Smoke composition and impact on human health and ecosystems

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Research background
Prescribed fires are used by land managers to reduce the risks from wildfire. From an alternative perspective, smoke from regular prescribed fires may have a greater impact on human communities and ecosystems than that produced by an occasional wildfire. A key issue driving this project was to understand whether the composition of smoke from prescribed fires differed from smoke produced by wildfires.

This project applied new and existing techniques to measure the contribution of prescribed burns to classical pollutants, including greenhouse gases, in smoke emissions. In addition, we measured background levels of certain components of smoke (e.g. volatile organic compounds (VOCs)) as these are emitted naturally, even in the absence of fire. Understanding the production of these compounds is important as they are involved in formation of atmospheric pollutants and affect human health.

Emissions from eucalypts
Three distinct groups of VOCs were identified during heating and combustion of leaves and stems of Eucalyptus species:

1. Reactive organic compounds (acids, aldehydes, ketones, isoprene and low boiling point terpenes) were emitted at temperatures from ambient to ~100 °C
2. Plant-specific isoprenoids (monoterpenes, sesquiterpenes) were emitted when heated to 200 °C
3. Oxygenated aldehydes, ketones, furans and substituted benzenes were emitted when combusted at 250-300 °C

Before the appearance of smoke, the composition of VOCs correlated well with various naturally occurring isoprenoids. Once combustion began, a different suite of VOCs formed during pyrolysis of cellulose and lignin were detected. It is therefore likely that ratios of cellulose/lignin in fuels can be used for predicting the composition of smoke produced from a given vegetation type and condition.

Effect of smoke on human health
An important component of our research provided a synopsis of the information available to the general public regarding the impact of smoke on human health. Although information was limited, it was found to be accurate and that there are processes in place for annual updates. This activity facilitated related research by Monash University showing emergency department in place for annual updates. This activity facilitated related research by Monash University showing emergency department.

The ecology of smoke
Our research also dealt with ecological and environmental aspects of bushfire smoke. For example, we quantified the loss of nutrients in smoke through oxidation of C, N and S during heating and combustion of different types of fuel (leaves, litter, bark, wood) from three forest types. We calculated that loss of N after complete removal of fuel, as might be expected from a high intensity wildfire would be:

Low productivity site = 3760 kg N km⁻²
Medium productivity site = 5810 kg N km⁻²
High productivity site (unburnt) = 5510 kg N km⁻²
High productivity site (burnt) = 6510 kg N km⁻²

Low intensity prescribed fires will release less N but the compounding effect of repeated burning on nutrient loss is unknown.

Outputs
Refereed journal articles and book chapters


Literature reviews and reports


Student theses