

Hydro-ecological responses of Arctic tundra lakes to climate change and landscape perturbation

Summary

Project Leader(s)

Wrona, Fred

The Arctic Climate Impact Assessment (2005) concluded that the annual mean warming for the areas north of 60°N to be 3.7°C for the period 2070-2089. Hence, the Arctic is expected to display a warming that is more than twice the global average, show decreases in snow cover and ice extent, display further retreat/degradation of permafrost, and have increased inter-annual variability in extreme precipitation events. Such significant changes/shifts in climatic regimes are expected to have far-reaching cascading impacts on the hydrology and ecology of Arctic freshwater ecosystems, which are highly sensitive to climate variability and change (CVC). Large-scale permafrost degradation (i.e., increased depth of seasonal active layer and/or landscape slumping) is predicted to increase with the effects of climate warming, along with enhanced addition of geochemical loadings (e.g., carbon, nitrogen, phosphorus) to the freshwater environment. In addition, changes in the timing and duration of lake-ice characteristics in conjunction with altered geochemical loadings are projected to dramatically affect affecting freshwater ecosystem productivity levels, energy mobilization pathways and community structure. The goals of this research are to: 1) conduct three integrated landscape-lake process and modeling studies that will improve our regional understanding of the sensitivities/responses of upland tundra lakes to CVC, and; 2) to develop and validate an integrated landscape-geochemical, lake-ice, hydro-ecological model applicable to cold regions/Arctic systems. The project is producing legacy data and products of direct benefit to the development of adaptation options for the conservation, protection and management of arctic freshwater ecosystems to present and future climate variability and change.

People

Network Investigators

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Publications

Articles Published in Refereed Publications

Beltaos, S., Carter, T. and Prowse, T., 2011, Morphology of Deep Scour Holes in the Mackenzie Delta, Canadian Journal of Civil Engineering, , Accepted

Bennett, K.E. and Prowse, T.D., 2010, Northern-Hemisphere Geography of Ice-Covered Rivers, Hydrological Processes, v.24, 235-240, Published

Dibike, Y., Prowse, T.D., Ahmed R. and Saloranta, T., 2009, Evolution of Northern Hemisphere Lake-Ice Phenology and Lake Water Temperature Profiles Under a Changing Climate, Proceedings of the 20th IAHR International Symposium on Ice., 1, Submitted

Dibike, Y., Prowse, T.D., Bonsal, B., de Rham, L. and Saloranta, T., 2009, Simulation of North American Lake-ice Cover under Contemporary and Future Climate Conditions, International Journal of Climatology, 1, Submitted

Dibike, Y., Prowse, T.D., Bonsal, B., de Rham, L. and Saloranta, T., 2011, Simulation of North American Lake-ice Cover under Contemporary and Future Climate Conditions, International Journal of Climatology, 1, Accepted

Dibike, Y.B., Prowse, T., Saloranta, T. and Ahmed R., 2010, Response of Northern Hemisphere Lake-Ice Cover and Water Thermal Structure Patterns to a Changing Climate, Hydrological Processes, , Accepted

Flanagan, K.M. and McCauley, E., 2010, Experimental Warming Increases CO₂ Saturation in a Shallow Prairie Pond, Aquatic Ecology, 10.1007/s10452-010-9313-0, Published

Kääb, A. and Prowse, T.D., 2011, Cold Regions River Flow Observed from Space, Nature Geoscience, , Submitted

Mesquita, P.S., Wrona, F.J. and Prowse, T.D., 2010, Responses of Benthic Invertebrate Communities to Shoreline Retrogressive Thaw Slumping in Arctic Upland Lakes, Canadian Journal of Fisheries and Aquatic Sciences, 1, Submitted

Mesquita, P.S., Wrona, F.J. and Prowse, T.D., 2010, Effects of Retrogressive Permafrost Thaw Slumping on Sediment Chemistry and Submerged Macrophytes in Arctic Tundra Lakes, Freshwater Biology, v.55, no.11, 2347-2358, Published

Mesquita, P.S., Wrona, F.J., Prowse, T.D., 2009, Effects of Retrogressive Permafrost Thaw Slumping on Sediment Chemistry and Benthic Macrophyte Communities of Upland Tundra Lakes, Freshwater Biology, 1, Accepted

Mesquita, P.S., Wrona, F.J., Prowse, T.D., 2010, Benthic Invertebrate Communities of Upland Tundra Lakes and Their Relationship with Retrogressive Permafrost Thaw Slumps, J. NABS, 1, Submitted

Prowse, T.D. and Brown, K., 2010, Hydro-ecological Effects of Changing Arctic River and lake Ice Covers: A Review, Hydrology Research 41.6, 454-461, Published

Prowse, T.D., L de Rham, Dibike, Y., 2008, Predicting Lake and River Ice: Modelling of Historic and Future Conditions, Ice and Climate News, v.10, 8-9, Published

Prowse, T.D., Shrestha, R., Bonsal, B. and Dibike, Y., 2010, Changing Spring Air-temperature Gradients Along Large Northern Rivers: Implications for Severity of River-ice Floods, Geophys. Res. Lett., v.37, L19706, doi:10.1029/2010GL044878, 1, Published

Thompson, M.S., Wrona, F.J., Prowse, T.D. and Kokelj, S.V., 2010, The Effect of Thawing Permafrost on Aquatic Nutrient Concentrations in Upland Tundra Lakes, Mackenzie Delta Region, Northwest Territories, Canada, Journal of Geophysical Research-Biogeosciences, , Submitted

Other Refereed Contributions

Brooks, R.N., Prowse, T.D. and O'Connell, I.J., 2010, Modelling Freshwater Ice Thickness across the Northern Hemisphere, Proceedings, American Association of Geographers Annual Meeting, Seattle, Washington. Submitted October 2010, n/a, Submitted

Brooks, R.N., Prowse, T.D. and O'Connell, I.J., 2011, Quantifying Freshwater Ice Across the Northern Hemisphere Using GIS and a Degree-day Ice Growth Model, Proceedings, WDCAG Annual Meeting 2011. Burnaby, BC, n/a, Submitted

Culp, J.C., Prowse, T.D. and Luiker, E.A., 2010, The Mackenzie River, Chapter 18, In: Field Guide to Rivers of North America, (Eds) A.C. Benke and C.E. Cushing, 356-375, Published

Dibike, Y., Prowse, T.D., Ahmed R. and Saloranta, T., 2010, Evolution of Northern Hemisphere Lake-Ice Phenology and Lake Water Temperature Profiles Under a Changing Climate, Proceedings of the 20th IAHR International Symposium on Ice, 8p, 1, Published

Harder, S., et al., 2010, Response of Arctic Lake Ice to Climate Change: Historical Trends and Future Scenarios, Water 2010 - 10th International Symposium on Stochastic Hydraulics and 5th International Conference on Water Resources and Environment Research, , Accepted

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Prowse, T.D. and Brown, K. 2010., 2010, Appearing and Disappearing Lakes in the Arctic and their Impacts on Biodiversity, In: Arctic Biodiversity Trends 2010 – Selected indicators of change, (Eds) T. Kurvits et al., 68-70, Published

Non-Refereed Contributions

Brooks, R. and Prowse, T.D., 2009, Development and Validation of a GIS-based Freshwater Ice Thickness Model for the Northern Hemisphere, Poster Presentation, 2009 ArcticNet Annual Scientific Meeting, 1, Published

Brooks, R., Prowse, T.D. and O'Connell, I.J., 2010, Modelling Freshwater Ice using GIS and a Degree-Day Ice Growth Model, ArcticNet Annual Scientific Meeting, December 14-17, 2010, Ottawa, Ontario, Canada, 1, Published

Brooks, R.N., Prowse, T.D. and O'Connell, I.J., 2010, Development and Validation of a GIS-based Freshwater Ice Thickness Model for the Northern Hemisphere, WDCAG Annual Meeting 2010, Edmonton, Alberta, n/a, Published

de Rham, L., Prowse, T.D., Beltaos, S. and Bonsal, B., 2009, Hydrology and Climatology of the Spring River-ice Break-up, Mackenzie River Basin, Poster Presentation, 2009 Environment Canada Science & Technology Forum, 1, Published

de Rham, L.P., 2010, Lake ice Thickness Profiling using Ground Penetrating Radar at Little Turkey Lake, Ontario, Canada., Internal Tech. Report, Environment Canada, Water & Climate Impacts Research Centre, Victoria, BC, 7p, Published

di Cenzo, P.D., Wrona, F.J. and Pietroniro, A., 2011, Arctic Freshwater Systems: Hydrology and Ecology, NWT IPY Results Conference, January, 2011, Inuvik, NT, n/a, Published

Dibike, Y., Prowse, T.D., Bonsal, B., de Rham, L., Ahmed, R. and Saloranta, T., 2009, Evolution of North American Lake-ice Phenology and Composition under a Changing Climate, Oral Presentation, 2009 ArcticNet Annual Scientific Meeting, 1, Published

Dibike, Y.B., Prowse, T., Ahmed, R., and Saloranta, T., 2010, Response of Northern Hemisphere Lake Ice Cover and Thermal Structure to a Changing Climate, CMOS-CGU Joint Congress, May 31 to June 4, 2010, Ottawa, Ontario, Canada, 1, Published

Dibike, Y.B., Prowse, T., Saloranta, T. and Ahmed, R., 2010, Climate Impacts on Northern Hemisphere Lake-Ice and Water Temperature Patterns, ArcticNet Annual Scientific Meeting, December 14-17, 2010, Ottawa, Ontario, Canada, 1, Published

Dibike, Y.B., Prowse, T.D., Bonsal, B. and de Rham, L. , 2009, Simulation of North American Lake Ice Cover under Contemporary and Future Climate Conditions, Poster Presentation, 2009 Environment Canada Science & Technology Forum, 1, Published

Dibike, Y.B., Prowse, T.D., Bonsal, B., L de Rham, 2008, Simulation of North American Lake Ice Cover under Contemporary and Future Climate Conditions, IPY Cryosphere workshop, Toronto, November 4-6, 1, Published

Flanagan, K., Thompson, M., Wrona, F.J., Prowse, T.D., McCauley, E. and Peters, D.L., 2009, Climate Change Impacts on the CO₂ Dynamics of Arctic Lakes, Oral Presentation, 2009 ArcticNet Annual Scientific Meeting, 1, Published

Gantner, G., Wrona, F.J., Thompson, M., Mesquita, P., Hille, E., Peters, D.L., Prowse, T.D. and Reist, J.D. , 2009, Trophic Interactions in Northwestern Canadian Tundra Lakes – Can Climate-induced Permafrost Thaw Slumping Affect Fisheries Habitat?, Oral Presentation, 2009 ArcticNet Annual Scientific Meeting, 1, Published

Wrona, F.J., Peters, D.L., Prowse, T.D., McCauley, E., Kokelj, S.V., Thompson, M.S., Mesquita, P.S., Dibike, Y.B., di Cenzo, P.D., 2008, Hydro-ecological Responses of Arctic Tundra Lakes to Climate Change and Landscape Perturbation: Highlights and Preliminary Results, 2008 ArcticNet Annual Conference Proceedings, 169, Published

Specialized Publications

de Rham, L.P, 2010, Lake Ice Thickness Profiling using Ground Penetrating Radar at Lake Tornetrask, Abisko, Sweden, Internal Tech. Report, Environment Canada, Water & Climate Impacts Research Centre, Victoria, BC, 11p, Published

de Rham, L.P., 2010, Lake Ice Thickness Profiling using Ground Penetrating Radar at Colour Lake, Axel Heiberg Island, Nunavut, Canada, Internal Tech. Report, Environment Canada, Water & Climate Impacts Research Centre, Victoria, BC, 9p, Published

de Rham, L.P., 2010, Lake Ice Thickness Profiling using Ground Penetrating Radar at Pavilion Lake, British Columbia, Canada, Internal Tech. Report, Environment Canada, Water & Climate Impacts Research Centre, Victoria, BC, 8p, Published

de Rham, L.P., 2010, Expansion of a Network to Study Ice on Canadian Rivers, Expansion of a network to study ice on Canadian Rivers, 5p + Apendices, Published

de Rham, L.P., 2010, Validation of the MyLake Model at Pavilion Lake, British Columbia, Canada, Internal Report, Environment Canada, Water & Climate Impacts Research Centre, Victoria, BC, 5p + Appendices, Published

de Rham, L.P. and Carter, T., 2010, Lake Ice Thickness Profiling using Ground Penetrating Radar at Lake Hazen, Ellesmere Island, Nunavut, Canada, Tech. Report, Environment Canada, Water & Climate Impacts Research Centre, Victoria, BC, 12p, Published

Mesquita, P., 2008, Effects of Retrogressive Permafrost Thaw Slumping on Benthic Macrophyte and Invertebrate Communities of Upland Tundra Lakes, MSc Thesis, University of Victoria, 1, Published