Clim. Past Discuss., 11, C1088–C1091, 2015
www.clim-past-discuss.net/11/C1088/2015/

Climate of the Past Discussions
Open Access

Interactive comment on "Stability of the vegetation–atmosphere system in the early Eocene climate" *by* U. Port and M. Claussen

Anonymous Referee #1

Received and published: 16 July 2015

Review of Port and Claussen: Stability of the vegetation–atmosphere system in the early Eocene climate.

I have been asked to offer a review of this manuscript from a geological data perspective. I shall therefore not offer many comments on the technicalities of climate and vegetation modelling, but may offer some suggestions on boundary conditions. The present manuscript seeks to explore the role of boundary condition vegetation cover on the climate of the Early Eocene: one experiment with global deserts and a second with global forests. Ultimately the study concludes that the vegetation is of secondary importance to the palaeogeography, but that different vegetation boundary conditions can lead to multiple climate states. Overall this is a pure modelling paper; geological time is used as a narrative for a series of sensitivity experiments, but geological

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

data is not utilised in any meaningful way and in one instance (grasslands in the Early Eocene) is actually ignored. Personally, as a non-modeller I was left with a sense of not seeing the purpose of the paper. It is well understood that vegetation influences climate through albedo and the hydrological cycle and that changing idealised vegetation boundary conditions can influence the model outcomes (e.g. Dutton and Barron, 1997; Notaro and Lui, 2008; Notaro et al., 2008; Knorr et al., 2011). Where the Early Eocene becomes interesting for these kinds of studies is the role that a variety of global forests can have on climate and how forest can be sustained at the high-latitudes through polar winters. This brings me to the main point of my review: at the moment this paper is palaeoclimate modelling for the sake of palaeoclimate modelling. No attempt is made to relate model findings to the reality of geological, palaeontological or geochemical data and for these reasons and the two I have elaborated on below I have reached a recommendation that the paper (and potentially the experiments) need major revisions. I will give two examples where for me the paper has fallen short in relating model results to the reality of Early Eocene data:

1) Central Asian desert: The paper concludes that "a desert in central Asia is much larger in simulations initialised with bare continents". Is there any evidence for an Early Eocene desert in Central Asia? This is an interesting point that has a mixed message in the published literature. Palaeobotanical data indicates a region of mixed forests with sclerophyllous elements (Collinson and Hooker, 2003), Wang et al. (2010) report on a flora with a minimum mean annual precipitation of 654 mm, pollen sequences from central and north-western China point to a subtropical arid vegetation that included trees (Wang et al., 1990; Utescher and Mosbrugger, 2007) and climate reconstructions from central China show mean annual precipitation of over 1000 mm for the Early Eocene (Quan et al., 2012a). What the current version of the manuscript lacks is any discussion on either previous modelling studies of the Eocene, modelling of the Asian monsoon in the Eocene (something that has been claimed did not begin until the Early Miocene: Sun and Wang (2005), though see Quan et al. (2012b) for a Late Eocene origin) or proxy evidence for any of the model results (I have focussed on China, but

CPD
11, C1088–C1091, 2015

much is available for North America as well).

2) Eocene grass: Even though it is rightly stated that grass in the Eocene was rare, and almost certainly restricted to the understory of forest environments (Bouchenak-Khelladi et al., 2010), the author's claim that grass behaves like shrubs and ferns in their vegetation model. My understanding of vegetation modelling is that grass and shrub PFTs have very different fire dynamic properties, which in the JSBACH model used, influence the mortality rate of PFTs (Brovkin et al., 2009). Furthermore, there is no justification provided for the use of C4 grasses, which did not evolve until the Late Oligocene and did not become widespread until the latest Miocene or Early Pliocene (Christin et al., 2009; Osbourne and Sack, 2012). Instead the justification is that the study intends to focus on the biogeophysical processes, but without making the vegetation scheme at least meaningfully Eocene the competitiveness built into the JSBACH model will only allow for the experiments to test the difference between the modern and the Eocene geographys.

Finally, The paper needs a thorough proof read to ensure that there are no spelling or grammatical errors and the real ages for the Early Eocene should be used, not the "about 54 to 52 Ma" currently provided.

References Bouchenak-Khelladi, Y., Verboom, G.A., Savolainen, V., Hodkinson, T.R., 2010. Biogeography of the grasses (Poaceae): a phylogenetic approach to reveal evolutionary history in geographical space and geological time. Botanical Journal of the Linnean Society 162, 543-557. Brovkin, V., Raddatz, T., Reick, C.H., Claussen, M., Gayler, V., 2009. Global biogeophysical interactions between forest and climate. Geophysical Research Letters 36, L07405: doi:10.1029/2009GL037543. Christin, P.-A., Salamin, N., Kellog, E.A., Vicentini, A., Besnard, G., 2009. Integrating phylogeny into studies of C4 variation in the grasses. Plant Physiology 149, 82-87. Collinson, M., Hooker, J.J., 2003. Paleogene vegetation of Eurasia: framework for mammalian faunas. Deinsea 10, 41-83. Dutton, J.F., Barron, E.J., 1997. Miocene to present vegetation changes: A possible piece of the Cenozoic cooling puzzle. Geology 25, 39-41.

Knorr, G., Butzin, M., Micheels, A., Lohmann, G., 2011. A warm Miocene climate at low atmospheric CO2 levels. Geophysical Research Letters 38, L20701. Notaro, M., Liu, Z.Y., 2008. Statistical and dynamical assessment of vegetation feedbacks on climate over the boreal forest. Climate Dynamics 31, 691-712. Notaro, M., Wang, Y., Liu, Z., Gallimore, R., Levis, S., 2008. Combined statistical and dynamical assessment of simulated vegetation-rainfall during the mid-Holocene. Global Change Biology 14, 347-368. Osborne, C.P., Sack, L., 2012. Evolution of C4 plants: a new hypothesis for an interaction of CO2 and water relations mediated by plant hydraulics. Philosophical Transactions of the Royal Society B: Biological Sciences 367, 583-600. Quan, C., Liu, Y.-S., Utescher, T., 2012a. Paleogene temperature gradient, seasonal variation and climate evolution of northeast China. Palaeogeography, Palaeoclimatology, Palaeoecology 313–314, 150-161. Quan, C., Liu, Y.-S., Utescher, T., 2012b. Eocene monsoon prevalence over China: A paleobotanical perspective. Palaeogeography, Palaeoclimatology, Palaeoecology 365–366, 302-311. Sun, X., Wang, P., 2005. How old is the Asian monsoon system?–Palaeobotanical records from China. Palaeogeography, Palaeoclimatology, Palaeoecology 222, 181-222. Utescher, T., Mosbrugger, V., 2007. Eocene vegetation patterns reconstructed from plant diversity - A global perspective. Palaeogeography, Palaeoclimatology, Palaeoecology 247, 243-271. Wang, D., Sun, X., Zhao, Y., 1990. Late Cretaceous to Tertiary palynofloras in Xinjiang and Qinghai, China. Review of Palaeobotany and Palynology 65, 95-104. Wang, Q., Ferguson, D.K., Feng, G.-P., Ablaev, A.G., Wang, Y.-F., Yang, J., Li, Y.-L., Li, C.-S., 2010. Climatic change during the Palaeocene to Eocene based on fossil plants from Fushun, China. Palaeogeography, Palaeoclimatology, Palaeoecology 295, 323-331.

Interactive comment on Clim. Past Discuss., 11, 1551, 2015.