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UNDERSTANDING DEEP ATLANTIC ECOSYSTEMS

THE UNIVERSITY of EDINBURGH

Biogeographical patterns in the deep ocean: environmental, biological, and historical drivers in the North Atlantic

ATLAS Annual General Meeting, Edinburgh 9-12th March

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 678760 (ATLAS). This output reflects only the author's view and the European Union cannot be held responsible for any use that may be made of the information contained therein.

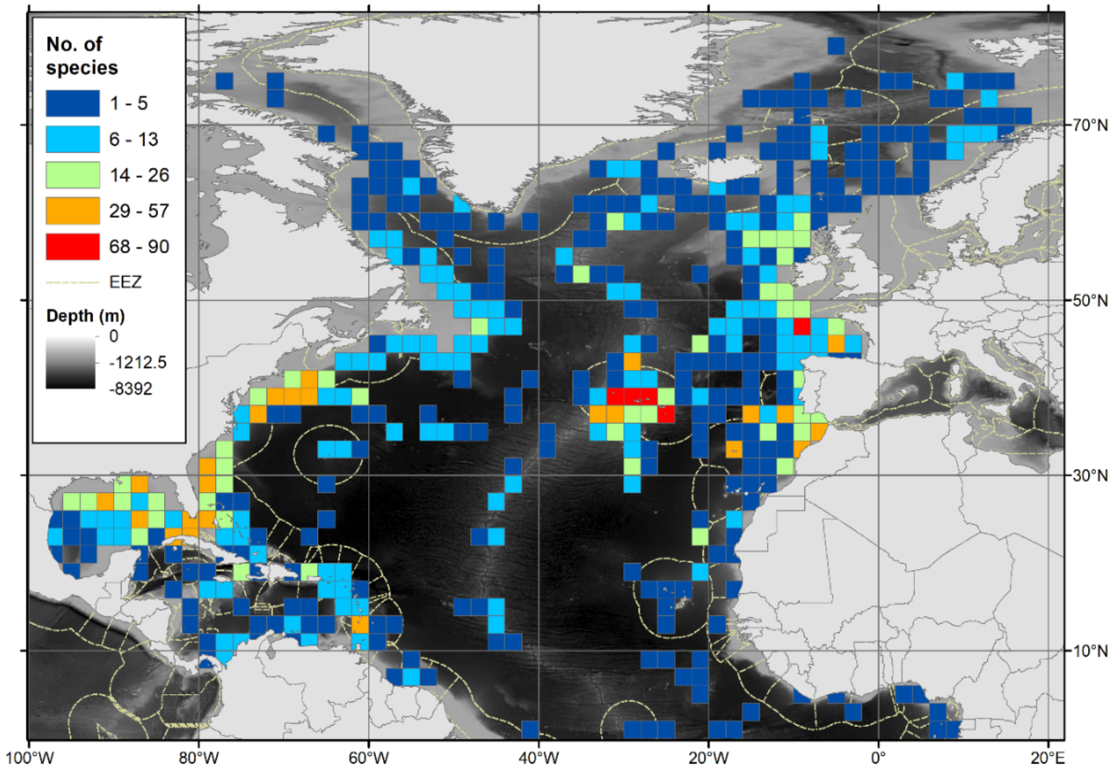
RATIONALE

Effective management of VMEs should be based on the full understanding of ecological processes and the assessment of the different scales structuring VMEs species diversity and communities.

Research Questions:

1. Are existing biogeographic classifications adequate to represent deep-sea VME biogeography?

2. Are current patterns of distribution in the North Atlantic a result of larval dispersal or environmental adaptation mechanisms?

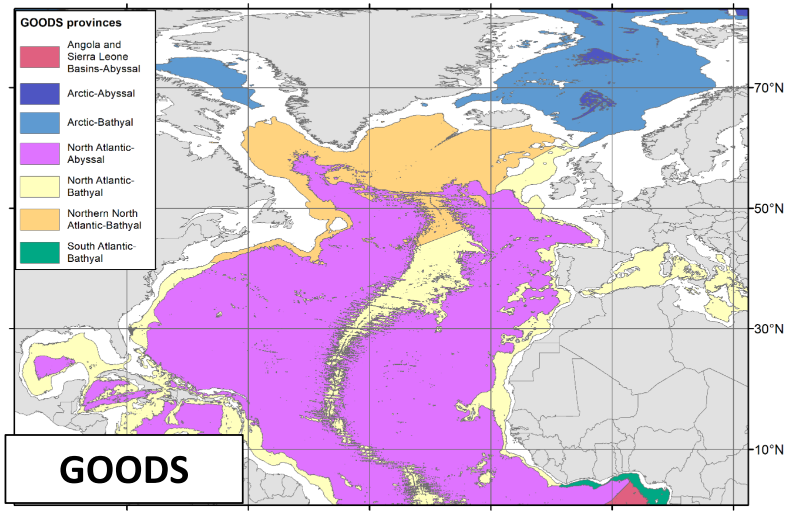


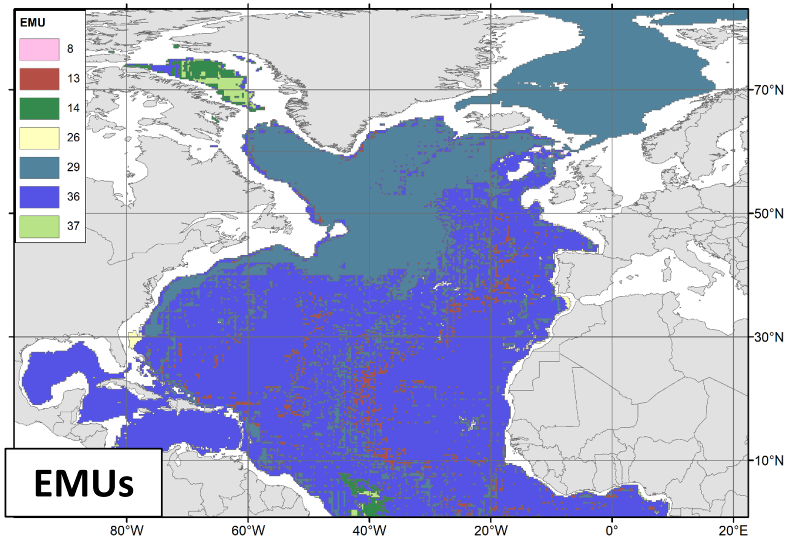
RQ1 Are existing biogeographic classifications adequate for VME taxa?

Background

- The lack of biogeographic data in the deep sea has pushed for approaches based on physiognomic proxies (i.e. bathymetry, oceanographic variables) not validated with species data.
- GOODS and EMUs have implemented this approach with expert knowledge and statistical modelling, respectively.

    - nMDS ordination and ANOSIM to test for significant differences in VME assemblages among GOODS and EMUS provinces.
    - Exploration of the effect of longitude on dispersal.

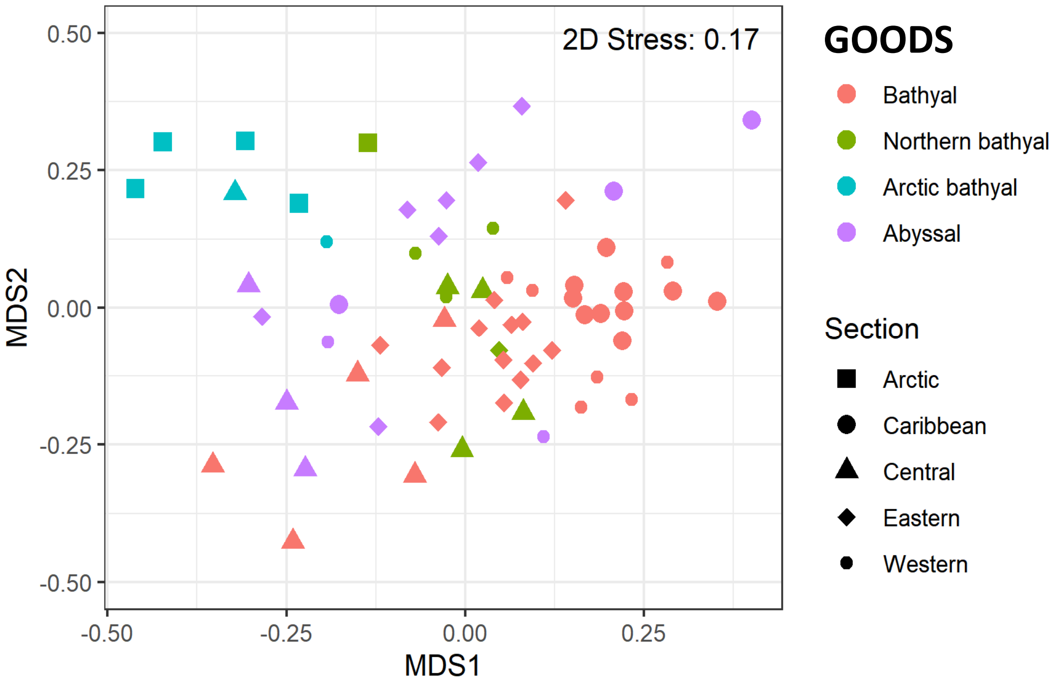


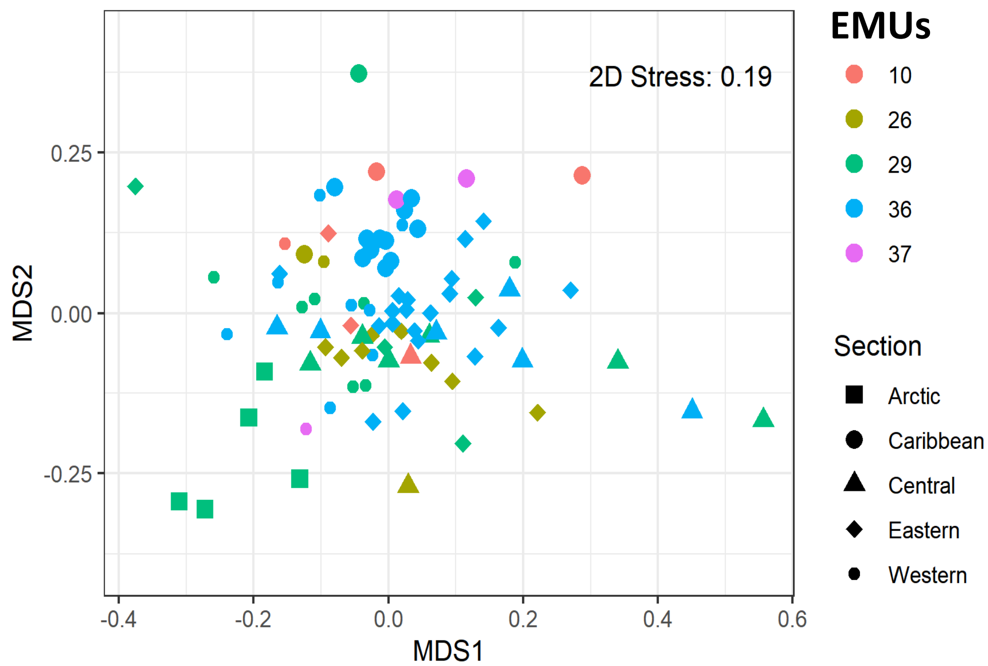


RQ1 RESULTS

- Significant spatial structure in assemblage composition:
  - **GOODS**: ↑*R* Global value **= depth has strong effect**
  - **EMUs**: ↓*R* global value **= no pattern in the nMDS plot**
- A **longitudinal gradient was evident** in GOODS.

		Global R	*P-value*
(A) ALL TAXA	**EMUs**	**0.196**	**0.0005***
	GOODS	**0.440**	**0.0005***
(B) EMUs	Scleractinia	0.168	0.014*
	Octocorallia	0.130	0.039*
	Porifera	0.162	0.005*
(C) GOODS	Scleractinia	0.048	0.335
	Octocorallia	0.177	0.054
	Porifera	0.262	0.006*





RQ1

CONCLUSIONS

- Expert driven classification (GOODS) performed better than purely statistical approaches (EMUs).
- Important effect of depth → Bathymetry co-varies with many factors that influence deep-sea species distribution patterns.
- Some evidence of an eastern and western differentiation in assemblage composition was observed in the nMDS ordination of the GOODS provinces only.
- Longitudinal patterns were not observed in the cluster analysis that included species from upper bathyal depths (200 – 800 m) → Topographic effect?

↳ **Refined GOODS could be implemented!**
(east and west Atlantic separation)

RQ2 Larval dispersal vs. environmental adaptation

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Background

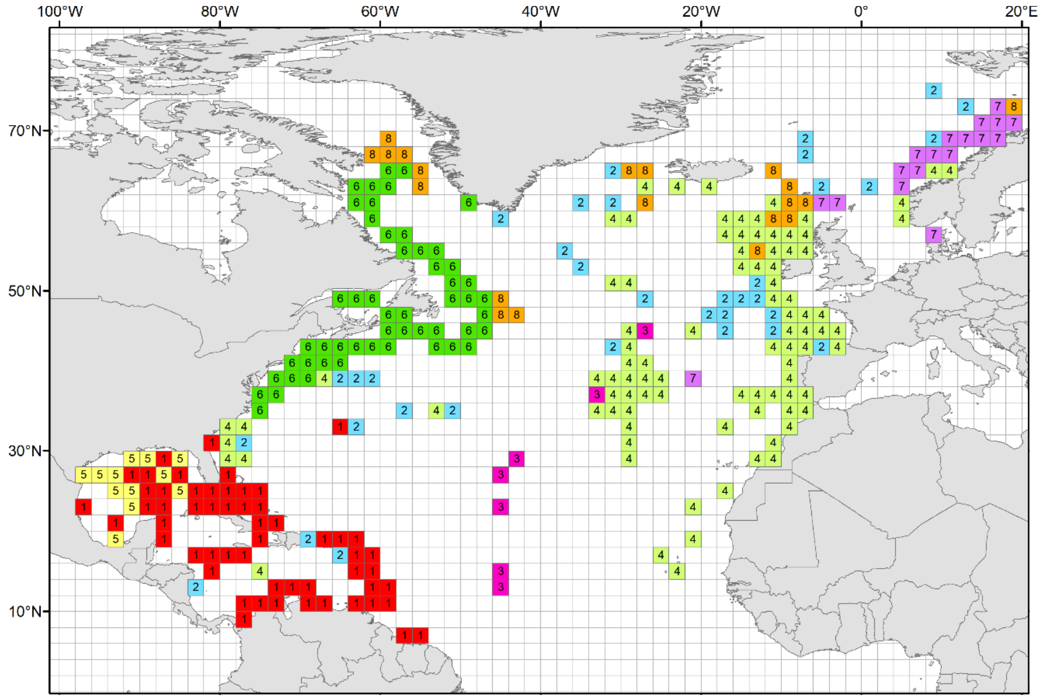
- Biotic and abiotic interactions control community structure at varying spatial and temporal scales, and generate spatial patterns that need to be assessed to disentangle the ecological processes structuring these communities.

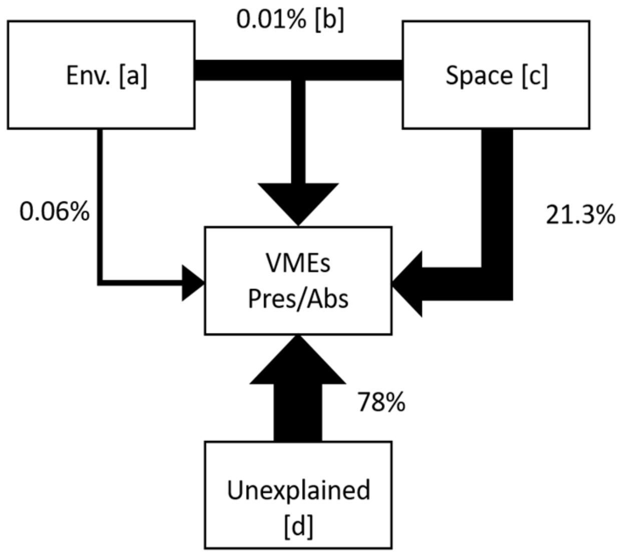
    - We aimed to describe the distribution of VMEs and relate these to environmental factors at basin scale.
    - Unravel the relative importance of environmental versus larval dispersal mechanisms in the biogeographical structure of VMEs.
    - Spatial variation in multivariate data through distance-based Moran's eigenvector mapping (dbMEM) and redundancy analysis (RDA).

RQ2 RESULTS

- 8 biogeographic clusters representing all VME taxa.
- dbMEM analysis provided vectors representing broad-scale patterns.
- Full spatial and environmental model explained 21.3 % of the variation of the data:

VME Presence/absence ~ T + Aragonite Saturation state + Calcite Saturation state + SD Oxygen + SD Si + EPC + pH + Currents Speed + Salinity + spatial eigenfunctions (broad-scale)





RQ2

CONCLUSIONS

- Change in resolution of environmental variables to match species data masks their potential effect.

- Role of space indicates that present broad-scale patterns of deep-sea VME distribution are likely a result of topography, distance-decay relationships or historical events.

- Biogeographical clusters were driven by the oceanographic conditions characterising the water masses present in each geographic area.

- **Larval dispersal mechanisms, primarily, and environmental processes (spatially structured environmental variables) not fully captured at the resolution of our study, potentially have determined the present-day distribution of complex habitats formed by VMEs in the North Atlantic.**

↳ **Implications for spatial management measures**

Acknowledgements

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Fisheries and Oceans Canada

Ifremer

UNCW University of North Carolina Wilmington

NERC Science of the Environment

SoS MinErals

EPSRC Engineering and Physical Sciences Research Council

Research Councils UK Energy For a Low Carbon Future

FAPESP São Paulo Research Foundation

Newton Fund

Universität Bremen

marum Center for Marine Environmental Sciences

National Oceanography Centre

Thank You

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