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Development of thermal stability curve to forecast water column stratification

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Lakes are lentic environmental with unique hydrodynamic, which depends on the morphology, in and outflows, and atmospheric variables. This last driving force has its influence represented, mostly, by radiation and wind. All the interactions in the water column are harmed when the water column is divided into layers with different densities.

This condition means no gas or nutrients exchanges, impairing the food channel, and oxygen availability across the lake. Lakes and reservoirs play a key role for the development of populations, industries, human activities that need water, and also as a landscape component, this context increases the necessity to ensure its availability during the year. In this perspective, the interest in understanding lakes' hydrodynamics and their effects on the water quality grew, aiming for appropriate management of the reservoirs and contributing areas.

To collaborate with the knowledge in this area this research intended to improve the reservoir operator's capacity to forecast situations that can compromise their uses. This objective was achieved by investigating the possibility of a functional relationship between the atmospheric forces and the lake thermal status changing.

Stratification can be postulated as an energy balance considering the energy incident from solar radiation and the kinetic energy transferred by the wind in terms of the surface wind-drag force. The lake's thermal conditions can be affected when an instability factor is inserted in the system. The wind's speed fluctuation produces the instability that transfers an amount of energy to the water column, provoking oscillations on the isothermals or internal waves.

A curve that represents this concept was constructed by crossing high-frequency field data from four lakes from two proxies, S* Rad-1 and W* S^{*-1}. The proxies describe the effectiveness of energy transfer from the atmospheric to the water column, and so, which is the ruling energy on balance at the moment. The variables included in it are **Rad** (total amount of the incident radiation on the last 24h ($J\ m^{-2}$)); **W*** (mean of the wind's speed variance in a time window ($m\ s^{-1}$), multiplied by the air density ($kg\ m^{-3}$) and the lake's depth (m)); and the **S*** (Schmidt Number mean of the last 24h ($J\ m^{-2}$)).

The determined curve represents the thermal condition of the lake as a balanced result of the external variables and potential energy contained in the water column. This tool was able to represent the lakes' thermal status rapidly and well, with little data information. Its performance was tested against most known lakes' indices (Lake Number and Wedderburn Number) presenting more accurately with fewer data. Those outcomes allow an improvement to the reservoirs' management tools and operations.