Modeling algae growth: coupling strategy and data assimilation

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Cultivating oleaginous microalgae in specific culturing devices is seen as a potential source of biofuel for the future. The complexity of this process coupling non linear biological activity to hydrodynamics makes the optimization problem very delicate. The large amount of parameters to be taken into account paves the way for a useful mathematical modeling.

Due to the high heterogeneity of raceways (small circular ponds whose water is driven into motion by a paddlewheel) along the depth dimension regarding temperature, light intensity or nutrients availability, we adopt a multilayer approach for hydrodynamics and biology.

For hydrodynamics, we use a multilayer Saint-Venant model that allows mass exchanges, forced by a simplified representation of the paddlewheel. Then, starting from an improved Droop model that includes light effect on algae growth, we derive a similar multilayer system for the biological part. A kinetic interpretation of the whole system results in an efficient numerical scheme. Results are given in 2D and 3D.

Afterwards, we develop a new theoretical framework for data assimilation on hyperbolic conservation laws. It is based on the nudging technique but it is applied on the kinetic description of the PDEs. We show numerical results on Burgers and Saint-Venant equations.