ATP³ Algae Testbed Public-Private Partnership

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Algae Growth Model of *Nannochloropsis* in Lab, Greenhouse, and Raceway

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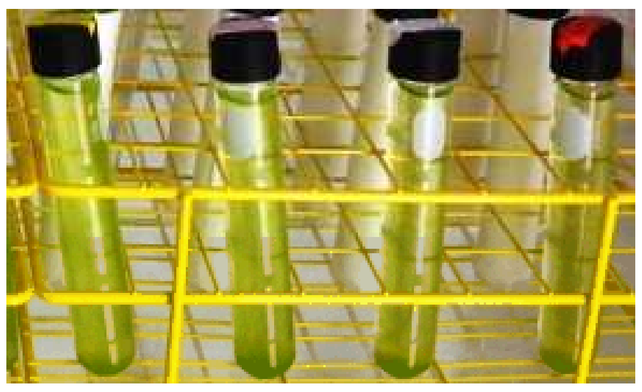
- We need to be able to optimize algae growth and lipid production in large commercial scale systems
- It is time consuming and expensive to test solutions at commercial scale
- A computational model facilitates faster and cheaper optimization
- This study shows model validation and scalability

– Models algae growth based on constitutive relations
  B – biomass concentration (g/m³)
  P – growth rate (1/d)
  B_M – metabolism rate (1/d)
  P_R – predation rate (1/d)
  P_M – max growth rate (1/d)
  f – growth limiting constitutive relations ($0 \le f \le 1$)

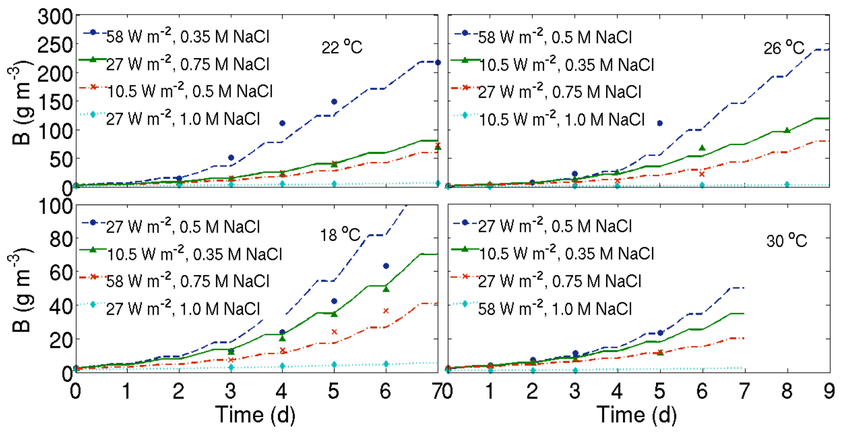
$$\frac{\partial}{\partial t}B(\mathbf{x},t) = \left(P - B_M - P_R\right)B(\mathbf{x},t) + \frac{B_L}{V}$$

$$P = P_M \cdot \left[f_1(N) f_2(I) f_3(T) f_5(S)\right]$$

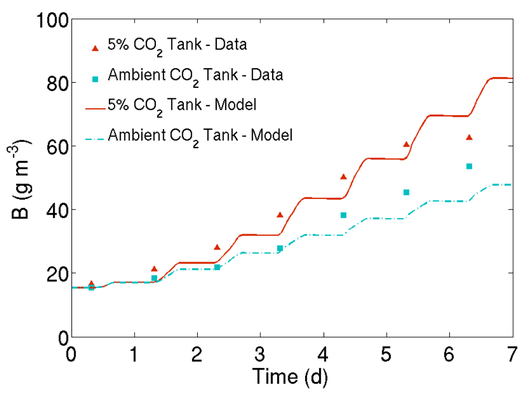
– Tracks nutrients, salinity, temperature, light, CO_2 and O_2
– Allows for sources and sinks of parameters

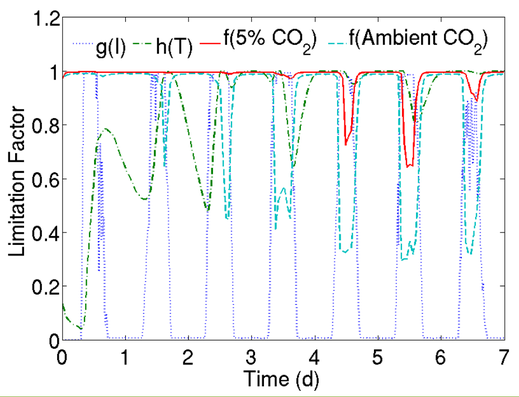


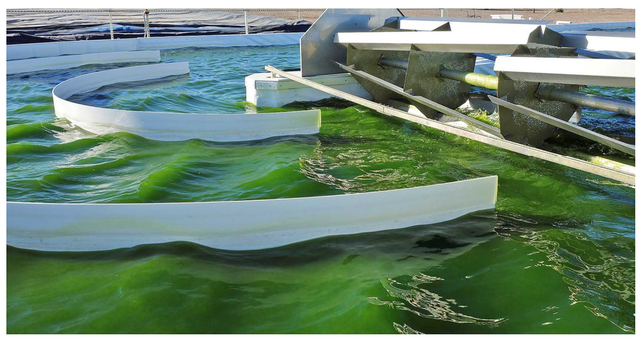
- Model is calibrated by lab scale data of *Nannochloropsis* growth
- Parametric study conducted to determine effect of light, temperature, and salinity on growth rate
- Results verified by comparing model to growth data



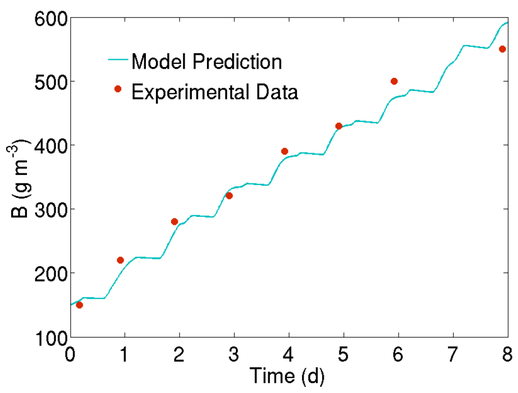
- Calibrated model is applied to greenhouse tank experiment
- Two tanks with differing bubble CO_2 concentrations analyzed
- Model correlated well to data
- Key parameters limiting growth were identified as temperature and CO_2

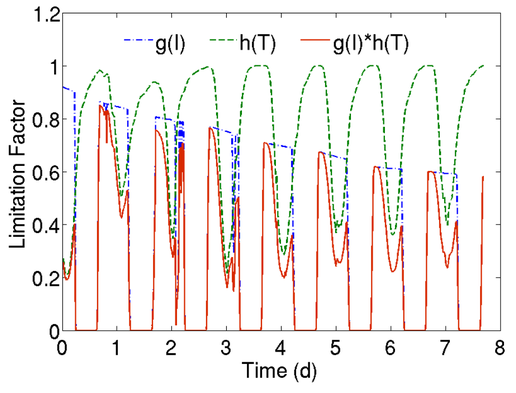






- Calibrated model is applied to open channel raceway experiment
- Model correlated well to data
- Key parameter limiting growth was identified as temperature





- The laboratory-parameterized model was scaled up to simulate two larger, outdoor experimental studies.
- The model accurately predicted the growth trends in greenhouse tanks and an open-channel raceway.
- The model was used to determine which environmental factors are most limiting to growth.
- This model could be used to study the scale-up effect comparing the lab-scale kinetics to larger scale systems including the effects of predation, depth-decay of light, optimized nutrient and CO_2 delivery, and pond design.
- As multifactorial data are accumulated for many algal strains, the model could be used for strain selection for various geographic and climatic locations.

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