Ocean Carbon Task Force

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The ocean is a powerful constraint on global budget and so (rather surprisingly) improvements in quantifying ocean carbon will help improve land carbon and global carbon assessments.

EO data are already used within annual global ocean carbon budgets.

Components and contributors to the most recent global carbon budget

The work presented here has been possible thanks to the enormous observational and modelling efforts of the institutions and networks below

Atmospheric CO_2 datasets
NOAA/ESRL (Dlugokencky and Tans 2022)
Scripps (Keeling et al. 1976)

Fossil CO_2 emissions
Andrew and Peters, 2022
CDIAC (Gilfillan and Marland, 2021)
UNFCCC, 2022
BP, 2022

Consumption Emissions
Peters et al. 2011
GTAP (Narayanan et al. 2015)

Land-Use Change
Houghton and Nassikas 2017
BLUE (Hansis et al. 2015)
OSCAR (Gasser et al. 2020)
GFED4 (van der Werf et al. 2017)
FAO-FRA and FAOSTAT
HYDE (Klein Goldewijk et al. 2017)
LUH2 (Hurtt et al. 2020)

Atmospheric inversions
CarbonTracker Europe | Jena CarboScope | CAMS | UoE In situ | NISMON-CO2 | CMS-Flux

Land models
CABLE-POP | CLASSIC | CLM5.0 | DLEM | IBIS | ISAM | ISBA-CTRIP | JSBACH | JULES-ES | LPJ-GUESS | LPJ | LPX-Bern | OCN | ORCHIDEEv3 | SDGVM | VISIT | YIBs

Climate forcing CRU (Harris et al. 2014) | JRA-55 (Kobayashi et al. 2015)

Ocean models
CESM-ETHZ | FESOM-2.1-REcoM2 | MICOM-HAMOCC (NorESM-OCv1.2) | MOM6-COBALT (Princeton) | MPIOM-HAMOCC6 | NEMO3.6-PISCESv2-gas (CNRM) | NEMO-PISCES (IPSL) | NEMO-PlankTOM12

fCO_2 based ocean flux products
CMEMS-LSCE-FFNNv2 |CSIR-ML6 | Jena- MLS | JMA-MLR | NIES-NN | MPI-SOMFFN | OS-ETHZ-GRaCER | Watson et al.

Surface Ocean CO2 Atlas SOCATv2022

All of the components boxed in red rely upon satellite observations and/or the ocean carbon estimate

Components and contributors to the most recent globcal carbon budget

Consequently, satellite Earth observation data play a major role in the annual GCB assessments as all of the observation based ocean carbon sink methods use satellite data, and then ocean data are used to constrain land carbon and budget closure (ocean is one of the two observational pillars)

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But these EO data are created in a non-optimal and inconsistent way as the GCB efforts lack any EO specific expertise and guidance.

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But the GCB is not alone with this sort of issue:

1. **The Integrated Carbon Observing System (ICOS)** are unsure how to handle the increasing amount of satellite observations and the increasing reliance on them for carbon assessments (whereas they understand the carbonate system well).

1. **Its likely that the EU Copernicus Climate Service (run by Eumetsat)** have similar issues, here they likely have a good understanding of the satellite data, but are less likely to appreciate the nuances between the satellite observations and the marine carbonate system.

2. **The NASA Carbon Monitoring System (CMS)** develops support for stakeholders needs for monitoring, reporting, and verification of carbon. The oceans are under-represented in this effort as it only includes ocean carbon model assessments (Poseidon-NOBM carbon fluxes with some data assimilation) but no ocean carbon observations component.

This importance to address the need for expert guidance at this satellite-carbon interface is likely to increase with time.

e.g.
model data and observations are diverging in IPCC and GCB assessments.

The IOC and UNESCO decadal Ocean Carbon Research roadmap questions:

- is the southern ocean a sink or a source?
- what is the role of biology?
- how will the ocean sink change in the future?

The wider ocean global carbon budget (GCB) community are trying to progress, but are overlooking EO advances as they are unsure how to handle them and they are misunderstanding satellite observation theory, data and approaches.

Up to date reviews, gap analyses and roadmaps exist and have identified the importance of satellite remote sensing – All peer reviewed & published

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Satellites will address critical science priorities for quantifying ocean carbon

Jamie D Shutler, Rik Wanninkhof, Watson, Ian Ashton, Thomas Holdin

Arico *et al* (2021) *Integrated ocean carbon research: a summary of ocean carbon research, and vision of coordinated ocean carbon research and observations for the next decade.* UNESCO and the International Oceanographic Commission, 45 pages.

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Earth-Science Reviews

Volume 217, June 2021, 103604

Sensing the ocean biological carbon pump from space: A review of capabilities, concepts, research gaps and future developments

Robert J.W. Brewin [a, b], Shubha Sathyendranath [b, c], Trevor Platt [b], Heather Bouman [d],

Clearly we should now offer expert advice and guidance on how to fully and correctly exploit satellite observations in relation to ocean carbon.

But, carbon assessments require synergy approaches, temperature, ocean colour, sea state and atmospheric measurements – so its more than just ocean colour.

A connected cross-disciplinary group is likely to enable faster and more coherent advice and guidance.

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IOCCG could provide the leadership to create an expert group to provide cross-satellite expertise and guidance for carbon focused research and monitoring, which is now needed.

Revitalisation of the IOCCG Ocean Carbon Task Force

The Ocean Carbon Task Force will provide a resource of expert advice across all areas of satellite observations relevant to carbon.

Formation of an expert group, lead by the IOCCG but in partnership with other relevant expert groups (GHRSST for temperature) and climate teams where relevant expert groups do not exist (e.g., sea state) or individual experts where specific climate teams do not exist (e.g., David Crisp, NASA, for satellite observations of atmospheric gases over the ocean).

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And then this group can actively:

1. Encourage the uptake of climate quality satellite data records for all methods of quantifying ocean carbon e.g., observation-based methods, model data assimilation with Earth system models, atmospheric inversion modelling and atmospheric potential oxygen approaches.
2. Provide support to annual assessments and related workshops (e.g., GCB and IPCC efforts).
3. Collectively this will help support the aims of CEOS Carbon Strategy.

Updates of the formation of the IOCCG Ocean Carbon Task Force

1. Text explaining and proposing the formation of an expert group and the '**The need for aligned scientific communities**' to support global carbon assessments is within the invited paper Shutler *et al.,* (in-review) which forms part of the NASA and ESA special issue named "Aquatic carbon stocks and fluxes: The big picture from remote sensing" within *Earth Science Reviews*. This Shutler *et al.* (in-review) paper is now in its second round of review.

2. Text provided to IOCCG contains the relevant text from Shutler et al (in-review) *Earth Science Reviews and explains the rationale and proposed aims of the* IOCCG Ocean Carbon Task Force

Shutler, JD Gruber, N.,*et al* including Rousseaux,C., Sathyendranath, S., (in-review), The increasing importance of satellite observations to assess the ocean carbon sink and ocean acidification, *Earth Science Reviews*.