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Seasonal variations in methane and nitrous oxide emissions factors in northern Australian savanna woodlands

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Burning of savannas and grasslands consumes more than one third of the total annual biomass burning globally. In Australia, savanna fires emit annually from 2% to 4% of Australia's greenhouse gas emissions. This has led to efforts to reduce savanna burning emissions through early season prescribed burning. These programs aim to change the fire seasonality from predominantly high intensity late season fires which are characterized by low levels of patchiness and high burning efficiencies to early-season fires characterized by low intensity, a high degree of patchiness and low burning efficiency. The result is a net reduction in fire area and associated carbon emissions. Mitigation of greenhouse gas emissions is predicated on there being little change in methane (CH4) or nitrous oxide (N2O) emission factors (EFs) as the fire season progresses, however, recent analysis of the emission characteristics of African savanna fires by Korontzi et al., indicates CH4-EF, in particular, could decline substantially as the fire season progresses. If this also occurs in Australian savanna woodlands, then the current mitigation strategy could be ineffective. To address the issue a series of field campaigns were undertaken in the savanna woodlands of Western Arnhem land, Australia to quantify the variability in CH4 and N2O EFs throughout the fire season.

This study compared CH4 and N2O EFs measured in smoke sampled from prescribed burning in late June/early July with those from late season fires in early October. It concentrated on the two major vegetation classes in Western Arnhemland; eucalypt open woodland, in which the fuel is composed predominantly tree leaf-litter supplemented by senescent native Sorghum, and sandstone heaths which are dominated by Spinifex hummocks. There were no significant differences in CH4 EFs between early or late season fires, however there were substantial differences between vegetation classes. The woodland emitted 0.3% of fuel carbon as CH4 compared to 0.15% in the sandstone heathland and pure Spinifex and Sorghum swords. The lower emission factors from the grasses compared to leaf litter can be entirely explained by higher combustion efficiency of grass fires. Emission of N2O were less dependent on combustion conditions; approximately 0.5% of fuel nitrogen was emitted as N2O, however there were no differences between early and late season fires or between vegetation classes. These results compare favorably with previous studies; the CH4-EF is similar to earlier measurements in open woodland, although the N2O-EF is lower than the value of 0.8% reported in previous work. Therefore we conclude that the proposed mitigation strategy is feasible and but the variation in EF with vegetation class calls for further quantification of EFs across all major vegetation types in the savanna regions.