

Supporting Information

Defining Mediterranean Sea biogeochemical subprovinces and synthetic ocean indicators using mesoscale oceanographic features

Anne-Elise Nieblas^{1,*}, Kyla Drushka², Gabriel Reygondeau³, Vincent Rossi⁴, Hervé Demarcq⁵, Laurent Dubroca⁶, Sylvain Bonhommeau¹

¹ Unité Mixte Recherche Ecosystèmes Marins Exploités 212, Institut Français de Recherche pour l'Exploitation de la Mer, Sète, France.

² Applied Physics Laboratory, University of Washington, Seattle, Washington, United States.

³ Center for Macroecology, Evolution and Climate, National Institute for Aquatic Resources, Technical University of Denmark (DTU Aqua), Charlottenlund.

⁴ Instituto de Física Interdisciplinary Sistemas Complejos, Institute for Cross-Disciplinary Physics and Complex Systems, (CSIC-UIB), Campus Universitat de les Illes Balears, Palma de Mallorca, Spain.

⁵ Unité Mixte de Recherche Ecosystèmes Marins Exploités 212, Institut de Recherche pour le Développement, Sète, France.

⁶ European Commission, Joint Research Center, Institute for Environment & Sustainability, Water Resources, Ispra, Italy.

* corresponding author: Anne-Elise Nieblas, anne.elise.nieblas@gmail.com

Figure S1: Boxplots of the bootstrapped (1000 times) between-clusters sum of squares divided by the total sum of squares (i.e., y-axis represents the proportion of the explained sum of squares) for k between 2 and 30 for k-means analyses performed on the (a) “classical”, (b) “mesoscale” and (c) “full” multivariate arrays. To identify the most appropriate k for each multivariate array, we define thresholds whereby the explained sum of squares for each additional k increases by less than 5% (red line) or less than 1% (blue line).

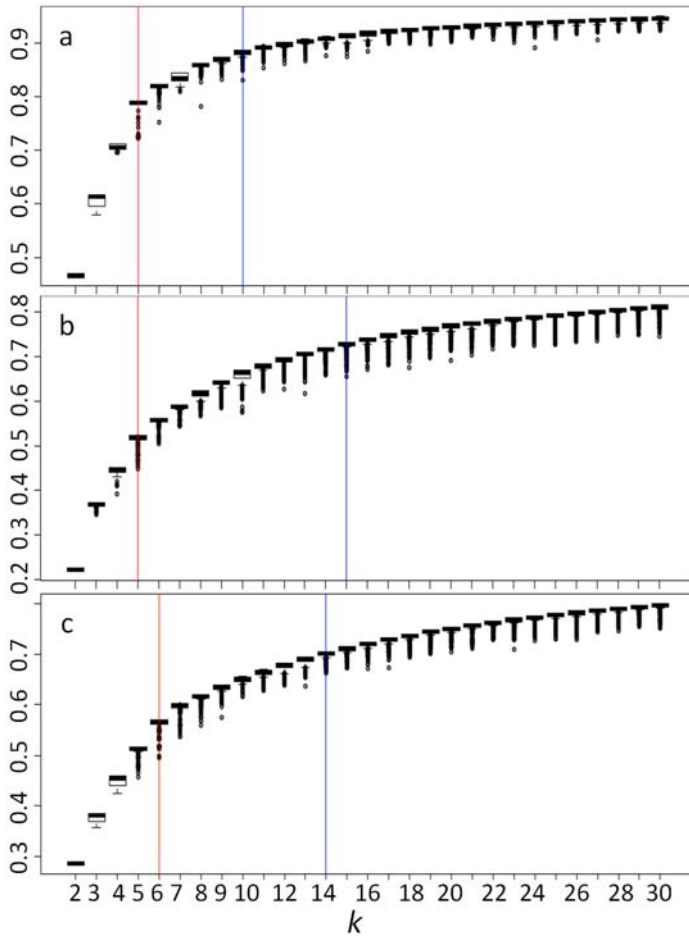


Table S1: The eigenvalues of each axis for the “full” multivariate array for biogeochemical subprovinces defined by the 5% threshold. To determine which principal components (PC) to retain, we used the common cutoff of eigenvalues ≥ 1 .

PC	subprovinces				
	1	2	3	4	5
1	1.85	1.52	2.32	1.61	1.44
2	1.20	1.24	1.20	1.21	1.15
3	0.98	0.98	0.92	1.00	1.08
4	0.81	0.96	0.87	0.98	0.91
5	0.75	0.81	0.43	0.81	0.78
6	0.41	0.49	0.26	0.38	0.64

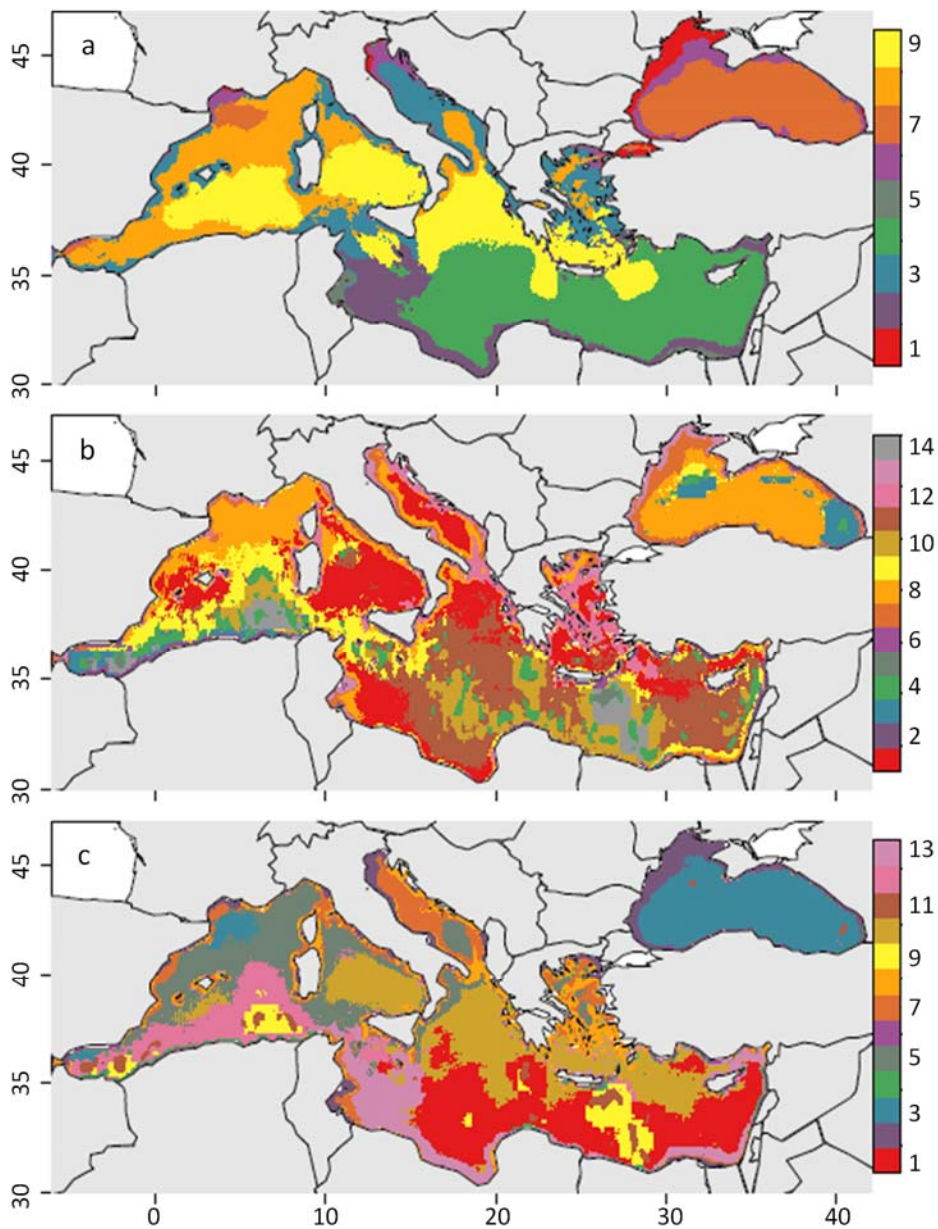


Figure S2: Biogeochemical subprovinces of the Mediterranean Sea for the (a) “classical”, (b) “mesoscale”, and (c) “full” multivariate arrays using a 1% threshold on the explained sum of squares to define the optimal number of subprovinces (see text).

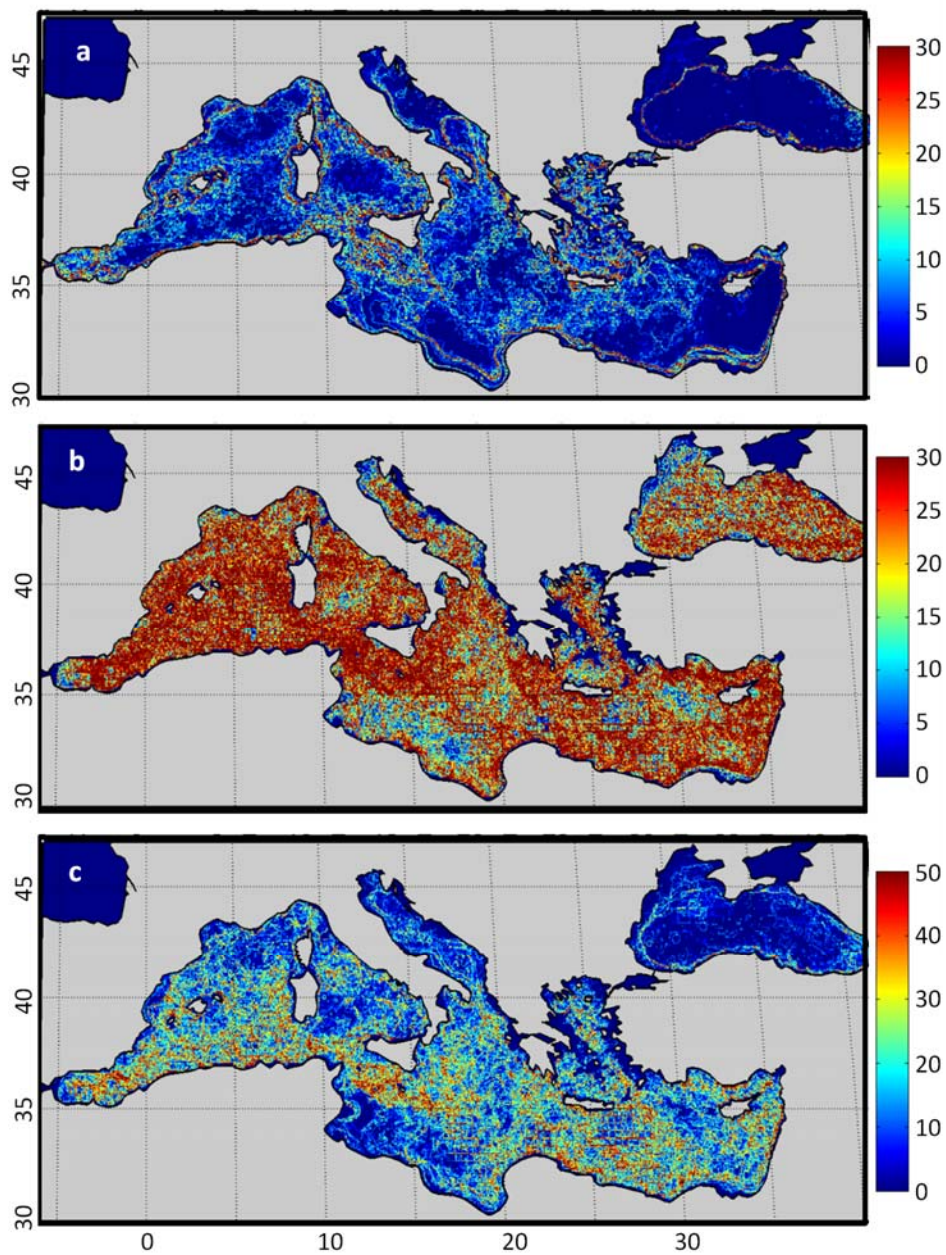


Figure S3: Spatial stability of the borders of biogeochemical subprovinces for the (a) classical, (b) mesoscale, and (c) full multivariate arrays. K-means analysis, using the k found in the time-averaged analyses (Table 1), are performed on the multivariate arrays at monthly time steps for the 101 months of the data set and using a 1% threshold on the explained sum of squares to define the optimal number of subprovinces (see text). Spatial stability is represented as the percentage of time that a boundary of the biogeochemical subprovinces is found at a particular pixel over the 101 months of the dataset. Red colors indicate stable borders.

Table S2: Correlation coefficients between the retained principal components (PC) for each of the full biogeochemical subprovinces and the monthly anomalies of the large-scale climate indices: North Atlantic Oscillation (NAO), the East Atlantic pattern (EA), the East Atlantic-West Russia pattern (EAWR), and the Scandinavian pattern (SCAND). Only correlations above the 95% significance level are included.

PC	Climate indices			
	NAO	EA	EAWR	SCAND
Full subprovince 1				
1				
2				
Full subprovince 2				
1		0.23	0.27	
2				
Full subprovince 3				
1		0.21		
2				
Full subprovince 4				
1				
2	-0.2			
3				
Full subprovince 5				
1	0.23		0.22	
2				
3				

Table S3: Correlation coefficients between the retained principal components (PC) for each of the full biogeochemical subprovinces. Significance levels are represented as $p < 0.001$ '***', $p < 0.05$ '*'.

PC1					
Subprovinces	1	2	3	4	5
1					
2	0.8 ***				
3	0.73 ***	0.61***			
4					
5					

PC2					
Subprovinces	1	2	3	4	5
1					
2	0.58*				
3					
4					
5					

PC3	
Subprovinces	4
4	
5	