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Interactive comment on "Distributions of glycerol dialkyl glycerol tetraethers in surface soils of Qinghai–Tibetan Plateau: implications of GDGT-based proxies in cold and dry regions" *by* S. Ding et al.

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We thank Huan Yang for his useful comments, which great improve our manuscript. Here, on behalf of my coauthor, I answer the comments as follows:

This paper provides valuable soil GDGT dataset from a cold and dry region, the Qinghai-Tibetan plateau (QTP), which is a hotspot for studying the paleoclimate change. This manuscript is generally well written. However, several issues should be addressed before it can be accepted for publication in Biogeosciences.

1) Introduction Developing or testing new proxies is of significant importance in paleoenvironment reconstruction. However, I am not quite clear about the purpose of the new calibration of MBT/CBT in this paper because there is no loess-paleosol sequence in the QTP. Paleoclimatic reconstruction in the QTP largely depends on the lacustrine or fluvial-lacustrine sediments, where the soil MBT/CBT calibration does not fit for the paleotemperature reconstruction. The authors therefore should re-consider the purpose of this research. Response: it is surely true that loess-paleosol sequence and lake sediments are valuable archives for paleoenvironmental reconstruction. However, understanding composition and distribution of brGDGTs in soils is of importance too since brGDGTs in lakes are mainly derived from terrestrial inputs. So if we want to develop brGDGTs paleo-proxies, we need to know the source of brGDGTs and compare GDGTs indices between aquatic and terrestrial environments. Another major merit of our work is with application of new chromatography method, we successfully identified 6-methyl brGDGTs, which are first reported in the QTP. This finding is helpful to explain lower correlation coefficients in earlier studies. We also developed new indexes based on those new compounds. We added these contents in the revised manuscript. Please see discussion and conclusion parts.

2) P487 Line 5 'The local climate is dry and cold with MAT of 0.1 _C and MAP of 317 mm'. I think the MAT can vary in a large amplitude due to a wide range of elevation (3066 to 5418 m). It is not easy to obtain the exact meteorological information for each sampling site as few meteorological stations were established in the QTP. Response: This is true. The air temperature decreases with elevation at a rate of 6 oC/1000 m. However, since our soil samples cover a large area of the QTP, other factors on air temperature should be considered such as locations and vegetation cover. In our studies, we added these contents in the section of "material and method" as "There are about 70 meteorological stations in the QTP, mainly distributed in the eastern part and northern border of the QTP. Thus, direct observation data on temperature and precipitation at our sampling sites are generally lacking. In this study, we use the WorldClim dataset (Hijmans et al., 2005) to interpolate annual, seasonal and monthly

mean precipitation and temperature (Table S1). The local climate is dry and cold. The MAT of our sampling sites ranges from -5.5 to 7.6 °C with a vertical lapse rate of 0.487 °C/100 m to 0.699 °C/100 m (Cheng et al., 2012). The vertical lapse rate of air temperature decreases from north to south of the QTP. The mean annual precipitation (MAP) at different altitudes varies from ca. 85 mm to ca. 495 mm."

3) P488 Testing the method only in Chinese loess plateau is far not enough to support its applicability in the QTP. How the final calibration looks like will be largely determined by these environmental parameters. The meteorological data in the QTP, though limited, can be obtained from a number of literatures and websites. The authors should clearly show that the method used is applicable to the QTP, especially because the QTP has a very complex landscape. Response: this is true. Considering complex environments, local or regional calibrations are needed. This is the reason we conduct GDGTs study in the QTP. We added related contents in our material and method part. Please see line 136 to 213 for details.

4) P488 Line 1-5 It is really not clear which season or months are the most humid or most warmest quarters in the QTP. Please be more specific. Response: good suggestion. After separation of 5-methyl and 6-methyl brGDGTs, we found there is no apparent seasonal bias with brGDGT indexes. We attribute this to strong correlation between seasonal temperature and annual temperature. Please see section 3.3.3 for details.

5) P488 Line 17-20 Huguet et al. (2006) should be cited because these authors proposed this internal standard. Response: we cited this reference in the revised manuscript.

6) P489 Line 3 The authors used a different elution gradient than the previous studies. An increase in the amount of B phase from 10% to 80% in 45 min seems to be a little bit large for GDGTs separation, and in turn the separation of GDGTs will be inevitably affected. The authors need to show the chromatogram of GDGTs. Response: we used

the new method as suggested by the reviewer 3 and rewrote analytical part (line 169 to 199)

7) P490 Line 6 It is not reasonable to compare the concentration of GDGTs measured with different LC-MS because each instrument has its own response factor. The GDGT concentrations for two data sets both have wide ranges, and it seems to be a little bit farfetched to say one data set is lower than another unless you perform an independent t-test on these datasets. Response: good suggestion. In the revised manuscript, we did not present and discuss the absolute concentrations. Instead we focus on relative abundance.

8) P490 Line 11-13 'iGDGTs are mainly of an aquatic archaea origin' This statement is not right. In some soils, iGDGTs can be very abundant and they mainly derive from soil Thaumarchaeota. This part needs to be re-written. Response: we accept this comment. And delete these statament in the revised manuscript.

9) P490 Line 15-20 The authoras omitted some important references, e.g. Yang et al.(2012, 2014) and Xie et al. (2013) because these papers investigated Chinese soils in a larger area and found low BIT values are widespread in alkaline and dry soils. P490 Line 15-20 'All these results support the existence of in-situ production of iGDGTs in the QTP soils'. It seems to be not necessary to conclude like this because iGDGTs have no other sources other than soils. P490 Line 20-23 Soil moisture appears to be an important factor controlling the BIT in soils. The authors should specify the relationship between soil moisture and BIT and then reach the conclusion. Response: For above four comments, as we mentioned in "response to reviewer 3", since we achieved separation of 5 and 6-methyl brGDGTs, traditionally defined BIT is no longer meanful. So we did not discuss the BIT index as well as iGDGTs in the revised manuscript.

10) P490 Line 24 'favorite' changed to 'favorable ' Response: we rewrote the abstract and made changes as well.

11) P492 Line 3-5 'when all three variables are considered to the dataset'. This sen-

tence is unclear. Pls rephrase. Response: we rephrase this sentence in our revised manuscript.

12) P492 Line 15-20 'In some semiarid and arid regions, a strong correlation between MAP and MBT was observed (Dirghangi et al., 2013; Menges et al., 2014). I didn't see very strong correlations between MAP and MBT in above two papers. Instead, the relationship is weak. The authors should at least provide the R2 and Pearson coefficient to demonstrate there are strong correlations between MAP and MBT. In fact, the MBT' has a much stronger correlation with soil pH than with MAP in Menges et al. (2014). ' a possible relationship between MAP and MBT' may be more appropriate. P493 Line 9-10 'Compared to soil pH, temperature and precipitation have much weaker influence on CBT (r2 = 0.44 and 0.03; Fig. 5)' The R2 does not correspond to theprevious environmental parameter. Please revise. Response: we accept this comment and made correction. Actually, as mentioned above, after successful separation of 5-methyl and 6-methyl brGDGTs, MAP became the least important factor on brGDGT distributions. So we focus on the relationship between brGDGT and MAT/soil pH in the revised manuscript. Please see result and discussion part for details.

13) P494 Line 5-15 It seems to be not logical to develop a calibration of MBT, CBT, and MAT or MAP here because MBT has no strong correlation with either MAT or MAP in the QTP. The recent calibrations of MBT/CBT all depend on the strong correlation between MBT and temperature. P496 Line 1-2 It is not reasonable to say 'our new calibration has successfully extended the minimum applicable threshold from 5 to -5 _C 'here due to the following reasons. First, the Eq.(12) only provided the RMSE for the total dataset. However, this RMSE may be largely determined by the GDGT data compiled from other publications because your dataset comprises only a relatively small proportion of the total dataset. I am not clear about the performance of this new calibration for MAT reconstruction inthe QTP alone. In most cases, the aim of developing new calibrations is to reduce thescatter and to improve the accuracy of paleoenvironmental reconstruction. The authors should provide the residual errors generated by

the Eq. (12), Chinese calibration (Yang et al., 2014) and the Peterse et al(2013) global calibration to compare whether the new calibration has a better performance. P496 Line13-15 'The reason for the slight bias of MBT-CBT towards winter season is that although more amounts of bGDGTs are produced in summer, more variation in bGDGT compositions occurs in winter'. This sentence is not logical' Did the authors analyze the correlation between winter T and MAT? In fact, these two parameters were highly correlated in Chinese region (Yang et al., 2014). Figure 4 The authors should add MBT and CBT to the RDA triplot to show the relationship of them with environmental variables. Response: we accepted above four comments. We already gave detailed answers to similar comments in the "response to reviewer 2 and 3". So here, we just explain them in brief. With separation of 5-methyl and 6-methyl brGDGTs, MAP became least important factor on brGDGTs in QTP. Meanwhile, we found with new data, modified MBT index such as MBT5ME can well estimate MAT, while modified CBT such as CBT" and CBT5ME have strong correlations with soil pH. In addition, there is no apparent seasonal bias based on new brGDGT data. We rewrote these points in the revised manuscript. Please see result and discussion part.

Interactive comment on Biogeosciences Discuss., 12, 481, 2015.