NETLAKE Guidelines for automated monitoring system development

013 What to Do About Ice?

Objective

The purpose of this fact sheet is to provide some practical advice on how to maintain automated monitoring systems (AMS) in lakes or reservoirs which experience a regular period of winter ice cover.

Considerations

For lakes that are regularly frozen in winter, and develop a long-lasting ice cover (greater that 1-2 cm thick), maintaining an AMS becomes more difficult. One is basically left with three alternative strategies for monitoring under ice covered conditions.

- Remove the AMS in the late autumn, and suspend the monitoring program until spring when the AMS can be re-deployed.
- Allow the AMS to become frozen into the lake ice cover, and continue monitoring.
- Deploy an AMS that is completely under water, below the level of the deepest expected ice thickness.

There are advantages and disadvantages to all of these approaches, which we discuss in more detail below.

The first strategy is probably the most common, especially for systems with expensive components, or profiling systems that have cables that regularly move through the water. There is no doubt that an ice bound AMS will often be subject to damage, especially during ice loss. So removal of the buoy during the winter is a reasonable safeguard to minimize instrument damage and maintain a long term monitoring program. It is however unfortunate that this must often be done, since the processes occurring during winter and at the times of the onset and loss of ice are ones that are expected to be strongly affected by climate change (Magnuson et al. 1997). Furthermore despite the best intentions, it is often difficult to re-deploy the buoy just following ice loss, especially on larger lakes where calm weather may be needed. We generally do not recommend removing the anchors, rather we attach a small marker buoy to each anchor rope and hope for the best. In most cases the anchors survive, although they may move. In the rare case that they do disappear they are not too expensive to replace. In cases where the buoy is removed during winter, it may be useful to supplement the monitoring program with a simple underwater deployment as described below.

The second strategy is to just leave the buoy in place during winter and continue measurements. This works well for meteorological measurements made above the water (or ice) surface, and for underwater sensors that are maintained at fixed depths, such as thermistor temperature sensors, oxygen sensors or multisensory sondes. At high latitudes one should consider the power requirements, and battery supply, as low light may limit the effectiveness of solar power systems. Given sufficient power, buoys frozen into the ice cover (Fig. 1) can work as well as during the ice free period. The greatest risk is at the time of ice loss, where in the worst case rapid movements of the lake ice sheet can rip lose anchors, damage submerged sensors, and even tip over the buoy. Such damage almost always occurs with ice loss is associated with a large wind event otherwise known as an ice shove event (Fig. 2). These events are most likely and most severe on large and wind exposed lakes. Overwinter deployment may in some cases be considered a reasonable strategy for small wind sheltered lakes, but there will always be some risk.

The final strategy involves mooring the buoy and sensors below the level of ice formation. This completely protects the sensors, and allows continuous measurements throughout the winter, The main disadvantage to this approach is that it is difficult to maintain telecommunications with the sensors or provide power to the sensors during winter, making this approach most suitable for the deployment of stand-alone logging sensors such as those made by Onset, PME or RBR, or multi-parameter sondes such as those made by YSI or Hydrolab. When using these systems in long under-ice deployments, consideration must be made to account for battery life data storage and measurement frequency. In some cases it has been possible to develop cabled under ice measurements systems which can provide data to an onshore data logger in near real time (Pierson et al. 2011 Example 3), and there are some bottom based profiling systems under development which could also be used under ice cover. The other potential pitfall with underwater deployments is that it can be difficult to find and retrieve the data loggers in the spring, since there is no surface marker buoy. There are several solutions to this. It is of course always good practice to obtain a precise GPS location, and use a brightly colored buoy that can be seen under water. When the deployment is not too far from land a long rope (that sinks) can be attached to the buoy anchor, and then led into land and securely fastened. This can be used to retrieve the buoy in the spring. If far from land a useful strategy is to attach a long bottom line system (Fig. 3) that can be snagged, with a drag hook from a moving boat searching near the known GPS location.

Examples

Figure 1. Water quality monitoring buoy frozen into Lake Sunapee N.H. USA. For many winters the buoy performed well, however in one year it was damaged at the time of ice loss. Photo credits: Midge Eliassen

Figure 2. Ice drifts on Lake Võrtsjärv (Estonia). When ice is broken up rapidly in large sheets that are moved by the wind significant AMS damage can be expected. Photo credits: Lea Tuvikene

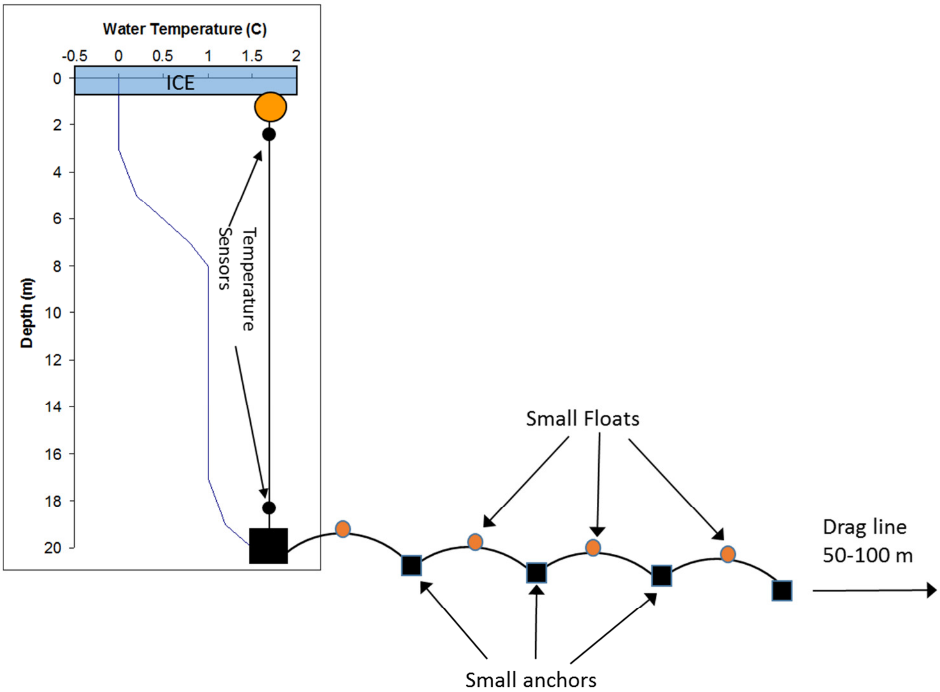

Figure 3. Under-ice temperature sensor deployment, also showing use of a bottom line that can be used with a drag hook to retrieve the system in the Spring. Modified from Pierson et al. (2011)

Likely Problems

Damage to systems frozen into the lake ice cover at the time of ice out.
Difficulty finding systems that are moored completely under water.

More information

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