# SIMULATION OF PHYTOPLANKTON RESPONSE TO STRONG WIND EVENTS IN LAKE VILLARRICA, CHILE

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Lake Villarrica is located in south central Chile, at the foot of the Andes Mountain Range (38° 18' S, 72° 05' W). Its altitude is 230 meters above sea level, its surface area is 176 $Km^2$ and its maximum depth is 167 m. The lake is regarded as monomictic and mesotrophic. Strong wind coming from the east is usually observed in the region. It corresponds to the kind of Foehn winds and is locally called "Puelche". Three or four Puelche events typically occur during summer time, when the lake shows a strong thermal stratification. The main goal of this study was to find out and simulate the response to the meteorological forcing created by Puelche events of the thermo-hydrodynamics and phytoplankton in Lake Villarrica. With this aim, a field study and numerical simulations using the software CE-QUAL-W2 were conducted. This software was selected due to its ability to solve the laterally averaged equations of motion and mass transport in water bodies such as lakes, linking them with a model for the dynamics of biochemical parameters including nutrients and phytoplankton biomass. Three groups of algae, most commonly found in Lake Villarrica were included in the model: diatoms and green and blue-green algae. These three groups are considered enough to accurately represent the dynamics of total phytoplankton within this lake. Chlorophyll-a associated with these algae was used as the main control parameter. Numerical simulations were carried out for the period of time extending from December 2003 to April 2004. During this same time span an automatic meteorological station was installed in the town of Pucón, by the east side of the lake, to complement meteorological data of an existing station. A month long campaign during February 2004 was also conducted to measure temperature profiles and other parameters at a station within the lake with intervals of about two days.

During the summer 2004, three episodes of Puelche wind were observed, between February 3rd and 6th, February 19th and 21st, and between March 10th and 11th. The basic characteristics in all of these wind events were the direction from the east and their high speed ($v_{max}$=13 m/s), in addition to an abnormally warm condition ($T_{max}$=35°C) and an abrupt reduction in the relative humidity to about 10%.

Fig. 1 shows results of the numerical simulations, forced by the registered meteorological data, averaged over horizontal planes within the lake. Horizontally averaged, vertical profiles of temperature, DO, total nitrogen, $PO_4$, and chorophyll-a are plotted as a function of time during the period of simulation. Vertical dashed lines indicate the occurrence of Puelche events. It is observed that by mid-December the nutrient input by the main inflow is transported by an intermediate density current towards the seasonal thermocline, product of the lower temperature of the inflow (12° C) with respect to the temperature of the surface layer of the lake (about 20° C). This is translated into an increase in the phosphorous concentration in the intermediate layer, and a decrease of this concentration in the surface layer due the presence of algae (Fig. 1d). Total nitrogen, however, increases in the surface layer because of the presence of algae (Fig. 1c). In January, the maximum concentration of algae is located approximately at a depth of 15 m (Fig. 1e), since phosphorous has been exhausted at the surface. This effect, added to the poor light conditions below the depth of 15 m and the advancement of the summer season, determines that the growth of algae is limited although phosphorous exists in excess in this region. By the end of January, temperature and irradiance decrease creates conditions for the continuous reduction in the concentration of phytoplankton biomass during the late part of the summer. Nevertheless, the model predicts that Puelche episodes during February and March helps increasing the surface concentration of phosphorous, which creates conditions to generate algal blooms after each one of the events (Figs. 1e). Lake Villarrica appears then to be more vulnerable to eutrophication than nearby lakes not affected by this meteorological phenomenon.

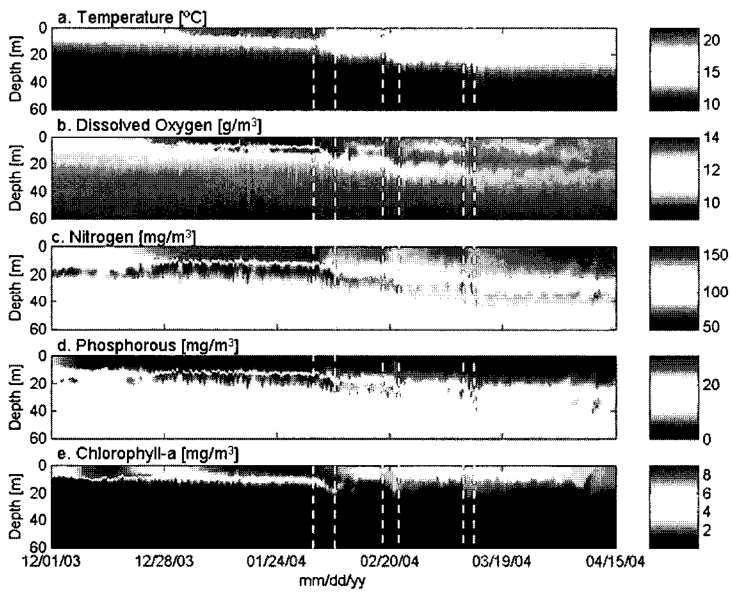


Fig. 1 Simulated time series of vertical profiles of physical and biochemical parameters.