

## ***Interactive comment on “Cumulated insolation: a simple explanation of Milankovitch’s forcing on climate changes” by F. Marra***

**Anonymous Referee #1**

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The purpose of the paper is to identify all the glacial termination of the last 900 ka from the computed summer insolation at 65N. The cumulated values of consecutive minimum and maximum of insolation is defined to be an index for the terminations. It is indeed an interesting question, long debated, to identify the age of the termination from the solar forcing (insolation). Unfortunately, amongst all the potential terminations identified from the index, and even after excluding a few of them, there are still almost as many correct and wrong guesses for the terminations. Of course the author tries to explain how to select the proper ones but this is not fully convincing.

The index is based on summer insolation at 65N. However, there is no justification for this choice, except that ‘it is maybe the most accredited’. Is there really no other justification?

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The definition of the index is based on ‘reasonable’ or ‘intuitive’ hypotheses (P557, l3, 5, 7) but there is no explanation of a mechanism behind such an index. Moreover, a link is often made between insolation and temperature but the next step, to the ice sheet is not made. Indeed, there is no indication on how the author relates global temperature to ice sheets. Is it through their extent, volume or depth? Moreover, it seems that the author assumes a linear relationship between insolation, temperature and ice sheet. Is it really the case? Some elaboration on that subject would be needed.

The explanation at the top of page 5557 is difficult to accept as it stands. Indeed, it is assumed that a slightly larger minimum of insolation, which may induce an additional thin layer of ice (thinner than in the case of lower insolation), on an already existing ice sheet (maybe thick and large), will lead to the melting a such a huge ice sheet, as soon as insolation is become large. I am not convinced that insolation is able to do that. Although, it may be the starting point of a much more complex process.

Then (p 5559) the author tries to compare the isotopic curve with a few points coming from the maximum and minimum of insolation. This leads to the comparison of two curves with very different resolution (probably less that 1ka for the isotopic curve and more than 20 ka for the author’s curve). It is therefore almost impossible to identify any correlation (from observation there is none, maybe from the computation of a coefficient of correlation is there one, this should be checked).

At last the author tests his index for times older that 900 ka BP. This time it is suggested that the index would be able to identify the peak of the isotopic record (not the Terminations anymore). Figure 3 obviously shows that it is not the case. The author therefore suggests that it might be due to the data, which is of course always possible. However, I would suggest another possibility, i.e. the index is not properly defined for time intervals dominated by 40-ka periodicity.

Detailed comments P5554 l12, p5557 l24, p5567 l4. A threshold of 742Wm<sup>-2</sup> in the summer insolation is identified (a posteriori) for pointing out to the dates of the termina-

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tion. We know that the total solar irradiance is varying. Does this affect this threshold? By the way, which value was taken in this computation?

P5555 I2 : "the aphelion position during the seasons". Well I think that I understand what is meant here, i.e. the time of passage (within the year) of the Earth at the aphelion. However, I don't think that it is clear for those who are not familiar with the topic.

P5556 I5 : a reference is missing here.

P5556 I12-19 : I am not sure to understand properly the purpose of this paragraph. It seems that the author means that the previous paper (Marra et al., 2008) was not right, or at least not convincing and that this paper will do better. Is there anything more in this paragraph?

P5557 I26, p5558 I21, p5567 I5: I do not understand the meaning of tract in this context. Does it mean 'portion'?

P5559 I16-I21 : the description of figure 2f provided here is not correct. First, it is said that it is 'a succession of relative minimum of insolation'. However, the values plotted are much too large for minimum of insolation. Moreover, label axis reads 'cumulated insolation'. Then it is written 'difference between each maximum and minimum of insolation'. Again, the values plotted are much too large (for example, at about 200 kyr, the difference between maximum (414 Wm<sup>-2</sup>) and minimum (345.5 Wm<sup>-2</sup>) values is less than 70 Wm<sup>-2</sup> far from values larger than 700 Wm<sup>-2</sup>).

P5561 I 3-5 : The author claims that he proposed a mechanism. However, I can only see hypotheses.

The figures are very small. They include a lot of information. Even full screen, it is hardly readable, in particular because it is important to view several panels simultaneously. The figure captions are more a continuation of the discussion than an explanation of the figure content.

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Spelling P5555 I17 : Le Treut Check all the references for spelling.

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