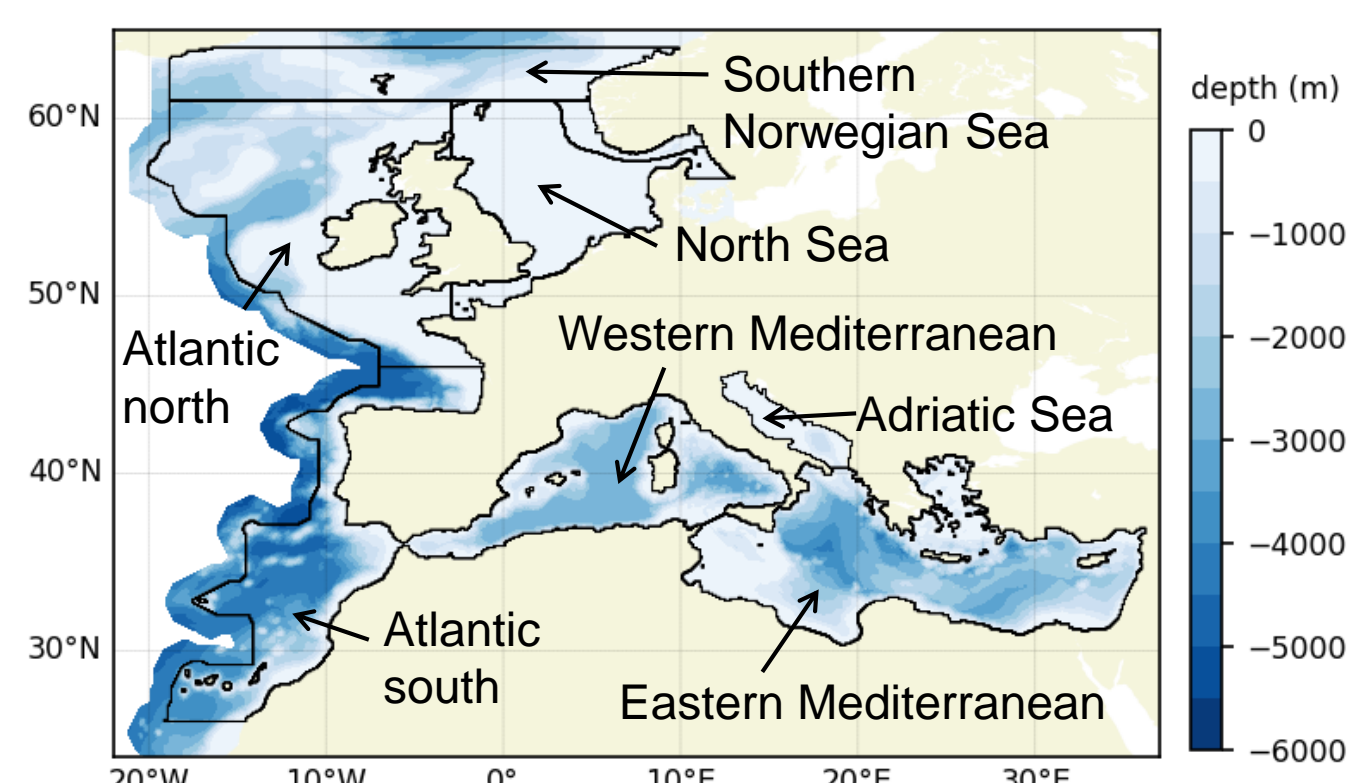




It's Not Just About Sea Surface Temperature: Synthesizing Information to Communicate Climate Change Projections for European Seas

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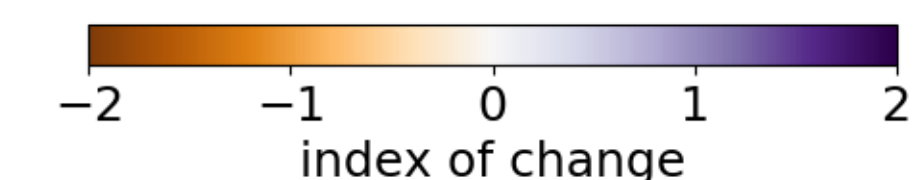
Users of climate model data often use maps of sea surface temperature as a quick way into the data. But outputs from regional climate models with a biogeochemical component contain a wealth of data of interest to stakeholders. How can we convey more information quickly and effectively?



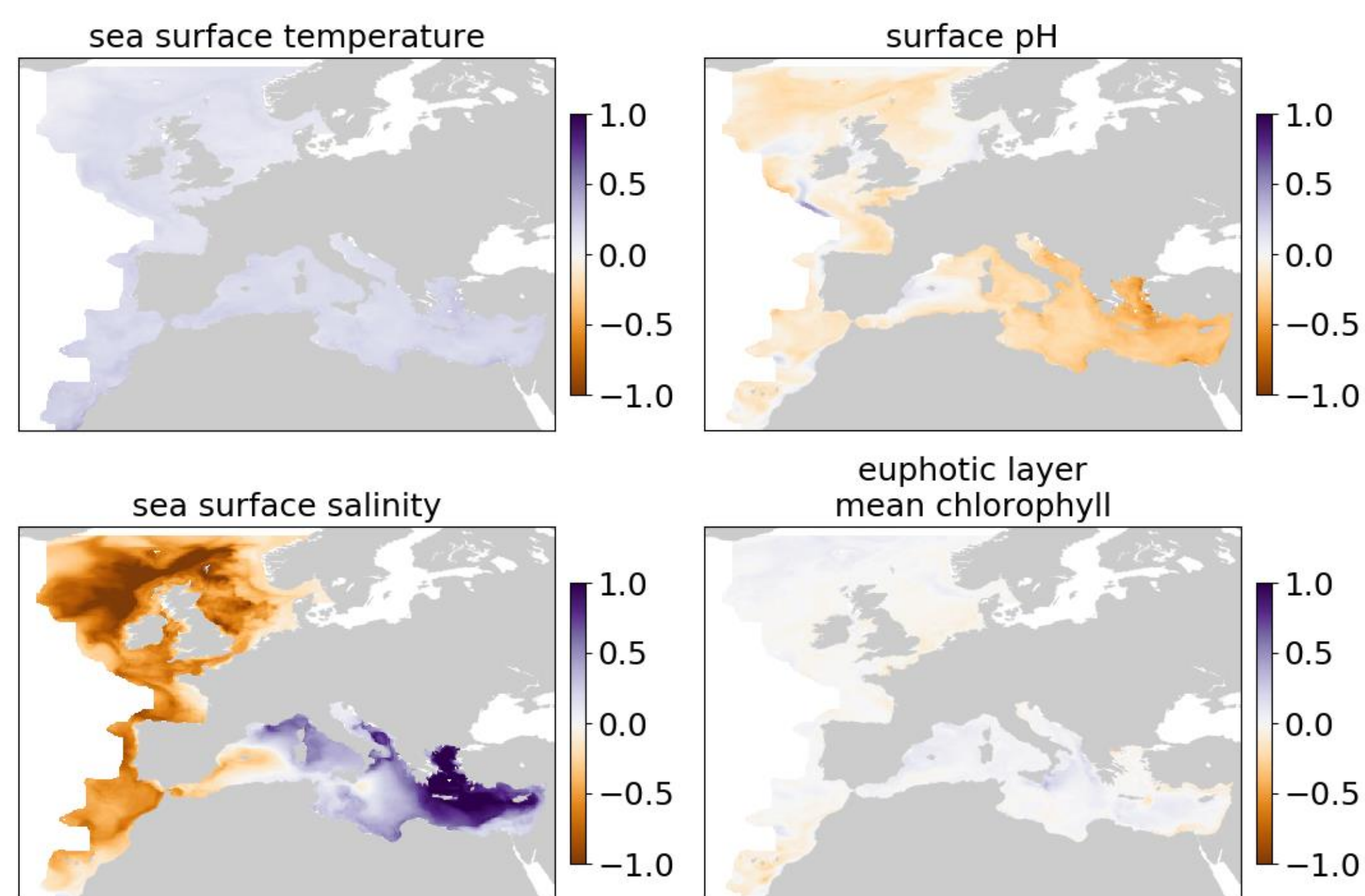
I have used outputs from a coupled physical-biogeochemical model for European seas to demonstrate some ideas. More details about the model are given at the bottom of this poster. The plot to the left shows the model domain and regions.

RCP 8.5	SST	SBT	surface salinity	MLD	net PP	euphotic layer chl	phytoplankton	zooplankton	bottom O ₂	surface pH	surface N	surface P	surface Si
Southern Norwegian Sea	0.9	0.1	-0.35	-29.4	-0	0.098	1	-8	-91.0	-0.078	-1.27	-0.09	-2.94
Atlantic north of 46°N	1.1	0.0	-0.59	-9.8	-7	-0.014	-78	3	-41.1	-0.038	-1.65	-0.13	-3.36
North Sea	1.7	1.5	-0.68	-1.9	-5	-0.033	-146	-43	-13.0	-0.025	-0.31	-0.12	-3.81
Atlantic south of 46°N	1.8	0.4	-0.43	-4.1	-76	-0.056	-329	-186	-12.2	-0.022	-0.18	-0.07	0.11
Western Mediterranean	2.3	2.0	0.03	-2.6	45	0.063	113	125	-29.2	-0.041	0.03	0.12	-0.45
Adriatic Sea	2.3	2.1	0.44	-1.0	39	0.036	48	95	-15.7	-0.057	0.09	0.27	-0.32
Eastern Mediterranean	2.5	2.0	0.49	-1.4	11	0.030	8	48	-19.8	-0.057	0.01	0.17	-0.35

RCP 4.5	SST	SBT	surface salinity	MLD	net PP	euphotic layer chl	phytoplankton	zooplankton	bottom O ₂	surface pH	surface N	surface P	surface Si
Southern Norwegian Sea	0.4	-0.1	-0.23	-9.1	-0	0.056	0	-4	-73.1	-0.058	-0.47	-0.04	-1.93
Atlantic north of 46°N	0.4	-0.1	-0.50	-4.4	-5	-0.006	-70	22	-42.4	-0.047	-0.82	-0.07	-2.96
North Sea	0.7	0.5	-0.53	-1.0	-13	-0.039	-116	-39	-4.7	-0.027	-1.09	-0.09	-3.90
Atlantic south of 46°N	0.9	0.3	-0.34	-1.6	-37	-0.037	-182	-40	-6.7	-0.029	-0.08	-0.04	0.43
Western Mediterranean	1.0	1.1	0.17	-1.1	54	0.085	169	140	-10.7	-0.037	0.10	0.15	0.17
Adriatic Sea	1.0	0.8	0.37	-0.2	35	0.045	112	106	-6.3	-0.049	0.14	0.26	-0.16
Eastern Mediterranean	0.9	1.2	0.33	-0.2	31	0.086	169	123	-9.7	-0.043	0.08	0.19	-0.21



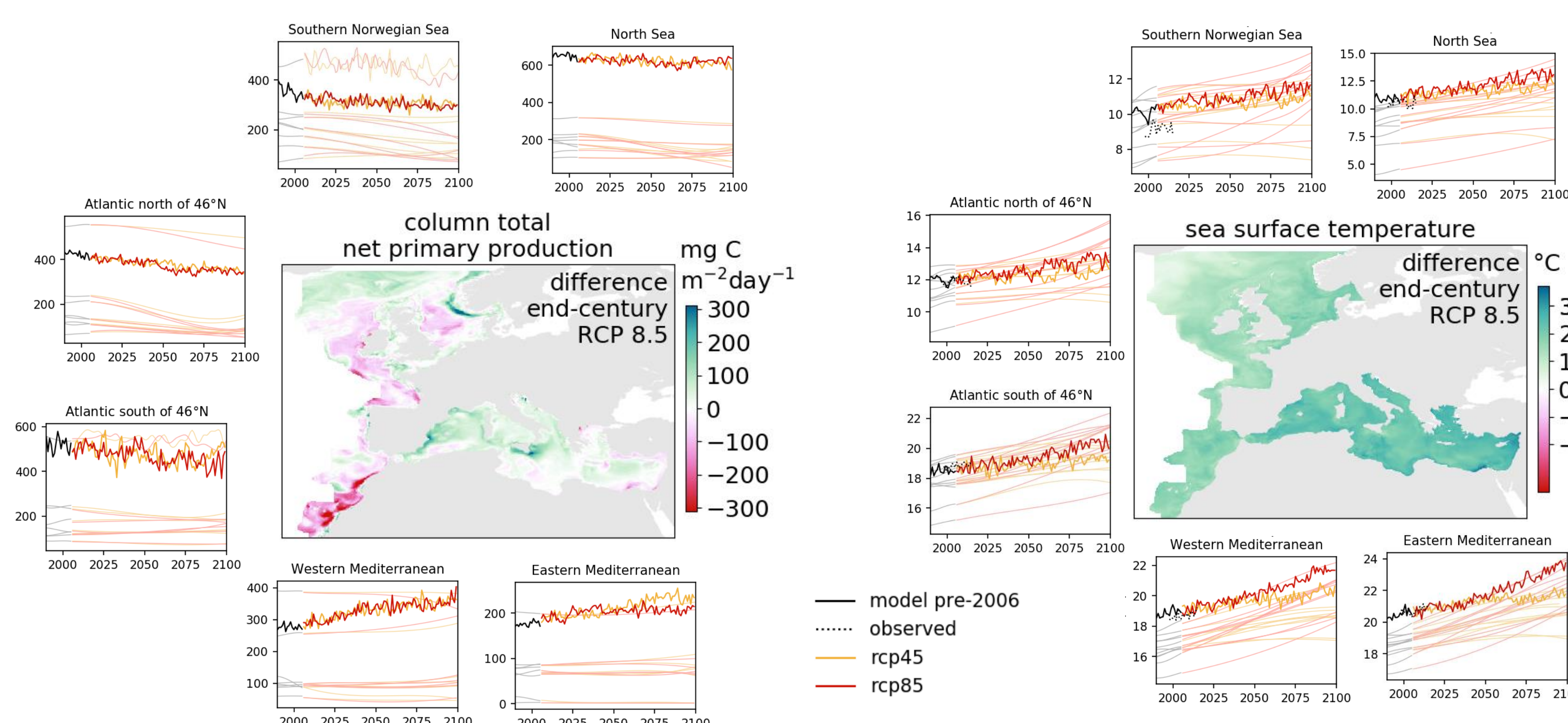
SST: sea surface temperature (°C); SBT: sea bottom temperature (°C); surface salinity (psu); MLD: mixed layer depth (m); netPP: column total net primary production (mg C m⁻² day⁻¹); euphotic layer chl: chlorophyll concentration averaged over the euphotic depth (mg m⁻³); phytoplankton: column total (mg C m⁻²); zooplankton: column total (mg C m⁻²); bottom O₂: bottom level dissolved oxygen concentration (mmol m⁻³); surface N: surface nitrate concentration (mmol m⁻³); surface P: surface phosphate concentration (mmol m⁻³); surface Si: surface silicate concentration (mmol m⁻³)



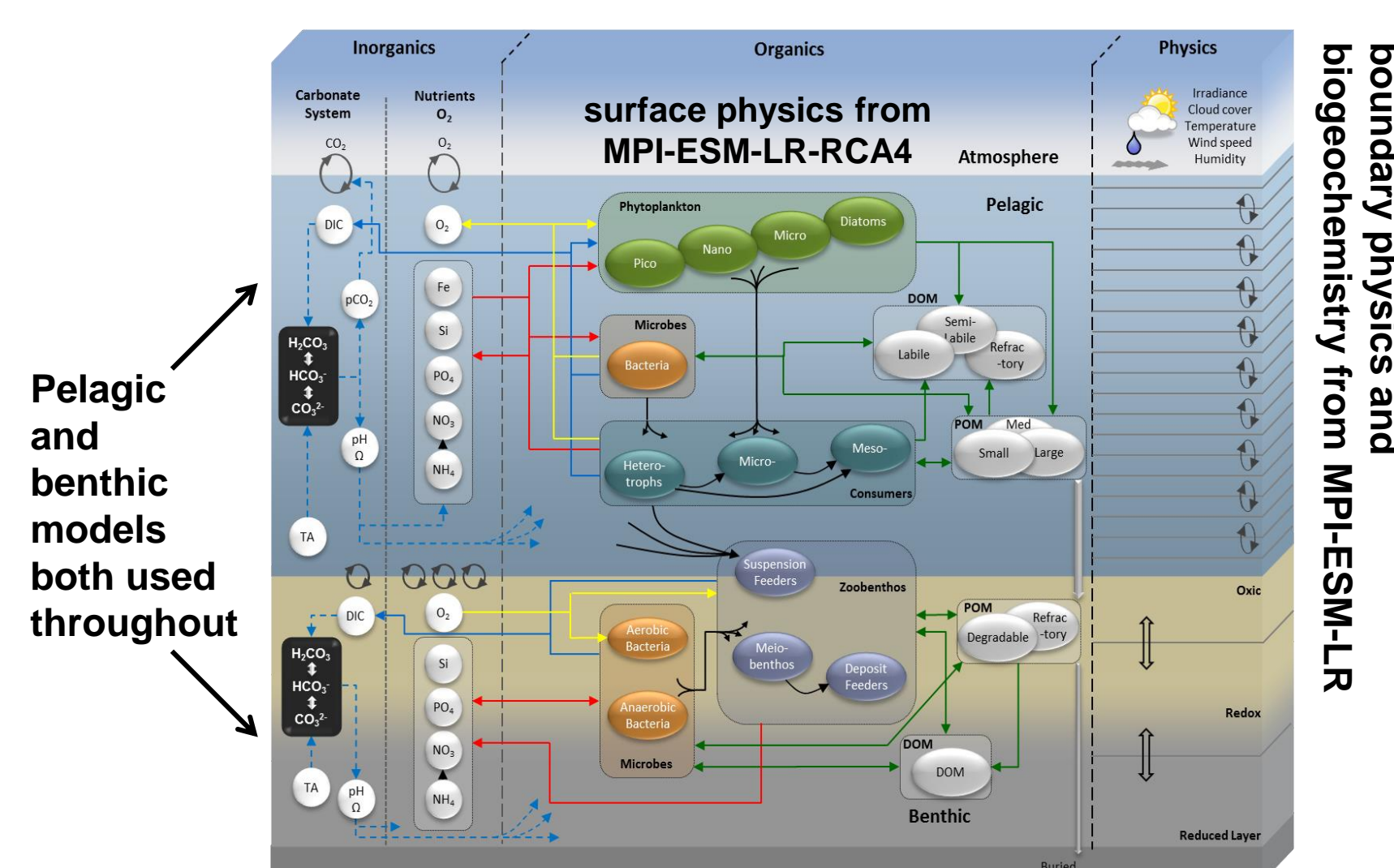
Scaled plots showing projected change at the end of the century under RCP 8.5; see the paragraph to the right for a description of the scaling method. The variables shown are key for the shellfish aquaculture industry.

Times series and maps show complementary information

Use them together, for multiple variables and multiple models.



— model pre-2006
— observed
— rcp45
— rcp85



Pelagic and benthic models both used throughout

Model information

- Physical model POLCOMS¹: baroclinic B-grid model suitable for shelf seas and deep water areas.
- Biogeochemical model ERSEM²: four phytoplankton functional types, three zooplankton, bacterial loop, independent tracking of C, N, P, Si, separate benthic model.
- Horizontal resolution 0.1° x 0.1°, 40 vertical levels, modified sigma distribution.
- Surface forcing from the global CMIP5 model MPI-ESM-LR³ downscaled by the regional model RCA4.
- Open ocean boundary conditions from the global model MPI-ESM-LR.
- River flow, N and P from the hydrological model E-HYPE, also driven by MPI-ESM-LR.

The model outputs are available from the Copernicus Climate Data Store:
cds.climate.copernicus.eu dataset sis-marine-properties

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Scale the change in different variables using the present-day range

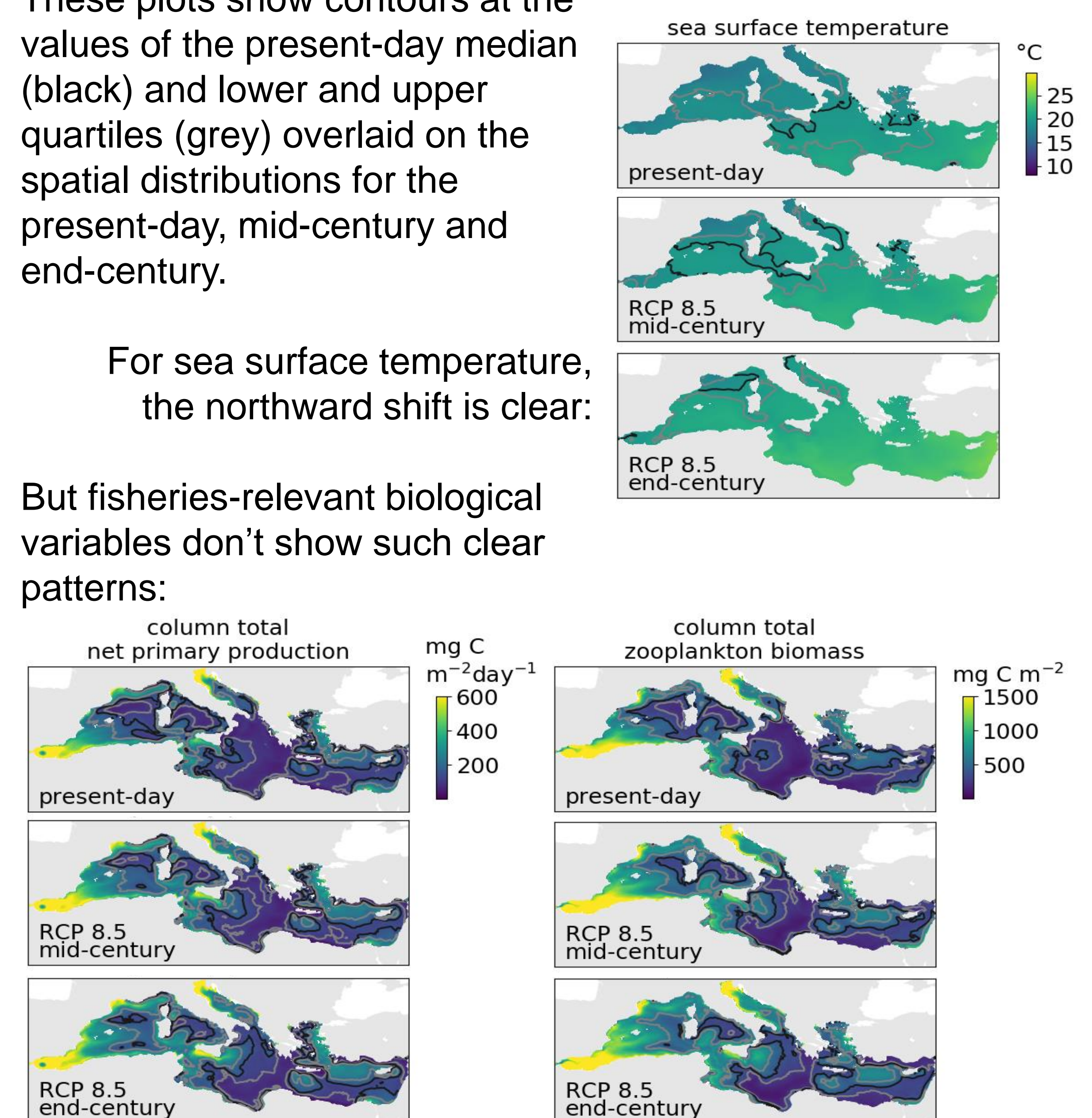
The table above shows projected change in multiple variables. The numbers give the change from the first 20 years of this century to the last 20 years. The colour shows the change divided by the difference between the maximum and minimum monthly values for 2000-2019. If the change is not significantly different compared to the present-day range the number is shown in grey. This method enables multiple variables to be compared and gives a sense of how the change compares to present-day variability. It can also be used to scale spatial plots (right).

Contours show changing distribution

These plots show contours at the values of the present-day median (black) and lower and upper quartiles (grey) overlaid on the spatial distributions for the present-day, mid-century and end-century.

For sea surface temperature, the northward shift is clear:

But fisheries-relevant biological variables don't show such clear patterns:



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References

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- Holt, J.T., James, I.D., 2001. An s coordinate density evolving model of the northwest European continental shelf 1. Model description and density structure. J. Geophys. Res. 106, 14015–14,034.
- <http://www.mpiet.mpg.de/en/science/models/mpi-esm.html>

Further information about the model can be found in Kay et al. 2018. Projections of physical and biogeochemical parameters and habitat indicators for European seas, including synthesis of Sea Level Rise and storminess. <https://cordis.europa.eu/project/id/678193/results>