Permafrost and Climate Change in Northern Coastal Canada

Summary

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This project analyzes how permafrost, or permanently frozen ground, responds to the changing climate. Permafrost is the foundation upon which northern communities and ecosystems rest, so determining its fate is important to a number of different disciplines and users. Remote sensing is used to map surface temperatures across northern Canada as they regulate the thermal regime of permafrost and regional climate models are used to predict coming changes in permafrost thermal regime under projected climate changes. The Canadian regional climate model is being improved so that changes in the permafrost will be incorporated as feedbacks into successive runs of the model; this will provide a more realistic projection of the temperature response of permafrost than is currently available. The impact of thawing permafrost is often a function of how much ice is found below the ground surface, so an important component of the project is to map where this ground ice is located, particularly in sensitive areas such as Inuit communities or in regions targeted for industrial projects. Other factors that have a bearing on the impact of warming permafrost are the types of soil, the vegetation cover, snow depths, and soil moisture, so these are elements that are also considered by our multi-disciplinary team. Changes to the landscape as a result of the changing permafrost temperatures are monitored, including the development of landforms such as slumps, changes in vegetation patterns, modification of drainage patterns, and coastal erosion. A range of environments are examined so that naturally occurring changes can be clearly distinguished from ones generated by development or land use. Projected permafrost temperatures and modifications to the landscape will be mapped to provide policy makers, managers and land use planners with the tools needed to assess the impact of a changing environment.

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Publications

Articles Published in Refereed Publications


Haltigin T.W., Pollard W.H., and Dutilleul P., 2010, Comparison of ground- and aerial-based approaches for quantifying polygonal terrain network geometry on Earth and Mars via spatial point pattern analysis, Planetary and Space Science, v.58, no.12, 1636-1649, Published


Lavoie, C., Hill, P.R., Allard, M.; St-Onge, G., and Lajeunesse, P., 2008, High-Resolution Seismo-Stratigraphy and Sedimentological Properties of Late and Postglacial Sediments in Lac Guillaume-Delisie Estuary and Nastapoka Sound, Eastern Hudson Bay, Canadian Journal of Earth Science, v.45, no.4, 427-441, Published


Tremblay, B. and Lévesque, E., 2010, Increasing erect woody vegetation in the Canadian Eastern Arctic: a case study from the forest – shrub tundra transition zone, Arctic, Antarctic and Alpine Research, 1, Submitted

Tremblay, B., Lévesque, E. and Boudreau, S., 2011, Recent expansion of erect woody vegetation in the Canadian Eastern Low Arctic., Arctic Antarctic and Alpine Research, Accepted

Other Refereed Contributions

Allard, M., Sarrazin, D. and Marchildon, C., 2008, Evidences of Impacts of Climate Warming on Permafrost in Nunavik (Northern Quebec), Proceedings of the Symposium on Mines and the Environment, Rouyn-Noranda, Qc, 1, Published


Blanche, J.-P., Sushama, L., et Laprise, R., 2008, Modeling Thermal and Moisture Regimes of Permafrost with the new Deep Soil Configuration in CLASS from 1961 to 2100, 3e Symposium Scientifique d’Ouranos, 1, Published


Carbonneau, A.-S. and Allard, M., 2010, Holocene geomorphic evolution and characterization of permafrost in Pangnirtung, Baffin island, ArcticNet Annual Scientific Meeting, Ottawa, December 13-17, 110, Published


Duguay, Y. Bernier, M., 2011, Potential of polarimetric SAR data for snow water equivalent estimation in subarctic regions, Proceedings of the PolInSAR workshop, 23-28 January, Frascati, Italia, Accepted


Non-Refereed Contributions

Allard, M., 2008, Permafrost and Climate Change, a Challenge for Planning and Construction in Arctic Communities, Symposium Planning for Climate Change, Iqaluit, 1, Published

Allard, M., Mate, D., Doyon-Robitaille, J., L’Héraltue, E., Oldenborger, G., Le Blanc, A.-M. and Slayden, W., 2010, Surficial geology mapping and permafrost characterization in Iqaluit, Nunavik, ArcticNet Annual Scientific Meeting, Ottawa, December 13-17, 95, Published
Angelopoulos, M., Pollard, W.H., Couture, N.J., 2010, Geophysical Detection of Ground Ice at Parsons Lake, NWT, IPY Oslo Science Conference, Accepted

Angelopoulos, M., Pollard, W.H., 2010, Integrated geophysical approach for the detection and assessment of massive ground ice in the Canadian Arctic and its implications for Mars exploration programs, Canadian Astrobiology Training Program Annual Meeting, Accepted

Angelopoulos, M., Pollard, W.H., Couture, N.J. and Gowan, R., 2010, Integrated geophysical approach for the detection and assessment of ground ice at Parsons Lake, Northwest Territories and Herschel Island, Yukon Territory, 63rd Canadian Geotechnical Conference and 6th Canadian Permafrost Conference, Accepted


Boulanger-Lapointe, N., 2010, Age structure and growth of arctic willows (Salix arctica Pall) populations in the High-Arctic., Talk presented at the National Environmental Research Institute, Aarhus University, Accepted

Boulanger-Lapointe, N., Lévesque, E., Schmidt, N.M., Baittinger, C., Boudreau S. and Forchhammer, M.C., 2010, Trends in Shrub Dynamic in the High-Arctic: The Case of the Arctic Willow, Talk presented at ArcticNet Annual Scientific Meeting, Accepted


Carbonneau, A.S., Gosselin, P., L'Hérault, E., Allard, M., Oldenborger, G., LeBlanc, A.M., Sladen, W., Mate, D., 2009, Assessing permafrost conditions and landscape hazards in support of climate change adaptation in Pangnirtung, Nunavut, ArcticNet Annual Science Meeting, Victoria, British-Columbia, 1, Published


Dufour Tremblay, G., Boudreau, S., Tremblay, B. and Lévesque, E., 2010, Alitudinal treeline dynamics in response to climate change in the vicinity of Kangiqsualujjuaq (Nunavik, Québec),, Talk presented at Understanding Circumpolar Ecosystems in a Changing World. Edmonton, Canada., , Accepted

Duguay, Y., Bernier, M., May, I. and R. Ludwig., 2010, Potential of multi frequency sar data for snow characterization in subarctic regions, ArcticNet Annual Scientific Meeting, Ottawa, 13-17 December, Poster, Published

Forbes, D.L. and Manson, G.K. , 2008, Coastal Impacts of a Warming Climate and Challenges for Northern Communities, Planning for Climate Change: Weathering Uncertainty, Iqaluit, NU, 1, Published

Forbes, D.L., Craymer, M., Manson, G.K., Marsh, P., Solomon, S.M. and Whalen, D., 2008, Subsidence, Flooding, and Erosion Hazards in the Mackenzie-Beaufort Region, United States and Canada Northern Oil and Gas Research Forum, Anchorage, AK, 1, Published

Forbes, D.L., Manson, G.K., Mate, D. and Qammaniq, A. , 2008, Cryospheric Change and Coastal Stability: Combining Traditional Knowledge and Scientific Data for Climate Change Adaptation, Ice and Climate News, 11, 17-18, Published

Fox, D. , 2009, Positive Identification of Palsa and Biotherm Features of the James Bay Lowlands with the Use of IKONOS - 2 Imagery, International Polar Year (IPY) Early Career Researcher Symposium, Victoria, B-C, 1, Published


Fritz, M., Lantuit, H., Couture, N.J., and Pollard, W.H., 2010, Dissolved organic carbon (DOC) from massive ground ice along the Yukon coast - Why does it matter?, ArcticNet Annual Science Meeting, , Accepted

Fritz, M., Schirrmeister, L., Meyer, H., Lantuit, H., Couture, N. J., Pollard, W. H., 2010, Notes from a small island in the western Canadian Arctic, AWI PhD Days, , Accepted

Fritz, M., Schirrmeister, L., Meyer, H., Lantuit, H., Couture, N.J., Pollard, W.H., 2010, Towards a paleoenvironmental reconstruction from permafrost deposits in the western Canadian Arctic, IPY Oslo Science Conference, , Accepted


Gibéryen T. and Allard, M., 2009, Community planning in Nunavik, Proceedings of the ArcticNet Annual Scientific Meeting, Victoria, BC, 98, Published

Gibéryen T. and Allard, M., 2009, Getting in touch with the northern social sciences, autochtones: appropriations, redéfinitions et connections” by Centre Interuniversitaires d’Études et de Recherches Autochtones & Association des Étudiants Autochtones (CIERA-AEA), Université Laval, Québec, 1, Published
Gosselin, P. and Allard, M., 2010, Severe permafrost degradation due to major fluvial thermoerosion event., ArcticNet Annual Scientific Meeting, Ottawa, 13-17 December, 128, Published


Haltigin, T.W., Pollard, W., Osinski, G.R., and Dutilleul, P., 2009, Morphological variation of polygonal terrain within scalloped depressions, Utopia Planitia, Mars, American Geophysical Union / Canadian Geophysical Union Joint Assembly, Toronto, ON, 1, Published


Jolivel M. and Allard, M., 2009, The Fate of Fine Sediments and Organic Carbon Released by Permafrost Decay, Eastern Coast of Hudson Bay, ArcticNet Annual Scientific Meeting, Victoria, B-C, Published

Jolivel M. and Allard, M., 2009, The Fate of Organic Carbon Released by Permafrost Decay, Eastern Coast of Hudson Bay, Joint Assembly, AGU, Toronto, On, 1, Published

Jolivel, M., 2009, Carbone issu de la degradation du pergélisol, un destin tout tracé?, Colloque facultaire FFGG, Un territoire, différants regards, Université Laval, 1, Published

L'Hérault, E. and Allard, M., 2009, Critical climate threshold likely to initiate active-layer failures on ice-rich silty clay slopes, Salluit Valley, Nunavik, Canada, Proceedings of the ArcticNet Annual Scientific Meeting in Victoria, B.C, 110, Published

May, I., Kim, J.S., Spannraō, K., Ludwig, R., Hainsek, I., Bernier, M. and Allard, M., 2010, Using in-field and D-InSar-techniques for the monitoring of small-scale permafrost dynamics in Northern Québec, Canada, IPY Oslo Science Conference, , Accepted


May, I., Kim, J.S., Spannraō, K., Ludwig, R., Heinsek, I., Bernier, M. and Allard, M., 2010, Using in-field and remote sensing techniques for the monitoring of small-scale permafrost decline in Northern Quebec, EGU Conference Vienna, , Accepted

May, I., Ludwig, R. and Bernier, M., 2010, Using land - and snow cover as indicators for permafrost distribution, ArcticNet Annual Scientific Meeting, Ottawa, 13-17 December,, Poster, Published

May, I., Ludwig, R., Bernier, M., Allard, M., 2009, Using remote sensing for the monitoring of Snow Cover Dynamics and Permafrost Decline, ArcticNet Annual Meeting, Victoria, B-C, 1, Published


Williams, K.K., Haltigin, T.W., and Pollard, W.H., 2009, Estimating ice wedge geometry using near surface geophysical methods, American Geophysical Union / Canadian Geophysical Union Joint Assembly, 1, Published
**Specialized Publications**


Allard, M., Lemay, M., Barrette, C. and Bell, T., 2010, Permafrost and climate change in Nunavik and Nunatsiavut: importance for municipal and transportation infrastructures., Implications of changing natural and socio-economic environments. An integrated regional impact study (IRIS) of the Canadian Eastern Subarctic Region, , Submitted

Allard, M., L'Hérault, E., Doyon, J. et Sarrazin, D., 2010, Analyse microclimatiqute adapté à l'aménagement du village de Salluit., Centre d'études nordiques, Université Laval, Rapport au Ministère des Affaires municipales, des régions et de l'occupation du territoire du Québec, 42p., Published


Angelopolous, M. C., 2009, Detection and Assessment of Subsurface Ice with Ground-Penetrating Radar on Herschel Island, Yukon Territory., B.Sc. thesis, McGill University, 81pp, Published

Barrette, C., 2010, Simulations numériques et projections des variations de l’épaisseur de la couche active à Salluit jusqu’en 2025., Thèse de maîtrise, Département de géographie, Université Laval, 124p., Published

Cray, H. A. , 2010, A Characterization of the Vegetation Communities of Three Retrogressive Thaw Slumps on Herschel Island, Yukon Territory, Canada, BA thesis, McGill University, 92 pp, Published


Haltig, T.W., 2009, Interpreting polygonal terrain network arrangements on Earth and Mars using spatial point patterns, Ph.D. dissertation, McGill University, 192 pp, Published


Larouche, M.-È., 2010, Interaction entre la dégradation accélérée du pergélisol discontinu et l'organisation du réseau de drainage, Québec subarctique., Université Laval, Département de géographie, thèse de maîtrise, 111p., Published

Lemelin, D., 2009, Formation et caractérisation des polygones de toundra de la région de la rivière Biscarat, Nunavik, Université Laval, Département de géographie, thèse de maîtrise, 94 pp, Published

Lévesque, A.-M., 2009, Salluit : analyse et reconstitution d'événements climatiques significatifs pertinents à l'aménagement du territoire et à la sécurité publique, Université Laval, Département de géographie, thèse de maîtrise, 77 pp, Published


L'Héraul, E., 2009, Contexte climatique favorable au déclenchement de ruptures de mollisol dans la vallée de Salluit, Nunavik, Université Laval, Département de géographie, thèse de maîtrise, 135 pp, Published