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Interactive comment on "Background albedo dynamics improve simulated precipitation variability in the Sahel region" *by* F. S. E. Vamborg et al.

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1 Summary

The manuscript presents a sensitivity study of the simulated evolution of Sahelian rainfall, to different schemes for the land surface in the model ECHAM5-JSBACH. More specifically, three schemes are compared: fixed vegetation and fixed background albedo (but active phenology), interactive vegetation and fixed background albedo and, finally, dynamic vegetation and background albedo. The experiment design consists, for each scheme, of three simulations covering the last century, forced by the same

reconstruction of sea-surface temperature over that period, but starting from different initial conditions.

The analysis focuses on rainfall variability and persistence, with special emphasis on the decadal positive and negative anomalies in rainfall that characterised the periods 1930-1970 and 1970-2000, respectively. Noteworthy, the authors also compare the model output with rainfall reconstructions based on observations, and albedo changes with satellite-based estimates. The main conclusion of the article is that the parameterisation of background albedo on soil carbon, combined with the direct amplifying action of vegetation dynamics, is essential to introduce the precipitation persistence and induce the succession of wet and dry periods observed in the Sahel. This is achieved even though the actual standard variations in albedo are rather low. It should be noted that this sensitivity study discards the direct anthropogenic influence on vegetation dynamics. The authors also acknowledge some limitations in the background albedo scheme for this particular application, as they note (a) that "the background albedo scheme was originally designed to capture slow albedo variations on centennial- to millenial (sic) time scales" and (b) the direct effect of soil moisture on albedo is not accounted for.

2 General appreciation

A robust analysis of decadal variability in climate models is always a challenge. On the one hand the experiment design should lead us to robust statistics, on the other hand one wants experiments that are sufficiently realistic to allow for verification against observations. From this prospective, the experiment design adopted here is a reasonable compromise, although it readily appears from Figure 2 (and the text discussion) that statistics will be poor. In particular, the authors have noted that the correlation coefficient is not here a reliable enough metric for selecting the best parameterisa-

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tion scheme. Hence, they focused on persistence which, from visual inspection of the time series, indeed makes sense. However, the existence or not of a pause in the wet anomaly around 1945 probably largely conditions the autocorrelation and power spectra.

Perhaps the most surprising result is the large difference in the standard deviation of albedo anomalies in $VEG_{DYN} + BG_{STAT}$(0.004) with respect to $VEG_{DYN} + BG_{DYN}$(0.0014). The difference is not, to me at least, visually obvious on Figure 8 although, admittedly, high amplitude events may largely affect standard deviation statistics. Yet, $VEG_{DYN} + BG_{DYN}$forms the family of experiments with the largest rainfall interdecadal variability. The authors have identified the paradox but the explanation could be more specific and better phrased: "the response of the precipitation to albedo changes is related to the annual variability of albedo rather than the mean albedo of either period" (p. 610) and "we find that it is not necessarily the largest mean change in albedo between the periods that is of importance, but rather the actual variations in the albedo". The crux of the story is frustratingly hidden behind the words 'actual variations' or 'annual variability' without really making clear what is happening.

Physically it is pretty obvious that slow changes in soil carbon content will act as a low-pass filter to changes in albedo. Given that SST are given (and hence can't react to changes in atmosphere dynamics), one would expect in a linear world the interdecadal changes in albedo should translate proportionnally into interdecadal changes in precipitation. It is not the case here, so some non-linear mechanism must be at work. For example, it is conceivable that the precipitation response to albedo changes depend itself on the SST. I believe it must be possible to dig this affair a bit further deep for the present article.

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3 Model specification

Although all parameters are presumably given in Brovkin et al. 2009 and Vamborg et al. 2011, a parameter table would improve the self-consistency of the present article.

4 Other minor comments

I must confess difficulties in following the argument p. 612 ll. 15–20. It is said that the present vegetation scheme uses a maximum vegetation time scale of 50 yr, whereas Eltahir and Wang use the productivity of the year before. I would therefore expect the latter to have more short-term dynamics but it does not seem that this is what is being implied here.

The reference to Crucifix (2005) in the 'comparison with other studies' may be quoted here a bit out of context. That article was an attempt to identify vegetation effects on precipitation persistence. One introductory sentence of that article was "A persistence of vegetation patterns from one year to the next is a prerequisite to explain persistent droughts or wet spells by vegetation dynamics.". The quote of the present article implies a different meaning: "the interannual memory of vegetation (...) is a prerequisite to find an amplification of rainfall". Why not rather cite the Crucifix article in the introduction, as it seems relevant?

5 Misprints

- p. 603 l. 12 : 'und' -> 'and' - at several locations: detangle -> disentangle - millenial -> millennial

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