Clim. Past Discuss., 7, C2156–C2159, 2012
www.clim-past-discuss.net/7/C2156/2012/

Climate of the Past Discussions

Interactive comment on "Vegetation-climate interactions in the warm mid-Cretaceous" *by* J. Zhou et al.

J. Zhou et al.

zotsing@umich.edu

Received and published: 3 January 2012

1) The authors could give an indication of the spatial resolution of the AOGCM in km, particularly for the ocean (i.e. at the equator). Does the relatively low spatial resolution present any problems when it comes to representing the oceanic connectivity of the Arctic and therefore the meridional heat transport into this region?

Ans: The resolution for ocean is nominal 3°. For modern simulation, the grid density around the Arctic area is increased by 1) displacing geographic northern pole to 75 °N, 40 °W in the Greenland, which allows more meridians in the ocean areas surrounding Iceland and Greenland; and 2) doubling grid density in the Labrador Sea and quadrupling grid density in the Denmark Strait. This treatment helps to represent more realistic Arctic oceanic connections without increasing grid cells. The actual modern ocean grid size is ~400 km in x direction around the equator and ~48-70 km in x direction at ~70°N. For our mid-Cretaceous simulations, the North Pole is displaced to the northeastern Siberia (~75 °N, 120 °E). The actual mid-Cretaceous ocean grid size is ~400 km in x direction around the equator and ~95-158 km in x direction at ~70°N. This treatment allows effective interbasin exchange.

2) The authors could briefly give some references regarding the performance of the model against the pre-industrial/modern climate. Are there any model deficiencies that would potentially affect this study? i.e. how well is the modern MOC modelled at this spatial resolution?

Ans: The present-day ocean circulation with this low resolution is in agreement with observational data. For example, the simulated intensity of North Atlantic meridional overturning circulation is 15.3 Sv (Bryan et al., 2006), comparable to present estimate in the North Atlantic (15 ±2 Sv) (Ganachaud and Wunsch, 2000). Model results with this low resolution are comparable to high resolution CCSM3 results (Yeager et al., 2006), and have been widely used in paleoclimate studies (e.g. Kiehl and Shields, 2005; Winguth et al., 2010).

3) The authors could expand on the term physiological CO2 concentration (p2807,L24). In setting this to 355 ppmv would this potentially overestimate canopy evapotranspiration fluxes to the atmosphere under higher atmospheric CO2 values? Would this physiological forcing have an impact on the surface climatology?

Ans: As plant transpiration decreases under enhanced pCO2, our usage of 355 ppmv physiological CO2 probably overestimates canopy transpiration. As a result, our model may overestimates vegetation cooling at low latitudes and underestimates vegetation warming at high latitudes. Unfortunately, tree PFTs collapse in our model with 2800/4480 ppmv pCO2, indicating that the physiological parameterization in DGVM may be unable to work appropriately under extremely high pCO2. Without any quantitatively understanding of CO2 physiological effects during mid-Cretaceous, we chose to use the model value.

4) Clarify some of the units and terminology used to describe the equilibrium state of the experiments. i.e. the linear trend for global vegetation cover is on the order of 10-3/century could this be described better?

Ans: The changes of global vegetation fractional coverage is negligible (~0.1%/100yr).

5) As the authors are aware, a problem that persists with the modelling of warm greenhouse climates are the continental interiors, (i.e. Siberian Interior). Models predict continental interiors similar to the present whereas geological climate proxies suggest more equable climates (reduced seasonality). Does realistic vegetation go some way to reconcile this mismatch? Figure 2 and 3 suggest not. Could this be commented upon.

Ans: Yes, our model results suggest that vegetation (mainly trees) has a modest warming effect on the continental interior (~2 °C) where vegetation could grow (Fig. 4b). In contrast, in the Siberian interior where tree PFTs are largely absent, the warming effect is insignificant. Vegetation does not promote a reduced seasonality at high latitudes. As shown in Fig. 5a, the most pronounced vegetation-induced warming occurs in the warm late spring-early summer rather than cold winter.

6) The proxy-model comparison of Figure 3 suggests potential problems in the low latitudes (at 10xDGVM) which would persist at lower CO2. The authors identify this proxy-model mismatch (p2810 L15), could they expand on why this mismatch exists?

Ans: As discussed in section 5, due to the lack of understanding of past ecosystems, paleo-vegetaion modeling relies on a modern understanding of PFTs and their bioclimatic, physiological, and dynamic relationships that may not be entirely appropriate for past times. The proxy-model mismatch at low latitudes may be largely associated with the evolution of angiosperms. Angiosperm-dominated tropical forests PFTs may not have appeared until the Paleocene. As a result, the inclusion of PFTs that represent modern angiosperm trees in our model may lead to the overestimation of tropical forests.

Interactive comment on Clim. Past Discuss., 7, 2803, 2011.

CPD

7, C2156–C2159, 2012

Interactive Comment