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PROGRAM B: B6 The Highfire Project: High country fuels and ecosystem functions

Unseen effects of Fire on Australian Alpine Ecosystems

Factors controlling methane consumption

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The Unseen Effects

Fire drastically and rapidly changes forest ecosystems, removing vegetation, exposing soil and depositing ash. The visible effects of fire are well known but much less is understood about the effects on atmospheric greenhouse gases. Methane (CH_4) is an important greenhouse gas, trapping more heat than CO_2 on a unit mass basis. Aerobic soils, such as those found in forests are important sinks of CH_4 consuming 15-45 Tg yr^{-1} of atmospheric CH_4 globally (3-10% of emissions). Methanotrophic bacteria responsible for this sink are greatly affected by soil disturbances such as fire.

This study examines the effects of fire and climate change on CH_4 consumption from sites located in the Bogong High Plains, Victoria.

Alpine forests are important atmospheric methane sinks

A static closed chamber technique was used to measure CH_4 consumption in the field in March 2007. Field sites were located in either Alpine ash forests or Snow gum woodlands and differed in burn histories and severities. All soils consumed CH_4, with Alpine ash and Snow gum sites consuming on average 45 and 54 µg CH_4 m^{-2} h^{-1} respectively (Figure 1). Measurements from this study are within the range reported in the literature of <1-30 μg CH_4 m^{-2} h^{-1} depending on site characteristics, soil conditions and time of sampling. This study showed a trend of decreasing CH_4 consumption with increased fire severity and time since burning.

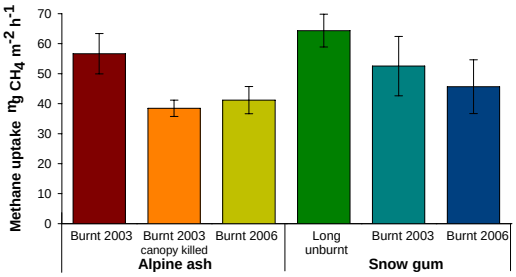

Figure 1: Methane consumption in the field. Error bars are standard errors. Bars are means of (from left to right): n =15, 10, 5, 15, 10, 5.

Disentangling fire effects on soil methane consumption

Fire affects soil properties which in turn can affect CH_4 consumption. Fire has been found to increase inorganic nitrogen in soil which generally inhibits CH_4 consumption. Burnt Snow gum sites had higher ammonium concentration in the soils but this did not correlate with CH_4 consumption (Figure 2). This could be due to interferences from other soil and environmental properties making it difficult to distinguish the effects of individual properties on CH_4 consumption in the field. This can be overcome in the laboratory by keeping conditions (e.g. temperature, moisture and bulk density) constant and varying the property of interest.

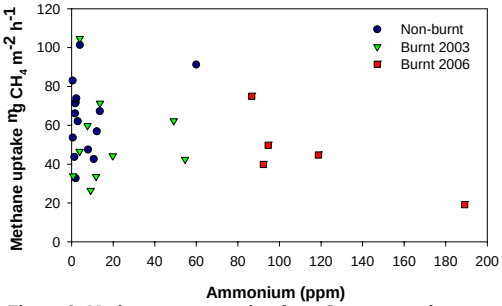

Figure 2: Methane consumption from Snow gum sites vs. soil ammonium. Each dot represents one flux chamber

Lab studies to identify factors controlling consumption

Laboratory incubations were conducted by sampling the gas inside air tight containers containing soil. Results (Figure 3) showed no significant difference between intact (undisturbed) and sieved cores taken from the same depth. Conducting incubations using sieved soils has the advantage of being able to control CH_4 diffusion by packing soil to the same bulk density and removing fragments of rock, charcoal and roots.

Diffusion of atmospheric CH_4 into soil is an important control on CH_4 consumption. The combined consumption rates of intact cores 0-5 and 5-10 cm from the soil surface showed greater uptake than whole cores of 0-10 cm (Figure 3). This suggests that increased surface area to volume ratio allows more CH_4 to diffuse into the soil resulting in higher CH_4 consumption.

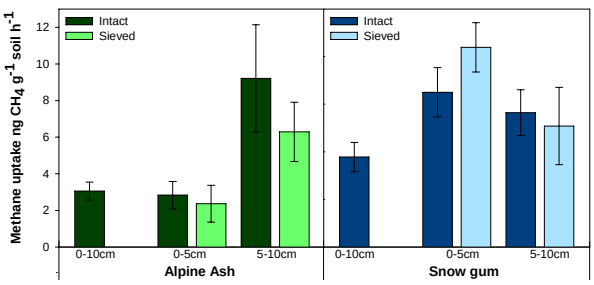

Figure 3: Methane uptake rates from lab incubations of intact and sieved cores at different depths. Error bars are standard errors. Each bar represents the mean of 5 samples.

Laboratory studies can be used to disentangle the effects of fire on soil as methane sinks in the Bogong High Plains. Future work will investigate the relationships between soil properties such as moisture, temperature, inorganic nitrogen and pH with methane consumption.

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