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Climate of the Past Discussions

Interactive comment on "Exploring the climatic impact of the continental vegetation on the Mezosoic atmospheric CO_2 and climate history" *by* Y. Donnadieu et al.

Anonymous Referee #1

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General comments

Over the past few years Donnadieu and his co-workers have been successfully simulating Mesozoic climate evolution, constantly adding to and improving their own models. The work presented here neatly tags on to a recent publication by Godderis et al. (2008; EPSL), in which the authors modeled the effects of changing Triassic-Jurassic palaeocontinental configurations on carbon dioxide consumption through silicate weathering. In that study the authors used a version of the GEOCLIM model that did not take into account the effects of changes in vegetation through time, but instead assumed a global cover of deciduous forests. In the present study, the authors

acknowledge the significance of vegetation in driving increased chemical weathering, and influencing the global water cycle (run-off), albedo, and roughness (a measure for the influence of vegetation on wind circulation). In order to improve their own model results they have now coupled the GEOCLIM model to a dynamic vegetation model (LPJ) that allows to simulate coeval vegetation changes. Perhaps not surprisingly, the model output is significantly different from the previous results, even though long-term trends in CO2 and annual mean temperatures remain unaltered.

The new modeling exercise brings to light the strong effects of large non-vegetated areas (deserts) during the arid Triassic that have a high albedo and low run-off rates. This results in relatively high atmospheric CO2 concentrations during the Triassic, and rapidly decreasing pCO2 during the latest Triassic and remainder of the Mesozoic. The authors attribute the long-term decrease in CO2 to the smaller area of barren surfaces due to the break-up of Pangaea and sea level rise, increasing silicate weathering, run-off and carbon burial. Furthermore, overall pCO2 is much higher than in previous model runs that did not include the effects of vegetation.

This study presents valuable information for modelers and non-modelers alike and a set of conclusions that can be used to further improve carbon cycle and palaeoclimate models in the future. I recommend to publish it with very minor corrections. Having said that, it should not be forgotten that the approach taken by Donnadieu and coworkers is purely a modeling exercise. As they themselves point out, their pCO2 reconstructions that take into account palaeocontinental configurations and vegetation differ significantly from proxy-based reconstructions obtained from plant stomata and soil carbonates. To reconcile models with direct observations remains a challenge, but also means that there is more work to be done. The authors indicate that they will next introduce a model for different soil types. Other important modifications could include considering the effects of extensive wetlands, as this type of ecosystem may have been very prevalent during some of the wetter intervals of the Mesozoic.

Technical comments:

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Page 1023, line 7: order is reversed here. Should read: where run-off and T are continental run-off and the mean annual temperature, respectively.

Page 1024, line 4-5: You are really describing multiple effects, not just a second effect. Rephrase.

Page 1026, line 19: Please define more clearly a python program?

Page 1027, line 2: Spell out PFTs.

Page 1027, line 7: You probably want to add here: Pteridophytes (ferns and fern allies) to be more accurate. In addition to the typical ground ferns that you are referring to, there were a host of other related plants growing in the Mesozoic understorey of tropical rain forests and on open plains, including mosses, tree ferns, horsetails, and seed ferns.

Page 1027, line 15: Undertaken not undergone.

Page 1030-31, line 1: This is very colloquial use of english. Maybe rephrase?

Interactive comment on Clim. Past Discuss., 4, 1021, 2008.