

1 **Final Author Comments for An update to the Surface Ocean CO<sub>2</sub> Atlas (SOCAT**  
2 **version 2) by D.C.E. Bakker et al.**

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5 Authors: We thank both referees for their positive, thoughtful, constructive and extensive  
6 comments and suggestions on our manuscript ‘An Update to the Surface Ocean CO<sub>2</sub> Atlas  
7 (SOCAT version 2)’. In the supplement (below) we discuss the comments point by point.  
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10 **Response to Anonymous Referee 1**

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12 **Referee 1: The MS by Bakker et al. presents the updated version of the Surface Ocean**  
13 **CO<sub>2</sub> Atlas (SOCAT version 2). SOCAT represents a very important effort to provide a**  
14 **comprehensive and consistent data set for the use in Earth System Sciences, particularly**  
15 **for research on the carbon cycle and ocean acidification. The SOCAT team made**  
16 **considerable efforts with regard to quality checks and the data quality is well**  
17 **documented in the downloadable data sets. I am intrigued by the high degree of**  
18 **organization that must be necessary to accomplish such a big project.**

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20 **Referee 1: The SOCAT data can be viewed or downloaded using different portals to**  
21 **which the user is redirected from the main webpage [www.socat.info](http://www.socat.info). This includes: 1)**  
22 **The cruise data viewer ([http://ferret.pmel.noaa.gov/SOCAT2\\_Cruise\\_Viewer/](http://ferret.pmel.noaa.gov/SOCAT2_Cruise_Viewer/)), which**  
23 **offers a complex mask to query data, but is however still intuitive. 2) The gridded data**  
24 **viewer ([http://ferret.pmel.noaa.gov/SOCAT\\_gridded\\_viewer/](http://ferret.pmel.noaa.gov/SOCAT_gridded_viewer/)), which allows the user to**  
25 **get a quick overview over the data by the help of an interactive web map system, time**  
26 **series plots, and plots of correlations between different variables. The user has the**  
27 **possibility to download gridded data for use in desktop applications like Matlab 3)**  
28 **Download complete data set from PANGAEA**  
29 **(<http://doi.pangaea.de/10.1594/PANGAEA.811776>), consisting in tab delimited tables,**  
30 **one for each cruise. 4) Download of complete data set, or large parts of the data set by**  
31 **region, (<http://cdiac.ornl.gov/ftp/oceans/SOCATv2/>) in one big tab delimited table I am**  
32 **very satisfied with the data download and data quality, and have only some critical**  
33 **remarks to download option 1).**

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35 Authors: We highly commend referee 1 for his/her thorough and helpful comments. In  
36 response we have streamlined the data download options from the Cruise Data Viewer by  
37 reducing the number of parameters and by making the parameter names (column headers)  
38 consistent with those used elsewhere for data download. We have clarified the options for  
39 data download in Tables 2 and 3 (former Tables 2 and 6).  
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42 **Referee 1: The authors did also a great job in presenting SOCAT in their MS. The MS**  
43 **reads very well, is informative and comprehensible. The authors clearly described the**  
44 **evolution of the data set from the older version, the data sources, data coverage and**  
45 **quality, the structure of the data set, how to extract and use the data, and future plans. I**  
46 **have only minor comments on the presented MS and the downloadable data sets, and I**  
47 **recommend publication after minor revisions. In the following, I present first my**  
48 **comments on the MS and then on the data download and downloadable data sets.**

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50 **Referee 1: Page 469 Line 8: Replace "have been" by "are".**

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Authors: The sentence has been revised to: ‘The quality control criteria, while identical in both versions, have been applied more strictly in version 2 than in version 1.’

**Referee 1: Page 470 Line 6: Replace “is” by “was”.**

Authors: Done

**Referee 1: Page 470 Line 27: Replace “by” by “for”.**

Authors: The sentence has been rephrased to: ‘Considerable year-to-year, decadal and long-term variation of CO<sub>2</sub> uptake is apparent in the North Atlantic Ocean’ following a suggestion by referee 2.

**Referee 1: Page 473: Maybe you should mention already here in the introduction that SOCAT v2 contains 10.1 million surface water fCO<sub>2</sub> values, which represents a substantial increase compared to the 6.3 million values in the older version.**

Authors: Text has been moved from the Introduction (Section 1) to later sections in response to comments by both referees. As a result, the text on 10.1 million surface water fCO<sub>2</sub> values in version 2 now follows mention of the 6.3 million values in version 1 (both in Section 2.1).

**Referee 1: Section 2 Page 475 Line 17: Insert a “for” after “available”**

Authors: ‘For’ has been added.

**Referee 1: P475 Line 21: The historical cruises which are listed as taken at midnight, but maybe were not, are they flagged in a way the user can easily identify the concerned values?**

Authors: These historical cruises have not been flagged for easy identification. We may consider this for future SOCAT versions.

**Referee 1: Page 477, Line 11; Page 478, Line 19: Here, I wondered a bit what the data set quality control flags A-D might stand for. I can imagine that A is very good, and D is not so good, but still sufficient, while S and E finally mean that the values are of insufficient quality. The definition of these quality control flags are not given until page 479. Maybe you should shortly explain the meaning of these flags (like A to D represents sufficient quality, with quality decreasing from A to D) and then state at the first mention of these flags that a definition of how these flags are attributed is given later. Maybe you could give the definitions of these flags as a small table, to provide the reader/user with a quick overview.**

100 Authors: In response to comments by both referees, the items in the section on ‘Key  
101 differences between versions 1 and 2’ (former Section 2.2) now follow relevant sections on  
102 data entry, (re-)calculation of recommended fCO<sub>2</sub>, secondary quality control criteria,  
103 secondary quality control in practice and SOCAT data products (new Sections 2.2 to 2.4).  
104 Thus, data set quality control flags are introduced before additional data set flags in the  
105 version 2 output files are discussed. A table now lists the quality control criteria for assigning  
106 data set flags (Table 9, after Table 6 in Pfeil et al., 2013). Text explaining the criteria has  
107 been added with cross-reference to Section 4.1.1 in Pfeil et al (2013).

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110 **Referee 1: Page 481, Line 4: Replace “interrogation” by “querying”.**

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Authors: Done

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115 **Referee 1: Section 3 Page 483, Line 8: Replace “repeat” by “repeated”.**

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Authors: Done

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120 **Referee 1: 1) Cruise data viewer ([http://ferret.pmel.noaa.gov/SOCAT2\\_Cruise\\_Viewer/](http://ferret.pmel.noaa.gov/SOCAT2_Cruise_Viewer/)).**  
121 **If the user selects one variable of interest (like pCO<sub>2</sub>), she/he can download a nice ready**  
122 **to use table with latitude, longitude, date and time, and the values for the chosen**  
123 **parameter. However, when I tried this several times, the downloaded table listed all**  
124 **samples including those for which the chosen parameter was not assessed (‘NaN’),**  
125 **although I did not check the respective option. That might be a bug.**

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Authors: A ‘NaN’ will appear for the chosen parameter, if a value is not available.

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130 **Referee 1: If you download ‘all variables’, you obtain a complex table with a lot of data**  
131 **columns. The variable column headings in the downloaded tables, but also the**  
132 **parameters you can chose for the map viewer (which correspond to the variable column**  
133 **headings), are not well in accordance with the descriptions in the MS (Table 6). With**  
134 **the help of the MS, I could figure out the meaning of most parameter names (column**  
135 **headings). However, a lot of variable names are not consistent between table 6 and the**  
136 **website or tables downloaded from the website. For instance ‘fCO<sub>2</sub>water\_equ\_wet’ in**  
137 **table 6 of the MS might be identical to ‘fCO<sub>2</sub>\_water\_equi\_uatm’ in the downloaded**  
138 **table, but I’m not so sure. Similarly, ‘pCO<sub>2</sub>water\_SST\_wet’ in table 6, does this refer to**  
139 **‘pCO<sub>2</sub>\_water\_sst\_100humidity\_uatm’ in the downloaded data table. The atmospheric**  
140 **pressure is called ‘Pressure\_atm’ in the data set, but ‘PPPP’ in table 6. In the data set, I**  
141 **did not find the column ‘Algorithm’, which could have been interesting. I find some**  
142 **data columns in the data table like ‘bottomD’ and ‘depth’, for which I do not know**  
143 **what they represent; and table 6 does not give any explanations on those. These are only**  
144 **a few examples. As the table 6 in the MS is however consistent with variable names**  
145 **from download options 3) and 4) (see below), maybe the variable names on this website**  
146 **should be renamed accordingly. Alternatively, you could explain each variable column**  
147 **name in the headers of the downloaded tables, like this is done for 3) and 4), or offer the**  
148 **definitions on your website.**

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150 Authors: The referee has identified several important issues. In response, the number of  
151 variables available in ‘Map of’ and ‘Download Data’ from the Cruise Data Viewer has been  
152 strongly reduced. The parameters available now match those in the synthesis files. Parameter  
153 names in the Cruise Data Viewer have been streamlined, both for the map viewer and for the  
154 downloadable files. The number of different names for parameters has been reduced. Table 3  
155 (former Table 6) has been expanded to include the file contents and parameter names for the  
156 file downloads via the Cruise Data Viewer. The algorithm or fCO<sub>2</sub>rec\_src, used for (re-  
157) calculation of fCO<sub>2</sub>rec, is available in all downloadable file types (Table 3). The Cruise Data  
158 Viewer now provides access to the Sample depth (Water sampling depth) and the bathymetric  
159 ETOPO2\_depth.

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162 **Referee 1: 2) The gridded data viewer**  
163 **([http://ferret.pmel.noaa.gov/SOCAT\\_gridded\\_viewer/](http://ferret.pmel.noaa.gov/SOCAT_gridded_viewer/)). The viewer is well functioning**  
164 **and well documented with several tutorial videos.**

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Authors: We thank the referee for his/her positive comments.

169 **Referee 1: 3) Download complete data set as zip from Pangaea**  
170 **(<http://doi.pangaea.de/10.1594/PANGAEA.811776>). The download of the whole data set**  
171 **as zip (295 MB) is fast. Once unzipped, the user finds the data set organized in 2,699**  
172 **tab-delimited text files, one for each cruise. Here, the column heading are consistent**  
173 **with the descriptions in table 6 in the MS. Further, each variable is shortly explained in**  
174 **the header of each downloadable table. Each table contains only variable columns for**  
175 **which there are variables, which makes them more clearly arranged. I am very satisfied**  
176 **with this download option.**

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Authors: These comments are much appreciated.

181 **Referee 1: 4) Download of complete data set or by region**  
182 **(<http://cdiac.ornl.gov/ftp/oceans/SOCATv2/>). From here, more compact formats of the**  
183 **whole data set can be downloaded, either the whole package as one table or one table**  
184 **for each region. With regard to variable names (column headings in the table), the same**  
185 **is true as for 3): the names are consistent with those used in the MS (table 6) and the**  
186 **header contains also short descriptions of each column heading. Also the structure of**  
187 **the downloaded table (order of columns) is in harmony with table 6 in the MS. The**  
188 **tables are much more clearly arranged than those downloaded from 1). As the tab**  
189 **delimited files are very large, one should directly import them with a decent data base**  
190 **management system, which works very well. I am very satisfied with this download**  
191 **option.**

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Authors: We thank the referee for his/her thorough assessment of the output files.

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197 **Response to D.K. Woolf (Referee 2)**

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199 **Referee 2: This paper provides a description of a major update to the “SOCAT” CO<sub>2</sub>**  
200 **Atlas. This atlas represents a major community effort of broad and deep utility and it is**  
201 **wholly appropriate that a transparent, detailed and definitive description of this**  
202 **product (and the data itself) should be in the public domain and ESSD provides a very**  
203 **suitable portal. Therefore, I have no doubt that in final form the description should be**  
204 **published in ESSD and I can hope only to assist slightly in ensuring the clearest and**  
205 **most meticulous version is completed.**

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207 **Referee 2: Generally the structure of the manuscript is well judged. All material (text,**  
208 **figures and tables) are at least useful. If necessary some of the material could be**  
209 **removed or condensed, but I can think of no good reason to do that. My main issue with**  
210 **the manuscript is that in a few instances insufficient detail is provided on the data itself**  
211 **and especially on the processing that leads to three SOCAT products. The main**  
212 **function of the paper should presumably be to present and explain the data, thus while**  
213 **the other material is interesting enough an emphasis must be on substantiating the**  
214 **statement that “The data : : have been subject to fully documented quality control”. In**  
215 **this respect the current manuscript is inferior to two previous papers in ESSD on**  
216 **SOCAT (Pfeil et al., 2013; Sabine et al., 2013), which did provide a large amount of**  
217 **detail and explained the philosophy behind the products. To some extent, the current**  
218 **manuscript can “lean on” the previous papers, but where it does, it should refer to the**  
219 **detail in those papers and state clearly whether there has been any revision. Where**  
220 **repetition is unnecessary, I suggest referring to specific sub-sections of Pfeil et al or**  
221 **Sabine et al, since this would make the reader’s task much easier. Where the new**  
222 **products differ from the old, the differences should be more carefully explained.**  
223 **Specific instances where the description could be more detailed (or alternatively, a**  
224 **precise reference to a previous description could be included) are scattered among the**  
225 **detailed notes below.**

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227 **Authors: We thank referee 2 for his constructive and detailed comments and suggestions. In**  
228 **response we have added cross-references to specific sections in Pfeil et al. (2013) and have**  
229 **explained procedures critical for version 2 in more detail. A list of CO<sub>2</sub> parameters used for**  
230 **the (re-)calculation of recommended fCO<sub>2</sub> has been added (Table 8, after Table 4 in Pfeil et**  
231 **al., 2013), as well as a list of the quality control criteria for data set flags (Table 9, after Table**  
232 **6 in Pfeil et al., 2013). In essence, while the quality control criteria for versions 1 and 2 are**  
233 **identical, they have been applied more rigorously in version 2. The discussion of differences**  
234 **between both versions has been extended (Table 1). A table listing grounds for suspension of**  
235 **data sets has been added (Table 10) with separate columns for data sets previously included**  
236 **in version 1 and data sets new to version 2.**

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239 **Referee 2: I cannot argue with the order of sections, but I found often that the text**  
240 **raised questions in my mind that were only answered much later (this may be apparent**  
241 **in some of my specific comments below). A few more ‘signposts’ such as “this is**  
242 **described later in Section X.Y” might help the reader.**

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244 **Authors: In response to comments by both referees, former Section 2.2 ‘Key differences**  
245 **between versions 1 and 2’ has been moved backwards in the text (to new Sections 2.2, 2.3**  
246 **and 2.4). First the procedures in version 2 are explained, before highlighting relevant**  
247 **differences between versions 1 and 2. This enables discussion of specific topics in a rounded**  
248 **manner and aims to reduce ‘the questions raised that were only answered much later’.**

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**Referee 2: The abstract told me what I needed to know, but it is in my view written rather eccentrically: P. 469, line 2. I'd prefer "is a product of" to "an effort by"**

Authors: 'An effort by' has been changed to 'an activity of'. The authors are keen to avoid confusion with SOCAT data products.

**Referee 2: P469 l3. Simplify to "It improves access to : : :"**

Authors: The sentence has been shortened and has been changed to: 'provides access to'.

**Referee 2: P469 l5 onwards could be written more plainly and informatively e.g. "Version 2 of SOCAT is an evolution of the previous release (version 1) with more data (increased from 6.3 million to 10.1 million values), extended data coverage (from 1968-2007 to 1968-2011) and a slight revision of processing."**

Authors: The sentence has been revised to: '*Version 2 of SOCAT is an update of the previous release (version 1) with more data (increased from 6.3 million to 10.1 million surface water fCO<sub>2</sub> values) and extended data coverage (from 1968-2007 to 1968-2011). The quality control criteria, while identical in both versions, have been applied more strictly in version 2 than in version 1.*'

**Referee 2: The sentence "Version 2 enables : : : until 2011" adds nothing except a little ambiguity.**

Authors: The sentence has been removed.

**Referee 2: P470 l4. Remove "has".**

Authors: Done

**Referee 2: P470 l27. Perhaps change "has been demonstrated : : : in the" to "of CO2 uptake is apparent in the"**

Authors: Done

**Referee 2: P471 l8-9. I suggest 'unpacking' the sentence "Underway : : : commercial routes" to "The fugacity can be measured underway in the surface water supply of ships. This method enables the use of a variety of ships including 'ships of opportunity' on commercial routes".**

Authors: Done

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300 **Referee 2: P471 l19. To be very pedantic, the use of the term ‘voluntary observing ships’**  
301 **is potentially confusing since it risks confusion with the Voluntary Observing Ship**  
302 **(VOS) Program (WMO etc.), which is a very distinct and long-established activity.**  
303 **IOCCP recognises a Global Volunteer Observing Ship (VOS) program for CO<sub>2</sub>, which**  
304 **also risks confusion with the original VOS program. I think sticking to ‘ships of**  
305 **opportunity’ is safer.**

306

307 Authors: ‘Voluntary Observing Ships’ has been replaced by ‘ships of opportunity’ throughout  
308 the text.

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311 **Referee 2: P471. Most of the references at l19-23 could be eliminated.**

312

313 Authors: We disagree. The surface water fCO<sub>2</sub> data described in these publications represent  
314 an important contribution to SOCAT data products. Two references have been removed.

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317 **Referee 2: P471 l29 – P472 l6. This sentence actually refers to one part of the process of**  
318 **calculating fluxes, but as written sounds like ‘interpolation’ is the only thing that is**  
319 **needed apart from the measurements of fugacity. This manuscript and the associated**  
320 **data stop short of flux calculations except peripherally in Section 5, but one of the**  
321 **products is a gridded data product of surface water fCO<sub>2</sub>. I suggest “Various methods**  
322 **have been used to infer basin wide distributions from limited observations of surface**  
323 **water fCO<sub>2</sub>: : :..”**

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325 Authors: The sentence has been revised as: ‘*Statistical techniques and modelling have been*  
326 *deployed to infer basin-wide distributions of surface water fCO<sub>2</sub> from limited*  
327 *observations ...*’.

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330 **Referee 2: Also, I am not convinced the long list of methods and references that follows**  
331 **is useful in the context of this paper.**

332

333 Authors: The number of references has been reduced.

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336 **Referee 2: P472-P473. No detail is given about the recalculation of fugacity from the**  
337 **original values reported by the observers to the ‘\_rec’ definition. It is true that this is**  
338 **covered in reasonable detail by an accessible reference (Pfeil et al., 2013), but since this**  
339 **step is key to the exact meaning of “fCO<sub>2</sub>\_rec”, I think that a brief explanation of two**  
340 **points should be given here. Firstly, what is meant by sea surface temperature (SST) in**  
341 **this context (you could refer to previously published explanations of intake temperature**  
342 **and TSGs)? Secondly, what is the premise for calculating fCO<sub>2</sub>\_rec from the actual**  
343 **measurements (in most cases at a different temperature)?**

344

345 Authors: The text on fCO<sub>2</sub>rec in Section 1 has been moved to and merged with text in Section  
346 2.1. The paragraph in Section 2.1 now reads:

347 ‘*SOCAT products provide surface water fCO<sub>2</sub> values at sea surface temperature (fCO<sub>2</sub>rec,*

348 *with ‘rec’ indicating recommended fCO<sub>2</sub>), which have been (re-)calculated from the original*

349 *CO<sub>2</sub> values reported by the data provider, following a strict calculation protocol. Sea surface*  
350 *temperature refers to the temperature at the seawater intake, often at about 5 m depth on*  
351 *ships. The procedures for the retrieval and formatting of these data, for the (re-)calculation*  
352 *of surface water fCO<sub>2</sub>, for quality control, and for the creation of data products were*  
353 *analogous to those used in version 1 (see Pfeil et al., 2013; Sabine et al., 2013), as described*  
354 *in Sections 2.2, 2.3 and 2.4. The sections highlight where version 2 differs from version 1*  
355 *(Table 1).'*

356 Further detail follows in Sections 2.2, 2.3 and 2.4. Section 2.2 now gives the equation for the  
357 temperature correction from the equilibration temperature to SST, while citing Section 3.3 in  
358 Pfeil et al. (2013).

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361 **Referee 2: Similarly, there is a case for noting the most significant features of the**  
362 **gridding at this point and then referring to 2.4.4 and Sabine et al. for more detail.**  
363 **Particularly, since you have mentioned various ‘interpolation methods’ on the**  
364 **preceding page, readers cannot be expected to guess the actual process if you don’t**  
365 **explain the philosophy behind the ‘Sabine et al.’ approach.**

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Authors: Section 2.1 now more clearly refers to Section 2.4 for a discussion of the gridding  
and provides a reference to Sabine et al. (2013).

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371 **Referee 2: It is especially important to know the criteria for eliminating data. It is**  
372 **clearly important to remove data that is known to be technically defective, but I would**  
373 **argue that it is disastrous to risk introducing “publication bias” by eliminating data**  
374 **only because it appears as an “outlier” in some sense to the “quality controller”. Pfeil et**  
375 **al. (2013) explain quality control for version 1, therefore my main concern is the**  
376 **statement (P473 117-19) “About 70 cruises contained in version 1 were removed from**  
377 **version 2 upon identification of data quality concerns”. If these data were considered**  
378 **suitable for version 1 (presumably passing the QC described by Pfeil et al.), what**  
379 **precisely led to their exclusion from version 2? Is part or all of the explanation related**  
380 **to “WOCE flags 3 and 4 were reset unintentionally : : :” {quoting from Table 1}? This**  
381 **should be explained immediately following P473 119, or the relevant sub-section**  
382 **‘signposted’.**

383

384 Authors: The quality control criteria in version 2 were very similar to those in version 1 (Pfeil  
385 et al., 2013). The quality control criteria have been applied more rigorously in version 2. The  
386 unintentional resetting of WOCE flags of 3 and 4 in version 1 has been corrected in version 2.  
387 Secondary quality control is signposted in Section 2.1 and is explained in Section 2.3. Section  
388 2.3 on secondary quality control has been expanded. Cross-references to relevant sections in  
389 Pfeil et al. (2013) have been added. For example, this paragraph has been added to Section  
390 2.3:

391 *‘The Southern and Indian Ocean Groups used these quality control criteria for the*  
392 *temperature change between the seawater intake and the equilibrator in versions 1 and 2*  
393 *(Sect. 4.1.3 in Pfeil et al., 2013):*

- 394 • *Warming should be less than 3°C;*
- 395 • *Warming rate should be less than 1°C h<sup>-1</sup>, unless a rapid temperature front is*  
396 *apparent;*
- 397 • *Warming outliers should be less than 0.3°C, compared to background data.*

398 *In addition:*



- 399       • *Cooling between the seawater intake and the equilibrator is unlikely in the high-*  
400       *latitude oceans for an indoor measurement system;*  
401       • *Zero or constant temperature change may indicate absence of SST values;*

402 *The above five guidelines were applied widely for open ocean data away from sea ice, as part*  
403 *of the systematic search for unrealistic data and outliers (see Sect. 2.3.3).'*

404 A section describing the search for unrealistic values in version 2 has been added as a 'Key  
405 difference with version 1'.

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407 Authors: The suspension of 70 data sets is NOT related to the correction of WOCE flags in  
408 version 2. A new table lists grounds for the suspension of 154 data sets, with separate  
409 columns for the 70 data sets previously included in version 1 and 84 new version 2 data sets.  
410 Issues identified in the 70 data sets include a constant atmospheric pressure entry in the  
411 absence of atmospheric pressure readings (59 data sets), problems with the entry of date, time,  
412 salinity or SST (e.g. month and day mixed up or SST and salinity reversed) (6 data sets),  
413 absence of a surface water CO<sub>2</sub> parameter (3 data sets), concerns on the quality of SST,  
414 equilibrator temperature or the temperature difference (1 data set) and concerns on the quality  
415 of atmospheric pressure (1 data set). Most of the 70 data sets have been revised and  
416 resubmitted to SOCAT version 3. Table 1 (Key differences between versions 1 and 2) now  
417 has an entry for the 70 data sets in version 1, suspended from version 2.

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419 Authors: WOCE flags of 3 (questionable) and 4 (bad) set during version 1 quality control had  
420 been accidentally reported with a flag of 2 (good) in version 1 data products. The WOCE  
421 flags of 3 and 4 from version 1 quality control have been reassigned to individual fCO<sub>2</sub>rec  
422 values in version 2 data sets. A total of 20,850 fCO<sub>2</sub> values (or 0.2%) has been given a  
423 WOCE flag of 3 or 4 in version 2.

424

425

426 **Referee 2: P473 I19-20. It may be useful to describe how much data is contributed by “4**  
427 **time series, moorings and drifters”. Was this “4 time series from either a mooring or a**  
428 **drifter”? What is the instrumentation? In these cases, how (if at all) does the**  
429 **‘recalculation’ differ from underway ship data?**

430

431 Authors: The sentence has been changed to: *‘The data sets in version 2 originate from 108*  
432 *different ships, 3 drifters, 3 ship-based time series and 13 mooring-based time series (Table*  
433 *7).'* A new table lists the data sets from time-series, moorings and drifters. The table also  
434 indicates the platform, the CO<sub>2</sub> instrument type, as well as the algorithm used. Algorithm 6  
435 (fCO<sub>2</sub>water\_SST\_wet) has been used for 69,609 fCO<sub>2</sub>rec values from moorings, drifters and  
436 time series, or 6.3% of the 1,097,880 fCO<sub>2</sub>rec values using algorithm 6 in version 2 (see new  
437 Tables 7 and 8).

438

439

440 **Referee 2: Is all the ship data from a pumped underway supply or are there other**  
441 **collection methods? If there are other methods, how does the ‘recalculation’ differ?**

442

443 Authors: All ship data is from an underway seawater supply.

444

445

446 **Referee 2: Are there identifiers in the databases and switches in the data viewer that**  
447 **enable isolation of particular methods (I have noted Section 2.2.2 on Expocodes that**

448 **clearly identifies the platform, so my query is on the collection method and type of**  
449 **instrumentation)?**

450

451 Authors: A new table (Table 7) lists the data sets from time-series, moorings and drifters with  
452 the platform and detection method in version 2. All other data sets have originated from an  
453 equilibrator with mainly infrared detection. Metadata (available via Pangaea and the Cruise  
454 Data Viewer) detail the methods for each data set. Future SOCAT versions will enable easier  
455 identification of the platform and the CO<sub>2</sub> instrument type, as now clarified in Section 4.2.

456

457

458 **Referee 2: P474 l5. Change “of “ to “to”.**

459

460 Authors: Done

461

462

463 **Referee 2: P475 l17. Add “for” after “available”.**

464

465 Authors: Done

466

467

468 **Referee 2: P476-477, Section 2.2.4. This section is very informative, but could be even**  
469 **more informative. The preferred procedure can be debated (for example, is it**  
470 **appropriate to exclude data from the synthesis files only because the seawater**  
471 **temperature is atypical for the season and region?), but this manuscript is not the place**  
472 **for that debate.**

473 **In my opinion, it is worth finding space in this manuscript for one or two extra tables,**  
474 **firstly to define as precisely as possible what criteria were imposed for the WOCE flags**  
475 **(e.g. a specific temperature anomaly criterion?) and secondly to give statistics of the**  
476 **number of data excluded from the synthesis, as far as possible sub-divided according to**  
477 **the active criterion. In the case of criteria, much of the explanation missing in this**  
478 **subsection is finally given in Section 2.3.2 (secondary quality control), therefore it is**  
479 **worth mentioning 2.3.2 here. Also, Section 4 of Pfeil et al is more informative and a**  
480 **sufficient answer may be “as Pfeil et al.”, but it would be better to state that in 2.2.4.**

481

482 Authors: The explanation of secondary quality control has been much expanded with cross-  
483 reference to Pfeil et al. (2013), as discussed above. A new table (Table 10) lists the grounds  
484 for suspension of 154 data sets. We do not provide statistics on the grounds for WOCE flags  
485 of 3 and 4 given to 0.2% of the individual fCO<sub>2</sub> values. The quality control comments  
486 (available via the Table of Cruises on the Cruise Data Viewer) provide some comments on  
487 the assignation of WOCE flags of 3 and 4. Discussions are underway on how to better  
488 document quality control decisions for WOCE flags of 3 and 4 in future SOCAT versions.

489

490

491 **Referee 2: P477 l20 – p478 l4. These sentences don’t really belong under “data entry”**  
492 **and supply a little more detail to the introductory material on P471. This material may**  
493 **be better gathered together (in Section 2.1?). As already commented for P473 l19-20, it**  
494 **would be useful to tabulate the contributions of different sensors and platforms to the**  
495 **total database.**

496

497 Authors: A point well made. The text in Section 2.1 has been merged with text in Section 2.2  
498 (former Section 2.3.1). Section 2.2 now has subsections on ‘Data origin’ and ‘Data entry’. A  
499 new table (Table 7) lists moorings, time series and drifters.

500  
501

502 **Referee 2: P479 I22. Spelling of “resemble”.**

503  
504

Authors: Done

505  
506

507 **Referee 2: Section 2.4.3. There seems to be a contradiction between P480 I20, “The**  
508 **synthesis files only contain : : . with WOCE flag 2”, and P481 I8-9 “The user can**  
509 **include data with a WOCE flag of 3 : : :”. Perhaps this arises since the Cruise Data**  
510 **Viewer is not accessing just the global synthesis data? But in that case, doesn’t this sub-**  
511 **section belong in Section 2.4.2? Please clarify.**

512

513 Authors: The Cruise Data Viewer enables subsetting the SOCAT synthesis products. The  
514 default setting provides access to fCO<sub>2</sub> values with a WOCE flag of 2. However, the Cruise  
515 Data Viewer enables access to WOCE flags of 3 and 4, if one selects ‘Include SOCAT  
516 invalids’. This has been clarified in the text and Table 2.

517  
518

519 **Referee 2: Section 2.4.4 is - I think - an example where an appropriate level of detail is**  
520 **supplied.**

521  
522

523 **Referee 2: Section 4.2. The title identifies ‘instrumentation’ and ‘sensors’; it may be**  
524 **better to discuss ‘sensors’ and ‘platforms’. Both the sensor and the platform can affect**  
525 **what is measured and how, while the current text only mentions the platform in the**  
526 **context of the choice of sensor. A talking point rather than something to be addressed in**  
527 **a revision of this manuscript: Placing sensors on platforms such as drifters and gliders**  
528 **undoubtedly raises issues (e.g. very limited calibration), but issues of disturbance are**  
529 **much less than an underway ship (where the moving ship disturbs the water column**  
530 **Referee 2: and the sample may be altered during its journey to the sensor). Thus for sea**  
531 **surface temperature, a temperature measured from a drifter or glider may be superior**  
532 **to intake temperature.**

533

534 Authors: The section title has been changed to: ‘Quality control flags for alternative sensors  
535 on a range of platforms’. The SOCAT community recognises the important contribution that  
536 sensors on a range of platforms make to monitoring surface water fCO<sub>2</sub>. The data set quality  
537 control flags have been revised, such that SOCAT version 3 can accommodate such data  
538 (Wanninkhof et al., 2013a).

539

540 **Referee 2: P484 I8. Replace “operation” with “operating”**

541  
542

Authors: Done

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545 **Referee 2: P484 I13-14. I suggest “The working group has recommended an appropriate**  
546 **set of quality control criteria for each sensor”.**

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Authors: The report of the working group has been published (Wanninkhof et al., 2013a). Section 4.2 has been expanded to incorporate the main findings by the working group: *‘The working group has determined which quality control criteria should apply to surface water CO<sub>2</sub> data from these new sensors and platforms. The term ‘data set quality control flag’ replaces ‘cruise quality control flag’. The accuracy of data with data set flags C and D has been specified as 5 μatm. A new data set quality control flag ‘E’ with an accuracy better than 10 μatm has been defined. The platform and the CO<sub>2</sub> instrument type will be identified as separate parameters. These quality control criteria and other recommendations of the working group will be adopted for SOCAT version 3.’*

**Referee 2: Section 4. I note from within Section 4.1.3 of Pfeil et al. (2013).“: : : Apart from these, no strict criteria for QC were defined : : : This will be improved in future versions of SOCAT.” That ambition is laudable (without clear criteria, the definition of the SOCAT products is less clear than it could be). What are the plans for Versions 3 and 4?**

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Authors: A recommendation will be made to adopt the secondary quality control criteria, as discussed above for P473, for all regions in version 3.

**Referee 2: Section 4. As described in Section 2.4.3 the original data and metadata is accessible from the global synthesis product via a doi number for the cruise file in PANGAEA. Has there been any consideration to giving a limited amount of metadata (e.g. a sensor type code) directly within the synthesis product?**

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Authors: Parameters for platform and CO<sub>2</sub> instrument type will be added to version 3 data products (Wanninkhof et al., 2013a).

## 578 **Reference**

579 Wanninkhof, R., Bakker, D. C. E., Bates, N., Olsen, A., Steinhoff, T., and Sutton, A. J.:  
580 Incorporation of Alternative Sensors in the SOCAT Database and Adjustments to Dataset  
581 Quality Control Flags. <http://cdiac.ornl.gov/oceans/Recommendationnewsensors.pdf>. Carbon  
582 Dioxide Information Analysis Center, Oak Ridge National Laboratory, US Department of  
583 Energy, Oak Ridge, Tennessee. doi: 10.3334/CDIAC/OTG.SOCAT\_ADQCF, 2013a.