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Interactive comment on "Hybrid insolation forcing of Pliocene monsoon dynamics in West Africa" *by* Rony R. Kuechler et al.

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Anonymous Referee #2

This is an excellent contribution to the understanding of monsoon dynamics in Africa, for the Pliocene time period, on which there is not much information and provides insights on climate dynamics in a warm world. Much of the value of the paper derives from its pretty unique time series of deuterium hydrogen isotopes in long chain n-alkanes derived from higher plant waxes. This is interpreted as a proxy for hydroclimate, and the justification for doing so is well addressed in the paper. To constrain further and strengthen the interpretations of their data, in my opinion the authors should take more into account the uncertainties surrounding the source regions

of the n-alkanes in their marine record. The authors do indicate that: "our records of the terrigenous fraction in marine sediments integrate huge catchment areas since large parts of the Saharan and the Sahel can be considered sources of the material of primarily eolian origin (Tiedemann et al., 1994; Vallé et al., 2014)." "predominance of eolian transport of plant waxes probably in the form of coatings on dust particles" " The low d13C31 variations are attributed to a relatively stable wind system (Tiedemann et al., 1994) and the integration of a large source area" In my opinion these are important issues that would need to be discussed in more detail in order to clarify, for instance if the biomarker signals are driven by changes in the wind system, source, and/or the modes of transport (e.g. particle sorting with distance, resuspension) of the particulate material rather than just climate at the source.

Response. Changes in the wind system affecting the biomarker signal can rather be excluded, based on the comparison with the Last Glacial Cycle (page 6, lines 1-4). Trade winds strengthened not before the beginning of the Pleistocene (Leroy & Dupont, 1994; Vallé et al., 2014) and thus would any influence of the trade winds have been negligible during the Pliocene. Furthermore, residence/transport times of plant waxes extracted from modern dust samples from offshore West Africa yielded a radiocarbon age of 650 $\pm$ 150 years (Eglinton et al., 2002). Since our records have a $\sim$4 kyr resolution, such potential contributions from pre-aged (or re-suspended) plant waxes have a negligible effect on our interpretations (page 7, lines 11-14).

I would also have provided a more extended discussion on the implications of the difference in magnitude of the isotopic signals interpreted in terms of hydroclimate changes between the late Pleistocene and the Pliocene. Few studies are capable of doing so with the pretty unique data set presented.

Response. We'll add the following sentence at the beginning of section 4.3: "In contrast to the stable carbon record, which show much less variability for the Pliocene than in the Last Glacial Cycle, the fluctuations in the Deuterium record are of the same amplitude indicating that large variations between arid and humid periods in West Africa occurred long before the intensification of Northern Hemisphere Glaciations." We else think that the general discussion on the isotopic signals is sufficient. For instance, the indication of more humid conditions during the Pliocene reflected in the plant-wax δ13C record is mentioned and explained (page 6, lines 1-7). Also with regard to differences in hydroclimate between the Pliocene and the Late Pleistocene, we stress the enhanced influence of the Northern Hemisphere Glaciation on the latitudinal insolation gradient (page 9, lines 4-9).

The frequency analysis seems quite noisy, and the relevant frequencies at given time intervals are often barely distinguishable from the noise. The discussion would have also benefited from a more detailed assessment of the significance of the frequency analysis in the different time intervals.

Response. The significance (against white noise) of the frequency analysis for each time interval is displayed in Figures 5 and 7 (p = 0.05) as is the cone of influence. We'll add a supplementary figure (SF 2) and a supplementary table, which illustrates the significance of the spectral peaks tested against red noise and, in addition, the little impact of the different age models (T94 versus T94R) on the spectral results.

As a response to the questions and comments Referee #1 also raised about our choice of age model we'll add the following short section in the Discussion:

"4.2 Choice of Age model.

We choose the age model based on stable oxygen isotopes advocated by Clemens (1999) over the original one of Tiedemann et al. (1994), since the former is independent from the dust record and produces a better fit with the global benthic δ18O stack (Lisiecki and Raymo, 2005), especially for the Zanclean. In general, both age models (dust and δ18O) contain the same orbital frequencies (supplementary information). However, the dust model assumes precession as the main forcing and accordingly, Pliocene dust peaks are tuned to insolation minima. In case of using the dust age model, the relationship of δD to insolation would be the same as for the dust to inso-

lation, which means a strong signal associated with precession. This also holds true for the alternative age model based on δ18O, but only for periods with large precession amplitudes, while obliquity has a stronger impact during times of low precession variability. Application of the dust age-model would also exaggerated the precession signal in the δD record, since both records (dust and δD) are well correlated. Moreover, tuning of the dust record would introduce some circular reasoning in our argument as the dust record partly depends on precipitation."

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Spectral analysis using REDFIT (Schulz & Mudelsee 2002) comparing the effect of different time-scales –the original dust tuned time-scale T94 in grey (Tiedemann et al. 1994) and the $\delta^{18}O_{benthics}$ based time-scale T94R in black (Clemens 1999)– on the frequency analysis of dust% (Tiedemann 1991) and δD_{31} (this study). The anaylsis is carried out in PAST (Hammer et al. 2001) using one segment and "false-alarm lines" based on parametric approximations (X^2-test). The Mid-Pliocene part runs from 3.62 to 3.00 Ma and the Early Pliocene part from 5.00 to 4.66 Ma.

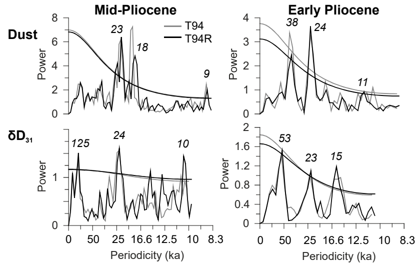

Fig. 1. SF2

Supplementary Table.

Significant power maxima in periodicity (reciprocal frequency) in ka of dust percentages (Tiedemann 1991) and δD_{31} (this study) on the original dust tuned time-scale T94 (Tiedemann et al. 1994) and the $\delta^{18}O_{benthics}$ tuned time-scale T94R (Clemens 1999) used in this study for two windows of the Pliocene: mid-Pliocene from 3.6 to 3.0 Ma and early Pliocene from 5.0 to 4.6 Ma. Significance is based on a X^2-test (Hammer et al. 2001). * significant at the 90% level; ** significant at the 95% level; significant at the 99% level.

Fig. 2. Supplementary Table Caption

period	record	age model	T94	age model	T94R
mid-Pliocene	dust%	25	*	24,4	**
		23	***	23	***
		18	***	18	***
		9	*	9	**
	δD_{31}	125	**	125	**
		25	**	24	**
		10	***	10	**
early Pliocene	dust%	40	**	38	**
		24	***	24	***
		18	*		
		11	**	11	**
	δD_{31}	55	*	53	**
		24	**	23	**
		15	***	16	***
				15	**

Fig. 3. Supplementary Table