INSTITUTE OF OCEANOLOGY
POLISH ACADEMY OF SCIENCES

Carbon return flux from the Baltic Sea sediments

Karol Kulinski, Anna Maciejewska, Aleksandra Szczepanska, Janusz Pempkowiak

Marine Chemistry and Biochemistry Department

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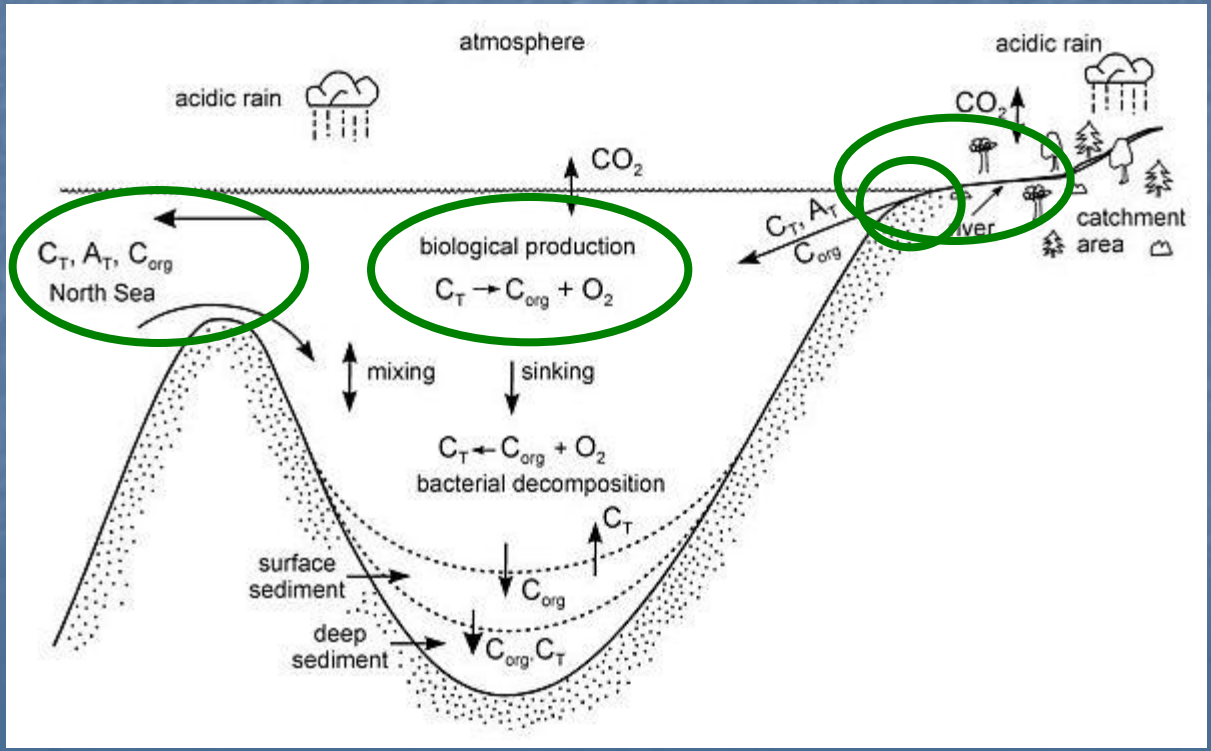
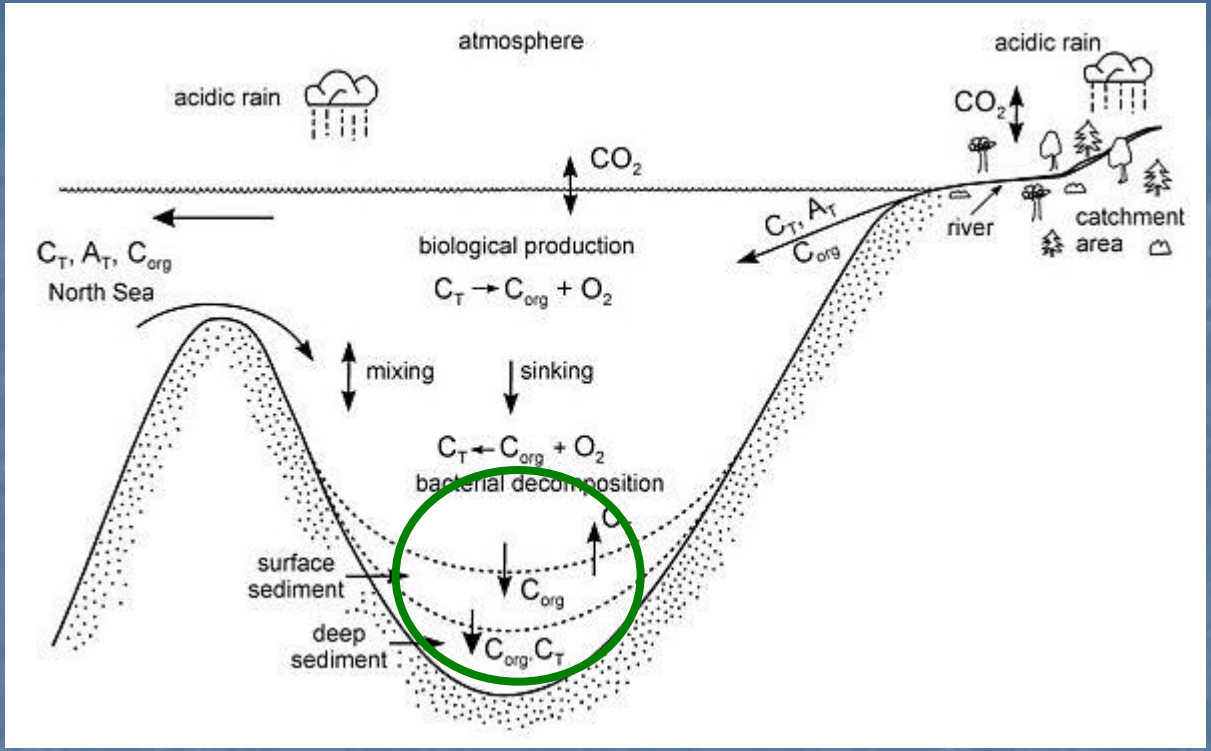
Sources of the organic matter in the Baltic Sea sediments:

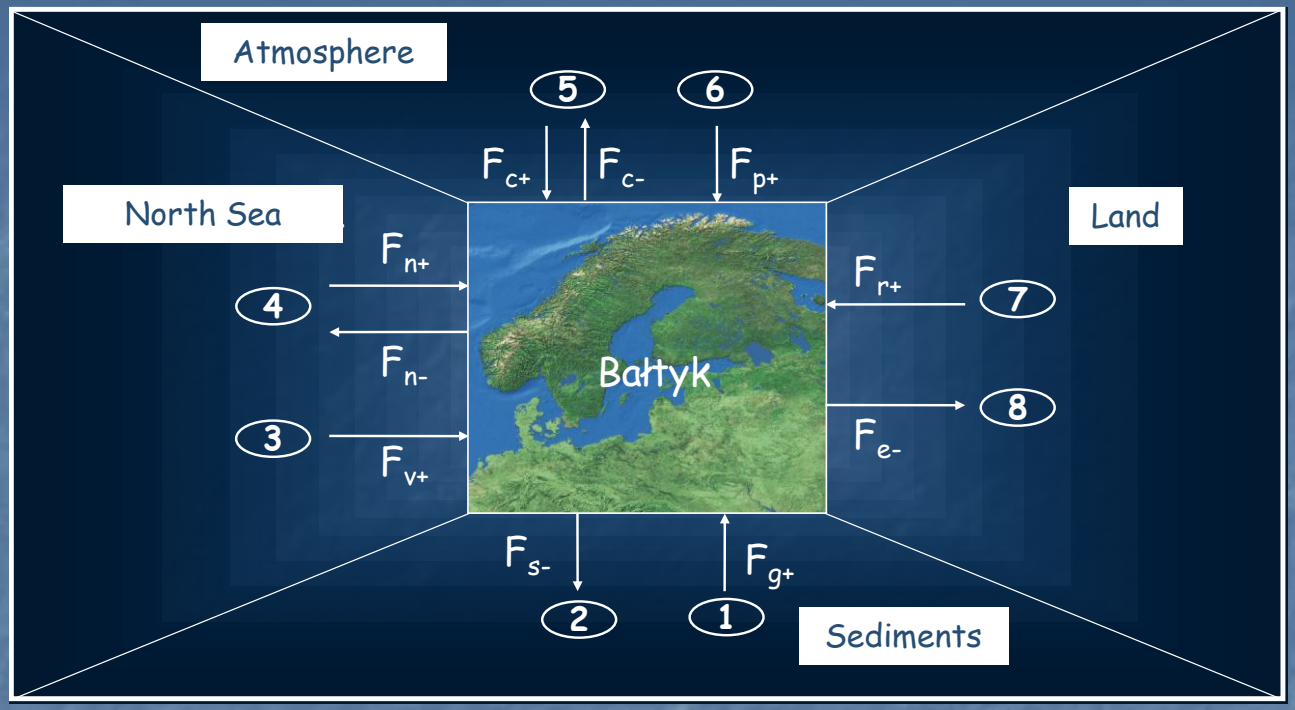
- autochtonous o. m. (primary production)
- land derived o. m. (via rivers)
- North Sea o. m. (via Danish Straits)
- benthos produced o. m. (coastal areas)





Baltic-C WP4 goals:

- What part of the deposited carbon is finally buried in the sediments?
- What is the carbon return flux from the sediments?



1 Groundwater seepage
2 Sedimentation
3 Ships pollution
4 North Sea + Baltic Sea water exchange
5 Air / Sea CO_2 exchange
6 Precipitation
7 Riverine runoff
8 Extraction

F... Carbon fluxes as a product of water volume and carbon concentration

Carbon load deposited to the sediments

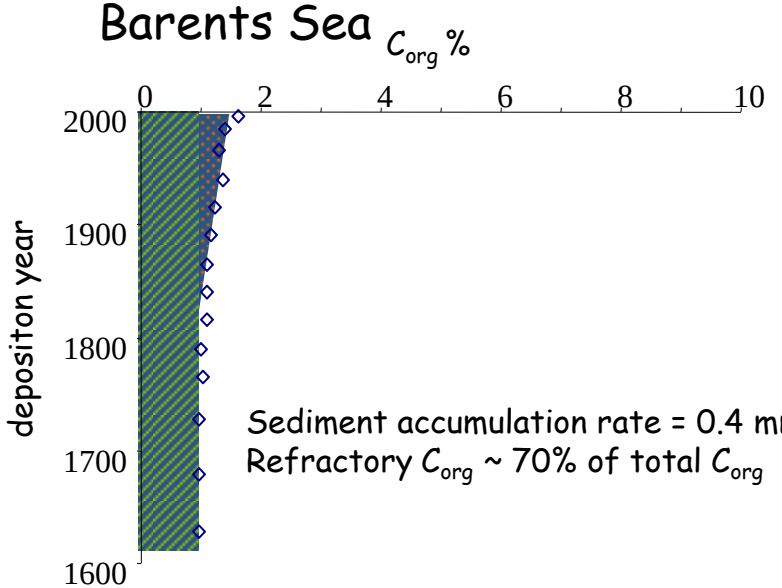
2,7 Tg C year^{-1}

Thomas et al., 2003

No data concerning carbon return flux from the sediments

Fresh organic matter production impact to sedimentary organic carbon

Barents Sea



Sediment accumulation rate = 0.4 mm/year
Refractory C_{org} ~ 70% of total C_{org}

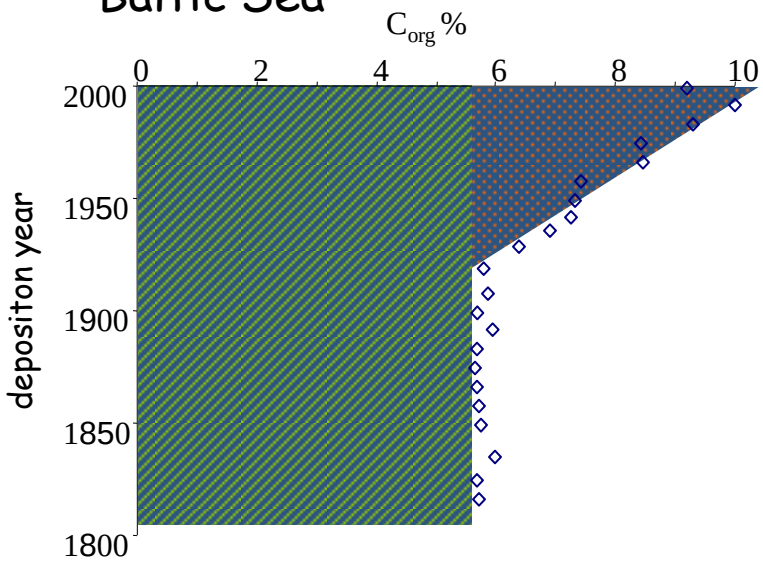
Refractory C_{org}

Labile C_{org}

Refractory Corg from eutrophication?

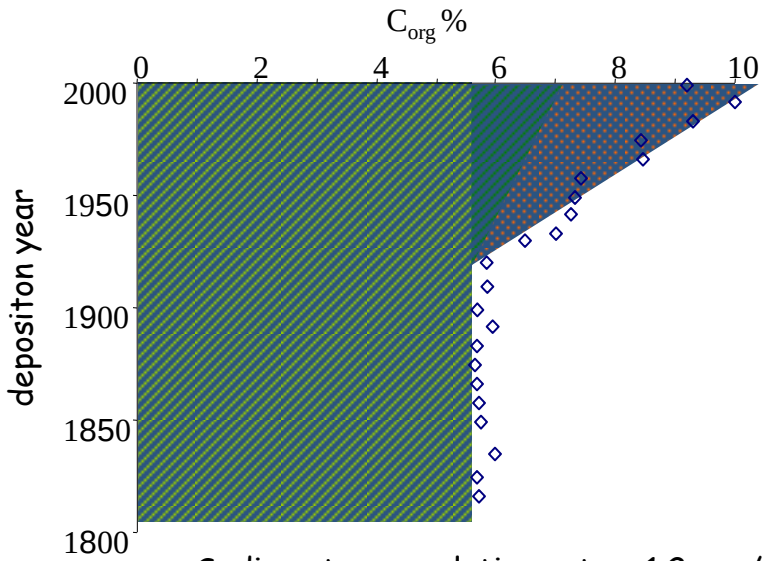
Baltic Sea

no-eutrophication scenario



Sediment accumulation rate = 1.2 mm/year
Refractory C_{org} ~ 55% of total C_{org}

eutrophication scenario



Sediment accumulation rate = 1.2 mm/year
Refractory C_{org} ~ 70% of total C_{org}?

Methods of the carbon return flux estimation from the bottom sediments:

- DIC and DOC concentrations gradient in the pore waters

$$J = -\phi D_{sed} \frac{\Delta C}{\Delta x}$$

J – diffusion flux

ϕ – porosity

D_{sed} – sediement diffusion coefficien t

$\frac{\Delta C}{\Delta x}$ – carbon concentrat ions gradient

$$D_{sed} = \frac{D_0}{\phi F}$$

$$F = \frac{1}{\phi^m}$$

D_0 – molecular diffusion coefficien t

F – tortuosity dependent factor

m – constant

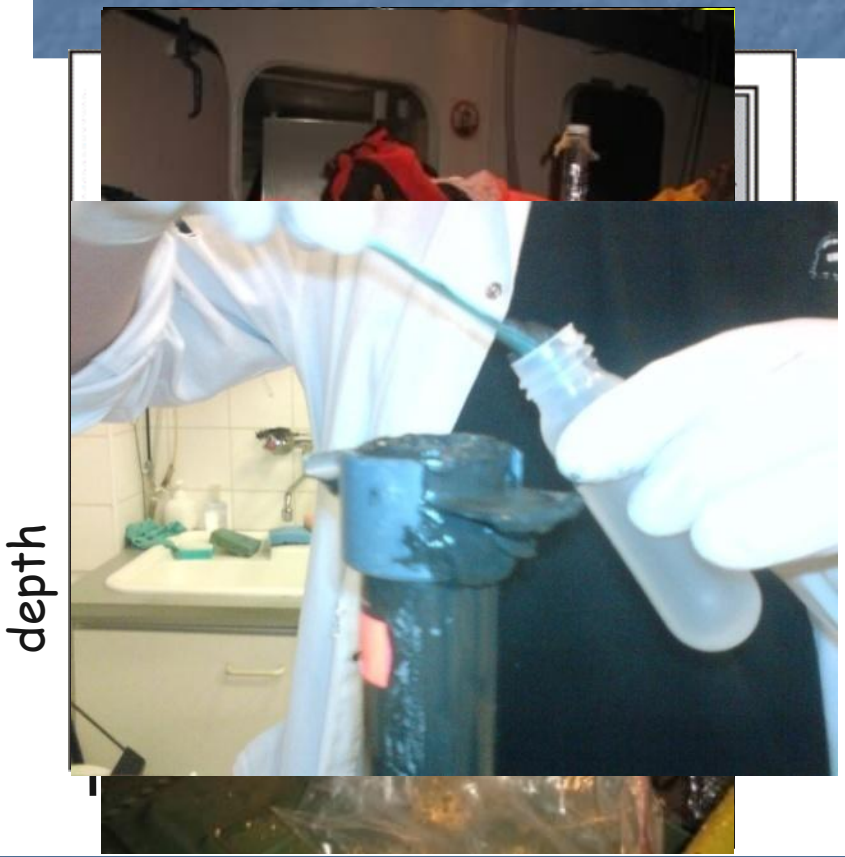
Ullman & Aller, 1982

Methods of the carbon return flux estimation from the bottom sediments:

- DIC and DOC concentrations gradient in the pore waters
- „Time Capsule"

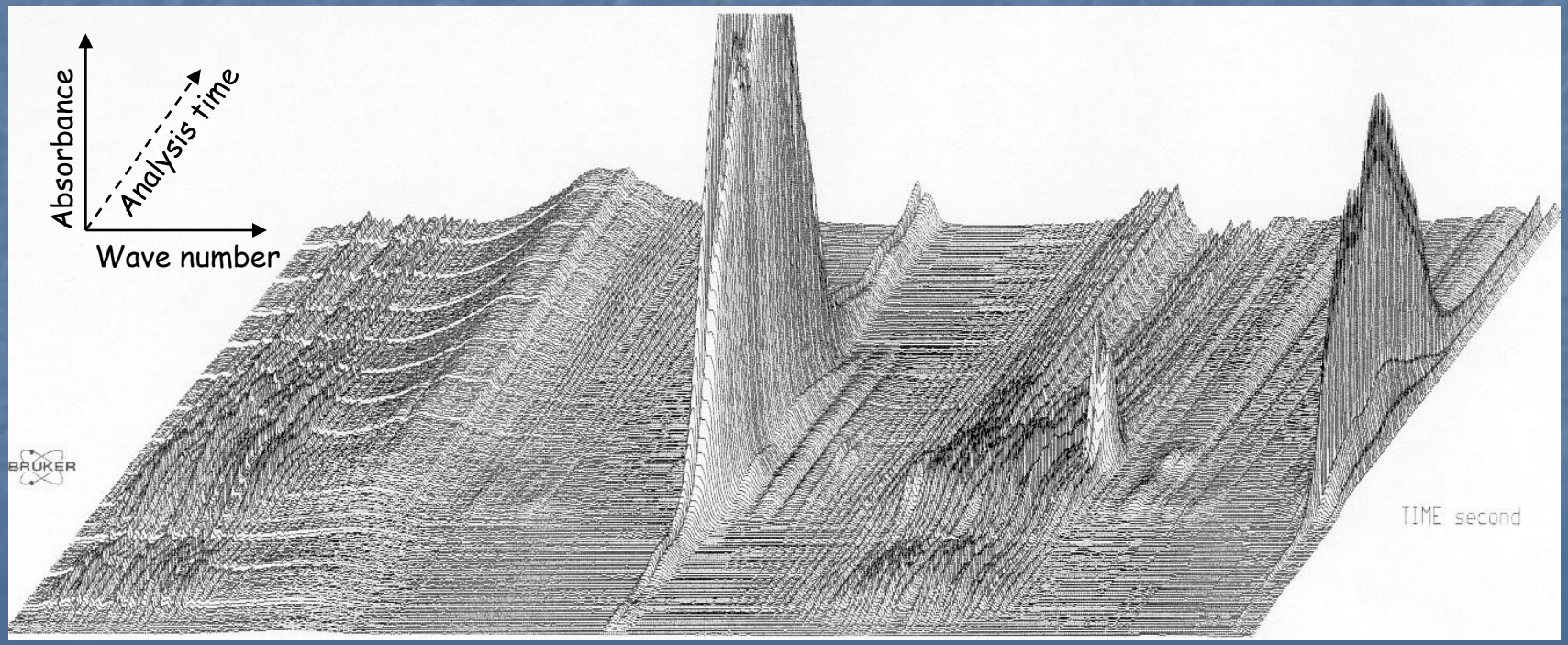
Incubation conditions:

- temp=17.0 0.5°C
- Ar atmosphere
- darkness



Methods of the carbon return flux estimation from the bottom sediments:

- DIC and DOC concentrations gradient in the pore waters
- „Time Capsule"
- Thermogravimetry (TG+IR)



Methods of the carbon return flux estimation from the bottom sediments:

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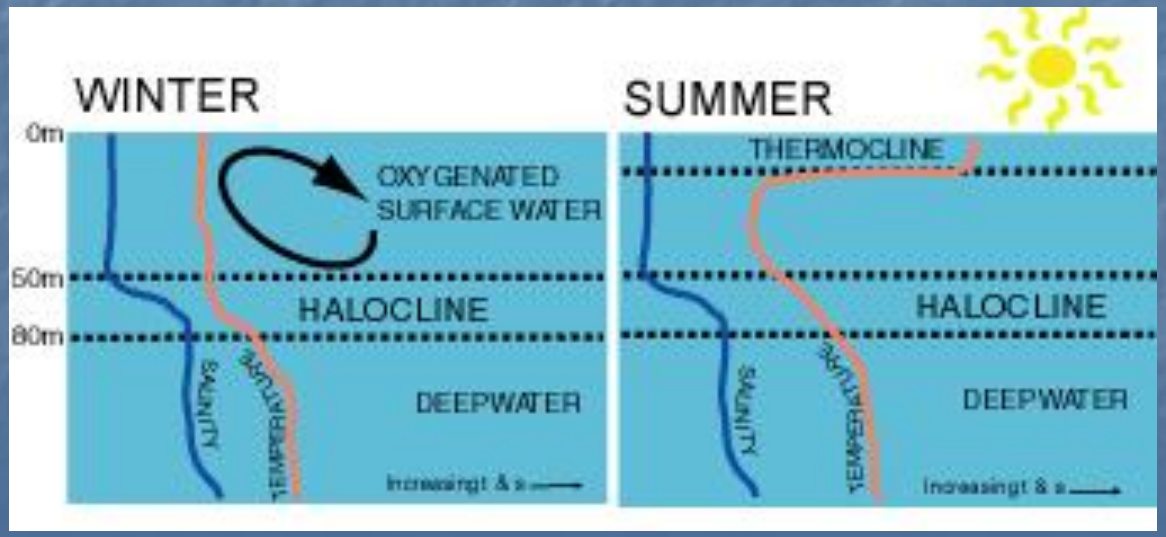

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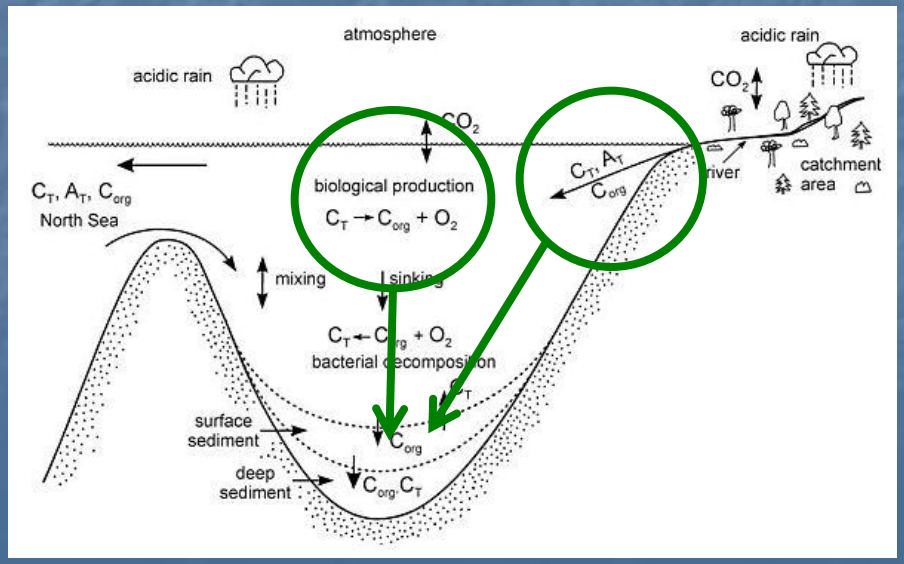
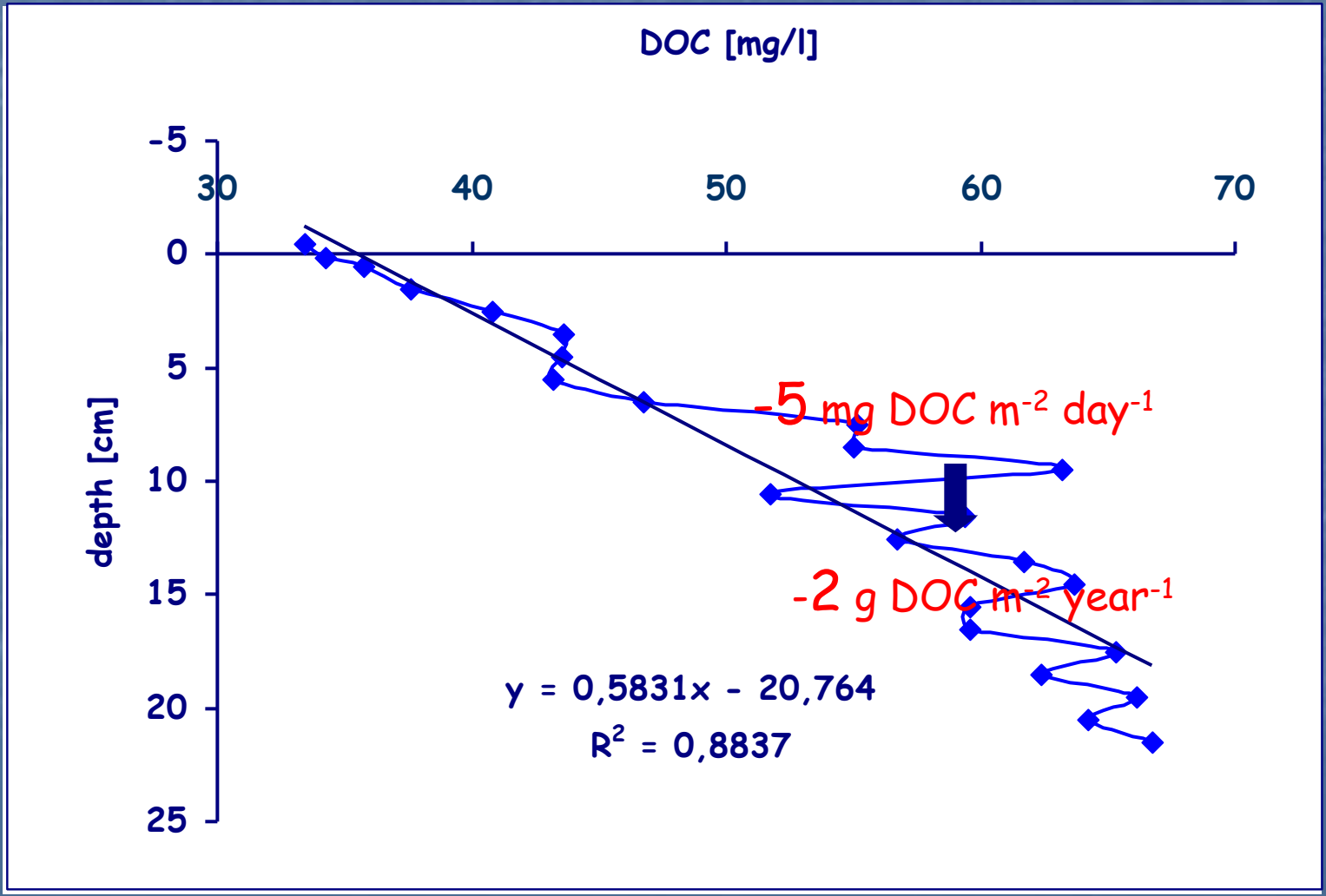
Methods of the carbon return flux estimation from the bottom sediments:

- DIC and DOC concentrations gradient in the pore waters
- „Time Capsule"
- Thermogravimetry (TG+IR)
- Dissolved carbon concentration increase in the deep water layer (Bernd Schneider)
- Isotopic composition of the organic matter in the sediments



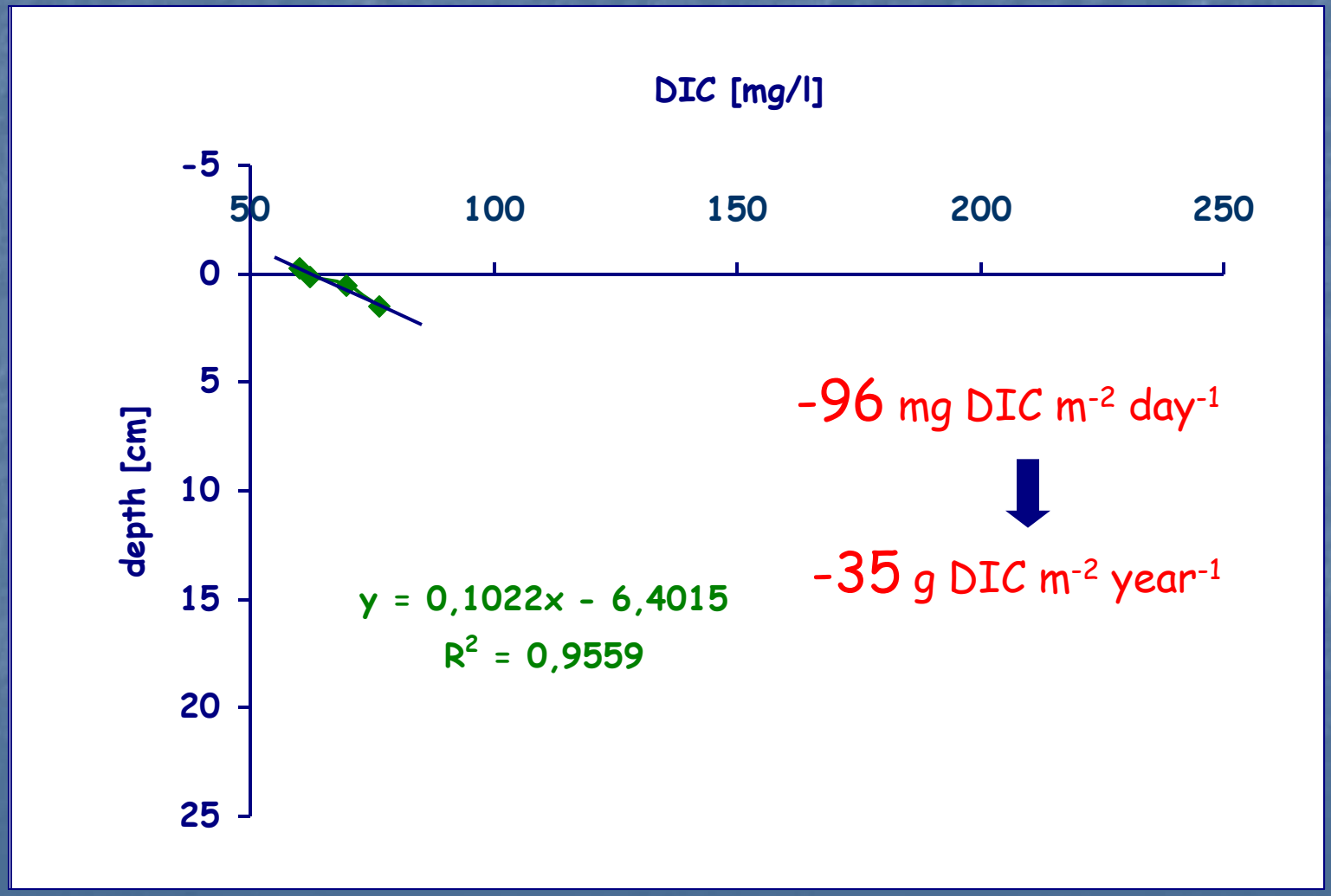
diffusion

DOC concentrations gradient



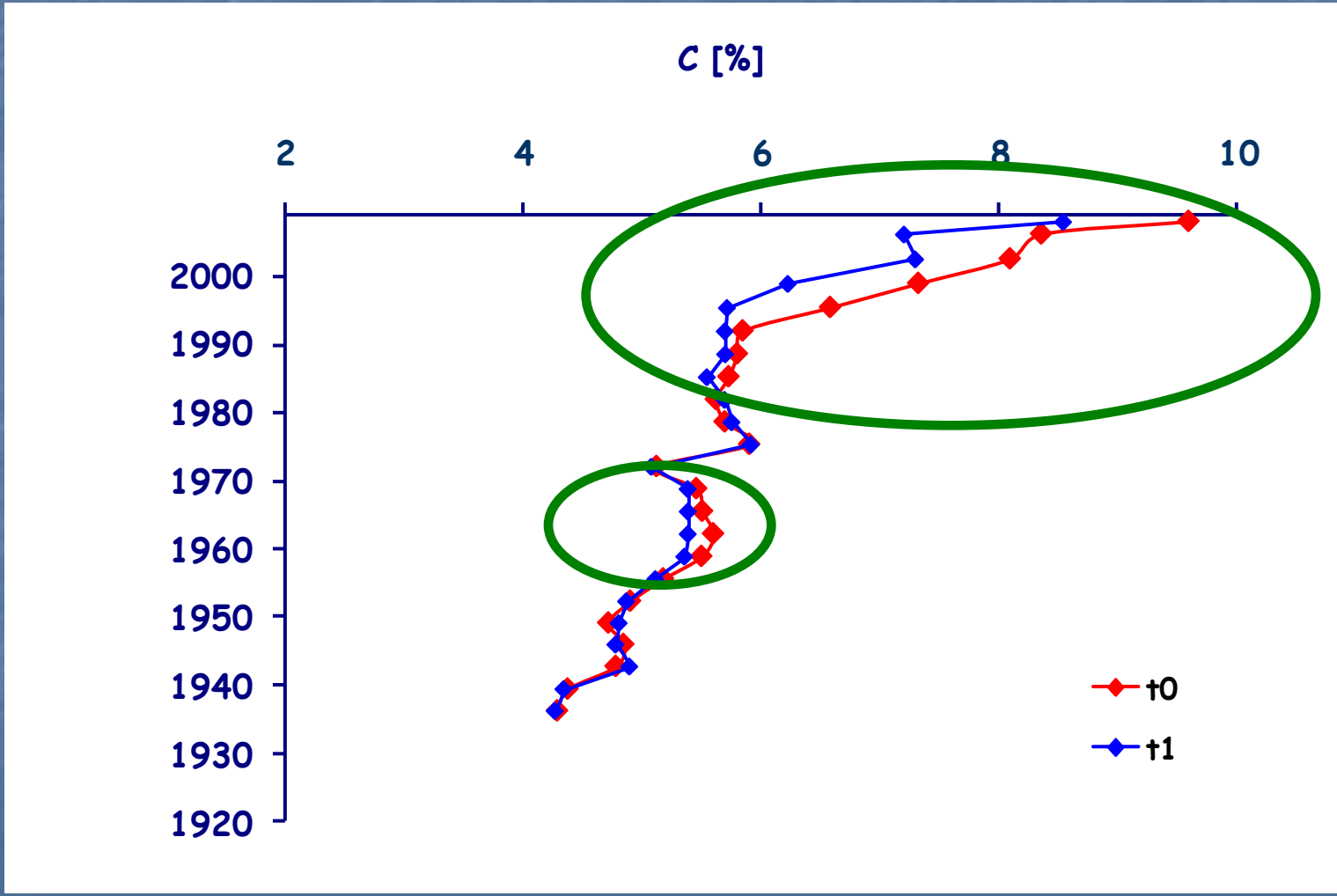
diffusion

DIC concentrations gradient



„Time Capsule"

C concentration changes after first stage of the experiment



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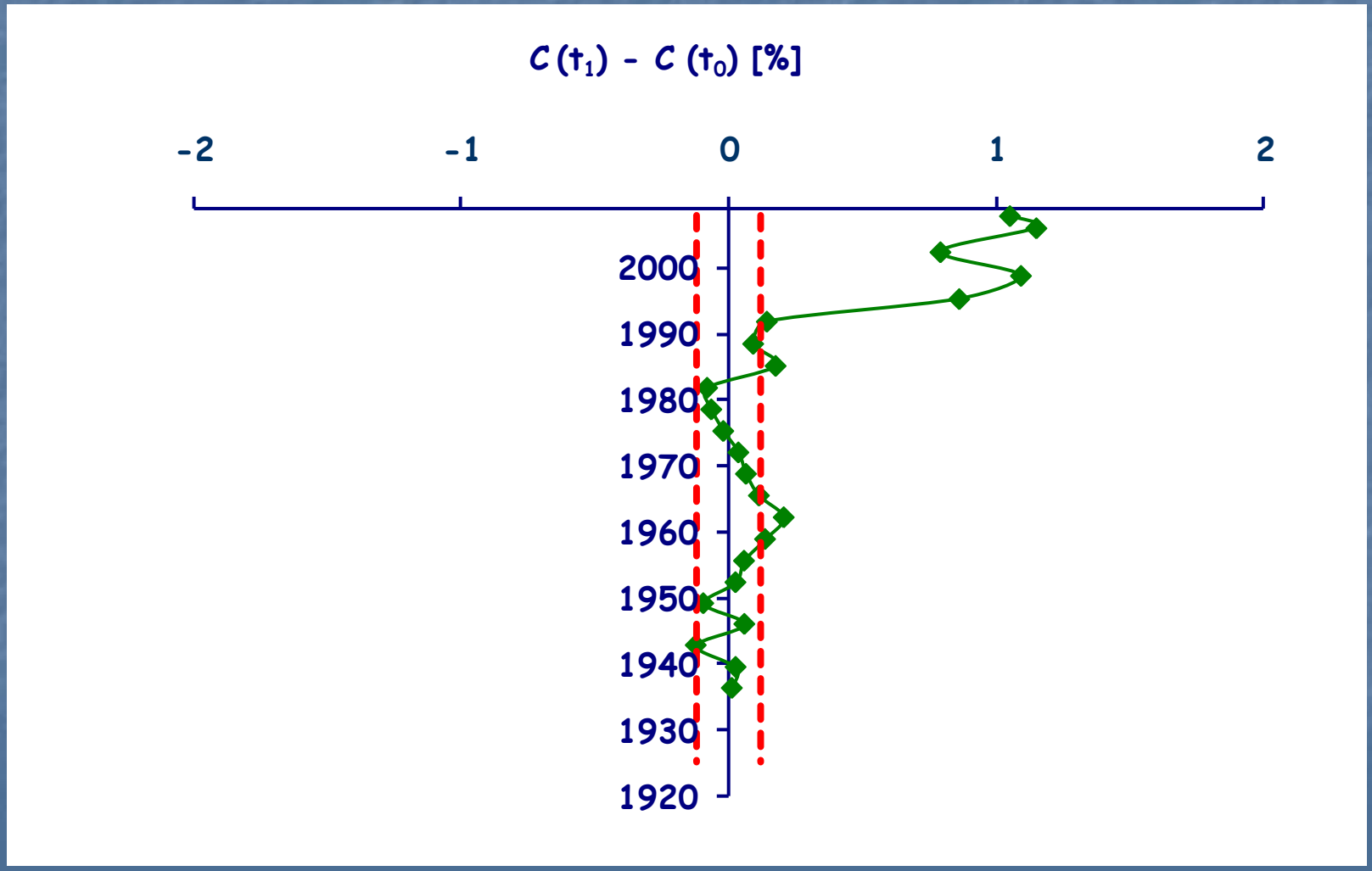


„Time Capsule"

$$C_{org} \rightarrow A + B + \ldots$$

$$\frac{-d[C_{org}]}{dt} = k[C_{org}]$$

$$\frac{d[C_{org}]}{[C_{org}]} = -k\,dt$$

$$\int_{[C_{org}]_0}^{[C_{org}]_t} \frac{d[C_{org}]}{[C_{org}]} = -\int_{t_0}^{t} k\,dt$$

$$[C_{org}]_t = [C_{org}]_0 \cdot e^{-kt}$$

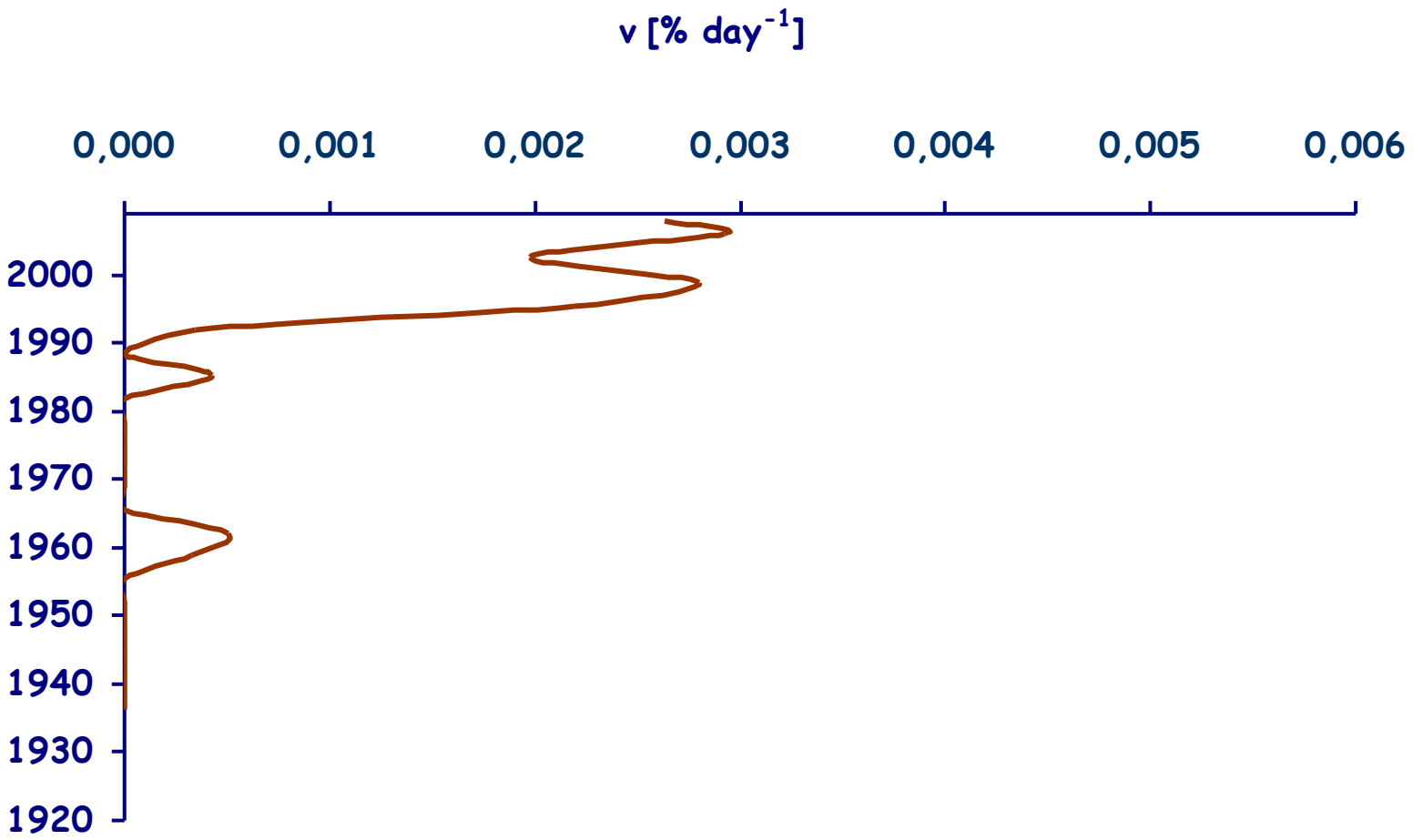
$$k = -\ln \sqrt[t]{\frac{[C_{org}]_t}{[C_{org}]_0}}$$

$$10°C \text{ temperatur e} \uparrow$$
$$\Downarrow$$
$$k \text{ double} \uparrow$$

$$v = k[C_{org}]$$

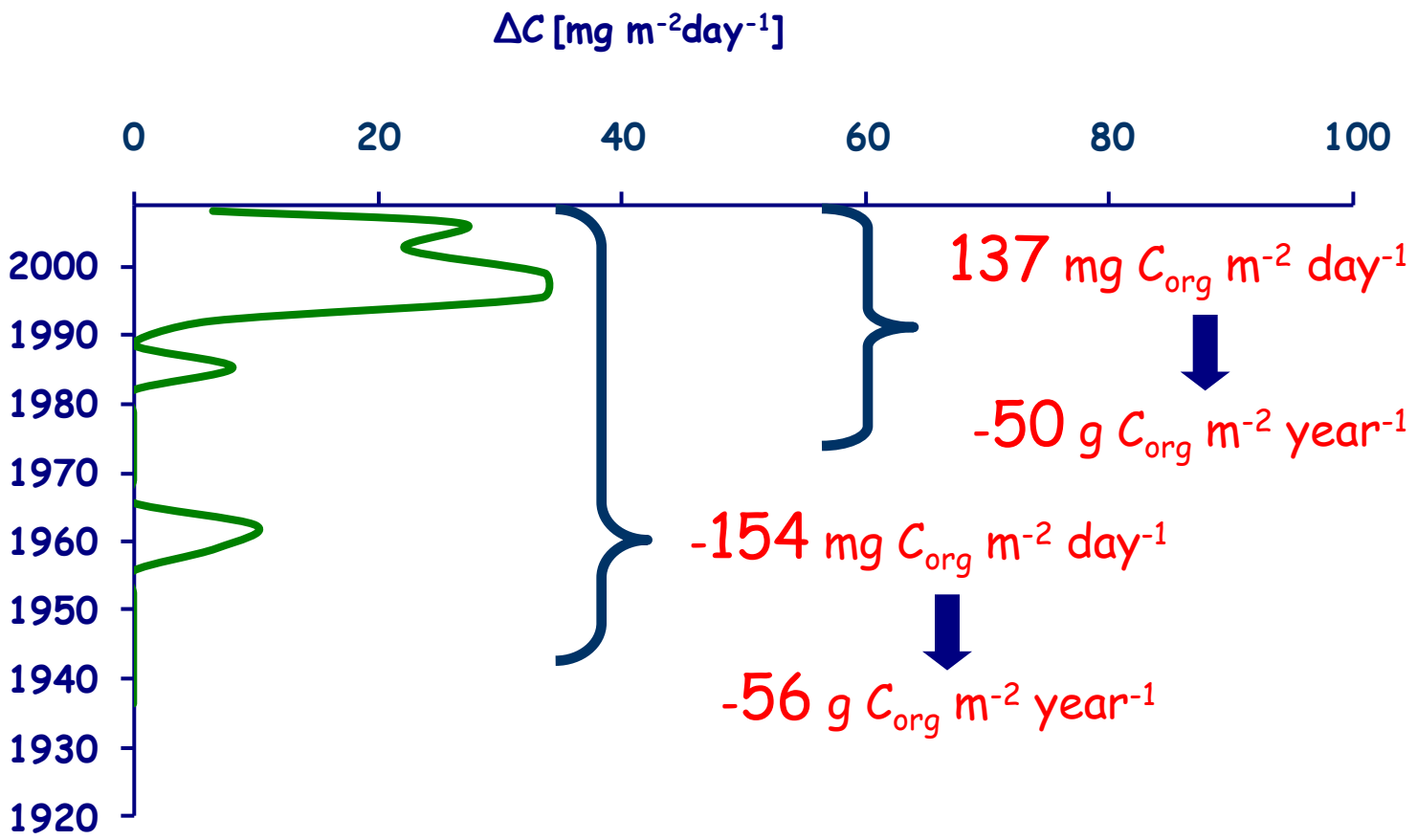
„Time Capsule"

Velocity of the decomposition and mineralization processes of C in the bottom sediments

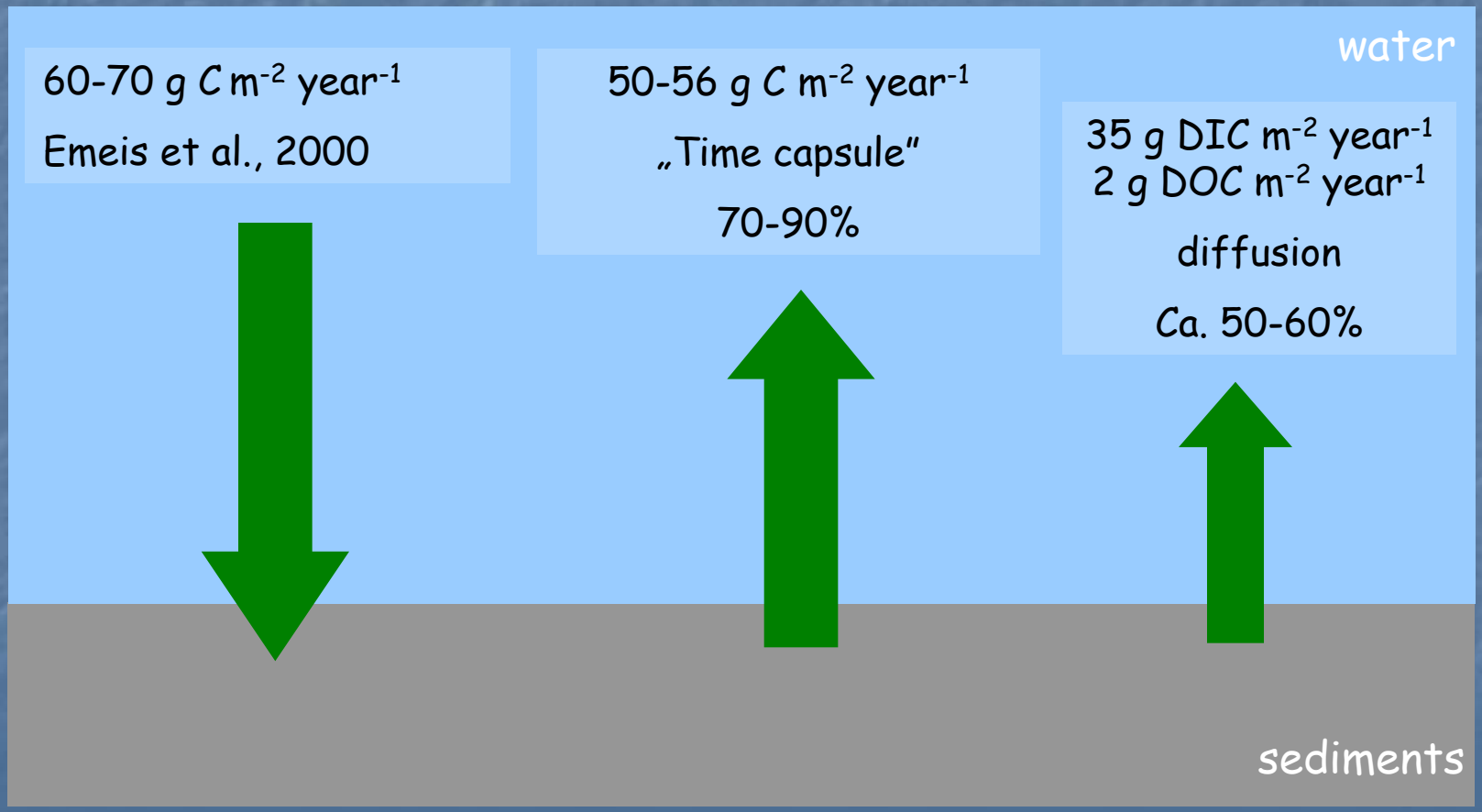


„Time Capsule"

Carbon return flux from the bottom sediments



- Results of „Time Capsule" experiment can be overestimated because of the higher mineralization and decomposition velocity in the first part of the experiment

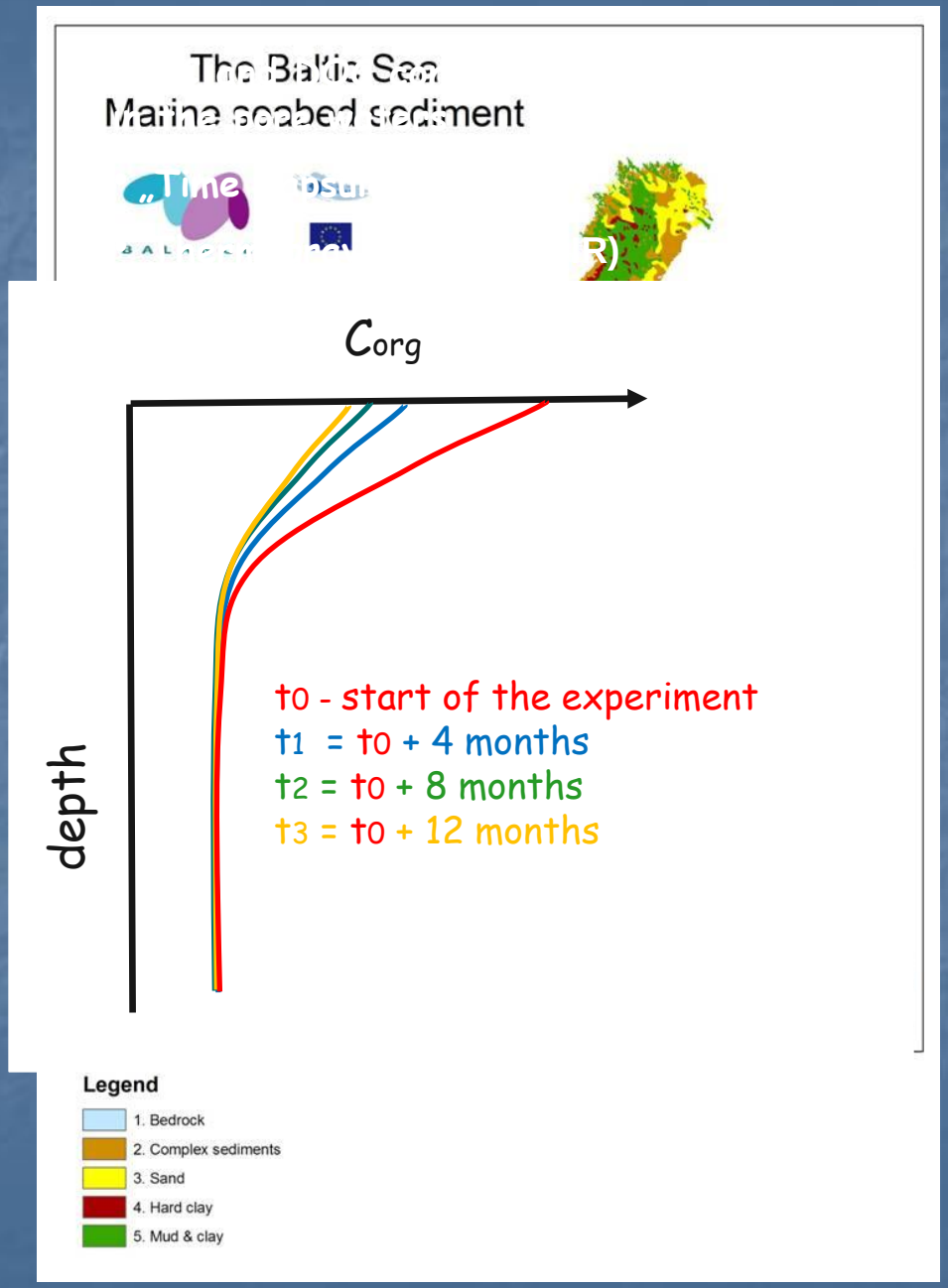


Summary:

- methods are identified
- limited accuracy and precision

Future plans:

- continuation of the „Time Capsule" experiment
- data from other regions of the Baltic Sea
- carbon return flux from the sandy sediments
- comparison of the results of all the identified methods



Thank you