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Interactive comment on "Plant functional diversity affects climate–vegetation interaction" *by* Vivienne P. Groner et al.

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We thank the Anonymous Referee #1 for the insightful comments. In the following we will provide a detailed response.

"The manuscript submitted by Groner et al to "Climate of the Past" discusses the influence of variations in plant functional types on climate at the end of the Holocene. The article is nicely written. However, it is based on assumptions that should be more fully argued or explained."

In order to consider this comment, we have to check back here if the Referee actually refers to Groner et al. (2015) published in Climate of the Past, or if the first part of the comment concerns the present manuscript, submitted to Biogeosciences. For now we

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assume that it is referred to the present manuscript.

"It has been shown for many years (actually, since the palaeogeographic map drawn up by N. Petit Maire et al., UNESCO-IGCP 252, 1993 and more recently through the reconstructions performed by e.g. Hély and Lézine, 2014) that plant cover in the Sahara during the Holocene was primarily not homogeneous with co-occurrence of plants that are today found in distinct phytogeographical areas. Desert plants are typically found in the Sahara today. These plants co-occurred during the late Holocene with tropical trees probably in restricted areas such as river or lake banks. Actually, pollen data show that tropical trees were present but we are unable to infer any evaluation of their coverage in the landscape from pollen data. In other words, palynologists show that the Holocene increased rainfall led to a dramatic increase in biodiversity. There has been no replacement of one biome by another but rather an interpenetration of plants taxa that are found today in distinct biomes. Moreover, the vegetation cover had a mosaic-like character and was certainly discontinuous."

We fully agree with this summary of the vegetation distribution during the African Humid Period. We based our study mainly on Hély et al. (2014) and their description of a highly diverse mosaic-like vegetation cover during the African Humid Period, see page 1 line 18. We agree that special features such as gallery forests must be described in more detail and we gladly introduce an additional descriptive paragraph to the introduction.

"An quantified evaluation of the vegetation cover would certainly be possible by applying the algorithms developed by Sugita and colleagues (2007) in West Africa."

As mentioned at the end of the introduction (page 2, line 29-31), "With our idealized set up, we do not expect our simulations to match reconstructions, rather we focus on qualitative differences between simulations to find mechanisms relevant for the ques-

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tion how PFT diversity affects climate–vegetation interaction."

"The importance of the coverage of one biome with respect to another one seems to me an important parameter to take into account, particularly if tropical trees were mostly restricted to the edges of streams and lakes. One of the major characteristics of plant distributions in dry areas is the presence of gallery forests along rivers or open water surfaces. These gallery forests can host tropical trees far from the climatic zone they originate from. In this case, trees are not in equilibrium with climate and survive under drier conditions only thanks to available ground waters. Actually we do not know since when the water available in the soil is no longer able to compensate for the lack of precipitation."

As mentioned above, we agree that gallery forests should be mentioned in the introduction as they are a crucial part of the study. EXP_{TD10} with the additional frost-tolerant tropical tree PFT aims at representing gallery forests as far as possible in JSBACH, not spatially but conceptually. We understand that further description is necessary here and we gladly adjust the manuscript to make the intention behind this experiment more clear.

"In this context, could you please precise what are the 21 PFTs used in your study, based on the plant types identifyed in pollen studies carried out in the Sahara and Sahel and how do you evaluate the coverage and distribution of each of them for the time periods you have selected."

JSBACH provides in general 21 PFTs based on the most common land cover types, but we used only 8 PFTs in this study which are summarized in Tab. 1. The cover fraction of each PFT is calculated by the model as a result of climatic conditions and competition as described in the manuscript Section 2.1.

"Additional comments: (1) Temperature of the coldest month: To my knowledge, tropical climates are characterized by relatively constant (hot) temperature throughout the year and a large diurnal amplitude. One of the most important

factors for plant distributions is rainfall and the length of the dry season, not temperature (at least in the lowlands). This, of course, in the case of a "climatic" and not an azonal distribution as is the case of forest galleries"

We agree on that, however during the mid-Holocene winter temperatures were cooler in North Africa than today, and our model simulated temperatures below the bioclimatic threshold, thus tropical trees could not establish in the experiments. With the experiment EXP_{TD10} we introduced the aspect of favorable microclimatic conditions especially in gallery forests.

"(2) C3/C4 grasses: roughly 30% of the Poaceae growing in the Sahara today are C3, particularly those growing in wet places and in the highlands (Maire Monod, 1950; Quézel, 1965; Maire, 1952; Quézel Santa, 1962; Quézel, 1954; Gillet, 1968....)"

The vegetation distribution presented in this study is a result of model simulations. We observe the occurrence of C3 grasses especially in the Mediterranean and in highlands, however under the given boundary conditions, C4 grasses are in our model more productive than C3 and thus the dominant grass PFT in most of the study domain.

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