Clim. Past Discuss., 6, C1303–C1306, 2011
www.clim-past-discuss.net/6/C1303/2011/

Climate of the Past Discussions

Interactive comment on "The effect of a dynamic background albedo scheme on Sahel/Sahara precipitation during the mid-Holocene" *by* F. S. E. Vamborg et al.

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Received and published: 19 January 2011

Response to Anonymous Referee #1

We would like to thank the reviewer for his clear and concise comments on the paper and especially for pointing out that the model description needs to be more detailed.

- the albedo seems to be separated in two components: visible and near infrared, but these two spectral bands don't cover the whole solar spectra. Could the authors explain how these two spectral bands are composed (or used) to compute the solar albedo (integrated on the solar spectrum), value which is needed for the energy budget modelisation.

We agree that this part needs some clarification. The total range of incoming solar radiation used in the radiation scheme is 0.25-4.0 μm (Roeckner et al., 2003). This range is split into six bands, three for the UV/VIS and three for the NIR-range (where the label NIR is assigned to all infrared wavelengths below thermal IR). The albedo values are used accordingly (α_{vis} for the three UV/VIS bands and α_{nir} for the three NIR bands.) We have added this explanation to the text of the article. We also want to add a comment here on why we distinguish between VIS and NIR albedo values in JSBACH. Components of the land-surface often have clearly distinct reflectances in the visible and the near-infrared. For instance, living vegetation is much more reflective in the NIR than in the VIS (e.g. Asner, 1998). The opposite case is snow, which can be extremely reflective in the VIS, but has much lower values in the NIR range (e.g. Grenfell et al., 1994). In order to capture the dynamics of the over-all albedo on land, one thus needs to make the distinction between these two spectral bands.

-the modelisation of the soil albedo function of the organic matter could have been more detailed: How equation 5 has been fitted ? how the parameters a and Clim have been defined ? one should give some references to justify the chosen values of these two parameters.

It is a widely used method to use spectral reflectance measurements in the VIS and NIR to estimate soil organic carbon content (SOC) or soil organic matter (SOM) (Ladoni et al., 2010). One of the methods most commonly used is to assume a linear relationship between SOM and reflectance, where reflectance is negatively correlated with the SOM. The main drawback of this method is that this relationship varies spatially, mainly due to different parent materials of the soil (Henderson et al., 1992). We therefore chose to represent the reflectance of these different parent materials with α_{ROCK}. The estimated maximum change in albedo due to SOM ($a \cdot C_{\text{lim}}$, in Eqn.5) lies between 0.1-0.3 in both the VIS and the NIR ranges (e.g. Stoner and Baumgardner, 1981; Curran, 1985; Bartholomeus et al., 2008). We chose the conservative estimate 0.15, since the larger estimates that we found, tend to stem from samples not only of different SOC but also different types of soils (e.g. Bartholomeus et al., 2008). Adding SOC to the soil only clearly affects the reflectivity to a certain saturation point (Curran, 1985), which is why we introduced C_{lim}. This limit is at around 5% SOM in the top soil (Curran, 1985). The proxy we use for SOM is the amount of carbon in the slow soil pool, output in kg(C)/m^2 and representing the whole upper soil column. These values are thus not directly comparable to the estimates for the saturation limit. To determine the limit we chose a value, which on the one hand corresponds to the transition from low to medium amounts of SOC in the top soil of tropical Africa (FAO, 2007). On the other hand a value that gives reasonable estimates for α_{ROCK}, i.e. that e.g. desert borders should not be as clearly seen in the α_{ROCK} maps, as they are in the α_{bg} maps. With $C_{\text{lim}} = 500$, this assumption is met very well in the VIS and quite well in the NIR. We also noticed that the units of a and C_{lim} had been mixed-up in the original manuscript, this has now been rectified.

-the specific LAI (SLAi) is not defined - the modelisation of the albedo of the litter is not clear (Eq 6)
Some confusion has probably arisen here because of a typo in the text. SLA means specific leaf area (not specific leaf area index) and it is a measure of leaf area per unit mass (in this case per mol(C)). This is an input parameter in JSBACH, which is pft-specific and it is used to calculate leaf area index (LAI) values for the green leaves of each pft. The LAI is obtained by multiplying the SLA with the carbon-mass of green leaves. However, here we want to know the LAI-equivalent of litter. We therefore derive a "litter"-LAI, by multiplying the SLA with the carbon-mass of litter. We have reordered the section and added some further sentences to clarify this approach.

- Figure 6 is too small and should be clarified We have split Fig.6 into two sep-

arate figures in order to increase the size of the individual plots. We have also extended the text in the label to increase clarity.

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