ETH zürich

Introducing the Modern Ocean Sediment Archive and Inventory of Carbon (MOSAIC v.2.0) database and its initial applications

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April 15, 2024

Supplementary Material

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mosaic.ethz.ch

EGU General Assembly 2024

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RESEARCH ARTICLE

10.1029/2023GB007839

Unraveling Environmental Forces Shaping Surface Sediment Geochemical "*Isodrapes*" in the East Asian Marginal Seas

Sarah Paradis[1], Markus Diesing[2], Hannah Gies[1], Negar Haghipour[1,3], Lena Narman[4], Clayton Magill[4], Thomas Wagner[4], Valier V. Galy[5], Pengfei Hou[6], Meixun Zhao[6,7], Jung-Hyun Kim[8], Kyung-Hoon Shin[9], Baozhi Lin[10], Zhifei Liu[10], Martin G. Wiesner[11,12], Karl Stattegger[13], Jianfang Chen[12], Jingjing Zhang[12], and Timothy I. Eglinton[1]

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Key Points:

- The distribution of organic matter in the East Asian marginal seas is governed by its provenance and hydrodynamic processes
- Three distinct *isodrapes* are found, driven by organic matter contents, its age, and mineral surface area
- Spatial machine learning can be an efficient tool to understand the distribution of organic matter in continental margins

Supporting Information:

Supporting Information may be found in the online version of this article.

Paradis et al., 2024

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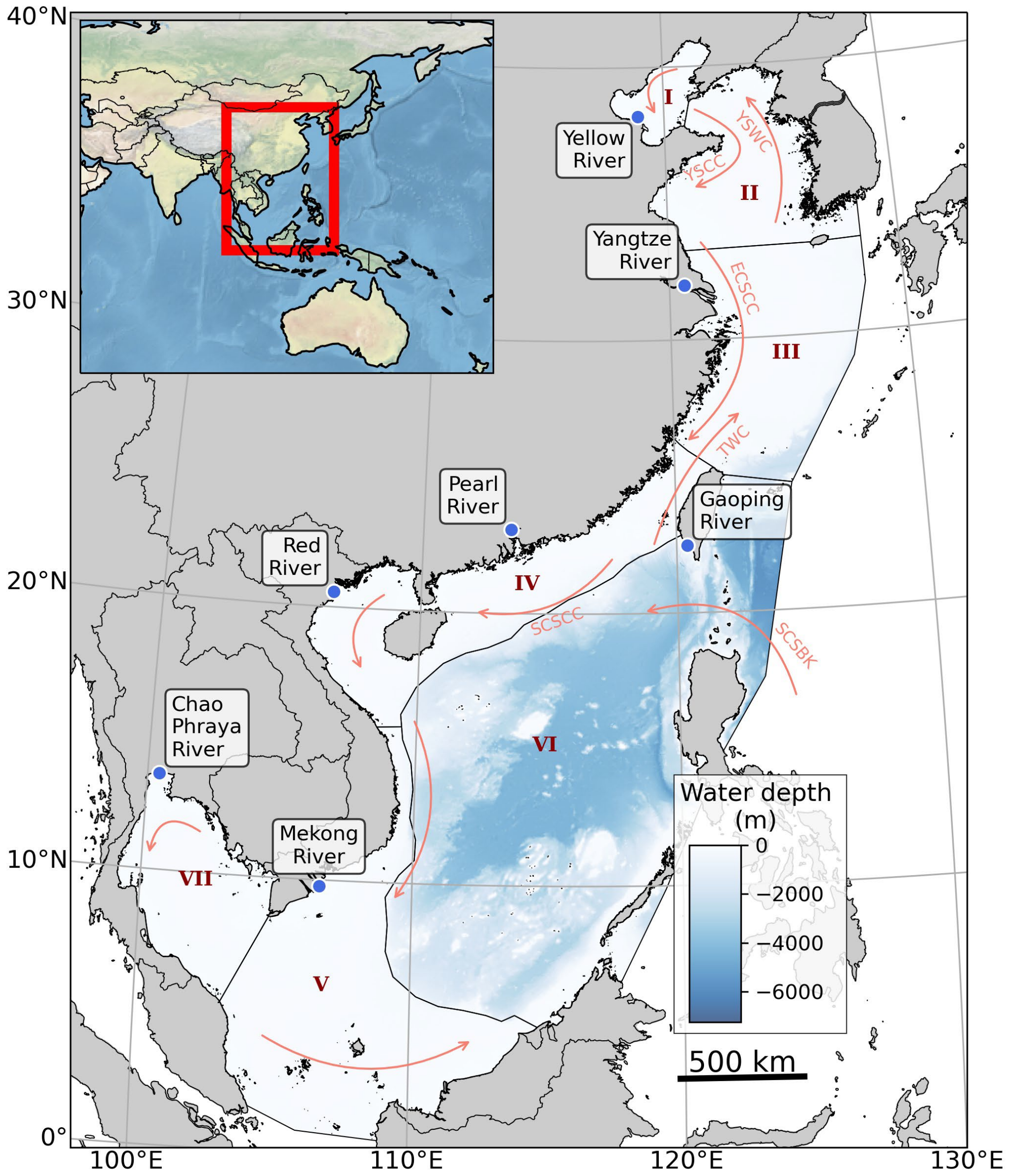
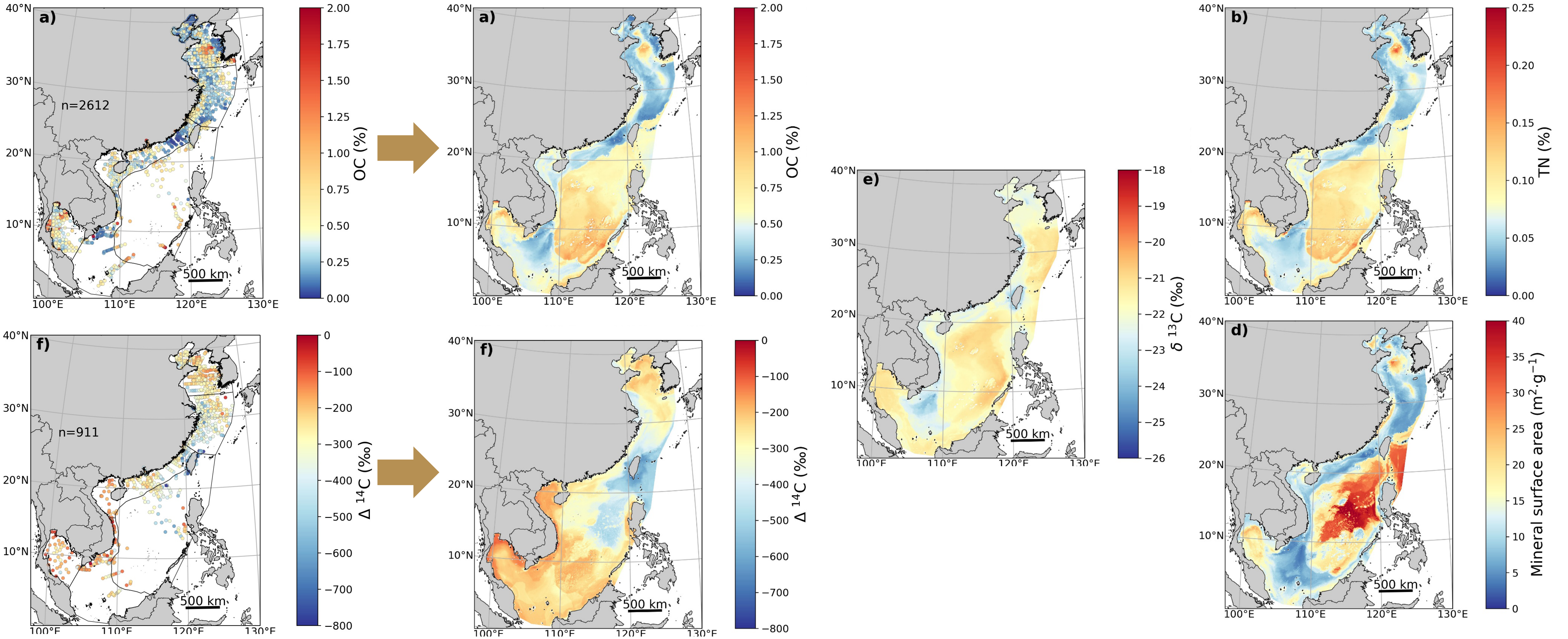
Aims:

1. Understand the regional-scale processes that affect the fate of OC in this highly-complex marginal sea system.
2. Identify regions where sediment with distinct geochemical composition drape the seafloor.



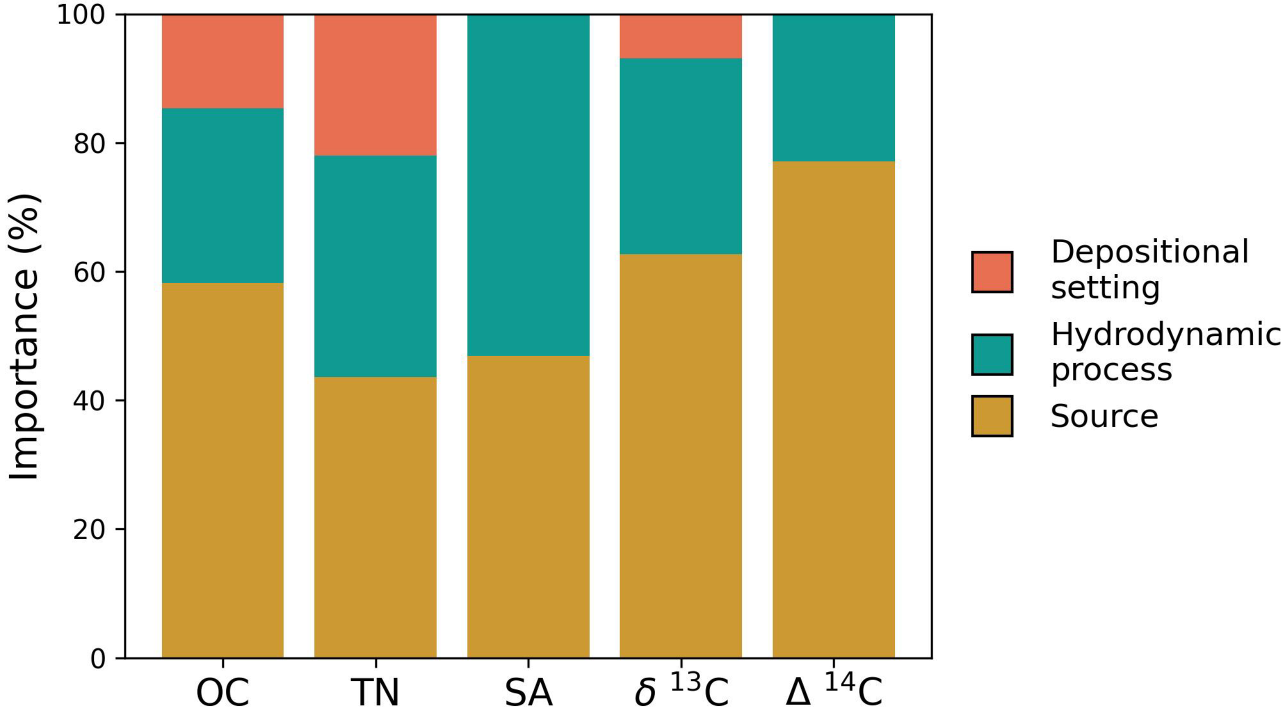
Paradis et al., 2024

Predict the distribution of geochemical composition using spatial Machine Learning models



Paradis et al., 2024

Understand the contribution of regional-scale processes (depositional setting, hydrodynamic process, source) that affect the distribution of OC, TN, mineral surface area (SA), $\delta^{13}C$ and $\Delta^{14}C$ in surficial sediments



Paradis et al., 2024

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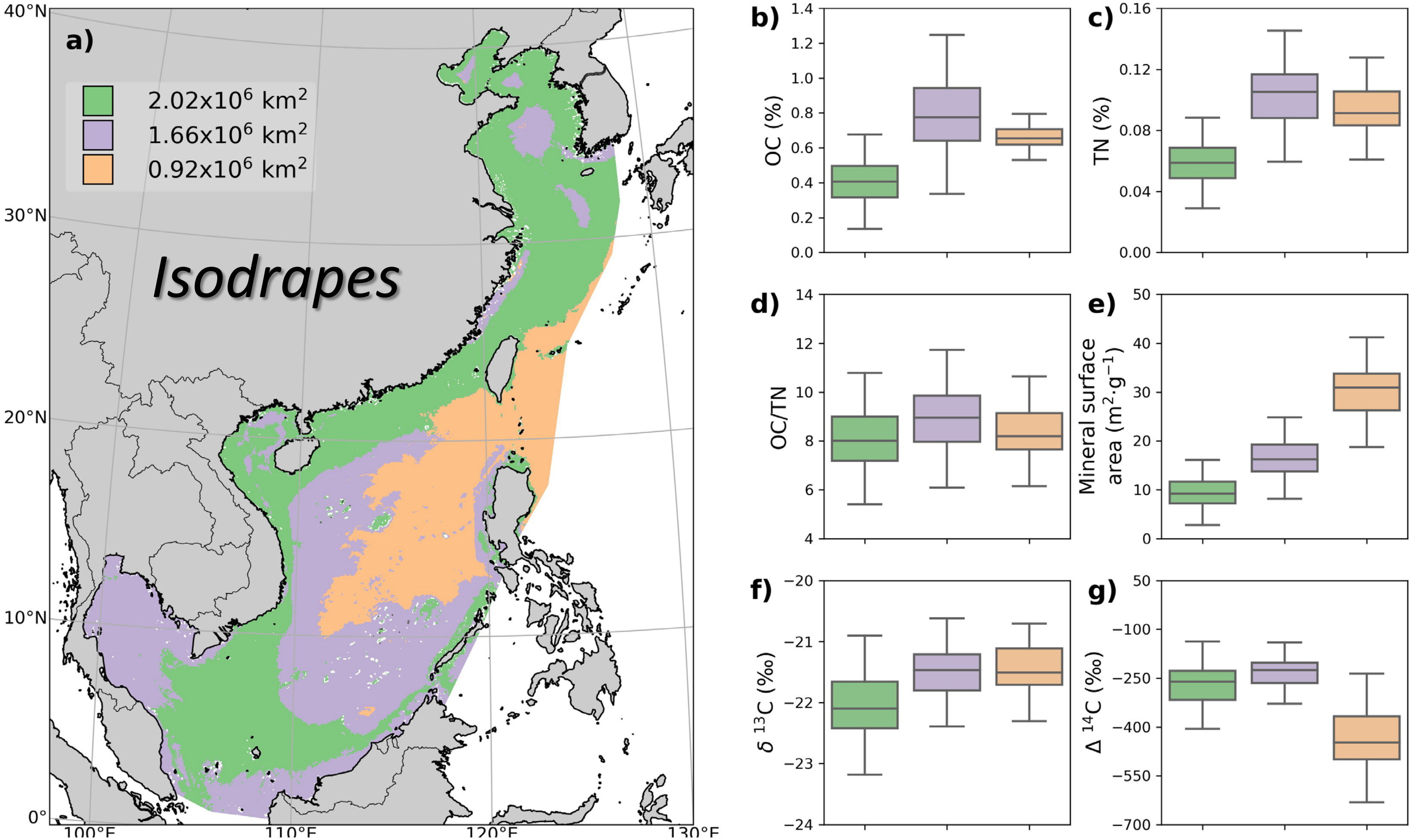
Identify regions where sediment with similar geochemical compositions drape the seafloor (***isodrapes***)



Paradis et al., 2024

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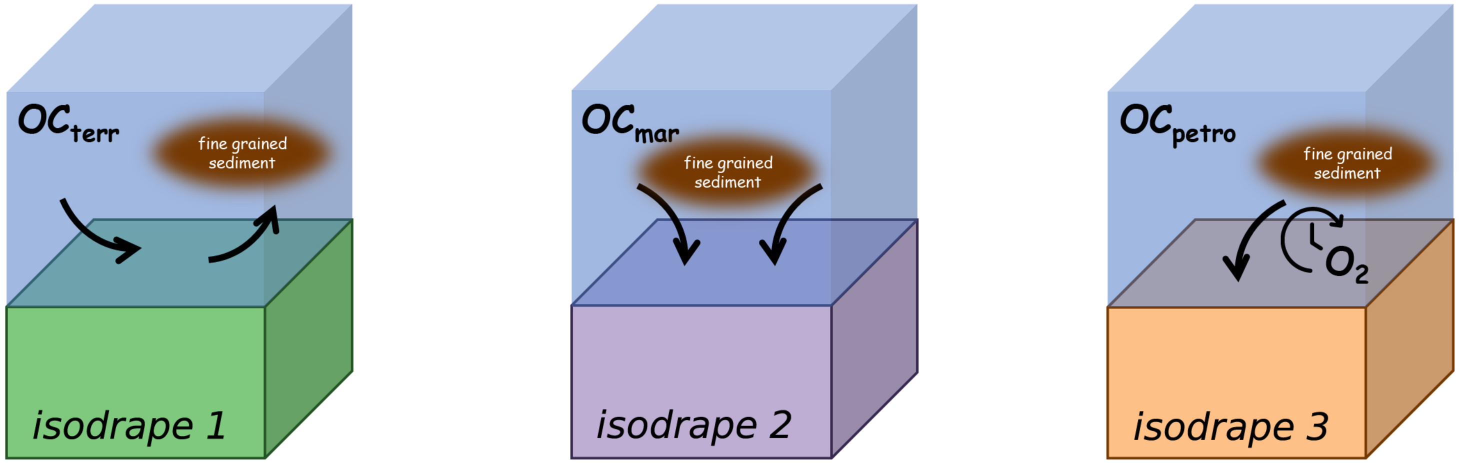
Characterize the environment, hydrodynamic processes, and predominant OM source in each of these ***isodrapes***



Environment	Shallow energetic continental shelves	Mud deposits	Deep basin
Hydrodynamic processes	Strong hydrodynamics prevent the deposition of fine-grained sediment enriched in OC	Subdued hydrodynamics allow the accumulation of fine-grained sediment enriched in OC.	Hydrodynamic sorting deposits fine-grained sediment with aged and degraded OC.
Predominant source	Pre-aged terrestrial OC	Fresh marine OC	Aged OC (petrogenic)

Paradis et al., 2024

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EGU24-5089, updated on 08 Mar 2024
https://doi.org/10.5194/egusphere-egu24-5089
EGU General Assembly 2024

Oral | Monday, 15 Apr, 09:40–09:50 (CEST) Room 2.23

Substantial amounts of organic carbon are accumulated and stored in surface sediments of the Norwegian continental margin

Markus Diesing[1], Sarah Paradis[2], Henning Jensen[3], Terje Thorsnes[4], Lilja Bjarnadóttir[5], and Jochen Knies[6,7]
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Diesing et al., under review

Background: Paris Agreement

Goals[1]

- to hold “the increase in the global average temperature to well below 2°C above pre-industrial levels”.
- to pursue efforts “to limit the temperature increase to 1.5°C above pre-industrial levels.”

Requires[2]

- that greenhouse gas emissions decline by about 45% from 2010 levels by 2030, reaching net zero around 2050.
- carbon dioxide removal on the order of 100–1000 Gt CO_2 over the 21st century to compensate for residual emissions and to achieve net negative emissions to return global warming to 1.5°C following a peak.

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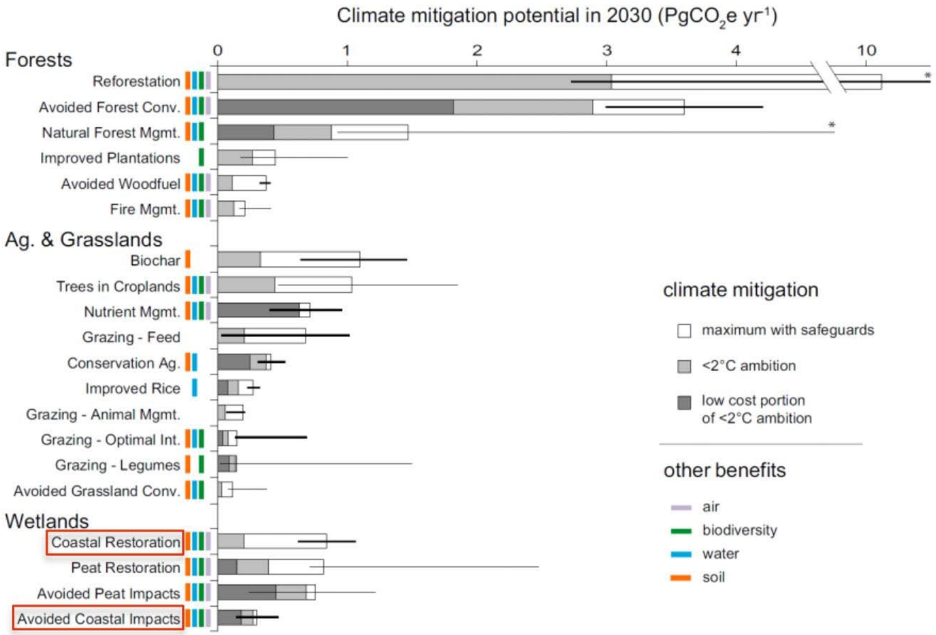
[1] https://unfccc.int/process-and-meetings/the-paris-agreement
[2] IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. doi:10.1017/9781009157940.001.

GEOLOGICAL SURVEY OF NORWAY - NGU -

Natural climate solutions

Natural climate solutions[3]

Bronson W. Griscom[a,b,1], Justin Adams[a], Peter W. Ellis[a], Richard A. Houghton[c], Guy Lomax[a], Daniela A. Miteva[d], William H. Schlesinger[e,1], David Shoch[f], Juha V. Siikamäki[g], Pete Smith[h], Peter Woodbury[i], Chris Zganjar[a], Allen Blackman[g], João Campari[j], Richard T. Conant[k], Christopher Delgado[l], Patricia Elias[a], Trisha Gopalakrishna[a], Marisa R. Hamsik[a], Mario Herrero[m], Joseph Kiesecker[a], Emily Landis[a], Lars Laestadius[l,n], Sara M. Leavitt[a], Susan Minnemeyer[l], Stephen Polasky[o], Peter Potapov[p], Francis E. Putz[q], Jonathan Sanderman[c], Marcel Silvius[r], Eva Wollenberg[s], and Joseph Fargione[a]



Blue carbon as a natural climate solution[4]

Peter I. Macreadie[1], Micheli D. P. Costa[1], Trisha B. Atwood[3], Daniel A. Friess[4,5], Jeffrey J. Kelleway[6], Hilary Kennedy[7], Catherine E. Lovelock[2], Oscar Serrano[8,9] and Carlos M. Duarte[10]

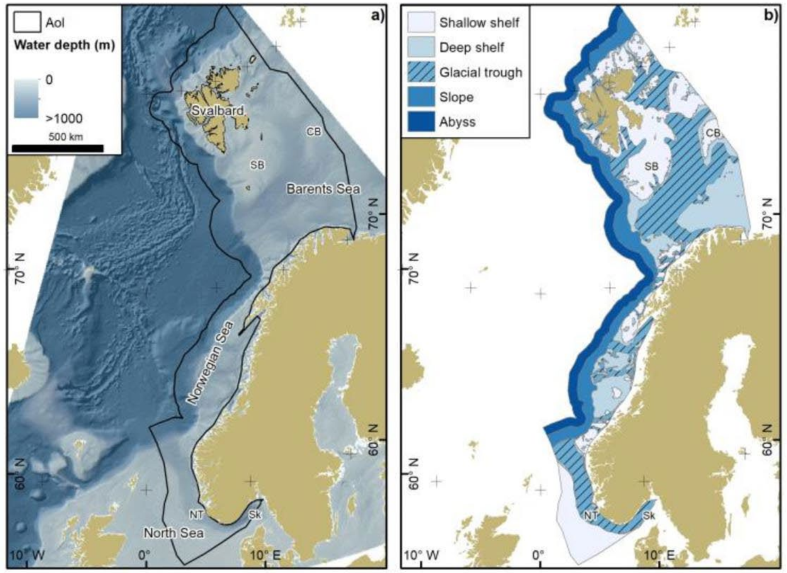
- 9-33 Pg C stored
- 0.36-1.85 million km^2
- 304 Tg CO_2 yr^{-1} avoided emissions through protection
- 841 Tg CO_2 yr^{-1} potentially removed through restoration

[3] www.pnas.org/cgi/doi/10.1073/pnas.1710465114
[4] https://doi.org/10.1038/s43017-021-00224-1

GEOLOGICAL SURVEY OF NORWAY - NGU -

Continental margin sediments

	Geographic extent (millions of km^2)	Organic carbon pool (Pg C)	Organic carbon sink (Tg C yr^{-1})	Mitigation potential: from avoided emissions (Tg CO_2 yr^{-1})	Mitigation potential: from carbon removal (Tg CO_2 yr^{-1})
Blue Carbon Ecosystems	0.36 – 1.85[4]	9 – 33[4]	37.3 – 59.7[5]	304[4]	841[4]
Continental margin sediments	58.9[6]	455[7]	248[6]	(340-370)[8]	Unknown



Aims

1. Map and quantify organic carbon stocks and pools
2. Map and quantify organic carbon accumulation rates and sink sizes
3. Compare with Blue Carbon Ecosystems in Nordic countries

[5] https://doi.org/10.1016/j.marpol.2023.105788
[6] https://doi.org/10.1021/cr050347q
[7] https://doi.org/10.3389/fmars.2020.00165
[8] https://doi.org/10.3389/fmars.2023.1125137

GEOLOGICAL SURVEY OF NORWAY - NGU -

Diesing et al., under review

Methods

- **Quantile regression forests** [12] for spatial prediction and quantification of uncertainty
- Uncertainty expressed as the **90% prediction interval**
- **Area of applicability** [13] of the models estimated
- Response variables:
    - organic carbon content (weight-%)
    - dry bulk density (g cm^{-3})
    - ^{210}Pb sediment accumulation rate (cm yr^{-1})
- Harmonised data from MOSAIC [14] plus data from PANGAEA [15].

- OCS = OC content * DBD * thickness (0.1 m)
- OCAR = OC content * DBD * SAR

[12] Meinshausen, N., *J. Mach. Learn. Res.* **7**, 983–999 (2006).
[13] https://doi.org/10.1111/2041-210X.13650
[14] https://doi.org/10.5194/essd-15-4105-2023
[15] https://doi.org/10.1038/s41597-023-02269-x

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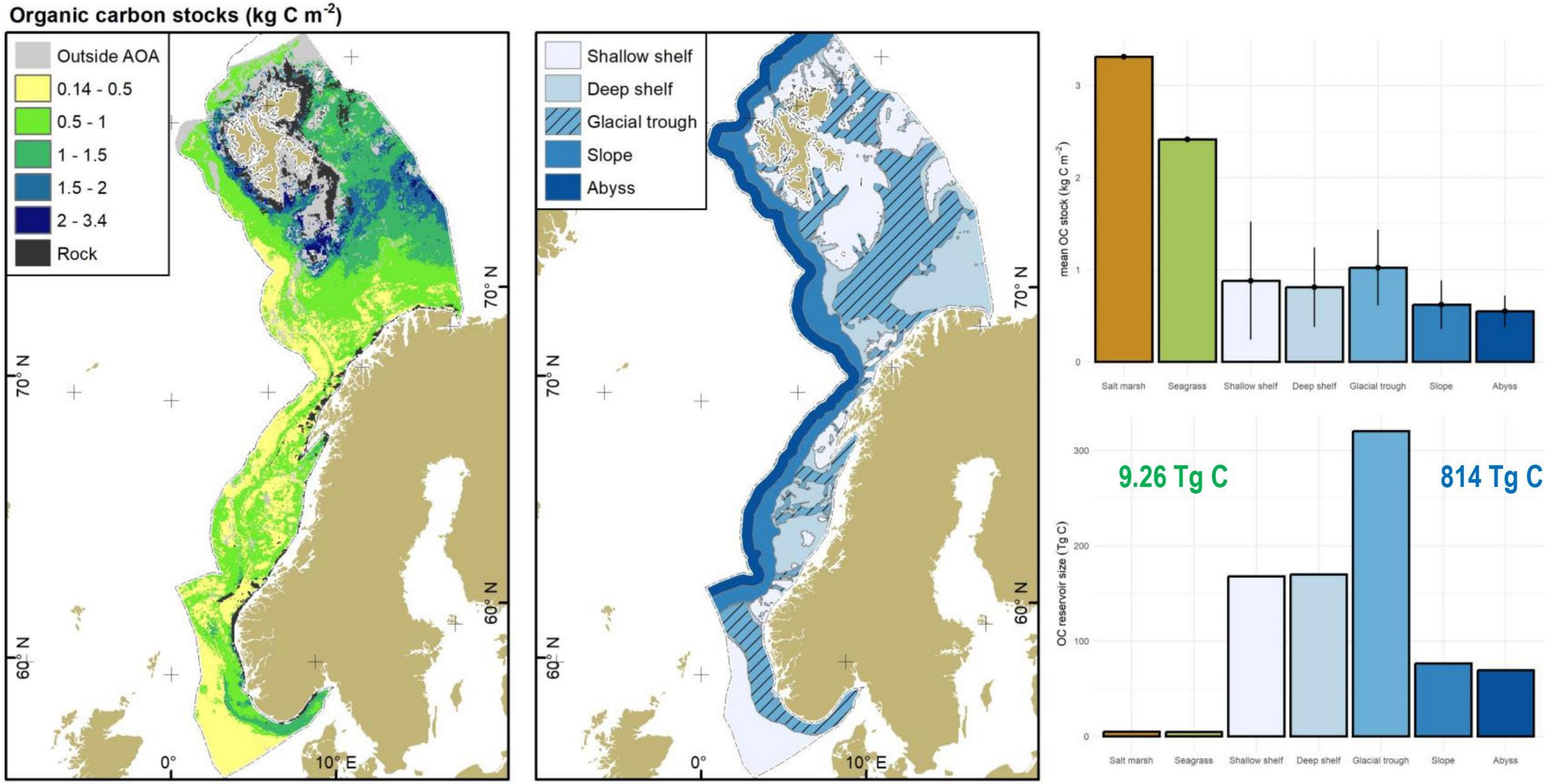
Organic carbon stocks and reservoir sizes



Nordic Blue Carbon stocks and reservoir sizes: https://doi.org/10.3389/fmars.2022.847544

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Diesing et al., under review

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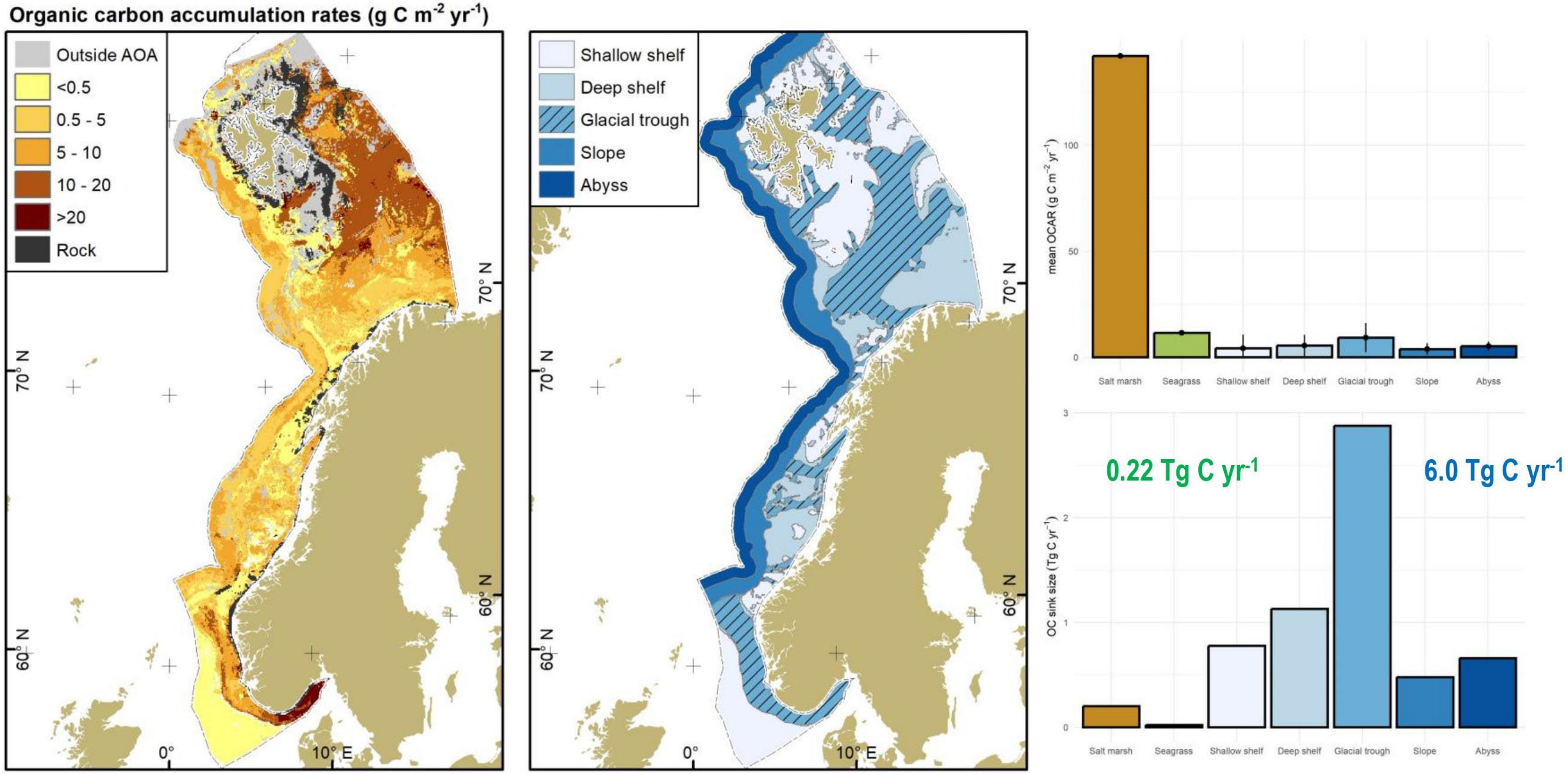
Organic carbon accumulation rates and sink sizes



Nordic Blue Carbon accumulation rates and sink sizes: https://doi.org/10.3389/fmars.2022.847544

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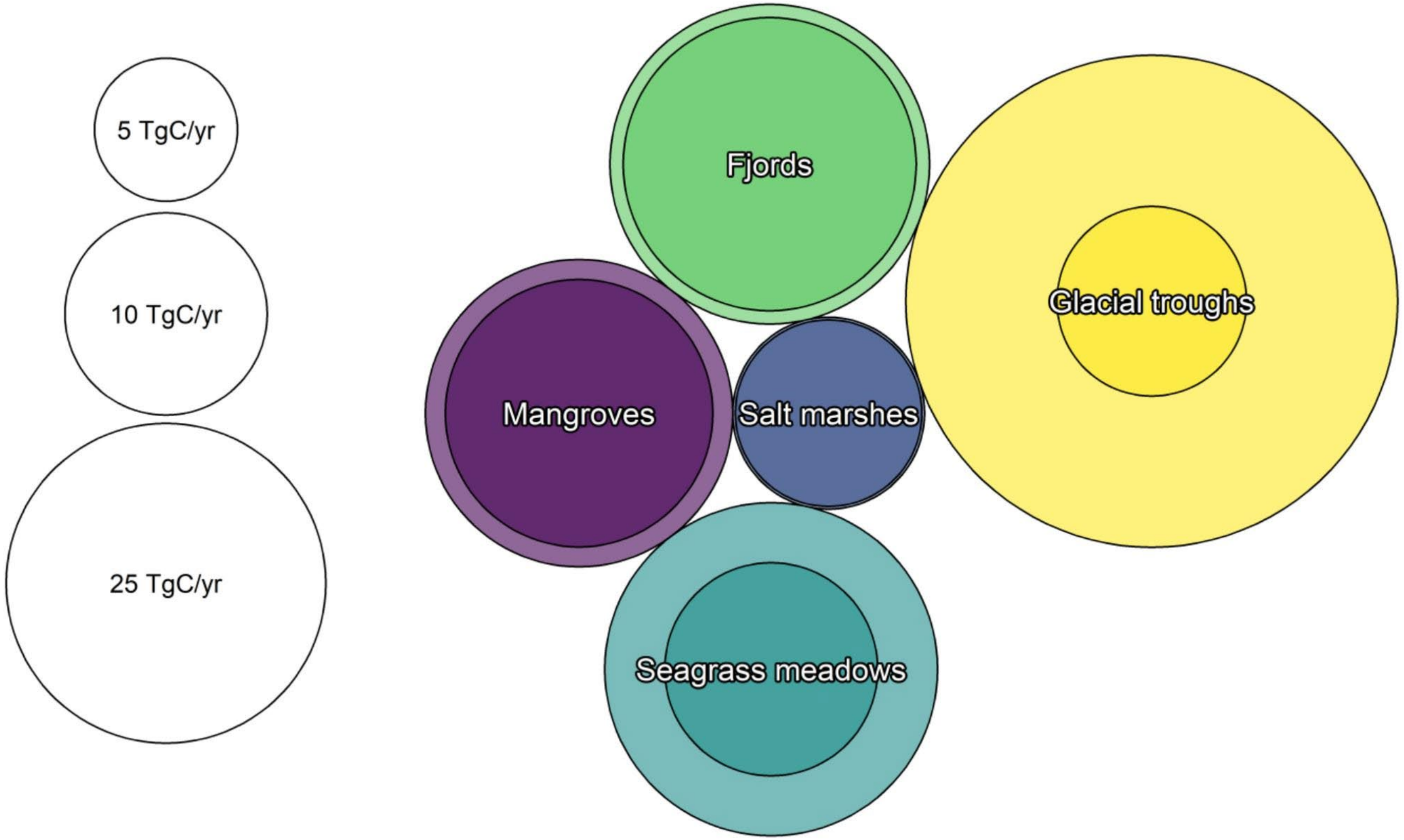
Upscaling



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Diesing et al., under review

Climate mitigation potential

Avoided emissions:

Stocks as a measure of vulnerability potential [16]

Vulnerable to disturbance (natural/human)

Focus on fishing with mobile bottom gear

Open questions:

- How to quantify remineralisation due to disturbance?
- How much remineralised C is reaching the atmosphere?

Carbon removal:

Accumulation rates as a measure of mitigation potential [16]

How to increase accumulation of organic carbon (additionality)?

- Increase input, decrease remineralisation

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[16] https://doi.org/10.1016/j.ecss.2020.107156

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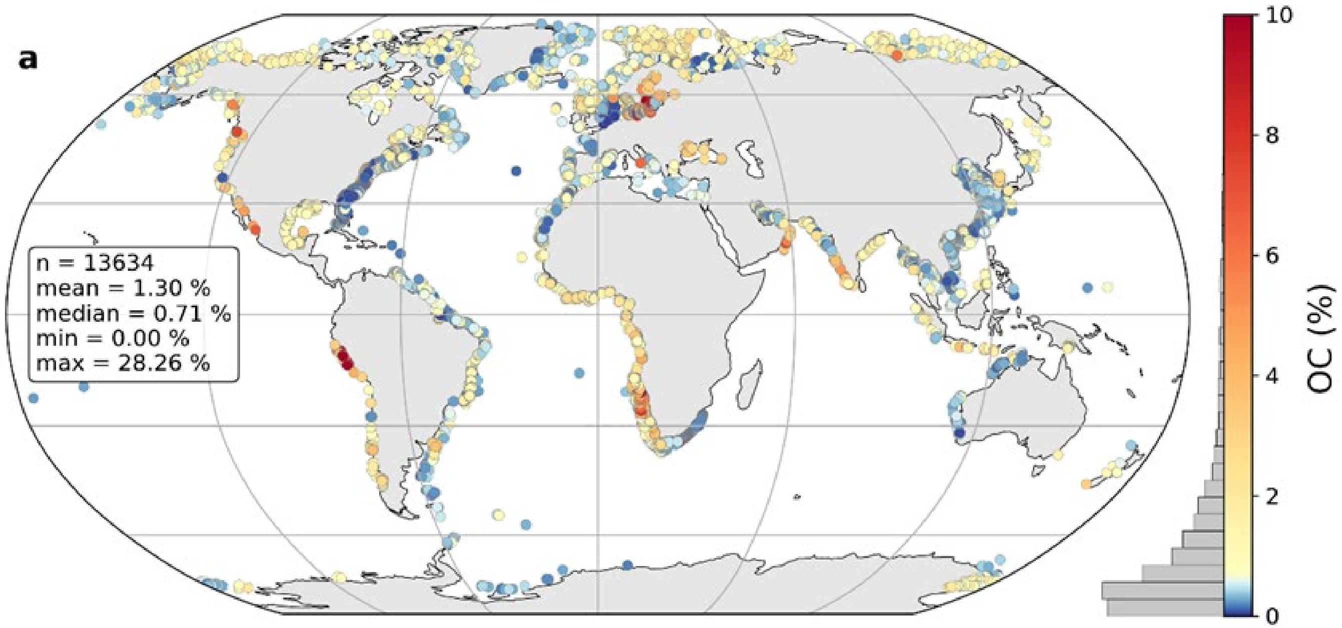
Take home messages

- Sedimentary organic carbon reservoirs and sinks are too large to be ignored
- Need to better constrain remineralisation due to human disturbance
- Need to explore possibilities to increase carbon removal

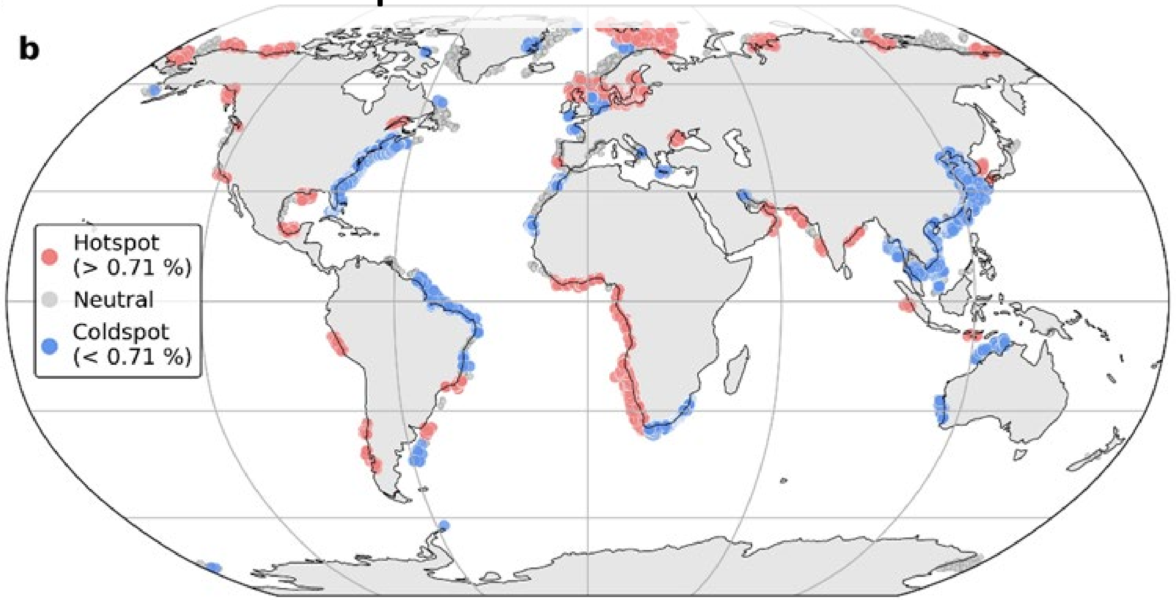
Thank you for your attention! Any questions?

Diesing et al., under review



Aims:

1. Characterize continental margins as spatially significant hotspots or coldspots of OC content
2. Identify the factors that make certain continental margins act as hotspots or coldspots



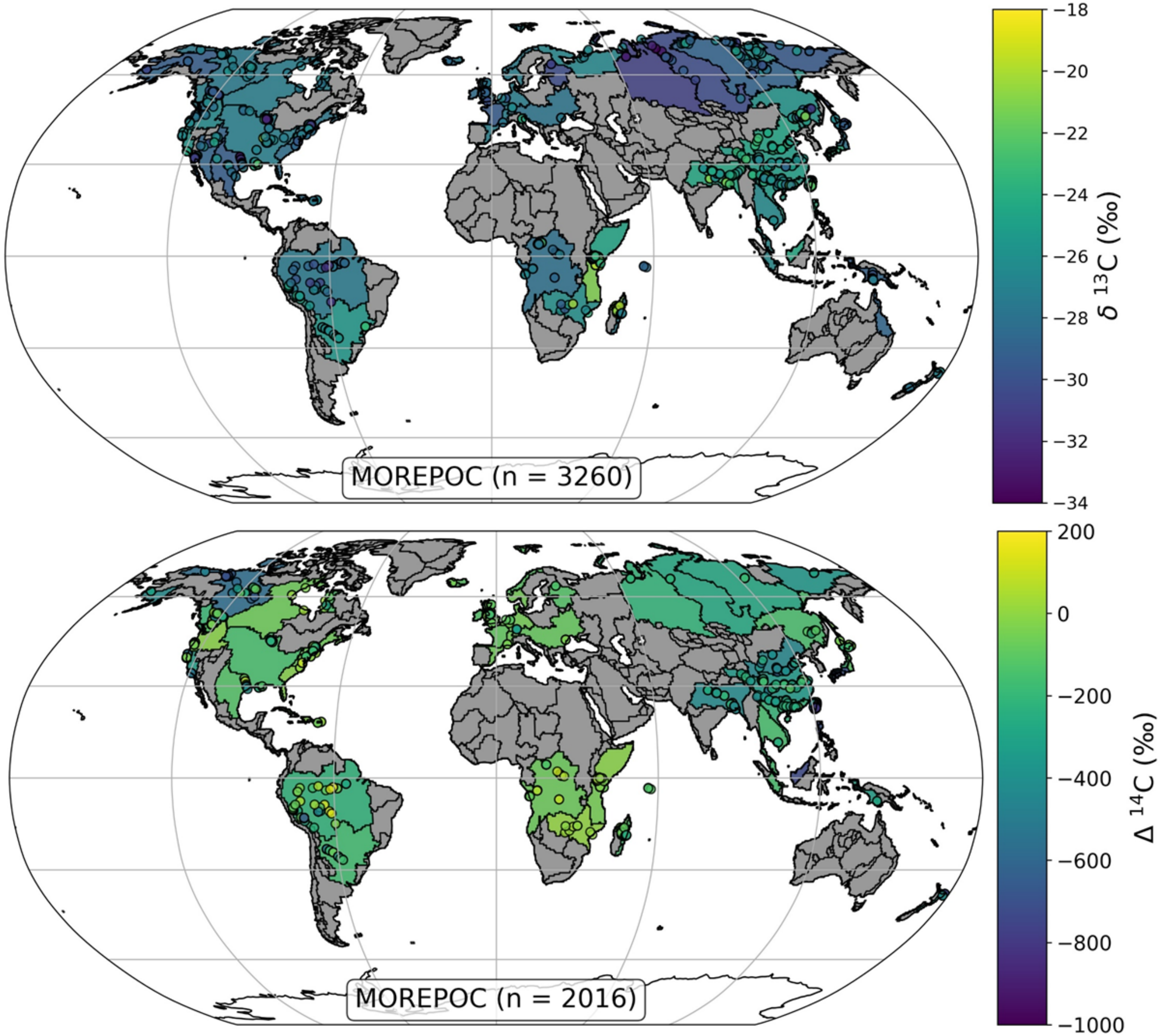
Paradis et al., in prep.

Aims:

1. Determine the source of OC (marine vs. terrestrial) deposited in marine sediments
2. Identify the distribution of terrestrial and marine OC deposited in marine sediments

River database (MOREPOC) + Marine sediment database (MOSAIC) + Marine POC database

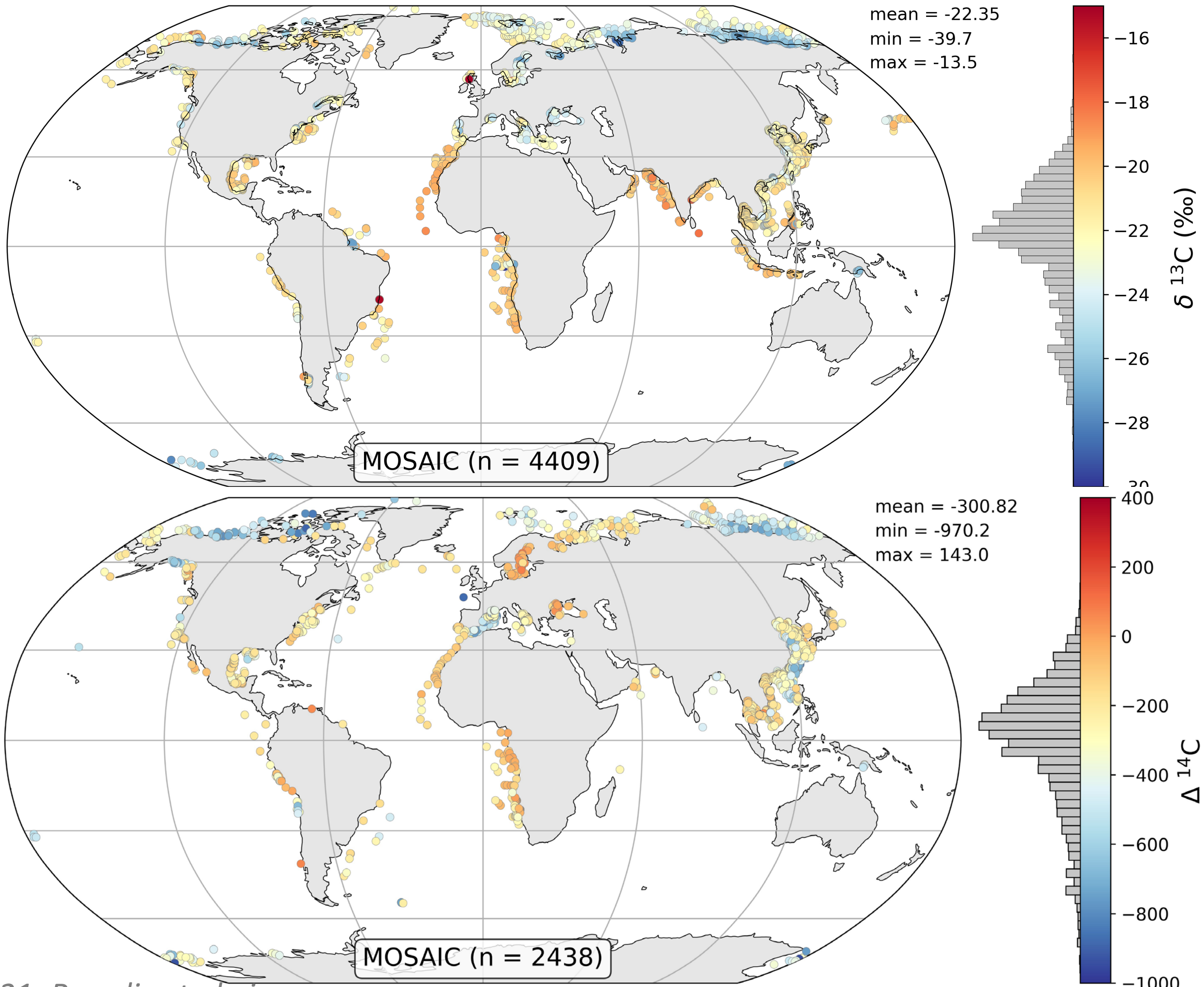
Paradis et al., in prep.



River database

Ke et al., 2022; Laruelle et al., 2013; Verwega et al., 2021; Paradis et al., in prep.

Marine sediment database



Ke et al., 2022; Laruelle et al., 2013; Verwega et al., 2021; Paradis et al., in prep.

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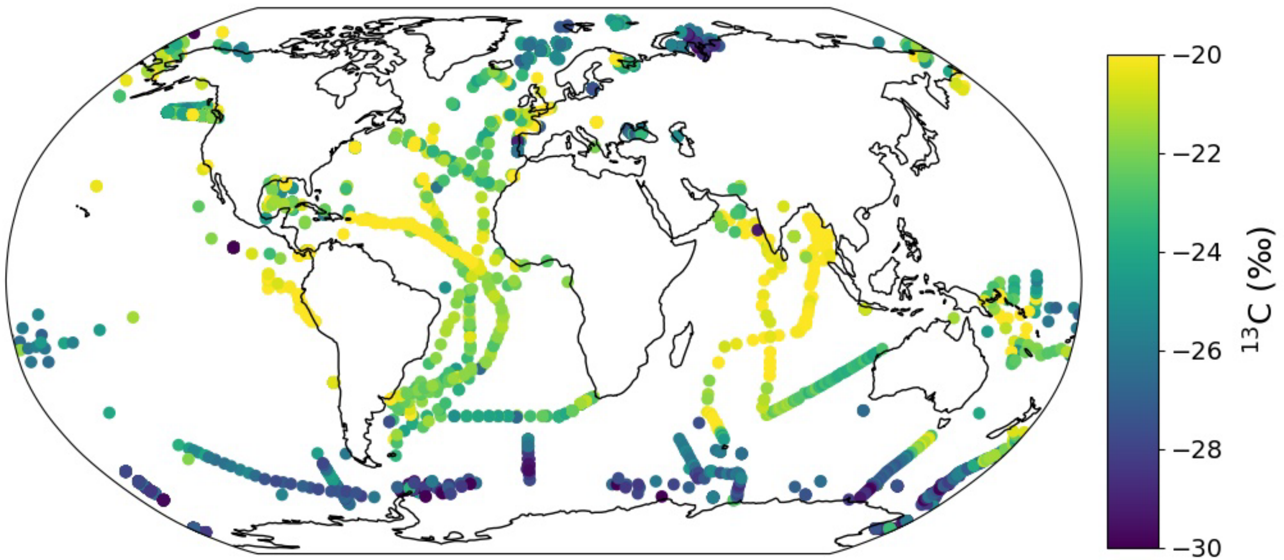
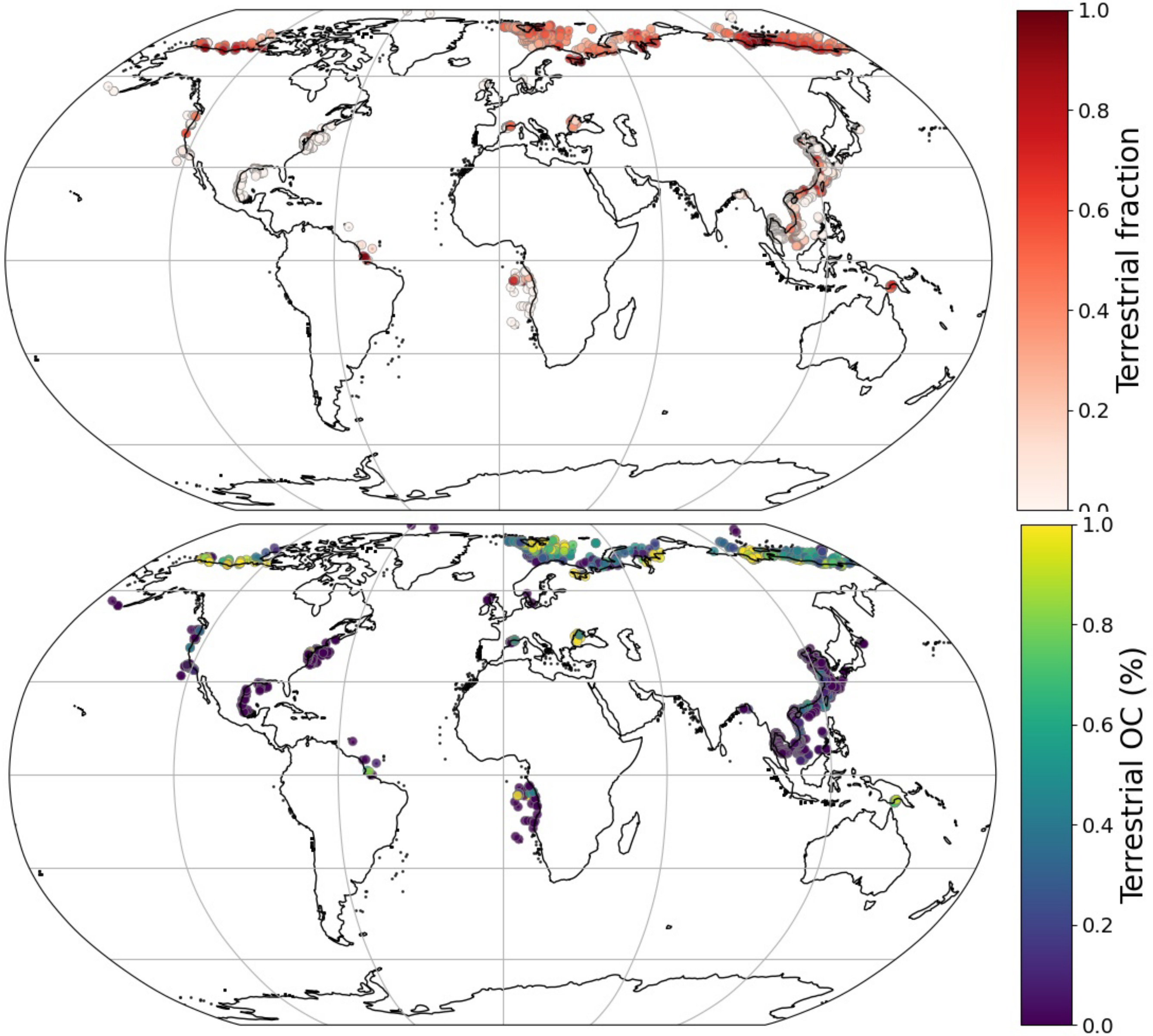
Marine POC database



Ke et al., 2022; Laruelle et al., 2013; Verwega et al., 2021; Paradis et al., in prep.

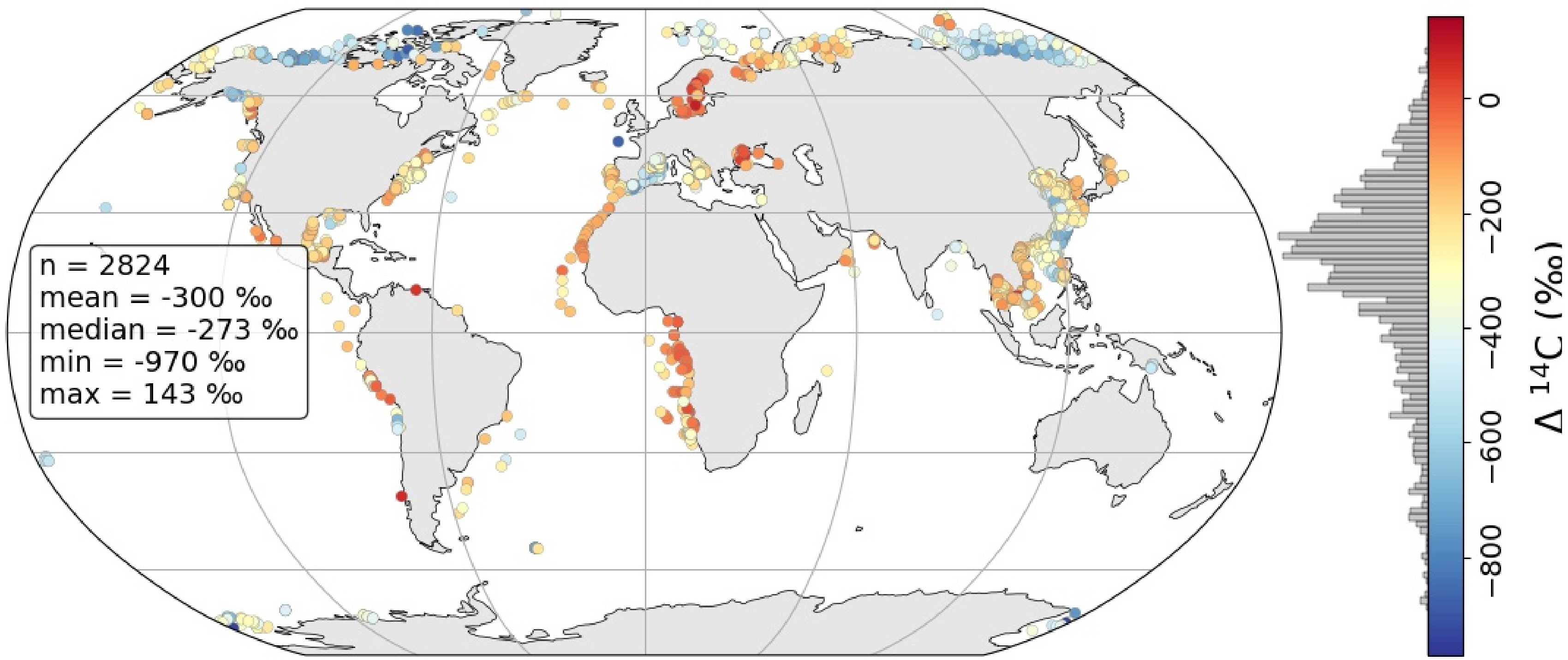
- Estimate the fraction of OC from terrestrial and marine origin
- Quantify how much terrestrial and marine OC is deposited in marine sediments



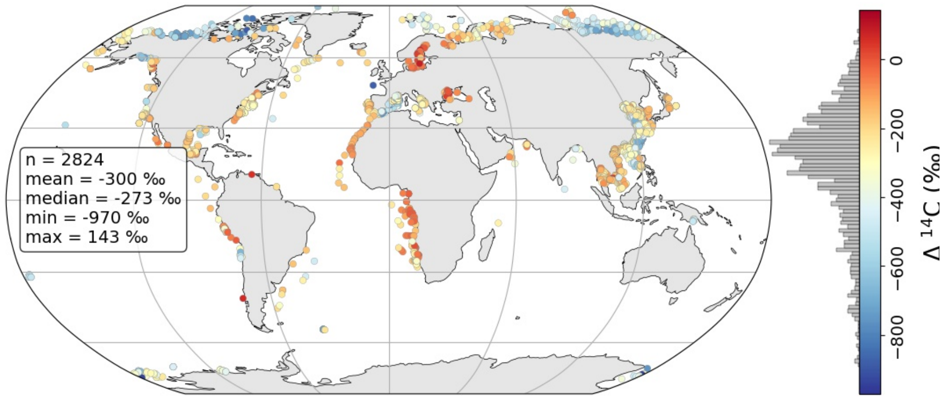
Ke et al., 2022; Laruelle et al., 2013; Verwega et al., 2021; Paradis et al., in prep.

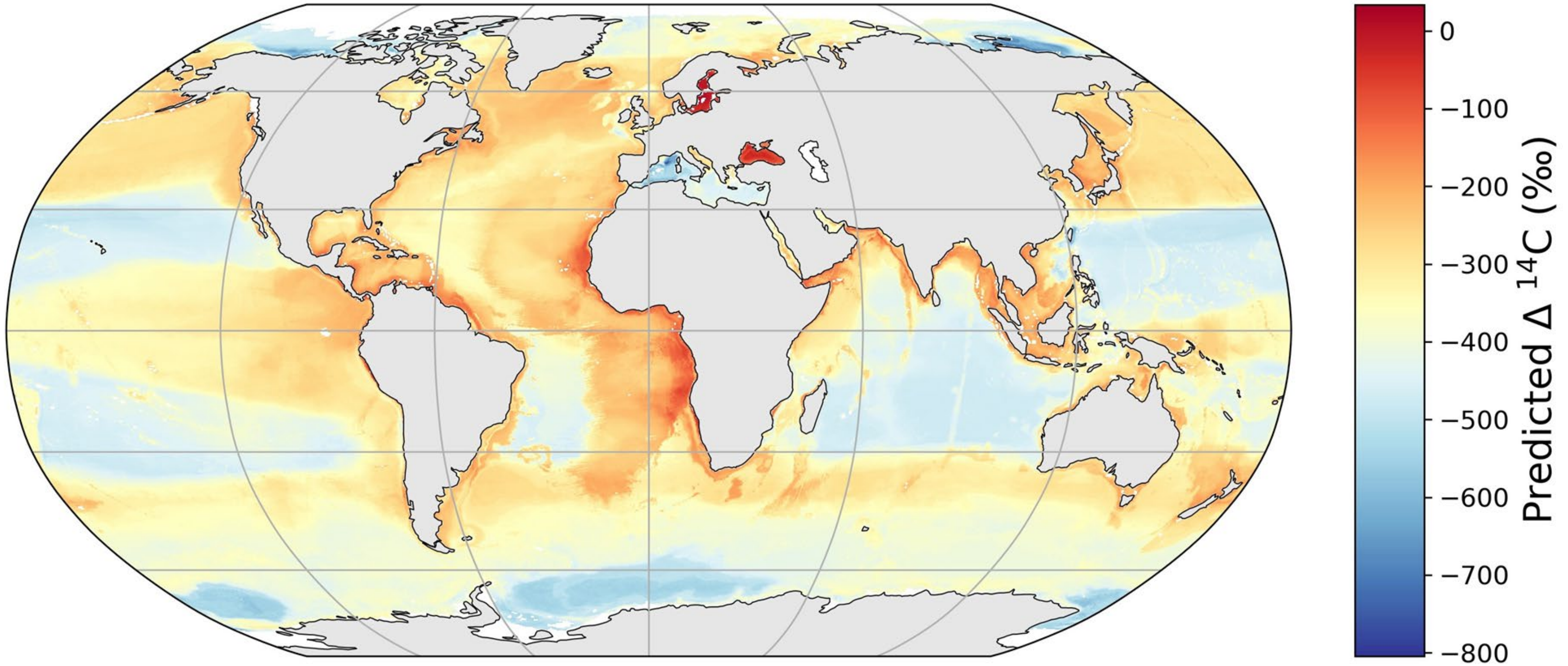
Aims:

1. Predict the distribution of OC ^{14}C in surficial marine sediments
2. Understand the spatial variations of OC ^{14}C in surficial marine sediments and relate them to reactivity of OC



Paradis et al., in prep.





Paradis et al., in prep.

…and more!