Modelling of POC concentration in the Baltic sea-water.

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with contribution from
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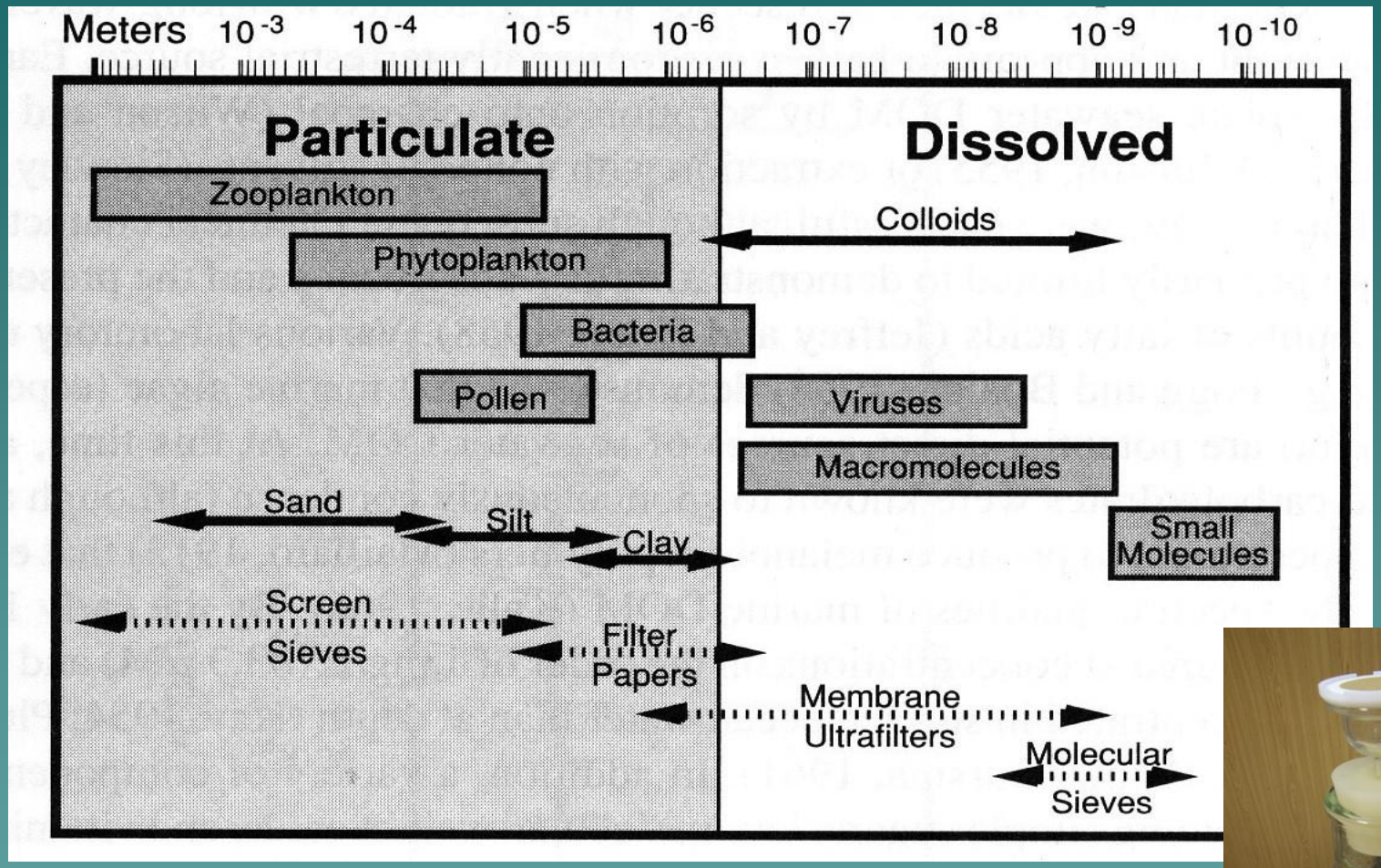
What is POC?

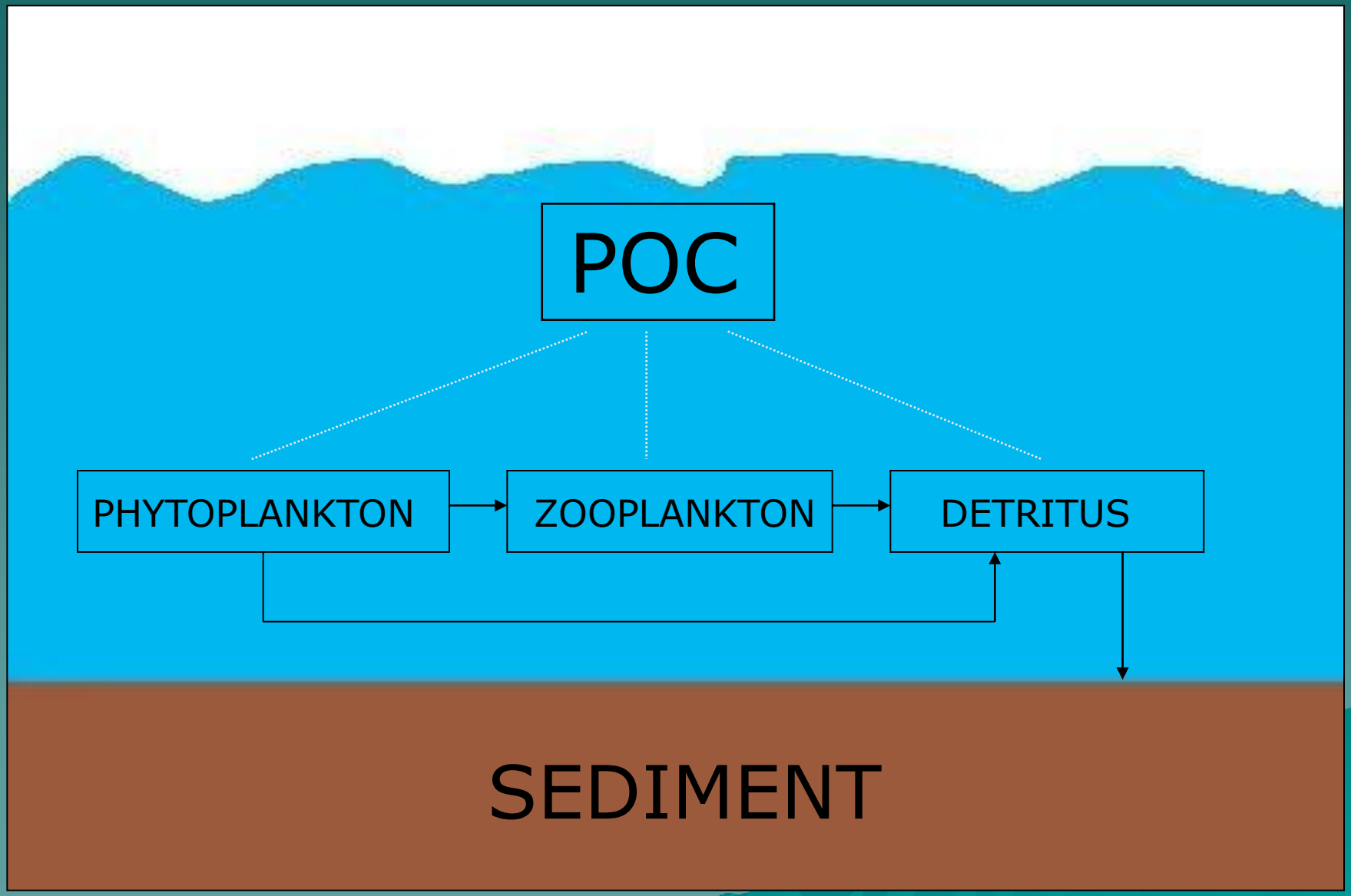
- Particulate Organic Carbon
- Measure of particulate organic matter (POM) in the marine environment
- POM ≈ 2.12 POC
- Sum of phytoplankton, zooplankton and dead organic matter (detritus) concentrations

Comparison of POC(POM) and DOC(DOM)



- We use 0.4 µm glass fibre filters

Relation POC with sediment



Why POC is important?

- Plays key role in many natural processes occuring in marine enviroment

  (e.g.vertical downwards transport of chemical substances: C, N, P, heavy metals, O_2 depletion, etc.)

Why information about POC is scarce?

It's hard to measure.

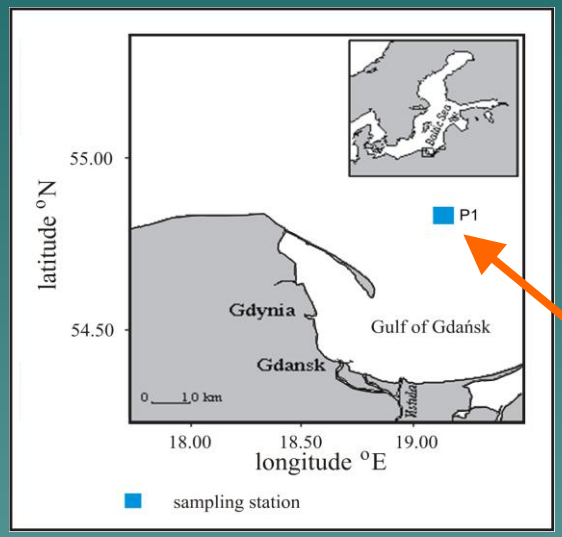
Moreover, other issues are:

- Natural POC variability
- Seasonal changes (light, temperature, etc.) and long time changes in seawater
- Accidental samples

The model I use has been developed to:

- Calculate the seasonal variations of POC in the southern Baltic Sea
- Make simulation of POC distribution in water column
- Predict POC changes in the marine environment

Location of sampling station

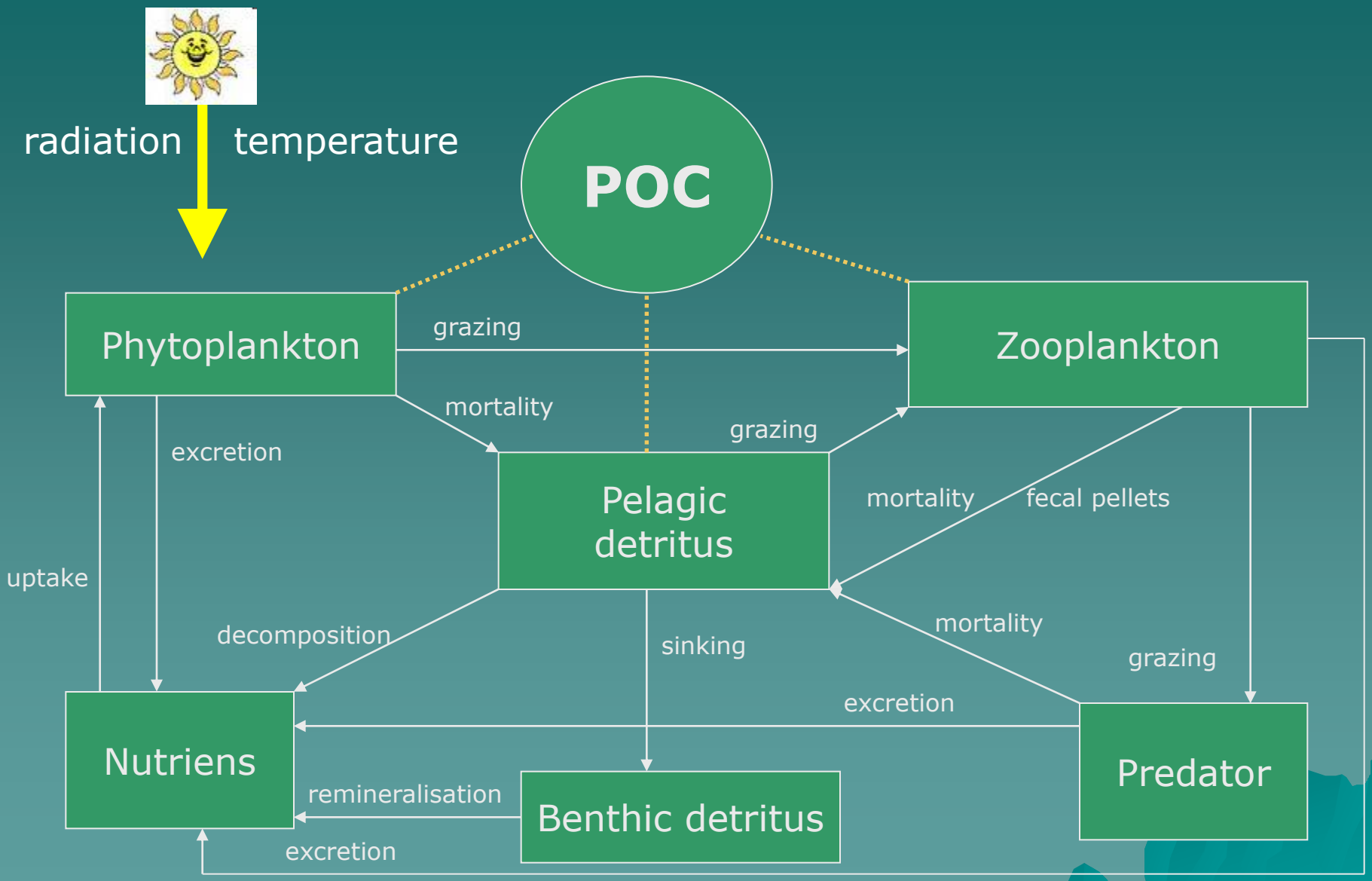


- r/v Oceania cruise (April 2009)
  Samples: sediments and water
- r/v Aranda cruise (January 2009)
  Samples: sediments and water


ARANDA
When every life counts...


OCEANIA
GDAŃSK

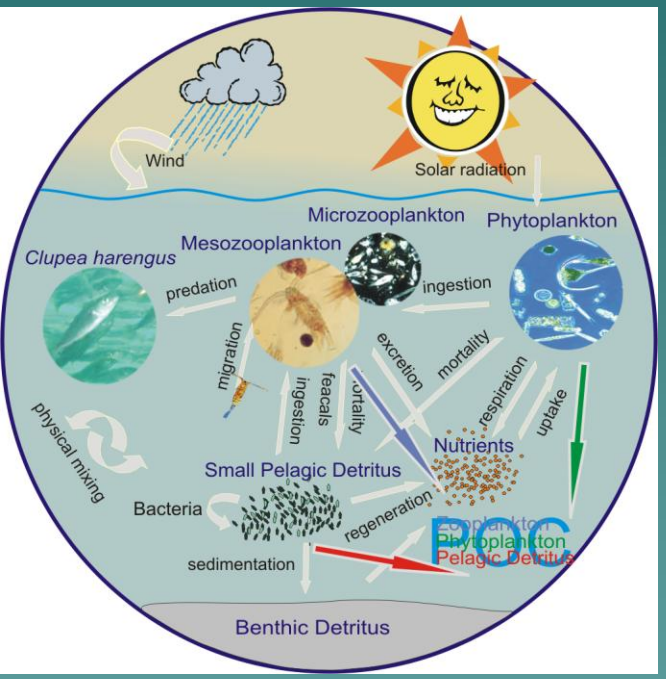
Sources and sinks of POC included in model



Equations used in model and model validation

Main equation:

$$\frac{\partial POC(z,t)}{\partial t} = \frac{\partial Phyt(z,t)}{\partial t} + \frac{\partial Zoop(z,t)}{\partial t} + \frac{\partial DetrP(z,t)}{\partial t}$$



Other equations showing sources and sinks:

$$\frac{\partial Nutr_N}{\partial t} = \frac{\partial}{\partial z}\left(K_z \frac{\partial Nutr_N}{\partial z}\right) - \mathrm{UPT_N} + \mathrm{REM_N} + \mathrm{DECP_N} + \mathrm{EXC_N}$$

$$\frac{\partial Nutr_P}{\partial t} = \frac{\partial}{\partial z}\left(K_z \frac{\partial Nutr_P}{\partial z}\right) - \mathrm{UPT_P} + \mathrm{REL_P} + \mathrm{REMI_P} + \mathrm{EXC_P}$$

$$\frac{\partial Phyt}{\partial t} + w_z \frac{\partial Phyt}{\partial z} = \frac{\partial}{\partial z}\left(K_z \frac{\partial Phyt}{\partial z}\right) + \mathrm{UPT} - \mathrm{EXCP} - \mathrm{MOR}_P - \mathrm{GRA}$$

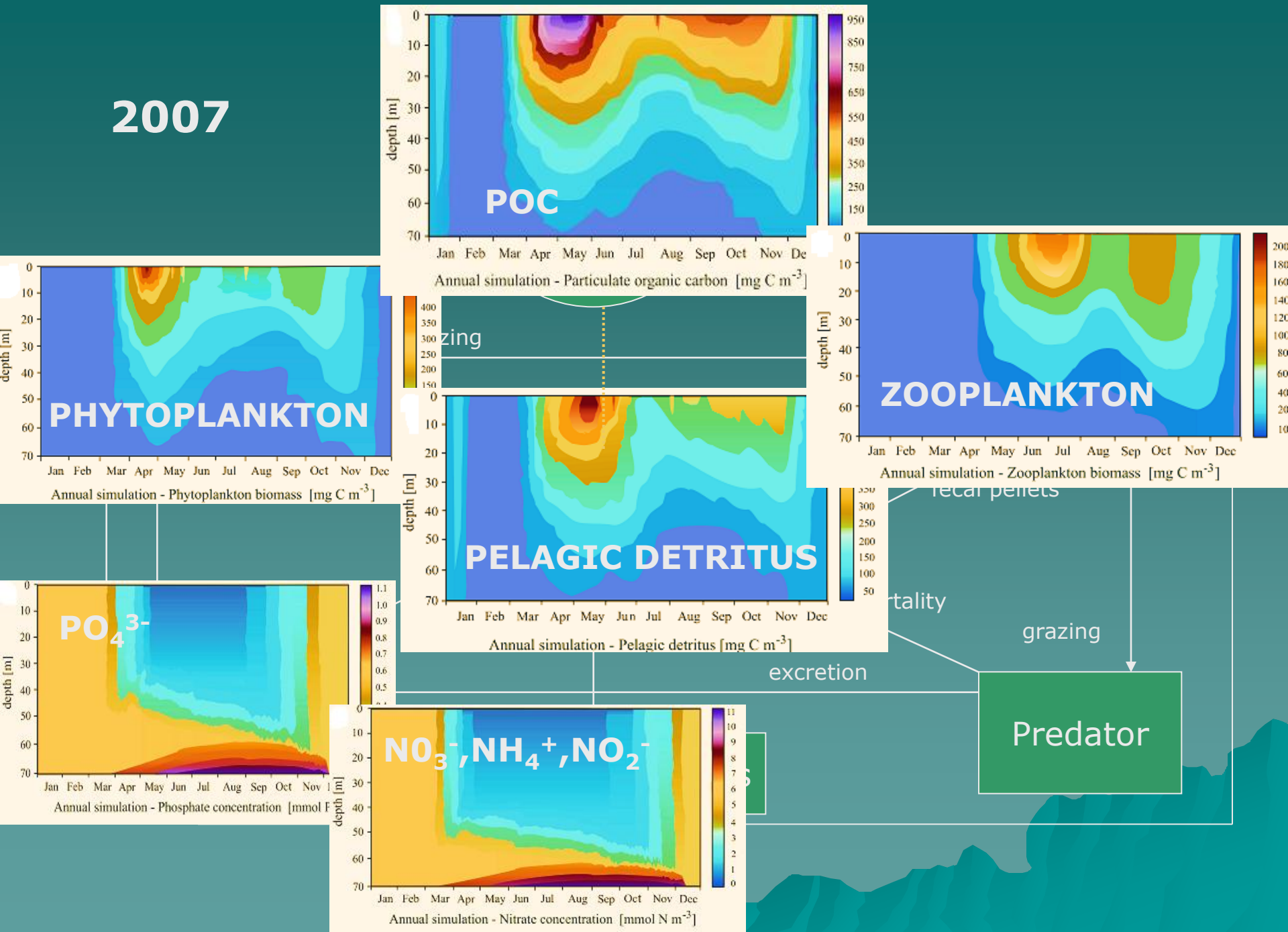
$$\frac{\partial Z}{\partial t} = \frac{\partial}{\partial z}\left(K_z \frac{\partial Z}{\partial z}\right) + \mathrm{GRA} - \mathrm{EXCZ} - \mathrm{PRED} - \mathrm{FEC} - \mathrm{MORZ}$$

$$\frac{\partial \mathrm{PDetr}}{\partial t} = \frac{\partial}{\partial z}\left(K_z \frac{\partial \mathrm{PDetr}}{\partial z}\right) + \mathrm{MORZ} + \mathrm{FEC} + \mathrm{MORP} - w_d \frac{\partial \mathrm{PDetr}}{\partial z} - \mathrm{SIND} - \mathrm{REMI}$$

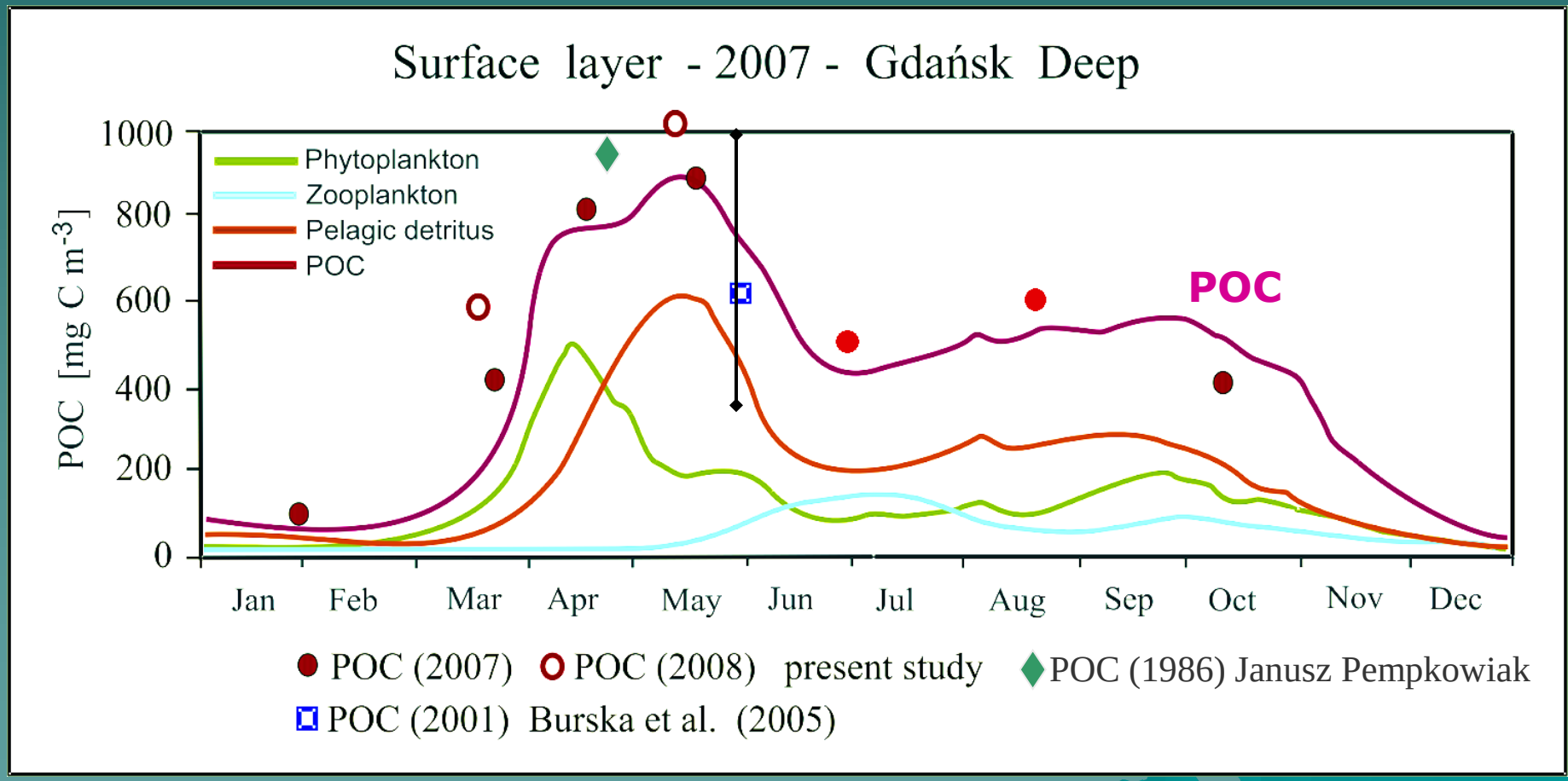
Dzierzbicka L., 2005-2006

GRA/GRZ/GRD-grazing, EXCP/EXCZ-excretion, PRED-predation, FEC -fecal pellets, MORP/MORZ-mortality, SIND -sinking, DECP–decomposition, REM–remineralisation, K_z-turbulence diffusion coeficient, g_B-predator growth rate, F-fluxes, UPT-uptake

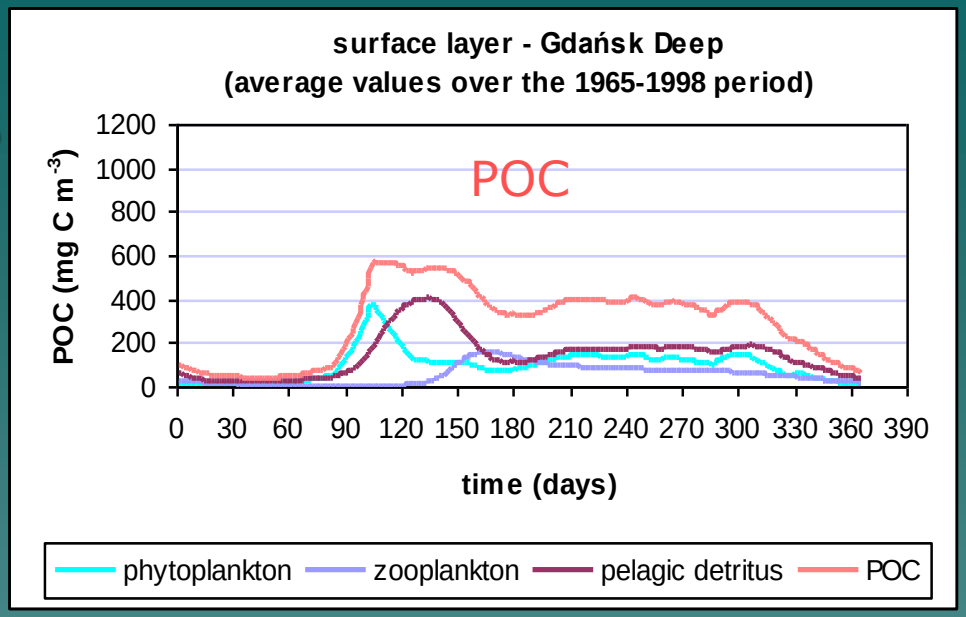
2007

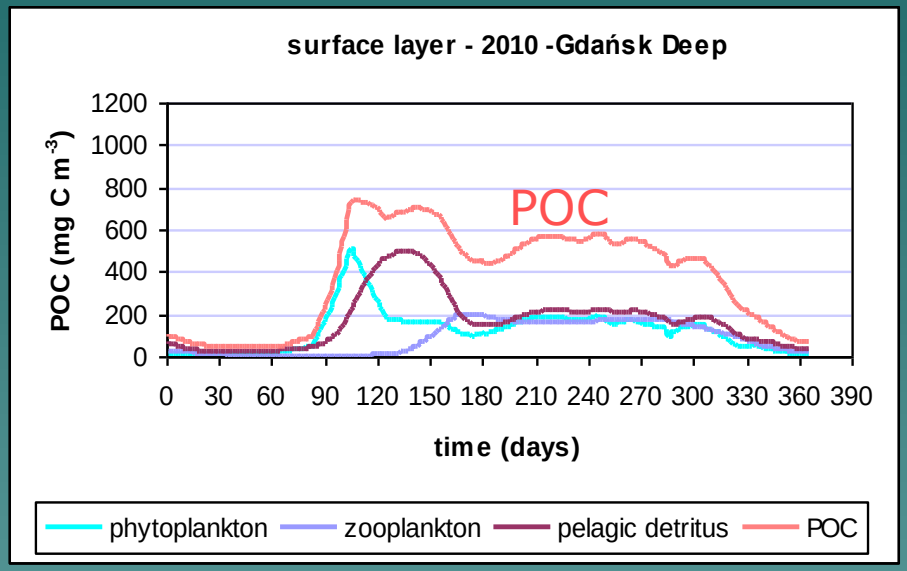

POC
Annual simulation - Particulate organic carbon [mg C m-3]
PHYTOPLANKTON
Annual simulation - Phytoplankton biomass [mg C m-3]
ZOOPLANKTON
Annual simulation - Zooplankton biomass [mg C m-3]
PELAGIC DETRITUS
Annual simulation - Pelagic detritus [mg C m-3]
PO4 3-
Annual simulation - Phosphate concentration [mmol P
NO3-,NH4+,NO2-
Annual simulation - Nitrate concentration [mmol N m-3]
depth [m]
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
zing
fecal pellets
rtality
grazing
excretion
Predator

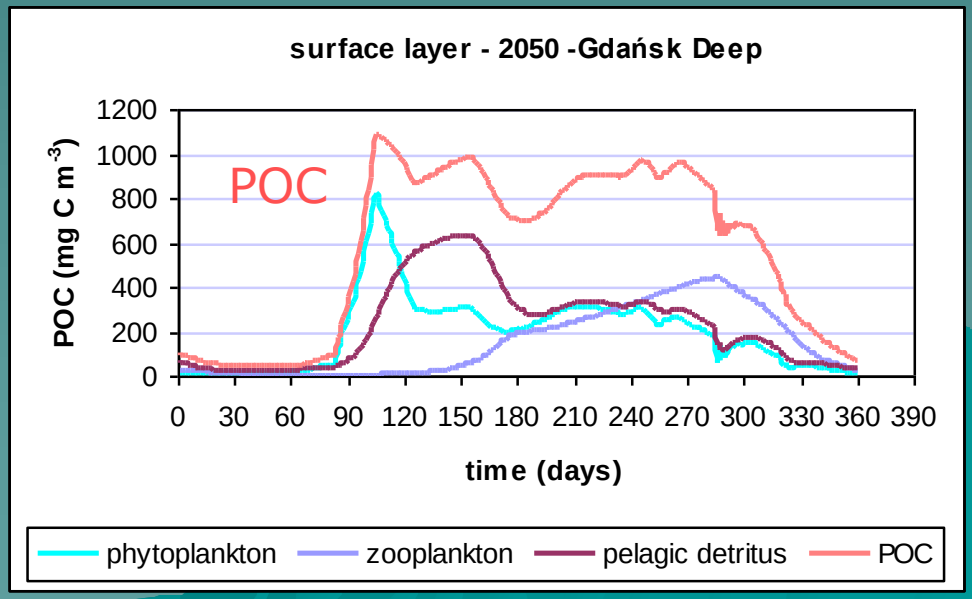
Modelled vs experimantal POC



Simulated annual cycles for POC in the surface layer of the Gdańsk Deep for the 1965-1998 period (avarage) and 2050







We assumed:

- Increase in the available radiation(PAR): 0.2% per year in the vegetation season, 0.05% in winter,
- Nutriens increase: 1% of conc. per year,
- Water temperature increase in the upper layer:: 0.008 C per year

(Renk H. et al.,1983, 1998, 2000)

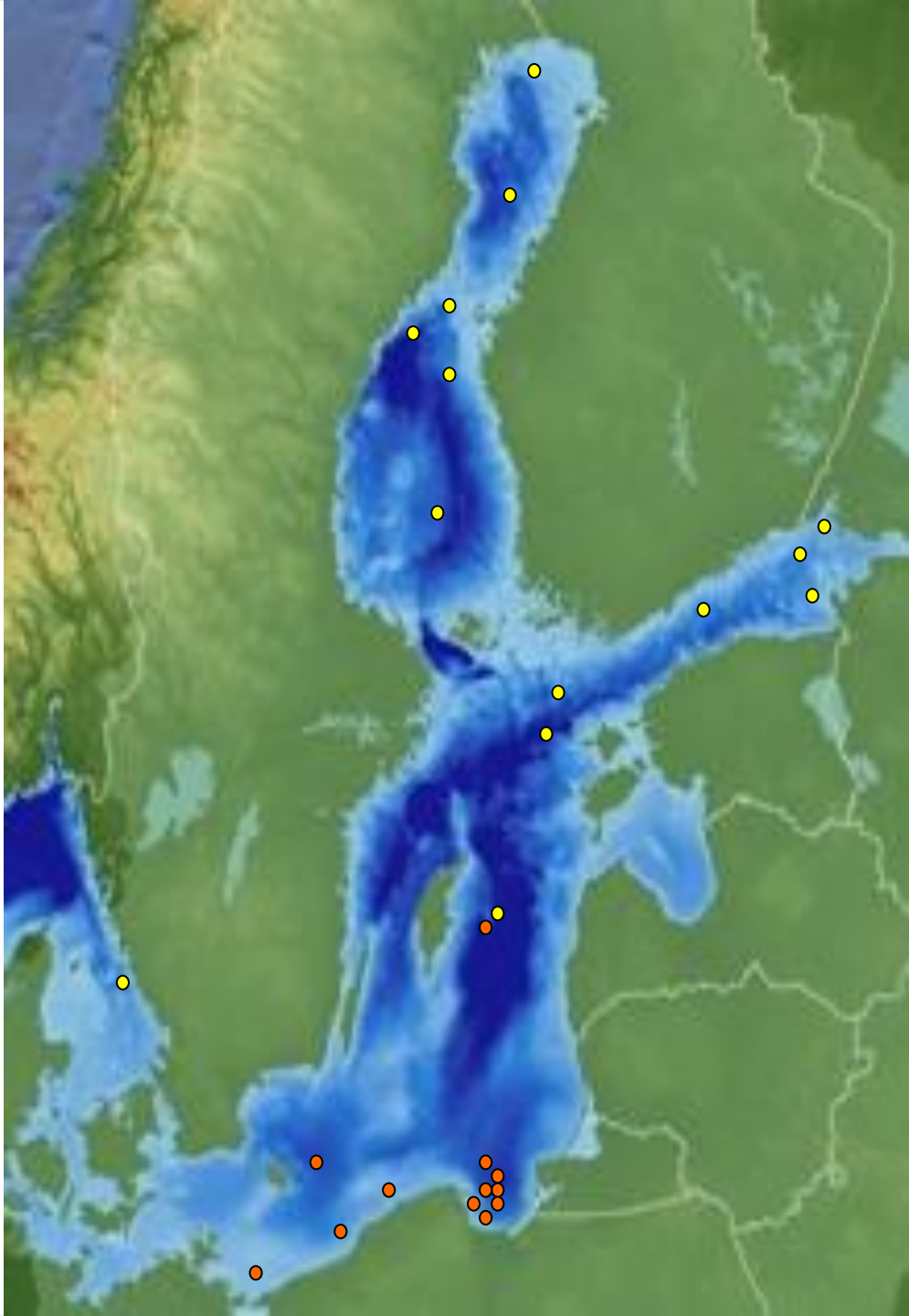
Conclusions

- **POC** – important for many physical, chemical and biological process in sea-water
- **POC** - source of carbon in sediment
- **POC** – can be modelled
- **POC** – increase of concetration in next decades is predicted

Plans for the future work

- To improve our model (POC-bacteria, DOC)
- Continuous model validation - in water column
- To analyse sources of POC in the coasted zone and in sediments (elemental analyses: N, C and stabile isotopes $\delta^{13}C$ and $\delta^{15}N$)

Analyses of sediment
(elemental analyses)
and
water samples
(POC, DOC, DIC)
from
r/v Aranda
and
r/v Oceania
cruise
and
use the results
to validate the model



Thank you.

Physical parameters model is based on

$$\frac{\partial u}{\partial t} - fv = \frac{\partial}{\partial z}\left(A_z \frac{\partial u}{\partial z} \right)$$

$$\frac{\partial v}{\partial t} - fu = \frac{\partial}{\partial z}\left(A_z \frac{\partial v}{\partial z} \right)$$

$$\frac{\partial T}{\partial t} = \frac{\partial}{\partial z}\left(A_z \frac{\partial T}{\partial z} - \frac{1}{c\rho} Q_g e^{-\beta z} \right)$$