Abstract

Optical $PM_{2.5}$ measurements are sensitive to aerosol properties that can vary with space and time. Here, we compared $PM_{2.5}$ measurements from collocated reference-grade (beta attenuation monitors, BAMs) and optical instruments (two DustTrak II and two DustTrak DRX) over 6 months. We performed inter-model (two different models), intra-model (two units of the same model), and inter-type (two different device types: optical vs. reference-grade) comparisons under ambient conditions. Averaged over our study period, $PM_{2.5}$ measured concentrations were 46.0 and 45.5 μg m^{-3} for the two DustTrak II units, 29.8 and 38.4 μg m^{-3} for DRX units, and 18.3 and 19.0 μg m^{-3} for BAMs. The normalized root square difference (NRMSD; compares $PM_{2.5}$ measurements from paired instruments of the same type) was ~ 5% (DustTrak II), ~ 27% (DRX), and ~ 15% (BAM). The normalized root mean square error (NRMSE; compares $PM_{2.5}$ measurements from optical instruments against a reference instrument) was ~ 165% for DustTrak II, ~ 74% after applying literature-based humidity correction and ~ 27% after applying both the humidity and BAM corrections. Although optical instruments are highly precise in their $PM_{2.5}$ measurements, they tend to be strongly biased relative to reference-grade devices. We also explored two different methods to compensate for relative humidity bias and found that the results differed by ~ 50% between the two methods. This study highlights the limitations of adopting a literature-derived calibration equation and the need for conducting local model-specific calibration. Moreover, this is one of the few studies to perform an intra-model comparison of collocated reference-grade devices.