Future climate scenarios for phosphorus and nitrogen dynamics in the Gulf of Riga

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Latvian Institute of Aquatic Ecology

KALME
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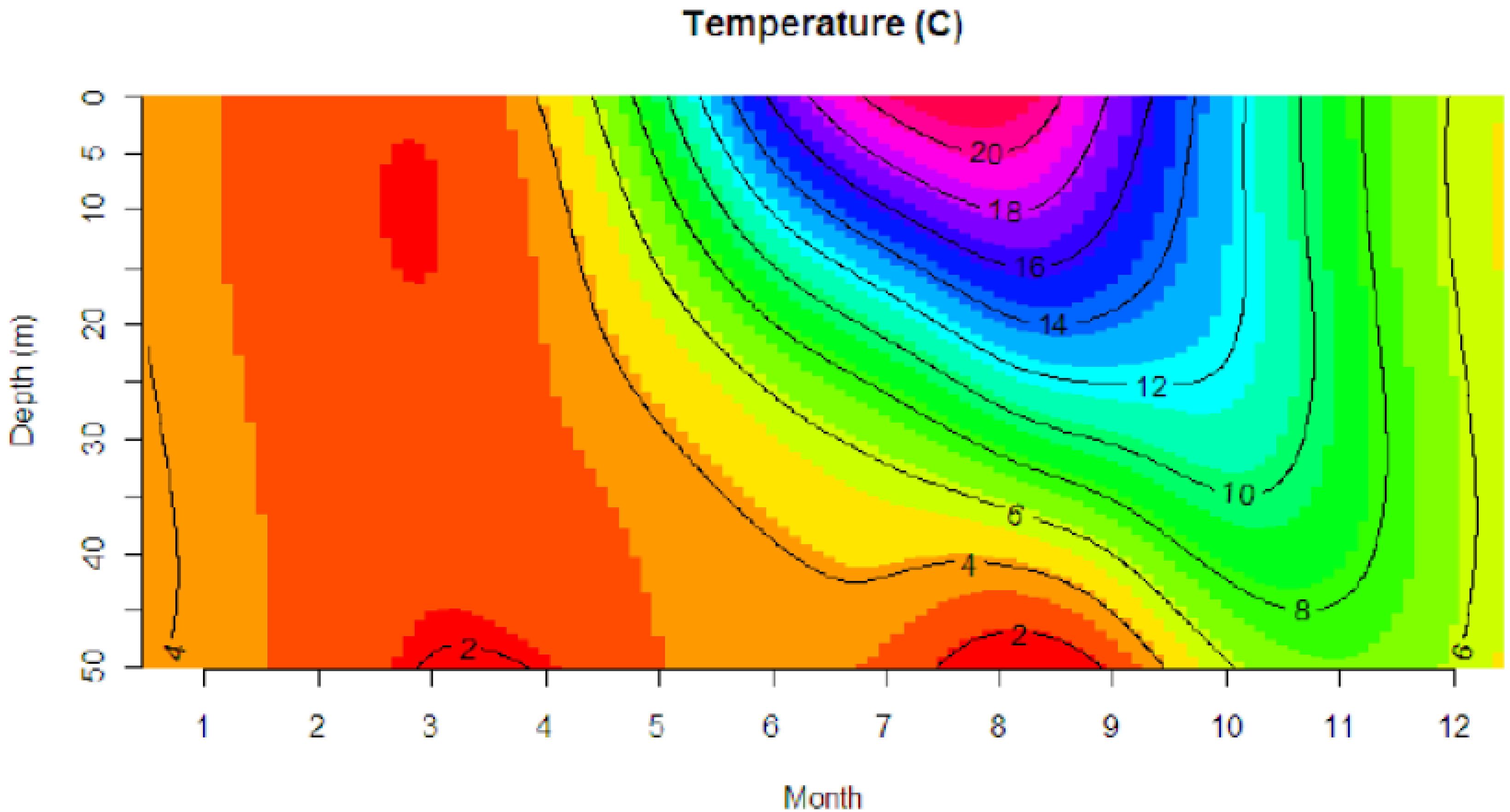
KLIMATA MAIŅAS IETEKME UZ LATVIJAS ŪDEŅU VIDI

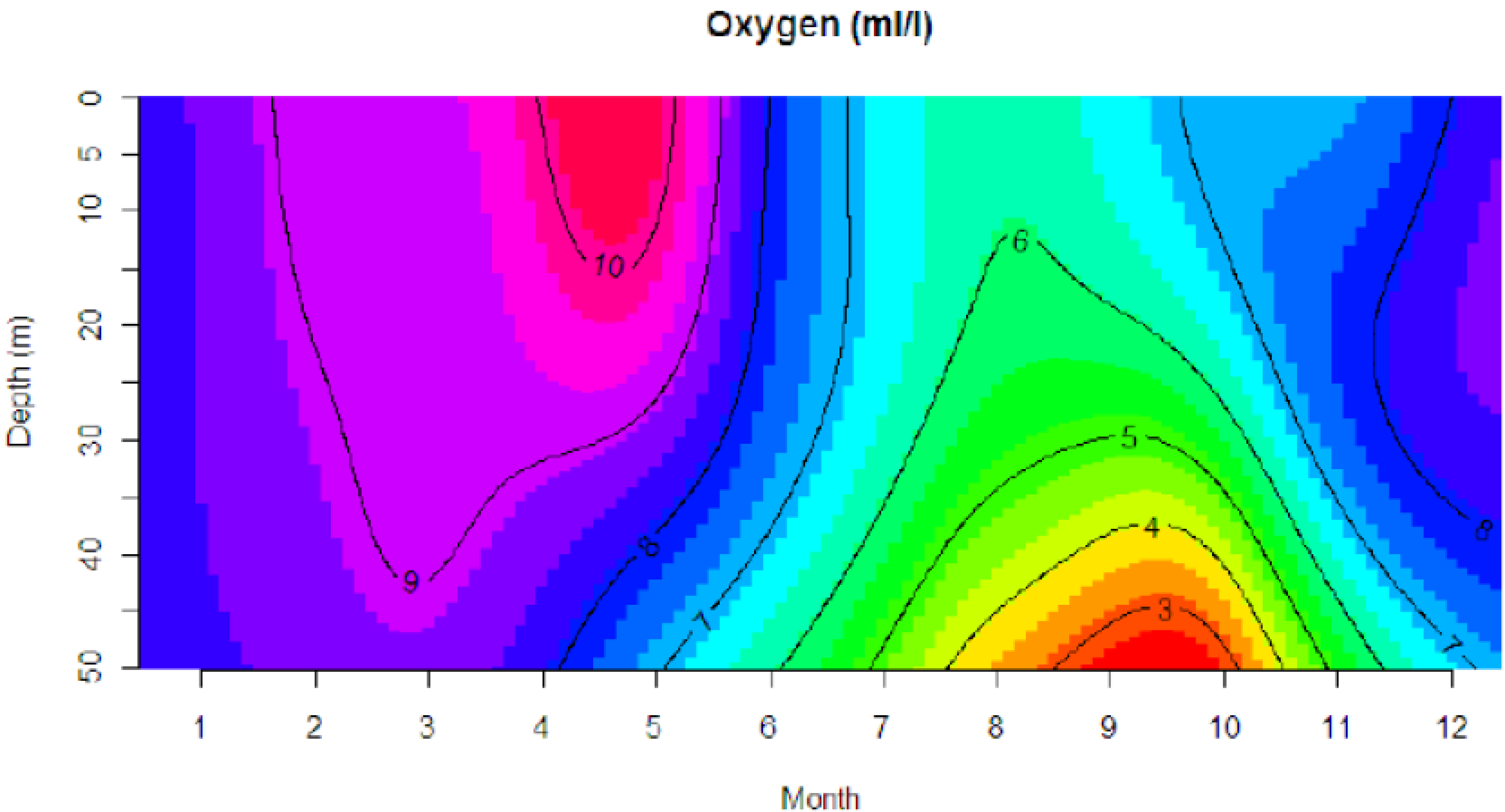
Gulf of Riga characteristics

- Semi-enclosed basin
- Connected to Eastern Gotland basin **surface** waters
- Salinity 5.5 – 6.2 PSU
- Shallow: average depth 22 m, maximum 56 m
- no permament halocline, seasonal thermocline, monomictic circulation
- High freshwater and riverine nutrient input
- Regular monitoring since 1973

Mean temperature (period 1973-2008)



Mean oxygen (period 1973-2008)



Model setup

- Biogeochemical model
  - phytoplankton, zooplankton and nutrients
  - NPZD Box model based on Savchuk 2002
  - 2 boxes (pelagic, demersal) + sediments
  - 3 phytoplankton groups
  - Zooplankton
  - NO_3, NH_4, PO_4, O_2
  - Calibrated to 28-year observation series

- Physical model (1D)
  - vertical temperature distribution in the GoR
  - General Ocean Turbulence Model (GOTM)
  - Coefficients of second order model: Cheng (2002)
  - Dynamic equation (k-ε style) for TKE
  - Dynamic dissipation rate equation

Ecosystem response

Temperature change

Climate change scenario

Climate data from PRUDENCE. Control: 1961-1990, Scenario A2: 2070-2100

Institute	Model	Driving data	Acronym	Experiment
SMHI	RCAO high res.	HadAM3H A2	HCCTL_22	control
SMHI	RCAO high res.	HadAM3H A2	HCA2_22	scenario

Extra downscaling of RCM data (bias correction via histogram equalisation):

relative humidity (used variable **td2m**)

air temperature (used variable **t2m**)

Original RCM data:

sea level pressure (used variable **MSLP**)

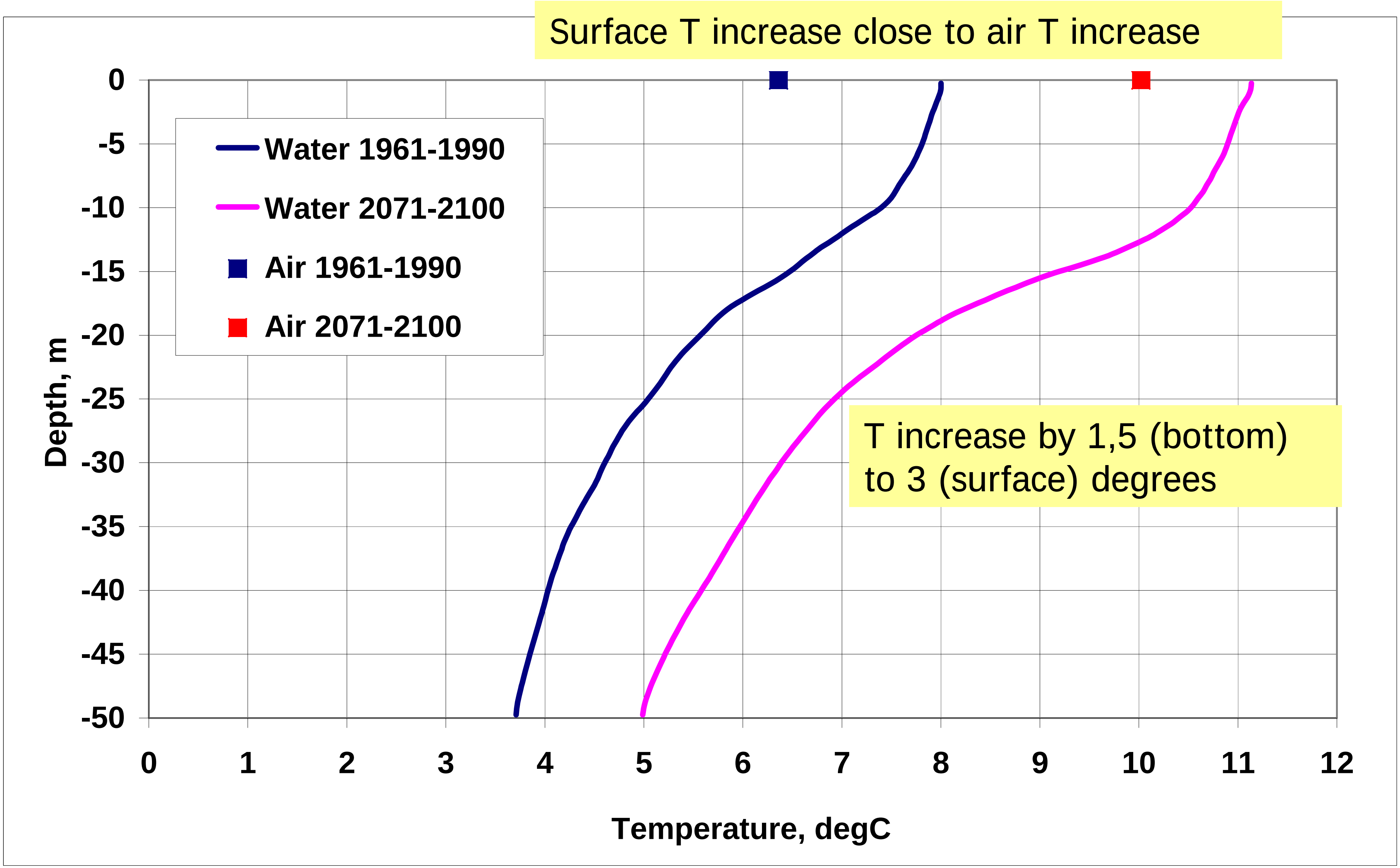
cloudiness (used variable **clcov**)

wind speed (used variable **w10m**)

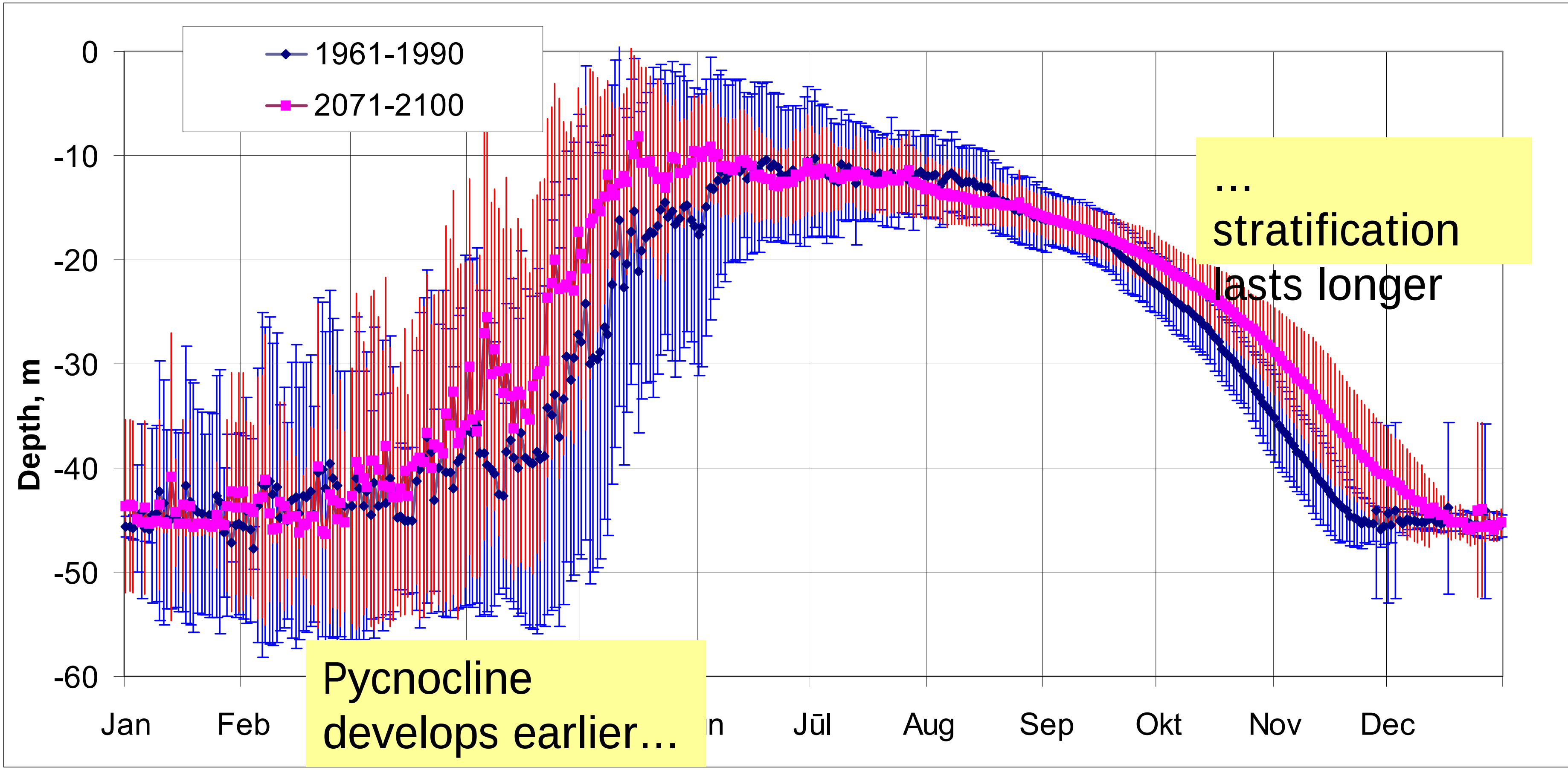
wind direction (used variable **w10dir**)

Calculations made for Gulf of Riga (50 m), 30 year period, daily output data – water temperature

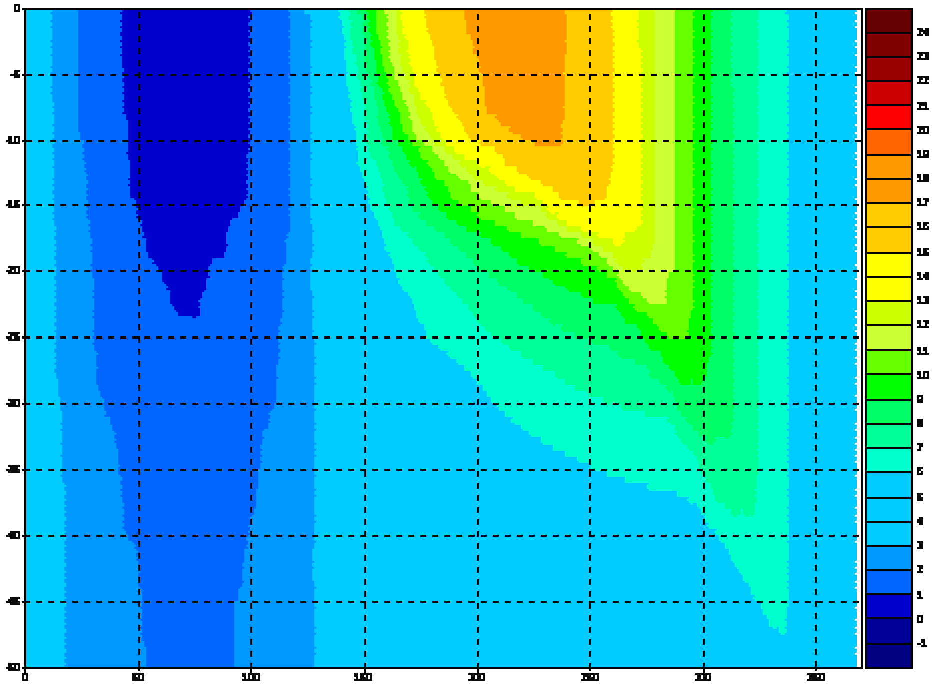
Physical model results – I
(mean temperature distribution over depth)



Physical model results – II
(mean daily pycnocline depth and its variation)

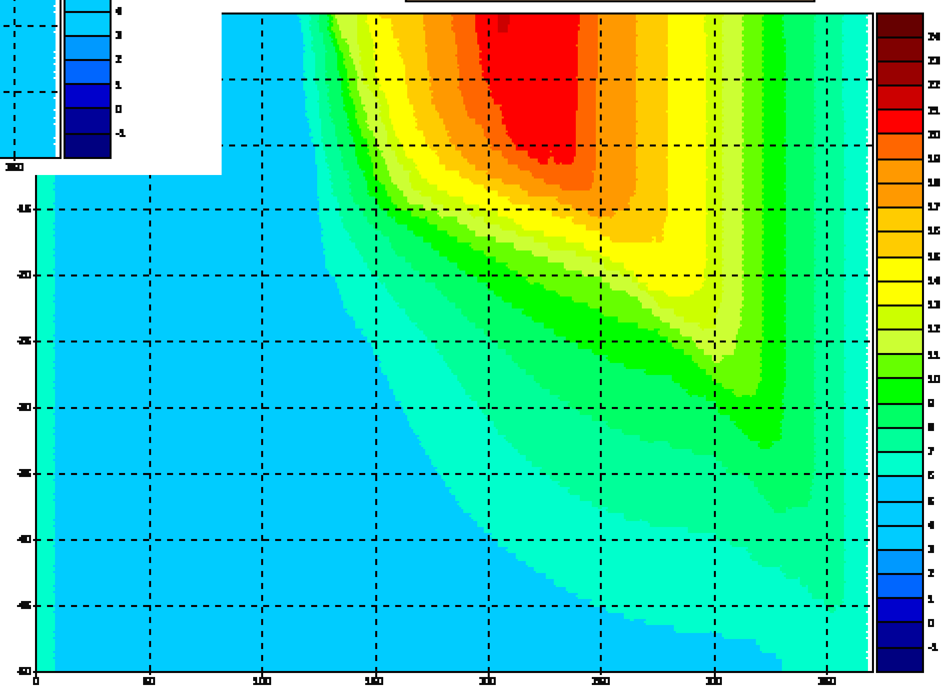


Physical model results – III
(mean time-depth plots of temperature)

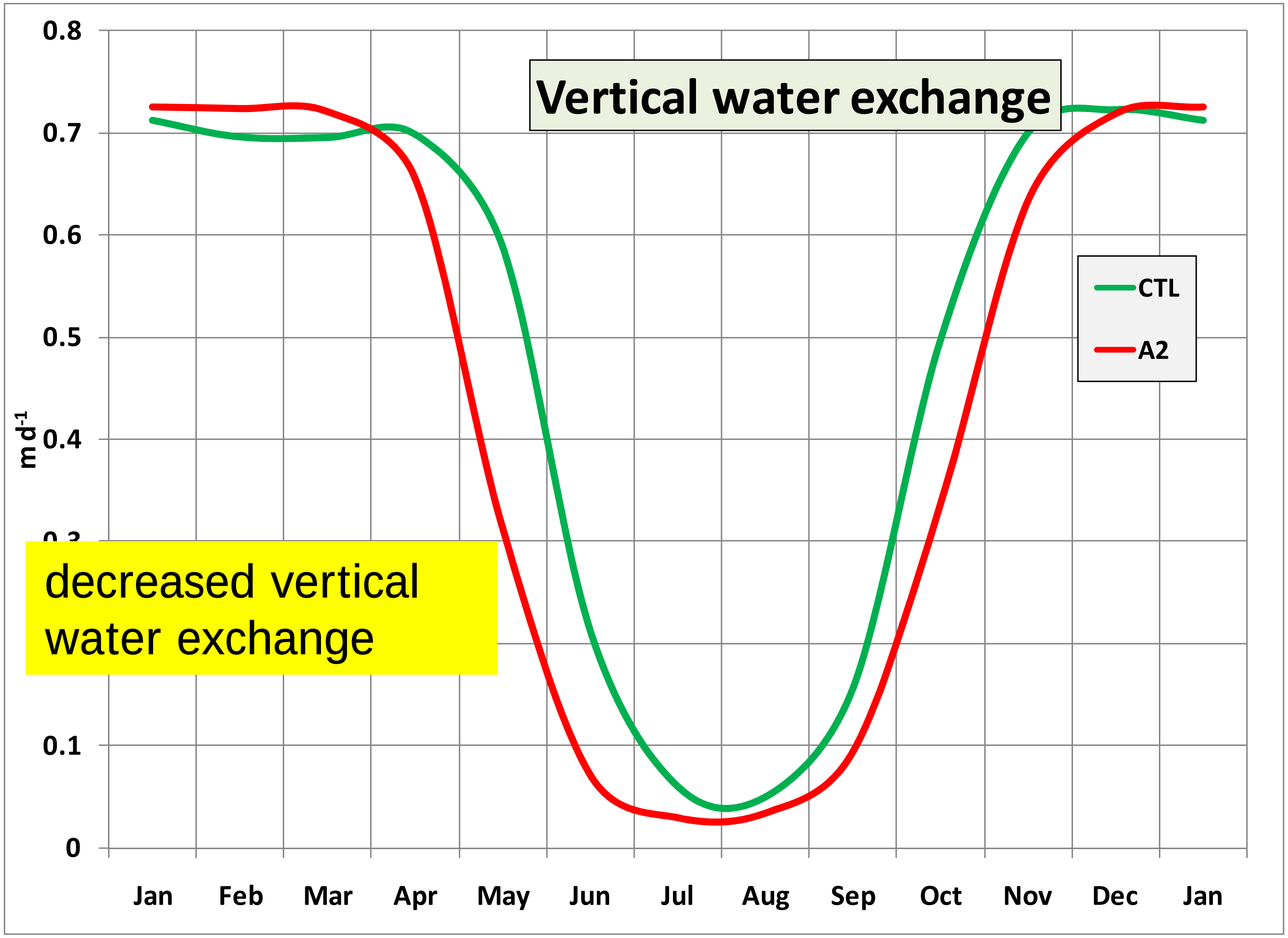


Contemporary climate

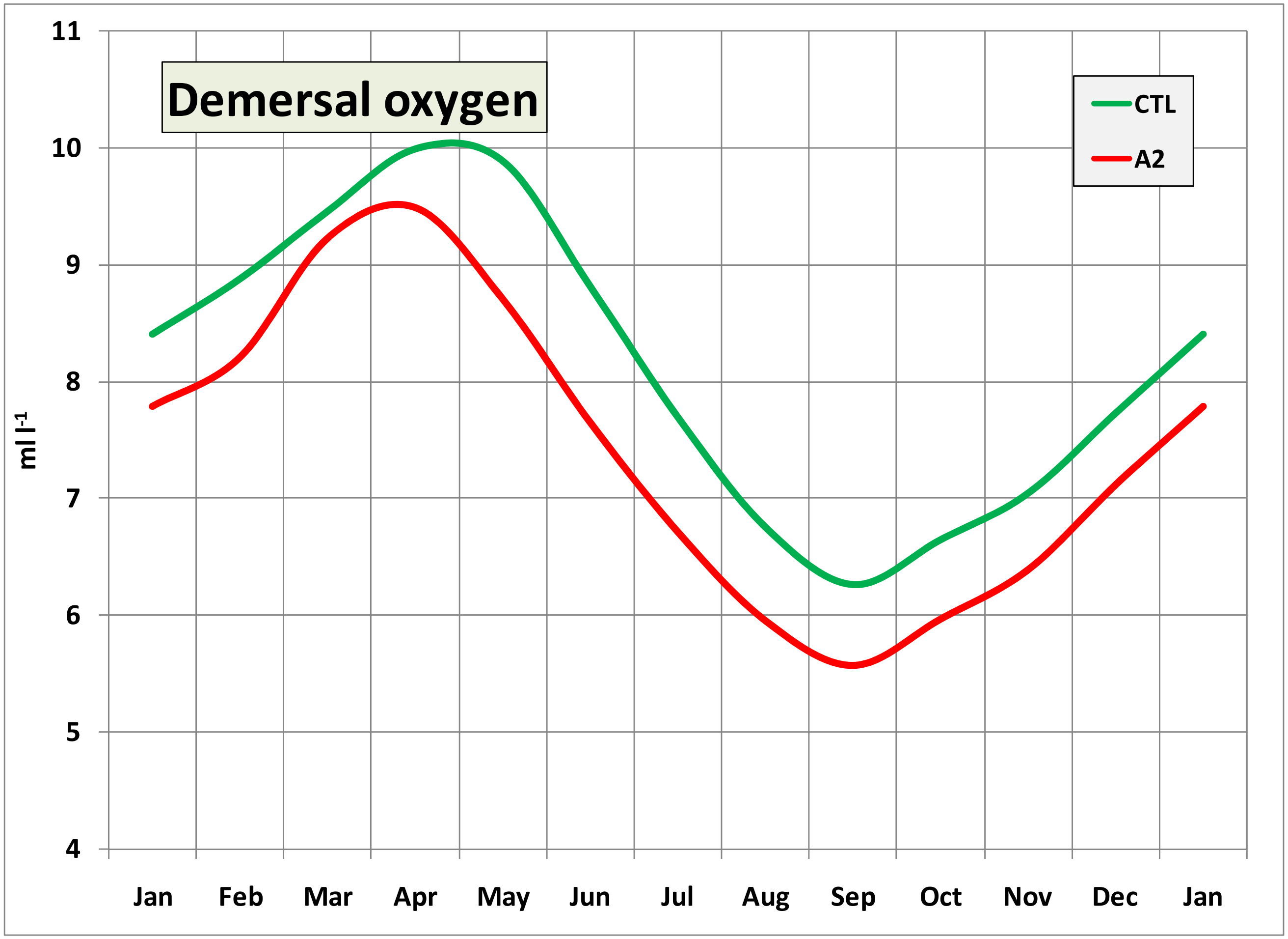
Climate change scenario A2



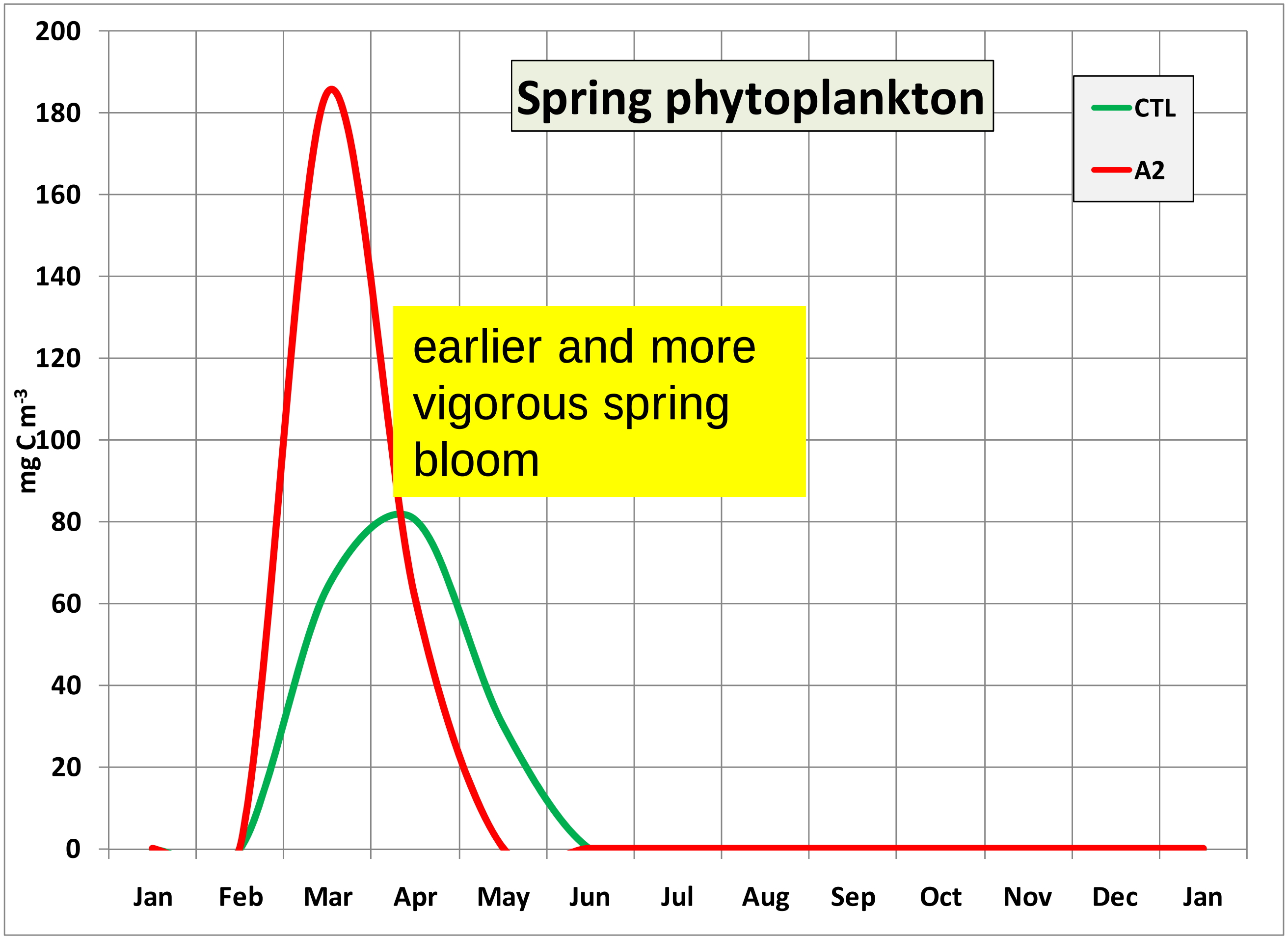
Vertical water exchange



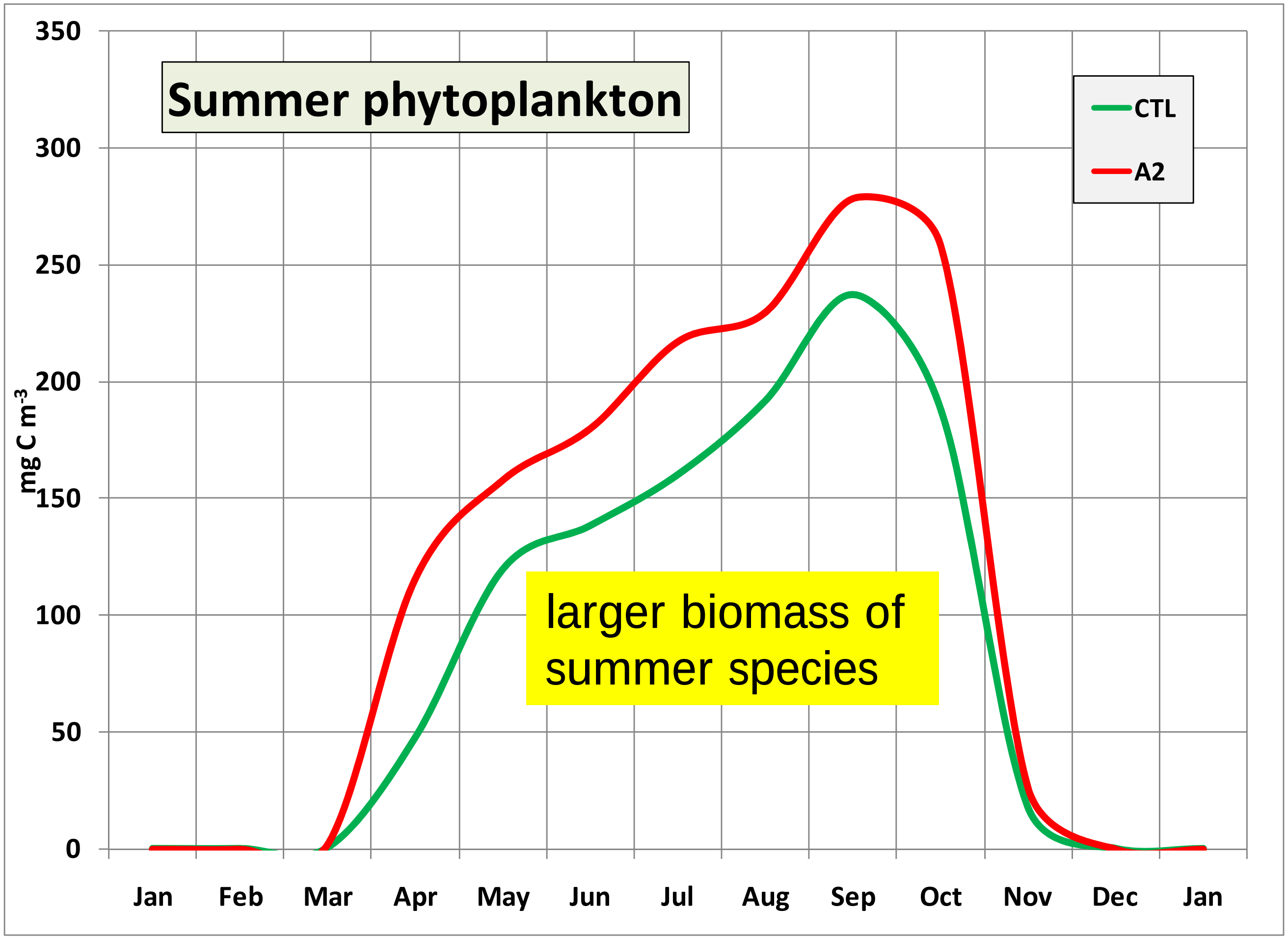
Demersal oxygen – GR mean



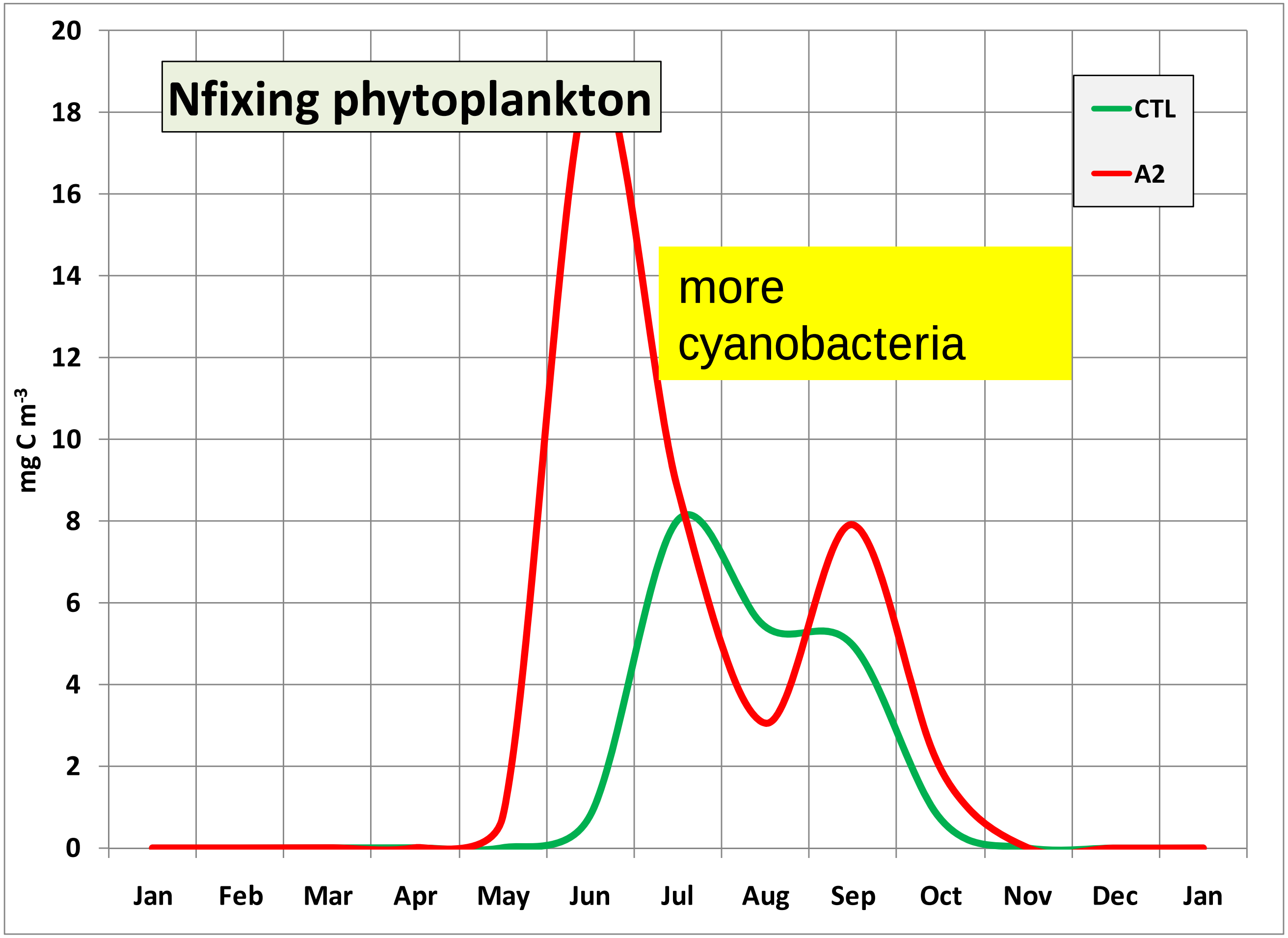
Species succession



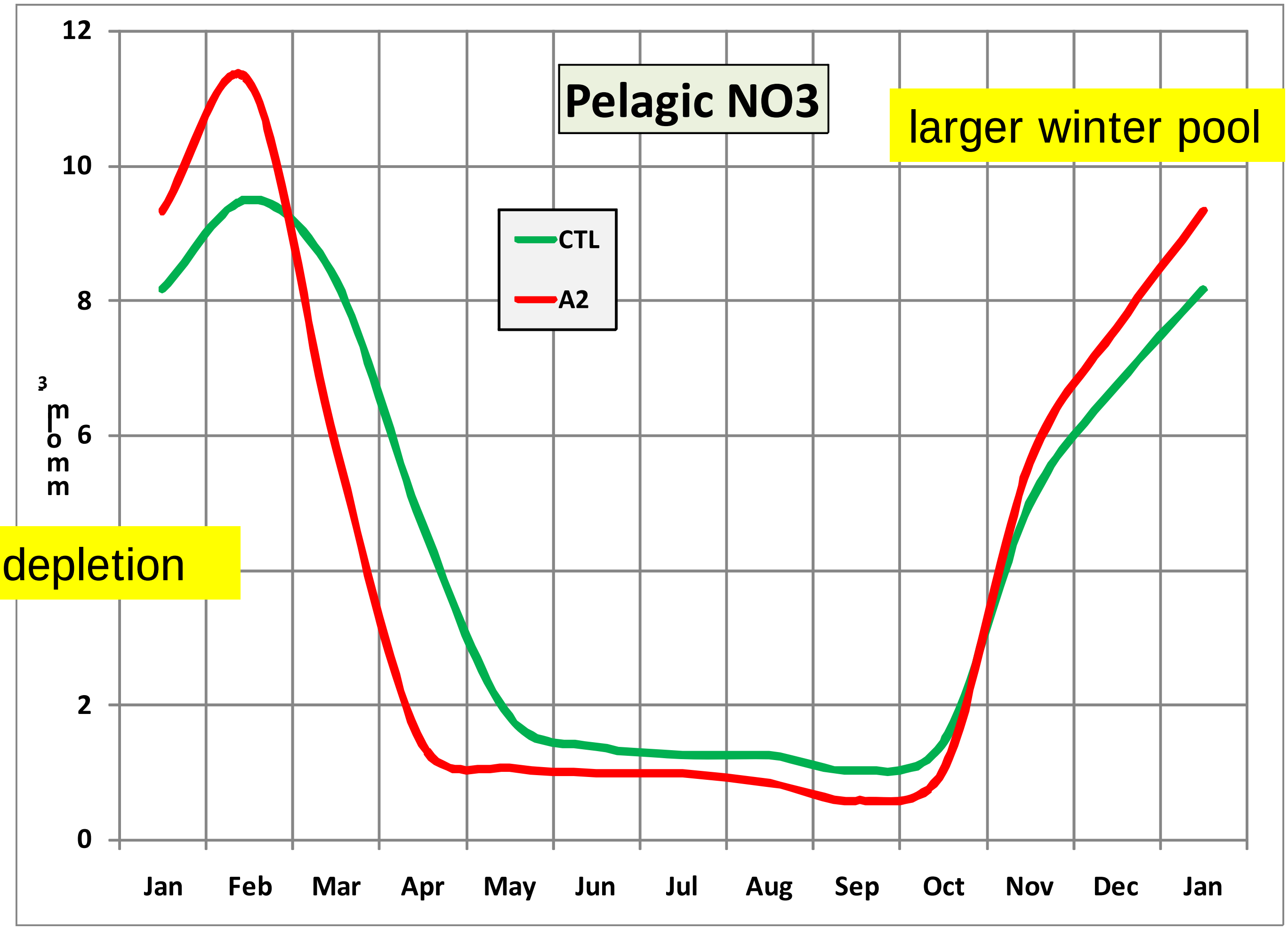
Species succession



Species succession



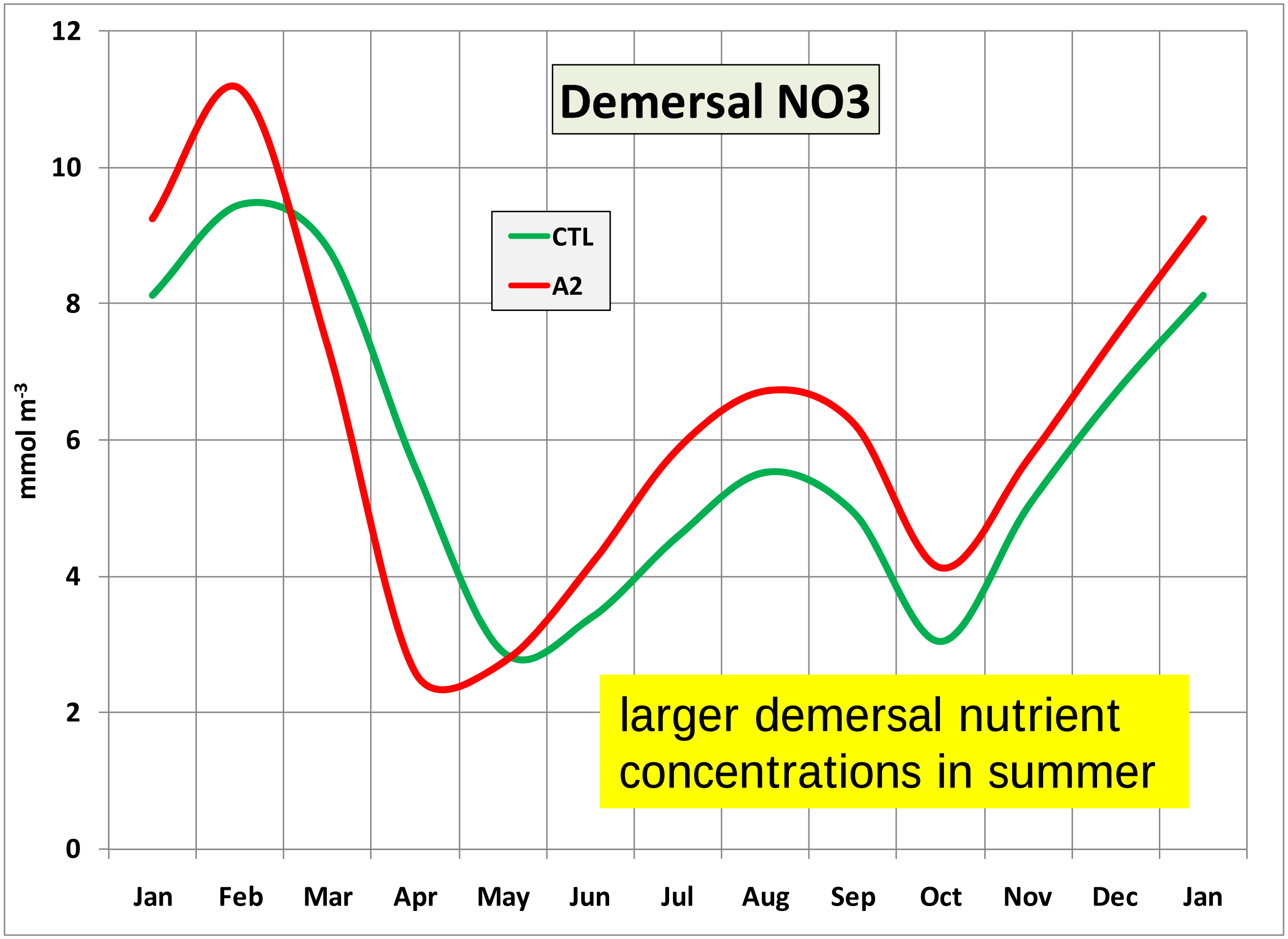
Pelagic nutrients



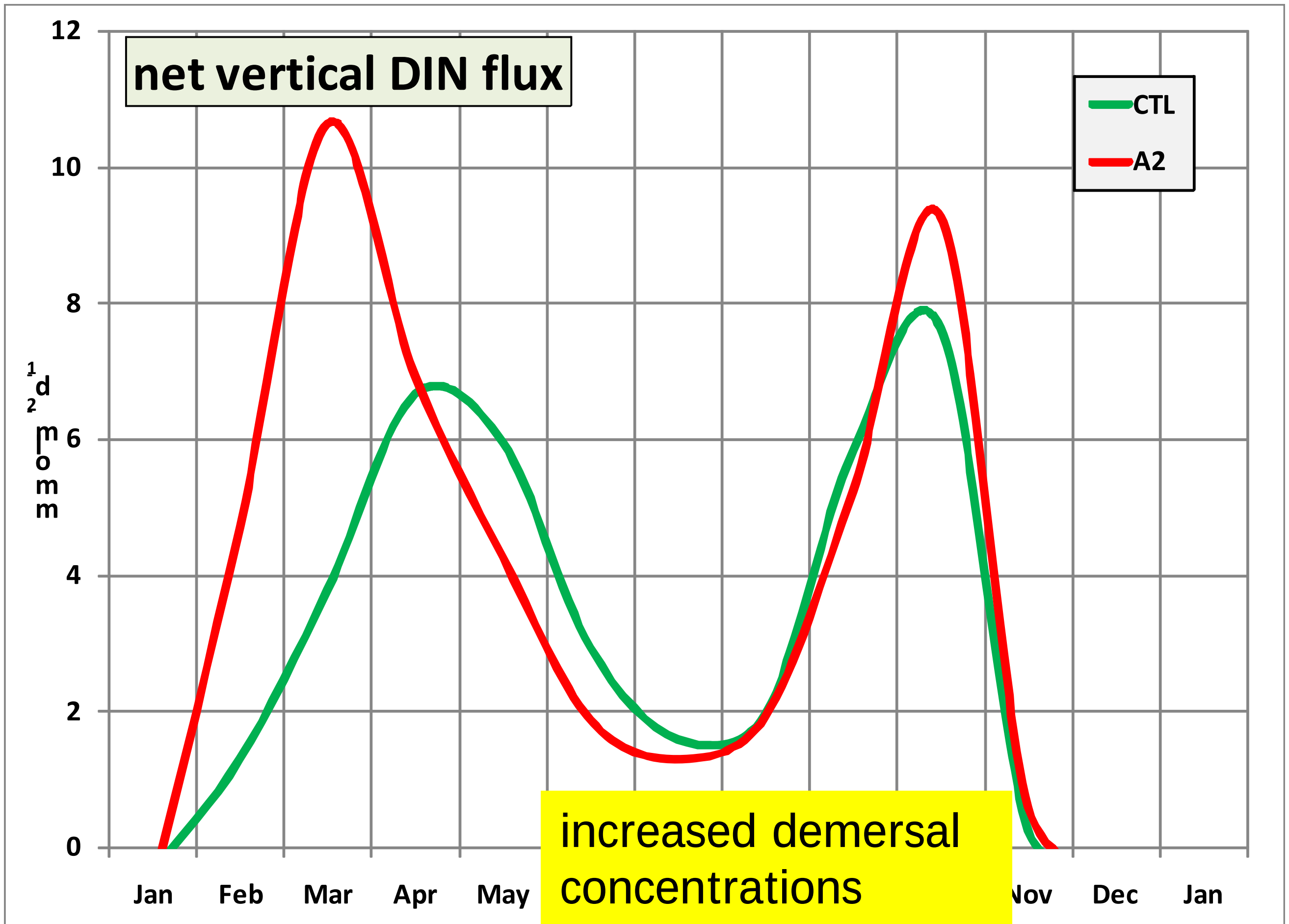
larger winter pool

earlier depletion

Demersal nutrients

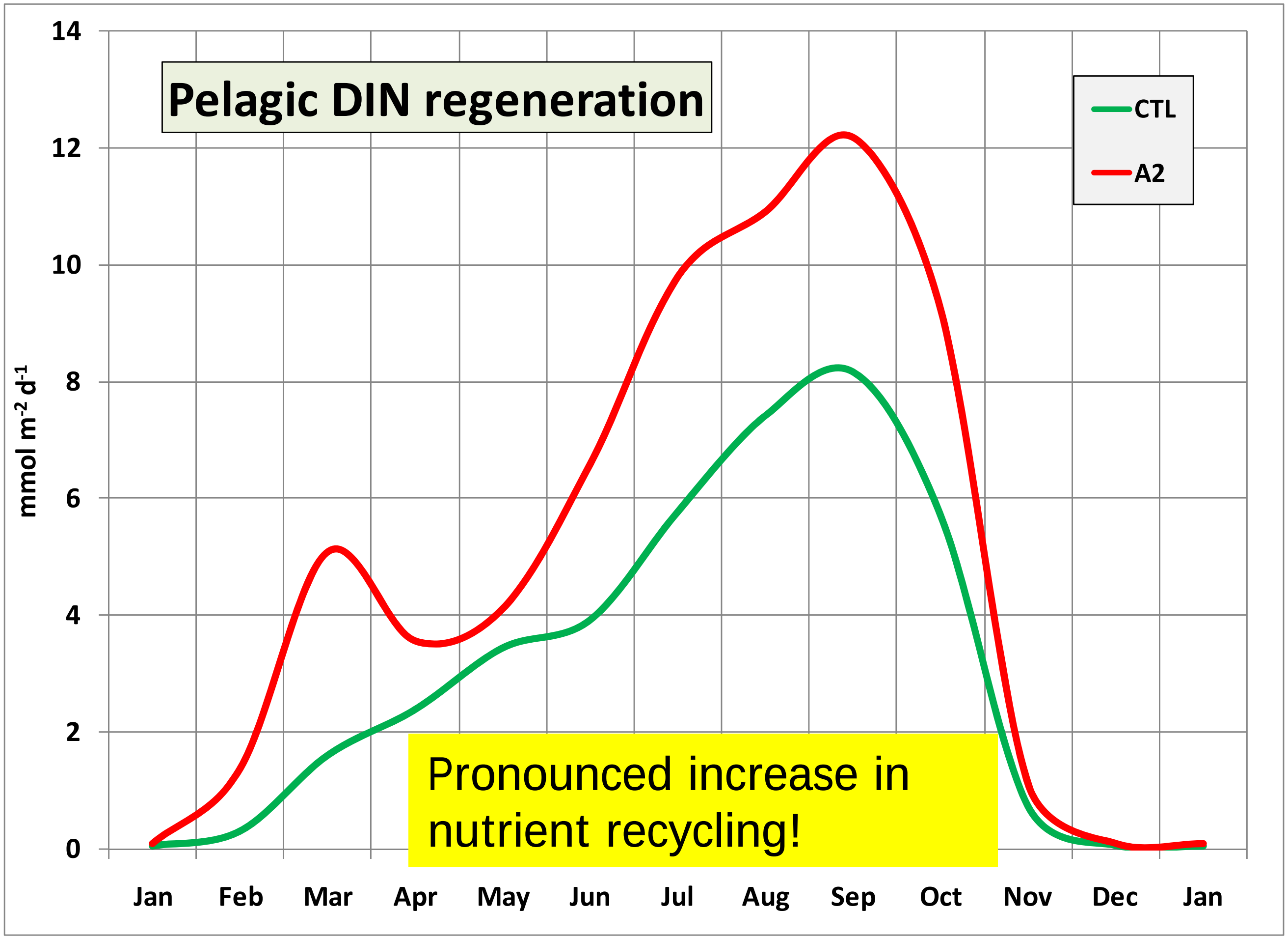


Vertical nutrient flux

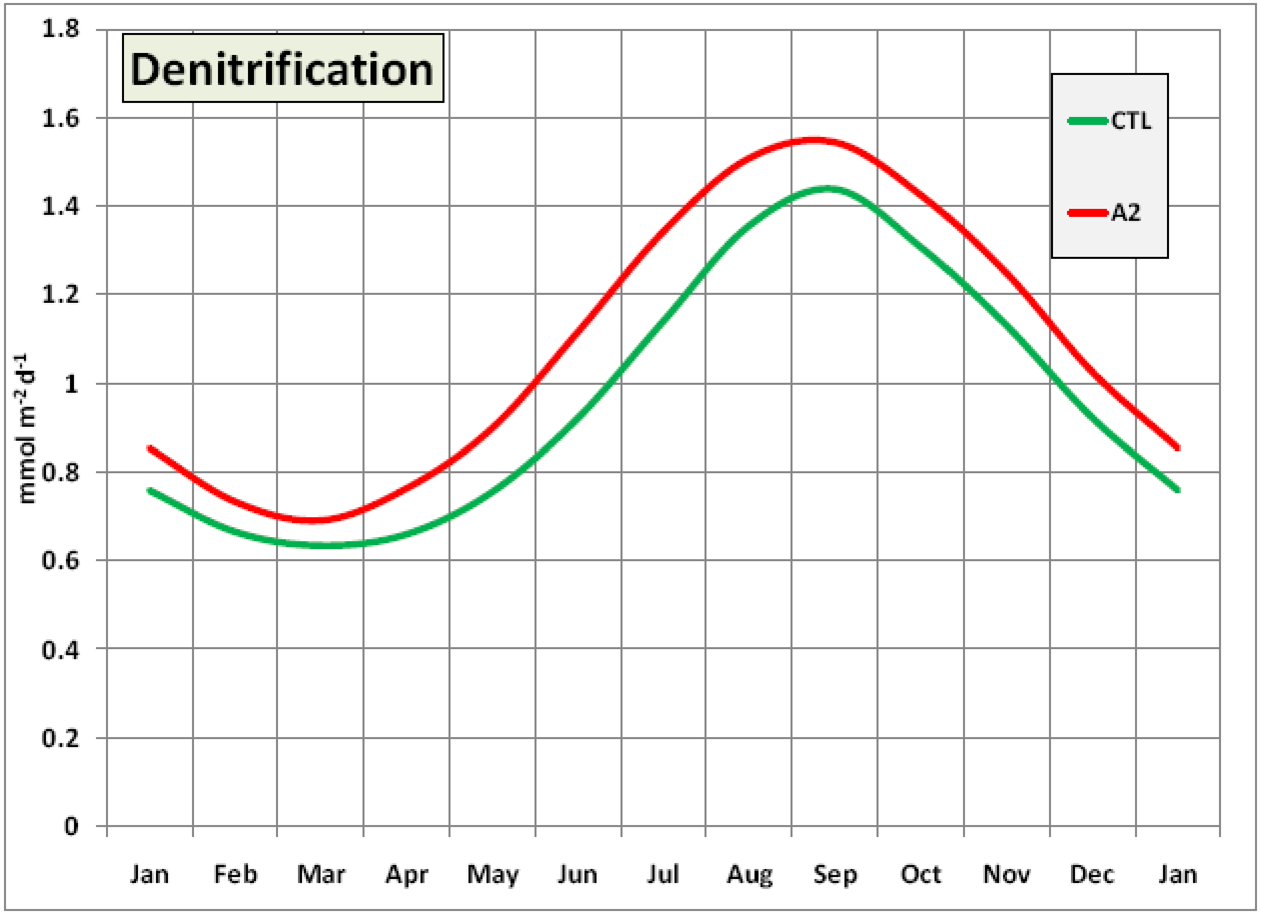


increased demersal concentrations compensate stratification effect

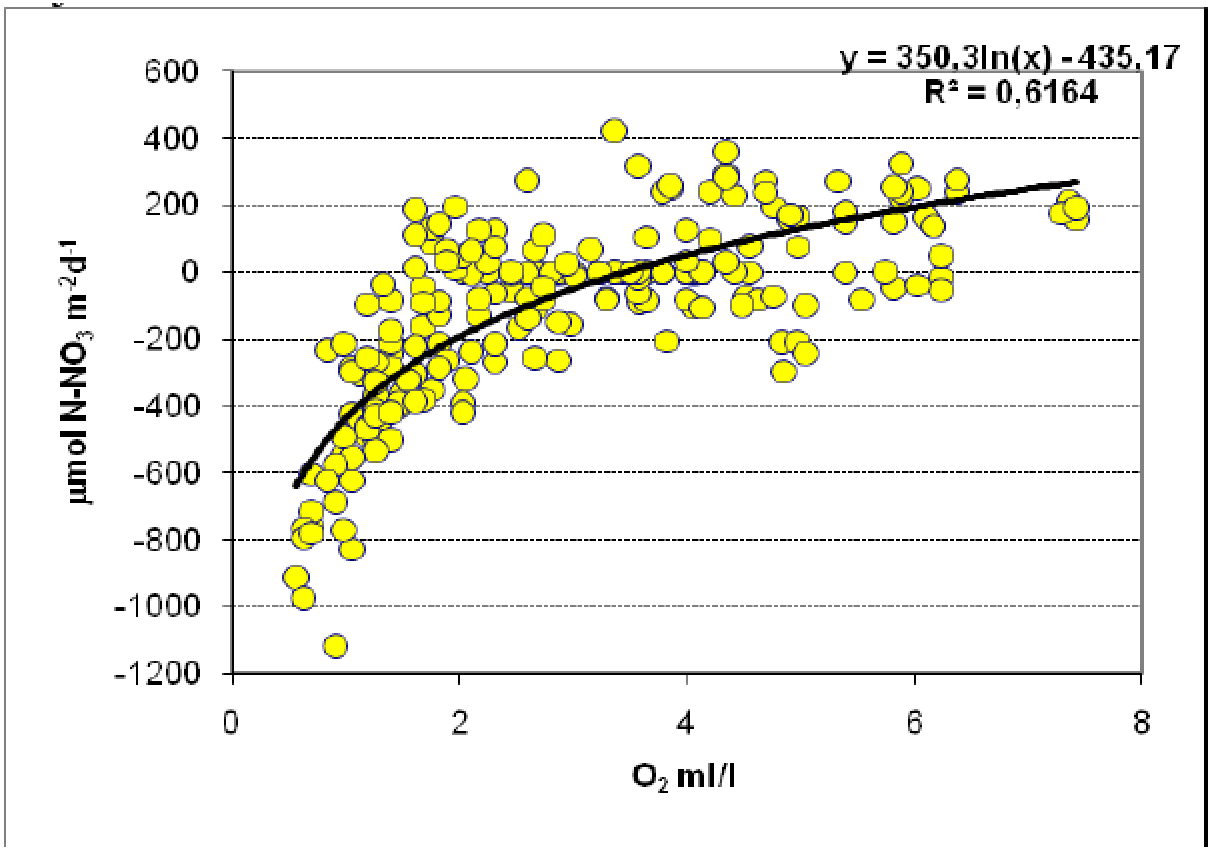
Nutrient regeneration



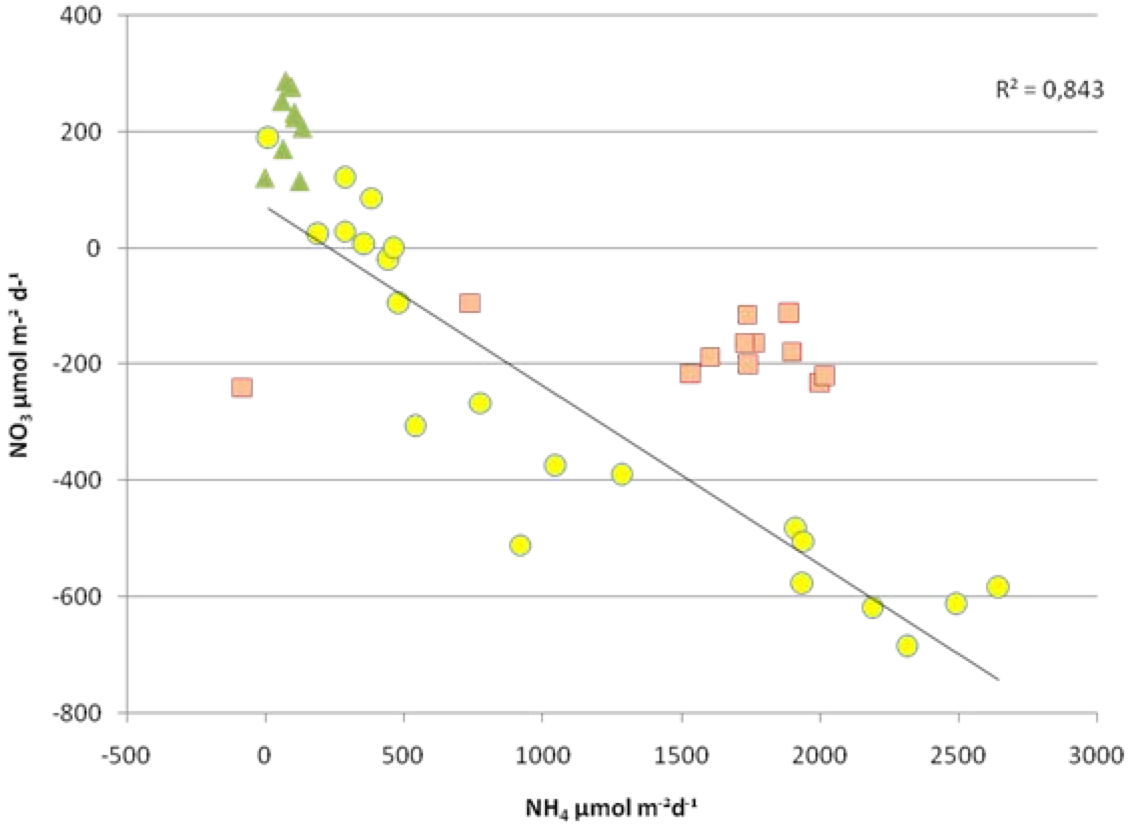
Denitrification



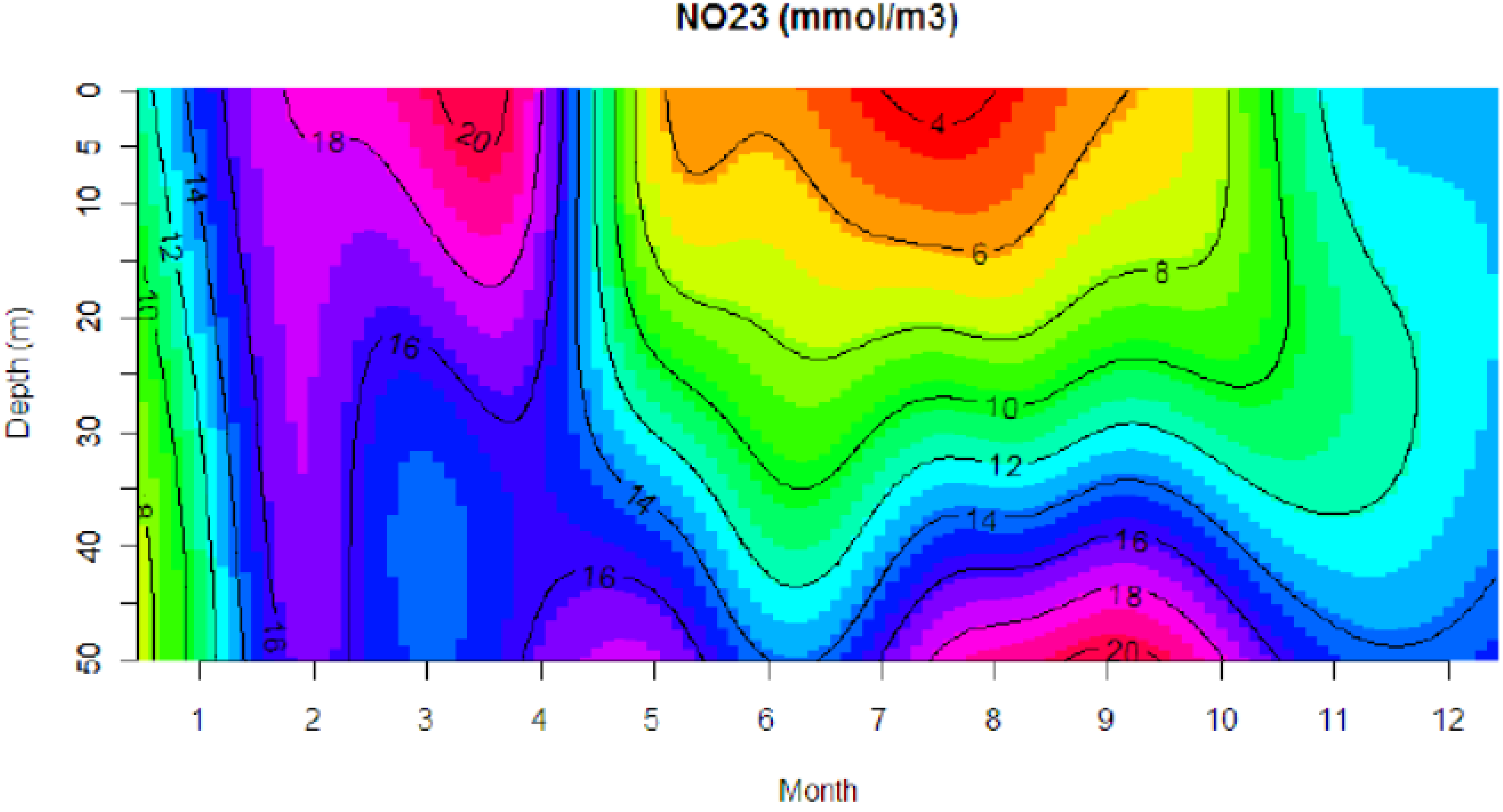
Nitrate uptake/release (oxygen control)



Ammonium versus nitraterelease



Mean nitrate (period 1973-2008)



Conclusions

- Increase in phytoplankton growth and primary productivity caused by increased nutrient regeneration
- Slightly increased winter nutrient concentrations
- Earlier spring bloom (earlier stratification, no ice cover)
- Larger summer phytoplankton biomass, more cyanobacteria because of more intensive nutrient regeneration
- Lower demersal oxygen concentration caused by more stable and longer stratification
- Denitrification – open question for future research