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When smoke comes to town - effects of biomass burning smoke on air quality down under

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Annually, biomass burning results in the emission of quantities of trace gases and aerosol to the atmosphere. Biomass burning emissions have a significant effect on atmospheric chemistry due to the presence of reactive species. Biomass burning aerosols influence the radiative balance of the earth-atmosphere system directly through the scattering and absorption of radiation, and indirectly through their influence on cloud microphysical processes, and therefore constitute an important forcing in climate models. They also reduce visibility, influence atmospheric photochemistry and can be inhaled into the deepest parts of the lungs, so that they can have a significant effect on human health.
Australia experiences bushfires on an annual basis. In most years fires are restricted to the tropical savannah forests of Northern Australia. However in the summer of 2006/2007 (December 2006 – February 2007), South Eastern Australia was affected by the longest recorded fires in its history. During this time the State of Victoria was ravaged by 690 separate bushfires, including the major Great Divide Fire, which devastated 1,048,238 hectares over 69 days. On several occasions, thick smoke haze was transported to the Melbourne central business district and PM10 concentrations at several air quality monitoring stations peaked at over 200 μg m-3 (four times the National Environment Protection Measure PM10 24 hour standard). During this period, a comprehensive suite of air quality measurements was carried out at a location 25 km south of the Melbourne CBD, including detailed aerosol microphysical and chemical composition measurements. Here we examine the chemical and physical properties of the smoke plume as it impacted Melbourne's air shed and discuss its impact on air quality over the city. We estimate the aerosol emission rates of the source fires, the age of the plumes and investigate the transformation of the smoke as it progressed from its source to the Melbourne airshed. We show that the smoke plumes that reached Melbourne during the summer of 2006/2007 resulted in elevated concentrations of particles and gases relative to non-fire impacted periods. The age of the plume was greater when smoke reached Melbourne (note that in our calculation of the plume age we do not distinguish between smoke and anthropogenic plumes). In addition, the older smoke plumes (30 hours) displayed higher concentrations of a number of gaseous and aerosol species relative to the younger smoke plumes (3 hours), particularly secondary reaction products, while the younger smoke plumes had higher concentrations of biomass burning marker compounds. This suggests that the enhanced photochemical activity in the smoke plumes significantly changes the aerosol composition of the smoke, potentially affecting the optical and thus radiative properties of the aerosol. This has implications for the modelling of aged smoke in chemical transport and climate models.