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Observations of Dynamic Ice Processes in a Channel Network

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EXTENDED ABSTRACT

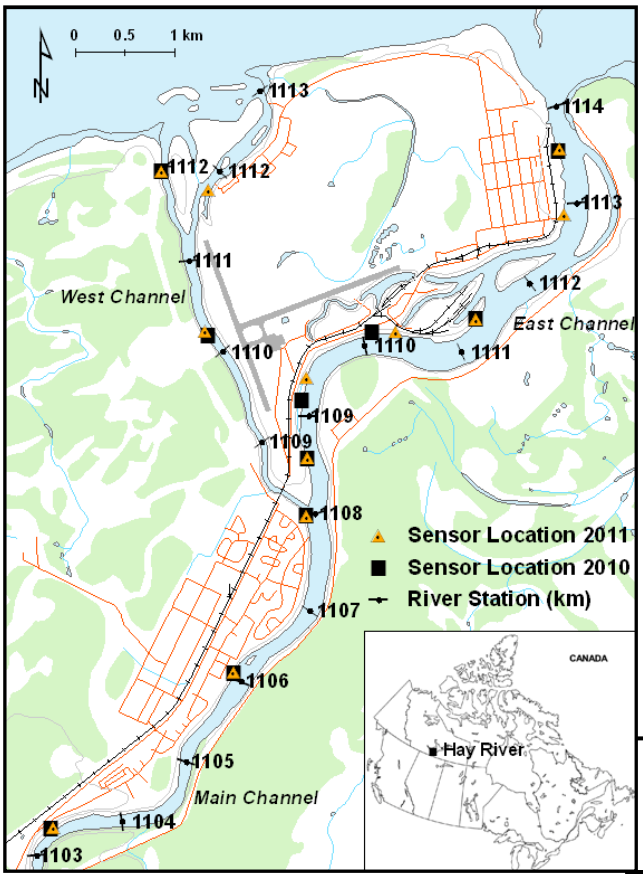

Figure 1. Hay River delta study site and location of sensors deployed in 2010 and 2011.

The town of Hay River in the Northwest Territories is a community threatened by ice jam flooding each spring. The town is located along the banks of the Hay River where it drains into Great Slave Lake, forming a delta with two main channels (Figure 1). Each spring, breakup upstream of the town is comprised of a cascade of ice jam formation and release events. The resulting ice runs bring significant volumes of ice into the delta that stop against the intact ice of Great Slave Lake. The University of Alberta River Ice Group has studied breakup on the Hay River from 2004 to 2011.

Ice run, jave, and jam events in the Hay River delta in 2010 and 2011 were extensively monitored using pressure sensors, automated time-lapse cameras and survey methods. As well, all major ice movements were

documented. Six cameras and ten pressure sensors were deployed in 2010 (Figure 1); ten cameras and twelve pressure sensors were deployed in 2011. The pressure sensors used were Schlumberger MiniDivers and MicroDivers (models DI501 and DI601, respectively). The sensors were synchronized to a single computer clock, programmed to record measurements at one or two minute intervals and installed in heavy steel cases. The cases were embedded in the river bank and surveyed to a common geodetic datum using a real-time kinematic global positioning system (RTK-GPS). The sensors were un-vented and their data were therefore post-processed to compensate for atmospheric pressure variations. The time-lapse cameras took photographs at varying intervals from 5 to 60 minutes. Ice jam profiles (example in Figure 2) were also surveyed along each channel with the RTK-GPS.

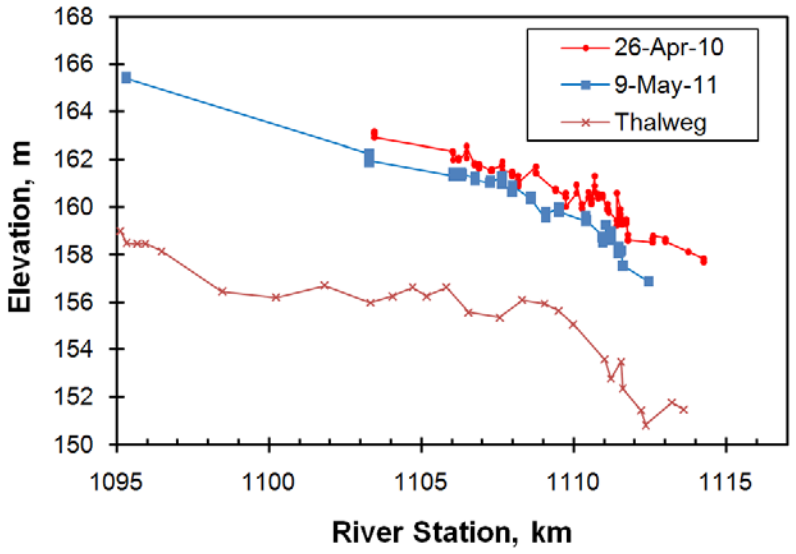

Figure 2. Final ice jam profiles measured along the Main and East Channels in 2010 and 2011.

The pressure sensors provided very detailed information of water levels in the delta and, in particular, demonstrate the propagation of waves in response to ice jam formation and release events. Figure 3 shows an example series of stage hydrographs collected during spring breakup in 2010.

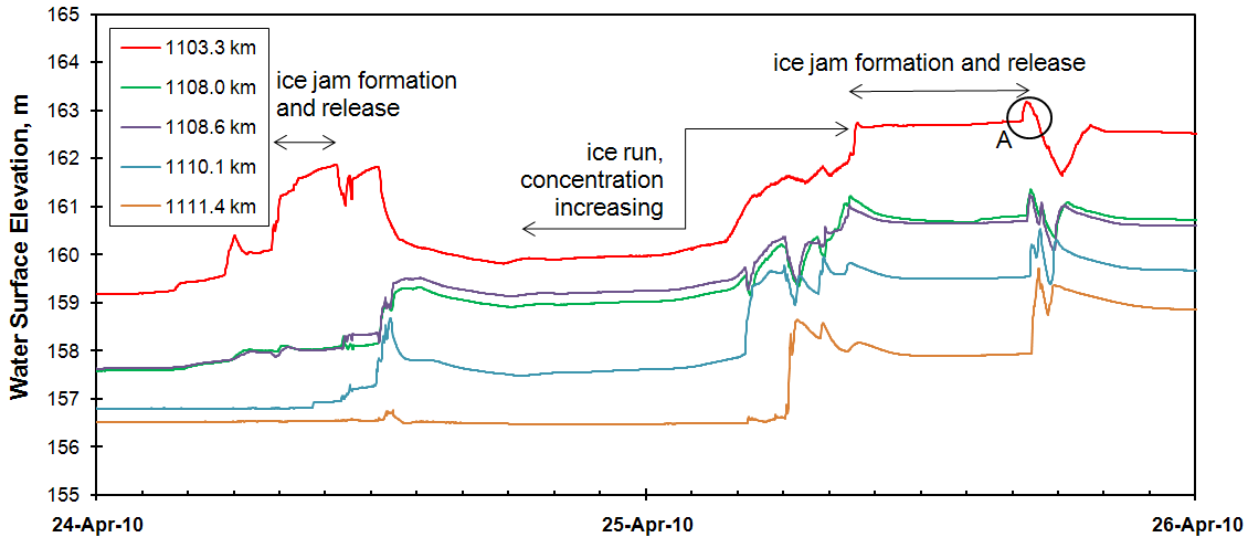

Figure 3. Stage hydrographs measured at five stations along the Main and East Channels, 2010. (Annotations refer to ice conditions observed at station 1103.3 km; the ice jam release event analyzed herein is marked with an "A".)

Figures 4 and 5 illustrate examples of the type of data that will be presented in the poster, including wave celerities for the ice jam release event "A" noted in Figure 3. The front and peak of wave "A" were tracked through the delta, and the speed of the water level disturbance was determined. As Figure 5 shows, the celerity of the wave front of wave "A" was similar in the East, West, and Main Channels but the peak of the wave travelled much slower in the delta channels than it did in the main channel. This decrease in celerity can be attributed to the effects of ice in the delta channels.

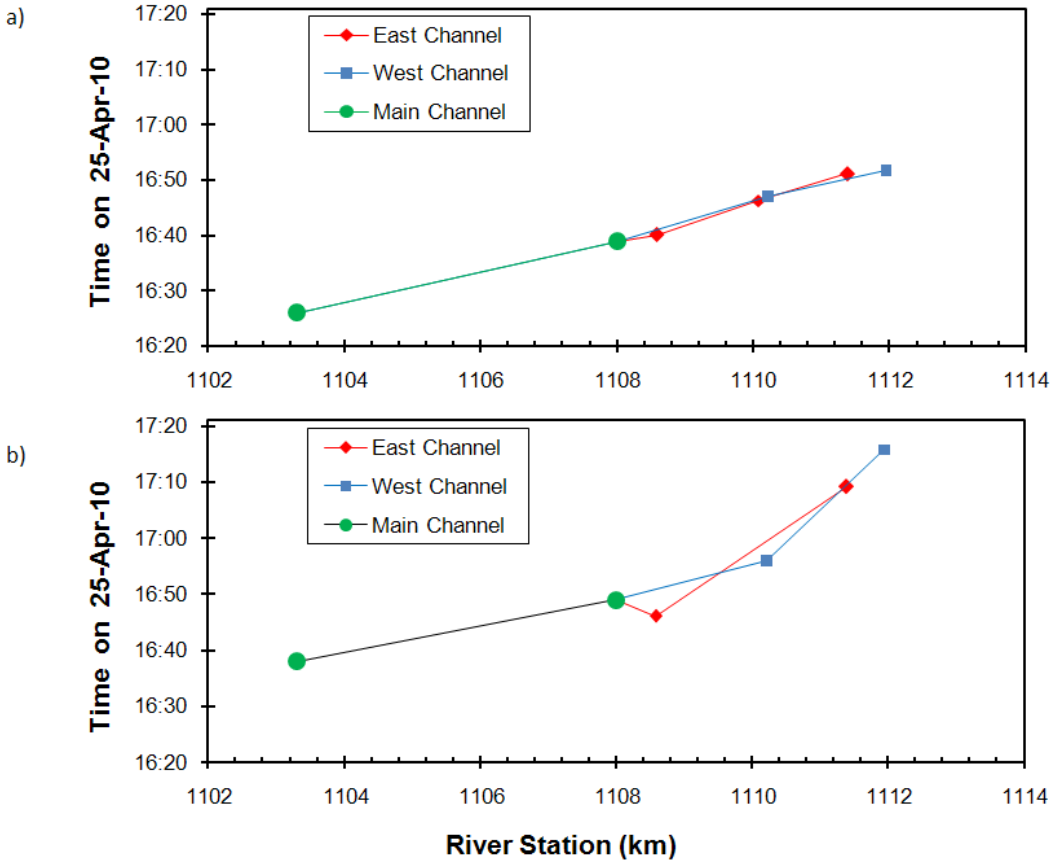

Figure 4. Propagation of the a) wave front and b) wave peak for ice jam release wave "A".

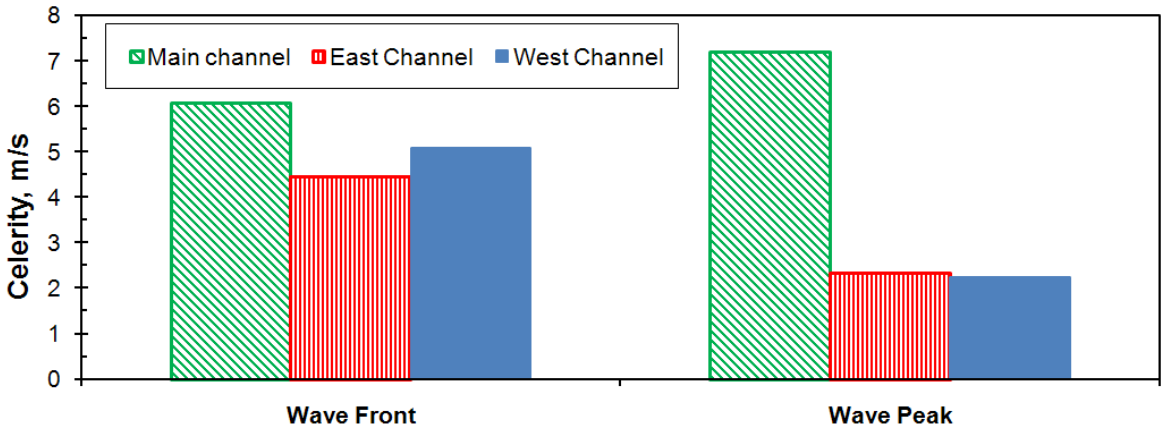

Figure 5. Celerity of the front and peak of wave "A" in the Hay River delta channels.