Autonomous vertically-resolved monitoring of Lake Manapouri

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Background

- Lake Manapouri is New Zealand's second deepest lake, and is situated in the Te Wahipounamu *South West New Zealand* World Heritage Area.
- Environment Southland began monitoring this lake in 2002, and have since collected over 100 discrete water samples and depth profiles at each of three monitoring sites. However, due to Manapouri's oligotrophic state, a high proportion of analytical results to-date lie below detection limits.
- Sampling has also been biased towards calm weather, and as such there is much yet to be understood about the dynamics and trajectory of water quality in the lake.
- There is a strong desire among community and stakeholders for the capability to detect any changes in water quality at Manapouri, and to manage inputs from catchment land use to prevent degradation.
- As part of an integrated program of monitoring and management in the Waiau catchment, partly funded by Meridian Energy, ES has commissioned the installation of an autonomous water column profiling lake monitoring buoy, designed and built at the University of Waikato.
- Automated water column profiling buoys can improve programs of management, monitoring and research by providing fundamental data, enable rapid response to water quality changes, reduce long-term monitoring costs, and enhance understanding of short- and long-term ecosystem change.

Design

- The Manapouri Monitoring Buoy (MMB) was deployed on the 1 December 2016.
- The buoy uses a custom built winch, controlled either manually or on a schedule (by datalogger) to autonomously profile the water column to a depth of 80 m or more, at sub-daily intervals.
- Profiling buoys have operated with success in Lakes Rotoehu and Rerewhakaaitu (Bay of Plenty) since 2013, however, this deployment will be the first in a deep New Zealand lake.
- Sensors include water temperature, dissolved oxygen, chlorophyll fluorescence, and turbidity, as well as a meteorological station mounted on the platform (Table 1).

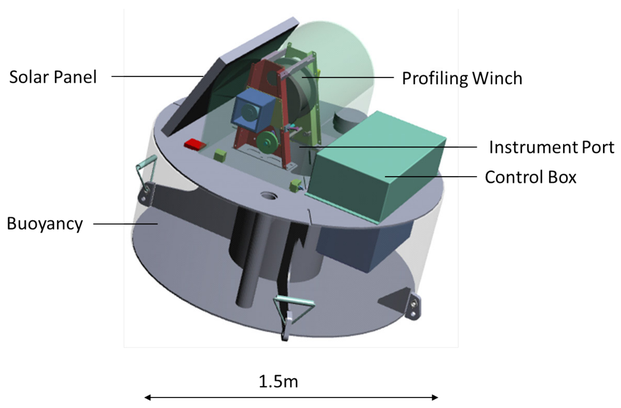

Figure 1. Overview of the profiling buoy design and components.

Table 1. Sensors included with the vertical profiling buoy

SENSOR TYPE	DESCRIPTION
Meteorology	Lufft WS502: Air temperature, relative humidity, barometric pressure, solar radiation, wind speed and direction (solar radiation can be optionally replaced with rainfall).
Temperature	Accuracy +/- 0.1 oC or better.
Dissolved oxygen	Hamilton Visiferm DO ARC
Chlorophyll fluorescence	Turner Designs Cyclops C7-C
Turbidity	Turner Designs Cyclops C7-T OR McVan Analyte

Data management

- Data is recorded by a HyQuest iRIS350FX datalogger, which also controls the profiler winch.
- Information is telemetered to HyQuest's HydroTel database and hosted via HyQuest's 'Global data Network', where it can be accessed by council staff and the general public.

Location

- The MMB is deployed in approximately 200m depth between Stony Point and Supply Bay, at the eastern end of the lake towards the outflow.
- This location captures the influence of all major inflows and is deep enough to represent lake dynamics, while still be sheltered from prevailing winds.
- Manual profiling data at this site dates back to 2008, providing useful context for future analyses.

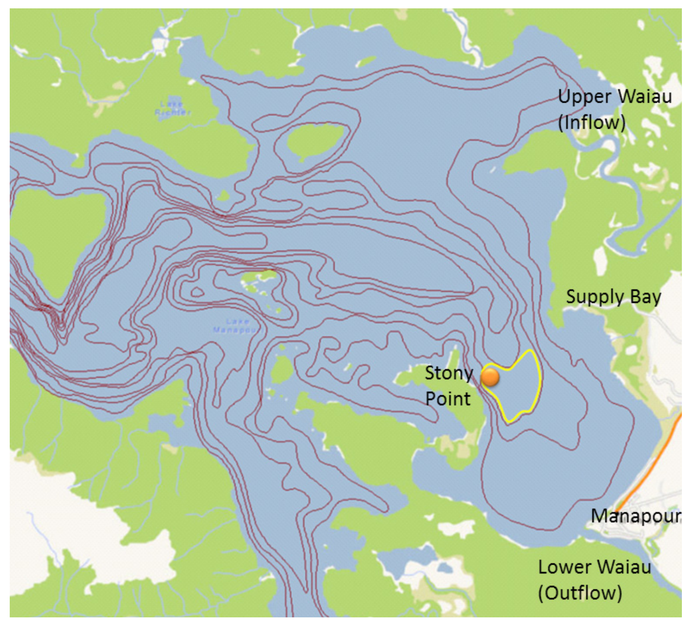

Figure 2. The deployment site on Lake Manapouri.

Mooring

- The MMB uses a three-point mooring system. This provides optimum stability and eliminates the possibility that the profiling cable becomes tangled in the mooring lines.
- Each arm is anchored with 3m of 40mm studlink chain connected to 10m of 16mm black chain. Approximately 200m of Dyneema synthetic rope attaches the mooring anchors to the surface buoy, which is chained to the monitoring instrument.
- Mooring arms are supported with a subsurface buoy for additional stability, and to prevent the line from slacking towards the profiling cable.
- Each arm was packaged in a 44 gallon drum for deployment. Chain was laid out on the deck of the deployment vessel before being lowered to the lake floor, using the vessel's bollards to control descent.

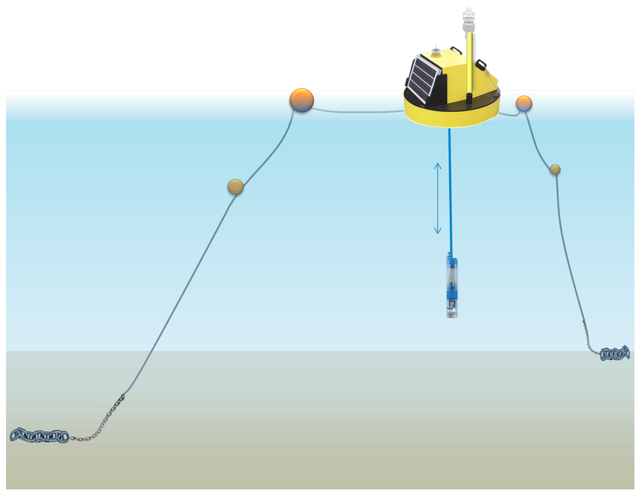

Figure 3. Mooring design for the Manapouri Monitoring Buoy (note that only two of the three arms are shown). Each arm has a subsurface buoy to prevent entanglement with the profiling cable.

Figure 4: Deployment of one of the mooring arms.

Example data

- The MMB has only recently been deployed so there are not enough data to present at this stage. It is anticipated that these high-frequency data will further the scientific understanding of fine-scale dynamics in glacial lakes, while also providing a tool to facilitate limit setting discussions with the local community.

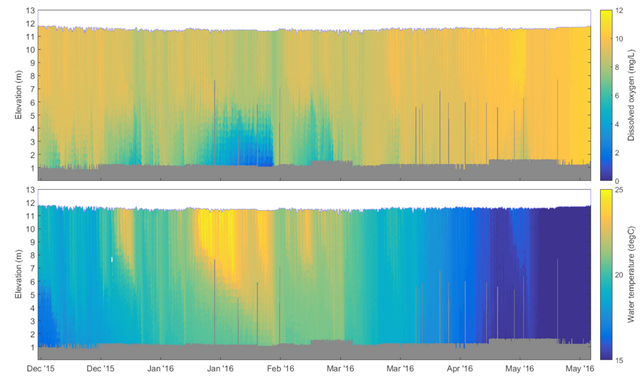

Figure 5: Example data for water temperature and dissolved oxygen from a water column profiling buoy at Lake Rerewhakaaitu, Bay of Plenty (data supplied by the University of Waikato and Bay of Plenty Regional Council).

Figure 6: The Lake Manapouri monitoring buoy, post deployment.