



Adam Hartland Roland Stenger

Lincoln Agritech, Hamilton
Aotearoa New Zealand

Adam.Hartland@lincolnagritech.co.nz
Roland.stenger@lincolnagritech.co.nz

How will rapidly rising atmospheric CO₂ concentrations affect freshwater systems?

Introduction

Exponentially rising atmospheric CO₂ concentrations have the potential to affect freshwater systems directly via gas exchange processes at the water/atmosphere interface and indirectly by modifying the terrestrial carbon input. However, the effects of changing carbon dynamics on water chemistry and ecosystem health are currently poorly understood (Fig. 1).

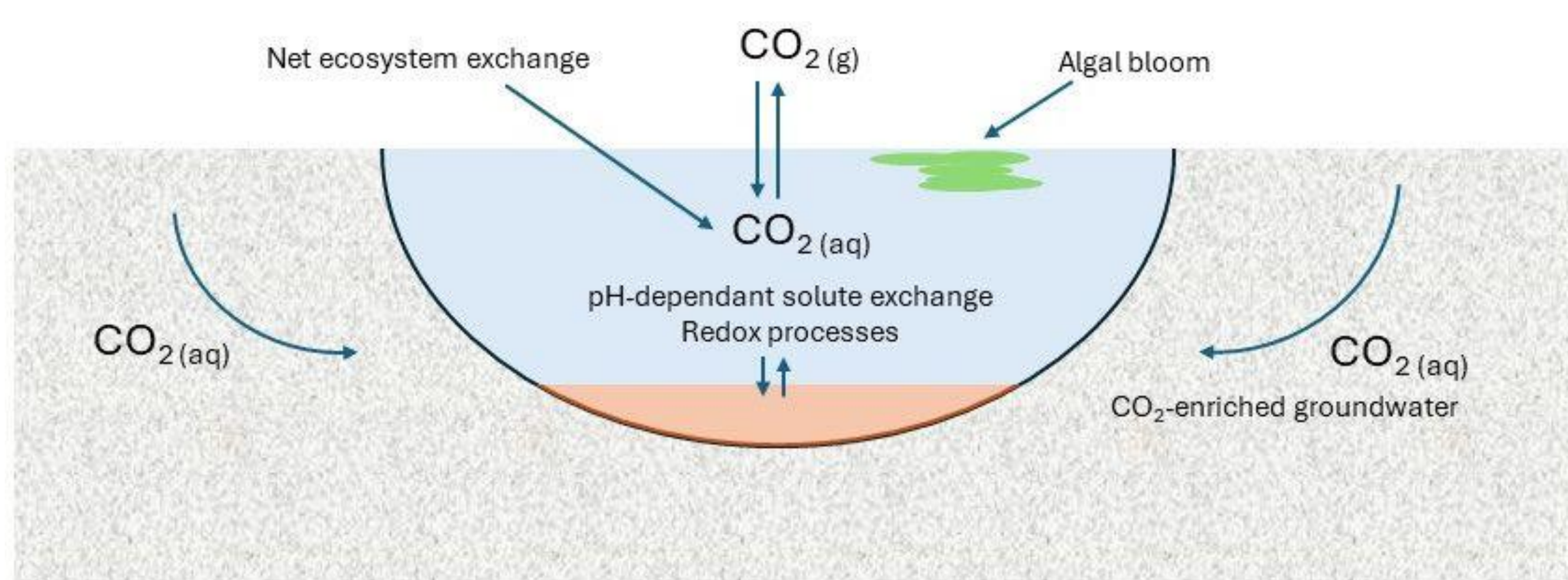


Fig. 1: Schematic illustrating the effects of ecosystem productivity and CO₂ exchange

Research Plan

Our research addresses fundamental questions concerning the relationship between CO₂ dynamics and water quality (i.e. pH, dissolved nutrients, carbonate saturation) and how future atmospheric CO₂ levels could influence phytoplankton (e.g. development of harmful algal blooms) and molluscs (e.g., kākahi, NZ freshwater mussels), (Fig. 2).

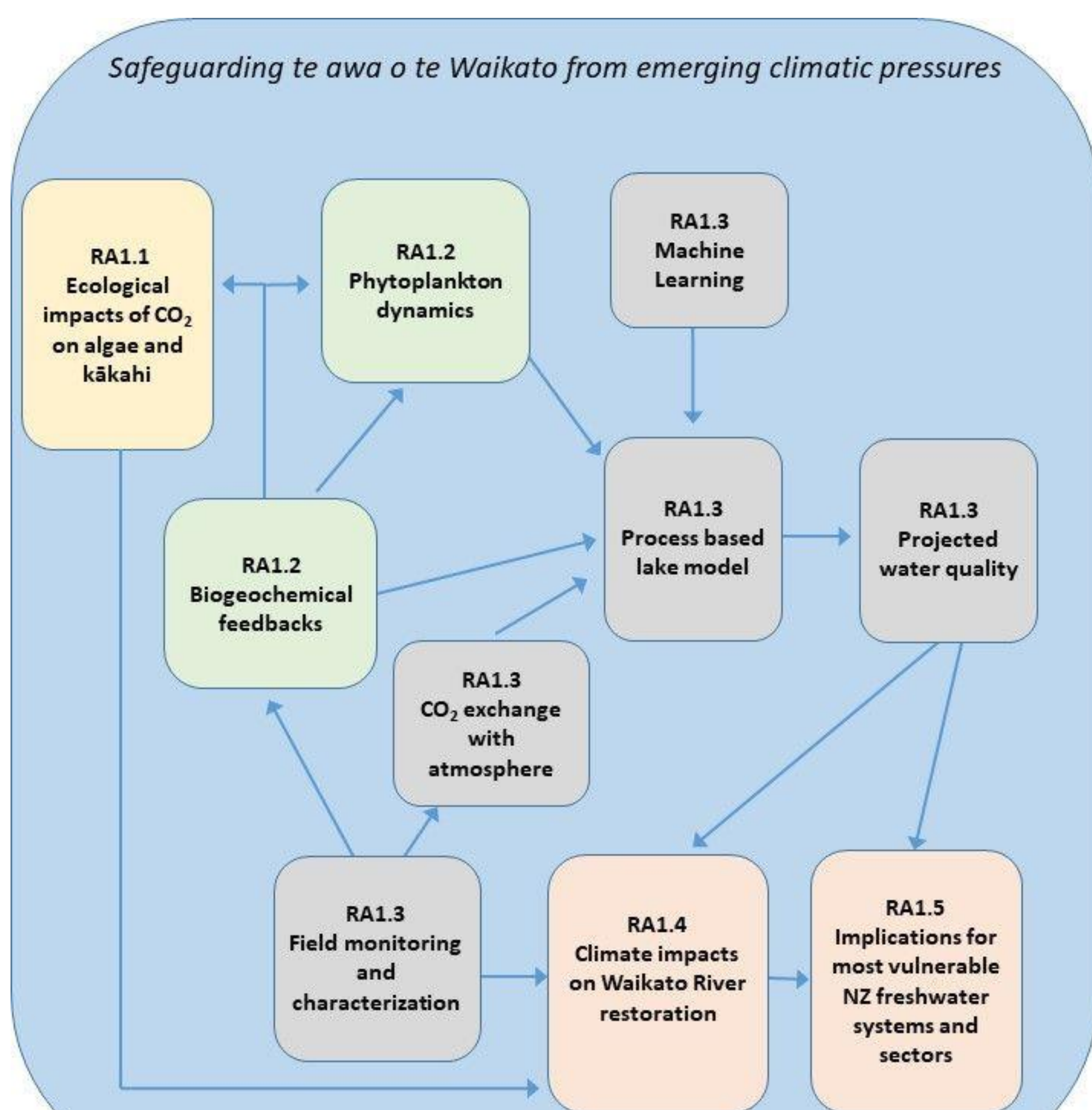


Fig. 2: Interacting lines of enquiry

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High-frequency monitoring



High-frequency monitoring focusses on four Waikato River sites, including two within Lake Karāpiro, a hydro lake created for electricity generation.

This stretch of river is intensively monitored using three sondes deployed from the shoreline and a buoy that enables vertical profiling to 22m depth.



The suite of sensors includes pCO₂, chlorophyll-a, CDOM, phycocyanin, DO, tryptophan fluorescence, and temperature.

Fig. 3: High-frequency monitoring using shoreline structure (top) or buoy (bottom)

The time series data (Fig. 4) and depth profiles (Fig. 5) will inform the development and validation of a mechanistic model of water quality and phytoplankton dynamics. This model will then help to predict the influence of climate change on water quality and explore the implications for long-term restoration plans of the iconic Waikato River, and freshwater systems more generally.

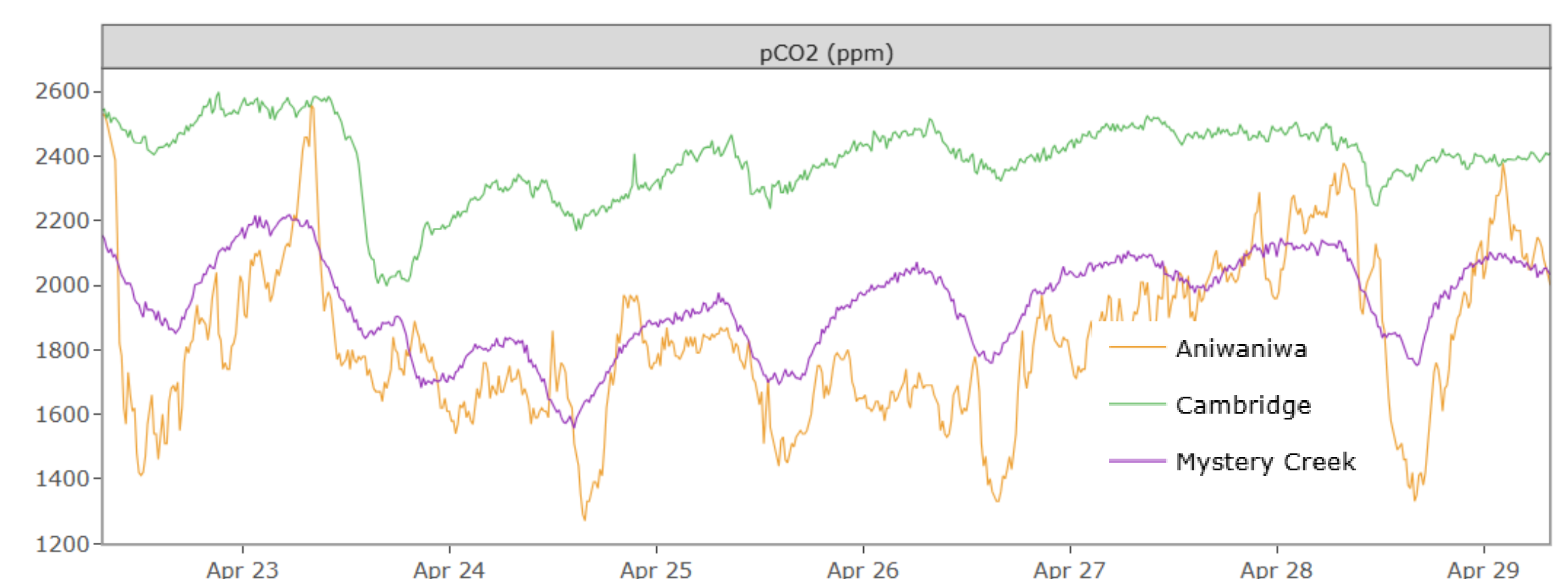


Fig. 4: CO₂ partial pressure time series for 7-day period (15 min frequency)

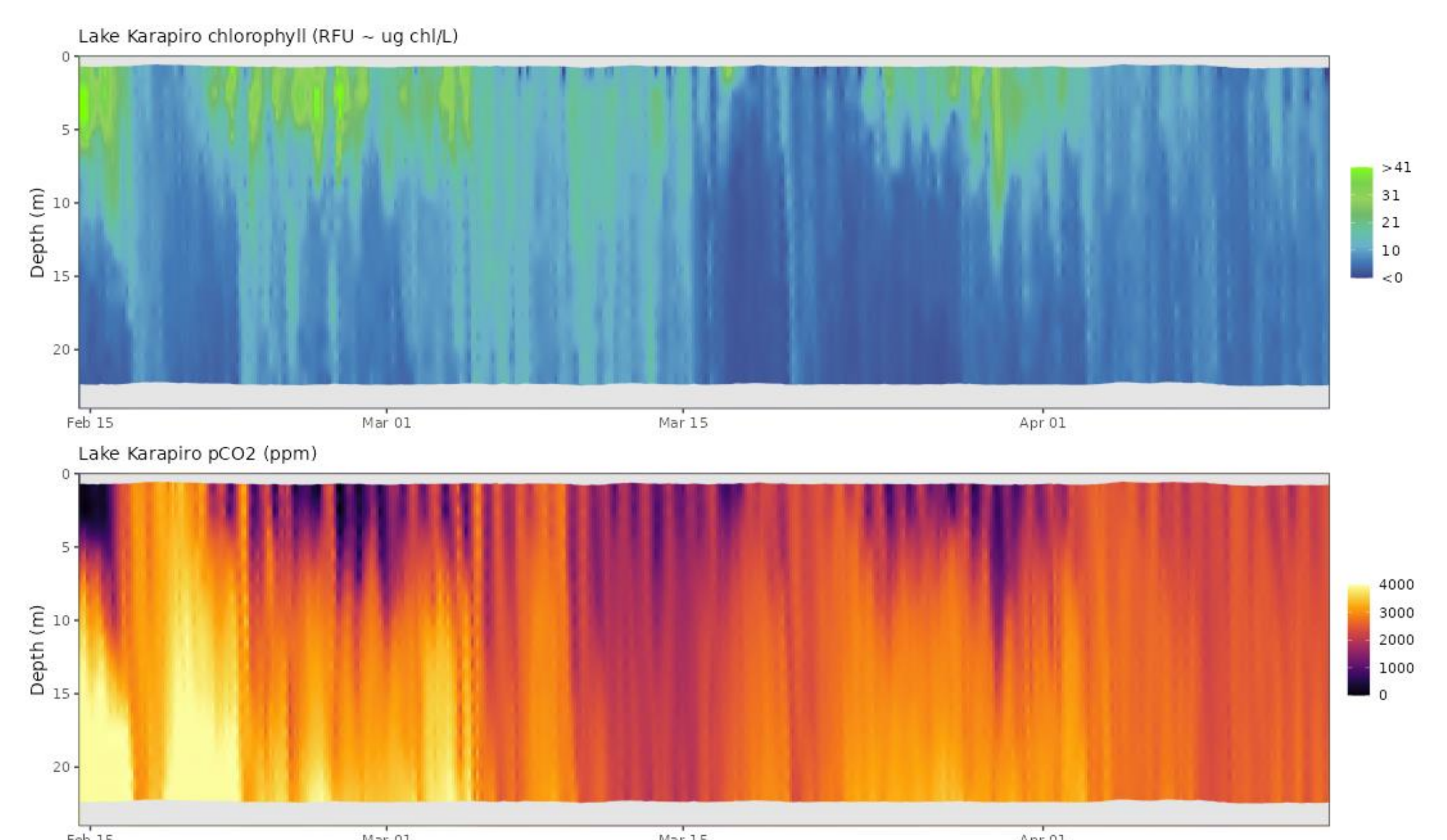


Fig. 5: Chlorophyll and CO₂ partial pressure depth profiles for 2-month period; recorded using buoy in Lake Karāpiro (4 hr frequency)

