INSTITUTE OF OCEANOLOGY
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Carbon stable isotopes – a useful tool for the carbon cycling study in the Baltic Sea

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Outline:
- introduction
- $\delta^{13}C$ in the Baltic Sea
- perspectives

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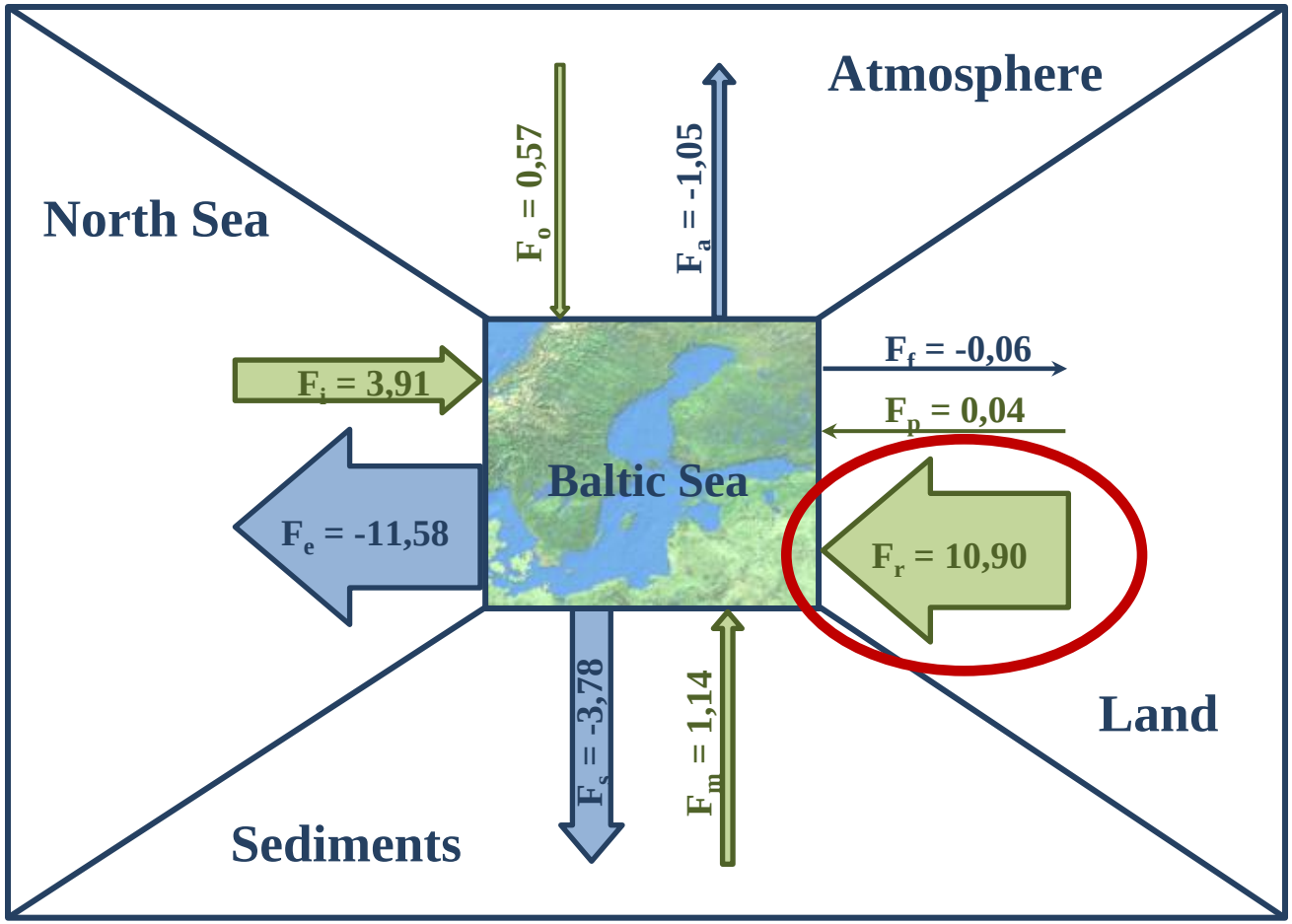
The carbon budget of the Baltic Sea



Values are in Tg (10^{12} g) C yr^{-1}

River run-off
IC: 62%
OC: 38%

Import from the North Sea
IC: 95%
OC: 5%

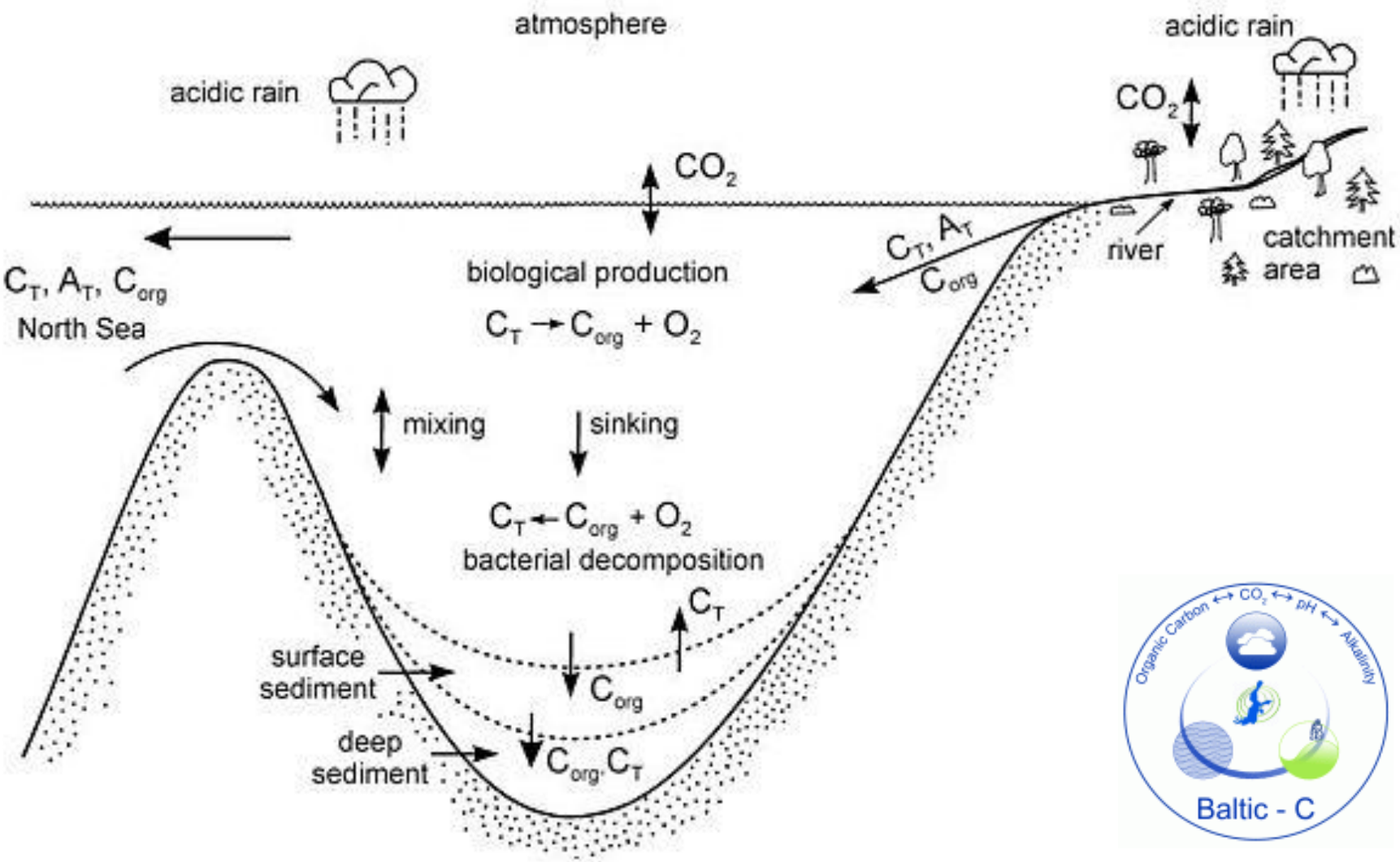
Export to the North Sea
IC: 83%
OC: 17%

Return flux from the sediments
IC: 91%
OC: 9%

Terrestrial C_{org} input 4.14 Tg C yr^{-1} ($0.34 \cdot 10^{12}$ moles C_{org} yr^{-1})

Terrestrial organic carbon in the Baltic Sea

$$C_{org} = DOC + POC$$



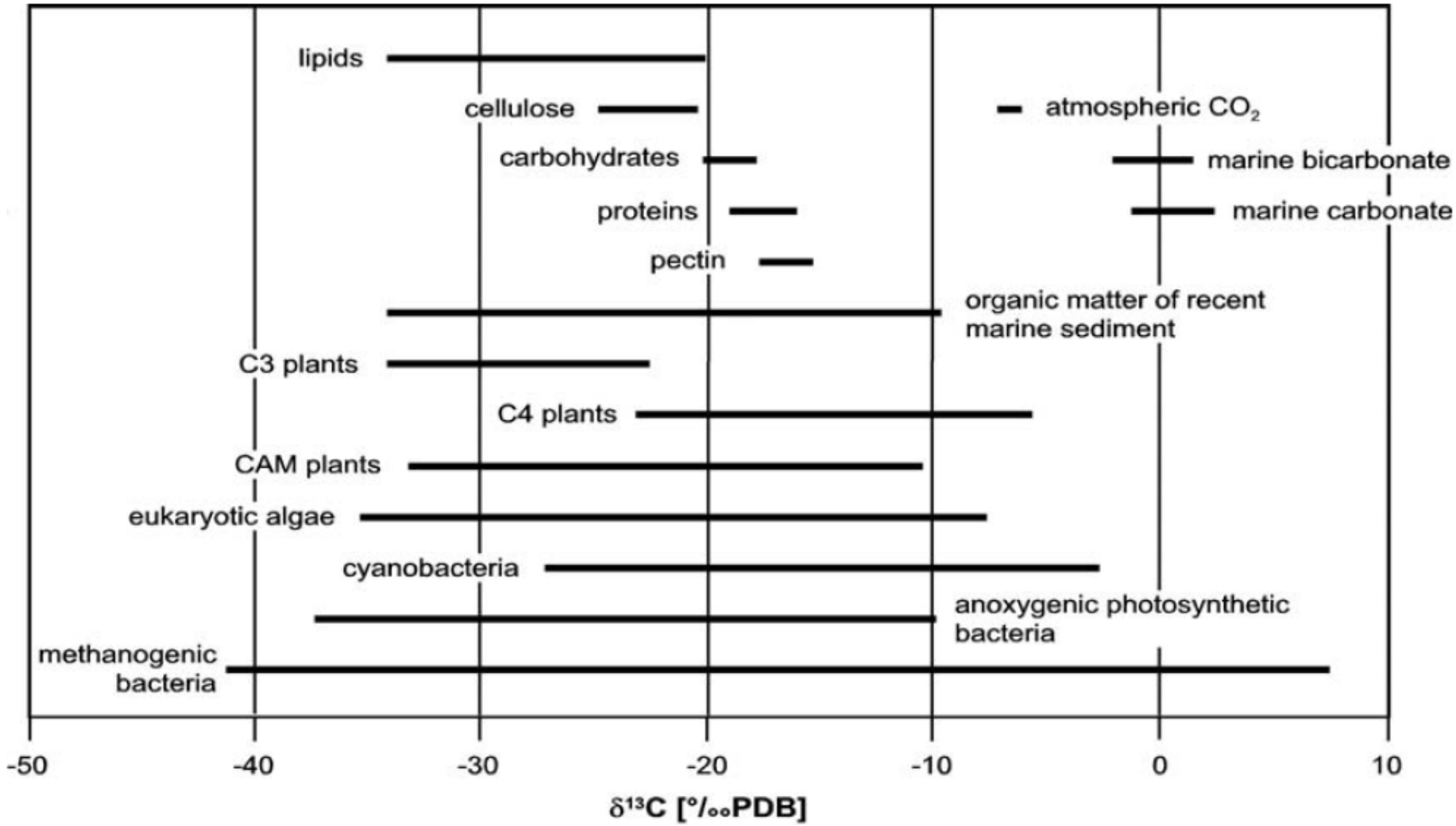
$\delta^{13}C$ - an isotopic fingerprint

$$\delta^{13}\mathrm{C} = \left(\frac{\left(\frac{^{13}\mathrm{C}}{^{12}\mathrm{C}}\right)_{\mathrm{sample}}}{\left(\frac{^{13}\mathrm{C}}{^{12}\mathrm{C}}\right)_{\mathrm{standard}}} - 1 \right) \times 1000\ ^{o}/_{oo}$$

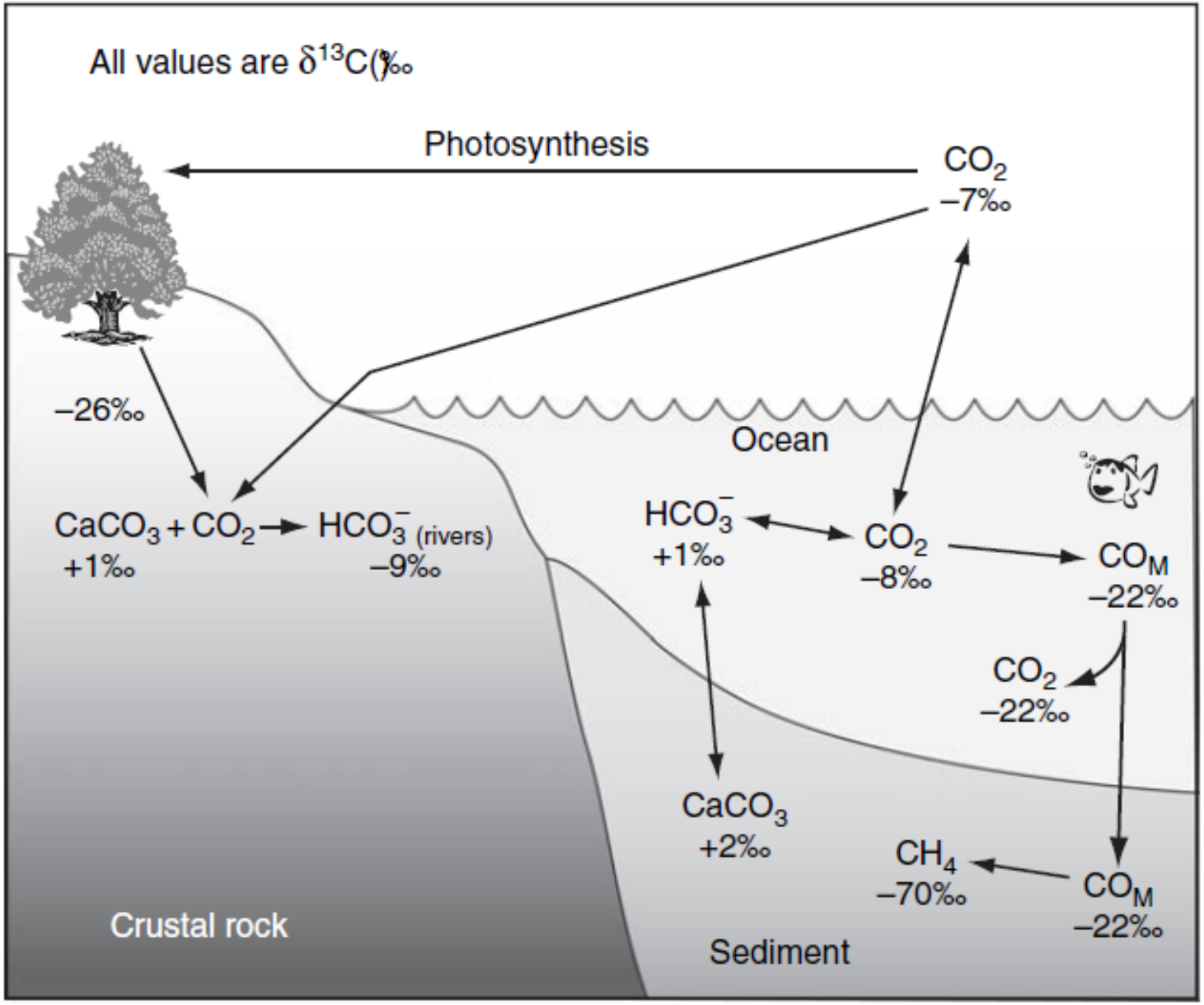
Standard – PDB (Pee Dee Belemnite)

Reference materials provided by IAEA

Carbon isotopic composition of autotrophic marine and terrestrial organisms in comparison to the range observed in inorganic and organic compounds (Schulz & Zabel, 2006)

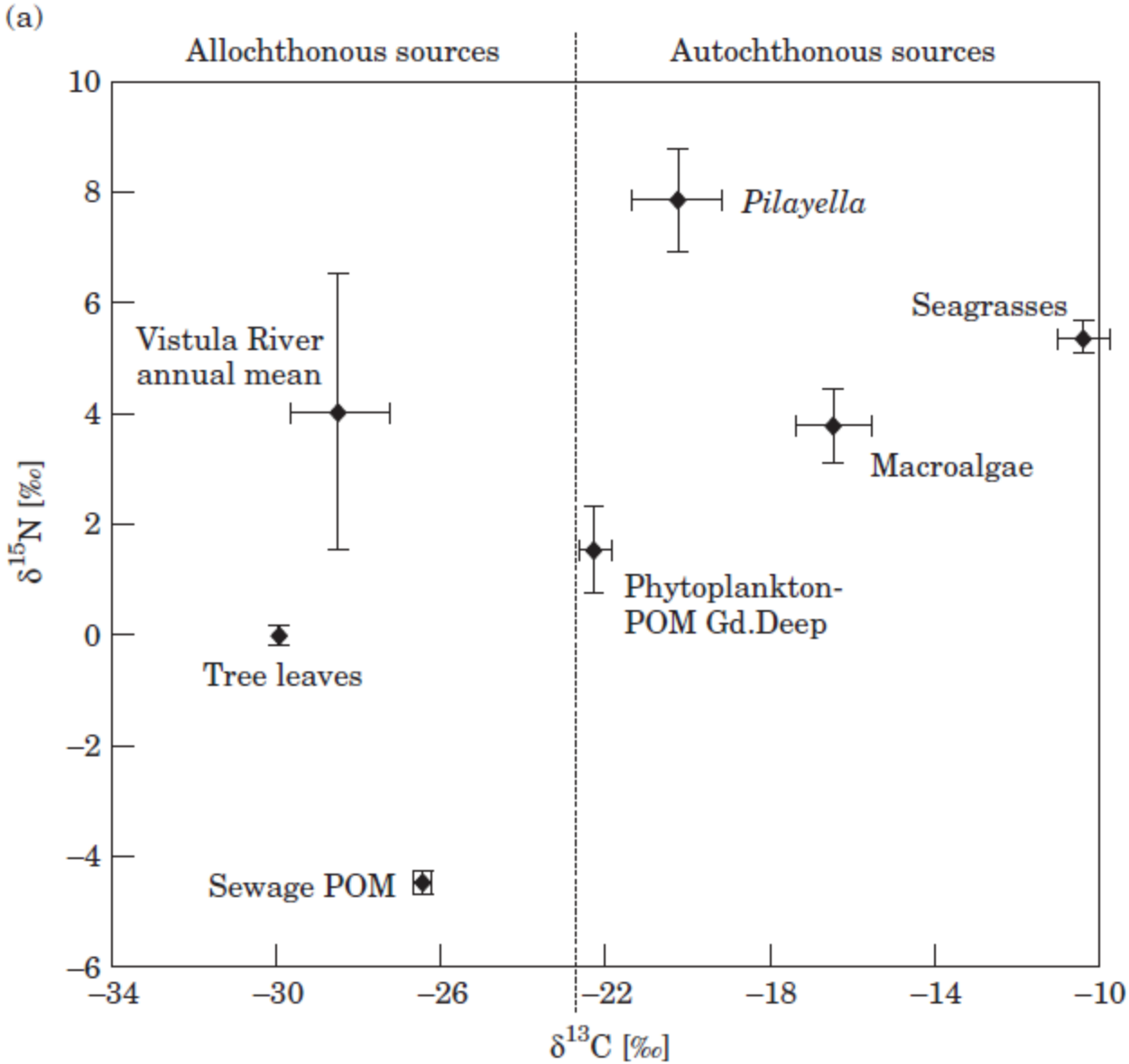


Carbon isotopic fractionation



Emerson & Hedges, 2008

$\delta^{13}C$ in the Baltic Sea



Maksymowska et al., 2000

$\delta^{13}C$ in the Baltic Sea

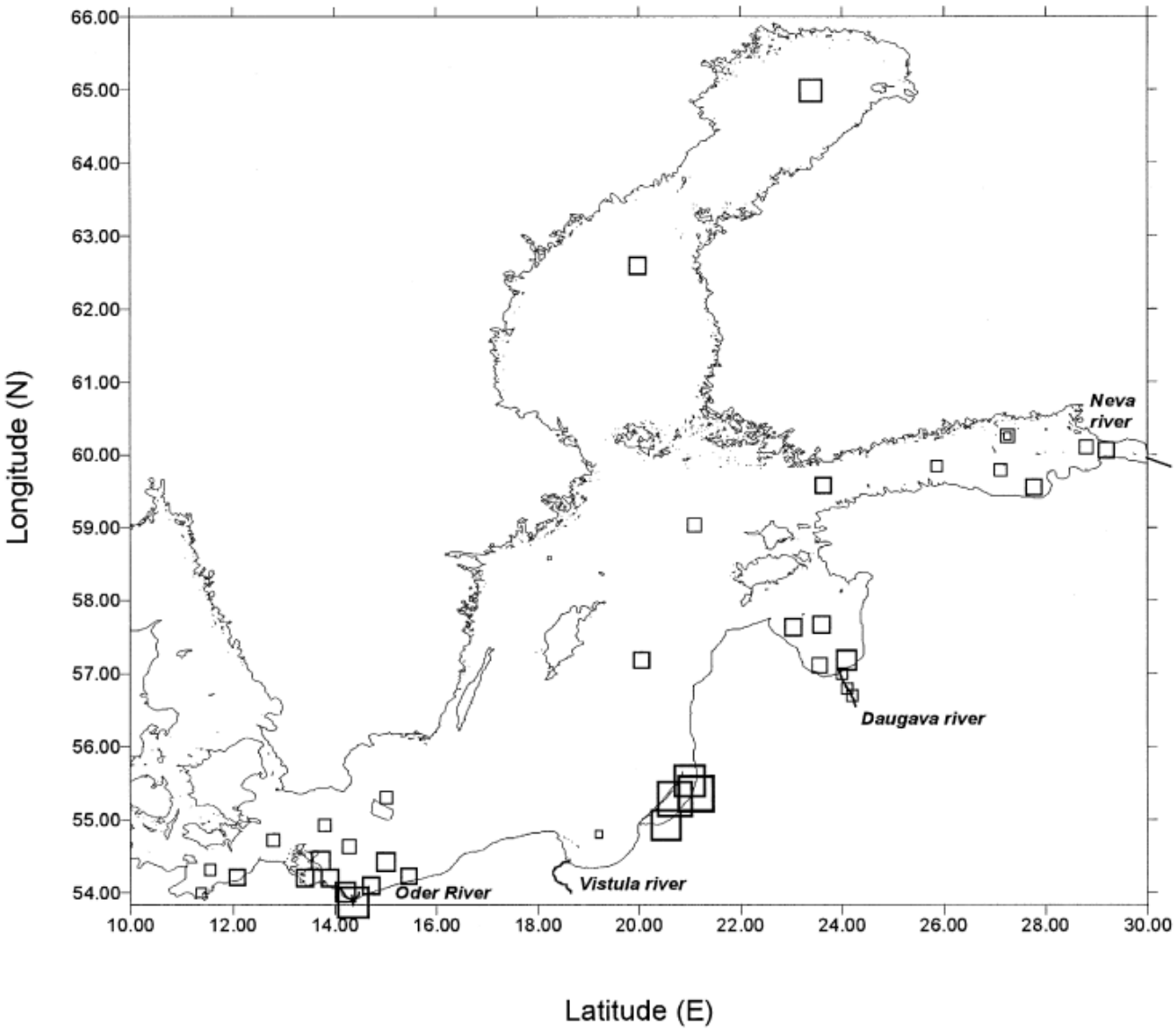


Fig. 5. Delta $\delta^{13}C$ values of surface sediments shown as squares proportional to the respective values (from 0.03 to 0.35 in. for values of −19.5‰ to −30.0‰, respectively).

Voss et al., 2000

$\delta^{13}C$ in the Baltic Sea

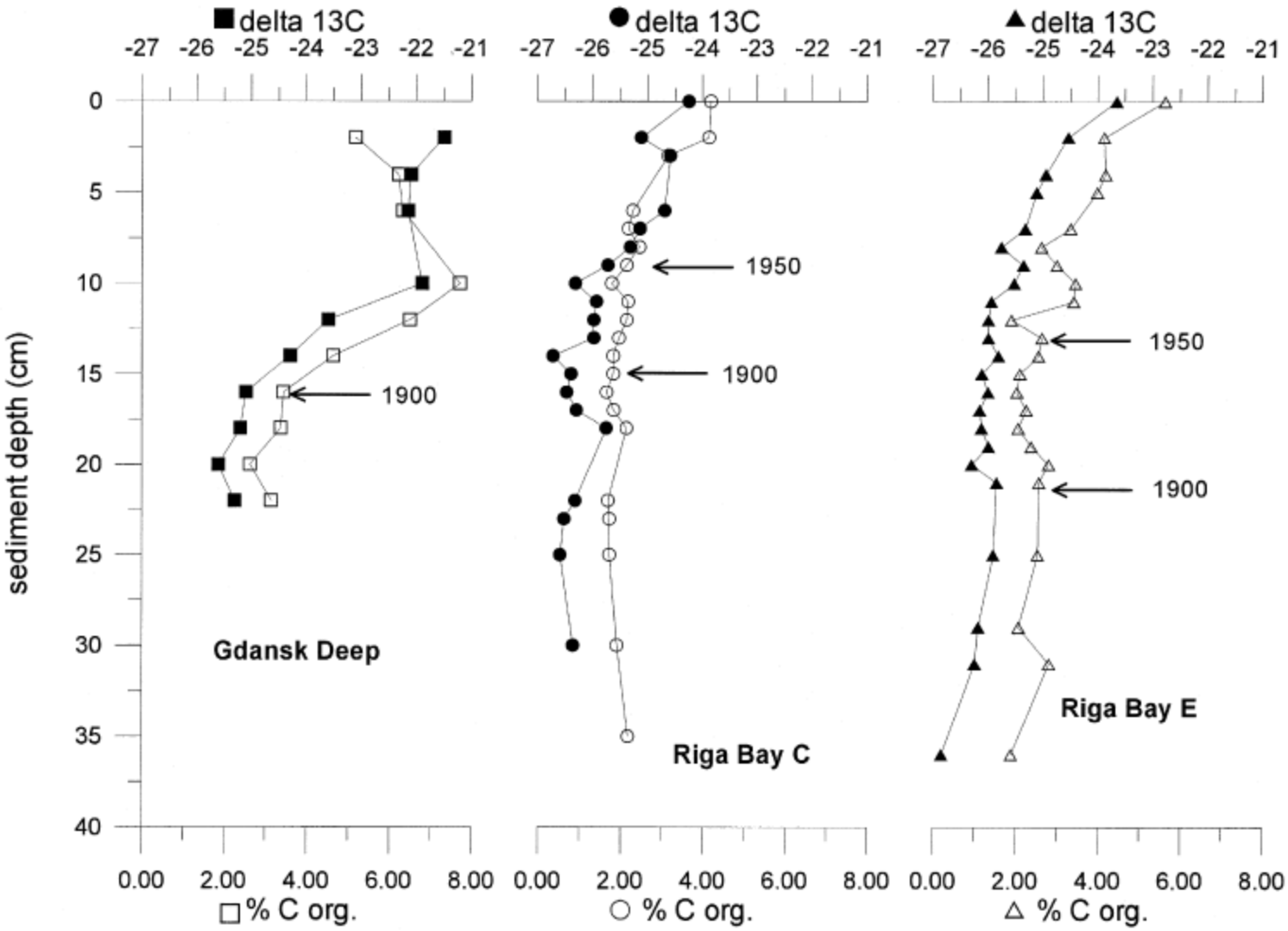
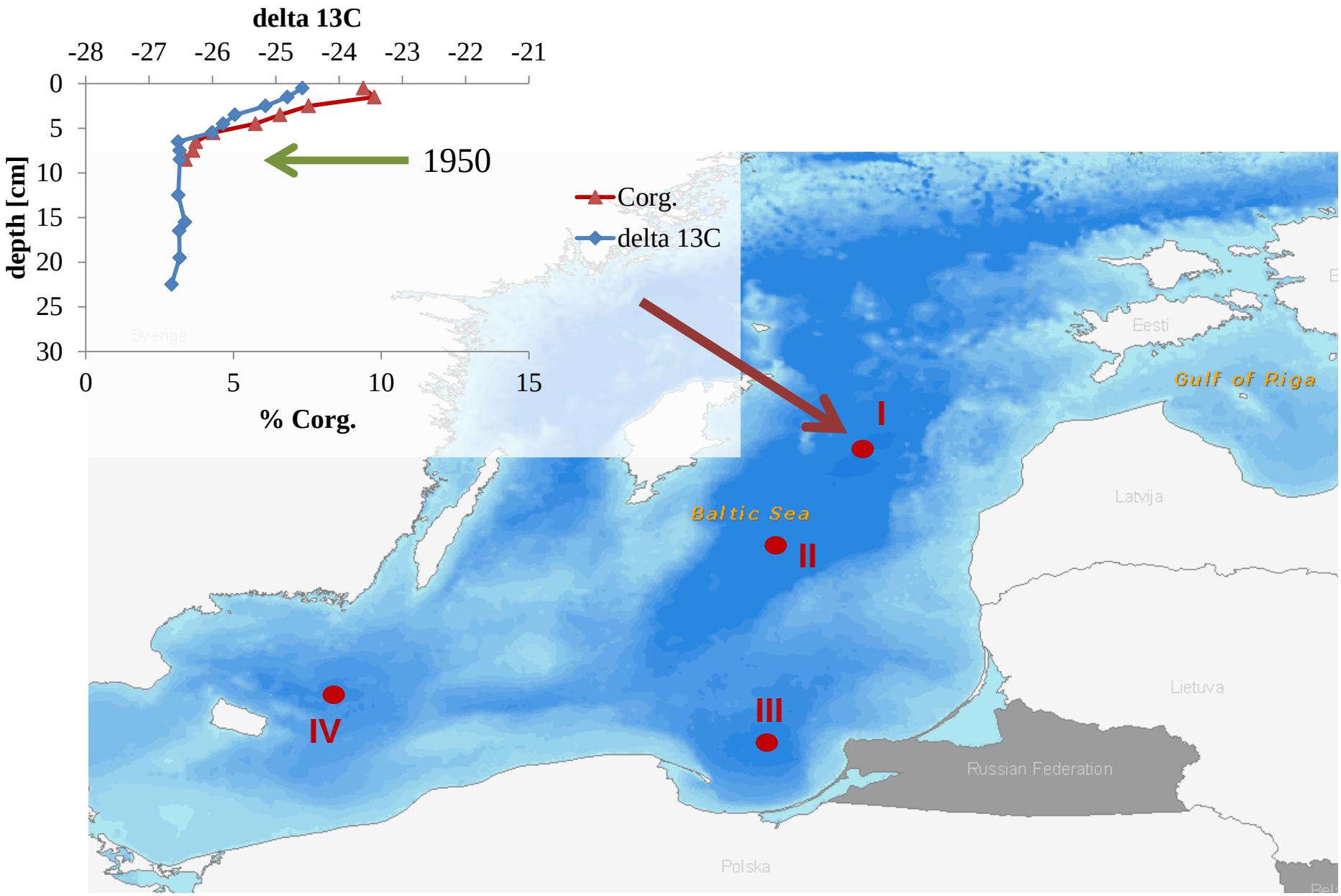


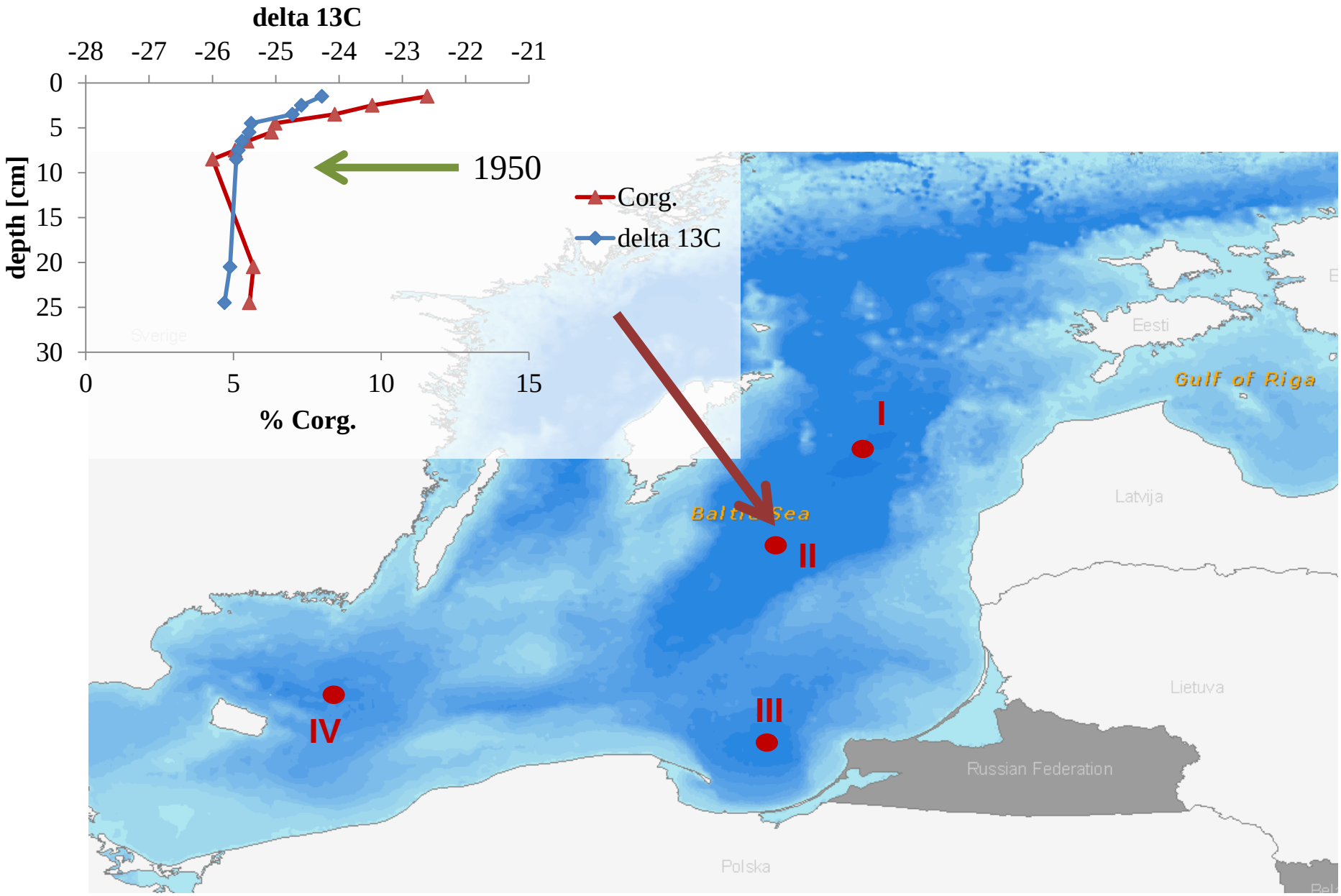
Fig. 6. $\delta^{13}C$ values and %wt. organic C of sediments of the Gdansk Deep and the Gulf of Riga.

Voss et al., 2000

$\delta^{13}C$ profiles in the Baltic Sea sediments



$\delta^{13}C$ profiles in the Baltic Sea sediments



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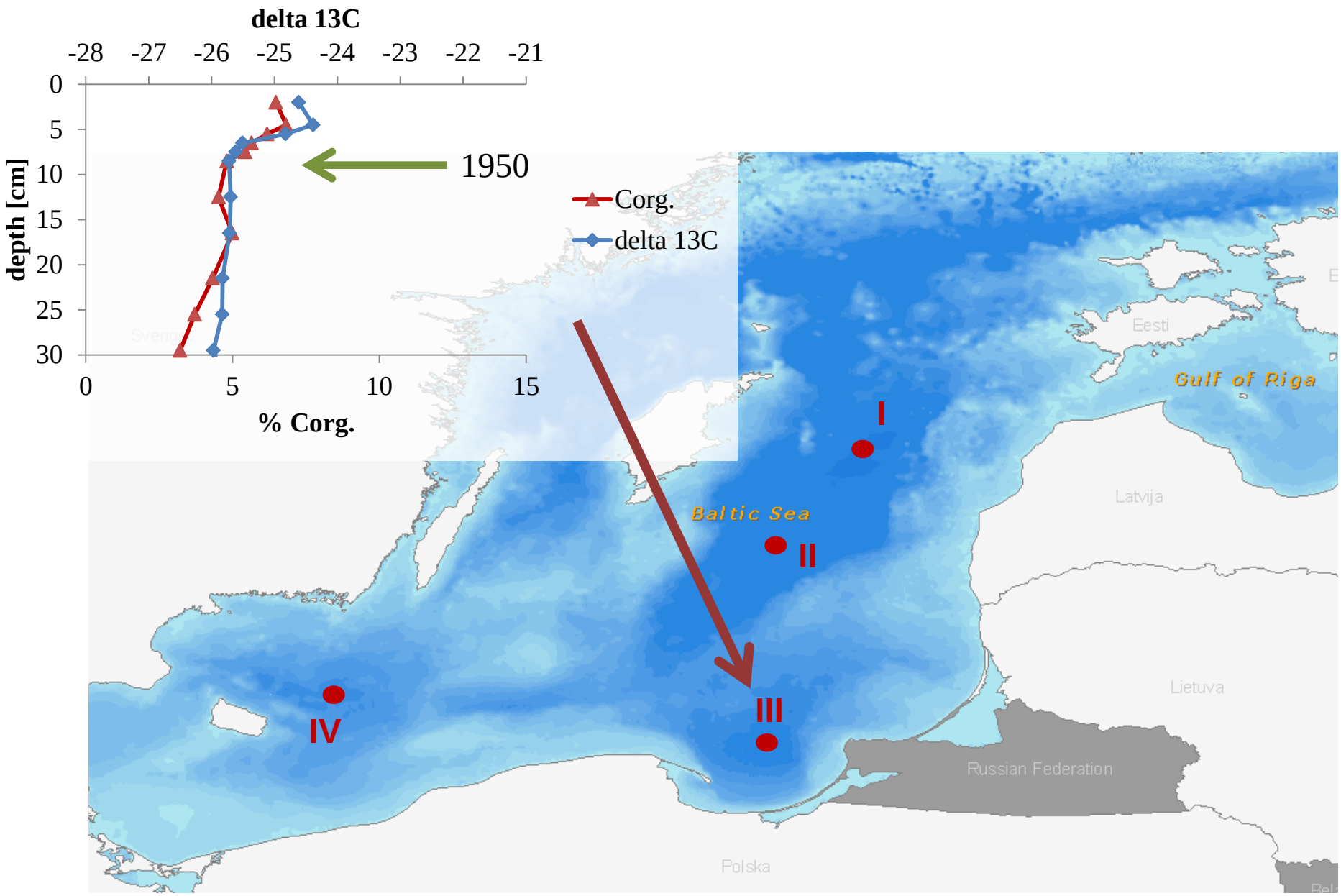
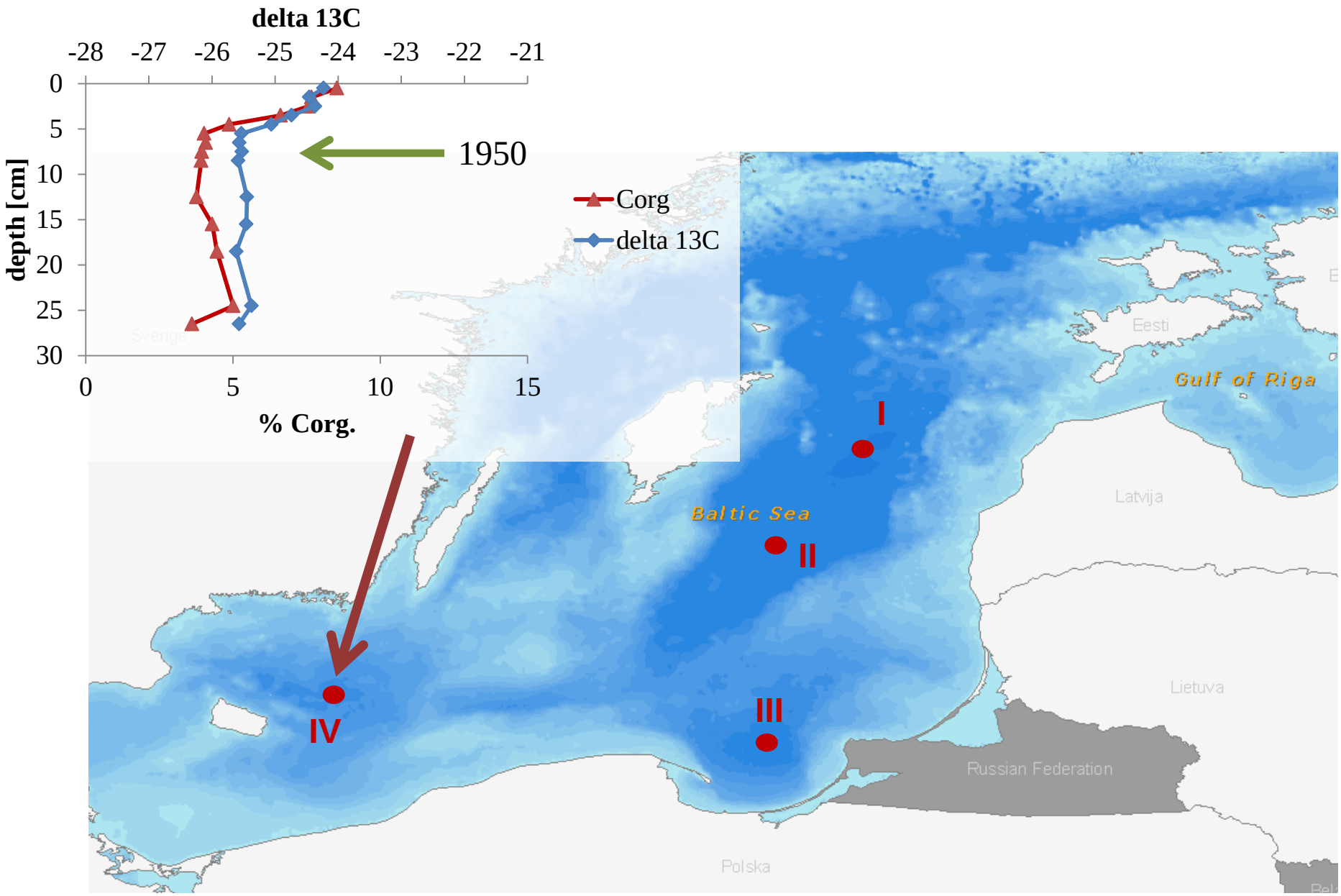
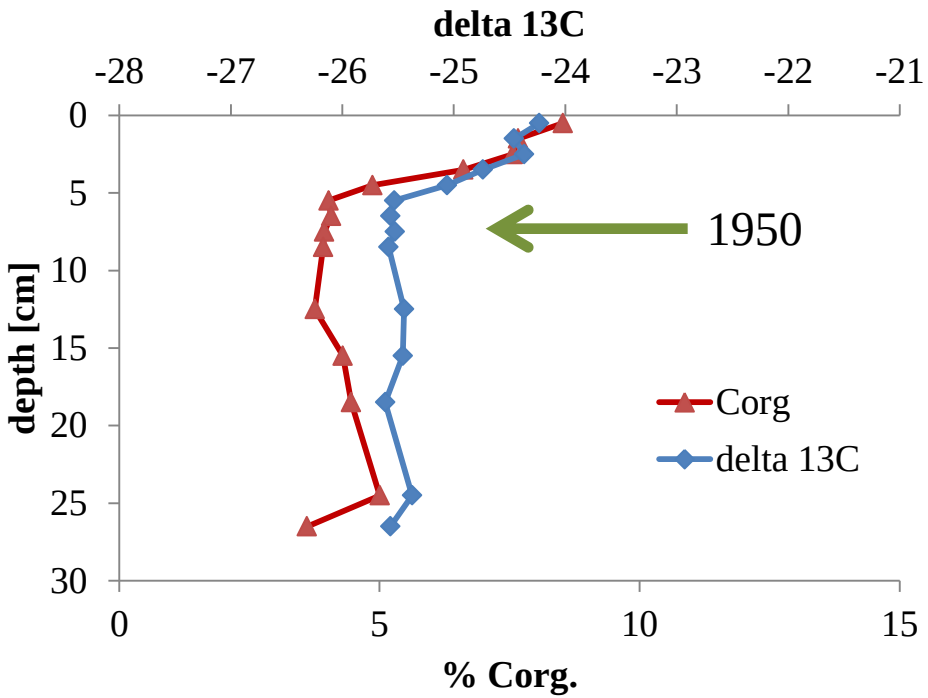


$\delta^{13}C$ profiles in the Baltic Sea sediments



$\delta^{13}C$ and C_{org} profiles from the Bornholm Deep sediments



Past (before 1950)

C_{org} = 4% d.w.
$\delta^{13}C$ = -25.5‰
Terrestrial C_{org} = 2.3% d.w.
Marine C_{org} = 1.7% d.w.

Present

C_{org} = 8%
$\delta^{13}C$ = -24.0‰
Terrestrial C_{org} = 2.7% d.w.
Marine C_{org} = 5.3% d.w.

Long-term minneralization (30% of C_{org})

Refractory marine C_{org} = 2.8% d.w.

Terrestrial C_{org} **$\delta^{13}C$ = -28‰**

Marine C_{org} **$\delta^{13}C$ = -22‰**

Conclusions:

- $\delta^{13}C$ may help to trace the terrestrial C_{org} in the Baltic Sea
- High contribution of terrestrial C_{org} in the bottom sediments of the Baltic (30-60%)
- $\delta^{13}C$ changes during the incubation of organic matter will provide with more accurate results about the increase of marine C_{org} burial due to eutrophication

Thank you