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SOCAT Community Event

Aims:

- Update the SOCAT Community on SOCAT progress;
- Welcome new members;
- Get feedback from the SOCAT Community;
- Set SOCAT strategy and agenda for next 2 years.

Key questions:

• How do we promote efficient quality control (version 3)?	**Session 1**
• How does automated data submission work (version 4)?	**Session 2**
• Should SOCAT include more parameters (version 4)?	**Session 3**
• How do we promote SOCAT science?	**Session 3**

Session 1	SOCAT version 3 quality control
Session 2	Automation for version 4
Session 3	Future SOCAT

SOCAT 1,2,3 A Community Activity

www.socat.info

Presenters: Upload slides in breaks;
Abstract of key points by 6 July;

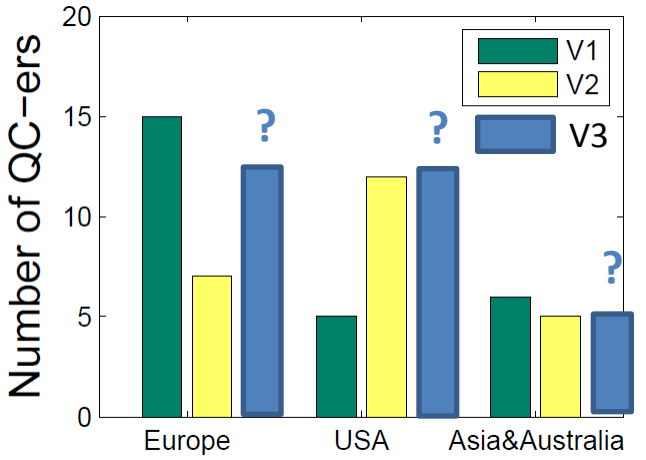
Rapporteurs: Minutes of discussions by 6 July;
S. Jones, Skjelvan, Van Heuven, Landschützer

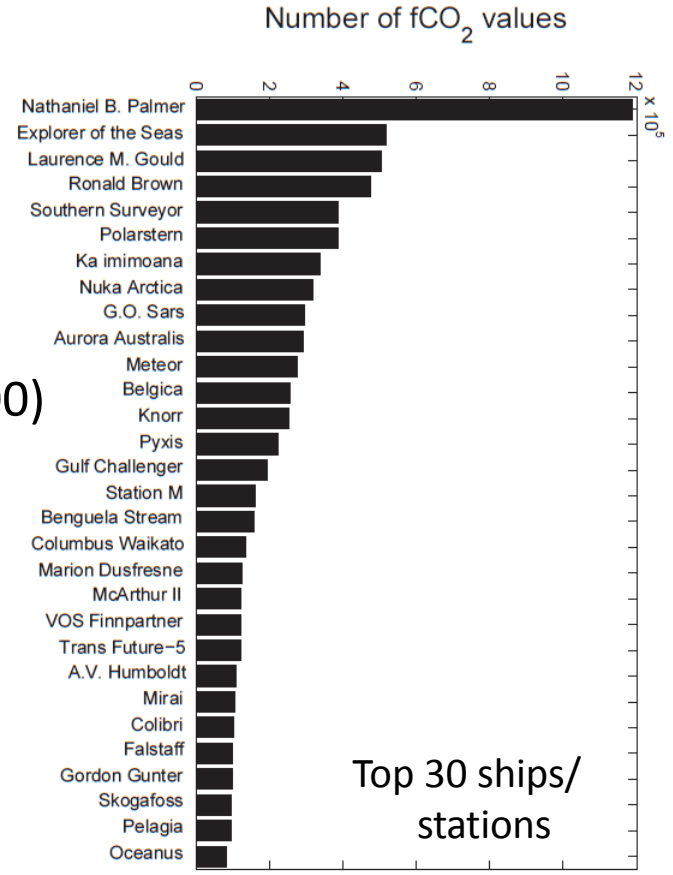
Vacancies: Chair and Rapporteur

Participants: Data provider? Quality controller? User? New?

Group photo – meet at main entrance after lunch (12:00)

Card for Steve Hankin



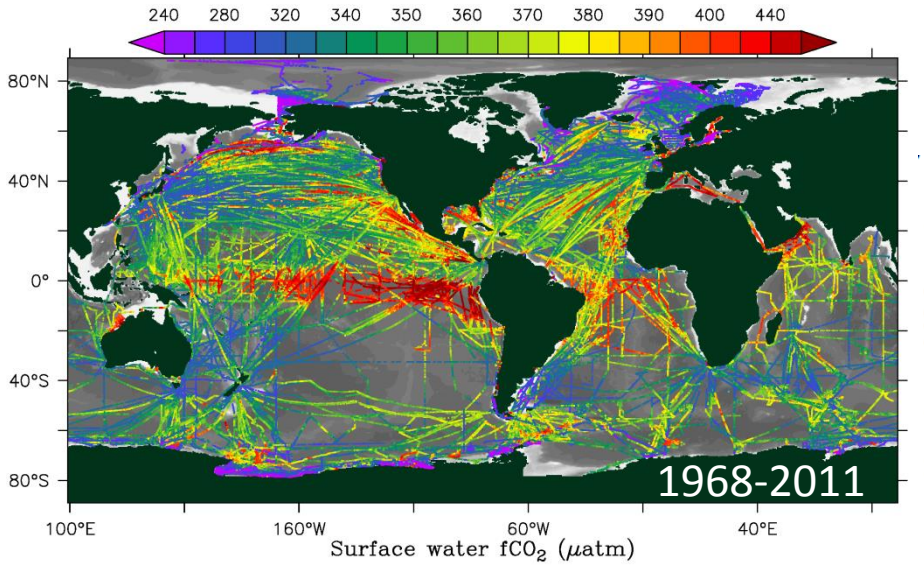


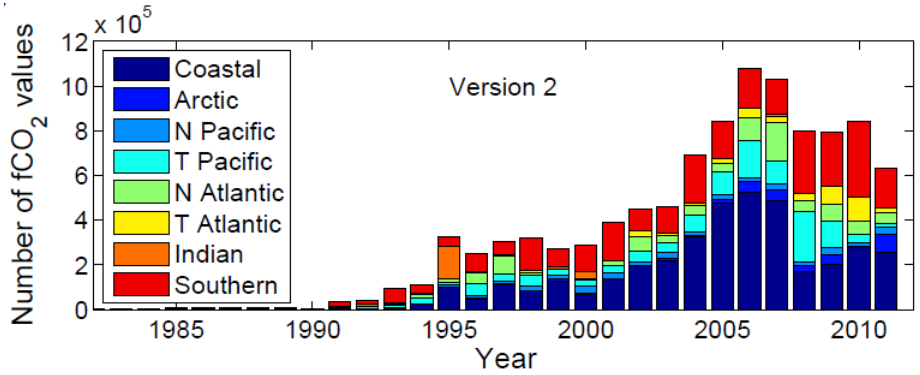
SOCAT is a community activity!

>100 data contributors, group leads, quality controllers and data managers!

Surface Ocean CO_2 Atlas (v2)

www.socat.info





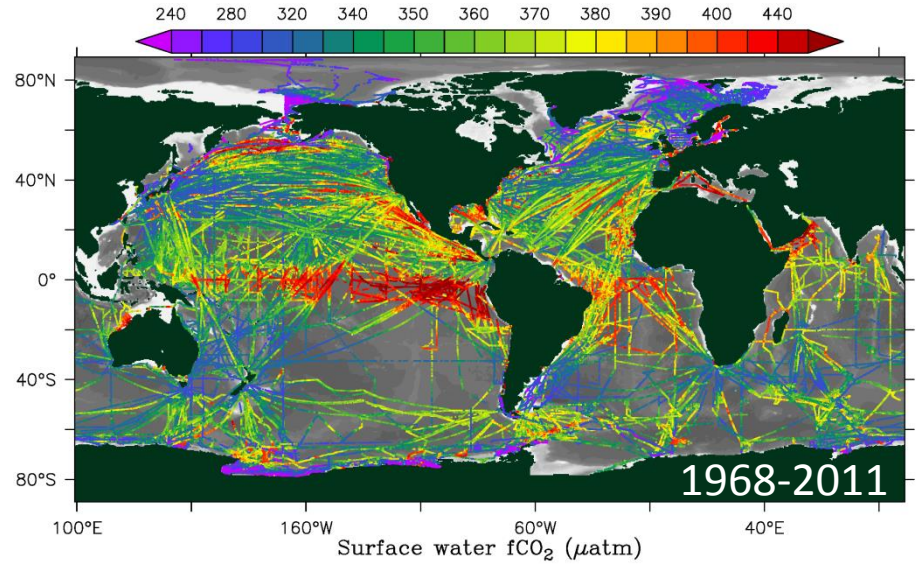
Surface ocean fCO_2 (fugacity of CO_2) in uniform format with quality control;

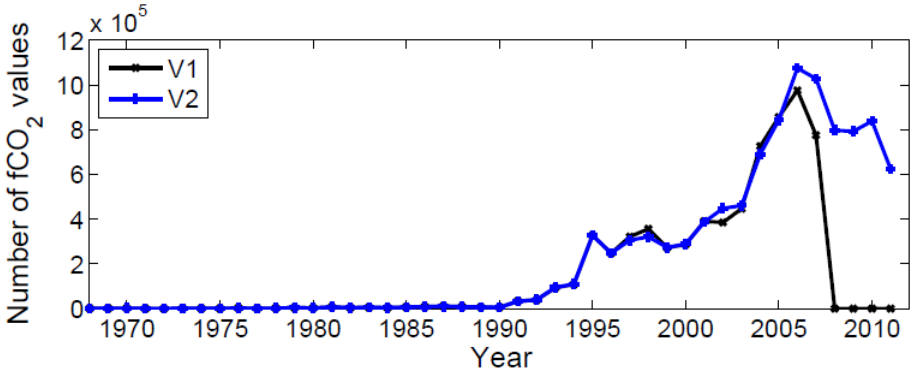
- Individual data set files;
- Global synthesis product for the global oceans and coastal seas;
- Global gridded products, no interpolation (1° x 1° global, ¼° x ¼° coastal);

Public access via http://www.socat.info/;
Interactive online viewers (Live Access Server);
Various formats, e.g. text, NetCDF, Ocean Data View, Matlab;
Documented in 3 ESSD articles.

SOCAT v2 in the Cruise Data Viewer

www.socat.info





2007: No public, global fCO_2 data set. Many formats, many data not public.

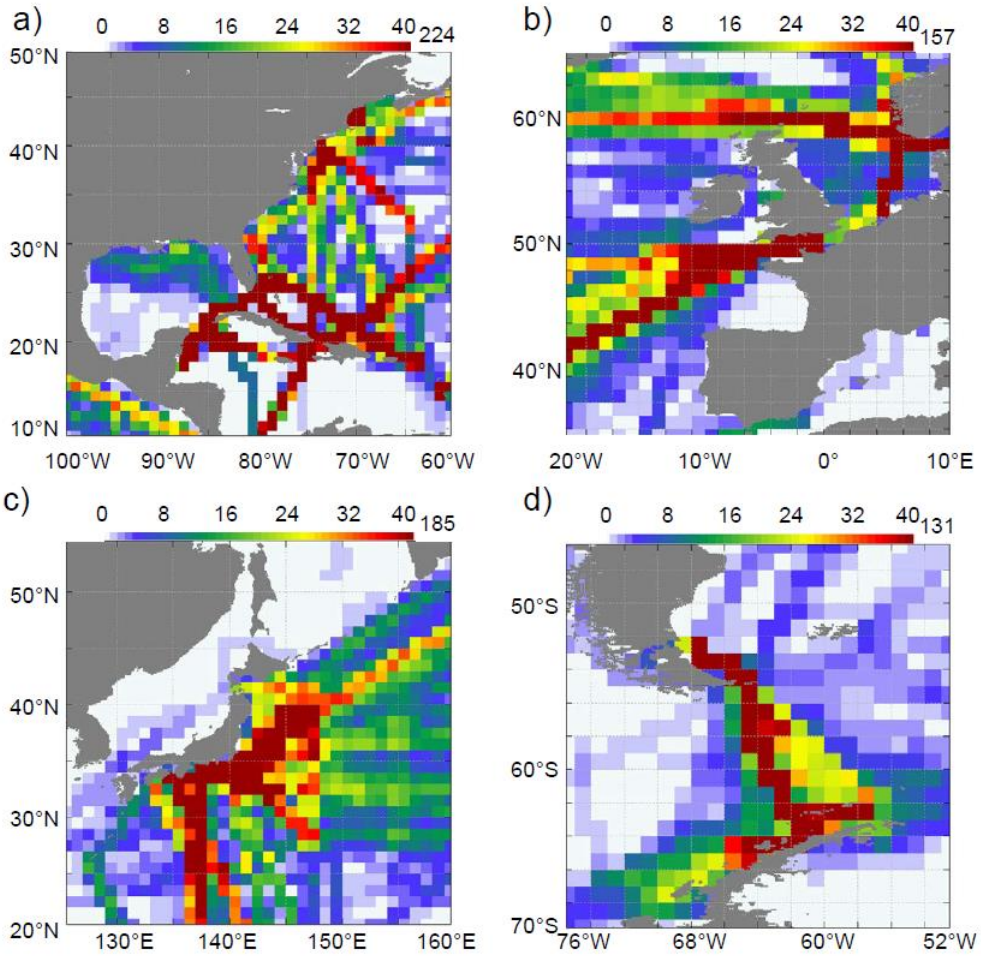
SOCAT: Surface ocean fCO_2 (fugacity of CO_2) in uniform format with quality control;
2011: SOCAT Version 1: 1968-2007, 6.3 million fCO_2, 1851 cruises;
2013: SOCAT Version 2: 1968-2011, 10.1 million fCO_2, 2660 cruises;

(Bakker et al., 2014, ESSD)

SOCAT v2 in the in Gridded Data Viewer

www.socat.info

NW Atlantic Ocean and Caribbean Sea



NE Atlantic Ocean, European shelf seas

NW Pacific Ocean

Drake Passage

Number of data sets with fCO_2 per 1° x 1° grid cell (2000-2009)

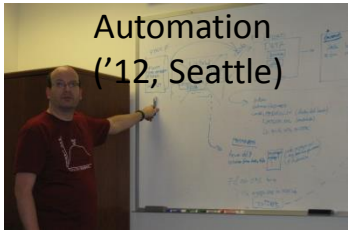
(Bakker et al., 2014, ESSD)

SOCAT 1, 2

www.socat.info

Key SOCAT activities

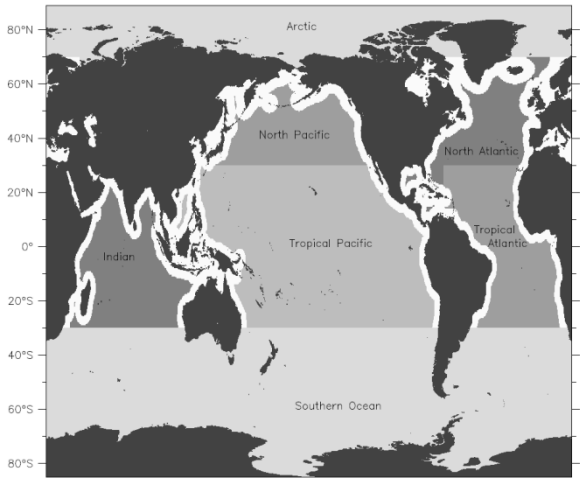
Website **www.socat.info**	*Pfeil*
Data entry and calculations	*Olsen, Pfeil*
Data management (CDIAC, PANGAEA)	*Kozyr, Pfeil*
Live Access Server (LAS) for QC, gridding, Cruise and Gridded Data Viewer	*Smith, O'Brien*
Automation	*Smith, O'Brien, Kozyr, S. Jones, Pfeil*
Alternative sensors V3	*Wanninkhof, Steinhoff, Bakker, Bates, Boutin, Olsen, Sutton*



Quality control by regional groups

www.socat.info

Coastal Seas:	30°S to 66/70°N, <400 km from land	*Hales, Alin, Cai*
Arctic:	north of 66-70°N	*Mathis*
North Atlantic:	north of 30°N	*Schuster*
Tropical Atlantic:	30°N to 30°S	*Lefèvre*
Indian Ocean:	north of 30°S	*VVSS Sarma*
North Pacific:	north of 30°N	*Nojiri*
Tropical Pacific:	30°N to 30°S	*Cosca*
Southern Ocean:	south of 30°S, incl. coastal regions	*Tilbrook, Metzl*
Global		*Bakker, Currie, Kozyr, Metzl, O'Brien, Olsen, Pfeil, Pierrot, Telszewski*



Do groups need for QC meetings?
Contact the group lead (or Dorothee), if you would like to join version 3 QC.

Publications documenting SOCAT

www.socat.info

Earth Syst. Sci. Data, 5, 125–143, 2013
www.earth-syst-sci-data.net/5/125/2013/
doi:10.5194/essd-5-125-2013
© Author(s) 2013. CC Attribution 3.0 License.

3009 views
48 citations (Google)

A uniform, quality controlled Surface Ocean CO_2 Atlas (SOCAT)

B. Pfeil[1,2,3], A. Olsen[1,2,4,5], D. C. E. Bakker[6], S. Hankin[7], H. Koyuk[8], A. Kozyr[9], J. Malczyk[10], A. Manke[7], N. Metzl[11], C. L. Sabine[7], J. Akl[12,13], S. R. Alin[7], N. Bates[14], R. G. J. Bellerby[15,16,2], A. Borges[17], J. Boutin[11], P. J. Brown[6,18], W. J. Cai[19], F. P. Chavez[20], A. Chen[21], C. Cosca[7], A. J. Fassbender[22], R. A. Feely[7], M. González-Dávila[23], C. Goyet[24], B. Hales[25], N. Hardman-Mountford[26,*], C. Heinze[1,2,5,16], M. Hood[27], M. Hoppema[28], C. W. Hunt[29], D. Hydes[30], M. Ishii[31], T. Johannessen[1,2], S. D. Jones[32], R. M. Key[33], A. Körtzinger[34], P. Landschützer[6], S. K. Lauvset[1,2], N. Lefèvre[11], A. Lenton[12], A. Lourantou[11], L. Merlivat[11], T. Midorikawa[35], L. Mintrop[36], C. Miyazaki[37], A. Murata[38], A. Nakadate[39], Y. Nakano[38], S. Nakaoka[40], Y. Nojiri[40], A. M. Omar[2,16], X. A. Padin[41], G.-H. Park[42], K. Paterson[12,13], F. F. Perez[41], D. Pierrot[42], A. Poisson[34], A. F. Ríos[41], J. M. Santana-Casiano[23], J. Salisbury[29], V. V. S. S. Sarma[43], R. Schlitzer[28], B. Schneider[44], U. Schuster[6], R. Sieger[38], I. Skjelvan[1,2,16], T. Steinhoff[34], T. Suzuki[45], T. Takahashi[46], K. Tedesco[47,**], M. Telszewski[48,**], H. Thomas[49], B. Tilbrook[12,13,50], J. Tjiputra[1,2], D. Vandemark[29], T. Veness[12,13], R. Wanninkhof[51], A. J. Watson[7], R. Weiss[52], C. S. Wong[53], and H. Yoshikawa-Inoue[38]

Earth Syst. Sci. Data, 5, 145–153, 2013
www.earth-syst-sci-data.net/5/145/2013/
doi:10.5194/essd-5-145-2013
© Author(s) 2013. CC Attribution 3.0 License.

1611 views
15 citations (Google)

Surface Ocean CO_2 Atlas (SOCAT) gridded data products

C. L. Sabine[1], S. Hankin[1], H. Koyuk[1,2], D. C. E. Bakker[1], B. Pfeil[4,5,6], A. Olsen[7,8], N. Metzl[9], A. Kozyr[10], A. Fassbender[1,20], A. Manke[1,2], J. Malczyk[11], J. Akl[12,13], S. R. Alin[1], R. G. J. Bellerby[14,4,*], A. Borges[15], J. Boutin[9], P. J. Brown[1,16], W. J. Cai[17], F. P. Chavez[18], A. Chen[19], C. Cosca[1], R. A. Feely[1], M. González-Dávila[23], C. Goyet[22], N. Hardman-Mountford[23,**], C. Heinze[4,5,8,16], M. Hoppema[24], C. W. Hunt[25], D. Hydes[26], M. Ishii[27], T. Johannessen[4,5], R. M. Key[28], A. Körtzinger[29], P. Landschützer[3], S. K. Lauvset[4,5], N. Lefèvre[22], A. Lenton[12], A. Lourantou[9], L. Merlivat[9], T. Midorikawa[30], L. Mintrop[31], C. Miyazaki[32], A. Murata[33], A. Nakadate[34], Y. Nakano[35], S. Nakaoka[36], Y. Nojiri[36], A. M. Omar[8,14], X. A. Padin[16], G.-H. Park[37], K. Paterson[12,13], F. F. Perez[38], D. Pierrot[22], A. Poisson[22], A. F. Ríos[39], J. Salisbury[25], J. M. Santana-Casiano[21], V. V. S. S. Sarma[38], R. Schlitzer[24], B. Schneider[29], U. Schuster[3], R. Sieger[24], I. Skjelvan[5,14,4], T. Steinhoff[29], T. Suzuki[40], T. Takahashi[41], K. Tedesco[42,***], M. Telszewski[43,***], H. Thomas[44], B. Tilbrook[12,13,45], D. Vandemark[25], T. Veness[13], A. J. Watson[3], R. Weiss[46], C. S. Wong[47], and H. Yoshikawa-Inoue[33]

Earth Syst. Sci. Data, 6, 69–90, 2014
www.earth-syst-sci-data.net/6/69/2014/
doi:10.5194/essd-6-69-2014
© Author(s) 2014. CC Attribution 3.0 License.

2678 views
7 citations (Google)

An update to the Surface Ocean CO_2 Atlas (SOCAT version 2)

D. C. E. Bakker[1], B. Pfeil[2,3], K. Smith[4,5], S. Hankin[4], A. Olsen[2,3,6], S. R. Alin[4], C. Cosca[4], S. Harasawa[7], A. Kozyr[8], Y. Nojiri[7], K. M. O'Brien[4,5], U. Schuster[9,*], M. Telszewski[10], B. Tilbrook[11,12], C. Wada[7], J. Akl[11], L. Barbero[13], N. R. Bates[14], J. Boutin[15], Y. Bozec[16,17], W.-J. Cai[18], R. D. Castle[19], F. P. Chavez[20], L. Chen[21,22], M. Chierici[23,24], K. Currie[25], H. J. W. de Baar[26], W. Evans[4,27], R. A. Feely[4], A. Fransson[28], Z. Gao[21], B. Hales[29], N. J. Hardman-Mountford[30], M. Hoppema[31], W.-J. Huang[18], C. W. Hunt[32], B. Huss[19], T. Ichikawa[33], T. Johannessen[2,3,6], E. M. Jones[31], S. D. Jones[34], S. Jutterström[35], V. Kitidis[36], A. Körtzinger[37], P. Landschützer[1], S. K. Lauvset[2,3], N. Lefèvre[38,39], A. B. Manke[4], J. T. Mathis[4], L. Merlivat[15], N. Metzl[15], A. Murata[40], T. Newberger[41], A. M. Omar[6,3,2], T. Ono[33], G.-H. Park[42], K. Paterson[11], D. Pierrot[13], A. F. Rios[43], C. L. Sabine[4], S. Saito[44], J. Salisbury[32], V. V. S. S. Sarma[45], R. Schlitzer[31], R. Sieger[31], I. Skjelvan[6,2,3], T. Steinhoff[37], K. F. Sullivan[13], H. Sun[21], A. J. Sutton[4,5], T. Suzuki[46], C. Sweeney[41], T. Takahashi[47], J. Tjiputra[6,3], N. Tsurushima[48], S. M. A. C. van Heuven[49], D. Vandemark[32], P. Vlahos[50], D. W. R. Wallace[51], R. Wanninkhof[19], and A. J. Watson[9,*]

Eos, Vol. 93, No. 12, 20 March 2012

10 citations (2012)

EOS
EOS, TRANSACTIONS, AMERICAN GEOPHYSICAL UNION
VOLUME 93 NUMBER 12
20 MARCH 2012
PAGES 125–132

Global Data Products Help Assess Changes to Ocean Carbon Sink

PAGES 125–126

Net oceanic uptake of the greenhouse gas carbon dioxide (CO_2) reduces global warming but also leads to ocean acidification [*Intergovernmental Panel on Climate Change (IPCC)*, 2007]. Understanding and predicting changes in the ocean carbon sink are critical to assessments of future climate change. Surface water CO_2 measurements suggest large year-to-year variations in oceanic CO_2 uptake for several regions [*Le*
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SOCAT Frameu
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managers have generously donated their time and expertise to SOCAT. These participants were organized into seven regional groups and a global coordination group. Six international workshops were held to resolve data integration and QC issues. The scientists developed protocols, software, and an interactive Web-based tool for data QC. SOCAT procedures were designed to be transparent and fully documented. Many additional data not yet in CDIAC were retrieved

oceans and coastal seas. The data originate from 1851 voyages by research vessels, commercial ships, and moored as well as drifting platforms. Two SOCAT products have been created: (1) a global data set of surface ocean *f*CO_2 from 1968 to 2007 (Figure 1) recalculated using a uniform procedure and subject to QC checks and (2) a global, gridded, monthly mean surface water *f*CO_2 data product with minimal temporal and spatial interpolation. The SOCAT data products and individual cruise files can be downloaded from PANGAEA (http://www.pangaea.de/), an International Council for Science World Data System, and CDIAC (http://cdiac.ornl.gov/oceans/). The data products can also be accessed via an interac-

SOLAS/IMBER Carbon groups

Second version of the Surface Ocean CO_2 Atlas (SOCAT) to be released this summer for climate research (2013)

A. Olsen[1], D. Bakker[2] and B. Pfeil[3]
[1]Geophysical Institute, Biogeochemistry, University of Bergen, Norway
[2]Environmental Science, University of East Anglia, United Kingdom
[3]Bjerknes Centre for Climate Research/GD, University of Bergen, Norway
Contact: are.olsen@gfi.uib.no; d.bakker@uea.ac.uk; benjamin.pfeil@uni.no

The second version of the Surface Ocean CO_2 Atlas has been assembled and is now distributed for testing among volunteers prior to the official release, which will take place during a special lunch session on the Tuesday of the 9th International Carbon Dioxide Conference in Beijing this summer (http://www.ioccp.org/slides/11-slide-1). SOCATv2 expands the first release of SOCAT by some four million *f*CO_2 data points,

active in SOCAT and some new faces have appeared. We would here in particular acknowledge the coastal region leads for v1.5 Arthur Chen and Alberto Borges, the v1.5 equatorial Pacific lead Richard Feely, and the v1.5 global group member Chris Sabine. These have been replaced by Simone Alin, Burke Hales, Wei-Jun Cai (all coastal), Cathy Cosca (Equatorial Pacific), and Denis Pierrot (global), which we wholeheartedly welcome. In addition we welcome the leader for the recently conceived Arctic group, Jeremy Mathis.

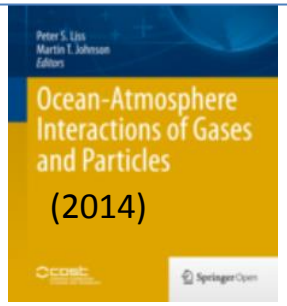
The SOCAT team has now started preparations for SOCAT version 3, and we take this opportunity to fix a number of underlying issues with SOCAT and aim for a re streamlined process. We would ention the ongoing effort towards lated submission system, allowing ors to submit their data and online, a process that will include d conformation checks, which will e SOCAT quality control team of ts more tedious tasks. Further, a gging scheme has been prepared anninkhof and colleagues, which is able for community review through page at www.SOCAT.info.

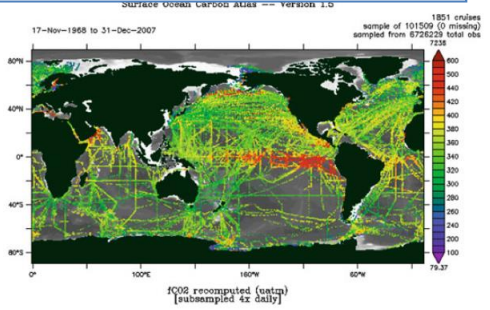
eciate all contributions to SOCAT, ple in the form of data product a, software development and ntrol. Please feel free to contact rs if you would like to contribute.

Please, cite ESSD publications:

V1: Pfeil et al. (2013) ESSD 5: 125-143;
V1: Sabine et al. (2013) ESSD 5: 145-153.
V2: Bakker et al. (2014) ESSD 6: 69-90.

≥ 34 peer-reviewed scientific articles (2009: 1, 2010: 1, 2011: 1, 2012: 2, 2013: 17, 2014: 13) and 3 book chapters (2014) cite SOCAT





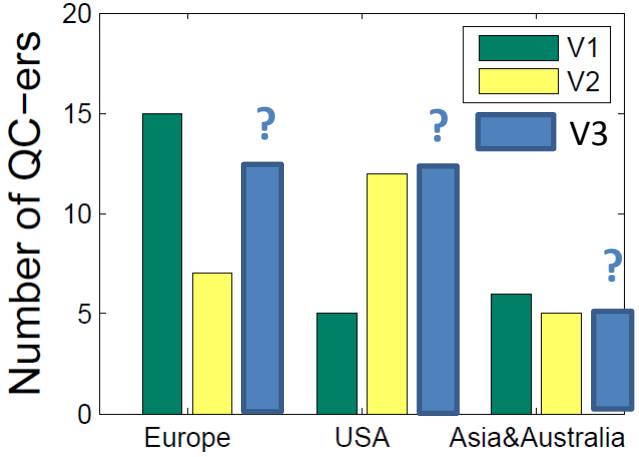
SOCAT 1,2

www.socat.info

SOCAT time table

- V3: 1900 cruises, 1957-2013 submitted (~50% new)
- **V3 Tests of quality control system (Aug 2014)**
- **V3 Quality control by regional groups (1 Sep- 30 Nov 2014)**
- **V3 QC meetings by groups (any?)**
- **V3 Quality control complete (30 Nov 2014)**
- V3 Early release (spring 2015)
- V3 Public release (summer 2015, **where?**)

- V4 Submit data to CDIAC (any time)
- **V4 Tests of automated data upload (autumn'14)**
- V4 Data submission system live (late '14/early '15)



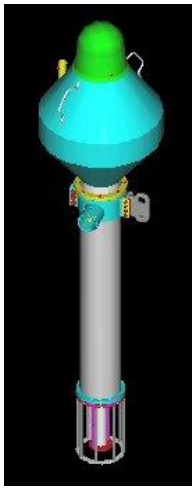
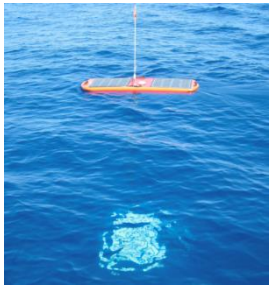
Inclusion of sensor data in SOCAT v3

www.socat.info

- Encourage calibration of sensors;
- Revision of data set quality control flags, based on accuracy;
- Update metadata forms for sensors (calibration!);
- Identification of platform type;

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

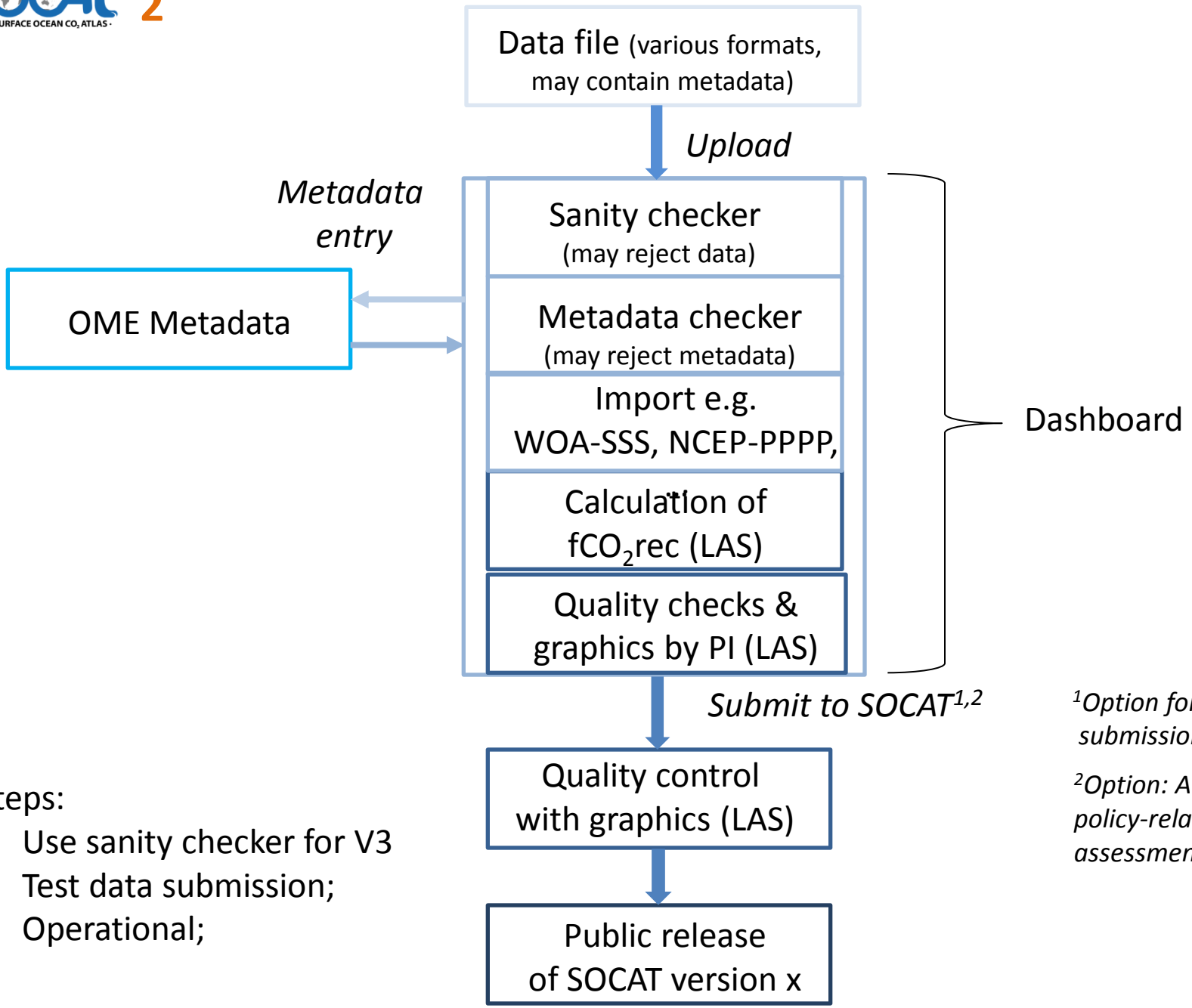
Flag	*Criteria*[a]
A (11)	(1) Accuracy of calculated fCO_{2w} (at SST) is better than 2 µatm (2) A high-quality cross-over with another dataset is available (3) Followed approved methods/SOP[c] criteria (4) Metadata documentation complete (5) Dataset QC was deemed acceptable
B (12)	(1) Accuracy of calculated fCO_{2w} (at SST) is better than 2 µatm (2) Followed approved methods/SOP criteria (3) Metadata documentation complete (4) Dataset QC was deemed acceptable
C (13)	(1) Accuracy of calculated fCO_{2w} (at SST) is better than 5 µatm (2) Followed approved methods/SOP criteria (3) Metadata documentation complete (4) Dataset QC was deemed acceptable
D (14)	(1) Accuracy of calculated fCO_{2w} (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
E (17) NEW	(Primarily for alternative sensors) (1) Accuracy of calculated fCO_{2w} (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
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



Wanninkhof, R., Bakker, D. C. E., Bates, N., Olsen, A., Steinhoff, T., and Sutton, A. J. (2013) Incorporation of Alternative Sensors in the SOCAT Database and Adjustments to Dataset Quality Control Flags. Recommendationnewsensors.pdf. doi: 10.3334/CDIAC/OTG.SOCAT_ADQCF.

Automated data submission



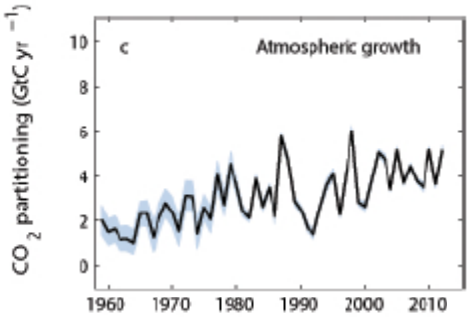
Steps:

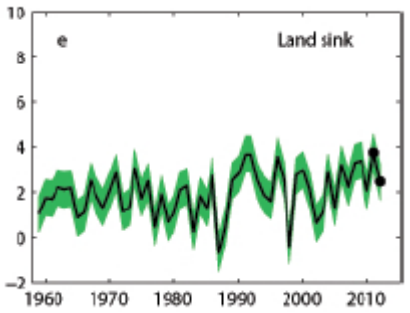
- Use sanity checker for V3
- Test data submission;
- Operational;

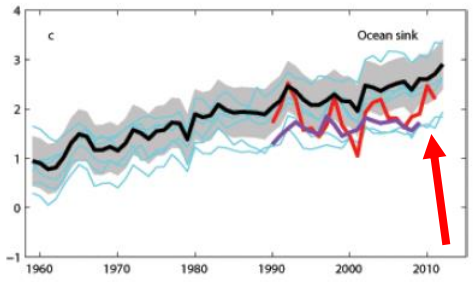
[1]Option for immediate submission to CDIAC

[2]Option: Available for policy-related assessments?

Global Carbon Project collaboration







GCP Proposal:

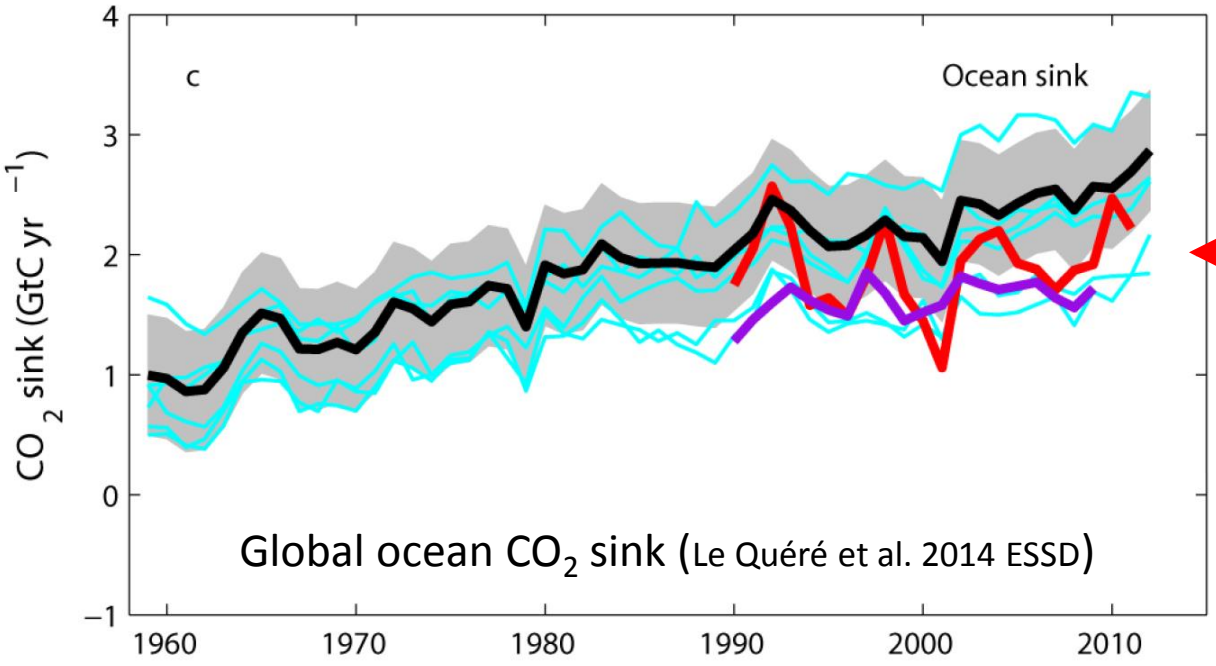
Use of **pre-QC data (via SOCAT infrastructure)** for the Global Carbon Budget 2014

- All new & updated data submitted to SOCAT v3.
- Recalculated fCO_2 without SOCAT quality control.
- GCP to consult PIs of all new & updated, public & non-public data.
- GCP to invite 1 co-author per team for 2012 & 2013 data.

Consultation by email and at CarboChange (08/04):
24 – I am in favour, incl. 2 with a concern on 1-author policy
05 – I have no opinion (yet)/ I have to know more
05 – I am against, incl. 2 with 'wait until SOCAT fits GCP timescale'.
34 - Total

Discussion at the SOCAT Community Event

SOCAT science



SOCAT v2-based CO_2 fluxes:

Rödenbeck et al., 2014, BGD

- Process studies;
- Ocean carbon sink and its seasonal, year-to-year, decadal variation;
- Initialisation and validation of ocean carbon cycle models.

Examples:
Surface Ocean pCO_2 Mapping Intercomparison (Rödenbeck et al., A1 talk, open to data-based products);
IMBER presentations by Nakaoka, Landschützer, Rödenbeck, Schuster, Jones, Le Quéré et al.
OceanGHGFlux ESA project (Woolf et al., http://www.oceanflux-ghg.org/)

SOCAT 3
SURFACE OCEAN CO_2 ATLAS

Journal of Marine Systems 113–114 (2013) 62–74
Contents lists available at SciVerse ScienceDirect
Journal of Marine Systems
journal homepage: www.elsevier.com/locate/jmarsys

Annual and seasonal fCO_2 and air–sea CO_2 fluxes in the Barents Sea

S.K. Lauvset [a,b,*], M. Chierici [d,g], F. Counillon [e], A. Omar [b,f], G. Nondal [b,f,h], T. Johannessen [a,b,f], A. Olsen [b,c,f]

Earth Syst. Sci. Data, 6, 235–263, 2014
www.earth-syst-sci-data.net/6/235/2014/
doi:10.5194/essd-6-235-2014
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Earth System Science Data

Continental Shelf Research 65 (2013) 52–63
Contents lists available at SciVerse ScienceDirect
Continental Shelf Research
journal homepage: www.elsevier.com/locate/csr
Research papers

Biogeosciences, 10, 6093–6106, 2013
www.biogeosciences.net/10/6093/2013/
doi:10.5194/bg-10-6093-2013
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Biogeosciences

≥34 peer-reviewed publications
(2009: 1, 2010: 1, 2011: 1, 2012: 2, 2013: 17, 2014: 13)
and 3 book chapters (2014: 3) cite SOCAT.

SOCAT Data policy:
Recognise the contribution of SOCAT data contributors and quality controllers in the form of invitation to co-authorship or citation of relevant articles.

Cite the relevant SOCAT ESSD publication,
documenting the data product.

In Situ CO_2 and O_2 Measurements on a Profiling Float

BJÖRN FIEDLER
GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany
PEER FIETZEK

Biogeosciences Discuss., 11, 3167–3207, 2014
www.biogeosciences-discuss.net/11/3167/2014/
doi:10.5194/bgd-11-3167-2014
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This discussion paper is/has been under review for the journal Biogeosciences (BG).
Please refer to the corresponding final paper in BG if available.

Interannual sea–air CO_2 flux variability from an observation-driven ocean mixed-layer scheme

C. Rödenbeck[1], D. C. E. Bakker[2], N. Metzl[3], A. Olsen[4,5], C. Sabine[6], N. Cassar[7], F. Reum[1], R. F. Keeling[8], and M. Heimann[1]

Prevalence of strong vertical CO_2 and O_2 variability in the top meters of the ocean

Maria Ll. Calleja,[1,2] Carlos M. Duarte,[1,3] Marta Álvarez,[4] Raquel Vaquer-Sunyer,[5] Susana Agustí,[1,3] and Gerhard J. Herndl[6,7]

variability of the Atlantic Ocean carbon sink

P. Landschützer[1], N. Gruber[2], D. C. E. Bakker[1], U. Schuster[1,*], S. Nakaoka[3], M. R. Payne[2,4], T. P. Sasse[5], and J. Zeng[3]

Sea–air CO_2 fluxes in the Indian Ocean between 1990 and 2009

V. V. S. S. Sarma[1], A. Lenton[2], R. M. Law[2], N. Metzl[4], P. K. Patra[5], S. Doney[6], L. D. Lima[6], E. Dlugokencky[7], M. Ramonet[8], and V. Valsala[9]

Observed small spatial scale and seasonal variability of the CO_2 system in the Southern Ocean

L. Resplandy[1,*], J. Boutin[1], and L. Merlivat[1]

SOCAT is a community activity!

>100 data contributors, group leads, quality controllers and data managers!