

**Second Referee Report on MS angeo-2019-97 “Historical Aurora
Borealis Observations in Anatolia during medieval period:
Implications for the past solar activity” by N. Maden**

General Comments

With regret, I found that the manuscript is virtually the same with the previous revision. I seriously suspect if the author has really revised the manuscript after receiving two referee reports. Even in the response, the author has failed addressing most of my previous comments and clarifying the novelty of this manuscript. The author has almost explicitly admitted that he has not consulted the original historical documents for his survey. He has failed to explain the strength of aurora and has not done anything more than repeating what Neuhäuser and Neuhäuser (2015) have written. More seriously, the revised manuscript does not involve revised phrases, while the author claimed to have done. Overall, I cannot consider this manuscript has been improved through the referee process. While I am extremely reluctant to repeat my previous comments, I have had to do that, as my previous comments have not been addressed appropriately. Unless otherwise the author has mistakenly uploaded a wrong file, I would recommend rejection of this manuscript.

Specific Comments

1. Serious Discrepancies between the Revision and Response

This revision made me seriously doubt if the author has indeed revised the manuscript after receiving two referee reports. Indeed, I found various discrepancies between the revision and the response. For example, reg. my major comment 2, the author stated “The sentence is revised as “One could decide whether an observation is strong aurorae by considering its color, brightness, dynamics, duration, geomagnetic latitude””, whereas this kind of phrase was not found in the main manuscript. Likewise, reg. my major comment 7, the author stated “A detailed information about sun spot observations is added to the manuscript”, while this kind of statement could not be found in the revision, either. The author has agreed to cite several overlooked references (e.g., Kataoka et al., 2017; Kataoka and Iwahashi, 2017, etc.), whereas they are not found in the revision. After all, the revision and response are seriously inconsistent with each other and made me seriously doubt if the author has indeed made any revision upon this

manuscript.

As the manuscript is – at least apparently – not revised at all, I do not think it would be meaningful to comment anything more than what I commented in the previous review. My following comments are not my comments on the revision, but my answers against what the author has written in his response letter.

2. Novelty of the Records

As I commented before, the largest issue for this manuscript is its novelty. What the author has done in this manuscript is to simply recompile the Anatolian auroral reports from the existing catalogs (not from the original historical documents!). Therefore, these presented results are unfortunately not new. The scientific method is currently no more than a repetition of Neuhäuser and Neuhäuser (2015), while the author's outcome for the solar activity around 774/775 contradict what Neuhäuser and Neuhäuser (2015) have concluded. In this case, the only potential novelty of this manuscript is – at best – the emphasis of the high solar activity around 774/775. As long as I understand, “ANGEO publishes *original* articles and short communications (letters) on research of the Sun–Earth system...”. Therefore, the originality of this manuscript is crucially important to let this manuscript get subjected to further considerations.

3. “Strength of the Aurora”

The author must read Neuhäuser and Neuhäuser (2015) more carefully. Neuhäuser and Neuhäuser (2015) have explicitly stated “we establish five criteria for the *likeliness* of the event to be an aurora which are selected to distinguish from the other effects” in page 230. As the author has cited “The observation is classified as potential (N=0), possible (N=1), very possible (N=2), N aurora is probable (N=3), very probable (N=4), or certain (N=5) according to the criteria number (N) satisfied”. This is not about strength but about likeliness. As the equatorward extension of auroral oval has good correlation with “strength” of magnetic storm (Yokoyama et al., 1998), the “strength” would be better understood with the equatorward extension of auroral oval. Therefore, repeating an excerpt from Neuhäuser and Neuhäuser (2015) does not make any good sense here.

4. The Validity of Criteria

More seriously, the author has entirely failed to address the scientific concern for the validity of Neuhäusers' criteria, only repeating what Neuhäusers described. As I commented previously, their criteria have been seriously doubted with counter-examples (Stephenson et al., 2019). The fact-based studies show that the equatorward boundaries of the aurora reach 25°, 24°, and 38° magnetic latitudes during the historical magnetic storms in 1770, 1859, and 1958 (Kimball, 1960; Kataoka and Iwahashi, 2017; Kataoka et al., 2019; Kataoka and Kazama, 2019). In the cases of such extreme space weather events, aurorae will be seen even southward from medieval Turkey (45 – 50.1° in magnetic latitude). It is also known that whitish pillar appears equatorward of the red glow during the strong magnetic storms, probably due to field-align currents carried by precipitating electrons (Kataoka et al., 2019). It is also not clear why fire or fiery means dynamics of aurora. The descriptions like “fire” more likely means auroral color and brightness (see Figure 1 of Kataoka and Kazama, 2019). The author needs to address these facts to evaluate validity of these criteria at the very least, if he strongly wishes to use these criteria in his manuscript. Otherwise, the author must not use these “criteria”.

5. Solar Activity around 774/775

While I appreciate scientific contribution by Mekhaldi et al. (2015), Neuhäuser and Neuhäuser (2015) have claimed “they [their auroral records] cannot support a hypothetical solar super-flare” in page 236, for example. This is almost in an opposite spectrum against Mekhaldi et al. (2015). The author needs to clarify what he can say from Anatolian records for such scientific conflict.

6. Chronological Coverage

Why “Any aurora observations could not be reached up to 1453”? That must be scientifically explained.

7. Definition of the Medieval Anatolia

As the medieval border is changeable, it is even more misleading to plot the present Turkish border. The border should be removed from the map. As the Turkish came into Anatolia only after the battle of Malazgirt in 1071 (e.g., Barber, 2012), it is misleading

to consider the Byzantine Anatolia as something equivalent with the territory of modern Turkey. Constantinople is situated on the European side and outside of Anatolia. In Turkish, it is geographically categorized as “Rumelia”. Eddesa and Amida are situated in Mesopotamia. Therefore, they are not in Anatolia either.

8. Relationship with Climatic Change

As I commented previously, the logic was extremely difficult to follow and the revision of humidity with auroral record has been applied without scientific explanations. The author needs to seriously note that the relationship between solar activity and climatic change in historical time span is not very clear (Vaquero and Trigo, 2012; Lockwood et al., 2017). Lockwood et al. (2017) have especially clarified how misleading to explain the Little Ice Age with the Maunder Minimum. They have casted a caveat “The association of the solar Maunder minimum and the Little Ice Age is also not supported by proper inspection and ignores the role of other factors such as volcanoes” in page 2.23 for example. This made me strongly doubt the validity of the author’s discussion for climatological impact. This manuscript cannot be published, unless otherwise the author removes their speculation about the climatic impact.

9. Conclusion

Accordingly, the fifth and sixth conclusions must be removed, as well as the discussions on the climate change. In the same time, the author needs to clarify which made aurora visible in Anatolia so frequently in the Byzantine period: solar activity or intensity of dipole moment and position of geomagnetic pole.