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The extreme forest fires in California/Oregon in 2020: Aerosol optical and physical properties and comparisons of aged versus fresh smoke

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Wildfire activity in the western United States during August to October 2020 was exceptional in terms of the fire severity and area burned. Extremely dry biomass fuels from near historic multi-year drought conditions were further exacerbated with very hot and dry conditions in 2020. These conditions when coupled with strong offshore flow allowed many ignitions to grow into extremely large and severe wildfires. Long-term monitoring at a few AERONET sites in California showed that the number of days with high Aerosol Optical Depth at 440 nm (AOD440>1) in 2020 was greater than any other year going back to the beginning of the data records in 2002. A wide range of fine mode particle volume median radii were retrieved from AERONET data over the course of these fires suggesting significant variability in combustion conditions and aging processes. Additionally, the fine mode radii in some of these smoke plumes in 2020 were very large especially at high AOD (~0.22 to 0.32 □m volume median radius), likely due to both coagulation and condensation occurring during aging at very high particulate concentrations. The largest fine mode particle radii combined with narrow distributions resulted in some very rare AOD spectra showing peak AOD at 500 nm and decreasing to lower AOD at both shorter and longer wavelengths. The most extreme retrieved size distributions and associated measured AOD spectra were principally observed in long-distance transported smoke plumes from these western United States fires at sites in Colorado, Maryland and Virginia, possibly due to further aging during transport. Additionally, strong absorption was sometimes observed at short wavelengths with much lower single scattering albedo at 440 nm compared to 675 nm in some plumes consistent with significant brown carbon (BrC) absorption in biomass burning particles. This strong BrC absorption signature observed at some California sites and dates remained similarly strong in some smoke plumes observed at some east coast sites in Maryland and Virginia, thereby suggesting that the lifetime of these particular BrC species was greater than 5 days, significantly longer-lived BrC absorption than often cited in the literature.