

## ***Interactive comment on “Variability and recent trends in the African carbon balance” by P. Ciais et al.***

**P. Ciais et al.**

Received and published: 10 July 2009

Reply to reviewers on “Variability and recent trends in the African carbon balance”; by P. Ciais et al.

Referee #1 P. Canadell (Referee)

This is an exceptionally well written and executed modelling study of the quantities and components of the net carbon balance of Africa. The analysis establishes a first baseline budget for the continent to be further improved and tested by assimilating in situ and remote sensing datasets, and further developing the model for African conditions. I applaud the effort and I recommend publication in Biogeosciences after a number of minor revisions are incorporated in a revised manuscript. We thank the reviewer and made all suggested revisions

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



1. Abstracts and throughout the text. Yet the period analysed is 1901-2002, there is only discussion on the last two decades. Eg, Abstract, lines 5-7, and also in results. The reader will keep asking, what happened prior to 1980?. Please include key results in text. We added key results prior to 1980. However, the quality of the CRU climate forcing data may not be high enough for interpreting historical changes prior to 1950. The CRU web site states that for temperature &#8220;Annual values are approximately accurate to +/- 0.05°C (two standard errors) for the period since 1951. They are about four times as uncertain during the 1850s, with the accuracy improving gradually between 1860 and 1950 except for temporary deteriorations during data-sparse, wartime intervals&#8221; and that &#8220;Fluctuations over time in the numbers and locations of adjacent stations may lead to abrupt and incorrect changes in the climate of an individual grid box, particularly changes in variability&#8221;

2. pg. 3499, lines 1-2. Provide a range of NPP for Savannas, not just one number from an unpublished source. Published ref added

3. pg. 3499, lines 8-9. Articulate better the reason why is important to quantify the carbon balance of Africa. An increase population is not a good one. changed

4. pg. 3500, line 2. Houghton 2003 reference is missing in the Reference section. Also, please check the paper same special issue by Canadell, Raupach and Houghton (2008). Ref added

5. line 10. Spell-out REDD Done

6. pg. 3501, line 5. Webber is missing in reference section. Please check all reference in text against Reference section. ref added

7. line 22. The description of the model includes a ...model dealing with vegetation dynamics processes. The text comes across as inconsistent with an early statement in the abstract (lines 4-5) ..but the natural vegetation dynamics were ignored. Please clarify this apparent inconsistency. Clarified in revised MS. dynamic vegetation module

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

was not used

8. pg. 3504. Provide full citation for Weber, and consistent with previous citation. Done

9. pg. 3505 and 3506. Make consistent the reference to Fig. Use simple (Fig. X) and delete additional sentences such as (This is shown in Fig. 1). done

10. pg. 3505, line 20. See edits: autotrophic respiration (RA (..) decreases more than wo times the heterotrophic; done

11. pg. 3507, line 2. Spell out EOF. Spelled

12. pg. 3509, lines 24-26. Inconsistent with the statement in the Introduction (pg. 3500, lines 6-9). Since 2000 the forest clearing rate is high, but before = low. This has been clarified

13. pg. 3510, line 6. policy incentive; not incentive policy. done

14. pg. 3512, line 8, the continents;. Do you mean all continents or continental wide Africa only? African Continent

15. Should the 13% (line 8) and 89% (line 13) add up to 100%? changed

16. Discussion on lines 18-21, see also Canadell, Raupach and Houghton (same special issue). added

Anonymous Referee #2

This is an informative and well-written analysis of the African terrestrial carbon balance as resolved by one model (ORCHIDEE). Its conclusions are clear and well presented, and the paper needs only minor revision to be ready for full publication in Biogeosciences. There are two issues where the paper could benefit from minor revision. The first is to clarify that this paper concerns the terrestrial carbon balance only, including fluxes ecosystems and land use change (LUC), rather than the total continental carbon balance including fossil fuel emissions. Another paper in this issue of Biogeosciences

**BGD**

5, S3458–S3463, 2009

Interactive  
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



S3460

(Canadell et al 2008) quantifies the African fossil fuel emission at 0.26 PgC/y for 2000–2005. For comparison, the present work finds a net terrestrial C sink of 0.15 PgC/y for the 1990s, including LUC emissions of 0.13 PgC/y, and a terrestrial C sink excluding LUC of 0.28 PgC/y. Thus Africa is unique among the world's large continents in having a terrestrial sink of similar magnitude (but opposite sign) to total emissions, in addition to the very high interannual variability of the sink. To reflect the orientation of this paper, I suggest that the title be slightly changed to Variability and recent trends in the African terrestrial carbon balance;(adding &#8216;terrestrial&#8217;). We thank the reviewer for this comment : we changed the title, added ref to Canadell et al. and make comparison of the terrestrial sink with fossil emissions in the conclusion.

The second issue concerns the estimated LUC emission flux. An important result from this study is the finding of a LUC flux half that of Houghton (2003), and its attribution to smaller assumed clearing rates. The paper by Canadell et al. (2008, see above) gives the Houghton value. The discrepancy is significant because of continuing uncertainty about global LUC emission fluxes. Three other recent papers are relevant: Hansen et al (2008) provide updated estimates of cleared area; Houghton (2005) discusses the role of biomass estimates in addition to cleared area in contributing to LUC flux uncertainty; and Grainger (2008) discusses problems with existing inventory methodologies for tracking forest area. This question is important not only for Africa but also because of the implications of possible global overestimation of the LUC flux (for example on the detected trend of the airborne fraction). Further comparisons of present estimates with other literature values (for both cleared area and biomass removed) would make this section more valuable. We present a comparison of present LUC estimate and discuss different estimates of forest area loss in revised MS &#8211; section 3 (although detailed understanding of these differences is beyond scope of our MS)

Additional minor comments: P3498 L18: "ecosystem respiration variations (mostly due to autotrophic respiration) are tailing with those of photosynthesis": what does "tailing" mean? Suggest "correlated with". Changed

P3499 L16: It is an important point that cultivated NPP may be lower than natural NPP. By how much? This means that human land use has a double C cycle effect, reducing both turnover (through NPP-respiration) and stores (through land clearing etc). Can large-scale studies such as this discern these effects? Haberl et al. (PNAS) report 15% lower NPP than potential NPP. This study is based upon harvest and land use data incorporated into the LPJ model.

P3503 L5: What is the source for these pool transfer ratios on land clearing, and how sensitive is the model to them? Does decay happen entirely in-situ or is there product removal (eg as timber)? The source is Mc Guire et al. 2001; see refs cited. These pools decay outside ecosystems (wood products use)

P3504 L10: How long does it take (in model years) to reach equilibrium? 10,000 years spin up is done. Clarified

P3504 L10: Why equilibrate at 2x2 deg? One would expect the fine spatial structure of land cover (eg forest/savannah) to be reflected in the equilibrium C pools. Climate forcing is 2 x 2 deg but within a 2 deg grid point, different vegetation types co-exist and each take a different equilibrium value. Clarified

P3505 L5: it may be basic, but it's useful to give flux relationships explicitly (eg:  $NBP = GPP - TER - fire - LUC$ ;  $TER = RA + RH$ ) because definitions are not universal, especially for NBP. Definition paragraph added in the end of section 2

P3505 L11: "tailed" again Changed to "correlated";

P3508 L1: "satellite-derived fire emissions" - more detail is needed here; preferably a figure or at least a reference. Ref added

P3507-3508: Are there correlations between African C balance and climate modes than ENSO, such as Atlantic oscillations or the Indian Ocean Dipole (IOD)? Africa would be one continent where the dominance of ENSO might be challenged by these other modes, because the Pacific is on the other side of the world and global telecon-

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

nections must be invoked to see any ENSO influence. Different monsoon regions in West Africa vs East Africa are influenced by distinct climate modes. In particular heavy eastern Africa rainfalls correlate with the Indian Ocean Dipole mode. But ENSO seems to be the dominant mode, influencing Sahel, Equatorial Africa and South Africa (see Douville et al. cited in text)

P3507-3508: there is an apparent contradiction in results 4 and 5: ENSO is a strong control on spatial patterns including fire, but only a weak control on continental temporal variability of fire. Why? The text offers two possible explanations (spatial asymmetry in ENSO response in north and south, and the role of time lags in fire response to climate forcing) but this is not fully resolved. This is not resolved, but north-south asymmetry seems to be the main cause

P3509: See comments on LUC flux, above. A new paragraph has been added on LUC in that section

---

Interactive comment on Biogeosciences Discuss., 5, 3497, 2008.

## BGD

5, S3458–S3463, 2009

---

Interactive  
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

