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Aerosol-climate interactions over southern Africa: the ENSO signal and interannual variability

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Southern Africa is a region that experiences high interannual climatic variability. It is also a region that, in general is poorly developed, has a high population growth rate and is at times politically unstable. As a whole, the region is extremely vulnerable to climatic changes, with a large proportion of the population depending on rain-fed agriculture as a source of income and subsistence. It is well known that the El-Nino/La-Nina oscillation contributes significantly to the climate variability over much of southern Africa; with El-Nino years generally being dry and warm in the southeastern parts and unusually wet in the eastern equatorial regions, whilst La-Nina years are generally wet and cool in the southeast, but dry in the eastern tropics. This in turn effects vegetation growth, and as a result the extent of biomass burning in the following dry season; with above-average wet seasons leading to increased burning, and drier than average seasons being followed by less extensive burning.

The savannas of Africa experience some of the most extensive burning in the world, and contribute a very significant portion of the aerosol loading over southern Africa during the dry austral winter season, from June through October. At present, however, the climatic impact of aerosols over southern Africa is poorly understood, particularly in terms of the interannual variability of these impacts. The regional climate model RegCM3 is used to investigate the climatic impacts of the aerosol burden over southern African further, with particular focus on interannual variability and the role of ENSO.

Preliminary results indicate that the impacts of the direct and semi-direct aerosol-effects on regional temperature, precipitation and circulation patterns vary between dry (El-Nino) and wet (La-Nina) years. There is a strong seasonality to these effects, with significant impacts occurring only during the austral winter, when biomass burning peaks throughout the southern Africa. Surface temperature decreases in all years, but more significantly in years with increased burning (generally following El Nino years), whilst atmospheric temperatures at altitude in the main aerosol layer increase, again more strongly when more aerosols are present. Circulation becomes more anticyclonic over much of the region as well. The main climatic signals are visible not only over the major aerosol source regions, but also in the so-called 'river of smoke', the main exit passage of air from the region out to the Indian Ocean. This outflow pathway shifts northwards during La-Nina periods, and southwards during El-Nino periods, with the associated climatic impacts shifting correspondingly. Since higher aerosol concentrations occur in the outflow region, impacts are more significant than in the surrounding regions.

Understanding the climatic sensitivity to the regional aerosol loading and its interannual variability is of vital importance, not only in terms of the present climate, but also particularly in future, with a tendency towards more El-Nino-like conditions being projected by many global models.