University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Master of Science

of

ABRA MARTIN

BAS (University of Guelph, 2012)

"Carbon Fluxes from High-Centre Polygonal Terrain in the Northwest Territories"

School of Environmental Studies

Thursday, December 3, 2015
10:00AM
David Turpin Building
Room A144

Supervisory Committee:
Dr. Trevor Lantz, School of Environmental Studies, University of Victoria (Supervisor)
Dr. Steve Kokelj, School of Environmental Studies, UVic (Member)
Dr. Elyn Humphreys, Department of Geography & Environmental Studies, Carleton University (Outside Member)

External Examiner:
Dr. Maria Strack, Geography and Environmental Management, University of Waterloo

Chair of Oral Examination:
Dr. Julie Zhou, Department of Mathematics and Statistics, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

Northern regions account for approximately 30% (1035 Pg) of the world's soil organic carbon (SOC). Much of this carbon is currently stored in permafrost soils, which are vulnerable to increasing air and ground temperatures. Permafrost landscapes rich in ground ice, such as high-centred polygonal terrain, are likely to be highly vulnerable to thaw. Degradation of ice wedges in high-centred polygonal terrain causes increased moisture and ground temperatures. These environmental controls are likely to have a large impact on carbon cycling in this terrain type. My M.Sc. research combined both lab and field-based analyses to investigate current and potential carbon emissions from high-centred polygonal terrain in the Tuktoyaktuk Coastlands.

To estimate the magnitude of future emissions from this terrain type I incubated 6 permafrost cores collected at two sites. Peat cores from 4 depths were each incubated under four conditions (cold anaerobic, warm anaerobic, cold aerobic, warm aerobic). The observation that carbon mineralization rates do not vary with depth demonstrates that the soil carbon liberated from permafrost in high-centred polygonal terrain will not be limited by SOC quality. This experiment also shows that emission rates will be moderated by temperature and moisture levels. To examine the impact of ice-wedge thaw on carbon emissions in high-centred polygonal terrain, we combined opaque chamber measurements of flux and estimates made from water samples using a gas diffusion model. Field sampling at two sites contrasted carbon emissions from polygon centres (n=18), wet troughs (n=18) and ponds (n=20). We also measured ground temperature and soil moisture using thermistors and a moisture sensor. Our field results demonstrate that ice-wedge degradation results in increased ground temperature, deeper active layers, and increased CO_2 and CH_4 emissions. Contrary to our expectations, CO_2 emissions were not limited by waterlogged conditions, demonstrating the importance of anaerobic CO_2 production. Our field measurements demonstrate that increasing temperatures are correlated with rising CO_2 emissions in aerobic environments, and rising CO_2 and CH_4 emissions in anaerobic environments. Taken together, these two studies demonstrate that as ground temperatures increase in high-centred polygonal terrain, carbon emissions are likely to increase.