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Biogeosciences
Discussions
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# *Interactive comment on* "Global analysis of radiative forcing from fire-induced shortwave albedo change" *by* G. López-Salda na et al.

**G. López-Salda na et al.**

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We would like tho thank anonymous referee #1 for the valuable comments and questions that would lead to improve the manuscript.

Anonymous referee #1 Response: In order to add a perspective of the impact of changes in shortwave albedo with other radiative forcing induce by fires, we will add the following paragraph in the conclusion section as follows:

Changes in shortwave albedo are not the only source of radiative forcing when fires affect the land surface. According to the IPCC Fourth Assessment Report (REFERENCE), biomass burning accounts for the 75% of the direct radiative forcing from organic aerosols and it is estimated at -0.5 ± 0.5 Wm-2 for the period of 1750-2005



(Forster et al., 2007). In the tropics, where incident solar radiation is larger than at higher latitudes, it can enhance the radiative effect from aerosols (Holben et al., 2001). Ross et al., 1998 found a radiative forcing of about -15 ± 5 Wm-2 during the 1995 Amazon fire season. Total black carbon emissions from biomass burning (3.3 TgC yr-1) represent 40% of the total black carbon emissions, with an additional 4.6 TgC yr-1 contributed by fossil fuel and biofuel combustion (Bond et al., 2004). Although the overall radiative forcing of smoke aerosol particles is negative, black carbon can produce positive radiative forcing. The global radiative forcing of total black carbon was estimated at +0.2 Wm-2 in the IPCC Third Assessment Report (Ramaswamy et al., 2001) and 0.55 Wm-2 in the IPCC Fourth Assessment Report (Forster et al., 2007).

References added: Holben, B.N., Smirnov, A., Eck, T.F., Slutsker, I., Abuhassan, N., Newcomb, W.W., Schafer, J.S., Tanre, D., Chatenet, B., Lavenu, F.: An emerging ground-based aerosol climatology - Aerosol optical depth from AERONET. J. Geophys. Res. 106, 12067– 12097, 2001.

Bond, T.C., Streets, D., Yarber, K.F., Nelson, S.M., Woo, J.-H., Klimont, Z:. A technology-based global inventory of black and organic carbon emissions from combustion. J. Geophys. Res. 109, 2004.

With regards to the evolution of burned are over some specific regions, we did not provide numbers about the evolution of burned area over time at local or regional scale. The main goal is to measure the impact of fires on the Earth system at global scale. However, we agree that some illustrative results showing the temporal evolution of burned areas over the two regions shown as examples, may be helpful. We therefore add two plots, one for Australia and another for northern hemisphere Africa, including burned area and radiative forcing over time as shown in figure 1a and 1b.

Specific comments. P7778-L25-26: "Using the three BRDF ..." is not clear and should be rephrased The paragraph will be rephrased as follows:

"The Global bi-hemispherical reflectance ($\alpha$_BHR) under isotropic illumination, also designated white-sky albedo, for every 16-day time period was computed using:

$\alpha$_BHR ($\lambda$)=f_iso g_iso+f_vol g_vol+f_geo g_geo (1)

where f_iso, f_vol and f_geo are the three BRDF model parameters, isotropic, volumetric and geometric. The integrated coefficients have the following values: g_iso=1.0, g_vol=0.189184 and g_geo= -1.377622.

P7779-L15: "per year" → "each year"? The sentence will be changed to: The areas affected by fire each year were derived using the MODIS. . .

P7780: What about peatlands? In which class are they included? Response: The MODIS land cover product we used for this study includes three different classification legends. We selected the IGBP (International Geoshpere-Biosphere Programme), which is the only one that includes peatlands in class 11: Permanent wetlands. Therefore, as part of the aggregation we performed, peatlands were aggregated into the "non-forest" class.

P7781L3: identify->identified Correction as follows: For every pixel identified as affected by fire. . .

P7781L17: missing coma Correction as follows: However, fire affects vegetated areas, which generally are very reflective in the near-infrared and after a burning event, show a decrease in reflectance due to vegetation loss and de- position of charcoal and ash.

P7781L24: uncertainties Correction as follows: Second, there are uncertainties in the day of burning.

P7782L9-14: The phrase is too long and should be cut. The phrase will be changed as follows: Ramaswamy et al. (2001) define radiative forcing as 'the change in net (down minus up) irradiance (solar plus longwave; in W m−2). In this study we do not consider longwave forcing. Once the change in albedo ΔA_fire was computed, the shortwave radiative forcing at the surface ΔF_0 exerted by changes in shortwave albedo due only to fire is estimated as: ΔF_0 = -dswrf_0âĘŞ ΔA_fire



P7782L15: DFsurface or DF0? Is it the same parameter? If so be consistent It is the same parameter. ΔF_surface will be changed to ΔF_0 as in response to comment P7782L9-14.

P7782L10: It would be appreciable if the authors could justify why they neglect the longwave calculations. A quick computation could prove if a change in albedo has a significant influence or not on the amount of energy absorbed by the surface and re emitted as LW flux.

Land Surface Temperature (LST) and emissivity can indeed influence fire-induce longwave radiative forcing. However since the main goal of this study is to quantify the impact of instantaneous shortwave albedo changes in areas affected by fire and taking in to account the findings from in the scientific literature it was decided to omit the contribution of longwave fluxes. Previous studies for Africa by Govaerts et al. (2002), Northern Australia by Jin and Roy (2005), North America boreal forest by Jin et al. (2012), also ingnored the role of longwave radiation.

References added: Jin, Y., Randerson, J. T., Goetz, S. J., Beck, P. S. a., Loranty, M. M. and Goulden, M. L.: The influence of burn severity on postfire vegetation recovery and albedo change during early succession in North American boreal forests, J. Geophys. Res., 117(G1), G01036, doi:10.1029/2011JG001886, 2012.

The sentence will be modify as follows: Ramaswamy et al. (2001) define radiative forcing as 'the change in net (down minus up) irradiance (solar plus longwave; in Wm−2). In this study we do not consider longwave forcing.

P7782-L22: It's very hard to see any correlated trends between BA and RF with this Y-axis scale. Maybe try to change the Y-axis for the RF? Plot will be changed as shown below in figure 2. Quantities in radiative forcing and albedo change are different due to introduction of burned area fraction requested by reviewer #2. Uncertainties are omitted, in order to show temporal variability.

Figure 2. Temporal changes of the annual global radiative forcing induce by fires (blue line) and albedo change (in red) spanning from 2002 to 2012. Bottom plots show the total annual burned area and the downward shortwave radiation fluxes at the surface. The dashed lines depict linear trends, where changes of rate per year are, for radiative forcing: -0.016Wm-2, albedo change: 9.33e-05, burned area: -2.15Mha and downward shortwave incoming radiation: 0.14 Wm-2.

P7782-L24: Figures should be introduced before referring to them. The authors should also explain the results from the figures instead of letting the reader decides what he should see in them. The following text will be included before introducing figures 4 and 5: Figures 5 and 6 show for the Sahel and Australia correspondingly: in panel (a), the approximate day of burn (DoB), instantaneous shortwave albedo change in panel (b), the relative albedo change in panel (c). Panel (d) depicts the associated radiative forcing. Areas in red tones indicate a large change and areas in blue tones small change in the aforementioned variables.

P7783-L10: and – and Quantities in radiative forcing are different due to an introduction of burned area fraction requested by reviewer #2. Correction as follows: . . . whereas the highest radiative forcing per unit area is located in forests of Australia in 2003 and 2006, Europe in 2010 and Asia in 2003, with mean continental values of 15.43 Wm-2, 15.26 Wm-2, 13.98 Wm-2 and 8.55 Wm-2 respectively (Fig. 3).

P7784-L0-7: Rephrase (too long) Quantities in radiative forcing are different due to an introduction of burned area fraction requested by reviewer #2. Paragraph will be rephrase as follows: Since the mean radiative forcing in areas where fire occurred during 2002–2012 is 3.99Wm-2, multiplying by the proportion of area affected by fire, the global mean radiative forcing is 0.0275Wm-2. When performing the same calculation at regional scale, for instance, Australia, the mean radiative forcing is 5.71Wm-2, and the mean area burned is 0.502 Mkm2, representing the 6.53% of the Australian territory. Therefore, the mean radiative forcing for Australia is 0.373 Wm-2, an order of magnitude higher than the global number.



Table 1 not useful (only 3 parameter), better to state the number in full text. Table 1 will be omitted and values in the equation will be shown as in response to comment P7778-L25-26.

Fig.1 not usefull. It would be more interesting if we had other information than the name of continents on it (i.e. global change in SW of albedo). Figure 1 will be omitted.

Fig.2 not easy to read: - Thicker lines + text - Change to a/b/c/d instead of blue red lines - What is the linear regression of the linear fit? /year Plot will be modified as stated in comment P7782-L22. The rate of change will be part of the figure description as follows: Figure 2. Temporal changes of the annual global radiative forcing induce by fires (blue line) and albedo change (in red) spanning from 2002 to 2012. Bottom plots show the total annual burned area and the downward shortwave radiation fluxes at the surface. The dashed lines depict linear trends, where changes of rate per year are, for radiative forcing: -0.016Wm-2, albedo change: 9.33e-05, burned area: -2.15Mha and downward shortwave incoming radiation: 0.14 Wm-2.

Fig 5-6: Add a-b-c-d) instead of top middle etc. Background color white would be easier to read Panels will have letters to be identified. Background colour will be change to white as in the following example from the approximate day of burn for Australia during 2003 in figure 3:

Please consider using the PDF provided in the supplement that facilitates the response using italics and different colours for the comments and new added text.

http://editor.copernicus.org/index.php?_mdl=msover_md&_jrl=11&_lcm=oc110lcm111e&_ac

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Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/11/C5995/2014/bgd-11-C5995-2014-supplement.pdf

Interactive comment on Biogeosciences Discuss., 11, 7775, 2014.



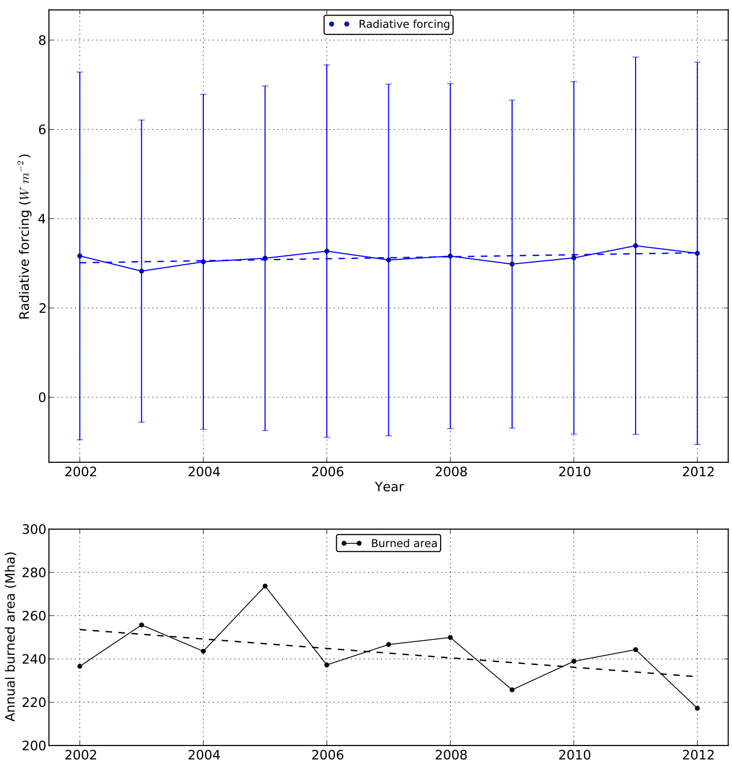


**Fig. 1.** Figure 1a. Temporal evolution of the radiative forcing and burned areas. Panel a) shows the profiles for Africa

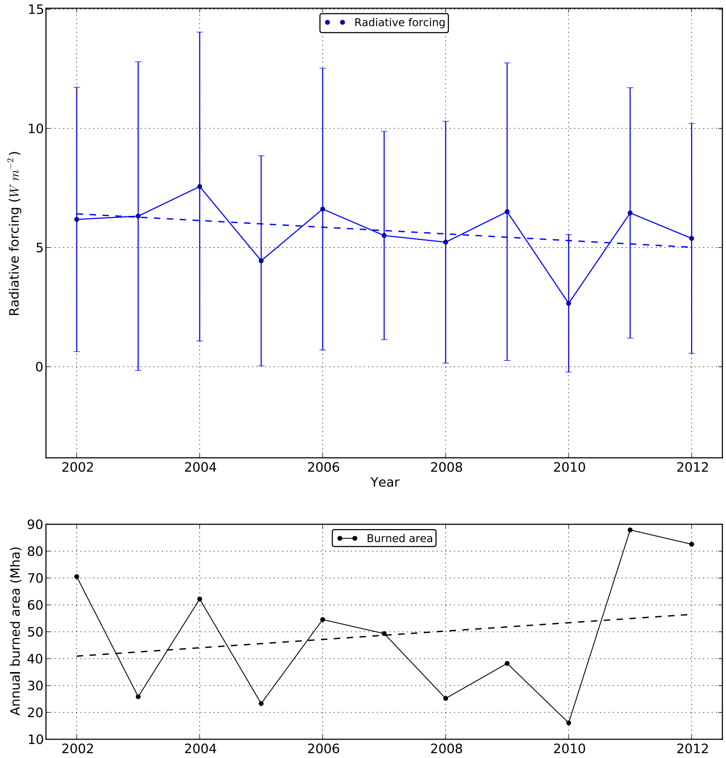


**Fig. 2.** Figure 1a. Temporal evolution of the radiative forcing and burned areas. Panel a) shows the profiles for Australia



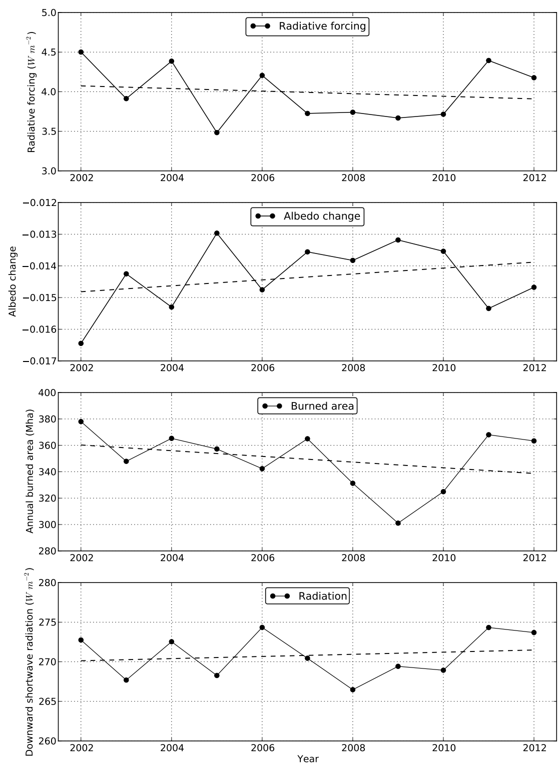


**Fig. 3.** Figure 2. Temporal changes of the annual global radiative forcing induce by fires and albedo change spanning from 2002 to 2012. Bottom plots show the total annual burned area and the downward SW

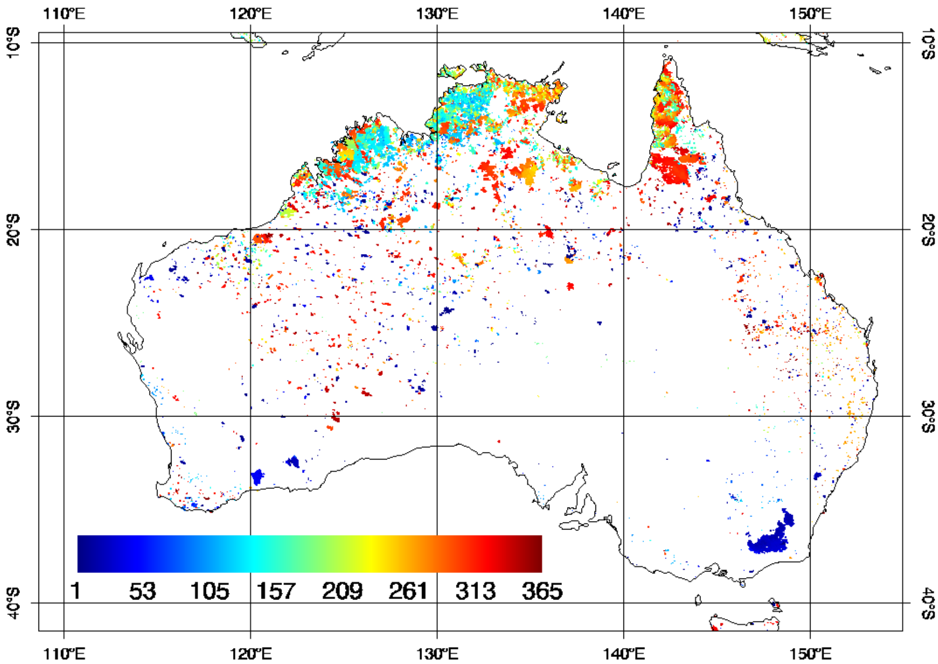


**Fig. 4.** Figure 3. DoB for Australia during 2003



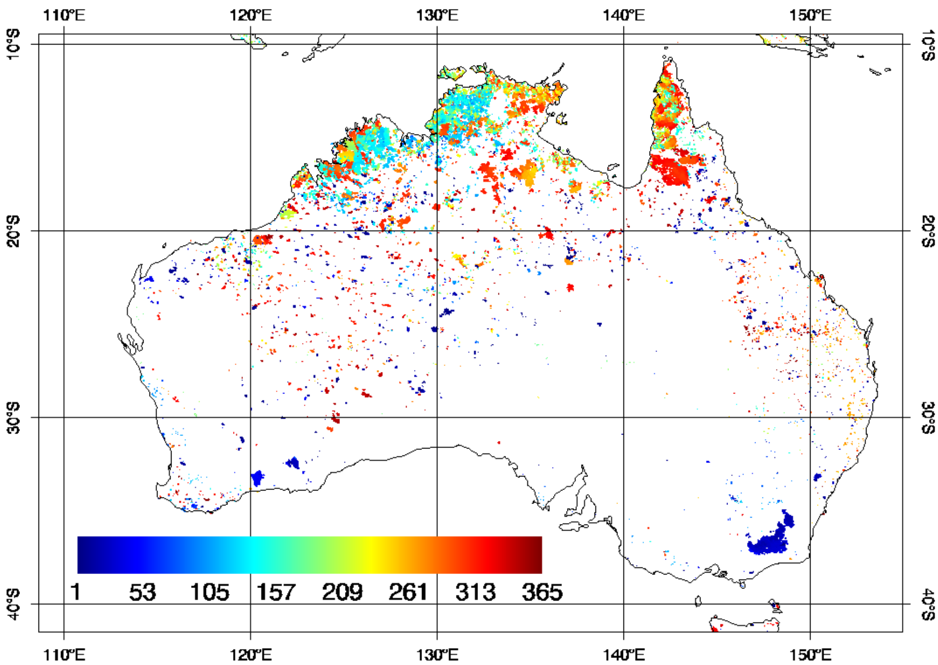


**Fig. 5.**