EGU21-2970
https://doi.org/10.5194/egusphere-egu21-2970
EGU General Assembly 2021

The influence of water depth and forcing factors on the performances of Machine Learning approaches for the simulation of lake surface water temperature

Azadeh Yousefi[1] and Marco Toffolon[2]
[1]Trento university, Civil and environmental engineering, Trento, Italy (azadeh.yousefi@unitn.it)
[2]Trento university, Civil and environmental engineering, Trento, Italy (marco.toffolon@unitn.it)

Some attempts to predict water temperature in lakes by means of machine learning (ML) approaches have been pursued in recent years, relying on the performances that ML showed in many different contexts. The existing literature is focused on specific applications, and does not provide a general framework. Therefore, we systematically tested the role of different forcing factors on the accuracy of the simulation of lake surface water temperature (LSWT), comparing ML results with those obtained for a synthetic case study by means of a physically-based one-dimensional model, GLM. Among the available supervised ML tools, we considered artificial neural network (ANN) with back propagation, one of the most common and successful methods.

In our modelling exercise, we found that the two most important factors influencing the ability of ML to predict LSWT in temperate climates are air temperature (AT) and the day of the year (DOY). All the other meteorological inputs provide only minor improvements if considered additionally to AT and DOY, while they cannot be used as single predictors. The analysis showed that an important role is played by lake depth because a larger volume per unit of surface area implies a larger heat capacity of the lake, which smooths the temporal evolution of LSWT. Such a filtering behaviour of deep lakes is not reproduced by standard ML methods, and requires an ad hoc pre-processing of AT input, which needs to be averaged with a proper time window. Moreover, while shallow lakes tend to be relatively well-mixed also in summer, deeper lakes can develop a strong stratification that tends to isolate the surface layer, modifying the thermally reactive volume and thus affecting the temporal evolution of LSWT. These considerations suggest that the physical dynamics of lakes, and especially of deep lakes, needs to be carefully considered also when adopting “black-box” approaches such as ML.