

Comments on the Manuscript:

Milankovitch, the father of paleoclimate modelling

By André Berger

"Contrary to what might be thought, Milankovitch has not calculated himself the long-term variations of the astronomical elements. He used them extensively for calculating the "secular march" of incoming solar radiation." These two sentences are, perhaps, the most important message of this manuscript. André Berger's clearly and concisely shows that Milutin Milankovitch is not the father of the astronomical theory of climate, but he is a paleoclimate modeler. He has advanced our understanding of Quaternary climate variations by two important and original contributions: the definition and use of caloric seasons and the concept of the "mathematical climate". This well written manuscript is a 'must read' for a special issue honoring the Milankovitch theory of Quaternary climate change.

Before publication, I would like to suggest considering one point, which might only be important for historical reasons. It does not touch the main message of the manuscript. On line 160 ff., it is stated that Milankovitch used the caloric seasons for the first time in his contribution (*Mathematische Klimalehre*) to the 1930 Köppen-Wegener Handbook. When going through the book "*Die Klimate der geologischen Vorzeit*" by Köppen and Wegener in 1924, I already find the concept of caloric seasons described by Milankovitch himself. Actually, Köppen and Wegener invited Milankovitch to contribute a piece of text in which Milankovitch himself cites his paper on "*Kalorische Jahreszeiten und deren Anwendung im paläoklimalen Problem*" (Ber. D. Königl. Serb. Adad. Bd. 1923). The text is very close to, albeit much shorter than, the text in Milankovitch's "*Kanon der Erdbestrahlung*" (1941). The defining figures (Figure 34 in "*Die Klimate ...*" and Figure 42 in "*Kanon ...*") are pretty much the same.

Regarding style, I would like to suggest rewriting the Abstract. When having read the Abstract, I frankly expected a rather technical paper. But likely, the manuscript is an eye opener for many paleoclimate modelers. Perhaps the two sentences I cited above, or similar sentences, could appear in the Abstract to make sure that everybody will read the paper. And it is a great pleasure to read it.

Minor comments:

Line 71: Not only the numerical values of the astronomical parameters were reproduced in Köppen and Wegener's "*Die Klimate ...*", but also the insolation during the caloric summer and winter. The famous fold-up figure in "*Die Klimate ...*" are already the caloric values, if I understood it correctly.

Line 142: Actually, Milankovitch himself wrote in his contribution to Köppen and Wegener's "*Die Klimate ...*": "Daß die folgende Tabelle sich auf die sommerliche Bestrahlung bezieht, geschieht auf Wunsch der Verfasser vorliegenden Werkes" (That the following table refers to summer irradiation is at the request of the authors of this work.) Hence, Köppen and Wegener claimed already in 1924 the summer half-year as decisive factor in glaciation – and they explicitly cited this as Penck's and Brückner's idea.

Typos etc.:

Title: paleoclimate modeling or palaeoclimate modelling? American or British English?

Line 38: Miskovitch or Miskovic? (In his “Kanon ...”, Milankovitch cited Miskovic as Michkovitch).

Line 48: 10^{-4} , not 10-4

Line 62: Milankovitch’s own words... taken from which paper or book? (Actually, you can find them in both, “Die Klima ...” and the “Kanon ...”.)

Line 80 ff. In the symbol $\Pi\gamma$, the γ should appear as subscript, if Milankovitch’s “Kanon ...” notation is followed, i.e., Π_γ . Likewise, Π_γ^0 rather than $\Pi\gamma 0$

Line 105, 107: which paper / book of Milankovitch’s are these quotes taken from?

Line 120: interested in (not ‘by’) obliquity.

Line 144: Brückner instead of Bruckner.

Line 164: ‘Canon’ or ‘Kanon’, both quotes appear in the paper. I would harmonize it.

Line 187: Klimalehre (not Klimalehere), Stefan law (not Sefan law)

Line 188: IR? I guess it’s infrared.

Line 205: Which “Köppen table” is meant?

Line 208 / 210: which paper / book is this quote taken from?

Line 239: amounted to 1920 caloric

Line 249: Neue Ergebnisse (not Neue Ergebnissen)

Line 294: Veränderungen der Bahnen der großen Planeten

Line 303: Klimate (not Kliamte)

Line 329: Erforschung der

Line 320: Klimalehre

Line 333: Erdbestrahlung