

## ***Interactive comment on “On misleading solar-climate relationship” by B. Legras et al.***

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### **Answer to referee #3**

We thank referee #3 for his comments and suggestions. Comments by the referee are highlighted and followed by our answers.

#### ***1) The title would sound better if replacing misleading by questionable.***

The title has been modified. See the answer to Referee #1.

#### ***2) Page 771-772: Modern minimum is not considered as a grand minimum (unlike the Maunder minimum). Even the Dalton minimum is not similar to the Maunder minimum the dynamo was somewhat reduced in strength but not suppressed.***

It is clear that the Maunder Minimum was "deeper" than the Dalton and Modern Min-

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ima. However, these two most recent minima are not fundamentally different from the Maunder Minimum as shown by cosmogenic isotopes records (see Delaygue and Bard, 2010, and reference therein). In addition, the Maunder Minimum is not the deepest of these solar minima (even over the past millennium) which are typical features of the Sun's behavior (about a quarter of its history over the Holocene period). Furthermore, the dynamo was probably not suppressed during the Maunder Minima as shown by decadal cycles in C14 and Be10 time series (Stuiver and Braziunas, 1993; Beer et al., 1998).

**3) Last para of section 2: It would be worth mentioning that the trend in TSI is still a subject of debates other TSI composites do not depict a decreasing trend.**

See our answer to Referee #2

**4) Same para: even though the sunspot number per se is not a good proxy for irradiance, it is used as the basis for TSI reconstruction in the past, in particular by Judith Lean. I suggest removing the confusing quotation here.**

The matter is precisely about using the "sunspot number per se" or more elaborated reconstructions often based on various sunspot properties (see our answer to Referee #2).

**5) Anyway, this reviewer see not much use of Section 2. It is not clear what is proposed by the authors to replace SN (TSI reconstructions by, e.g., Lean or Solanki or Froehlich?) and how it can affect the studied relation.**

It is clear that one of our major criticisms is that a proper attribution study must take into account the multiplicity of individual forcings (instead of the Sun only as done by the LMKC and KLMC). This is the main point of section 2, which is further reinforced by comments of Referee #4 who requested that we add more references to reliable attribution studies (Hegerl et al., 2003, 2007; Stott et al., 2006; North and Stevens, 1998; Huntingford et al., 2006) in addition to (Meehl et al., 2004; Lean and Rind, 2008, 2009;

Benestad and Schmidt, 2009) already cited in the submitted version. Concerning solar forcing curves alternative to the raw sunspot numbers, see our answer to Referee #2. This important point is the main reason why Judith Lean (2010) wrote that "terrestrial studies are no longer relegated to using geophysically meaningless sunspot numbers a proxy for solar irradiance".

**6) Page 781, line 11: from bottom: the last sentence In other words... is recommended to be removed.**

We felt that this sentence is necessary as it summarizes the core of the error made by LMKC in estimating the variance of the solar shift. In the third part of their comment to our work, the authors of LMKC demonstrate that they still misunderstand this crucial and rather elementary point. The paragraph has been rewritten and separated in two parts to improve clarity. In their comment, the authors of LMKC have shown that they still misunderstand this main point. The paragraph has been rewritten and separated in two parts to improve clarity.

**7) Page 781-782: the last part (on the Students t-test) needs to be given in more detail. The significance level (0.05?) should be defined.**

The p-value has been defined in the text.

**8) Page 784, line 22: the end of the paragraph This error ... needs to be given in more detail. It is hard to understand what the authors want to say here.**

The paragraph about KMLC has been rewritten as a separate section. See the answer to Referee #2.

**9) Page 785, line 20, last para: a more balanced view on cosmic ray effect ought to be given e.g., a mechanism alternative to Svensmarks one was proposed by B. Tinsley (electroscavenging). The authors may want to refer to a recent review of empirical evidences of cosmic ray effects.**

We have added the reference by Gray et al. (2010) who provide a full section (4.4)

reviewing the effects of charged particles on the global atmospheric electrical circuit.

**10) It would be worth stating that sunspot activity was indeed very high since 1950s (accidentally concurrent with the anthropogenic effect) e.g., Solanki et al. (Nature, 2004).**

We agree with Referee #3 and this is an issue which we stated in our paper (lines 16-17 page 770, 23-27 p. 777, 19-26 p. 783, 3-4 p. 784, 2-3 p. 785). We have thus further emphasized that point in the revised version. There are several papers already cited in our paper (Lean, 2010; Lockwood and Stamper, 1999; Lockwood et al., 1999; Delaygue and Bard, 2010), showing that the past 50 years are indeed unusual when compared to the previous centuries. More demonstrations are provided by Gray et al. (2010), now added to the reference list. Referee # 3 cite the paper by Solanki et al. (2004) who reinforced that point. However, the claim by Solanki et al. is that the past 70 years of solar activity are completely unusual when compared to the very long period of the last 8 millennia. There is still a debate about other effects that could affect this conclusion (see specific discussions in Muscheler et al. (2005) and in Bard and Frank (2006)). Consequently, it may be preferable not to open the discussion on this other interesting debate, that is not fully relevant to our discussion, the studied time period being much longer than that of interest in our paper and those by LMKC and KLMC.

**11) Special comment regarding the Supplementary material. This reviewer can hardly understand it since he/she is not familiar with Mathematica. Presently it is a mixture of pieces of code and texts that is difficult to follow. A simple plain description of the procedure followed by the code would be useful.**

The fact that calculations can be presented as a notebook with formatted text and scientific notations is one of the main interest of Mathematica although it may be at first disconcerting for users more familiar with procedural programming. We have added a short description of the sequence of calculations in the notebook.

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