Interesting simulations, but what about the real world?

The Abstract severely overestimates the uncertainty in estimates of the change in land carbon storage between the last glacial maximum (LGM) and pre-industrial time. The impression is given that the biogeochemical consequences of land-ocean transfer are small, and even of unknown sign. Hence the last sentence of the Abstract, which implies (unjustifiably in my view) that land biogeochemical feedbacks can be neglected on these time scales.

The problem arises as soon as the range of modelled values for the LGM – PI difference in land carbon storage is given as –440 to +37 PgC. In fact, only the value of –440 PgC is defensible. The other three values calculated assume either that there was no vegetation on the exposed continental shelves, and/or that pre-existing vegetation and soil carbon was not transferred to the ocean but somehow remained *in situ*. The main text makes clear that the authors do not, in fact, consider these as likely alternatives; so they should not be given equal weight.

The problem is compounded by a superficial treatment of the literature on observationally based estimates of this difference. The current text gives equal credibility to attempts made two decades ago to estimate carbon storage "bottom-up", either via manual interpolation of sparse pollen records (e.g. Adams & Faure 1998, Crowley 1995) or based on climate and biome model simulations (e.g. Prentice et al. 1993) A review of this topic (Prentice & Harrison 2009) noted the unreliability of all of these methods, which (a) assume a constant carbon density per biome and (b) disregard the effect of CO_2 concentration on plant productivity and, therefore, carbon storage.

Ciais et al. (2012 – nb, this should be 2011) is cited for the large range of previously published values that is summarized there. But Ciais et al. more importantly provided the most comprehensive analysis of benthic $\delta^{13}C$ data to date, and a complete isotopic mass balance calculation, arriving at a best estimate of –330 PgC. Ciais et al. also attributed the discrepancy between this observationally based estimate and several larger, model-based estimates to the counterbalancing effect of a large inert carbon pool (putatively stored in permafrost) at the LGM. This idea is further supported by the recent work of Crichton et al. (2016) showing that the $\delta^{13}C$ record of atmospheric CO_2 over the deglaciation can be well explained by a substantial permafrost carbon contribution to the deglacial CO_2 rise.

The authors give too little information about the land biosphere model that they used. In particular, no information is given about the formulation of the CO_2 effect on primary production. This effect is critical given the large variations in atmospheric CO_2 that occurred during the period studied. The plant functional type maps show unrealistically extensive tropical forests at the LGM (in comparison to pollen data, see e.g. Prentice et al. 2011; and offshore *n*-alkane $\delta^{13}C$ measurements, see e.g. Bragg et al. 2013). This suggests that the model underestimates the effect of low CO_2 on global biome distribution and also may mean that the strength of the biogeophysical feedback – a key point of the paper – has been underestimated.

A minor point concerns the East Siberian ice sheet. According to the cited reference, and most other recent treatments, there was no such ice sheet during the last glacial period.

Finally, although the paper makes much of the limited contribution of changes in terrestrial carbon storage to the long term course of atmospheric CO_2 concentration in part due to compensating oceanic mechanisms, this is not a new finding. For example, the analysis by Joos et al. (2004) – of which Paul Valdes was a co-author – accounts for the $CaCO_3$ compensation mechanism and indicates a more than six-fold "dampening" of the effect of terrestrial carbon storage changes on atmospheric CO_2 over multimillennial time scales.

New references:

Bragg, F., I.C. Prentice, S.P. Harrison, G. Eglinton, P.N. Foster, F. Rommerskirchen and J. Rullkötter (2013) Stable isotope and modelling evidence for CO_2 as a driver of glacial-interglacial vegetation shifts in southern Africa. *Biogeosciences* **10**: 2001-2010.

Crichton, K.A., N. Bouttes, D.M. Roche, J. Chapellaz and G. Krinner (2016) Permafrost carbon as a missing link to explain CO_2 changes during the last deglaciation. *Nature Geoscience* **9**: 683-686.

Joos, F., S. Gerber, I.C. Prentice, B. L. Otto-Bliesner and P.J. Valdes (2004) Transient simulations of Holocene atmospheric carbon dioxide and terrestrial carbon since the Last Glacial Maximum. *Global Biogeochemical Cycles* **18**: GB2002.

Prentice, I.C. and S.P. Harrison (2009) Ecosystem effects of CO_2 concentration: evidence from past climates. *Climate of the Past* **5**: 297-307.

Prentice, I.C., S.P. Harrison and P.J. Bartlein (2011) Global vegetation and terrestrial carbon cycle changes after the last ice age. *New Phytologist* **189**: 988-998.