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Interactive comment on "The contribution of land-use change versus climate variability to the 1940s CO_2 plateau: Former Soviet Union as a test case" *by* Ana Bastos et al.

Anonymous Referee #2

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The authors in the current paper (The contribution of land-use change versus climate variability to the 1940s CO2 plateau: Former Soviet Union as a test case) elaborate on their prior finding published in Biogeosciences (Re-evaluating the 1940s CO2 plateau doi:10.5194/bg-13-4877-2016) about the observation of the plateau of SOC emissions around 1940s and its possible drivers. One interpretation they find, or better to say, hypothesize, WWII venue and associated withdrawal of cropland from land use (62 Mha) across the former Soviet Union, could heavily contribute to such plateauing of the carbon emissions. On one hand, it is a very interesting hypothesis, but it has to be carefully validated. However, many statements and data used in this manuscript do not allow to validate such hypothesis. Presented study simplifies the process of

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LUC caused by war conflicts, which in some cases may yield to massive abandonment (case of Nagorno-Karabakh http://link.springer.com/10.1007/s10113-014-0728-3 and Bosnia http://dx.doi.org/10.1080/01431160801891879), or opposite-maintaining extensive farming on occupied lands (feeding the Caliphate –ISIS in Syria and Iraq http://iopscience.iop.org/article/10.1088/1748-9326/aa673a) (authors hypothesize all occupied land by Nazi was abandoned). Major issues here, A) authors do not account, not all Soviet agricultural land occupied by Nazis from 1941 to 1943 was abandoned (authors simply subtract numbers on cropland acreage from 1941 to 1943). Authors also did not consider the role of trade and food supply by the Soviet Allies (for instance, in the States we see cropland expansion over this period) and C emissions associated with deforestation during the war, fires and such and spatially differentiated land use displacement (it would be best at least to go with stats at the subnational level). B) Authors made a non-plausible assumption about immediate spontaneous afforestation (regarding the cropland extent Nazis occupied predominantly agricultural areas in forest-steppe and steppe zone, thus first would be grassland encroachment). The amortization period regarding C sequestration was not accounted in their model (ORCHIDEE-MICT modeling results were also not validated). C) Authors did not describe/ discuss why other socioeconomic shocks, such as the Civil War in Russia (30 Mha land was abandoned) and recent massive long-lasting abandonment after the breakup of the Soviet Union (60 Mha) did not reflect in the plateauing the C emissions. In the end of the abstract authors conclude “Even if land-abandonment during WWII might contribute to a relatively small fraction of the sink required to explain the plateau, it is still non-negligible, especially since such events have likely been registered in other regions”. Given the all caveats with stats and assumption and expected abandonment would result in 6-10% of the gap sink required to explain the plateau (with current data), evidence suggest the role of abandonment was marginal in the plateauing C emissions and overstated.

I recommend to carefully evaluate all these caveats and to use a deductive approach to ground the hypothesis about the role of land-use change or simply concentrate on

the modeling exercise and leave out interpretation of drivers. I have a feeling, you just made a nice modeling exercise, and try to pin with the war story or better to say, the Soviet development until 1960 (it is also not clear, why until 1960?).You also never reflected on change in economy and industry during the war period and industry decline, which had probably higher contribution to reduction of C during the war in FSU compared to agricultural land use. It is also not clear from the text, if you also look just at the war period and contribution of WWII or the Soviet Union and associated land-use (you talk about war, you talk about soviet period, then about the period during the 20th century, however you tend to reconstruct stats from 190 to 1970?, figure 1), this does not help either to concentrate on your story. Last but least, you need a better structure of the manuscript; there are a lot of inconsistencies with the periods and data you used, the story is not clear, all sections of the manuscript are fuzzy and in the discussion you need to dedicate a fair amount of space to discuss your major findings, comparison with other studies and caveats.

Major issues/ caveats in more details. 1. Authors state from 1941 to 1943 abandonment comprised 64 Mha of croplands of the Soviet Union, which is one/ third of cultivated croplands in 1940, a pre-war year (they simply perform the subtraction of the numbers before and after the major peak of the Great Patriotic War in 1943 (name, which is common across the Soviet Union for the WWII activities at the Eastern Front) However, evidences suggest Nazi maintained agricultural production and reorganized kolhozes and sovkhoses to feed the Third Reich (12% of consumed food to Nazi Germany was coming from fSU), they had to feed Wehrmacht at the Eastern front (3 -4 mln people annually), plus to maintain remaining population on occupied lands (60% from total fSU's population, if i am not mistaken, were living on occupied lands). While the infrastructure has been deteriorated (50%-60% of agricultural equipment was not functioning by the end of 1941), deeply behind the Red's lines, particularly on Chernozem lands, the agriculture has been restored and even equipment was brought from Nazi Germany (this was also a part of Nazi's program to further expand at the expense of best endowed soils in Russia and Ukraine and resettle land poor Germans).

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So, despite cleansing, massive deaths and destruction of equipment, Nazis still had to maintain agriculture to feed above-mentioned groups on occupied territories. I am not a big expert on the state of land use on occupied lands during WWII, but this has to be discussed and additional evidences are needed to estimate, which portion of occupied agricultural lands was truly abandoned. At the same time, a loss of agro-environmentally endowed lands forced Soviet Union partially expand production in Siberia and Kazakhstan- land use displacement (to capture such displacement you need to look at the oblast level statistics if such displacement occurred). Last but not least here, Soviet Union received technology and food support via lend-lease program from the States, thus causing via teleconnection additional cropland expansion in North America (please take a look at the agricultural statistics of the US). This has not been discussed and accounted in the C estimates, which makes me feeling, the contribution of Soviet Union in C savings is oversimplified. 2. Continuing here the discussion about the caveats, authors assume, a bulk of abandoned lands just in three years has reverted into shrubs and trees. First, depending on site condition, even in temperate Russia, it may take even up to 20 years for the field to be encroached by shrubs. At the same time, a bulk of potentially abandoned lands (occupied by Nazis) was located in the central and southern Russia and Ukraine (authors did not show an area of potentially occupied by Nazis). If Nazis would not maintain farming (which was not the case) in the Black soil region, first we would observe a grassland restoration, but not shrubs and trees. I also did not find how did you account where abandonment would occur (I see only stats at country level). 3. Studies confirm, during the first three years after the abandonment, there might be even C losses and largest C sequestration, particularly in the above ground biomass and in soil will start after 10 years after abandonment in European Russia and Ukraine (for further details please see Quandary over Soviet croplands http://www.nature.com/doifinder/10.1038/504342a and Schierhorn et al. 2013 http://dx.doi.org/10.1002/2013GB004654). In this regard, it is not clear how C gain just in three years has been assessed. Here I also provide a criticism; you also did not validate your modeling results on C uptake on abandoned lands, to reflect if

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your estimates are plausible (no any soil chronosequences were used for the contrast and I did not see your C sequestration map for WWI period). 4. There have been similar massive LUC processes/ shocks-the Civil War in Russia (roughly 30 Mha were abandoned over similar period), post-Soviet transition from state-command to market driven economy (60 Mha from 1990 to 2010), Virgin Lands Campaign cropland expansion (just from 1953 to 1964-40 Mha on new croplands), recent massive afforestation in China. Why these processes did not yield to plateau or toward a rapid increase of C emissions? Reflection on that is necessary.

Additional comments. It would be best if you would provide line numbering to make the comments.

The abstract can be condensed.

It is not clear if data has been assembled at provincial (gubernya or oblast like level) or national level (one number per year for entire country). For instance, if we talk about the former Soviet Union, do you use only one value for Russia without further disaggregation for oblast (s) provinces? How then did you track, where did cropland expansion occur and where was an influence of WWII? Country-level data is not sufficient for such analysis, especially if you talk about land-use displacement (mentioned in the work of Linz).

Block 15. P 3 the Soviet Union is one of the well documented countries regarding the agricultural statistics (for instance, explicit statistics exists on crops and yields back to 1913). LUH1 report and Luyri et al. have different numbers, simply they use different assumptions about LUC. If statistics is scarce and contradictory to your opinion, why do you use the sources of contradictory statistics? Block 20 p 3 “the new farmland created likely did not compensate land abandonment in the affected war territories”. I am questioning here, likely or did not? I would recommend by using a deductive method to further explore, how much, in fact, land was actually abandoned with account for land-use displacement. You use just one number per country, without any account

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for land use displacement (you need to go down to oblast level data, which is available for FSU)

block 30 p. 3 not clear the objectives, if you talk about Soviet Union, or 20th century or WWII period if you reconstruct what happened during 20th century, then you need stats by 2000 (I see some simulations by 2000 and in figure 1 stats is between 1910 and1970,but in the text you state,1913-1916).

block 10 p.4 Lyuri et al. (2010) is a book in Russian, which chapter, or dataset did you use? How well Lyuri et al. data match Nove and which parameter did you use as a proxy for abandonment (arable land or sown areas?). I am a bit surprised you rely on assumptions from the book of Nove (1982) another edition is from 1990, which is a rough book for a broader audience. You need to disentangle land use and rely on studies on economic performance on occupied lands. There has been plenty of studies by Russian historians and former Generals of Wehrmacht (testimonies).

block 25 p. 4 how well LUH1 matches selected statistics from Lyuri and Nove ? it is not clear from the text why do you use Hurtt data jointly with HYDE 3.1. Plus earlier in the text you criticized HYDE data and then you use HYDE, I assume, to disaggregate your statistics at the national level.

2.2. Socio-economic statistics Why do you need population and GDP, how does this related to land-use demand and land abandonment. It would be best to explain in the introduction. How GDP for fSU is reliable?

Block 10 p.5 “The relationship between population and economic output with total crop area likely changed over the 20th century due to agricultural mechanization and fertilization or to rural exodus. Nevertheless, they provide reasonable proxies to evaluate the variability of crop area reconstructed by FSU–REF and the FSU–NEW statistics.” Did you use linear relationship in the end between population and land-use demand? I fully agree, by the end of XIXth century, such linear relationship is not valid for Russia and fSU.

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2.3 ORCHIDEE-MICT

Why did you use this model not any other process-based dynamic vegetation models (e.g., LPJ–GUESS? How did you (if you) validate your model, particularly, it was not designed to model C sequestration on abandonment. I assume, this model does not have agricultural component, such as LPJmL.

“The new soil carbon module was shown to reproduce the amount of 5 soil carbon in the high latitudes and the seasonal exchange of CO2 resulting from the seasonal imbalance between gross primary productivity (GPP) and total ecosystem respiration (TER). Fire occurrence is simulated using the SPITFIRE fire model as described in Yue et al. (2014), which is well calibrated to simulate boreal fires”. This all interesting, but how did you account for agriculture? It is not clear, how did you parametrize your model and what were inputs (e.g., crop rotation, mechanization, fertilizers, land use)? There is nothing sad if you validated your model, particularly on C stocks on abandoned lands.

3.1 Updated gridded LUC data

How did you account or simulate abandonment-prone area in the occupied zone? I do not see any reconstruction of land-use. Did you distribute evenly abandoned lands across fSU? 4.2 Carbon fluxes during the 20th century you tried to reconstruct land use from 1910 until 1960,right? How does this come to entire 20th century?

Block 10 p. 8 you use the references to almost yellow literature Linz and Nove, no any studies by the Russian historians or any other historians who worked on reconstruction of land use on occupied lands. Again, a subtraction of two numbers, before and after main venue of war, when a large portion of agricultural land was occupied, does not mean a complete termination of land use (since for Nazis it was a task and doctrine to obtain these fertile soils).

My elaboration on your modeling of C dynamic will be irrelevant based on the comments presented before, if you adjust them, they could change completely the picture

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about sequestered C. I recommend carefully revisit my comments if you envision disentangle the effect of socio-economic shocks on land-use and C stocks. You may also downplay the story and concentrate on modeling exercise, with the account for above-mentioned comments.

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