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Interactive comment on "Dependence of the cyclization of branched tetraethers (CBT) on soil moisture in the Chinese Loess Plateau and the adjacent areas: implications for palaeorainfall reconstructions" *by* H. Wang et al.

Anonymous Referee #2

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In their manuscript, Wang et al determined the environmental controls on the CBT index, i.e. the degree of cyclisation of branched GDGTs, in arid soils from the Chinese Loess Plateau (CLP) and its near vicinity. The authors find that soil moisture is the most important factor controlling the CBT index in their sample set, and propose to use the CBT index as a proxy for paleoprecipitation. This is tested on three loess-paleosol sequences from the literature.

Given the current interest in (branched) GDGTs and their potential to provide new continental paleoclimate information based on their distributional changes in loess-paleosol

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sequences, I think that this paper may eventually be published in Biogeosciences after addressing the following issues:

Major issues - The finding that CBT in (semi-)arid soils is primarily driven by soil water content (SWC)/precipitation is different from earlier studies that report pH (Peterse et al., 2012 GCA; Menges et al., 2014 GBS) or temperature (Yang et al., 2014 GCA) as most important control. These differences need more discussion, and the relation with temperature is not even mentioned. Please elaborate. Furthermore, the conclusion that precipitation is the most important factor is mainly based on the fact that the correlation efficient of MAP and SWC with CBT is higher than that of temperature and CBT, but thorough statistical evidence is not given. Previous studies (Tierney et al., 2010 GCA; Peterse et al., 2012, GCA; Yang et al., 2014 GCA) have performed RDA and partial RDA to identify the individual contribution of each environmental parameter, but this is lacking here. Especially since MAP and temperature are intercorrelated in the used dataset, proper statistical support is needed to make such claims. Please also include soil pH in the RDA.

- The dataset is presented as containing 97 samples, which are collected from 33 sites (2-5 samples per site). This narrows down the range of environmental variability quite substantially. It should be highlighted what distinguishes the different samples collected at one site so that they each count separately. In addition, the recently published paper by Yang et al. (2014, GCA) contains a much larger soil dataset (from up to 130 samples locations, the largest part coming from the loess plateau), which is readily available as supplementary information, but not used in this manuscript. Especially when proposing a new proxy it is key to base (empirical) relations and transfer functions on the largest possible dataset, and that the data of Yang et al should be included in the analysis.

- Although the title already states that CBT depends on soil moisture and can thus be used as a paleoprecipitation proxy, the link between CBT and precipitation is not made in the introduction. Instead, the introduction is very general, and only states that the 'environmental controls on the CBT' would be tested, as well as the use of CBT as a

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quantitative proxy for 'a certain environmental parameter'. This is very vague, so please better specify the goal of deriving a paleoprecipitation proxy. To do so, the authors also need to clearly introduce what the general problem is with branched GDGTs in arid soils. And speaking about the underestimation of MBT-CBT-based temperatures for soil in arid regions, what happens with MBT in this sample set? Generally, MBT seems to be more problematic in arid regions than CBT (e.g. Menges et al., 2014 BGS).

- CBT as proxy for paleoprecipitation: The application bothers me somehow, as the CBT-based paleoprecipitation records presented in the manuscript are not any different from the CBT-based pH records presented in the cited papers except for in the numbers on the axes. The pH of a soil is linked to a.o. precipitation, and CBT-derived pH has so far always been interpreted as a measure of precipitation intensity. Changing the name of the axis does not change the trends, timing, or interpretation, and thus provides no new insights. The only argument in favor of CBT as direct paleoprecipitation proxy would be the quantitative aspect of it. Unfortunately, the authors refrained from validating their proxy by comparing their paleoprecipitation records to modern data. A comparison with the uppermost samples with the modern MAP reported in the papers of Peterse et al., 2011, 2014; Jia et al., 2013, and Gao et al 2012 indicates offsets between measured and reconstructed MAP that are larger that the reported calibration error of 50mm: Yuanbao reported MAP=500mm, reconstructed MAP=$\sim$720mm Lantian reported 670mm, reconstructed $\sim$800mm Mangshan reported 645mm, reconstructed $\sim$690mm I hope that these offsets will be decreased once the data of Yang et al are added to the calibration dataset, but this clearly needs more discussion.

Minor comments -Introduction: The authors mention so many proxies for monsoon precipitation intensity, that all seem to agree. Why would we need another proxy? What are the insecurities of all the mentioned proxies? What is the explanation that needs to be validated (p10017, line 19)?

- please change alkalescent to alkaline throughout the ms. All the soils in the dataset have pH>7.

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-Materials and methods: Mention the sampling time in this section. Were all samples taken within the same period with comparable weather conditions? SWC can vary quite substantially with changing weather conditions, especially in an area that is as much influenced by the monsoon as the CLP. Stable conditions are thus important for the reliability/meaning/interpretation of the relations for which SWC data are used. What is a relation with SWC telling you if it probably largely varies over an annual cycle? What is the reason that CBT is linked to SWC instead of MAP, especially if you propose to use CBT as a proxy for MAP rather that paleo-SWC? What would SWC explain that MAP cannot?

-P10018, lines 18-20: mention the r2 and RMSEs of the different calibrations.

-Section 3.1: The authors spend quite some space on explaining why they think branched GDGT-producers are not further introducing cyclopentane moieties to their structure after a certain pH threshold, and pH thus no longer drives the CBT index, but they do not provide a single explanation how precipitation possibly influences the degree of cyclisation. I think this needs more elaboration. Also discuss the option of a community change rather than membrane adaptation to explain the trends.

-P10022, line 13-18: I checked the CBT-pH plots in Sun et al., 2011 JGR and Schoon et al., 2013 OG, but I do not see the flattening-off at high pH in these figures. Also, since the GDGTs have seemingly different producers in lakes and soils I am not sure if it is fair to directly compare their behavior.

- p10023, lines 14-17: to what extend could the difference in range between pH (7.5-9 -> small) and MAP (∼100-∼700 -> large) explain the difference in correlation with CBT?

- section 3.3: explain how exactly the MS record supports CBT as paleoprecipitation proxy. I can see clear differences between the records in all loess sections, both in amplitude and in timing. How are they related?

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Other comments: The text would benefit from corrections by a native English speaker. I have picked out only a few mistakes: P 10016, line 1: rephrase: The use of bGDGTs in loess-paleosol sequences has been shown promising in continental. . . Line 20: records P10017, line 2: natural archives Line 10: intensity Line 17: trace metal Line 23: enabled Line 24: mention what GDGT stands for. P10018, line 6: found (not founded) Line 22: tools to quantitatively infer past. . . P10019, line 2-3: other factor(s) may play a role in the cyclisation of brGDGTs in alkaline soils. P10020 line 1: what are local soils? Do you mean soils representative for the CLP? Line 8: replace by: The SWC of the soils was obtained by weighing the sample before and after freezing. Line 10: replace 'sample pH' by 'soil pH'. Line 18: replace 'climate station' by 'weather station'. Also rephrase the following sentence - 'nearest station' can never refer to multiple stations, and end your sentence after averaged (delete the rest). Line 20: choose between 'moreover' and 'further', both is superfluous. P10022, line 4: smaller Line 5: replace 'calibration' by 'soil sample set' P10023, line 9: overall, these mechanisms could Line 12: as a response to some other factor(s). line 23-24: what relationship are you referring to here? This is not directly clear to me. P10024, line 14-15: of the effect of soil moisture availability on bGDGT producers in Yongdeng P10025, line 2-3: R2=0.02? Then change 'weak correlation' into 'no correlation'. Figures: indicate which datapoints are from the CLP, so it is clear on what points the precipitation calibration is based on. P1026, line 7: according to the

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