SOCAT version 2022
for quantification of ocean CO_2 uptake

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Abstract – The ocean absorbs a quarter of the global CO_2 (carbon dioxide) emissions from human activity[c]. The community-led Surface Ocean CO_2 Atlas (**www.socat.info**) is key for the quantification of ocean CO_2 uptake and its variation, now and in the future. SOCAT version 2022 has quality-controlled *in situ* surface ocean fCO_2 (fugacity of CO_2) measurements made on ships, moorings, autonomous and drifting surface platforms for the global ocean and coastal seas from 1957 to 2021. The main SOCAT synthesis and gridded products contain 33.7 million fCO_2 values with an estimated accuracy of < 5 µatm. A further 6.4 million fCO_2 sensor data with an accuracy of 5 to 10 µatm are separately available. SOCAT is used for quantification of ocean CO_2 uptake and ocean acidification and for evaluation of climate models and sensor data. The SOCAT synthesis products are a crucial step in the value chain based on *in situ* inorganic carbon measurements of the ocean[e], which provides policy makers with vital information in climate negotiations. The need for accurate knowledge of global ocean CO_2 uptake and its variation makes sustained funding of *in situ* surface ocean CO_2 observations and their synthesis imperative.

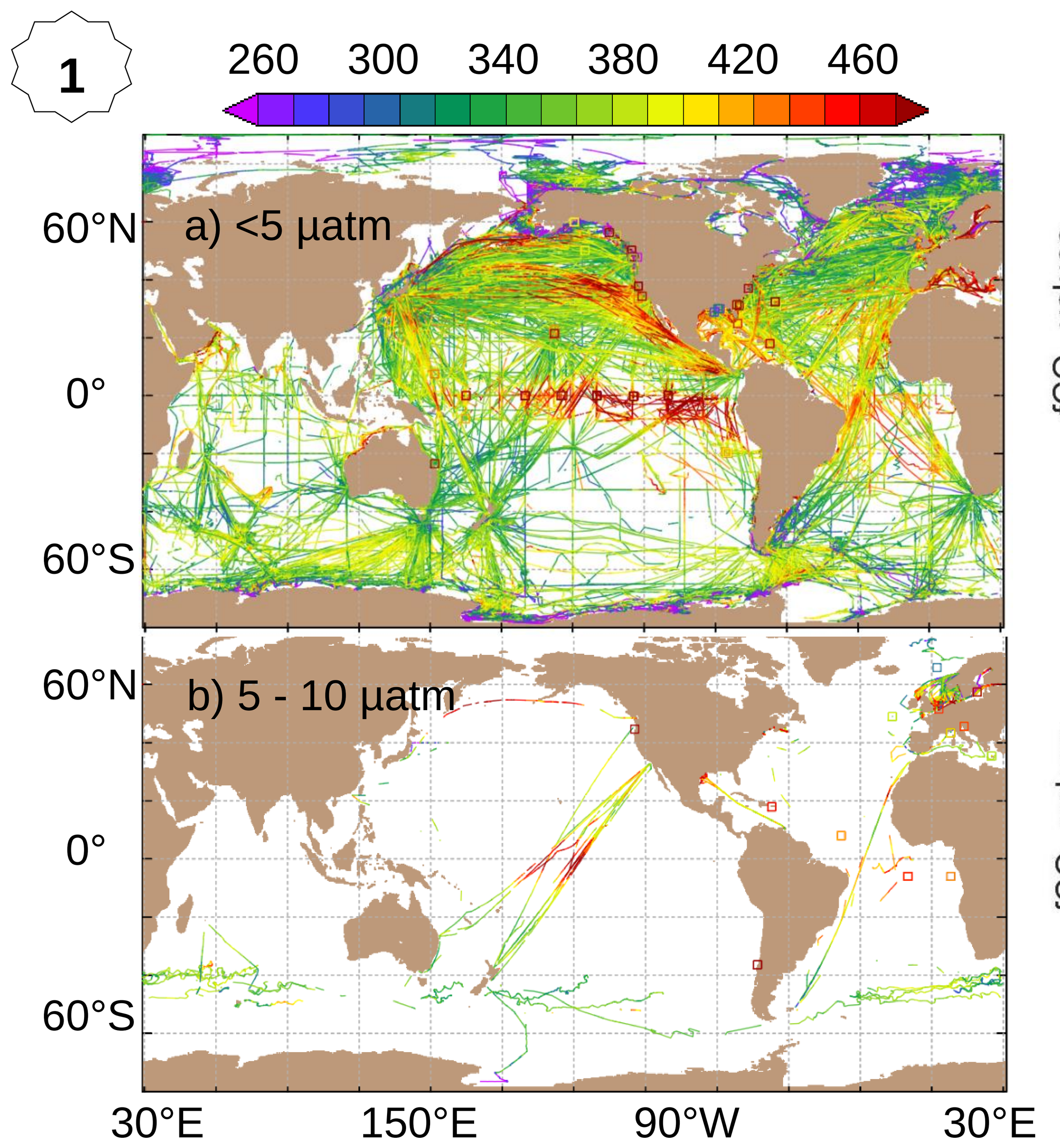

Fig. 1. In situ surface ocean fCO_2 values (colour coded, µatm) with an estimated accuracy of a) < 5 µatm and b) 5 -10 µatm in version 2022. Squares indicate moorings. The main synthesis and gridded products contain fCO_2 values in Fig. 1a. The fCO_2 values in Fig.1b are separately available.

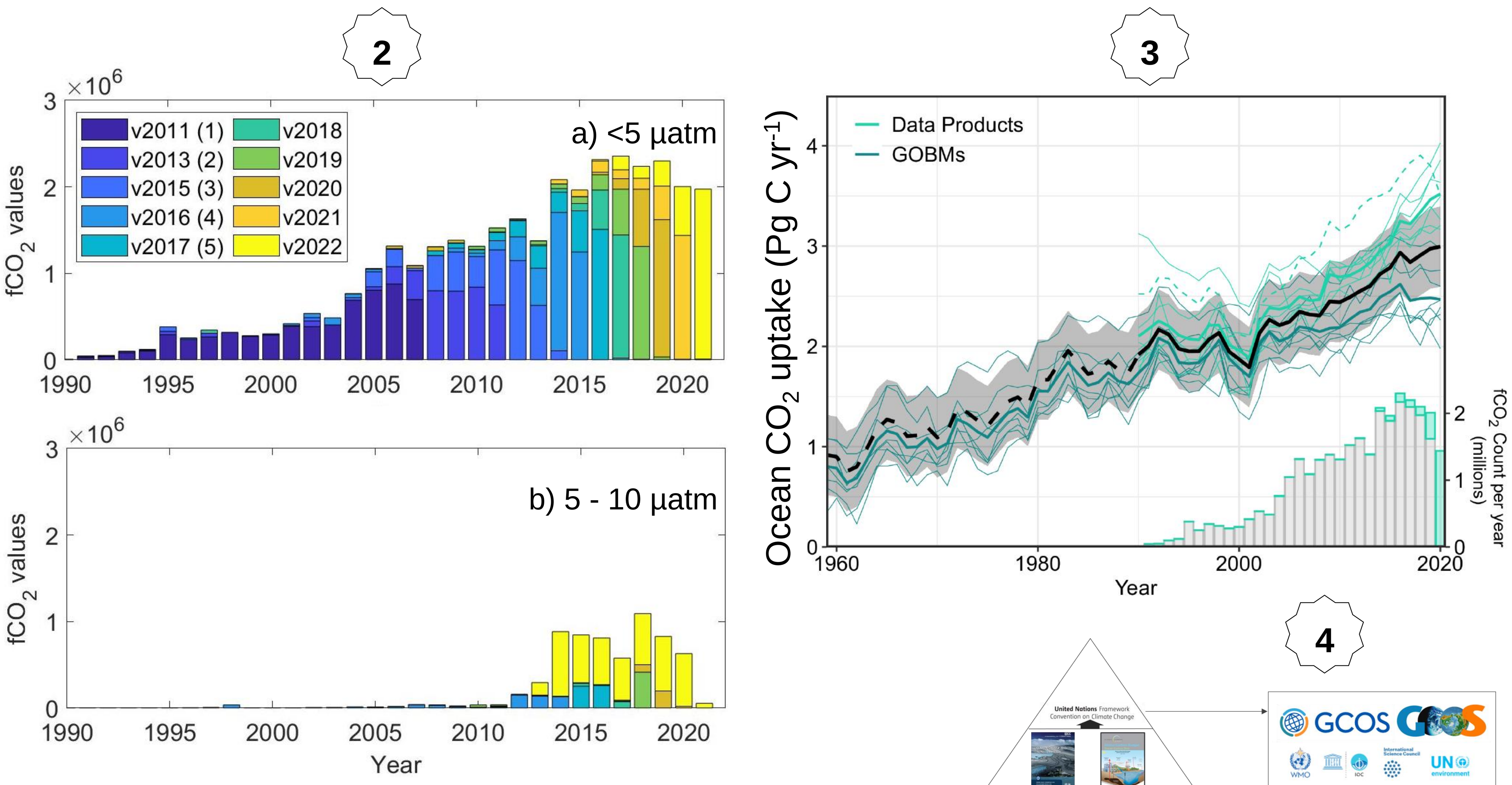

Fig. 2. Number of surface ocean fCO_2 values with an estimated accuracy of a) < 5 µatm and b) 5 -10 µatm for each year by SOCAT version.

Fig. 3. Ocean CO_2 uptake in the 2021 Global Carbon Budget[c]. Cyan lines for SOCAT-based estimates. Darker sea-green lines for model results. From[c].

Fig. 4. The value chain based on in situ inorganic carbon measurements of the ocean. Modified from[e].

Key features of SOCATv2022

- *In situ* surface ocean fCO_2 measurements on ships, moorings, autonomous and drifting surface platforms for the global ocean and coastal seas from 1957 to 2021
- 33.7 million good quality fCO_2 values with an accuracy of < 5 µatm in the main synthesis and gridded products (Fig. 1a & 2a)
- 6.4 million fCO_2 values with an accuracy of 5 - 10 µatm, mainly from sensors, are available separately (Fig. 1b & 2b).
- Community-led quality-control (QC) and synthesis
- Annual, public release
- Online viewers and data download (www.socat.info)

Outlook

- v2023 data submission by 16/01/2023, QC by 31/03/2023
- Fragile, short-term funding

Scientific findings, applications and impact

- Quantification of ocean CO_2 uptake[b,c,f,h,i,k,l] and acidification[d,g,j]
- Evaluation of models[a] and sensor data[m]
- Data gaps in time and space addressed through advanced interpolation schemes[d,g, h,i,k,l]
- Year-to-year and decadal variation in ocean CO_2 uptake[l]
- Models underestimate variation in ocean CO_2 uptake[l]
- Cited in hundreds of peer-reviewed scientific articles and reports
- Critical policy info from value chain[e]
- Contribution to UN Decade of Ocean Science for Sustainable Development and SDGs 13 and 14 (#OceanAction20464)

Outlook (cont.)

- Automation of metadata upload
- Component of a SDG 14.3 federated data system

Data Use: To generously acknowledge the contribution of SOCAT scientists by invitation to co-authorship, especially for key data providers in regional studies, and/or reference to relevant scientific articles. **Acknowledgements:** We thank the numerous contributors, funding agencies, IOCCP, SOLAS and IMBER. **Documentation v3-v2022:** Bakker et al. (2016) ESSD 8: 383-413; **v2:** Bakker et al. (2014) ESSD 6:69-90; **v1:** Pfeil et al. (2013) ESSD 5:125-143; Sabine et al. (2013) ESSD 5:145-153. **References:** Eyring et al., 2016[a]; Fay et al., 2021[b]; Friedlingstein et al., 2022[c]; Gregor and Gruber, 2021[d]; Guidi et al., 2020[e]; Hauck et al., 2020[f]; Jiang et al., 2019[g]; Landschützer et al., 2014[h]; Laruelle et al., 2018[i]; Lauvset et al., 2015[j]; Rödenbeck et al., 2014[k], 2015[l]; Williams et al., 2017[m]. **Affiliations:** [1]UEA, UK (**d.bakker@uea.ac.uk**); [2]NOAA-PMEL, USA; [3]UiB & [4]BCCR, Norway; [5]IOW, Germany; [6]VLIZ, Belgium; [7]JMA, Japan; [8]NOAA-NCEI, USA; [9]NORCE, Norway; [10]LOCEAN/IPSL, France, [11]CIRES, UoC & [12]NOAA-GML, USA; [13]NIES & [14]Hirosaki University, Japan, [15]CICOES, UW & [16]NOAA-AOML, USA; [17]GEOMAR, Germany; [18]CIMAS, UM, USA; [19]CSIRO & [20]AAPP, Australia; [21]SMHI, Sweden.