Interactive comment on "Divergent predictions of carbon storage between two global land models: attribution of the causes through traceability analysis" *by* R. Rafique et al.

R. Rafique et al.

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General comments The authors have applied the recently developed traceability framework for benchmarking terrestrial carbon cycle models (Luo et al (2012), Xia et al (2013)) to two such models, to compare their simulated ecosystem carbon storage capacity and to explain the differences they find. The study demonstrates the power of the traceability framework approach in elucidating the mechanisms underlying differences in behaviour between models. The outcome of this work is suggestive of how useful a larger study with a greater number of terrestrial carbon cycle models could

prove to be. The paper is generally well written and clear.

Specific comments The only concern I have with this work is the difference in forcing used to drive CABLE and CLM CASA'. The authors do address this, and demonstrate that the forcing is largely comparable, although for some biomes the differences in precipitation and air temperature were significant. A repeat simulation by one model with the forcing of the other (or the same for both) would be useful to indicate how important this difference in forcing might be to the overall result though I suspect it would not change the results significantly. However should a similar study be undertaken with a greater number of land surface / terrestrial carbon cycle models I would hope common forcing to be a feature. Also, it would be good to see a little more on the soil carbon stores which are barely mentioned in the paper.

Technical corrections Page 1580 line 14: was a function OF the

Response: We have corrected this in the revised manuscript.

Page 1580 line16-17 – Lines 17-19 constitute a more detailed version of lines 16-17 so presumably lines 16-17 should be deleted.

Response: The lines 16-17 have been removed from the revised manuscript.

Page 1581 line 1: should be (Sitch et al. 2015)

Response: We have corrected this in the revised manuscript.

Page 1581 line 7: The "The" at the start of the sentence is a bit unnecessary. Response: We have corrected this in the revised manuscript.

Page 1581 line 19-20: "for the period 1850-2100" makes more sense

Response: We have corrected this in the revised manuscript.

Page 1582 line 18: Luo et al 2003 is not referenced – the Luo et al 2001 reference listed is actually from 2003 though so I think it is that which needs changing.

Response: Luo et al., (2003) and Luo et al., (2001) are two different studies. They have been checked and clarified in the manuscript.

Page 1582 line 18: Should this be Luo et al (2003) given the above?

Response: Luo et al., (2003) and Luo et al., (2001) are two different studies. They have been checked and cited properly in the manuscript.

Page 1583 line 22: Missing comma after CLM.

Response: We have corrected this in the revised manuscript.

Page 1584 line 9: Could perhaps do with another sentence giving a bit more detail as to how the aggregation was done.

Response: We worked with the model output, so we assigned 1 pft per gridbox, i.e. the pft that occupied most of the area in a gridbox (CLM-CASA' simulates up to three pfts per gridcell). CLM-CASA' has 12 carbon pools (simulated at the pft level), and CABLE has 9 carbon pools. We included a table below as a supplement to the manuscript and provided full names of the pools in the caption of Figure 3.

(TABLE IS INCLUDED IN SUPPLEMENTARY MATERIAL)

Page 1584 line 12: Q10 is used without any prior explanation as to what it is so a few words stating what it is would clarify Response: The role of Q10 has been clarified in the revised manuscript.

Page 1584 line 19: using THE following equation

Response: We have corrected this in the revised manuscript.

Page 1584 line 22: ...vector of length n "representing the carbon pool sizes"?

Response: Yes and this has been clarified in the revised manuscript.

Page 1585 line 1: "exit rates of carbon left in pool" is not all that clear – presumably it means the rate of loss of carbon from each pool via decay or respiration

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Response: The "exit rates of carbon left in pool" has been replaced with "carbon losses through respiration" in the revised manuscript.

Page 1585 line 12: here the baseline ecosystem residence time is a function of A, C and B, but on page 1582 line 24 you state that the baseline carbon residence times are usually preset in a model according to vegetation characteristics and soil types. Confused me at first, but on re-reading I think it is the case that A, B and C are all usually function of model parameters and therefore it follows that the baseline ecosystem residence time is also? If so this could be spelled out a little more.

Response: We appreciate reviewer's deep concern on this point. We acknowledge that A, B and C are functions of model parameters, which are usually preset in models, based on vegetation and soil characteristics. This has been clarified in the introduction section of revised manuscript.

Page 1586 line11: Xia et al 2013 not 2012

Response: Our apology, the reference by Xia et al 2012 has been added in the revised manuscript.

Page 1587 first paragraph. A table summarising the residence time, NPP and ecosystem carbon storage capacity for each pool for both models might be a useful

Response: We appreciate reviewer's concern on the presentation of results. However, after considerable thinking about this suggestion, we believe a diagram representation is preferred over tables. The figures 3 and 6 represent the residence times, NPP and carbon storage capacities for the two models.

Page 1591 lines 1-2: ...and evergreen broadleaf forest AND SHRUB? in CABLE, and evergreen broadleaf forest, C4 GRASSES, SHRUB in CLM-CASA',

Response: This has been clarified in revised manuscript with the following sentence: "The C4G, evergreen broadleaf forest and shrubs in CABLE and C4G, shrubs and evergreen broadleaf forest CLM-CASA', showed the highest temperature scalar values

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amongst all other biomes, respectively".

Page 1591 lines 4: tundra in both CABLE and CLM-CASA' ?

Response: The information about "tundra in both CABLE and CLM-CASA'" has been updated in the revised manuscript.

Page 1591 lines 8: ...(0.87) in CABLE and EBF (0.98?) in CLM-CASA' ? Response: The correct values have been verified and updated in the revised manuscript.

Page 1591 lines 9-10: Overall, the lowest water scalar was DNF in CLM CASA' and the lowest temperature scalar was Tundra in CABLE?

Response: The suggested information "Overall, the lowest water scalar was observed in the deciduous needleleaf forest in CLM-CASA' and the lowest temperature scalar was observed in Tundra in CABLE" has been added in the revised manuscript.

Page 1591 line 11: ...for most biomes

Response: This is corrected in the revised manuscript.

Page 1595 line23: , 2003 not 2001

Response: Luo et al., (2003) and Luo et al., (2001) are two different studies. They have been clarified and properly cited in the manuscript.

Page 1598 final two columns might be a little clearer if CABLE was expressed as a fraction of CLM-CASA' or the other way round, rather than one minus the other.

Response: The table 1 in revised manuscript has been updated with the fractional differences of parameters between CABLE and CLM-CASA'.

Page 1599: presumably the units of the grey contour lines are kgC ?

Response: Yes, thank you. The unit has been added to the caption of figure 1.

Page 1604: line 4: T and W need subscripting.

Response: The subscripts have been fixed in the revised manuscript.

Please also note the supplement to this comment:
http://www.earth-syst-dynam-discuss.net/6/C1148/2016/esdd-6-C1148-2016-supplement.pdf