

## ***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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General comments:

The manuscript aims at presenting the current state of global carbon cycle observations and the needs for a more comprehensive observing system that could not only help researchers to determine carbon fluxes at high spatial and temporal resolution over the continents and oceans, but also to support policy-relevant decision making. To accomplish this overwhelming task is not trivial, due to the many different aspects, which need to be taken into account, and the necessity to include expertise from many different co-authors (i.e., more than 50 on the current manuscript). This difficulty may

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be the reason why the paper, as it currently is, is largely non-digestible, at least for this reviewer. I guess the first question that needs to be posed and answered is: Who are the expected readers of this manuscript?

Accordingly, sections 1 and 3 need to be re-written. Section 1, the introduction, is a bit confusing as the authors are jumping from one topic to another and from one scale to another, and back. A clear structuring and shortening could largely help to get a clear idea of the problem and of the aims of the study.

Section 3, which should give the state-of-the art of our current observation system would also very much benefit from focusing and shortening. If it were meant as a real review, the required “educational” part is lacking. Currently, it is more a listing of details, supported by figures which have legends and axes that are literally unreadable, because all fonts are much too small. (I think it is not a good idea to put more than two global maps with a lot of detail on one A4 page). Here I would have liked to find dedicated Figures (possibly supported by tables in a Supplement) which would clearly illustrate the (many) gaps in our current observational systems. This would give the readers/researchers, who work on improving the situation, information at hand, that could be shown to funding agencies/stakeholders and help to convince them to invest in the urgently needed much more comprehensive observation system (that is described in Section 4 of the manuscript).

Section 4 is the clearest one in the manuscript. However, here it would help the reader if the acronyms, which have (or have not) been explained somewhere earlier, e.g. in Section 3, would be explained again and if key references would be included (again) (many are completely missing, see below).

In summary, the manuscript needs major revisions and I cannot recommend publication in its present form. I am wondering if some of the many co-authors on the paper could help to improve it and make it the very valuable document it potentially could be.

Further comments on details in the manuscript, which also need revision:

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Abstract: Line 11: "several orders of magnitude" means to me at least factor 1000: This sounds unachievable . . .

The importance of error assessment for all components should be mentioned in the abstract.

General for the whole text: Please explain ALL ACRONYMS when they show up FIRST (not somewhere later or not at all . . .).

Page 11452, line 12: I guess it is not totally clear that the full increase of CO<sub>2</sub> and CH<sub>4</sub> is man-made.

Page 11453, line 2: how to create sinks of CH<sub>4</sub>? Line 13: give a number of the reduction target and a respective reference. Line 29 ff: the sentence "For the latter . . ." is unclear.

Page 11454, line 5: exactly 56%? Give uncertainty and reference (i.e. Ballantyne et al., Nature 488, 2012, would be appropriate here). Line 13-14: how long do the time series have to be, appr.?

Page 11456, line 17: the topic of "tipping points" has not been discussed later-on (or I over-looked that), why define them here?

Page 11458, line 8ff: also negative feedback is possible. How do you know that feedbacks are not yet active? Line 18: give uncertainty on the 93%.

Page 11460, line 9ff: give reference to ICOS, sentence is unclear/incomplete.

Page 11461, line 14: why show only France in Figure 2C? IER gives all Europe which should be shown here. Line 18: earlier the uncertainty for industrialized nations was stated as 5% (not 6%)

Page 11462, line 25: are you sure these are exactly 200 observational sites?

Page 11463, line 11: are all aircraft sites without long-term funding? Line 23: Give

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reference to the "Corporate Venture". Line 24: sounds as if all other CO<sub>2</sub> observations are not calibrated. Give reference to ICOS.

Page 11464, line 4: should read "assurance" (unfortunately, there is not insurance for quality . . .) Line 14: include "total" before "column" and mention that only one total column number is currently available from satellite data (am I correct?) Line 15: How can satellite data COMPENSATE for too low surface network density, needs re-phrasing.

Page 11465, line 25: be careful with nomenclature: ppm could stand for mixing ratio or mole fraction (which is not the same e.g. in the case of CO<sub>2</sub>).

Page 11468, line 21: what is meant with "transfer standard"?

Page 11469, line 12ff: as far as I understand, fluxes can only be estimated from Delta\_pCO<sub>2</sub>, not from pCO<sub>2</sub> alone, could be confusing (also in Figure 5 caption).

Page 11470, line 24ff: sentence/relation unclear.

Page 11471, line 12ff: Delta\_pCH<sub>4</sub>, same comment as above for Delta\_pCO<sub>2</sub>, give reference for the ocean CH<sub>4</sub> source.

Page 11472, line 24ff: not clear which data come from satellite or in situ, where do the winds come from?

Page 11475, line 7: sounds as if ecosystems otherwise are always sinks . . .

Page 11476, line 3: what is the period of inventories? I guess you mean the time period between two inventories?

Page 11483, line 24: what is a global 300m map?

Page 11484, line 1: ditto, perhaps include "resolution"

Page 11486, line 23: specify what improves the quality and relative to what.

Page 11490, line 12ff: I do not agree that with more meta data bias correction would be possible. Our current InGOS NA2 ([www.ingos-infrastructure.eu](http://www.ingos-infrastructure.eu)) exercise to esti-

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mate uncertainties (random and bias) for historical CH<sub>4</sub> and N<sub>2</sub>O data shows that the individual PIs need to be involved to estimate uncertainties of their data.

The representativeness error should also be mentioned in this section 4.1.

Page 11491, line 1.3: I do not understand this point.

Page 11492, line 25: what does it mean in terms of fluxes: factor of two error reduction?

Page 11495, line 3: give reference. Line 21: what means "accurate" in a quantitative sense? Line 24: "where possible"? I would say this is really necessary!

Page 11497, line 18: give reference to the 14C-CO<sub>2</sub> method. 14C-CH<sub>4</sub> is largely contaminated by nuclear emissions, and thus useless to estimate the fossil component (see Levin et al., 1992, Radiocarbon in atmospheric carbon dioxide and methane: global distribution and trends, in: R.E. Taylor, A. Long and R.S. Kra (Eds.) Radiocarbon After Four Decades: An Interdisciplinary Perspective, Springer-Verlag, New York, 503-517.)

Line 24: give reference to fossil fuel proxies (i.e. CO, NO<sub>x</sub>, other), see also Page 11499, line 21-24.

Page 11498, line 25ff: give references.

Page 11501, line 2-3: why exactly 1 ppm for CO<sub>2</sub> and 5 ppb for CH<sub>4</sub>?

Page 11502, lines 5-9: give references to explain the tracers SF<sub>6</sub> and 222Radon.

Page 11503, line 3: the term "space-time covariance matrices" has never been explained Line 7: should read: ocean "CO<sub>2</sub>" sink Lines 12ff: explain how these numbers have been estimated and give references

Page 11506, lines 10ff: give reference. Fig 7 is not readable (could go to a supplement, I guess).

Page 11507, lines 12ff: what is "optimal accuracy"? I guess what is important is com-

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patibility?

Page 11509, line 24: give reference to explain BEF, DBH, ...

Page 11514, line 3ff: ... and "organic soil carbon"... is this the same as the soil carbon inventories, regularly made?

Page 11515, line 24-25: "waste management" needs to be included when listing CH<sub>4</sub> emissions.

Page 11517, line 11: what is MRV

I guess, also Megacities are "hot spots".

Page 11522, line 11 & 14: include also quality control

Page 11523, line 10: should better read "...incomplete data and missing estimates of realistic uncertainties, various ..."

Page 11526, line 22: explain and give reference to WMO WIS, also to CF-1 and netCDF

Page 11527-8: Include a remark that uncertainty estimates need to be put on existing/historical data sets (e.g. stored in the WDCGG)

Figure 1A and 1C: Give two space axes, as for Fig 1B & 1D

Figure 3: Why not show all surface sites with data in the WDCGG? Figure 4: What is the x-scale in 4B?

Figure 5: See comment above but note that Delta\_pCO<sub>2</sub> is plotted in A and B.

Figure 6: Chose different color for "Phase 3"

Figure 9: Explain acronyms AFOLU, NEE

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