Research Paper Summary

Submitted By: Zeeshan Ahmad

Submitted To: Prof. Viviana Vladutescu

EET-3132 Remote Sensing, spring 2016

Molenar, John V. ***Theoretical Analysis of PM2.5 Mass Measurements by Nephelometry - # 110***

In this Article, Molenar gave theroretical Analysis of PM2.5 Aerosol mass measurements by Nephelometry and Light Scattering Photometry. Molenor briefly explained about PM2.5 Aerosol that Aerosol are composed of haze and dust, two separate external particles. Haze is the mixture of sulfate, nitrate, organic and light absorbing carbon while the PM2.5 dust fraction is made of fine crustal material of soil. So, for measurement of gravimetric PM2.5 mass, the Teflon filter media is used. Similarly, all these particles sulfate, nitrate, organic and light absorbing carbon and dust fraction should give an estimated PM2.5 mass measurement on Teflon filter. But, the fraction of nitrate particle volatilize up to 10 % to 90 % from the Teflon filter depending on the temperature, time of year, sampling duration and aerosol chemistry. "Thus, assuming 50% of the nitrate is lost from the Teflon filter essentially matches the loss of nitrate due to the heated inlet of the nephelometers that is required to bring the sampling chamber relative humidity down to 40%." (Molenor 6). Also, for atmospheric aerosol, semi-empirical growth curve is derived when there is no resolved speciated aerosol data to estimate the mass of water associated with hydrate aerosol.

Also, due to large distribution PM2.5 haze aerosol, it is difficult to get similar data to improve measured mass mean diameters and geometric standard deviations for reasonable data rather than their estimated joint frequency distribution. So, for improve data, distribution of haze and dust fraction for PM2.5 aerosol and volume which average the scattering efficiencies of the two fractions is determined. Still, if the PM2.5 aerosol model is distributed according to given analysis, uncertainty of approximately ±40 will exist in PM2.5 mass from light scattering measurements.

By looking at all these factors, Molenor presented the idea of Nephelomety and light scattering to measure the PM2.5 mass. Nepholometer are proven to be accurate and precise in the measurements of aerosol scattering coefficient. It is portable, moderate coast compared to filter based aerosol samplers and require low maintenance. Signal output of nepholometer is proportional to: $2\,\pi \int_\lambda \int_\varphi B(\varphi,\lambda)\,\sin(\varphi)\,d\varphi\,R(\lambda)\,d\lambda$. "The volume scattering function, both of the calibrating gas and aerosol to be measured, is a function of wavelength and scattering angle. Thus, the measured scattering coefficient depends on the weighted average of the instrument response of both the aerosol and Rayleigh calibration gas or calibration aerosol." (Molenor). The response of integrated nephelometer shows less than 5% error in the measured aerosol scattering coefficient for PM2.5 aerosol when it is calibrated with Rayleigh gas results.

So, when integrated nephelometer is operated properly, it will result in small error of PM2.5 aerosol scattering coefficient, and will add few percent to the uncertainty in PM2.5 mass which is estimated from scattering measurements that comes from varying aerosol properties. Also, the error associated with different scattering efficiencies and the scattering phase functions are different from Rayleigh gas and PM2.5 aerosol. In addition, to get the appropriate calibrated constant nephelometer must be calibrated with simultaneous gravimetric measurements of the PM2.5 aerosol.