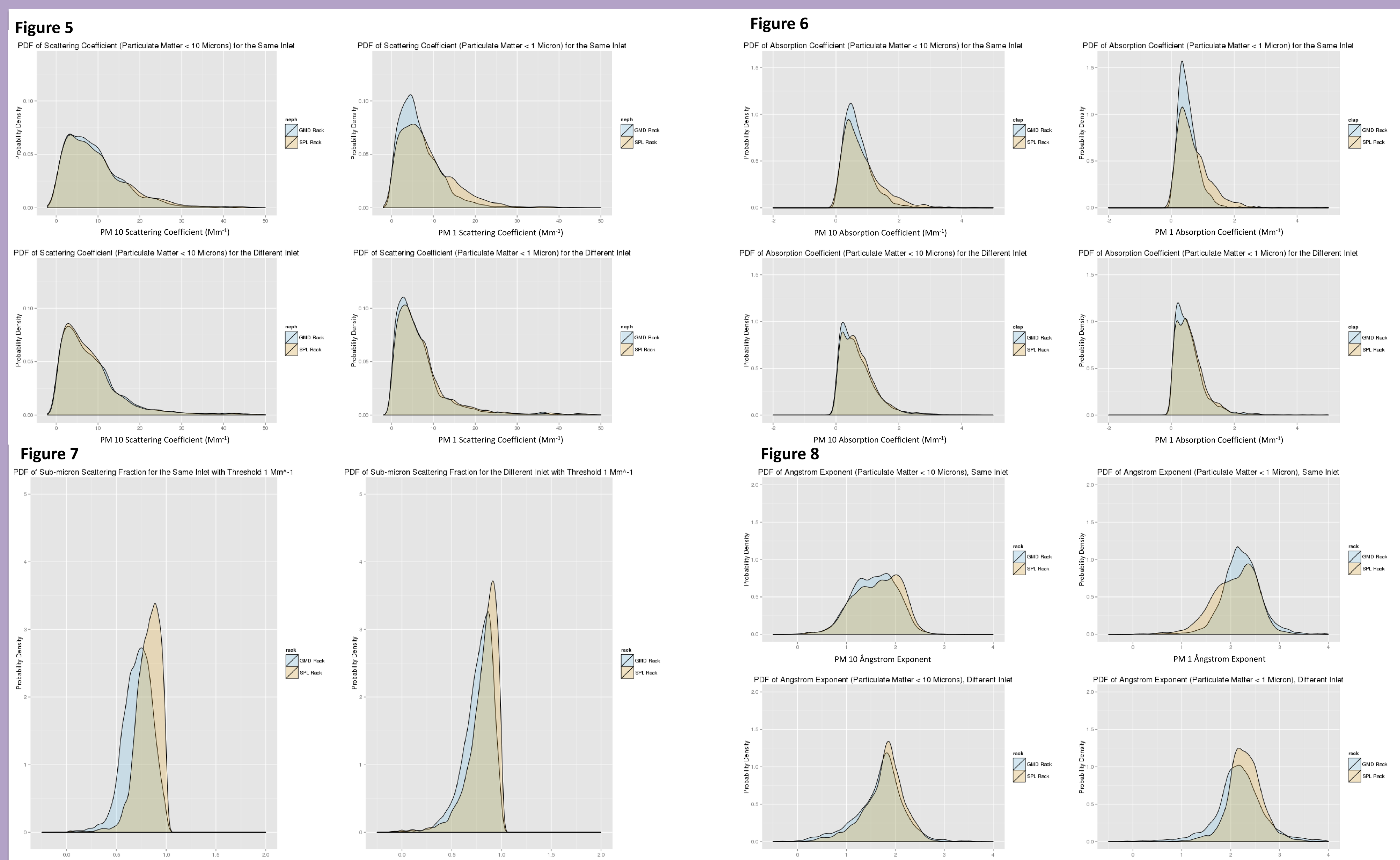

Figure 5: Probability density function plots of scattering coefficients for every inlet setup and size cut (top left). Figure 6: Same as Figure 5, but for absorption coefficients (top right). Figure 7: Same as Figure 5 and 6, but for sub-micron scattering fraction (bottom left). Figure 8: Same as Figures 5, 6, and 7 but for the Angstrom Coefficient (bottom right).

Results (cont.) and Discussion

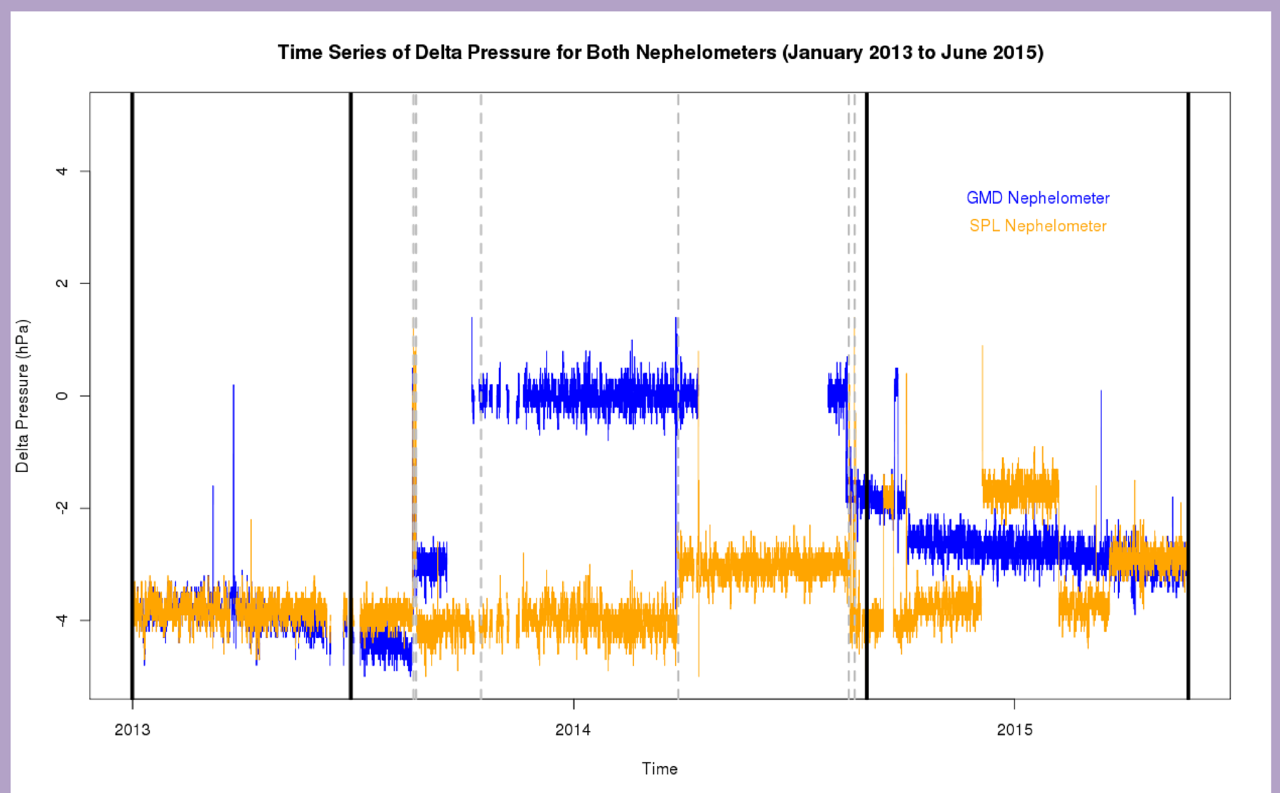

Figure 10: Pressure differences (PM1-PM10) for the SPL and GMD nephelometer. Only one set of pressures are shown (impactor pressures excluded), since after computing a linear regression on both sets, it was determined they agree very well. The solid black lines denote the beginning and end of the comparison periods, while the dotted grey lines depict when there was impactor box servicing or annual maintenance.

Key Results:

- While both racks where on the different inlets, all variables agree very well.
- For the time that the racks were on the same inlet, large discrepancies exist. This includes smaller values for scattering/absorption coefficients and sub-micron scattering fraction for both size cuts on the GMD rack.
- The linear regression for the scattering coefficient of the different inlet arrangement has values within ~1-4% of the 1/1 line, while the same inlet setup varies as much as ~40%.
- The PDFs of the Ångstrom exponent for PM1 vary considerably.

Conclusions

To summarize, while there is very good agreement between the instruments when the SPL and GMD racks were on different inlets for both size cuts, the same inlet configuration only agrees well while on the PM10 size cut.

While there are a handful of hypotheses that exist that could explain the behavior we see, there are only two that we cannot reject:

1. Particle bounce occurring inside the impactor for the SPL rack while on the same inlet.
2. The GMD impactor box being improperly assembled, causing particle loss.

The particle bounce hypothesis is more likely to occur than the improperly assembled impactor box, since it was shown that the impactor had not been cleaned in many months in 2013. Nonetheless, we can be fairly certain that a problem with either the SPL or GMD rack impactor box (or both) is responsible for the discrepancies shown, and that different inlet configurations are not a large source of measurement discrepancy.