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Application of Principal Component Analysis to Aerosol Size Distribution Data

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We have developed a methodology for applying principal component analysis to aerosol size distribution measurements. When suitable weights are applied to the data, the method provides a fast and robust means of reducing the data dimensionality. The resulting representation of the data is greatly simplified in that it replaces roughly 30 size bins with as few as five monomodal components while preserving virtually all the information in the original data. The resulting components can not be directly identified with specific sources. However, the resulting data simplification can greatly assist in the analysis of size distribution data.

By treating the components as measured variables, the size distribution data can be combined with trace gas and meteorological measurements in a conventional absolute principal component analysis. Applying this method to four sets of field measurements obtained at three sites in southern Ontario yields a highly consistent sets of results. Factors that can be identified as photochemically produced secondary aerosol particles, regional pollutants (including accumulation mode aerosol particles), and concentration variations due to boundary layer dynamics were observed at all the sites. In addition, at Hamilton (an urban site), we identified a factor associated with local industrial emissions; at Simcoe (a rural site heavily impacted by regional scale pollution), we observed a factor consisting of processed nucleation mode particles; and at Egbert (a rural site often within the Toronto urban plume) we identified a factor associated with transported fine particles.