nature portfolio

https://doi.org/10.1038/s41558-021-01266-5

Supplementary information

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In the format provided by the authors and unedited

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Threat by marine heatwaves to adaptive large marine ecosystems in an eddy-resolving model

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Supplementary Table 1 | The CMIP5 models used in this study.

Model	Institution
1. ACCESS1.0	Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia and Bureau of Meteorology (BOM), Australia
2. ACCESS1.3	
3. CanESM2	Canadian Centre for Climate Modelling and Analysis, Canada
4. CMCC-CM	Euro-Mediterraneo sui Cambiamenti Climatici, Italy
5. CMCC-CMS	
6. CMCC-CESM	
7. FGOALS-s2	State Key Laboratory of Numerical Modeling for Atmospheric Sciences and Geophysical Fluid Dynamics, China
8. GFDL-ESM2G	NOAA Geophysical Fluid Dynamics Laboratory, USA
9. GFDL-CM3	
10. INM-CM4	Institute for Numerical Mathematics, Russia
11. IPSL-CM5A-LR	Institut Pierre-Simon Laplace, France
12. IPSL-CM5A-MR	
13. IPSL-CM5B-LR	
14. MIROC-ESM	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies and Japan Agency for Marine-Earth Science and Technology
15. MIROC-ESM-CHEM	
16. MIROC5	
17. MPI-ESM-LR	Max Planck Institute for Meteorology, Germany
18. MPI-ESM-MR	
19. MRI-CGCM3	Meteorological Research Institute, Japan
20. MRI-ESM1	

Supplementary Table 2 | The SST trends, mean and standard deviation (std) of annual MHW days and mean intensity during historical and future periods.

Large Marine Ecosystem (LME)	1975-2004	2071-2100	Historical period (1975-2004)				Future period (2071-2100)							
							Mean warming-inclusive threshold				Future threshold			
	SST trend (°C decade^{-1})		Annual days (days)		Mean intensity (°C)		Annual days (days)		Mean intensity (°C)		Annual days (days)		Mean intensity (°C)	
			mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
1. East Bering Sea	-0.13	0.64	33.8	1.7	1.2	0.3	361.8	5.8	3.5	0.6	41.3	2.3	1.5	0.3
2. Gulf of Alaska	-0.10	0.52	34.3	2.2	1.4	0.2	356.7	8.6	2.6	0.4	37.7	2.8	1.5	0.2
3. California Current	-0.11	0.46	34.6	1.5	1.4	0.2	355.3	9.7	2.6	0.3	35.2	1.9	1.5	0.2
4. Gulf of California	0.08	0.32	36.6	1.7	1.1	0.2	360.1	5.0	2.6	0.3	37.8	2.2	1.2	0.1
5. Gulf of Mexico	0.13	0.40	32.7	2.3	1.0	0.2	362.3	5.4	3.3	0.3	36.2	2.2	1.1	0.2
6. Southeast U.S. Continental Shelf	0.11	0.32	27.4	5.0	1.2	0.4	353.3	17.7	2.9	0.2	31.9	4.3	1.2	0.3
7. Northeast U.S. Continental Shelf*	0.27	0.63	32.7	4.1	2.4	0.9	349.8	29.8	5.0	0.8	35.6	3.8	2.1	0.5
8. Scotian Shelf*	0.18	0.89	33.9	3.4	2.1	0.6	362.7	6.8	5.8	0.6	38.3	3.9	2.2	0.4
9. Newfoundland-Labrador Shelf*	0.02	0.94	29.3	5.3	1.8	0.4	333.3	36.1	3.5	1.5	35.2	4.1	2.6	0.8
10. Insular Pacific-Hawaiian	0.14	0.36	35.6	2.1	1.0	0.2	361.3	3.5	2.7	0.2	35.9	1.6	1.1	0.1
11. Pacific Central-American	0.07	0.37	32.4	2.6	1.1	0.3	357.8	10.8	2.6	0.4	33.6	2.9	1.2	0.3
12. Caribbean Sea	0.08	0.41	34.0	3.1	0.6	0.1	364.8	1.3	2.6	0.3	35.8	2.0	0.8	0.1
13. Humboldt Current*	-0.09	0.43	33.8	2.6	1.2	0.3	324.1	44.2	2.0	0.8	34.9	2.5	1.4	0.3
14. Patagonian Shelf	-0.03	0.42	30.6	3.0	1.2	0.5	352.8	13.1	2.0	0.7	35.6	3.3	1.3	0.4
15. South Brazil Shelf	-0.08	0.36	29.4	2.9	1.2	0.2	333.4	26.7	2.1	0.2	30.2	3.0	1.4	0.2
16. East Brazil Shelf	0.02	0.28	33.6	2.6	0.6	0.1	363.7	8.6	2.4	0.2	35.0	2.8	0.6	0.2
17. North Brazil Shelf	0.07	0.34	30.2	3.5	0.6	0.1	365.0	0.2	2.5	0.1	32.8	2.4	0.7	0.1
22. North Sea*	0.19	0.50	35.9	2.7	1.2	0.2	358.4	8.6	2.6	0.3	36.8	2.7	1.4	0.2

23. Baltic Sea	0.35	0.54	39.8	2.3	1.7	0.2	361.6	3.2	3.7	0.5	43.3	4.0	1.6	0.2
24. Celtic-Biscay Shelf	0.17	0.49	35.8	2.1	1.1	0.2	351.0	9.8	2.1	0.3	38.2	2.1	1.4	0.2
25. Iberian Coastal*	0.05	0.43	35.9	2.1	1.0	0.2	331.6	38.3	1.9	0.2	37.4	2.8	1.3	0.2
26. Mediterranean	0.28	0.57	40.3	3.8	1.1	0.2	364.1	3.3	3.5	0.5	41.8	3.8	1.2	0.1
27. Canary Current*	0.07	0.39	33.6	2.1	0.9	0.2	355.2	16.6	2.1	0.5	35.9	2.1	1.1	0.2
28. Guinea Current	0.08	0.40	30.3	1.9	0.7	0.2	364.9	0.4	2.9	0.2	33.3	1.8	0.8	0.1
29. Benguela Current*	0.09	0.32	33.0	2.7	1.2	0.4	352.4	20.7	2.5	0.4	33.9	3.5	1.3	0.4
30. Agulhas Current	0.06	0.37	28.8	4.3	1.3	0.5	336.3	51.5	2.7	0.3	30.8	4.9	1.5	0.6
31. Somali Coastal Current	0.07	0.46	31.8	1.8	1.0	0.2	363.7	4.0	3.1	0.3	35.9	2.5	1.0	0.2
32. Arabian Sea	0.08	0.51	32.6	2.4	0.9	0.2	360.8	7.1	2.6	0.4	36.0	2.1	1.1	0.2
33. Red Sea	0.17	0.50	35.4	2.6	1.1	0.2	360.5	4.6	2.6	0.3	37.7	2.5	1.3	0.2
34. Bay of Bengal	0.10	0.39	32.2	1.8	0.7	0.1	364.3	1.7	2.7	0.2	34.2	1.7	0.9	0.1
35. Gulf of Thailand*	0.06	0.42	33.0	1.4	0.8	0.1	364.7	0.5	2.7	0.2	36.0	1.9	0.9	0.1
36. South China Sea*	0.03	0.47	32.3	1.6	1.0	0.2	361.5	4.1	2.5	0.2	33.5	1.8	1.2	0.2
37. Sulu-Celebes Sea	0.13	0.37	29.7	2.5	0.7	0.1	364.8	0.3	2.6	0.2	32.2	1.9	0.8	0.1
38. Indonesian Sea	0.12	0.37	31.4	2.5	0.7	0.1	364.3	3.0	2.6	0.3	33.3	2.1	0.8	0.1
39. North Australian Shelf	0.15	0.45	35.0	1.7	0.9	0.1	363.5	1.9	2.4	0.3	37.4	2.0	1.0	0.1
40. Northeast Australian Shelf	0.08	0.43	33.7	1.8	1.0	0.1	360.6	3.2	2.1	0.2	34.5	1.6	1.2	0.1
41. East-Central Australian Shelf	-0.02	0.44	31.2	3.3	1.6	0.4	329.5	31.5	2.4	0.3	31.7	2.7	1.8	0.4
42. Southeast Australian Shelf	-0.01	0.29	31.6	2.1	1.6	0.6	315.0	35.6	2.3	0.6	32.7	3.2	1.8	0.7
43. Southwest Australian Shelf	0.10	0.26	31.7	3.1	1.4	0.6	302.7	49.9	2.1	0.4	32.7	3.3	1.6	0.6
44. West-Central Australian Shelf	0.17	0.27	30.2	2.5	1.7	0.3	301.2	34.0	2.4	0.2	31.0	1.8	1.9	0.3
45. Northwest Australian Shelf	0.15	0.38	34.9	1.7	1.0	0.1	361.4	5.0	2.5	0.2	35.7	1.7	1.1	0.2
46. New Zealand Shelf	-0.01	0.27	33.1	2.8	1.1	0.2	343.7	36.9	1.9	0.3	35.5	3.1	1.1	0.2
47. East China Sea*	0.06	0.49	31.4	5.6	1.6	0.2	340.8	15.6	2.9	0.3	33.4	5.8	1.7	0.2
48. Yellow Sea*	0.13	0.60	34.8	2.9	1.7	0.2	360.9	7.8	3.7	0.5	41.0	3.9	1.6	0.2

49. Kuroshio Current	0.17	0.58	31.2	4.0	2.1	1.0	300.3	51.9	3.2	0.9	32.8	3.8	2.2	0.8
50. Sea of Japan/East Sea*	0.16	0.64	33.4	3.0	2.4	0.5	342.7	14.8	3.9	0.6	35.7	3.9	2.3	0.4
51. Oyashio Current	0.32	0.81	33.6	2.3	2.5	1.2	342.5	41.8	4.6	0.5	35.6	2.4	2.8	0.9
52. Sea of Okhotsk*	-0.05	0.73	33.7	3.7	1.5	0.2	362.4	7.8	4.7	1.0	41.5	3.9	1.8	0.3
53. West Bering Sea	-0.12	0.56	33.1	2.1	1.3	0.2	363.5	4.0	3.9	0.5	40.5	2.8	1.4	0.2
59. Iceland Shelf and Sea	0.15	0.74	33.8	5.6	1.3	0.4	352.5	22.8	3.5	1.3	38.5	3.6	1.5	0.2
60. Faroe Plateau*	0.18	0.57	33.8	3.5	1.0	0.3	362.5	2.8	2.5	0.5	35.5	2.8	1.3	0.2
62. Black Sea	0.33	0.64	40.6	2.7	1.3	0.1	363.2	1.2	3.7	0.4	40.1	2.4	1.5	0.1
63. Hudson Bay Complex	0.00	1.17	29.6	3.9	1.1	0.3	342.3	28.7	2.3	0.7	41.0	2.8	2.1	0.2
65. Aleutian Islands	-0.02	0.53	33.2	2.7	1.1	0.1	364.9	0.3	4.0	0.5	39.2	2.5	1.4	0.1

[#] The standard deviation is calculated based on the spatial coverage on each LME, and for future period, both the mean warming-inclusive and future thresholds are applied

*The LME with the fishing capacity ranking the top 15 among all the LMEs (Fig. 1A in ref. [1])

Supplementary Reference

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