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Comment

Interactive comment on “Current systematic carbon cycle observations and needs for implementing a policy-relevant carbon observing system” by P. Ciais et al.

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In this paper the authors present a very comprehensive view on global carbon observations and a global carbon observation system. This is a long paper covering a wide range of disciplines that is difficult to review in detail comprehensively. I will therefore focus this review on some general remarks and on the ocean part of the carbon system, which is my specialty. Obviously this article is not a science article in the sense that it presents new data, but more of a policy paper. The authors do in general, a very good job in covering the major aspects of global carbon cycle observations. It is obvious that this document has evolved during a long time-period, something that is

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sometimes evident by lacking some recent key references. I support the publication of this article, but I have some remarks that I think the authors should consider.

– We thank the reviewer for his/her careful review and offer detailed answers below.

The manuscript covers a wide range of programs, agencies, variables etc. Please make sure that abbreviations are spelled out on the first use. Possibly it could be very useful to have a list of abbreviations for such a long article as well.

– All acronyms/abbreviations are now spelled out on the first use. In addition, we have compiled the list of acronyms in the Appendix.

Page 11493, line 11: “Emissions needs to be measured at a 1-10 km scale”. This is a very ambitious goal. The motivation given is “to be comparable or better than those currently accepted for inventories by developed nations”. In my mind, this is a poor motivation for such an ambitious goal, and it tells me that the system requirements are already in place (at least in the developed world). I suggest a scientific rationale to make the point.

– Scientific rationale has been added. Given the huge uncertainty on local, regional emissions inventories, this requirement is in fact very ambitious for independent measurements of emissions.

Similarly, on page 11495, line 14, it is stated that “to improve estimates. . . a resolution of 1 km, hourly over the globe is needed”. I read this and think; “if that is what it takes to make an improvement it seems that we are doing pretty fine with the current system, why should we invest to make this better”. Please state the scientific (and societal) relevance for such a system (of observations and modeling activities).

– Scientific/societal relevance have been stated in the revised text.

Section 4.6.1: What is the motivation for a so much denser sampling network over the north Pacific (every 200-600 km) vs. the north Atlantic (ever 1500 km)? I would think that it should be the other way around. It would be good to be able to compare this to

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the current state, but under that section a different metrics is used. Also, in this section it is referred to an amount of “samples” when you probably mean “crossings”.

– The text referred to 1500 km both for N Atlantic and for N Pacific. Finer sampling only concerned Equatorial Pacific. Sentence has been clarified. The “samples” has been replaced by “crossings”.

Page 11504, section 1: This text is very similar to the text in the GO-SHIP white paper. This would be a good place to refer to this initiative.

– GO-SHIP initiative mentioned and reference added.

Page 11505, section 7: I could not agree more on the need of coordination of carbon (and acidification) sampling. This is not anything new, obviously, and there are groups that are doing coordination. This would be a good place to mention IOCCP (International Ocean Carbon Coordination Project), for instance.

– IOCCP mentioned.

Minor comments:

Page 1452, line 19: “For the period...” This is an abrupt switch from CH4 to CO2, without any wording stating so.

– The whole paragraph revised for clarity and logic.

Page 1454, line 6: Add reference after “1959”.

– Reference added to IPCC AR5 carbon cycle chapter.

Page 11468, line 9: Is the order of figures correct?

– The order of Figures is correct, i.e. Fig. 7 at the top of this page, and Fig. 3b later in text. Figure 3 was called earlier at page 11462 (Section 3.3.1).

Page 11468, line 13: Figure 3B?

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– The figure number should read “Fig. 3b”.

Page 11471, line 8: The data collection PACIFICA is now finalized and published at <http://cdiac.ornl.gov/oceans/PACIFICA/>

– The reference to published PACIFICA data set is added.

Page 11471, line 10: The global scale uptake of anthropogenic CO₂ in the ocean is documented by a large range of publications (several of them listed in the review by Sabine and Tanhua, 2010), but I would agree that the global-scale accumulation is not quantified yet.

– Noted.

Page 11472, line 5: A number of carbon related (pCO₂, TA, pH, DIC) sensors for ocean use on autonomous vehicles are being developed and tested. This should be mentioned here, and appropriate referenced.

– Point added to the revised text.

page 11477, line 24: It could be worth mentioning that the information on the flux of carbon to the ocean from land is essential to close the ocean carbon budget.

– “The information on the flux of carbon to the ocean from land is essential to close the ocean carbon budget” and that is now mentioned in text.

Page 11489, line 28: The authors refer to the need to quantify the uncertainty here. I could not agree more on the need to carefully document uncertainties. However, the combined effect if uncertainty (random deviations from the “true” value”) and accuracy (systematic biases) should be the key variable to document. I suggest making the distinction between uncertainty and accuracy more consequent throughout the manuscript, not just on this occasion.

– We carefully checked and revised manuscript accordingly.

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Page 11498, line 11: I have not done the math, but I would think that having atmospheric stations spaced 200 km from each other over the globe would be significantly more than 2000 stations. I think the authors meant something else, please make this clear.

– Thank you for this comment; number of stations over land should be approx. 4000.

Page 11506, section 2 (upper): Sediment traps are not “remote sensing”, although that data would be useful for calibration of remote sensors.

– “Sediment traps are not “remote sensing, although that data would be useful for calibration of remote sensors”. The bullet point was revised to include this statement.

Table 2: Data standardization; this is stated as “low”, but this is not true for oceanic CO2 data where the data are reported on standardized formats. Similarly, for “data access” there is probably a distinction to be made between different carbon data streams where some are more easy to access than others. Is “continuous, hourly” really a valid for a carbon observation system (under the line “temporal continuity”) in general? I can see this be possible for some atmospheric observation systems, for instance, but not as a whole for the system described in this article.

– Table 2 is only relevant for atmospheric data. This has been clarified in the revised caption.

Figure 1B: The “Long term baseline station” square mention Mauna Loa. Unfortunately, the Mauna Loa observatory is located several thousand meters above the ocean. A better example for the ocean would be HOTS (Hawaii Ocean Time-Series).

– Mauna Loa is an iconic station that measures the global trends of natural sinks (from the CO2 growth rate). The example of BATS and HOTS was added for the ocean in the figure.

Figure 5A: State which data set this figure is based on.

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– This figure is based on SOCAT dataset. Added in the caption.

Figure 5D: This figure looks like the GO-SHIP plan, and does not necessarily reflect actual measurements the last decade. It would seem appropriate to mention GO-SHIP here as well.

– Done.

Figure 4B: Please explain the acronyms in the title of the graphs, and add units on the X-axis.

– Acronyms are names of satellite missions and could not be explained (clarified in the caption). Units of X axis added (dimensionless weights).

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