Biogeosciences Discuss., 5, S1937–S1940, 2008
www.biogeosciences-discuss.net/5/S1937/2008/

Biogeosciences Discussions

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

Anonymous Referee #2

Received and published: 12 October 2008

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 from ecosystems and land use change (LUC), rather than the total continental carbon balance including fossil fuel emissions. Another paper in this issue of Biogeosciences (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 “terrestrial”).

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.

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".

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?

BGD

5, S1937–S1940, 2008

Interactive Comment

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)?

P3504 L10: How long does it take (in model years) to reach equilibrium?

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.

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.

P3505 L11: "tailed" again

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

P3507-3508: Are there correlations between African C balance and climate modes other 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 teleconnections must be invoked to see any ENSO influence.

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.

P3509: See comments on LUC flux, above.

References

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5, S1937–S1940, 2008

Interactive Comment

Africa Biogeosciences Discussions.

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Review by Mike Raupach, 12 Oct 2008

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

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