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Remote Sensing of Aerosol Composition

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The aerosol robotic network (AERONET) has provided radiometric inversions at hundreds of surface stations for more than 15 years. The operational product uniquely provides size distributions and complex refractive indices at four wavelengths (440, 674, 870, and 1020 nm), which is enough information to determine column concentrations of soot carbon, brown carbon, and iron oxide. This speciation is possible because soot carbon has a spectrally flat refractive index, and enhanced imaginary indices at the 440 nm wavelength are caused by brown carbon or hematite. Carbonaceous aerosols can be separated from dust in imaginary refractive index space because 95% of biomass burning aerosols have imaginary indices greater than 0.0042 at the 675–1020 nm wavelengths, and 95% of dust has imaginary refractive indices of less than 0.0042 at those wavelengths. However, mixtures of these two types of particles can not be unambiguously partitioned on the basis of optical properties alone, so we also separate these particles by size. Regional and seasonal results are consistent with expectations. Monthly climatologies of fine mode soot carbon are less than 1.0% by volume for West Africa and the Middle East, but the southern Africa and South America biomass burning sites have peak values of 3.0 and 1.7%. Monthly-averaged fine mode brown carbon volume fractions have a peak value of 5.8% for West Africa, 2.1% for the Middle East, 3.7% for southern Africa, and 5.7% for South America. Monthly climatologies of iron oxide volume fractions show little seasonal variability, and range from about 1.1 to 1.7% for coarse mode aerosols in all four study regions. Finally, our sensitivity study indicates that the soot carbon retrieval is not sensitive to the component refractive indices or densities assumed for carbonaceous and iron oxide aerosols, and differs by only 15.4% when these parameters are altered from our chosen baseline values. The associated soot carbon absorption aerosol optical depth ($AAOD$) does not vary at all when these parameters are altered, however, because the retrieval is constrained by the AERONET optical properties.