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# ***Interactive comment on “Effective heat transport of Gulf Stream to subarctic North Atlantic during Miocene cooling: evidence from “Köppen signatures” of fossil plant assemblages” by T. Denk et al.***

**B. Tiffney (Referee)**

Bruce.Tiffney@ccs.ucsb.edu

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Does the paper present novel concepts, ideas, tools, or data? The paper offers an increasingly focused and widely applicable approach to the classic “Nearest Living Relative” (NLR) technique for estimating paleoclimate. While the concept of estimating paleoclimates by the climatic affinities of their nearest living relatives is not new, using the specificity of the Köppen system is, and offers the opportunity to create far more detailed hypotheses of paleoclimatic signals.

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Are substantial conclusions reached? Yes

Are the scientific methods and assumptions valid and clearly outlined? Yes

Are the results sufficient to support the interpretations and conclusions? Yes

Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? Yes

Do the authors give proper credit to related work and clearly indicate their own new/original contribution? Yes

Does the title clearly reflect the contents of the paper? See below

Does the abstract provide a concise and complete summary? Yes

Is the overall presentation well structured and clear? Yes

Is the language fluent and precise? Yes

Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? Yes

Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? No

Are the number and quality of references appropriate? Yes

Is the amount and quality of supplementary material appropriate? Yes, and deeply appreciated

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General Comments: By virtue of their static nature, plants have provided a tool for the estimation of past climates. The more closely related to living taxa, the greater the probability that “physiological uniformitarianism” may be assumed – that is, if the genetic controls of morphology are such that we can place the fossil in a living genus or

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perhaps even species, similarly we might assume a stable genetic control of physiology. This is the basis of the “nearest living relative” approach used by many paleobotanists to estimate Cenozoic climate. However, the nearest living relative process is a very generalized method of estimating paleoclimate.

The current paper offers a continuing refinement of the nearest living relative approach by locating the nearest living relatives within their Köppen zones, permitting a more refined method of estimating the amount and annual distribution of moisture as well as annual temperature regime. The possibility that physiological uniformitarianism does not universally apply, and that some taxa may have evolved physiologically, but not morphologically, is countered by the use of a larger number of species, reducing any errors that might occur.

The authors have provided their database (and linked with other data collections of a similar nature), pointing the way towards a global basis for a common methodology of estimating paleoclimates, at least within the Cenozoic where extant genera and, as one approaches the present day, species may be found in the fossil record. This is a deeply appreciated contribution to our common endeavor.

#### Specific Comments:

The title is slightly misleading, as in fact there is not extensive discussion of the heat transport via the Gulf Stream within the body of the paper. However, the data presented make the impact of the Gulf Stream clear. Perhaps an alternative might be to invert the title to read “Evidence from “Köppen signatures” of fossil plant assemblages for effective heat transport of Gulf Stream to subarctic North Atlantic during Miocene cooling”. A figure comparing the decline in global temperatures in the Northern Hemisphere against those observed in Iceland would reinforce the unique aspects of the climatic changes of the last 15 Ma in the N. Atlantic.

You might specifically note that the use of this approach, as detailed as it is, still assumes that plant genera and particularly species exhibit “physiological uniformitarian-

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ism. That is, within a taxon, the climatic affinities remain fairly stable over time, and if they change, are reflected in some way in their morphology, prompting the erecting of a new species or genus.

Technical corrections:

Page 13564 Line 18 “The observed sequence of climate change in the North Atlantic can only be explained. . .” Suggest “The observed sequence of climate change in the North Atlantic can most likely be explained. . .”

Page 13566 line 12 suggest “Iceland, 342 taxa based upon macro- and megafossils. . .”

Page 13568 Line 12 suggest “climate type is defined by several climate parameters. . .”

Page 13568 Line 18. Suggest “Northern Hemisphere ranges from 5.5 to 18.9 oC

Page 13569 line 27. I suggest you might define the “actualistic principle” as some in North America might not be versed in the idea of “actualism”.

Page 13570 line 7. Neither Anderberg & Anderberg nor Flora of China appear in the citations.

Page 13570 line 10. Delete the comma after “both”.

Page 13570 line 13. As I printed the paper out to read it, “Lieth” did not appear, just “Climate Diagram World Atlas, 1999.

Page 13570 line 16. Suggest writing out m a.s.l. as some might not recognize this abbreviation.

Page 13571 line 7. Suggest deleting “here: The Köppen signatures of PA.”

Page 13571 line 23. “Hegi, 1966b, a” should be “Hegi, 1966a, b”

Page 13572 line 15 Suggest “frequencies of plants representing particular climate types. . .”

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Page 13572 line 26. I note that you cite the authors for species throughout, but query if you might also want to do so for genera elsewhere? Or is this a specific “stylistic” approach of the journal to do so only for species?

Page 13574 line 12. Suggest “order to observe changes in their frequencies within floras over the course of the past 15 Ma.”

Page 13574 line 23. Suggest deleting “in terms”.

Page 13576 line 6. I would say that figure 5 alone really illustrates this.

13577. In the Discussion, I would suggest commencing with a brief reiteration that the northern North Atlantic is “odd” in that it does not track the climatic declines of the last 15 Ma like the rest of the world. This underscores the general interest of this paper.

Page 13579 line 20. I suggest deleting the ( ) around conifer.

Page 13580. Could the three citations to Browicz & Zielinski be combined into one citation? Or do 1982 and 1984 lack the volume numbers of the series?

Page 13585. Is Shen, 1992 a Ph.D. or a Master’s thesis?

Page 13588 Table 2. In the center “ third letter temperature classification - should the number in brackets be (2006)?

Page 13590, Table 4. In the right column about  $\frac{3}{4}$  the way down the code “Csb” is followed by a superscript 5 – should that in fact be a “d”?

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Interactive comment on Biogeosciences Discuss., 10, 13563, 2013.

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