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Ocean monitoring indicator (OMI) of the Copernicus marine environment monitoring service global yearly ocean CO₂ sink

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COPERNICUS
MARINE ENVIRONMENT MONITORING SERVICE

QUALITY INFORMATION DOCUMENT

Ocean Monitoring Indicator (OMI) of the Copernicus Marine Environment Monitoring Service

Global yearly ocean CO₂ sink

GLOBAL_OMI_HEALTH_carbon_co2_flux_integrated

Issue: 3.0

Contributors: Trang Chau, Marion Gehlen, Frederic Chevallier

Approval date by the CMEMS product quality coordination team: dd/mm/yyyy

QUID for CMEMS OMI: GLOBAL_OMI_HEALTH_carbon_co2_flux_integrated	Ref: Date: Issue:	CMEMS-OMI-QUID-GLO-HEALTH-carbon-co2-flux-integrated September 2021 4.0
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CHANGE RECORD

Issue	Date	§	Description of Change	Author	Validated By
1.0	October 2019	all	Creation of the document	Marion Gehlen, Thi Tuyet Trang Chau	
2.0	December 2019	/	Update of Figure, references Modification of method description and validation	Thi Tuyet Trang Chau, Marion Gehlen, Frédéric Chevallier	
3.0	September 2020	/	Update of Figure, references Modification of evaluation results	Thi Tuyet Trang Chau, Marion Gehlen, Frédéric Chevallier	
4.0	September 2021	/	Update of Figure, references Modification of evaluation results	Thi Tuyet Trang Chau, Marion Gehlen, Frédéric Chevallier	

Product name: GLOBAL_OMI_HEALTH_carbon_co2_flux_integrated

Dataset name: global_omi_health_carbon_co2_flux_integrated

Indicator evaluation method:

The OMI global yearly ocean CO₂ sink represents the ocean uptake of CO₂ from the atmosphere computed over the whole ocean. It is computed by multiplying the 12-month running mean of the surface ocean downward CO₂ mass flux (fgco2) [kg m⁻² s⁻¹], a variable from the MULTIOBS_GLO_BIO_CARBON_SURFACE_REP_015_008 product, by the area of each grid cell, and then taking the sum over all cells. The unit is finally converted to PgC per year (Figure 1). The yearly estimate of the ocean CO₂ sink corresponds to the mean of a 100-member ensemble. In line with Friedlingstein et al. (2020), yearly uncertainties are estimated as their corresponding ensemble standard deviation (1σ).

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Global integrated surface downward flux of total CO₂

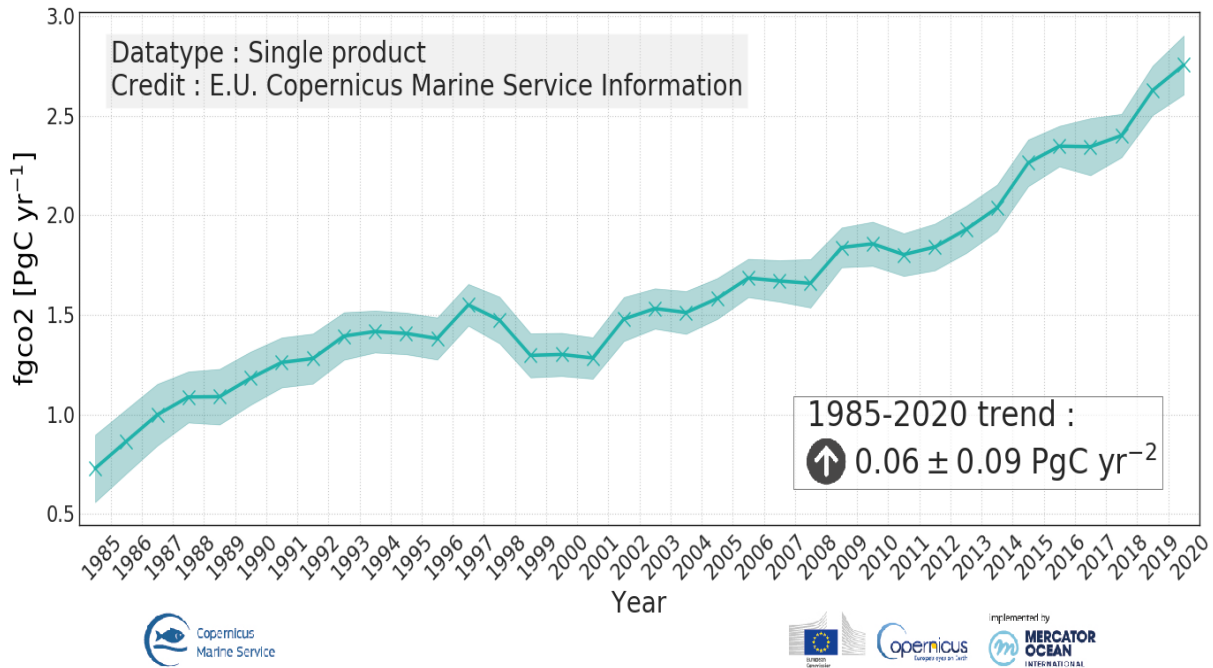


Figure 1: Area-integrated yearly surface downward flux of total CO₂ for 1985-2020. Plain line: mean of 100 samples; range: empirical 68 % confidence interval (mean estimate ± standard deviation) computed from 100 samples. The trend and its variation are computed as the mean and standard deviation of the differences between consecutive fluxes of CO₂.

Scientific evaluation:

The global ocean CO₂ sink corresponds to the global integral of fgco2 over space and time. The rate of uptake increases by 0.06 PgC/yr² over the full period. The yearly flux time series presents a plateau in the 90s followed by an increasing growth rate of 0.08 PgC/yr² since 2000. In 2020 [resp. 2019], the global ocean CO₂ sink was 2.75±0.15 [resp. 2.63±0.12] PgC/yr (Figure 1). The average of yearly contemporary fluxes over the full period 1985-2020 is 1.62±0.12 PgC/yr with an interannual variability (temporal standard deviation) of 0.48 PgC/yr. The scientific evaluation relies on the comparison with estimates of the anthropogenic CO₂ uptake by the ocean that are published by the Global Carbon Project (Friedlingstein et al. 2020; <https://www.globalcarbonproject.org/carbonbudget/index.htm>). The reconstructed field covers approximately 96.15% of the total ocean area (361,900,000 km²). In order to compare the present estimates to Friedlingstein et al. (2020), contemporary fluxes are corrected for the total area and the preindustrial outgassing of riverine carbon by adding 0.78 PgC/yr (Resplandy et al., 2018). This adjustment yields an anthropogenic flux estimate of 3.51±0.13 PgC/yr for 2019. This is above the estimate by Friedlingstein et al. (2020) of 2.6±0.6 PgC/yr. The latter estimate corresponds to the mean of flux estimates from global ocean biogeochemical general circulation models (GOBMs). The uncertainty estimate combines the interannual variability derived from GOBMs (± 0.4 PgC/yr) and the uncertainty of the mean ocean sink over the 90s, which is taken as a reference (± [0.2-0.4] PgC/yr). The

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new ensemble-based approach (Chau et al. 2021) yields spatio-temporal varying uncertainties which are lower than the previous published total estimate of ± 0.6 PgC/yr. The uncertainty estimates of the annual CO₂ uptake for the years in the 2000s are smaller than the uncertainties estimated for the years in the 1980s or recent years (Figure 1), as the sea surface pCO₂ observation network densifies. Shown in the following table, the somewhat higher anthropogenic flux estimates of the ensemble approach fall within the full range ($\pm 3\sigma$) of those by Friedlingstein et al. (2020). Further refinement of ocean C sink estimates relies on improved and sustained ocean observation efforts.

Periods	OMI_HEALTH_carbon_co2_flux_integrated [PgC/yr] (Mean \pm uncertainty)		Friedlingstein et al. (2020) - anthropogenic flux estimate [PgC/yr]
	Contemporary flux estimate	Anthropogenic flux estimate (see text for definition)	
2020	2.75 \pm 0.15	3.65 \pm 0.15	-
2019	2.63 \pm 0.12	3.51 \pm 0.13	2.6 \pm 0.6
2010-2019	2.14 \pm 0.12	2.93 \pm 0.12	2.5 \pm 0.6
2000-2009	1.55 \pm 0.11	2.40 \pm 0.11	2.1 \pm 0.5
1990-1999	1.36 \pm 0.12	2.20 \pm 0.12	2.0 \pm 0.5
1985-1989	0.95 \pm 0.15	1.77 \pm 0.16	-

Product used for indicator evaluation:

The CO₂ flux used to compute the OMI global yearly ocean CO₂ sink is derived from CMEMS MULTIOBS_GLO_BIO_CARBON_SURFACE_REP_015_008 product
<http://marine.copernicus.eu/documents/PUM/CMEMS-MOB-PUM-015-008.pdf>,
<http://marine.copernicus.eu/documents/QUID/CMEMS-MOB-QUID-015-008.pdf>.

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