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A simplified model for a warning system of harmful algal blooms in lakes, application to Grangent reservoir (France)

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Potentially harmful phytoplankton blooms have occurred more frequently in lakes in the last decade. Lake managers need monitoring and warning systems to forecast the risk of cyanobacteria proliferation at the depth of the main lake usages, e.g. at the surface for bathing and recreational activities and at the depth of the water intake for drinking water production or irrigation.
An autonomous monitoring and warning system was recently developed in the PROLIPHYC research project (funded by the sustainable development programme (PRECODD) of the French national agency for research (ANR)). Temperature, chlorophyll-a fluorescence at five excitation wavelengths and dissolved oxygen concentration are measured every 30 min at two target depths alternatively. Metric vertical profiles are measured up to four times a day between these positions. Meteorological data are measured every 30 min: air temperature, pressure and humidity, solar radiation, wind speed, rain. The bio-fouling protection of the sensors by in-situ daily chlorination enables the maintenance period to be as high as 3 months. Measured data are transmitted daily by GPRS to the onshore laboratory. They are automatically filtered, formatted and processed by a coupled physically-based ecological model. Status and predictive indicators, like the concentration and growth rate of cyanobacteria, are computed from the simulation results and displayed on a user interface. When a phytoplankton bloom is forecasted, a warning message is automatically sent to the lake manager.
This presentation focuses on the use of the one-dimensional coupled model DYRESM-CAEDYM for the short-term simulation of the cyanobacterium Microcystis aeruginosa dynamics in Grangent reservoir, located on the Loire river in France. Contrary to long-term studies with this complex model on large and extensively-monitored lakes like Constance or Kinneret, we chose to restrict input data to those available in real time and to limit as much as possible the number of calibration parameters. The selected biological processes are the growth, respiration, death and vertical migration of cyanobacteria. They are described as functions of water temperature and incident solar radiation only. Nutrients are supposed to be unlimiting factors in the short term. In summer, the reservoir is kept full and the effect of the river flow on phytoplankton dynamics in the epilimnion can be neglected. Therefore, the forcing data reduce to the local weather forecast (air temperature, nebulosity and wind speed), available on the website of the national weather service Meteo France. Initial conditions are the vertical profiles of water temperature and cyanobacteria concentration measured by the buoy.
To assess the efficiency of this simplified model, the results of simulations based either on the meteorological observations at the nearby airport or on the local weather forecast are compared to the buoy measurements for the same time period. The model describes correctly the trend of the cyanobacteria concentration. We expect the system to be robust enough and easy for an engineering consultancy to be set up on other lakes with comparable characteristics.