The Surface Ocean CO$_2$ Atlas (SOCAT) enables detection of changes in the ocean carbon sink


Version 2: 81 contributors from 51 organisations in 17 countries on 5 continents
In 2011:

CarboChange kick-off meeting, Neptun Hotel, Bergen, Norway, 9 March 2011
Surface Ocean CO₂ Atlas (SOCAT)
SOCAT scientists 2007-2011

Meetings in Paris, Delmenhorst, Bremen, Kiel, Tsukuba, Norwich, Hobart, .... & by Skype.

Support by IOCCP, SOLAS, IMBER, SCOR, CSIRO, SFB754, IFM-Geomar, NIES, EU COST 735, CarboOcean, CarboChange, ....
SOCAT articles

SOCAT highlight – Science News or EOS, .. (Bakker et al.)

ESSD technical article(s) - The more the better!
• Technical global paper on the uniform data and QC (Olsen, Pfeil, Bakker et al.), draft available at public release, main reference for SOCAT data set;
• Technical paper on LAS (Hankin, Koyuk, Malczyk);
• Technical paper on the gridding (Chris);
• Regional technical papers?

Scientific articles – THINK articles!
• At least 1 high flying paper;
• Special Issue?
• Some papers in time for IPCC AR5.
• Comments and suggestions for a logo are much appreciated.
In 2015:

CarboChange final meeting, Radisson Blue Norge Hotel, Bergen, Norway, 19-22 February 2015

Individual data set files / Global synthesis product / Global gridded products; Public access to regular releases via http://www.socat.info/; Interactive online viewers (LAS); Downloadable (text, NetCDF, ODV, Matlab); Documented in 3 ESSD articles (68 citations in peer-reviewed publications);
Documentation and data policy

www.socat.info

SOCAT data policy:
Recognise the contribution of SOCAT data contributors and quality controllers by invitation to co-authorship or citation of articles. Regional studies: Invite data contributors as co-authors.

Cite the relevant SOCAT ESSD publication:
V1: Pfeil et al. (2013) ESSD 5: 125-143;
V1: Sabine et al. (2013) ESSD 5: 145-153;
An activity by the marine carbon community;
Meetings in Paris, Seattle (3x), Tsukuba, Beijing, Bergen, by Skype.
Meeting support by IOCCP, IMBER, SOLAS, SCOR, Carbochange, NOAA, NIES, ....
Version 3 quality control in progress

- **Version 3 needs QC-ers!** (Contact d.bakker@uea.ac.uk)
- **Quality control by 10 January 15 March 2015;**
- 1200 of 1850 new/updated data sets (1957-2013) need QC;
- Update of QC flags for **sensor data with documented in situ calibration**;
- Update of quality control system and QC cookbook;
- Early release (Summer 2015);
- Public release (7 September 2015, SOLAS OSC)
Revision of QC flags (version 3)

- Inclusion of sensor data;
- Encourage in situ calibration of sensors;
- Update metadata forms for sensors (calibration) (v4);
- Identification of platform type (v4);

Table 3. Proposed criteria for dataset quality control flags of the SOCAT database version 3.0

<table>
<thead>
<tr>
<th>Flag</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (11)</td>
<td>(1) Accuracy of calculated fCO₂ (at SST) is better than 2 µatm (2) A high-quality cross-over with another dataset is available (3) Followed approved methods/SOP criteria (4) Metadata documentation complete (5) Dataset QC was deemed acceptable</td>
</tr>
<tr>
<td>B (12)</td>
<td>(1) Accuracy of calculated fCO₂ (at SST) is better than 2 µatm (2) Followed approved methods/SOP criteria (3) Metadata documentation complete (4) Dataset QC was deemed acceptable</td>
</tr>
<tr>
<td>C (13)</td>
<td>(1) Accuracy of calculated fCO₂ (at SST) is better than 5 µatm (2) Followed approved methods/SOP criteria (3) Metadata documentation complete (4) Dataset QC was deemed acceptable</td>
</tr>
<tr>
<td>D (14)</td>
<td>(1) Accuracy of calculated fCO₂ (at SST) is better than 5 µatm (2) Did or did not follow approved methods/SOP criteria (3) Metadata documentation incomplete (4) Dataset QC was deemed acceptable</td>
</tr>
<tr>
<td>E (17)</td>
<td>(Primarily for alternative sensors) (1) Accuracy of calculated fCO₂ (at SST) is better than 10 µatm (2) Did not follow approved methods/SOP criteria (3) Metadata documentation complete (4) Dataset QC was deemed acceptable</td>
</tr>
</tbody>
</table>

NEW

NA...NF (version 4)
Submitted data to SOCAT that has not undergone independent dataset quality control as indicated by the “N”. The NA, though NF are the flags provided by the submitting group.
Automated data upload, version 4

Collect data set

Automation meeting (Seattle, 21-23 Oct. ’14)
Data upload system live (16 March 2015)

Upload data set

SOCAT Dashboard

- OME – metadata entry
- data column checker
- data file range checker

Preview data set

LAS
- subsetting
- visualization
- download
- QC checks

Data submission to SOCAT QC

www.socat.info
Towards annual SOCAT releases

○ V3 schedule
  ■ QC ends: 15 March 2015
  ■ Release: 7 September 2015 (SOLAS OSC, Kiel)

○ V4 schedule
  ■ Data upload and QC begin: 16 March 2015
  ■ Data upload ends: 31 Jan 2016
  ■ QC ends: 31 March 2016
  ■ Release: 30 June 2016

○ V5 schedule
  ■ Data upload and QC ongoing
  ■ Data upload ends: 31 Jan 2017
  ■ QC ends: 31 March 2017
  ■ Release: 30 June 2017

Starting with version 4, data upload and QC can be done simultaneously.
Additional parameters and other news

Salinity and sea surface temperature in SOCAT are not quality controlled. SOCAT encourages data providers to submit high-quality salinity and temperature.

SOCAT will accept additional surface water parameters, accompanying fCO₂ data (e.g. CH₄, N₂O, DIC, TA, pH, nutrients) from version 4 onwards. These additional parameters will not be quality controlled and will be reported in separate files.

SOCAT Community Event on 7 September 2015 at the SOLAS OSC, Kiel.

SOCAT Community Event,
Bergen, Norway,
23 June 2014
Impact of SOCAT


<table>
<thead>
<tr>
<th>Scientific application</th>
<th>Number (of 59)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference to SOCAT and/or fCO₂ data</td>
<td>30</td>
</tr>
<tr>
<td>Use of SOCAT tools</td>
<td>1</td>
</tr>
<tr>
<td>Figure of fCO₂ data distribution</td>
<td>5</td>
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<tr>
<td>fCO₂ in process studies, e.g. ocean acidification and genomics</td>
<td>4</td>
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<tr>
<td>Coastal and ocean CO₂ sink estimates</td>
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<td>Model validation</td>
<td>6</td>
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<tr>
<td>Regional pH trends</td>
<td>1</td>
</tr>
</tbody>
</table>
Ocean carbon sink estimates

Data-based methods estimate different year-to-year and long term variation in the ocean carbon sink.

(Figures: Le Quéré et al., 2014; Landschützer et al., 2014; Rödenbeck et al., 2014)
Surface Ocean pCO₂ Mapping Intercomparison (SOCOM) (Christian Rödenbeck)

Meeting: 11-13 February 2015, NIES, Tsukuba, Japan
• Comparison of annual mean anomalies;
• Subsampling of 6 RECCAP models to SOCAT v2 data;
• Global ocean biogeochemical models underestimate spatial and temporal variation in fCO$_2$.

Séférian et al. (2014) GRL
Conclusions

SOCAT is a powerful data synthesis product documenting the ocean carbon cycle.

Applications include:
• Quantification of the ocean CO$_2$ sink (e.g. Global Carbon Budget, SOCOM);
• Assessments of ocean acidification;
• Validation of ocean biogeochemical models.

SOCAT has >> 100 contributors. Contribute to and/or use SOCAT. Acknowledge the contribution of the data providers, e.g. by invitation to co-authorship, notably in regional studies. d.bakker@uea.ac.uk.
SOCAT is a community activity! >100 data contributors, group leads, quality controllers and data managers!