The “Harry Lake” Adventures

CTD data from a Northern Lake

by Rolf Lueck, Rockland Scientific International Inc.

Figure 1 Harry Lake, located in northern British Columbia, Canada, is approximately 3 km long and 0.8 km wide. It is only accessible by float plane. A stream flows into its southern end and the outflow is at the northern end.

“Harry Lake,” in the far north of British Colombia is accessible only by floatplane, leaving it nearly untouched. The lake was discovered by Harry Luck in 1975 and has been used for recreational purposes every September since then. It has no official name and has been dubbed Harry Lake by the floatplane service that flies Harry and his party into the lake. Harry’s brother Rolf Lueck, President of Rockland Scientific International, has been visiting the lake since 1997 and this gives him an opportunity to test new equipment in a secure and pristine environment. For example, one can safely moor a thermometer in the lake for a whole year without worry of losing it to recreational fishermen.

In September of 2007, Rolf and his brother George, who has never before measured anything in the ocean or a lake (other than the lenth of the fish that he catches in a lake), used the Alec Electronics COMPACT-CTD to take a section of vertical profiles along the entire axis of Harry lake (Figure 2). The COMPACT-CTD proved so small and easy to use that George was able to perform each of the 27 casts while Rolf skippered their small aluminum car-top boat. Rolf’s brother was heard to say, “This is so easy and so much fun, I think you people are over-paid.” Rolf collected ancillary GPS data at each of the stations, which started at the southern end of the lake, and stretched to the north.

Figure 2. George Lueck, holding the CMPACT-CTD and about to become a successful field limnologist.

Harry Lake consists of two basins. The southern and larger of the pair has very shallow water in its southern 500 m. Moose are frequently seen walking across this section with water up to their shoulders. Small boats can only navigate this area with their outboard motors in "high-drive". A stream at the southern end of these shallows forms the main flow into the lake. In late September, this inflow is already close to 0°C as evidenced by thin layers of ice in the shallows around the stream.

At the southern most CTD station (HL2007_3), the lake deepens steeply and reaches a maximum depth of 25m at station HL2008-8, which is about 400 m into the section (Figure 3). The lake shallows abruptly at station HL2007-18 to depths of only ~2m. This sill area is flanked by several large, shallow bays as well as several islands that are frequently traversed by the local wildlife (Figure 5). The northern basin is relatively small and never reaches deeper than 10m.

The southern basin is deep enough to form a seasonal thermocline that persists into September. The surface water is still over 6°C while the deepest water is very close to 4°C, the temperature of maximum density of fresh water (Figure 3, Figure 6 and Figure 7). The layer of nearly homogeneous water between 4 and 10m depth is the mixed layer created by strong winds a few days before the measurements. Solar radiation has created a weak thermocline between the surface and 3m depth that is easily eroded by the next wind event or night time cooling by long-wave radiation. With further cooling the entire southern basin will eventually have a temperature of 4°C (top to bottom). This is frequently called "over-turning" because water can move freely from top to bottom without being hampered by the stratification of density. After this time, additional cooling will create light water that remains at the surface (maximum density occurs at 4°C) and eventually the surface will freeze. Overturning occurs twice per year, once to allow freezing in the fall and again in spring to allow the surface to warm.

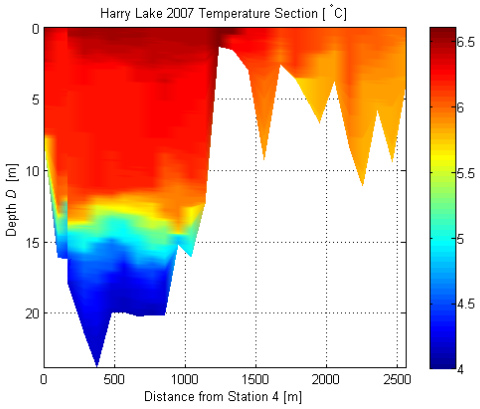

Figure 3. A section of temperature along the axis of Harry Lake.

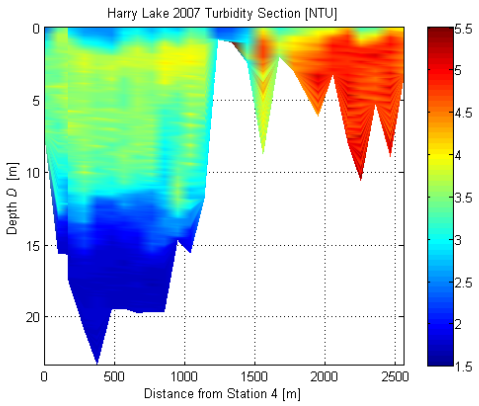

Figure 4. A section of turbidity along the axis of Harry Lake.

Figure 5. Moose standing next to one of the many islands between the southern and northern basis of Harry Lake.

The shallow northern basin is already 0.5°C cooler than the southern basin and it does not have a seasonal thermocline. This is partly because it is shallower than 10 m, which is the depth of surface mixing evident in the southern basin. That is, wind and waves can mix the northern basin from top to bottom. However, the shallow bays around the sill area are easily cooled and their water will flow mainly into the northern basin because of the prevailing south-to-north current in the lake. The addition of water from the bays will accelerate the cooing of the northern basin. Very likely this same advection of water from the bays accelerates the warming of the northern basin in late spring and summer.

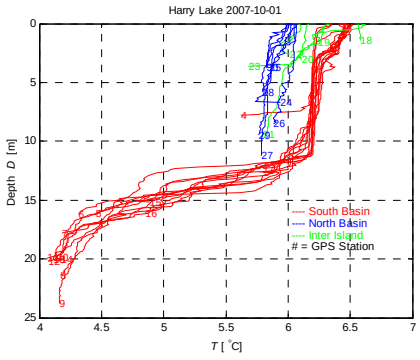

Figure 6. Temperature profiles from the southern basin (red) the northern basin (blue) and the sill region between them (green).

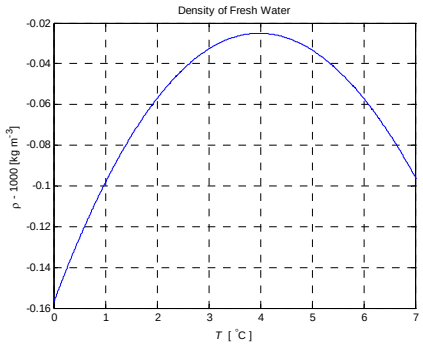

Figure 7. The density of freshwater at atmospheric pressure as a function of temperature. The maximum density occurs at 4°C.

The inflow stream is cold and certainly below 1°C which makes it less dense than all of the water in the southern basin (Figure 6 and Figure 7). One would expect the inflow water to ride on the surface of the southern basin. But this cannot persist for long. Any mixing of the cold surface water with the warmer water beneath it will create water with an intermediate temperature. This mixed water will have a density that is larger than either of the original waters and will immediately sink. For example, if 1 part of 0°C water is mixed with 2 parts of 6°C water, the resulting mixture will have a temperature of 4°C and will have the potential to sink right to the bottom of the southern basin. A close examination of Figure 3 indicates that cold water is reaching up the slope at the southern end of the basin and may be evidence for the mixing of inflow water with the basin water. A similar "reaching" cannot be seen at the northern slope of this basin. The region near the slope may be an interesting area for the direct measurement of turbulence that must be associated with the mixing and sinking of the inflow water.

The bottom water in the southern basin is incredibly clear with turbidities of around 1.5-2 NTU. The northern basin is significantly more turbid than the rest of the lake, possibly due to the inflow of cold water from the shallow bays near the sill. That is, the water in the bays is likely to be fairly turbid because the bays are shallow and wind and waves will easily stir the bottom sediments and bring them into suspension.

Rolf plans to return to Harry Lake this September, with his brothers, and take microstructure profiles with the VMP-500 made by Rockland Scientific International Inc. This is a small and light profiler optimized for working from small boats.