Fire, vegetation change and potential feedbacks to the global carbon cycle

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Vegetation in Australia has been shaped by fire. Fire frequency, intensity and season are key determinants of the floristic composition of the great majority of Australian plant communities. Large amounts of carbon are lost to the atmosphere during fires as a result of combustion of vegetation and ground fuels, and as a result of the heating of the upper layers of soil during and after fire. Post-fire changes in leaf litter inputs and rates of decomposition add to these, significant step-changes over the lifetime of most plant communities. Fire induced changes in floristic composition, and in carbon fluxes to and from soils, thus have large ramifications for the carbon cycle of our ecosystems.

Alpine areas of Australia have been highlighted as potentially the most vulnerable to the changes in temperatures in the next few decades. The intensity and frequency of fires in these areas is expected to change due to reduced rainfall and an increase in mean temperatures – that could lead to longer periods of high fire risk. Similarly, possible reductions in the periods of snow cover, and thus reductions in insulation of surface soils by the snow 'blanket', could actually increase the likelihood of frosts severe enough to freeze water in surface soils.

The majority of previous studies of soil respiration have used 'static chambers' and either closed (change in CO_2 concentration over time) or open or dynamic systems (difference in CO_2 concentration between chamber inlet and outlet). We have developed a novel system whereby O_2 uptake as well as CO_2 efflux can be measured dynamically. Using an open flow system combined with a differential oxygen analyser (DOX) and an Infra Red Gas Analyser (IRGA), we can quantify respiratory quotients as well as rates of respiration.

We used this novel system to elucidate environmental and biotic controls of carbon fluxes for three vegetation types - snow gum with shrub understorey, snow gum with grass understorey, and grassland, in the alpine region of NSW.

Preliminary results show clear differences in soil respiration among vegetation types. Fastest rates of respiration are produced by soils from snow gum communities with shrubby understories, over all measured temperatures (5 – 40 ^{o}C). Soil from grassland communities respired the most slowly and snow gum communities with grassy understorey were intermediate between the other two communities. Strong spatial replication in the field and comprehensive laboratory studies result in strong statistical significance for the observed differences. For example, rates of respiration by soils from snow gum with shrub understorey communities were, on average, 3.5 times faster than those by grassland soils at 20oC. Future work in this project will examine the direct influence of fire on soil respiration rates and the influence of fire has on soil carbon substrates.

The influence of fire in the carbon balance of montane and sub-alpine ecosystems in Australia is virtually unexplored but clearly of importance given the extent of the ecosystems concerned, their carbon density, and their sensitivity to both fire and climate. Much more research is required, especially research focused on developing clear understandings of the biological processes that govern release of C. This is a crucial a priori step in the sensible modelling of fire and climate influences on C balance, at all of: regional, continental and global scales.