The Day the Sun Stood Still: Using global Thermodynamic MHD Simulations to Infer the Structure of the Solar Corona and Inner Heliosphere during the Maunder Minimum - Response to Reviewer

We would like to thank the reviewer for their positive criticisms, which had identified several issues that have been thoroughly addressed in the revised version. Below are the comments from the reviewer (*italics*) and and our response to them (**bold**).

Overall, the manuscript is well written, albeit wordy. I think that it could be reduced by at least four pages (10%) by tightening up the text, removing duplications, and avoiding some of the hedging sentences written around tenuous hypotheses, without loss of content.

We have carefully read through the manuscript identifying, and removing redundant statements. Some of the 'hedging' sentences, however, are necessary to convey the somewhat divergent views of the co-authors. Additionally, we believe that the background information is necessary to fully interpret the observations of the Maunder Minimum. We have shortened the text, although not to the extent suggested by the referee. Moreover, we were compelled to add text to address some of the referee's comments below.

The authors may think the primary title an amusing play of words, but the Sun did not stand still in any sense of the word, nor was the Maunder Minimum anything analogous to a day (in fact, the authors argue that if anything the Maunder Minimum was a time of slow but persistent change). I suggest a revision is in order, or that the first part of the title simple be cut: the words past the colon cover the contents beautifully.

Apart from the wordiness and a few relatively minor comments below, I recommend the manuscript for publication, hoping for some edits in line with my comments, but otherwise much as written.

Indeed, at least one of the authors thought that the title was a particularly funny play on words; however, not everyone probably spent as much time as he did watching black and white Sci-Fi movies on a Saturday morning. Moreover, given that the reviewer, along with several of the co-authors think that the title was misleading, we have (after shedding a few tears) changed the title to reflect the main point of the paper. The new title reads:

"Inferring the Structure of the Solar Corona and Inner Heliosphere During the Maunder Minimum using Global Thermodynamic MHD Simulations"

A few relatively minor comments:

The long paragraph ending on p. 6 implies a difference of opinion that does not exist: Schrijver et al (2011) did NOT aruge that the 2008/2009 period offered a view of the Maunder Minimum from the perspective of the heliospheric field. In fact, they explicitly write that "... the persistent largescale dipolar field [in 2008/2009] may not be characteristic of the least active Maunder Minimum phases." The authors acknowledge that in the opening paragraph of their Discussion, but as written in Section 1 it implies something that is, in fact, not what Schrijver et al. focused on at all.

Agreed. Schrijver et al. did make this point, and emphasizing their earlier point, which focused more on the small-scale, or localized structure of the corona during the Maunder Minimum is misleading. To rectify this, yet incorporate the point that their statement implies, namely, that the structure of the Maunder Minimum Sun was not static, we have modified the sentence to read:

"They concluded that "the best estimate of magnetic activity...for the least-active Maunder Minimum phases appears to be provided by direct measurements in 2008-2009," although they acknowledged that the presence of a large-scale dipolar field may not be representative of the deepest portions of the Maunder Minimum. "

In the last par. of Section 2.4, the authors argue that "coronal features returned sometime between 1708 and 1766." But the evidence discussed preceding that suggests that faint coronal structures were already visible by 1706. So should it not be "... between 1698 and 1706"?

Observations of the 1706 eclipse conflicted with one another in the sense that one set suggests a structureless corona whereas the other suggests the presence of some quadrupolar structure. Weighing the various sources we would maintain that the structure appeared after 1706; however, to address this, we have added "likely" to the statement about when coronal structures reappeared.

Some discussion of "this resolution" and the reasons to choose " $\pm 10G$ and $\pm 3G$ " for the "parasitic polarity" at the bottom of p. 20 would seem in order: field strengths are around 1kG, but flux densities depend on resolution.

Agreed. We have expanding the following sentence: "The former was chosen to match the observed flux (at this resolution) during 2008, and the latter is simply a 1/3 scaling" to now read:

"Strong field magnetic elements in the photosphere are typically $\sim 1 \text{kG}$; however, flux densities are dependent on resolution. The value of ± 10 G was chosen to match observed values from synoptic magnetograms assembled at this resolution during the 2008 time period, while the ± 3 G value is simply a 1/3 scaling."

The opening sentence of Section 5 is written sloppily: yes, the Sun would have been "substantially the same", but the Sun is not the topic of the paper, nor is the "recent 2008/2009 minimum", but the large-scale, inner-heliospheric field is.

Agreed. We have rewritten this statement as follows:

"Our results suggest that the most likely state of the corona during the Maunder Minimum was not merely that of the 2008/2009 solar minimum, but rather a state devoid of any large-scale structure, driven by a photospheric field composed of only

ephemeral regions, and likely substantially reduced in strength."

The first paragraph on p. 32 mentions "proponents of a 2008-like Sun". Who are they? Schrijver et al. (2011) explicitly stated they were not commenting on the heliospheric field, and Svalgaard and Cliver (2007) cannot be because they wrote their paper before 2008. There's a tendency in the manuscript to evoke differences of opinion that do not exist. I suggest this sentence, and similar ones, be modified.

Agreed. We have modified the earlier statements to correctly reflect what Schrijver et al. (2011) stated. We have also modified this sentence to read:

"Thus, we suggest, that the list presented in Table 2 more stronger favors the "ephemeral-like" scenario than might be otherwise intuited."