1. Introduction

The permafrost region of Canada (Fig. 1) is one of the most rapidly warming regions on the planet. Large-scale modeling studies indicate poleward shift of the discontinuous permafrost zone due to the warming of a degree or more by 2100. 

Fig. 1. Permafrost distribution pattern in Canada. 

2. Study Site – Scotty Creek Research Basin

Scotty Creek is in the Northwest Territories (NWT) of Canada (Fig. 1), and is covered with a 230 m layer of peat. 

Three distinct landcover types with different hydrological functions exist as a consequence of peat moss processes. 

(1) Permafrost plateaus rise 1-2 m above the surrounding wetlands and generate runoff that feeds fens and bogs (Fig. 3a). They support spruce forests. 

(2) Channel fens provide drainage, and support vascular aquifers. 

(3) Flat bogs store water and occasionally drain to channel fens. They are dominated by Sphagnum moss and contain acidic water. 

Thawing of permafrost plateaus can change the relative proportion of forests and wetlands, and connectivity of hydrological pathways.

3. Methodology

- Annual frost table (FT) surveys on a transect. 
- Remote sensing of permafrost plateaus (Hayashi et al., 1999). 
- Meteorological stations near FT transect. 
- Soil temperature/moisture monitoring stations. 
- Resistivity measurements. 
- High-resolution (4 m) satellite image in 2000. 
- High-resolution (1 m) LiDAR survey in 2008. 
- Electrical resistivity imaging (ERI) in 2009.

4a. Results: Frost Table Dynamics

Annual frost surveys on the same line every year in the permafrost plateau (Fig. 4) across a permafrost plateaus due to the lateral freezing from both sides (Fig. 5a). Elevation surveys from 2005 and 2006 indicate that the plateau is evolving as the active layer is increasing in length. 

This demonstrates the encroachment of fen and bog into forested (Fig. 3c). As the trees die and fall, the plateau edges are exposed to radiation inputs and the contact with relatively warm surface water in the wetlands, thereby accelerating the diminution of permafrost and expansion of non-permafrost. 

The permafrost plateaus are thawing from the edges which is the last to thaw. 

4b. Results: Permafrost Imaging and Mapping

Resistivity surveying along ERI (see Fig. 4) clearly delineated permafrost under the mires. The resistivity data were used for modeling. 

The enhanced and adjacent wetlands may not have the importance of lateral heat transfer. The high-resolution survey showed the deeper of the active layer under a forest. These results further evidence for the feedback mechanism. 

The permafrost plateaus are thawing from the edges which is the last to thaw. 

5. Conclusions

The peatland, discontinuous permafrost of Scotty Creek watershed is thawing with the climate warming, which is consistent with model prediction in the literature. 

The thawing does not occur as a result of uniform reduction in ground temperatures. 

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Wetland-Forest Transition at the Edge of Permafrost: Roles of Water and Energy Transport Processes

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