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Smoke aerosol properties and ageing effects for Northern temperate and boreal regions derived from AERONET source and age attribution

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Particulate emissions from wildfires impact human health and have a large but uncertain effect on climate. Modelling schemes depend on information about emission factors, emitted particle microphysical and optical properties and ageing effects, while satellite retrieval algorithms make use of characteristic aerosol models to improve retrieval. Ground based remote sensing provides detailed aerosol characterisation, but does not contain information on source.

A new method is presented to estimate plume origin land cover type and age for AERONET aerosol observations, employing trajectory modelling using the HYSPLIT model, and satellite active fire and aerosol optical thickness (AOT) observations from MODIS and AATSR. It is applied to AERONET stations located in or near Northern temperate and boreal forests, for the period 2002-2013. The results from 629 fire attributions indicate significant differences insize distributions and particle optical properties between different land cover types. Smallest fine mode median radius are attributed to plumes from cropland/natural vegetation mosaic (0.143 μm) and grasslands (0.147 μm) fires. Evergreen needleleaf forest emissions show a significantly smaller fine mode median radius (0.164 μm) than plumes from woody savannas (0.184 μm) and mixed forest (0.193 μm) fires. Smoke plumes are predominantly scattering for all of the classes with median single scattering albedo at 440 nm (SSA(440)) values close to 0.95 except the cropland emissions which have SSA(440) value of 0.9. Overall fine mode volume median radius increase rate is 0.0095μm per day for the first 4 days of ageing and 0.0084 μm per day for seven days of ageing. Changes in size were consistent with a decrease in Angstrom Exponent and increase in Asymmetry parameter. No significant changes in SSA(λ) with ageing were found.

The implications of this work for improved modeling of aerosol radiative effects, which are relevant to both climate modelling and satellite aerosol retrieval schemes, are also discussed.