Open Access History of Geo- and Space Sciences Discussions

Hist. Geo Space. Sci. Discuss., author comment AC3
https://doi.org/10.5194/hgss-2021-17-AC3, 2022
© Author(s) 2022. This work is distributed under
the Creative Commons Attribution 4.0 License.

Reply on RC2

Mustafa Efe Ates

Author comment on "Pioneers of the ice age models: a brief history from Agassiz to Milankovitch" by M. Efe Ateş, Hist. Geo Space. Sci. Discuss., https://doi.org/10.5194/hgss-2021-17-AC3, 2022

Below are my responses/comments to Andreas Schmittner (Reviewer #2). My responses/comments are in regular font, Reviewer's are in italics.

This brief review of ice-age models is well written and I enjoyed reading it. I think it may provide a nice historical introduction for students and or non-climate-scientists to the topic. I especially liked the last two figures (7 & 8), which illustrate the applicability of Milankovitch's mathematical calculations with evidence from the geological record. However, I have two main comments/concerns that I think the author should consider in revising the work, in addition to several smaller and more technical comments.

I would like to thank Andreas Schmittner for his kind words. I'm also very grateful for the valuable suggestions and for the careful reading of the manuscript. I think all his comments are to the point. I hope my replies here do justice to his comments and some of his concerns as well.

My first main point is that a recent review of Milankovitch published last year by Andre Berger (https://doi.org/10.5194/cp-17-1727-2021) should be considered by the author. There is considerable overlap between the two works, and I would encourage the author to minimize the overlap, emphasize the differences, and to acknowledge the work by Berger.

I thank the Reviewer for pointing out the work of Berger 2021and bringing it to my attention. Andre Berger is one of the main researchers in astronomical theory of paleo-climates. That is why I have cited his two different works in my manuscript. It is unfortunate that I was not aware of his 2021 article. This manuscript was written before 2021 and from that onwards I check new publications that may be of interest. Nevertheless, somehow I overlooked this relevant article. In sum, the Reviewer is certainly right when he says that "Andre Berger… should be considered by the author". Additionally, as the Reviewer constructively suggests, I will also minimize the overlaps and maximize the differences between the two works.

My second main point is that the equations in the manuscript are not well motivated, and I didn’t understand them. They should be better explained. E.g. in equations (2) – (5), what is the difference between Delta_Q and Delta_W? The different terms in the equations should be explained and motivated so that a typical reader can understand them.

The Reviewer is right. I have received similar suggestions and comments from the Reviewer 1 and the Commentator 1 (Z. Bora Ön). Accordingly, the equations in the text will not appear in its original form. In order to improve the tractability of the text for readers who want to be broadly informed about the issue, I will explain the equations in words. Accordingly, the part of the text (lines 300-380) which contain equations will be rewritten. In other words, you will find equations explained descriptively in the final revised manuscript. The Reviewer is also right when he says “I think it (the manuscript) may provide a nice historical introduction for students and or non-climate-scientists to the topic”. My revised final version of the manuscript would be compatible with this saying as well.

Detailed technical comments:

Line 35: replace “have” with “has”

Thanks for the correction. Done.

Line 107: replace “a glacier” with “glaciers”

Thanks for the correction. Done.

Line 220: insert “to” after “lead”

Thanks for the correction. Done.

Line 253: insert “at perihelion” after “winter”

Thanks, it's worth emphasizing this detail. Done.

Line 294: why is it compared here to the langley unit? Is this used elsewhere or was it a popular unit at that time?

Langley unit [Ly] is a unit recognized by the International System of Units SI which is used to measure the heat budget. However, there are other units besides Ly. For example BTU (British Thermal Unit) and J/m^2 (joule per square meter) are some of them which are also used to measure the heat density (like incoming solar radiation, or forest fire). In effect, there is no special thing about Ly. Nevertheless, by merely mentioning Ly leaves an opposite impression. So, following the Reviewer’s comment, I will also convert Milankovitch’s unit of radiation to other common units. This, I hope, may sweep away this opposite impression. I thank the reviewer for raising this point, which was not sufficiently specified in the manuscript.

Line 298: replace "year's" with "half-year's"

Done.

Line 299: I assume "colder" here means "has less insolation than". Perhaps clarify.

True. I will clarify this point in the revised version.

Line 336-338: This is an interesting context, not mentioned by Berger's review.

I warmly thank the Reviewer for this comment.

Line 380: What for values other than 90 and 270? It would make more sense if the different signs represent a range of longitudes of perihelion.

I thank Reviewer for the comment. Milankovitch gave paramount importance to Π☐☐ (longitude of the perihelion relative to vernal equinox) because glaciation processes occurs when Π☐☐ attains the values of 90° and 270°. In his words "The great amplitudes of insolation producing the glacial periods occurred… at times at which the longitude Π☐☐ of the terrestrial perihelion attained 90° and 270°" (Milankovitch 1941, p.263). The situation with ☐ε (low obliquity), e☐ (large eccentricity) and Π☐☐=90° favors the Northern hemisphere glaciation. The situation with ☐ε (low obliquity), e☐ (large eccentricity) and Π☐☐=270°, on the other hand, favors the Southern hemisphere glaciation. That is why, in some other place, he emphasized Pilgrim's calculations as follows: "Pilgrim … computed the secular variations of the elements Π☐☐, e, ε for each fifth millennium and for all those points of time at which Π☐☐ equals 90° or 270°" (Milankovitch 1941, p.253). In responding to the Reviewer's question regarding values other than 90° and 270° (i.e. 0°, 180° and 360°), the best way perhaps is to cite Milankovitch again. He asserts the following: "When Π☐☐ attains the value of 180° the annual seasons … are equal and both hemispheres stand on par […] At Π☐☐ =360° both hemispheres, at equal annual seasons, are completely on par and everything starts again [0°]" (Milankovitch 1941, p.253). So, on December 21, for example, when Π☐☐=270°, the below sign "-" is valid. It is because the mean insolation that the Northern Hemisphere receives (in southern winter) is less than the mean insolation the Southern Hemisphere receives (in northern winter). At Π☐☐ = 90° the reverse conditions hold for two hemispheres. However, when Π☐☐ =0°, Π☐☐ = 180° and Π☐☐ = 360° there would be no significant difference between both hemispheres with respect to the summer and winter (i.e. summer and winter lengths will be almost equal). Therefore, according to Milankovitch, the signs "+" and "–" are valid only at Π☐☐=90° and Π☐☐=270°.

Line 395: insert "of lower equivalent geographical latitude" after "cases"

Done.

Line 399: Do we know if Milankovitch decided to plot this particular metric (equivalent latitude) for better comparison with work by others such as Penck and Bruckner?

Thanks for this interesting question. I have no textual evidence that Milankovitch used a specific metric to compare his results with those of Penck and Brückner. Nonetheless, it seems intuitively plausible that Milankovitch made such an adaptation based on Köppen's advice. It is actually a quite nice topic to research upon. If I obtain any new information on this topic, I will include it in the final version of the manuscript.

Fig. 1: units should probably be changed from deg F to deg C

The units are now changed from °F to °C. Moreover, I have redrawn the chart because the first version was of poor image quality.

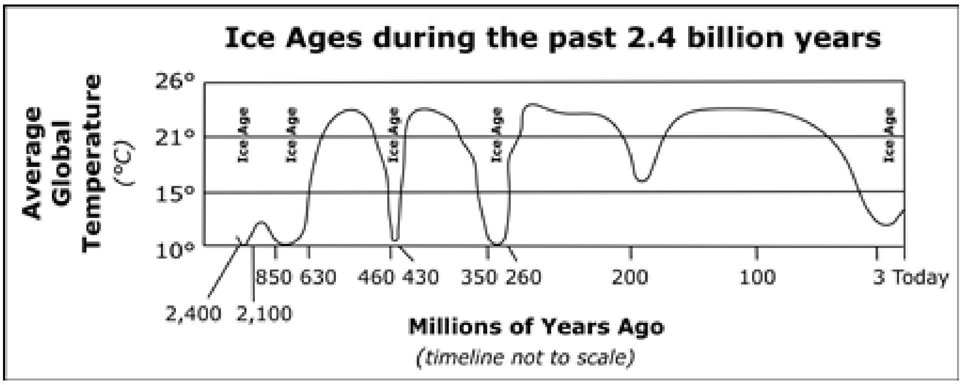
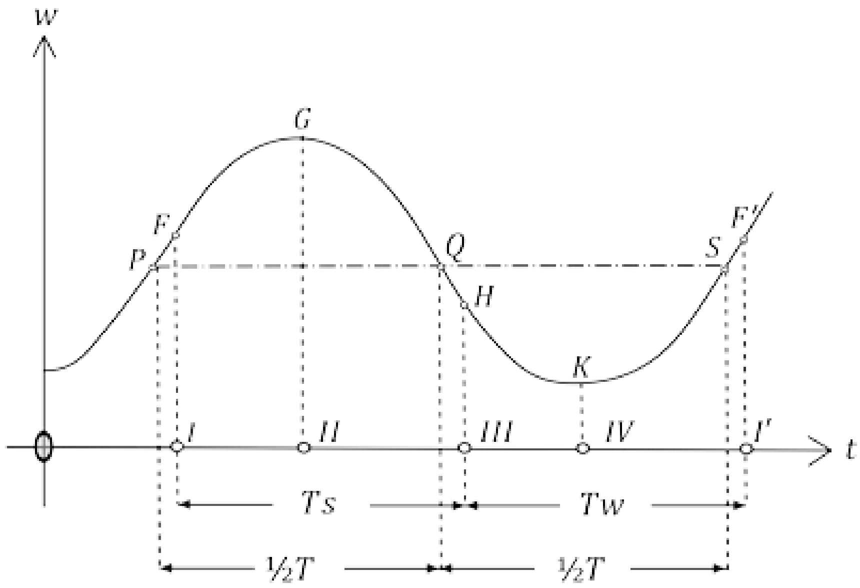


Fig. 6: I don't understand this figure. Why is T_S not equal to 1/2 T? In other words, why does point F not coincide with point P? What is the difference? Please explain.

The reviewer is certainly right. I sincerely thank the reviewer for making this point because this is a point which I did not sufficiently explain in the manuscript. TS and TW denote astronomical half-years, the summer and the winter half-years, in order. But for Milankovitch, TS and TW do not separate the year according to stronger and weaker insolation. Instead, TS and TW divide the year according to the duration of the day. However, as Milankovitch asserts, the duration of the day has no any significant relation with the insolation. The analytical solution is given by Milankovitch in the ***Kanon*** (1941, pp. 275-278). On the other hand, the figure that I used in the manuscript (fig.6 below) represents the geometrical solution.



In the figure, time is plotted on the horizontal axis (t). The insolation, on the other hand, is plotted along the vertical axis (w). The points on the curve PFGQHKSF' represent the course of radiation at an arbitrary latitude (φ). The astronomical summer half–year (Ts) is represented by the segment I–III, and the astronomical winter half–year (Tw) is represented by the segment III–I'.

To understand this solution, please kindly notice the plotted points QH and SF' on the curve. These are the last irradiation intervals of astronomical summer half-year (TS) and astronomical winter half-year (TW), respectively. When we compare QH with SF', however, we see that the final irradiation interval of TS (i.e. QH) is smaller than the final irradiation interval of TW (SF'). To avoid this unwanted situation, Milankovitch introduces caloric half-years. Like the astronomical calendar, each year's duration is 182 days, 14 hours and 54 minutes, but differently a caloric winter includes every day which is colder than the days in the summer half year (1/2T on the right-hand side). Conversely, a caloric summer includes every day which is warmer than the days in the winter half year (1/2T on the left-hand side). In this way, Milankovitch provides "a better insight into the march of insolation in remote times" (1941, pp. 274).

Reference(s)

Milankovitch, M.: Kanon der Erdbestrahlung und seine Anwendung auf das Eiszeitenproblem, Belgrade: Royal Serbian Academy Special Publications, vol. 132, (Canon of insolation and the ice-age problem, English translation by Israel Program for Scientific Translations, Jerusalem, 1969), 1941.