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# *Interactive comment on* "Strong winter monsoon wind causes surface cooling over India and China in the Late Miocene" *by* H. Tang et al.

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The study of Tang et al. bases its conclusion on results from two methodological approaches to infer palaeoclimates, of which one is the so-called "co-existence approach" (CA). The CA is a derivate of the mutual climate range method that makes use of the nearest-living relative (NLR) principle using a protocol prone to stochastic effects and data error (Grimm and Denk, 2012; Grimm et al., 2015). Its main sources of error are taxonomic uncertainties, incorrect associations of fossil taxa with NLRs, and problems in determining minimum-maximum climate tolerances of taxa used as NLRs (e.g. Grimm and Denk, 2012; Utescher et al., 2014, sections 3 and 4; Grimm et al., 2015). Tang et al. exclusively rely on previously published and unpublished/undocumented CA results, but unfortunately none of the above listed critical issues have been adequately addressed in the original papers or in the current study.

Issue 1: Problems with reliability and comparability of used mean annual temperature and coldest month mean temperature CA estimates

Most of the palaeobotanical studies used by Tang et al. relied on CA in combination with minimum-maximum tolerance data recorded in the Palaeoflora database (PFDB). According to Utescher et al. (2014) PFDB has records for hundreds of NLRs for seven climate parameters undergoing permanent updates. Of these, only a single one (mean annual temperature, MAT) has been made accessible to the public via the Palaeoflora homepage. Using the accessible data, including those of the studies used also by Tang et al. (e.g. Xu et al., 2008; Xia et al., 2009; Jacques et al. 2011; Liu et al. 2011), we have shown that palaeo-MAT values produced in CA+PFDB studies are highly problematic and that PFDB is riddled by erroneously recorded tolerances (Grimm and Denk, 2012). Tang et al. refer to a few studies which used other sources for climate tolerance data than PFDB, which hinder comparability of the compiled data (cf. Utescher et al., 2014). Inconsistencies between PFDB and non-PFDB tolerance data can indeed be significant and may directly affect the reconstructed MAT and other climate parameters used unreflectingly by Tang et al. For instance, MAT tolerances obtained independently by Xu et al. (2008), Xia et al. (2009), and Jacques et al. (2011) and PFDB database (accessed online 2011/2012, and checked against Quan et al., 2012, app. B, the only pre-2015 CA+PFDB study documenting the used climate data) can differ in the minimum and maximum tolerance values by 1–19(!) °C. In addition, MAT tolerances used by Jacques et al. (2011; a mix of Xia et al.'s estimates, new data, and PFDB data) are at least 2 °C too narrow for 35 out of 52 checked taxa (Grimm and Denk 2012, ES2). For 21 taxa used in Liu et al. (2011), minimum MAT tolerances are 1–10 °C too high and maximum tolerance up to 5 °C too low (Grimm and Denk, ES2). For the reasons outlined in Grimm and Denk (2012) and – in great detail – Utescher et al. (2014), coldest month mean temperature (CMT) reconstructions using CA+PFDB are equally problematic.

Issue 2: Method- and database-inherent bias towards certain subtropical climates when using CA in conjunction with PFDB tolerance data

Most importantly, regarding the conclusions put forward by Tang et al., CA+PFDB reconstructions generally converge to certain types of climates: moderate, non-extreme climates in which a great number of northern hemispheric taxa possibly could coexist (i.e. typically subtropical conditions). This is also visible from the results reported in the supplement of Tang et al., which would indicate a fairly uniform temperature regime across China and south of the (proto-)Himalayas for the late Miocene. The reconstructed (much) warmer climates than today for high-latitudes in China and (slightly) colder than today for low-latitudes are in stark contrast to the modern situation, but strongly evocative of the results of most CA studies published to date, particularly those focussing on China. Notably, also the CA+PFDB study by Quan et al. (2012) on the Eocene of China reconstructed comparable climates for nearly all assemblages, despite the fact that those assemblages covered all parts of China and the entire Eocene (examples given in Fig. 1). Random subsampling of the Quan et al. (2012) PFDB data converge to the subtropical climate of southwestern China with increasing number of randomly selected NLRs (Grimm et al., 2015, fig. 6). This clearly hints towards a database/method-inherent bias towards a certain climate type regarding not only MAT values (Grimm and Denk, 2012) but regarding all temperature values (and precipitation figures; Grimm et al., 2015). With best-possible climate tolerance data at hand, Thompson et al. (2012) note in fact the impotency of 'unweighted' mutual climate range techniques such as CA to conclusively reconstruct the substantial warming since the last glacial maximum in North America. The findings by Grimm and Denk (2012) and Thompson et al. (2012) have led other authors (Eldrett et al. 2014, Kotthoff et al. 2014) to dismiss PFDB data and to modify CA to account for effect of unrepresentative taxa: exotic elements (statistical outliers) that can severely bias CA reconstructions. Tang et al. appear to have overlooked these studies entirely.

Issue 3: Discrepancies with recently formulated (Utescher et al., 2014) CA standards and recommendations for CA studies

Utescher et al. (2014) also provide guidelines for the documentation of CA studies: 1) full documentation of lists of fossil taxa, 2) list of fossil taxon – NLR associations, 3) tolerance data of used NLR. Of the CA reconstructions used by Tang et al., only the studies of Xia et al. (2009) and Jacques et al. (2011) provide such documentation to some degree, and hence, it is impossible to judge for the most part how reliable or biased their palaeoclimate reconstructions for the late Miocene of China are and how reliable they are for the Indian floras used as a second source of evidence (referenced here as "T. Utescher, unpubl. data"). Tang et al.'s table S1, documenting important results to support the main claims of the authors, follows this worst-practise tradition by only reporting the CA results, but no lists of fossil taxa, fossil-NLR associations, or the NLR tolerance ranges as deemed minimum requirement by Grimm and Denk (2012) and more recently by Utescher et al. (2014). Without such documentation, any value provided remains entirely meaningless.

There are more inconsistencies between this study and the recommendations/observations in Utescher et al. (2014). In that paper, the authors advocate to use only the most-recent update of the PFDB to counter the problem of inconsistent tolerance data (see above). Utescher et al. (2014) note that substantial updates have been recently made to the PFDB, hence, it is difficult to understand why the authors rely on CA reconstructions that used probably outdated (and erroneous) PFDB tolerance data and data of studies using independent tolerance data rather than providing genuine results using the purportedly updated PFDB to support their conclusions.

Furthermore, Utescher et al. (2014) caution against interpreting CA results at high precision. They claim that the maximum possible accuracy of CA temperature estimates lies in the range of 1–2 °C. This claim is clearly not met regarding MAT (Grimm and Denk, 2012) in published studies, and the accuracy of CMT has remained untested. Under the assumption that the values provided in Tang et al. table S1 are the so-called 'center values' (the arithmetic mean between the lower and upper boundary of the 'coexistence interval') and the "ranges" refer to the width of the coexistence interval, one can easily observe that for only two of the yellow marked localities the reconstructed potential palaeo-climate values lie below the modern values. In all other cases the values suggested by the reconstructed coexistence intervals overlap with the modern situation; the reconstructions – even if reliable which must be questioned in the absence of proper documentation – show no evidence for substantial surface cooling, neither comparing the situation in India vs. China in the late Miocene, nor with respect to the modern situation in East Asia if the actual CA intervals are taken into account and not only the 'center values' (cf. Mosbrugger and Utescher, 1997)

Additional references

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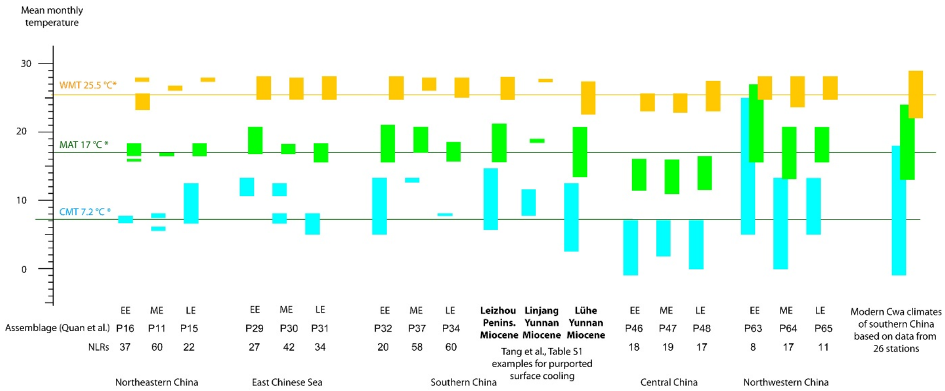


**Striking homogeneity of CA palaeotemperature estimates in China through space and time.** Shown is the overall CA-reconstructed climate situation in China in the Eocene (EE = early Eocene, ME = middle Eocene, LE = late Eocene) according to Palaeoflora data used by Quan et al. (2012; see Grimm et al., 2015). Note the eye-catching similarity between the reconstructed Eocene climate in all(!) parts of China with the situation in the Miocene as documented in Table S1 of Tang et al. for critical assemblages (in bold font) and the modern situation in southern China (Yunnan to Jiangsu, indicated to the right): mostly subtropical *Cwa* climates with low winter and high summer precipitation and hot summer, locally approaching tropical conditions. [*:WMT, MAT, and CMT values indicated to the left of the diagram are artificial coexistence intervals (94+% 'coexistence') computed based on all 200+ NLRs listed in Quan et al., 2012, appendix B)]

**Fig. 1.**