Authors responses to referee #1

General comments

The paper fills a niche, as it sorts out uncertainties regarding (seasonal) effects of past global land cover change on evapotranspiration. This is a major step forward compared to earlier approaches based on single models or data sets. I have some (minor) comments for clarification.

We thank referee 1 for the review. We will improve this study in a revised version of the manuscript, taking into account all minor comments for clarification. Please find below our response to each specific comment.

Specific comments

Given the different models and data sets involved, the text and the method is a bit hard to follow at places. I think it would be helpful to have an overview scheme (flowchart) that shows what LULCC patterns were used for what model (I understand that they differed among models?), and with what data sets these results were then combined (i.e. the ET and vegetation products listed in table 1). Also, it is not clear how the vegetation maps mentioned on p. 2055 (from 1870 and 1992) relate to those mentioned in section 2.2 - are those from 1992 the same?

We agree. The methodology involves a number of steps and diverse datasets, and needs an overview picture. A flowchart is being included in a revised version.

To compute empirical models of ET, we used present-day data-driven products, including the land-cover map derived from MODIS. We then used the set of different land-cover maps from each LSM model that participated in LUCID (each of the 6 LSMs use their own map) to force our empirical models and, with that, reconstruct the ensemble of ET climatologies for 1870 and 1992.

It is not clear to me whether (some of) the models used do compute feedbacks of LULCC to climate.

Fig. 4 suggests so, as pronounced changes occur also in regions where there was no major LULCC (northern Australia, parts of South America, southeastern USA)? If such feedbacks are considered, this seems to be a significant progress compared to earlier studies cited (e.g. Gordon et al.) and should be high-lighted, providing a bit more detail on the (coupled) models used. If not, its omission should be discussed.

The results shown in Fig. 4 are not from coupled model simulations but from empirical models of ET. This will be clarified with the flowchart added to the revised manuscript. This figure shows the average reconstructed ET change based on empirical models. As mentioned in Section 2 and recalled in discussion/conclusions, feedbacks involving changes in one of the drivers used (downward radiation, precipitation, SWE) are not accounted for in these reconstructions, because we used the same forcing (the mentioned drivers) for both the preindustrial and the present-day estimates. Feedbacks associated to other variables (such as temperature or vapor pressure deficit) should be implicitly included (not evaluated) through the ET heterogeneity in space and time that is deduced from the various products adopted.

Any chance to say something about individual ET components (transpiration, evaporation, interception)? Certainly to be left for future studies, but worth mentioning; see. e.g. a paper by Murray et al. on global interception trends, in Ecohydrology 2014. There are also other papers on LULCC effects on global ET, such as by Rost et al. Adv. Geosci., 18, 43-50, 2008l.

This is an interesting question. To look at individual ET components would be an interesting task that we have not addressed. Our models are based on net ET data, without sub-components details. Process-based or semi-empirical models of ET that separate components of ET (such as GLEAM) are probably more appropriate tools to look further into that question (as in the Rost et al. paper).

Page 2056: What LULCC data underlie the JSBACH and TESSEL models?

The LUCID modellers used the same agricultural data (crop and pasture maps) of 1870 and 1992, but used different methods to include this information in their own LSMs for obtaining a vegetation distribution map. This means that each LUCID modeler has made (reasonable but arbitrary) decisions about which “natural land” has been suppressed to fit in the observed crop and pasture maps. Thus, each LUCID LSM has a different fractional vegetation distribution map. This is explained shortly in section 2.4 and will be further clarified in the revised manuscript.

We mention the range of global forest area loss between 1870 and 1992 that resulted from the different vegetation maps used by each LUCID model (because forest area loss was not used as a constraint to create LUCID vegetation maps) to highlight the large differences of vegetation distribution changes among the LUCID models, which are also reflected by our ET reconstructions. In the particular case of JSBACH, croplands and pastures were allocated over (natural) grasslands principally, resulting into low changes in forest area from 1870 to 1992. An opposite decision (allocation of cropland and pasture over forest mainly) was used in the case of TESSEL.

Gordon et al. paper: sometimes it is said they don't include vegetation, sometimes it is said otherwise, please clarify. And is it really a data-based study (global ET data aren't available)?

We did not say that the Gordon et al. did not include vegetation, and we will clarify this point in the revised manuscript. The Gordon et al. study attempted to estimate changes in ET induced by past LULCC, and quantify the components of these changes associated with land-cover alteration (mainly deforestation) and with the increase of irrigation.

The Gordon et al. estimate is not based on direct ET observations, but uses a semi-empirical model of ET driven by observational data of climate (temperature and precip.). "Data-driven" is then used in our study in a wider sense, given that the products of ET used as basal information were themselves obtained indirectly (a caveat regarding this is mentioned at the end of section 6). However, these products are likely the best available global information of ET.

Page 2060, "Considering irrigation...": How do you conclude that with irrigation your estimate would be between 400 and 3500 km3? The irrigation issue needs to be sorted out more properly. Maybe there are some more studies worth a citation, which looked at global (macro-scale) irrigation effects on ET.

We meant there that the cited publications show a large range of ET change when considering the effects of irrigation, going from -400 km3/yr in the case of Gordon et al., to -3500 km3/yr in the case of Sterling et al. We mean that our estimate in which irrigation is partially accounted for was in-between those two values. We will reformulate this sentence.

The paper would benefit from a small paragraph trying to explain why ET increases/decreases due to LULCC (i.e. what are the likely processes - pointing to the need for studying these in more detail in future publications).

We agree and the requested paragraph will be added.

Technical comments

There are a few typos.

Table 1: place the variables used in an extra column.

This will be done

Fig. 1b: Mention in the legend what red and blue mean. The paper uses some non-conventional methods/statistics so any supporting explanation of the figures is helpful.

We will improve the figure legends and captions.