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# *Interactive comment on* "Earth Orbit v2.1: a 3-D visualization and analysis model of Earth's orbit, Milankovitch cycles and insolation" *by* T. S. Kostadinov and R. Gilb

**Anonymous Referee #2**

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This paper presents a very useful tool for visualising and analysing the Earth's orbit. The Earth Orbit Model will have wide applications for both science research and education. The paper is presented in two parts; initially an overview of orbital fluctuations or the Milankovitch cycles is given. The software is then explained in detail and a brief section on model validation is included. In general the paper is well written and provides enough detail for the end user to appropriately use the model.

Specific comments on the manuscript

1. There are inconsistencies in the usage of the terms Ky and yr that should be addressed.



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2. pp 5950 (8): The authors mention the 100 Ky problem briefly. The text would benefit from a little more explanation as to the nature of the problem and its significance.

3. Although it is interesting to see the EPICA/deuterium data included in the model, there are climate records that span greater intervals of Earth history that would also be useful to compare to the orbital parameters. For example, going back 5 Ma, the benthic oxygen isotope curve of Lisiecki and Raymo (2005) could be added. Or to go back even further in time, one of the Zachos compilations would be a useful comparison. It might also be better to allow the user the option to display the data-model comparison or not, as looking further back in time than the EPICA record, one currently ends up with an empty plot at the bottom of the screen.

4. True anomaly is first mentioned on pp 5955 (9 & 22 & 25), however the term is only described on pp 5957. I think the reader would benefit from description/definition of the true anomaly in the first instance that the term is used.

5. pp 5961 (7-18) – The authors discuss the effect of the varying length of the seasons over geologic time scales. I am not sure if I have understood correctly, but is this essentially the same problem as has been identified within the palaeoclimate community as pertaining to the definition of the calendar (i.e. fixed-day/angular or classical)? If this is the same problem, it might be useful to the reader to have a few sentences relating the author's description of the problem to other published efforts to understand the effect of this problem, when considering different orbits over time (e.g. Jousamme and Braconnot, 1997; Chen et al., 2010 – Climate Dynamics)

6. Validation of insolation output. It is great to see the authors validate their independent calculations in such a way. The authors state: "Validation is excellent; all test cases result in differences less than 1Wm−2 (Fig. 5)". It might be easier for the reader to determine the effectiveness of the insolation solution by comparing the magnitude of the disparity to the kind of magnitude in discrepancy that one might expect using alternative astronomical solutions for that time (e.g. BL78, BL92 and Laskar, 2010).



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In other words, the different astronomical solutions may lead to an insolation discrepancy of X Wm-2 at certain points in time, with the differences becoming larger in the further back in time (on the whole). How do the differences shown here compare to the inter-solution differences one might expect?

7. pp 5965 (7) – I find the term +10 000 yr since present difficult to understand, is this 10 000 years in the future? Perhaps rephrase.

8. 5965(23) – Define UT

9. Figure 2. It might be useful for the reader to have a little more description as to what the lines on the orbital configuration mean – give details of the black and the red lines. Maybe additionally show a Palaeo case and describe what it means when you are looking at July and it falls in the wrong season with regards to present day. Also, at what latitude is figure 2a representing for the 16 September and using which calendar start date. It would be good for the figure caption to contain enough information that the GUI user could reproduce it with ease. The text on the figure in this case is a little small and difficult to read.

10. Figure 5. Could the authors comment as to why the error bars are so much larger at 80°S 10,000 years ago than for any of the other cases?

11. Figure 6. It is not clear from the figure caption or the text what causes the discontinuity in the green and black lines in figure 6. Is this related to the leap year considered? Could the authors elaborate on this please?

Specific comments pertaining to the GUI

1. In the Milankovitch Orbital Parameters section the input requirements for the choice of year is in years since J2000, however, in the Time Series and Insolation Plotting Options section, the input should be in thousands of years since J2000. This is slightly confusing and it should be considered whether the inputs should both be in the same units. Additionally an example alongside the input box of what numbers (+/-) would be



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necessary input values to calculate insolation properties for e.g. 20,000 ka BP or 2 Ma ago, would be beneficial to the user.

2. The authors refer to the Astronomical Unit in Table 1 as a constant/variable model input parameters. From the GUI the AU changes with every solution requested – that AU varies might not be obvious to the reader. Perhaps therefore, the authors should list in the table which values are constant assumptions and which vary depending upon the GUI inputs.

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Interactive comment on Geosci. Model Dev. Discuss., 6, 5947, 2013.