



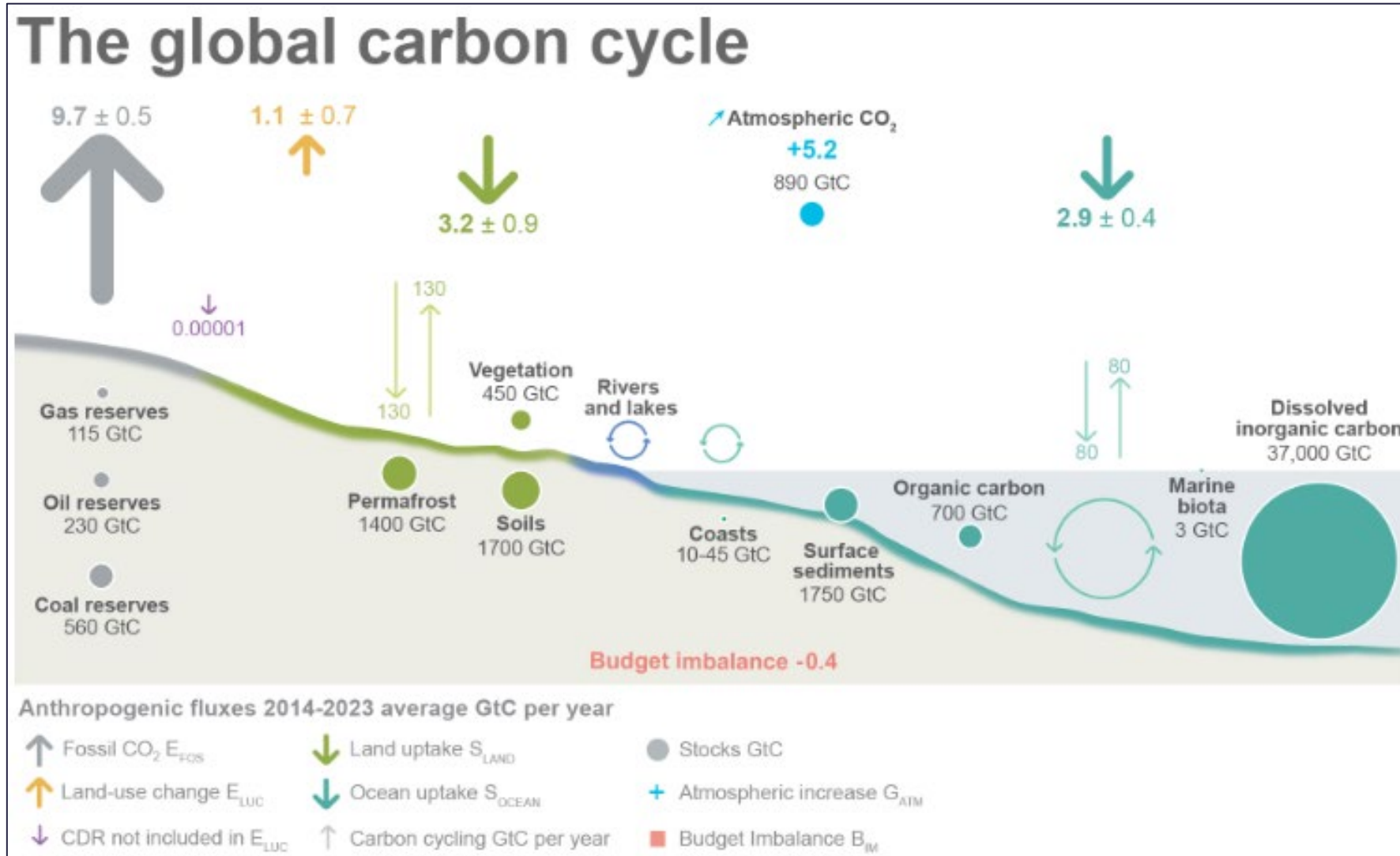
PI: Prof. Mark J. Costello, Nord University (NO)

Blue carbon and the distribution of organic carbon stores in the seabed of Europe

Dorte Krause-Jensen & Christian Lønborg, Aarhus University
in collaboration w. colleagues from MPA Europe and beyond

MPA Europe Symposium and N. Atl. Stakeholder Workshop
Copenhagen, Denmark, 18. February 2025

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“The amount of carbon captured and stored by coastal and marine living organisms” → A focus on **management** of rooted **coastal vegetated ecosystems** (Nellemann *et al.*, 2009).

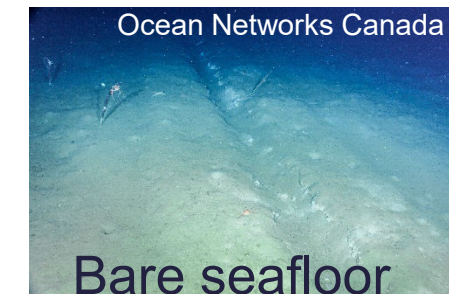
“BC ecosystems are **coastal vegetated ecosystems** w. rooted vegetation and marine coastal, continental shelf and offshore **sediments**. The most important issue is the long-term storage of carbon.” (European Marine Board, 2023).

“All biologically-driven carbon fluxes and storage in marine systems that are *amenable to management*” (IPCC).

MPA Europe: Broad focus on OC in European seafloor habitats



“Established BC habitats”
→ protection & restoration



→ reduced trawling



Key objectives of MPA Europe on blue carbon

- Open-source **database** of organic carbon in seafloor habitats
- Identification of **key drivers** of carbon storage
- **European map** reflecting carbon storage capacity
- Propose **scoring system** for carbon storage capacity



Data call to scientific community

(Collaboration w. OBAMA-NEXT and other projects)

Additional data from databases & papers

(Collaboration w. MARCO-BOLO)

EURO-carbon database (v1)

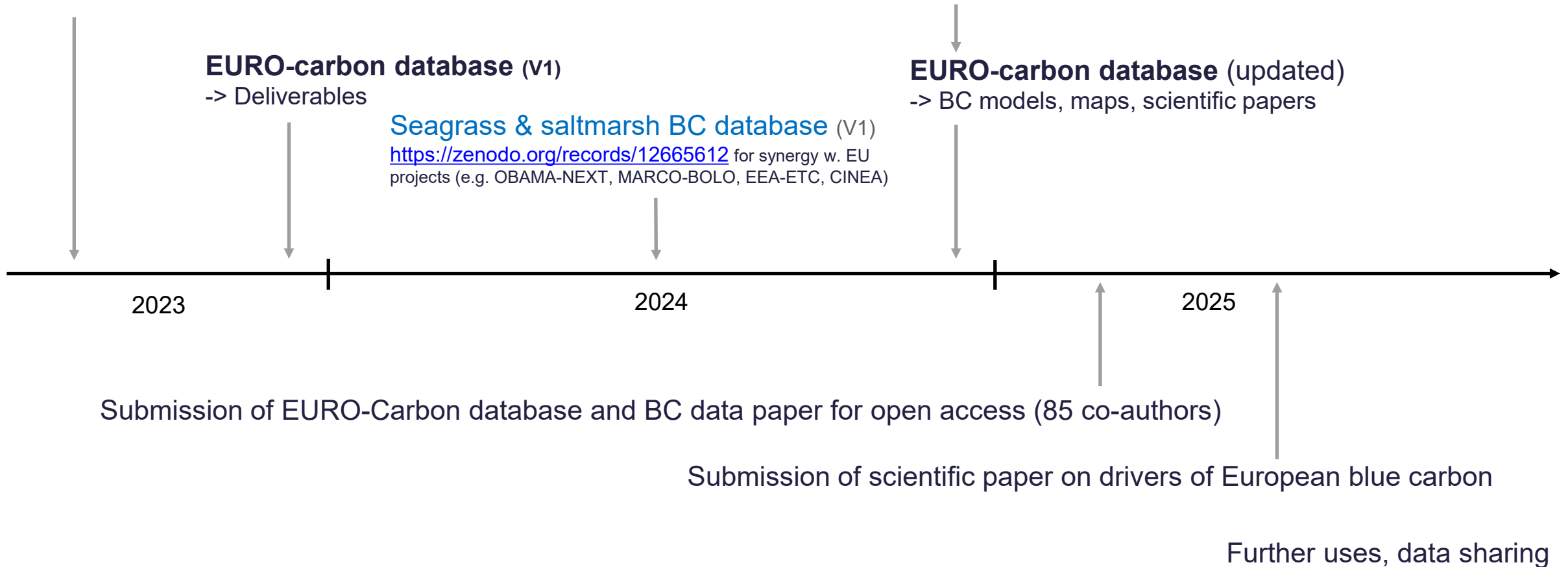
-> Deliverables

Seagrass & saltmarsh BC database (V1)

<https://zenodo.org/records/12665612> for synergy w. EU projects (e.g. OBAMA-NEXT, MARCO-BOLO, EEA-ETC, CINEA)

EURO-carbon database (updated)

-> BC models, maps, scientific papers



Follows the **FAIR** principles (Findability, Accessibility, Interoperability and Reusability)

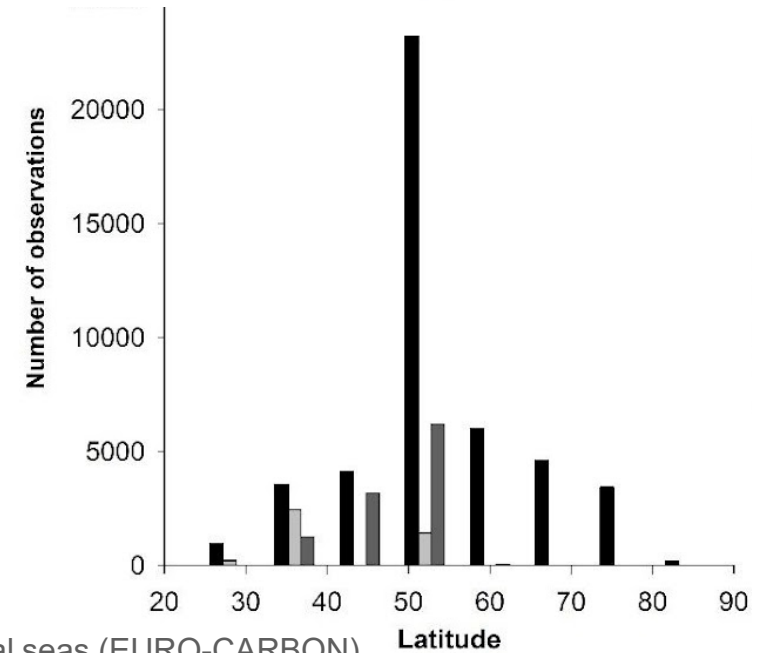
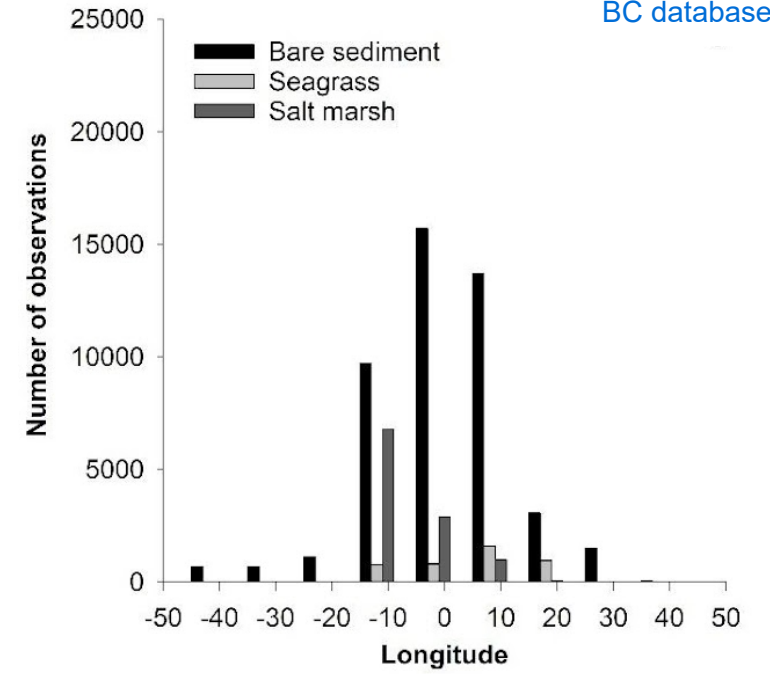
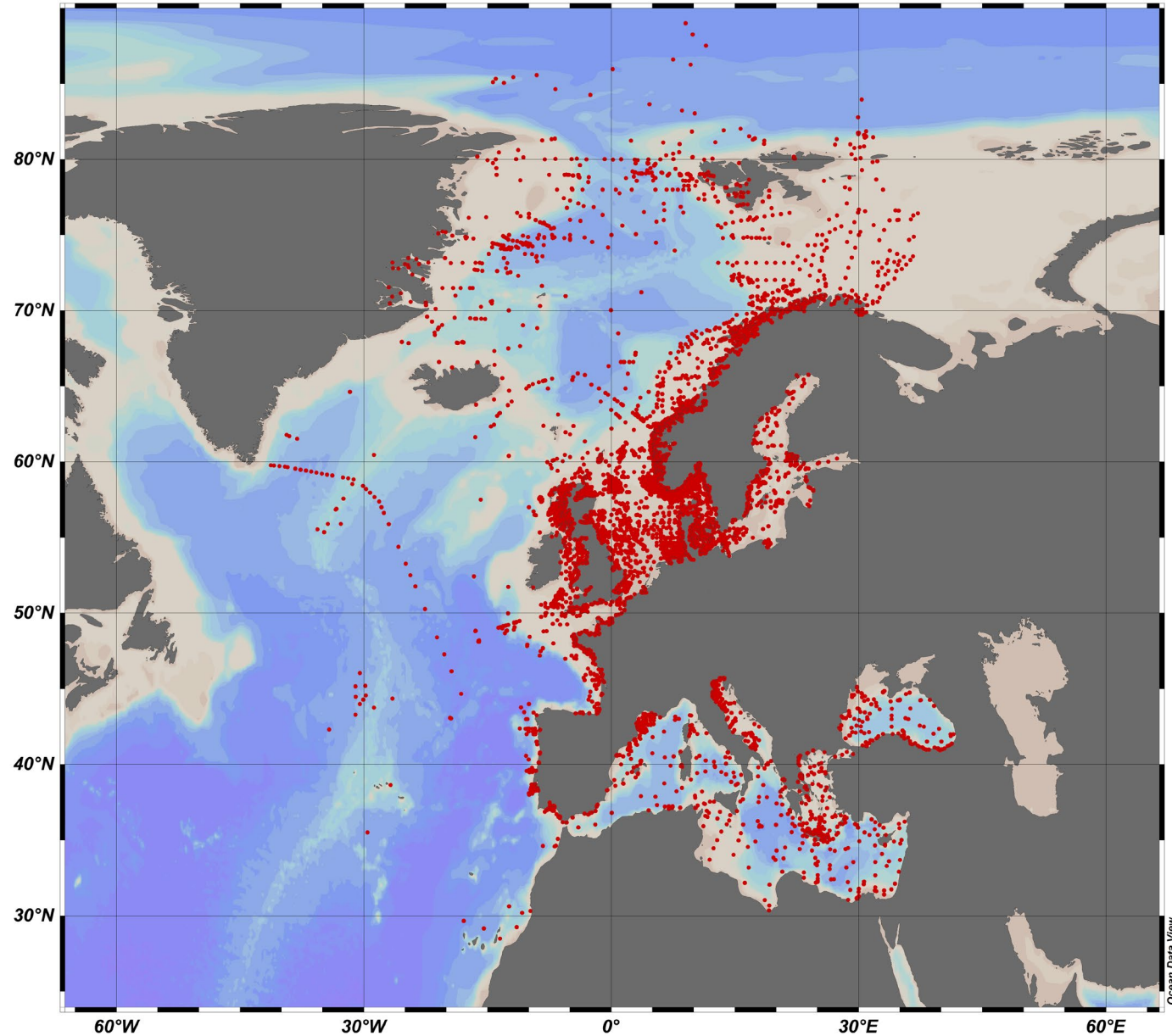
Quality-assured data on *measured* seafloor OC from **data providers**, existing **databases** and scientific **papers**

Main variable: Organic Carbon (OC) content (%)		
Habitats	# Obs.	Avg (min-max)
All	61155	2.5 (0.0-41.6)
Bare sediments	46242	1.9 (0.0-18.9)
Seagrass sediments	4148	2.3 (0.0-23.3)
Saltmarsh sediments	10746	5.0 (0.0-41.6)

Other key carbon variables:

- Dry bulk **density** (g cm⁻³): 18130 obs -> for calculation of **OC stock**
- **OC accumulation rate** (g OC m⁻² y⁻¹): 720 obs

Geographical distribution of observations



Relate OC to environmental variables via machine learning -> models for prediction and mapping

Blue carbon data from EURO-Carbon

- % OC of surface sediments (top 10 cm); excluding saltmarsh habitats

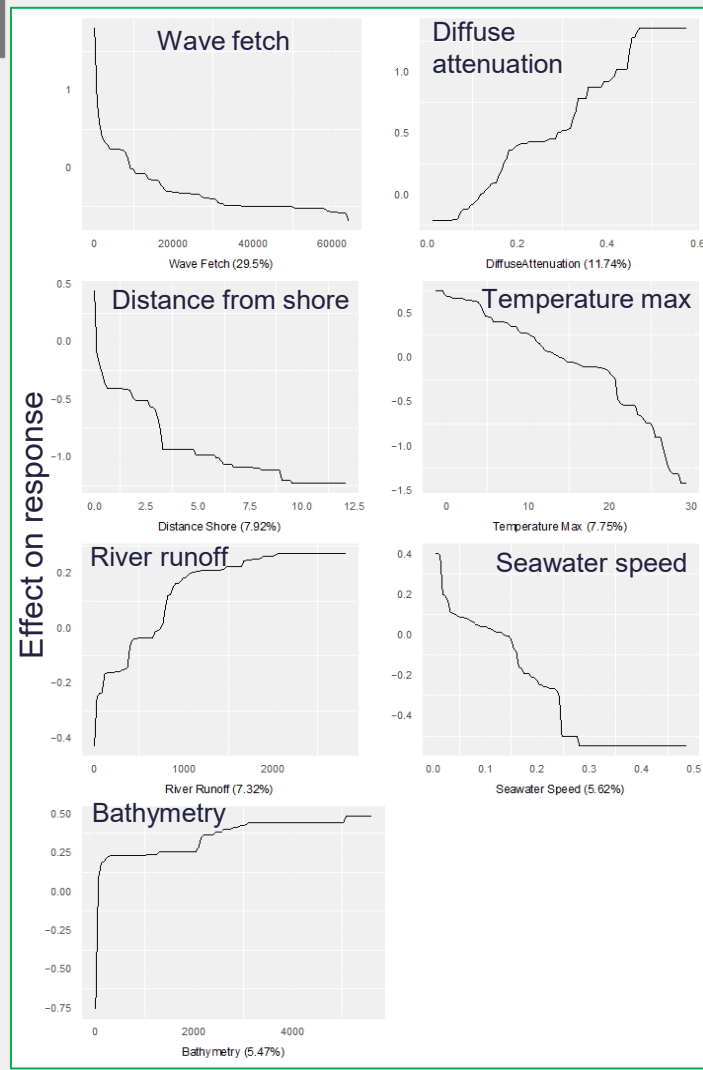
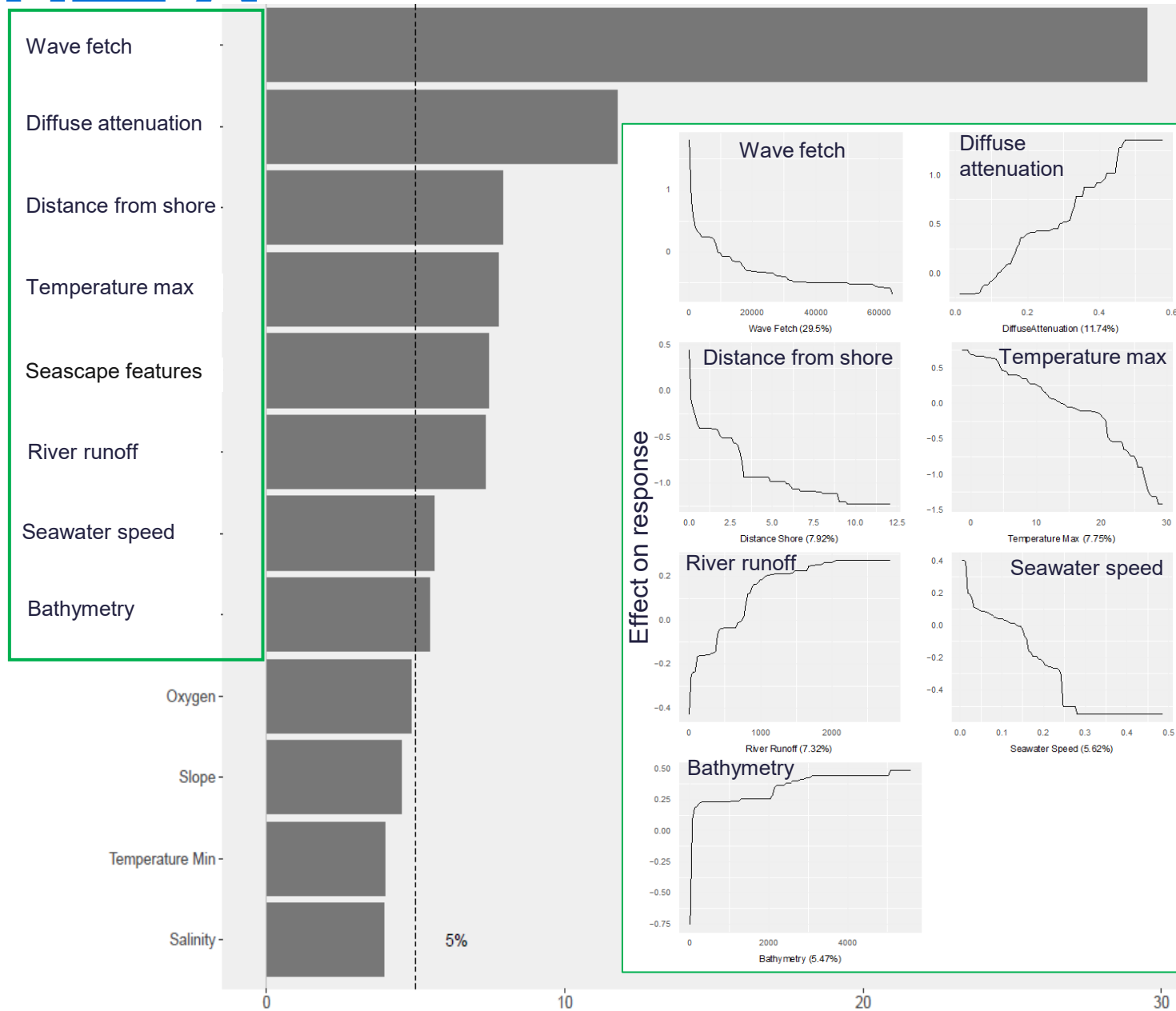
Relevant predictor variables:

- Distance to shore, bathymetry, slope, sea surface temperature (max and min), diffuse attenuation, salinity, seawater speed, dissolved oxygen (Bio-oracle v3.0, Assis et al 2023) :
- Wave fetch – Mike Burrows, SAMS
- Seafloor geomorphic features (<http://www.bluehabitats.org/>)
- Avg. annual surface river runoff (Fekete et al. 2002)

Modelling:

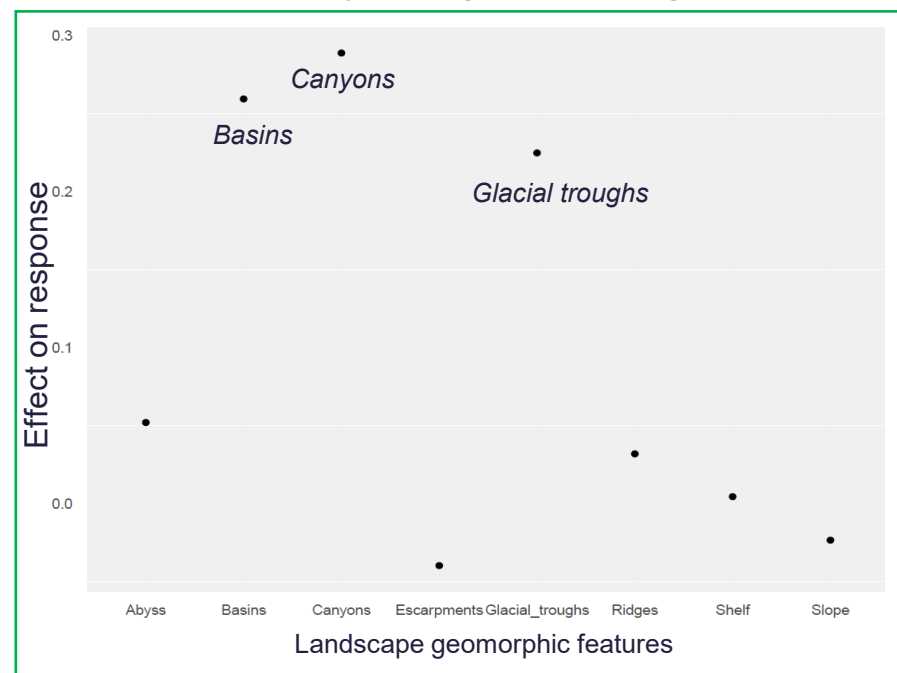
- Spatial resolution of 0.01° (~850 m at 40° latitude) = > 16000 pixels
- Boosted Regression Tree algorithm.

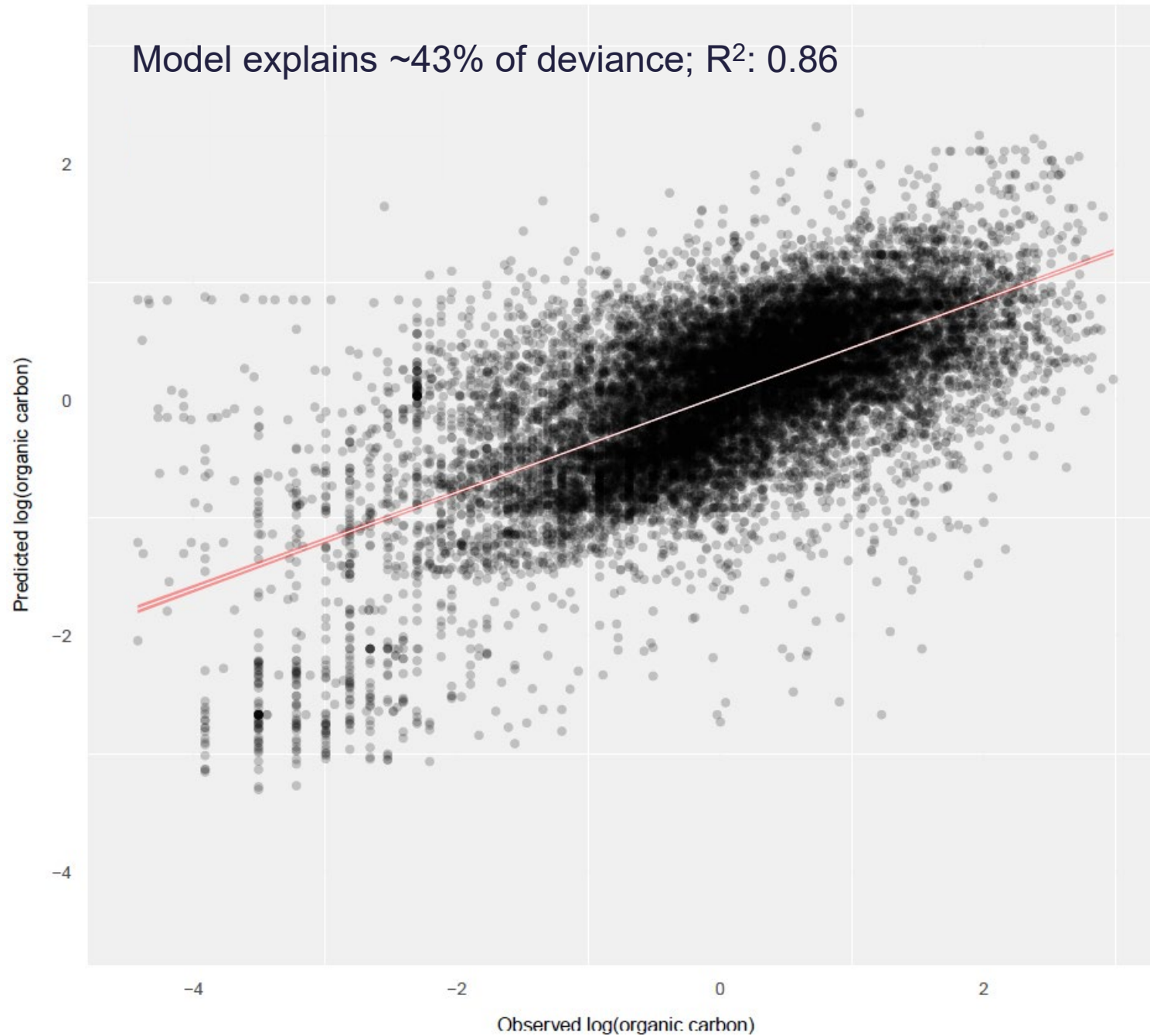
Predictor

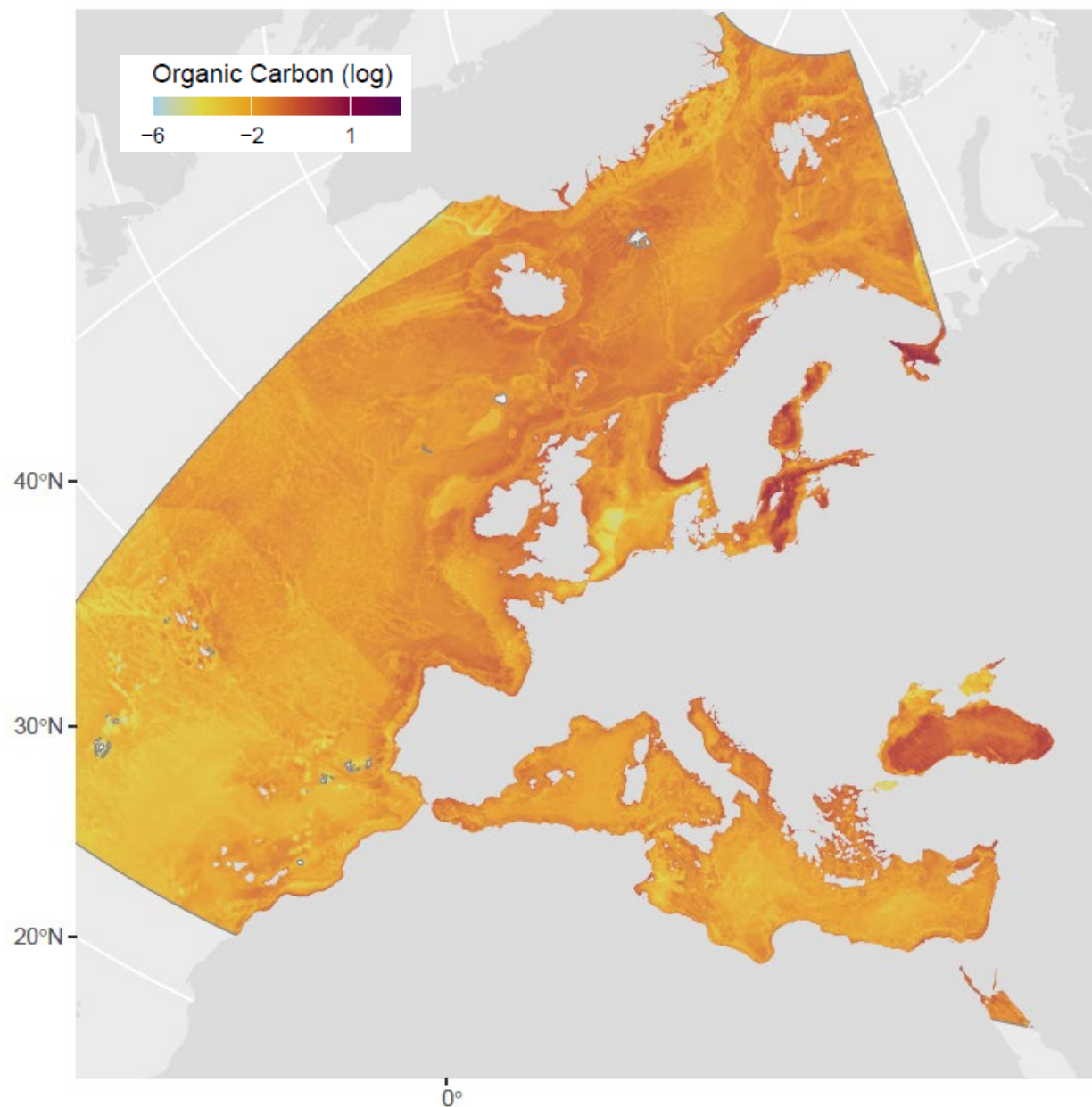


Increasing OC content towards areas w. these characteristics:

- Sheltered (low fetch, seawater speed)
-> natural sedimentation areas
- High turbidity, high river runoff
-> providing particles of organic matter
- Low Tmax
-> limiting decomposition rates
- Close to the shore (e.g. sheltered bays) or in basins, canyons, glacial troughs







Hotspots of OC content

- Nearshore and some offshore deep areas
- Baltic Sea (high river flows - large estuary, cool), Black Sea (high river flows, stratification, deep), White Sea (but beyond MPA Europe focus). By contrast, low OC in shallow North Sea areas

Our initial BC scoring system used 20% quantiles of BC obs. to define 5 levels of BC

SCORE	1	2	3	4	5
Definition	Very low	Low	Moderate	High	Very high
Blue Carbon Index (BCI) (20% quantiles)	0-0.4	0.4-0.8	0.8-1.5	1.5-2.5	>2.5

Perspectives

- MPA Europe: Maps of biodiversity and blue carbon to guide prioritization of European MPA's
- Further identification of patterns and drivers of OC-content, stocks and OC accumulation rates (OCAR)
- Recommendations for prioritization future sampling effort
 - Better spatio-temporal data coverage e.g. in the Mediterranean Sea and Black Sea
 - More ancillary data: Dry bulk density, sediment nutrient content, OC accumulation rates
- 'Living' database to support European BC data sharing



Pekaa Turi