OCEAN DEOXYGENATION

"OCEANS ARE LOSING THEIR BREATH"

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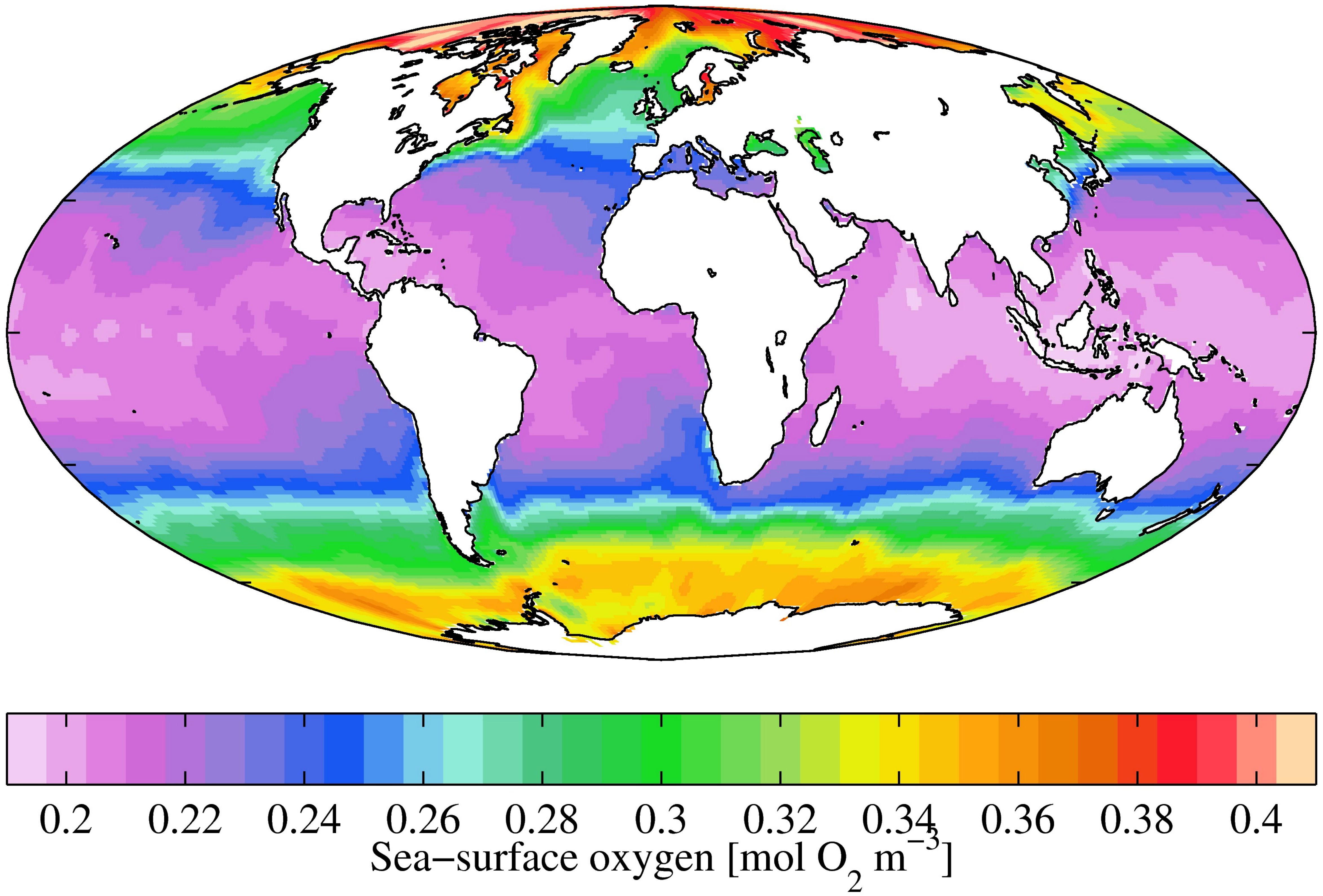
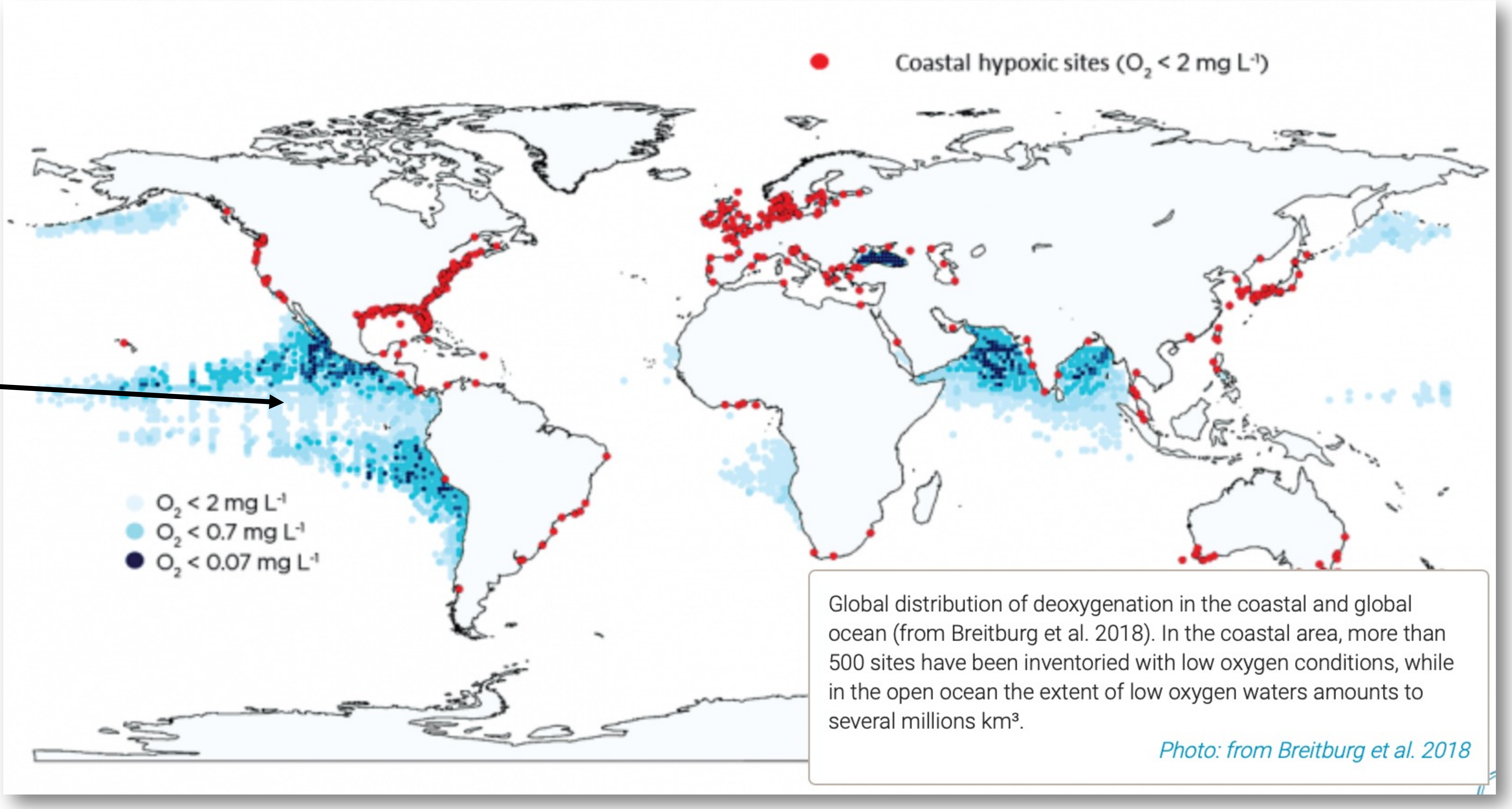
The dissolved O2 concentration in the ocean is, on average, 162 µmol kg–1(or roughly 5.05 mg L–1) with levels:

i) above 500 µmol kg–1 in super-saturated productive Antarctic waters,
ii) close to zero in some coastal sediments, and

iii) permanently anoxic in deep habitats of isolated water bodies, namely the Black Sea and the Cariaco Basin

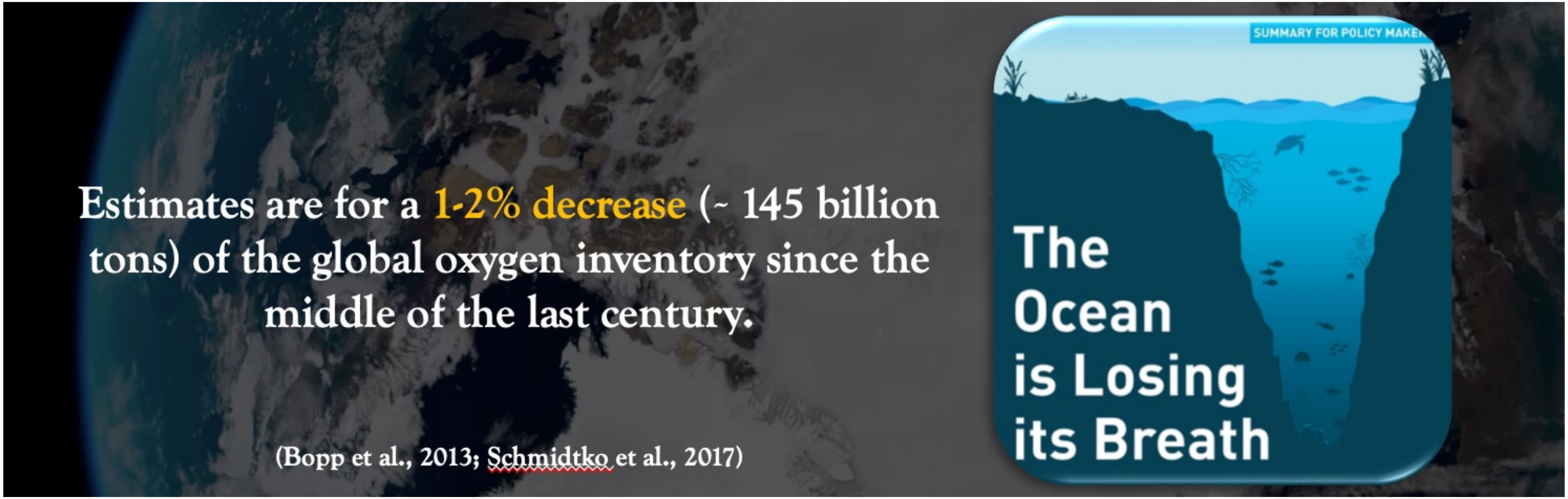


Hypoxic areas (low oxygen levels) are widespread and comprise about 5% of global ocean volume. Included in these areas are the massive Oxygen Minimum Zones (OMZs), usually between 100 and 900 m deep in both the Eastern Atlantic and Pacific tropical oceans.



Global distribution of deoxygenation in the coastal and global ocean (from Breitburg et al. 2018). In the coastal area, more than 500 sites have been inventoried with low oxygen conditions, while in the open ocean the extent of low oxygen waters amounts to several millions km³.

Photo: from Breitburg et al. 2018


Estimates are for a 1-2% decrease (~ 145 billion tons) of the global oxygen inventory since the middle of the last century.
(Bopp et al., 2013; Schmidtko et al., 2017)
SUMMARY FOR POLICY MAKE
The Ocean is Losing its Breath

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2017

LETTER

doi:10.1038/nature21399

Decline in global oceanic oxygen content during the past five decades

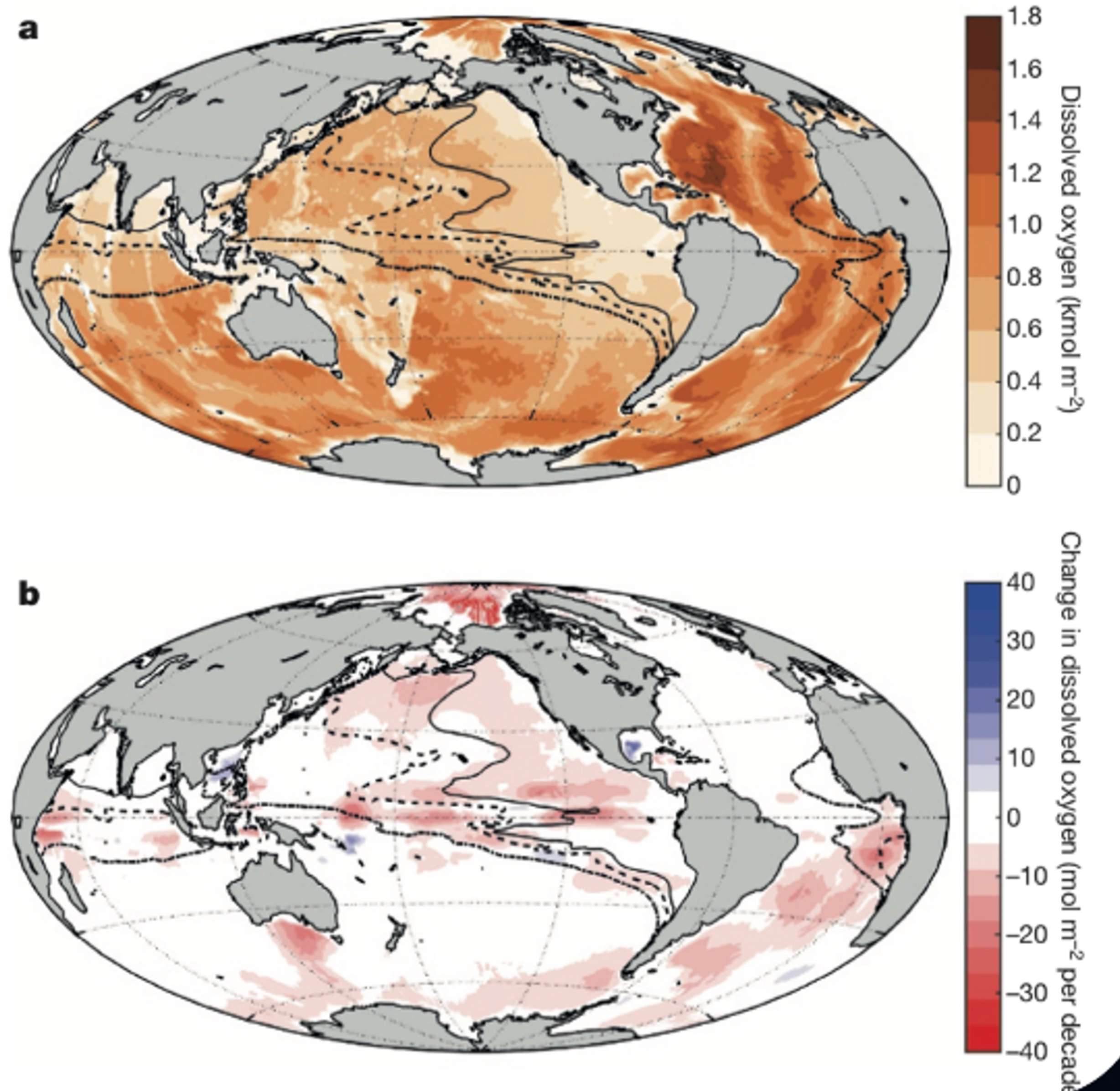
Sunke Schmidtko[1], Lothar Stramma[1] & Martin Visbeck[1,2]

RESEARCH LETTER

Table 1 | Oxygen content and change per basin

Basin	Oxygen content (Pmol)	Oxygen change (Tmol per decade)	Change as percentage of global change	Volume as percentage of global ocean volume
Arctic Ocean	4.7±0.2	−73±30	7.6±3.1	1.2
North Atlantic	26.9±0.1	−9±19	0.9±1.9	8.5
Equatorial Atlantic	15.9±0.0	−72±20	7.5±2.1	5.7
South Atlantic	22.4±0.1	−119±27	12.4±2.8	7.8
North Pacific	24.5±0.1	−173±40	18.0±4.2	16.3
Equatorial Pacific	25.5±0.4	−210±125	21.9±13.0	16.3
South Pacific	33.1±0.1	−71±37	7.4±3.9	14.3
Equatorial Indian Ocean	10.7±0.1	−55±49	5.7±5.1	6.6
South Indian Ocean	26.1±0.1	−27±34	2.8±3.5	10.2
Southern Ocean	37.6±0.1	−152±47	15.8±4.9	13.1
Total	**227.4±1.1**	**−961±429**	**100**	**100**

Trends that are more significant than two standard errors are marked in light grey. See Extended Data Table 1 for an extended version of this table.



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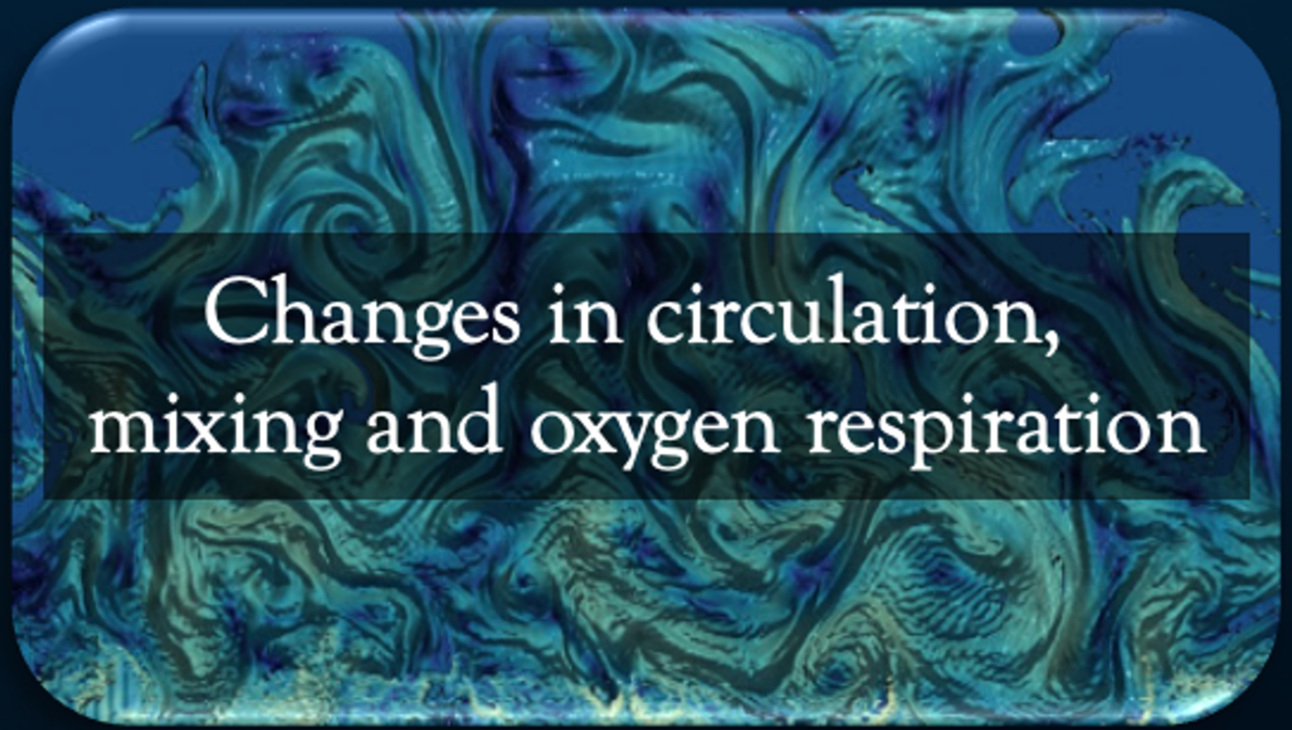
Warming is considered a major driver:

Directly

Indirectly




nature geoscience

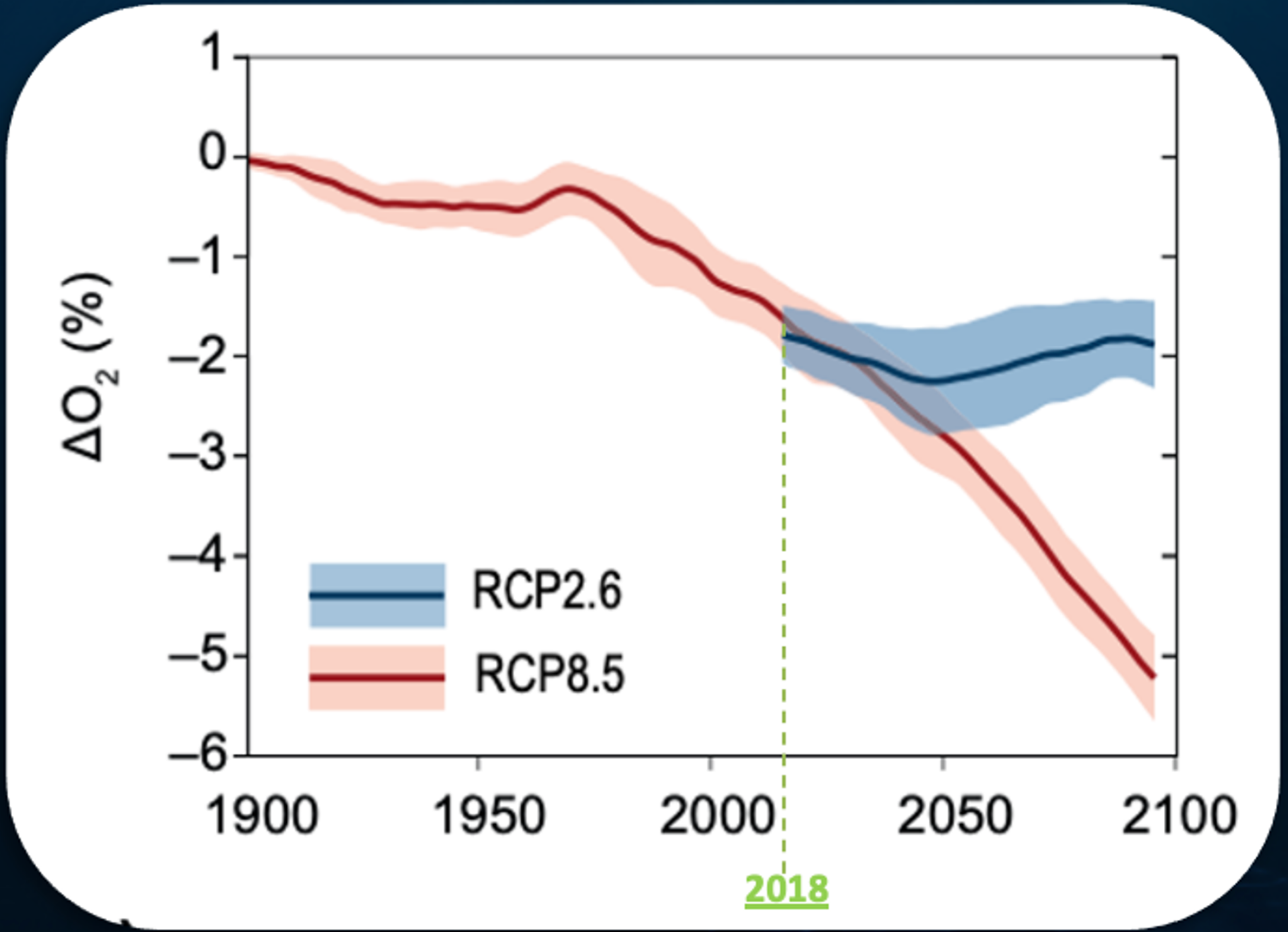
REVIEW ARTICLE

Drivers and mechanisms of ocean deoxygenation

Andreas Oschlies[1,2,4], Peter Brandt[1,2], Lothar Stramma[1] and Sunke Schmidtko[1]

Direct observations indicate that the global ocean oxygen inventory is decreasing. Climate models consistently confirm this decline and predict continuing and accelerating ocean deoxygenation. However, current models (1) do not reproduce observed patterns for oxygen changes in the ocean's thermocline; (2) underestimate the temporal variability of oxygen concentrations

Ocean deoxygenation future trends



(IPCC 2019)

Lose up to 3 % until 2100

MOVIE – A Breathless Ocean

https://www.youtube.com/watch?v=chp3rtJLJtk

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Our recent study shows that hypoxia effects are more deleterious than those predicted for future warming and acidification

(pdf available in the folder)

nature ecology & evolution

ARTICLES

https://doi.org/10.1038/s41559-020-01370-3

Check for updates

Impacts of hypoxic events surpass those of future ocean warming and acidification

Eduardo Sampaio[1,2,3] ✉, Catarina Santos[1], Inês C. Rosa[1], Verónica Ferreira[4], Hans-Otto Pörtner[5], Carlos M. Duarte[6], Lisa A. Levin[7] and Rui Rosa[1]

Over the past decades, three major challenges to marine life have emerged as a consequence of anthropogenic emissions: ocean warming, acidification and oxygen loss. While most experimental research has targeted the first two stressors, the last remains comparatively neglected. Here, we implemented sequential hierarchical mixed-model meta-analyses (721 control–treatment comparisons) to compare the impacts of oxygen conditions associated with the current and continuously intensifying hypoxic events (1–3.5 O_2 mg l^{-1}) with those experimentally yielded by ocean warming (+4 °C) and acidification (−0.4 units) conditions on the basis of IPCC projections (RCP 8.5) for 2100. In contrast to warming and acidification, hypoxic events elicited consistent negative effects relative to control biological performance—survival (−33%), abundance (−65%), development (−51%), metabolism (−33%), growth (−24%) and reproduction (−39%)—across the taxonomic groups (mollusks, crustaceans and fish), ontogenetic stages and climate regions studied. Our findings call for a refocus of global change experimental studies, integrating oxygen concentration drivers as a key factor of ocean change. Given potential combined effects, multistressor designs including gradual and extreme changes are further warranted to fully disclose the future impacts of ocean oxygen loss, warming and acidification.


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