

# SOCAT version 6: 23 million *in situ* surface ocean CO<sub>2</sub> observations

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**Abstract** - The Surface Ocean CO<sub>2</sub> Atlas (SOCAT, [www.socat.info](http://www.socat.info)) is a synthesis activity by international marine carbon scientists (>100 contributors) with annual public releases. SOCAT version 6 has 23.4 million quality-controlled surface ocean fCO<sub>2</sub> (fugacity of carbon dioxide) observations from 1957 to 2017 for the global oceans and coastal seas, as well as additional calibrated sensor data. SOCAT enables quantification of the ocean carbon sink, ocean acidification, and evaluation of ocean biogeochemical models in a changing world. SOCAT represents a milestone in biogeochemical and climate research and in informing policy. SOCAT is at risk without sustained funding.

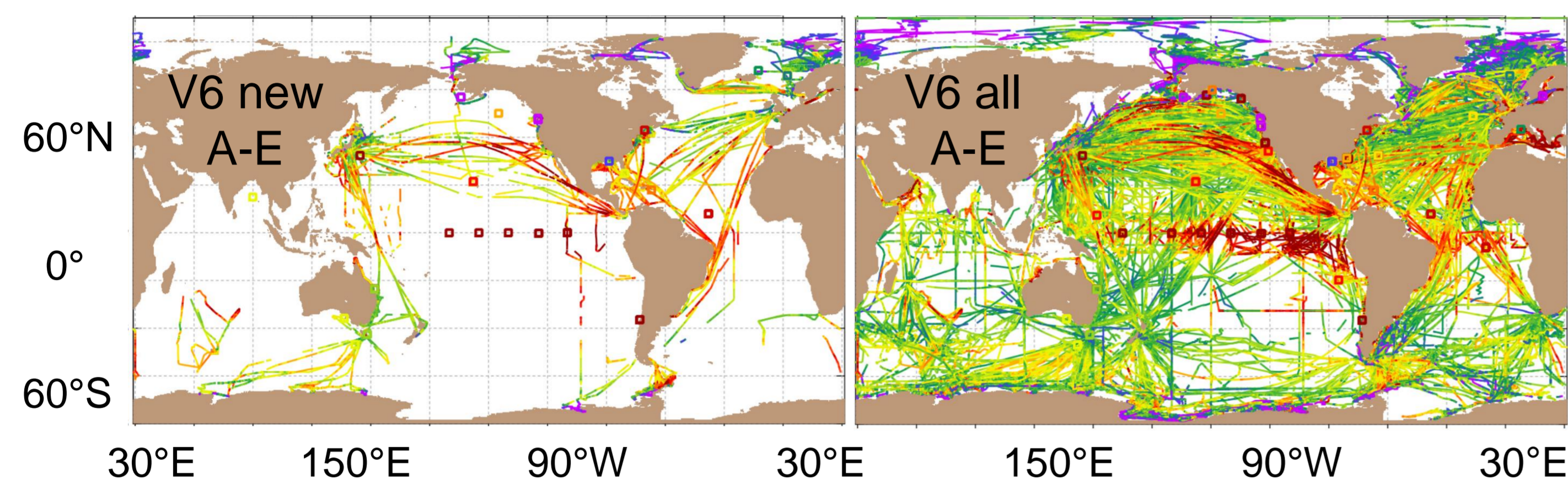


Fig. 1. a) Newly added and b) all quality controlled surface water fCO<sub>2</sub> observations (μatm) in version 6 (flags of A-E). Squares indicate moorings.

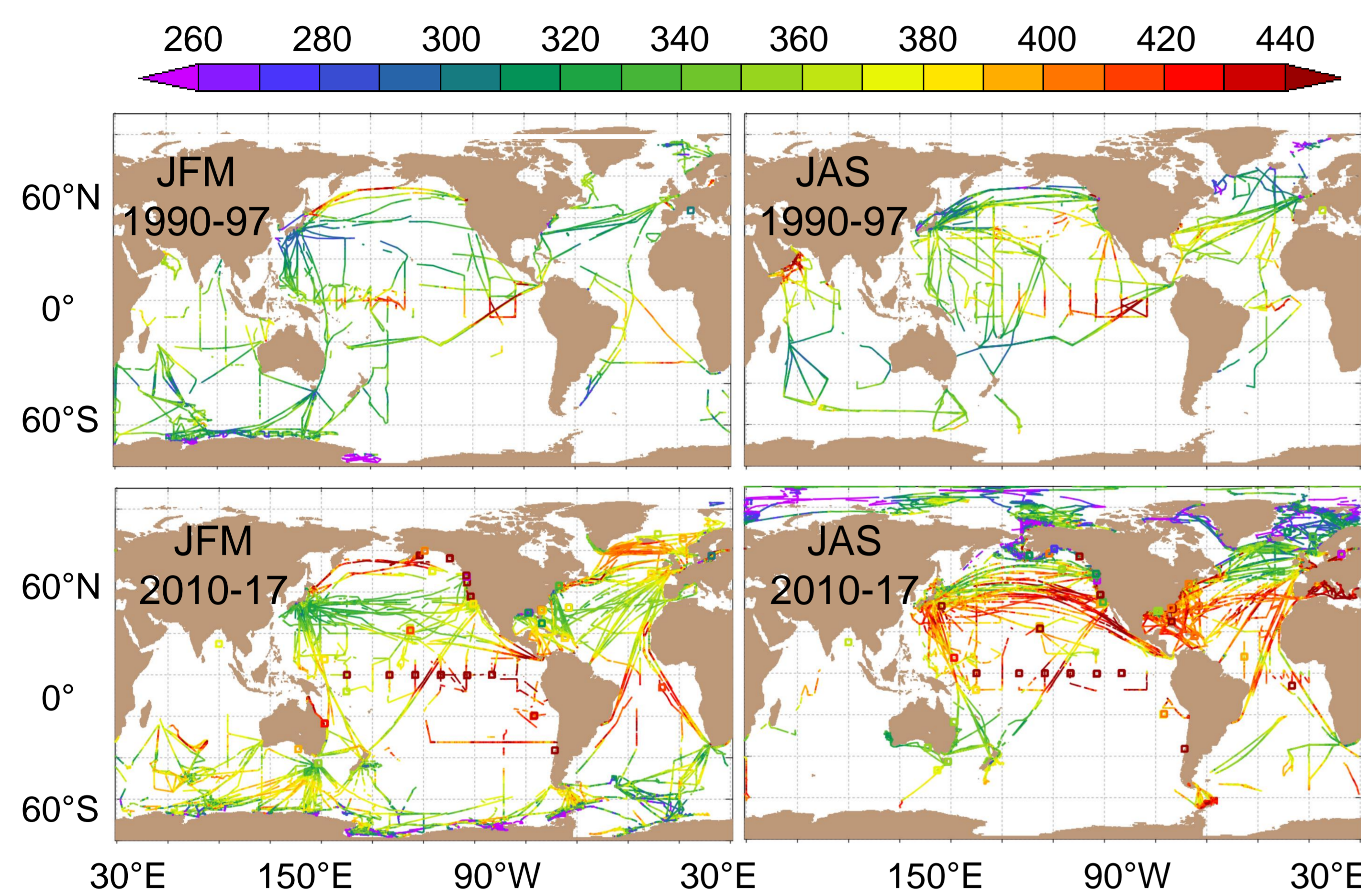


Fig. 2. Surface water fCO<sub>2</sub> values (μatm) in January, February, March (JFM) and July, August, September (JAS) for 1990-97 and 2010-17 in version 6 (data set flags of A-E).

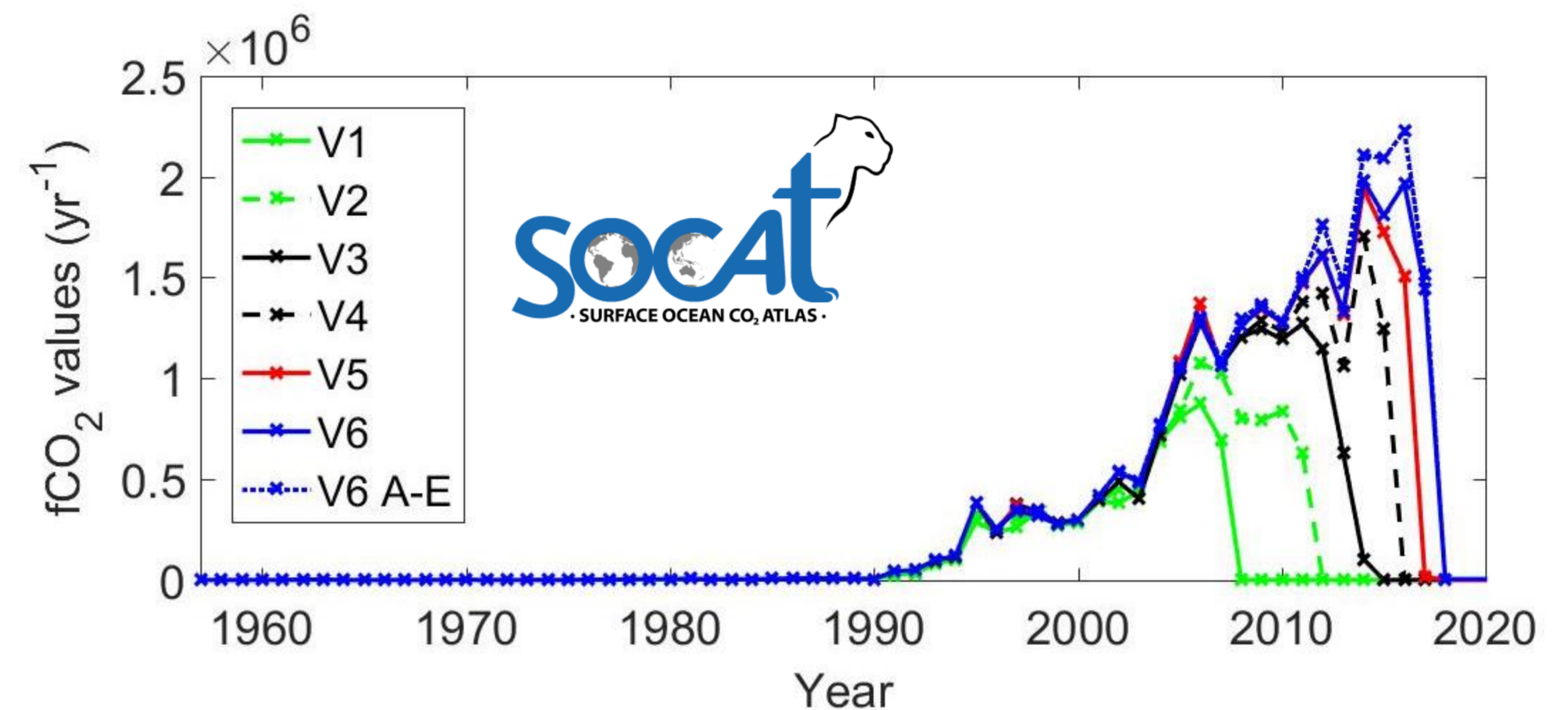


Fig. 3. Number of surface water fCO<sub>2</sub> values per year with flags of A-D in versions 1 to 6 (accuracy < 5 μatm) and with flags of A-E (accuracy < 10 μatm) in version 6.

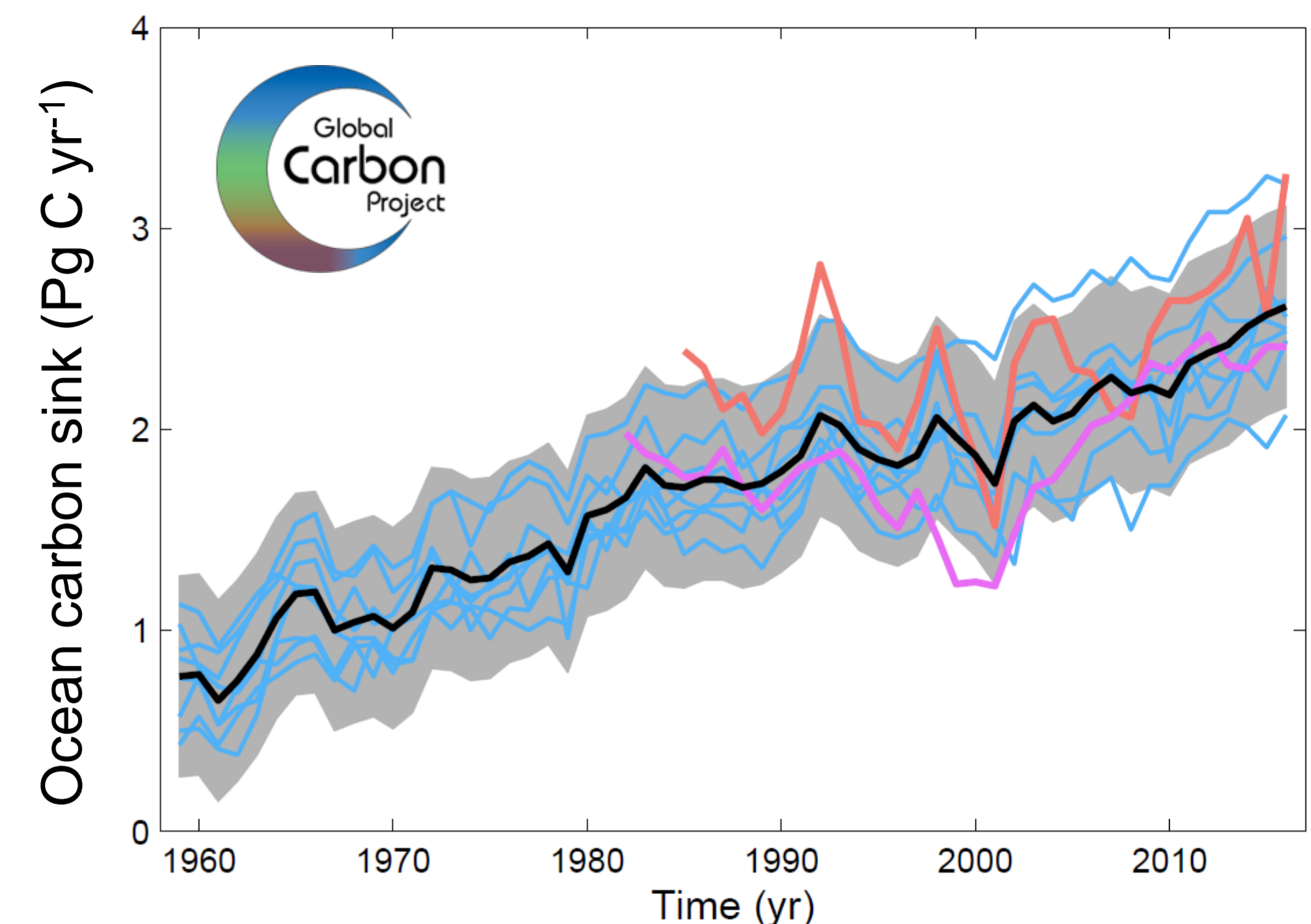


Fig. 4. Anthropogenic ocean carbon uptake in the 2017 Global Carbon Budget<sup>f</sup>. Shown are SOCAT-based mapping results (pink<sup>b</sup>, orange<sup>g</sup> lines), model results (blue lines), the model ensemble mean (black) and model uncertainty (grey shading). Figure from Le Quéré et al., 2018<sup>f</sup>.

## Key features:

- *In situ* surface ocean fCO<sub>2</sub> measurements from ships, moorings and other platforms.
- Synthesis and gridded, quality controlled products of surface ocean fCO<sub>2</sub> values for the global oceans and coastal seas:
  - V6 (2018): 23.4 million fCO<sub>2</sub>, 1957 - 2017,
  - V5 (2017): 21.5 million fCO<sub>2</sub>, 1957 - 2016,
  - V1 (2011): 6.3 million fCO<sub>2</sub>, 1968 - 2007
 with an accuracy of fCO<sub>2</sub> < 5 μatm (data set flags of A-D)
- Plus 1.2 million calibrated sensor data (<10 μatm, flag of E).
- Access via online viewers and data download ([www.socat.info](http://www.socat.info)).
- Consistent quality control (QC).
- No QC for sea surface temperature and salinity.
- New contributors welcome.
- V7 submission ends 15/01/2019, QC ends 31/03/2019.

## Scientific findings, applications and impact:

- Large data gaps.
- Documents the increase in global surface ocean fCO<sub>2</sub>.
- Large year-to-year variation in the global ocean carbon sink<sup>g,h</sup>.
- Increasing seasonal marine CO<sub>2</sub> variations<sup>c</sup>.
- Models underestimate variation in ocean carbon sink<sup>h</sup>.
- Quantification of the ocean carbon sink<sup>b,d,g,h</sup>, ocean acidification<sup>e</sup> and priors for the land carbon sink<sup>g</sup>.
- Informs mapping products<sup>b,f,g</sup>, the Surface Ocean pCO<sub>2</sub> Mapping Intercomparison<sup>h</sup> and the Global Carbon Budget<sup>e</sup>, evaluation of Bio-Argo floats<sup>i</sup> and models<sup>g</sup>, incl. CMIP<sup>a</sup>.
- Cited by >210 peer-reviewed scientific articles and reports.
- Annual public releases as a Voluntary Commitment to the 2017 UN Ocean Conference (#OceanAction20464).
- SOCAT is at risk without sustained funding.

**Fair Data Use** - To generously acknowledge the contribution of SOCAT scientists by invitation to co-authorship, especially for 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-V6: 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<sup>a</sup>; Landschützer et al., 2014<sup>b</sup>, 2018<sup>c</sup>; Laruelle et al., 2018<sup>d</sup>; Lauvset et al., 2015<sup>e</sup>; Le Quéré et al., 2018<sup>f</sup>; Rödenbeck et al., 2014<sup>g</sup>, 2015<sup>h</sup>; Williams et al., 2017<sup>i</sup>. **Affiliations** - <sup>1</sup>UEA, UK ([d.bakker@uea.ac.uk](mailto:d.bakker@uea.ac.uk)); <sup>2</sup>Uni Research, Norway; <sup>3</sup>UiB, Norway; <sup>4</sup>NOAA-AOML, USA; <sup>5</sup>BCCR, Norway; <sup>6</sup>NIWA, New Zealand; <sup>7</sup>LOCEAN, France; <sup>8</sup>NIES, Japan; <sup>9</sup>Hirosaki University, Japan; <sup>10</sup>NOAA-PMEL, USA; <sup>11</sup>JISAO, UW, USA; <sup>12</sup>CIMAS, USA; <sup>13</sup>U Exeter, UK; <sup>14</sup>CSIRO, Australia; <sup>15</sup>ACECRC, Australia.

