On the possible FLake model ecological applications

by

Sergey Golosov[1], Katerina Shipunova[1], Ilia Zverev[1], Arkadiy Terzhevik[2] , Georgiy Kirillin[3] , Cristoff Engelhardt[3] and Dmitriy Mironov[4]

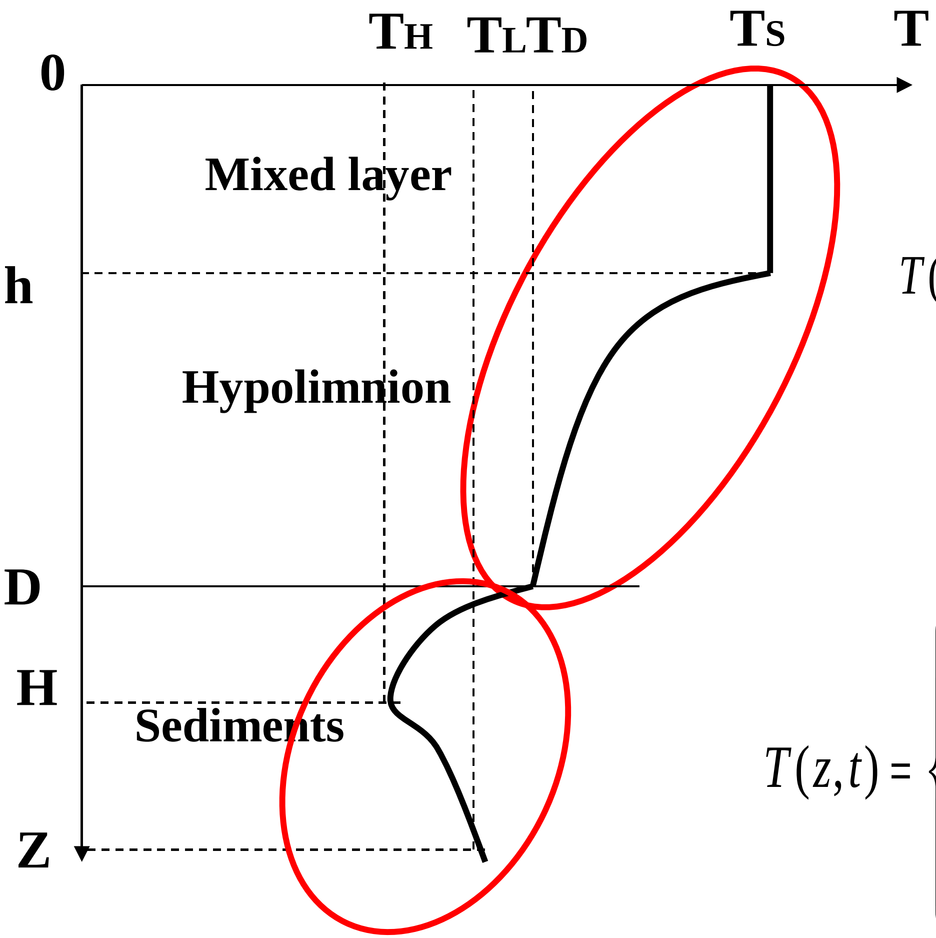
[1] **Institute of Limnology RAS (St-Petersburg)**
[2] **Northern Water Problems Institute RAS (Petrozavodsk)**
[3] **Institute of Freshwater Ecology and Inland Fisheries (Berlin)**
[4] **German Weather Service (Frankfurt-on-Main)**

OUTLINE

- FLake as the base of ecological model FLakeEco
- FLake and FLakeEco as “ideological twins”
- Feedbacks between FLakeEco and FLake
- Future trends in FLakeEco development

Output parameters of the FLake model	Ecosystem processes in the FLakeEco
I(z,t) – incoming solar radiation	***PP*** – phytoplankton primary production
QS, QD –surface and water – bottom heat fluxes	***ME*** – mass exchange at the boundaries
U* – friction velocity at the water surface	***ME*** – mass exchange within the water column
T(z,t) – temperature profile	***BR*** – biochemical reactions
h ,(D-h) – mixed layer and hypolimnion thickness	***SD*** – spatial distribution of populations
t_{ice} ***and*** l_{ice} - duration of ice-covered period and ice thickness	***OD, PP*** – oxygen depletion and primary production in winter

Basic parameterizations of the Flake model



$$T(z,t) = \begin{cases} T_S & 0 \le z \le h \\ T_S - (T_S - T_D) f_1\left(\frac{z-h}{D-h}\right) & h \le z \le D \end{cases}$$

$$T(z,t) = \begin{cases} T_D - (T_D - T_H) f_2\left(\frac{z-D}{H-D}\right) & at\ H \le z \le D \\ T_H + (T_L - T_H) f_3\left(\frac{z-H}{L-H}\right) & at\ L \le z \le H \end{cases}$$

Functions f_1, f_2, f_3 should be experimentally defined

Ecological applications of the FLake ideology

Typical vertical distribution of “admixture” concentration

↓

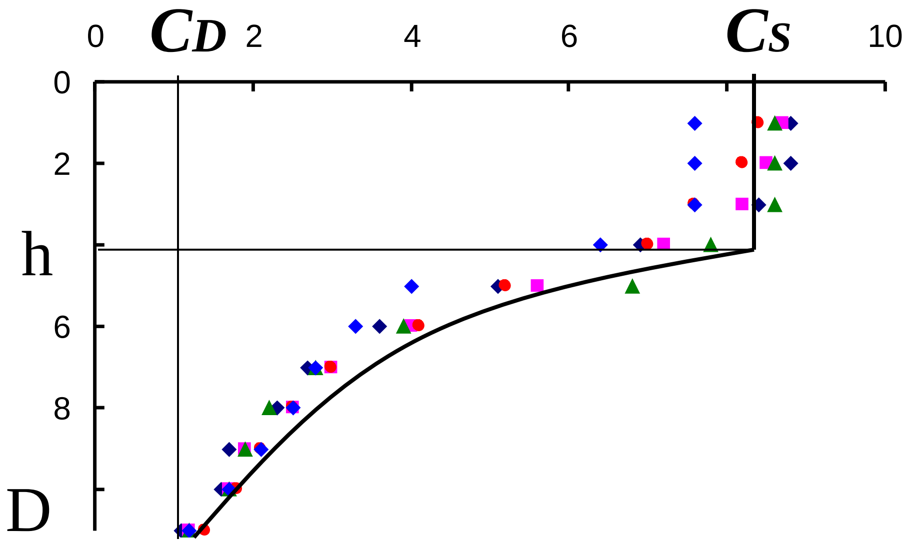
Parametrical representation of the profile

↓

FLake based solution of the equation of non-conservative admixture transfer

Annual dynamics of DO concentration in lakes

Typical distribution
(data from summer
2003 field campaign
In Lake Vendyurskoe
(Russia)

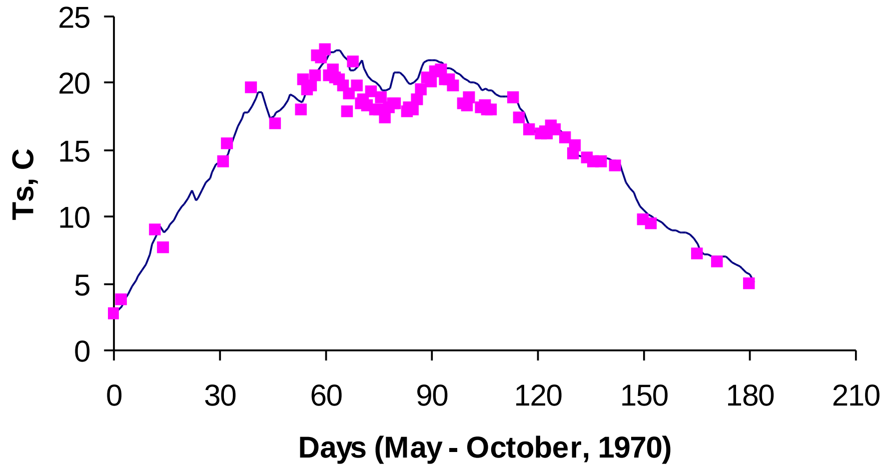


The profile parameterization

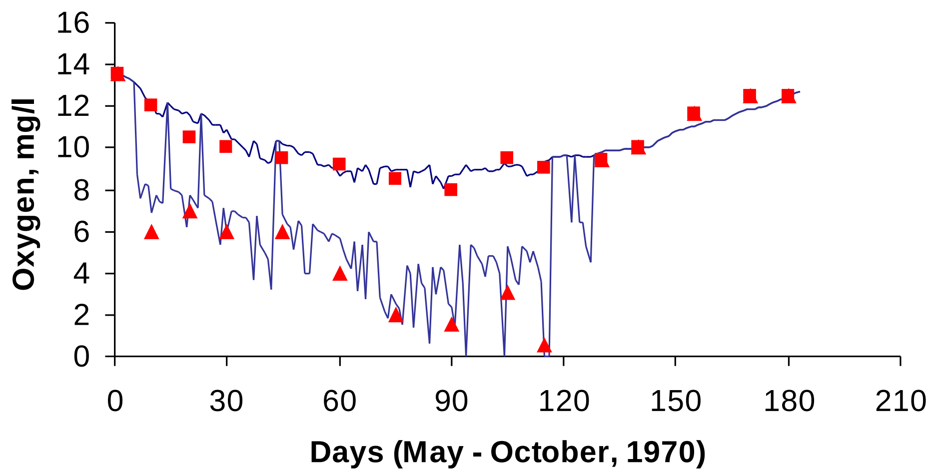
$$C(z,t)=\begin{cases} C_S & \textit{within the mixed layer} \\ C_S-(C_S-C_D)\,f_{DO}\left(\dfrac{z-h}{D-h}\right) & \textit{below the mixed layer} \end{cases}$$

Results of modeling, Lake Krasnoye, (Russia, 1970)
Open water case

Mixed layer temperature (from FLake model)

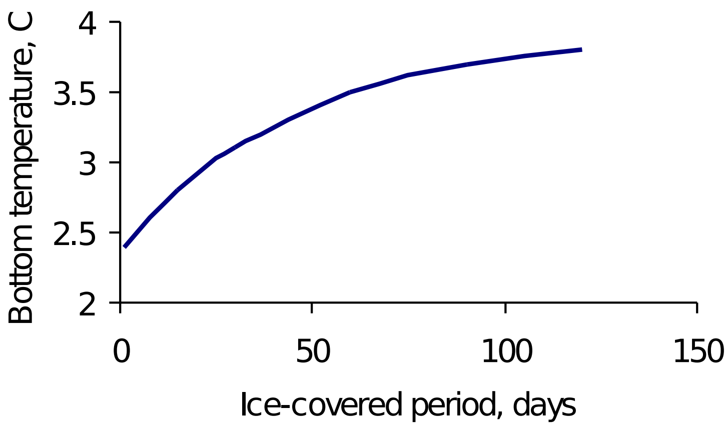


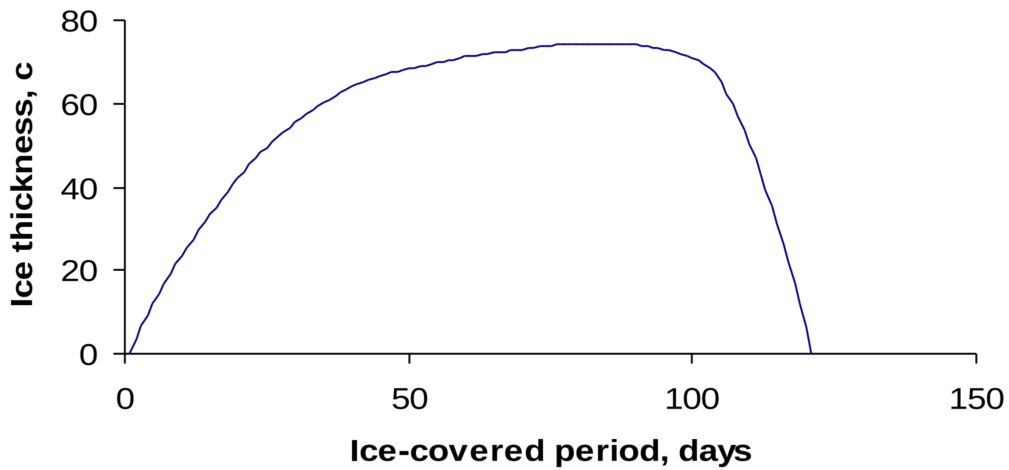
DO distribution dynamics



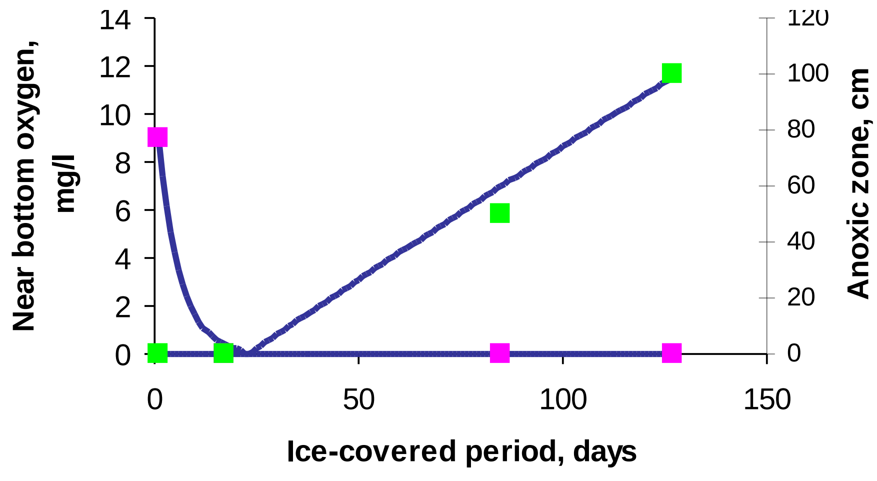
Results of modeling, Lake Vendyurskoe, (Russia, 2002) Ice-covered case

Temperature and ice from FLake model





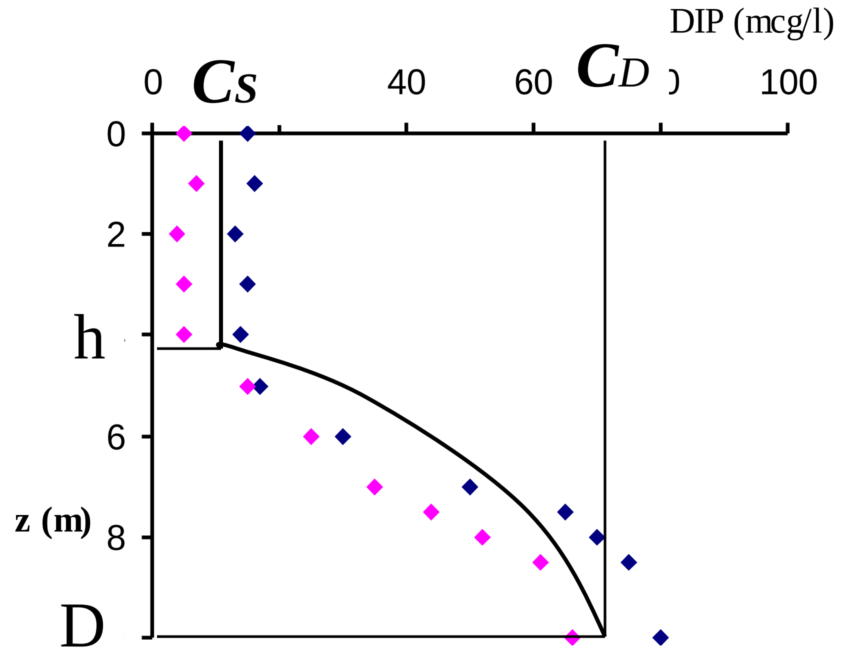
Development of anoxic zone at 11.5 m depth



- DO concentration
- Anoxic layer thickness
- Modeled results

Annual dynamics of Dissolved Inorganic Phosphorus (DIP) in lakes

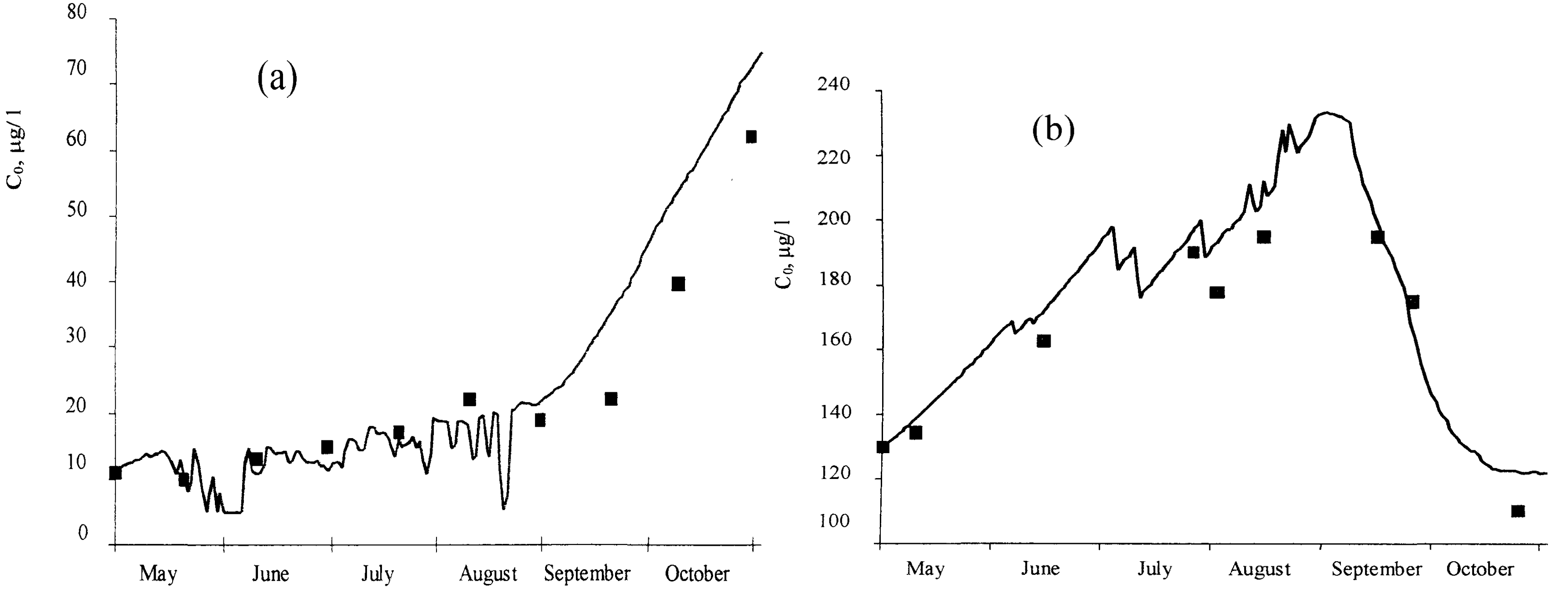
Typical distribution
(data from summer
1970-71 field observations
in Lake Krasnoye (Russia)



The profile parameterization

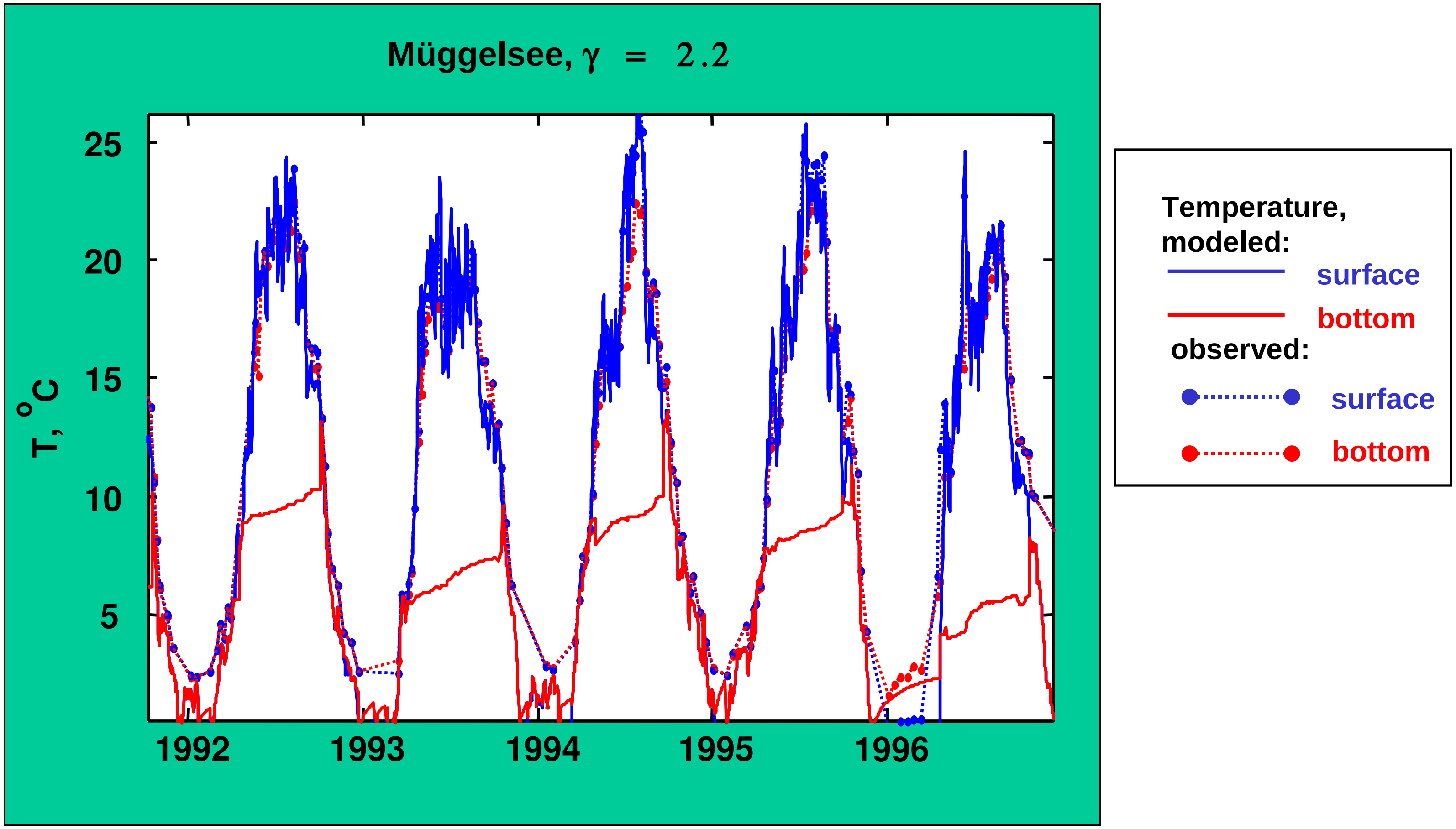
$$C(z,t) = \begin{cases} C_S & \textit{within the mixed layer} \\ C_S + (C_D - C_S)\, f_{DIP}\left(\dfrac{z-h}{D-h}\right) & \textit{below the mixed layer} \end{cases}$$

Results of modeling, Lake Krasnoye (1970)



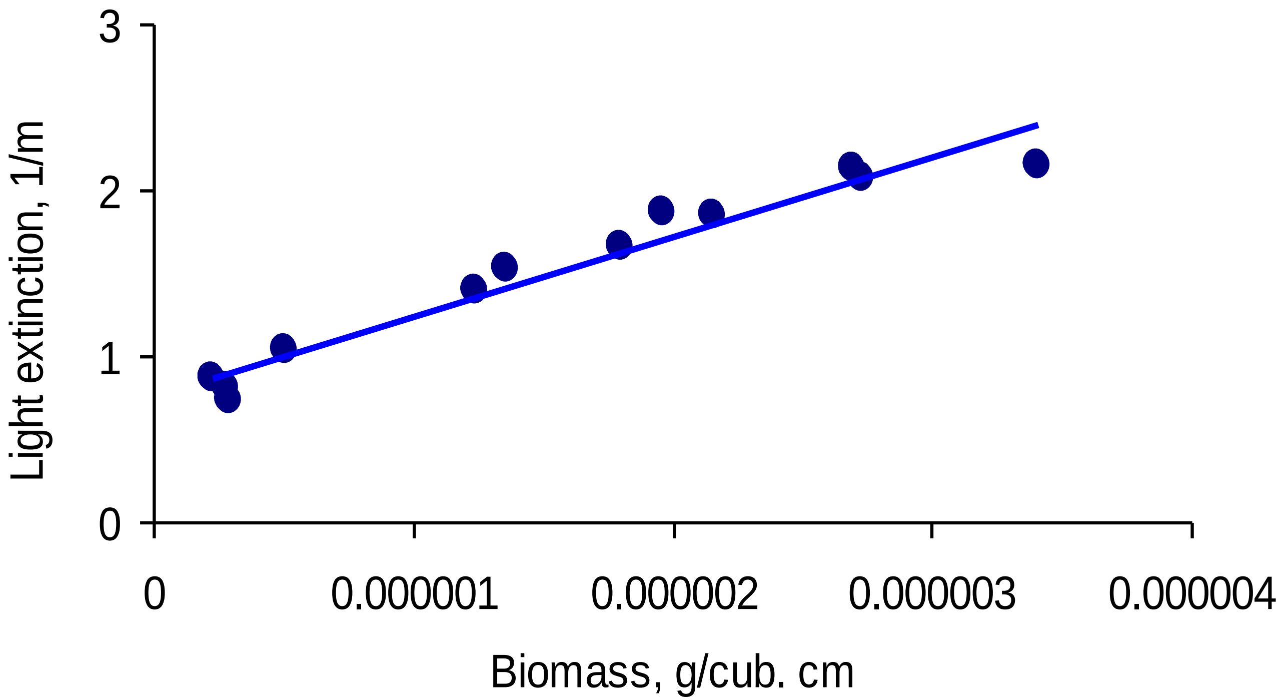
The DIP concentration in the lake’s upper mixed layer (a) and in the upper sediments (b)

On the possible feedbacks between FLakeEco and FLake (effect of transparency decrease)



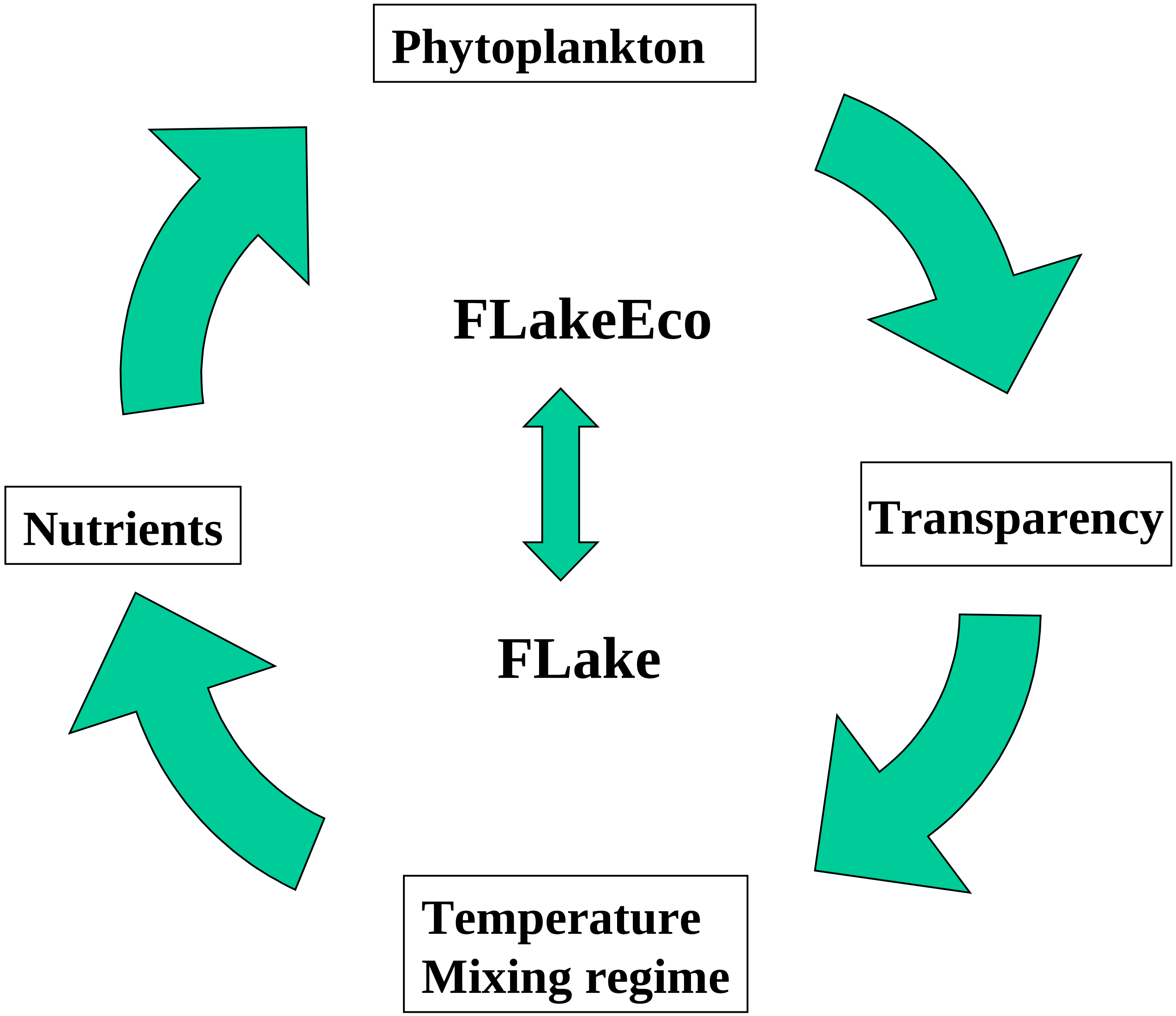
Light extinction variability strongly impacts the lake thermal and mixing regime

Seasonal variability of light extinction



Constant γ could be a source of poor modeling results (mixing over- or underestimation)
Primary production should be taken into account as a source of transparency variability at the lake thermohydrodynamics modeling

Scheme of the feedbacks

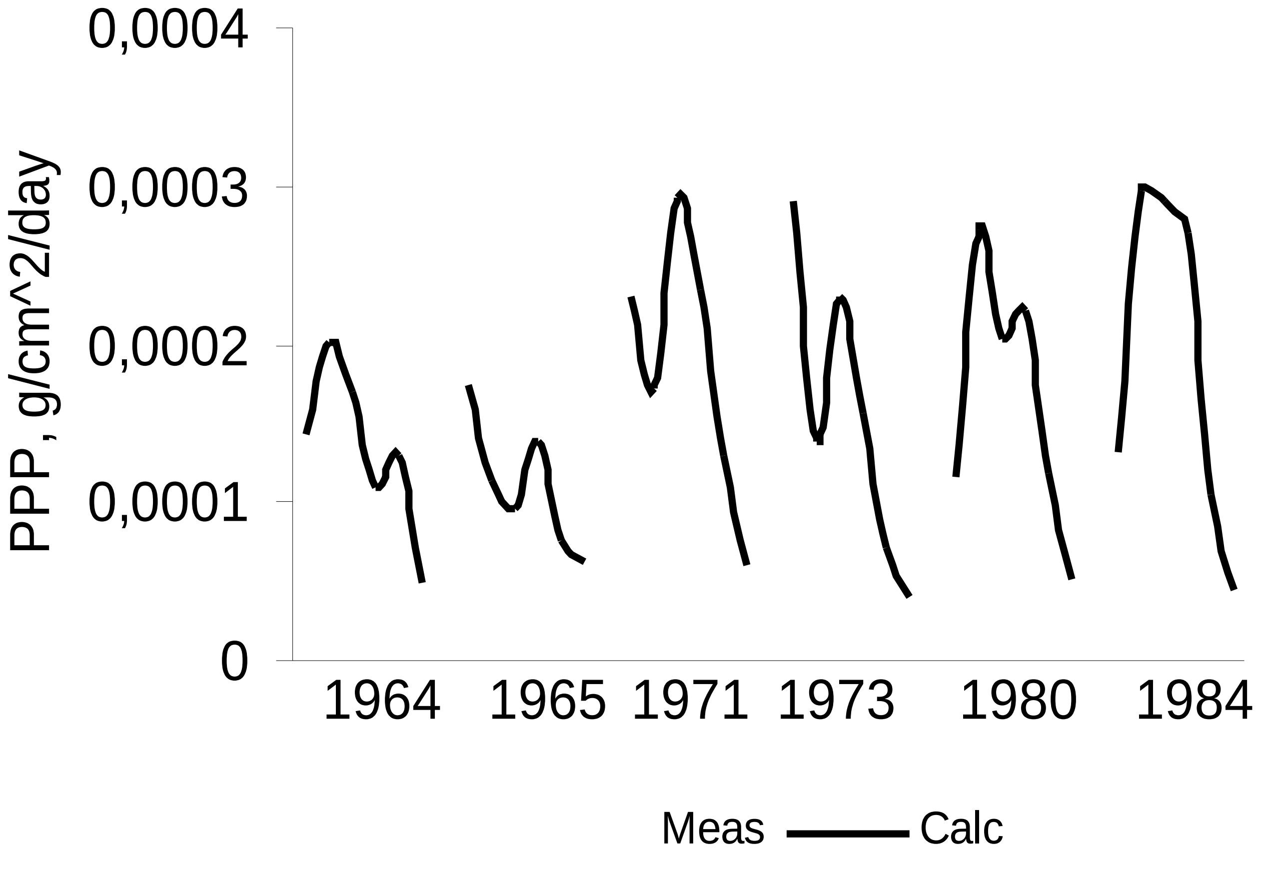


Future trends in FLakeEco development

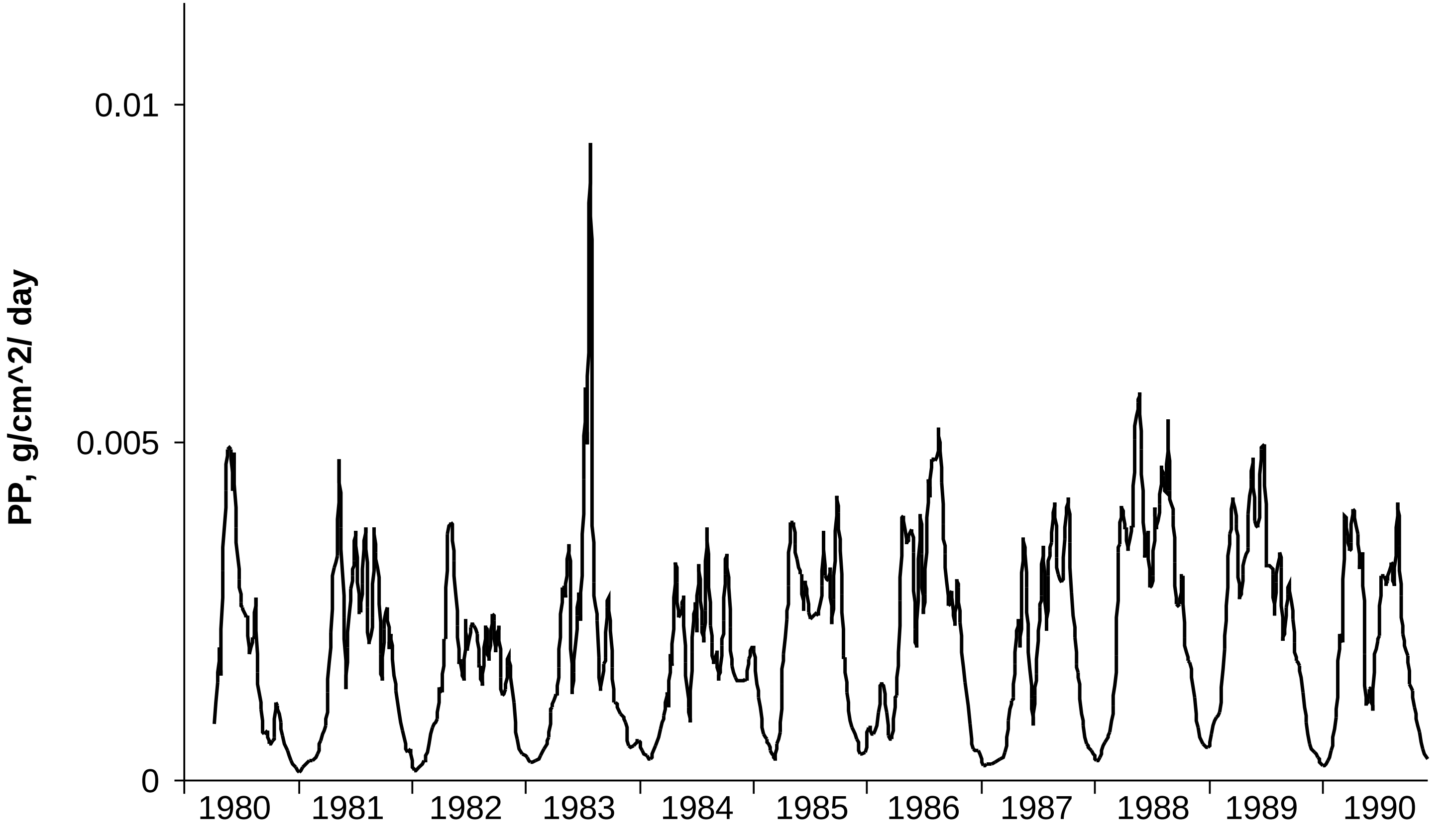
- To test the FLakeEco against data from lakes of wide range of trophic state
- Further development of biochemical module of the model (multi species phytoplankton community, widening of the nutrient variables list, etc.)
- Taking into account presence of feedbacks between FLake and FLakeEco to develop a single whole computer code for both models

Thanks
for your attention!

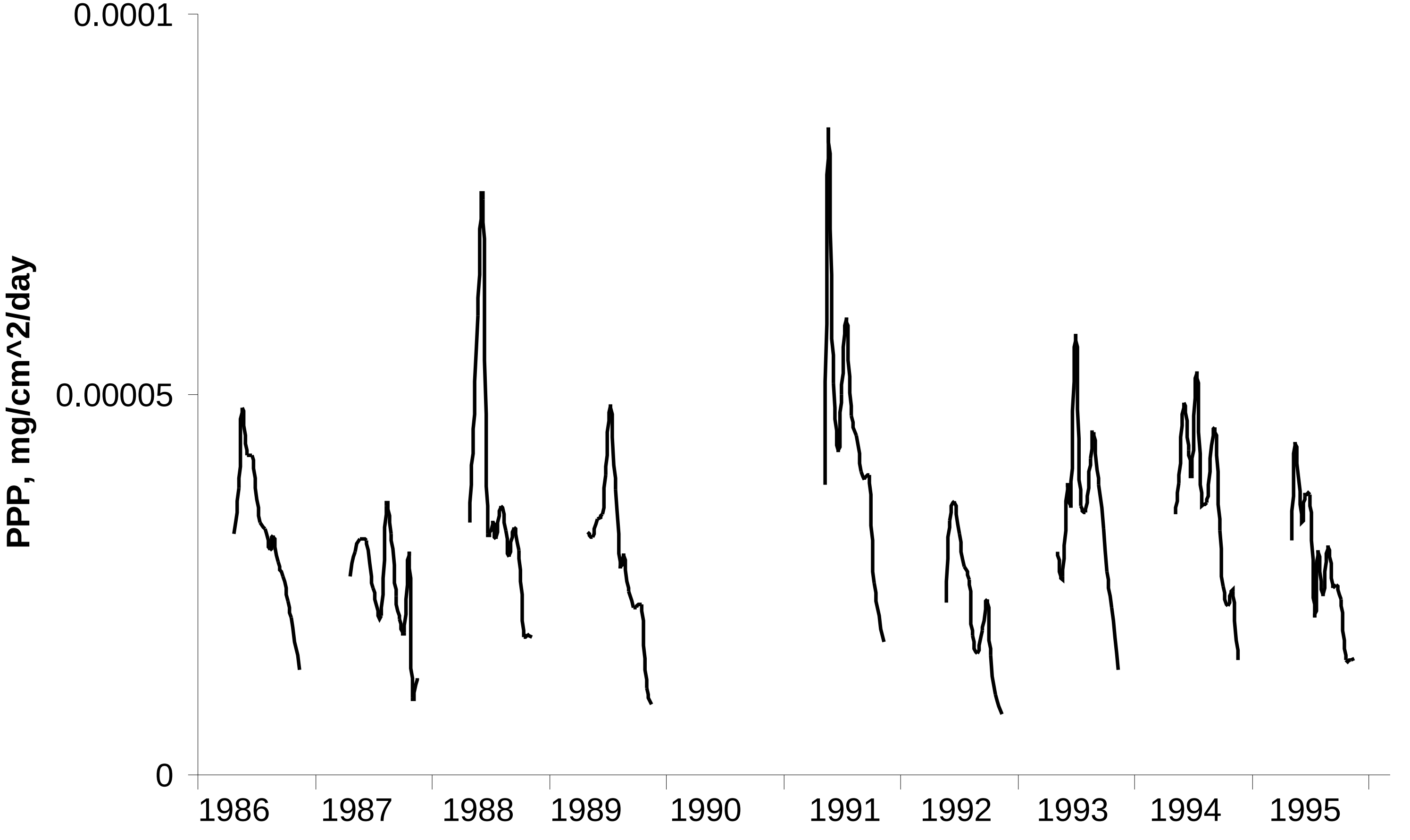
Mesotrophic Lake Krasnoye, Karelian Isthmus, Russia, 60 °N



Eutrophic Lake Müggelsee, Berlin, Germany, 53 ^{O}N



Olygotrophic Lake Sparkling, Northern America, 46 ON



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