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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.

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We would like to thank the referee for reviewing the manuscript. We acknowledge that the clarity of the manuscript can be improved the relevance of the results better posed and are willing to revise the manuscript accordingly. Still, we believe the referee may have missed some of crucial aspects of this work related with: (i) the goal of this study; (ii) the sources of the data used to update cropland area in fSU and their validity; (iii) the spatial representation of the new LUC dataset; (iv) the processes represented in the land-surface model and their credibility.

Regarding (i), this work is a comparative study focusing on two different processes that

may contribute to an increased biospheric sink as discussed in Bastos et al. (2016): natural climate variability versus land-use changes possibly unaccounted for in reference datasets (including the TRENDYv4 model results in Bastos et al. (2016)). Therefore, it is essential to compare our results to the DGVMs in TRENDYv4 (for climate variability) and with the LUC dataset used to force these models, i.e. LUH1, which is based on HYDE 3.1. These are **state-of-the-art models and datasets** used by the global carbon-cycle community to evaluate both processes (natural climate-driven C-sink and LUC emissions).

As for (ii), we pointed out that LUH1, since it is based on HYDE3.1, does not rely on national statistics before 1961 (since then, FAO data is available), but on a simple extrapolation based on country-level population to estimate changes in cropland area and uses a simple linear interpolation to produce annual values from decadal changes (Fig. 1). The use of total population in societies that underwent drastic socio-economic changes during the early 20th century (industrialization, rural-exodus) likely fails to reflect real changes in cropland area, especially during periods of drastic shocks (as the Civil War or WWII periods). Therefore, we made an effort to collect official statistics of cropland area from the Russian Empire and the fSU (reference list in Supplementary Data and at the end of this reply) until 1961, when global FAO records start (which is also based on national statistics). These official records are, to the best of our knowledge, the most reliable source of informati Several economists who studied intensively the fSU have discussed that while official crop production estimates have been questioned, the official numbers of cropland extent are considered reliable, as discussed in the manuscript (e.g. Wheatcroft and Davies, 1994). Naturally, as in any inventory, official numbers are subject to a certain degree of uncertainty, and this is even more true for early periods in history. But again, we would like to re-emphasize that we are interested in understanding how much could the differences between LUH1 and the national statistics we collected contribute to the estimated LUC emissions, as this is a comparative study. We believe such an explorative approach, even though our collected data is also subject to uncertainty, can provide further insights on closing the carbon budgets for the period of 1940-1950.

(iii) Based on the new data collected for fSU totals (and country level), we produce spatially-explicit maps to force our model. These maps are updated based on the spatial distribution of cropland, forest and grassland in LUH1 and therefore take into account geographical differences in cropland distribution. These spatially-explicit maps essentially are based on satellite data, either the original LUC datasets (e.g. HYDE) or the ORCHIDEE reference PFT maps. We then **update** the gridded data in LUH1 on a pixel-by-pixel basis, distributing the differences betwe the two datasets at fSU level proportionally to the pixel-level fractional cover of cropland. This is common procedure in LUC studies (Peng et al., 2017). Even if the criterion is simple, the comparison of our updated maps with LUH1 at country level (Supplementary Figure A3) shows that our updated maps capture the country-level values reported in the national statistics, with especially good fit for the countries encompassing the largest fraction of total cropland extent. For a given pixel, a reduction of cropland is replaced by forest (FOR scenario) or grassland (GRA) plant-functional types. Again, we explain in the manuscript that this simple approach can provide two extreme scenarios that we further used to explore the carbon budget question, a typical approach in scientific investigation. In the land-surface model (iv), cropland is NOT immediately replaced by a fully grown forest nor does afforestation take place. It simply means that the model will simulate, after a decrease in cropland, forest-type (or grassland-type) vegetation slowly growing in place of crops, taking several ye and depending on climate conditions for growth and survival. The simulations we designed follow exactly the protocol used by the LUC community to estimate the legacy fluxes, loss of C-sink capacity and interaction with climate resulting from LUC, by using process-based models like ORCHIDEE-MICT (Houghton et al., 2012). This is common procedure for instance in the estimates of the Global Carbon Budget (LeQuéré et al. 2015), used in Bastos et al. (2016). Several factors cotribute to high uncertainty in LUC emission estimates (Pongratz et al., 2014), but

our approach and model used are among the state-of-the-art methods used by the co and are therefore, scientifically valid.

We address these issues in more detail in a point-by-point reply to the referee's comments in the PDF attached.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2017-267/bg-2017-267-AC2-supplement.pdf

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