

Dear Dr. Igo Paulino,
Editor
Annales Geophysicae (ANGEAO)

Ref : angeo-2019-97
Title : Historical Aurora Borealis Observations in Anatolia during medieval period: Implications for the past solar activity
Journal : Annales Geophysicae (ANGEAO)

Thank you for your constructive and helpful feedback, scholarly comments and timely processing of our submission. I have just revised the manuscript in view of the constructive and helpful editorial and reviewer comments as outlined in detail below and the paper is now ready to resubmit the journal of Annales Geophysicae (ANGEAO) titled "Historical Aurora Borealis Observations in Anatolia during medieval period: Implications for the past solar activity". Please find our response (in red) to reviewer's specific comments (in black) step by step below.

I would like to thank the reviewers for their thoughtful comments. Responses to comments are presented in the following pages along with explanations.

Thanks again and looking forward to hearing from you.

Best regards,

Dr. Nafiz MADEN
Corresponding author

Detailed Response to Reviewers

Response to comments from Anonymous Referee #1:

General Comments:

In this paper, the author reports an overview of historical Aurora observations reports in Anatolia and Middle East regions in the medieval period based in historical texts, chronicles and aurora catalogs records. The paper tried to make a relationship between the auroral activity and the past solar activity, the past climatic changes, economy and society living in the remote time.

My view on the paper is that though the discussions are interesting, but the paper do not bring clear new results and it was missing a interconnection between the historical facts, the beliefs of the ancient people and the new science that explain the Aurora phenomenon as a direct relation between the Sun events and the geomagnetic field, and also the current status of aurora observation in the north and south hemispheres. There are some scientific explanation that should be present in the paper and the cited time periods in the medieval era need to be more clear, explaining/discussing a little more some sentences and not just cite the previous papers or historical texts/chronicles. Due to these problems found in the paper I recommend to not accept the paper as it is presented.

Reply: Thank you for your comment. The constructive comments by the reviewers are really appreciated.

Major Comments:

1) The title and other citation along the text do not include the approximate time period: e.g., in the title "Historical Aurora... during the medieval period...". I think that the approximate years or century could be cited. The correct location in time (type of calendar, year and/or century) should appear clearly in a historical text.

Reply: The title of the manuscript is changed according to the reviewer comment.

2) In the Introduction section it was not defined/explained the Aurora phenomenon, neither the physical mechanisms responsible for the occurrence of this event (solar particle precipitation/solar wind, geomagnetic storms, and loss cone of particle perception/Earth magnetic field configuration, and the interaction of such charged/energetic particles with the neutral/ionized compounds of the upper atmosphere); for this kind of paper would be very interesting to show a couple examples of Auroras registered in the present time; it was missing the explanation that Auroras exist in both hemispheres (North: Borealis Aurora; South: Austral Aurora), and the physical process/mechanism involved in the Aurora light emission is exactly the same, the magnetosphere and the Earth magnetic field configurations (approximately a

magnetic dipole) and intensity have a very important role in the occurrence of Auroras (this was mentioned in some way, but not discussed and none map/cartoon was showed - for the present period). Auroras also can be observed in other planets besides Earth. In fact, I missed a deeper technical revision (including photos, a global map showing the Auroral regions in both north and south poles) in the introduction section.

Reply: *I would like to the Reviewer #1 for the encouraging and positive comments to improve the manuscript. The goal of this study is to compile a historical Anatolian aurora catalog (hAAC) during medieval period by scanning the available sources and catalogs in literature. The available catalogs described above present a number of records covering Europe, Japan, China, Russia and Middle East. There is no study dealing only with the historical aurora observations recorded in Anatolia. The catalog could be used to analyze the past solar activity and planetary climatic changes impacting on the economy and human events. This research may also contribute to the understanding of public perception of the historical auroras. Anatolia have not been studied until now with respect to meteorological and aurora observations. So, in the introduction section, it was not explained the physical mechanisms of the Aurora phenomenon. The Auroras in other planets seem entirely irrelevant.*

3) In the Results and Discussion, I could not see discussion based on the summarized parts of historical records, and neither explanations of the relationship between Auroras and Climatic Changes/solar variability/society economy. These relations should be better discussed and explained in light of the current time when the climactic changes are discussed in a global scenario.

Reply: *Thanks to the Reviewer #1 for the constructive comments to improve the quality of the manuscript. In the "Results and Discussion" section, the aurora records and climate changes are discussed in detail in Line 304 to 322. Also, a discussion between Climate change and socio-economist growth is added to this section according to the reviewer comment.*

4) In the Conclusions, it was stated that in the paper was established a relationship between the strong solar activity and auroral activity by integrating meteorological data (pg 15, lines 347-349). I could not see any meteorological data and evidence for such relationship along the paper or this was not stressed or adequate explained.

On page 16, lines 363 and 364, the author suggested future investigations in order to establish a relationship between the solar variability and climatic changes. The current paper have the aim to obtain some relationship between these two phenomena, but it was not clear. Why the author do not use one of the suggestions (for example: "Medieval Climate Anomaly") and improve the current paper? This would be much more interesting than just make a revision on previous paper and texts from historical manuscripts, without a deep discussion.

Reply: *I would like to thank the Reviewer #1 for their thoughtful comments. The "meteorological data" is changed with the "historical-climatological data" throughout the manuscript.*

The sentence in the conclusion section is omitted.

Minor issues:

Line 10/11 (pg 1): "...in order to understand the past solar activity and possible physical mechanism using historical texts, chronicles and other auroral records?". At the end of the reading it was not clear/understandable the physical mechanism beyond the auroras. Can the author improve the paper in order to satisfy this purpose?

Reply: The sentence is revised according to the reviewer comments.

Line 14/15 (pg 1): "The data of the catalog strongly support that there is a considerable relationship between the aurora activity and past strong solar activity". Again, the paper did not clarify the above relationship.

Reply: The sentence is revised according to the reviewer comments.

Line 16-18 (pg 1): "An unusually high auroral activity during the years around 1100... is quite consistent with the past solar variability, geomagnetic field intensity and planetary climatic changes". The text did not present clearly the relationship between the unusually high auroral activity around 1100 and the planetary climatic changes.

Reply: I do not agree with the Reviewer #1. So, the sentence is not changed or deleted.

Line 58 (pg 3): "... maxima of auroral observations **conform** to the maxima in sunspot records...". The author confirm the use of "conform" or do you mean "confirm"?

Reply: The "conform" is changed with the "comply with".

Line 66 (pg 3): The word "Aurora" in the sentence " historical Anatolian aurora catalog (hAAc)" is not used in capital letter (A) due to the acronym "hAAc"? Please check this sentence and acronym throughout the paper. At this same line, it is important to mention the time period correspondent to the "medieval period" just after this sentence between parentheses.

Reply: The "historical Anatolian aurora catalog" sentence and the "(hAAc)" acronym are checked throughout the paper.

Line 68 (pg 3): I suggest to replace "planetary climactic changes" for "Earth climactic changes".

Reply: The "planetary climactic changes" terms are changed as "Earth climactic changes".

Line 71/77/78 (pg 4): The acronym "hAAc" here appear as "hAAC". The author need to standardize this sentence and acronym. In the begging of this section it is interesting to

show a map of Anatolian region, its borders at the current days with other countries (Today, which countries are in the Anatolian region? Turkey only our other countries), that is, the text in the lines 77/78 could be better explained in terms of the medieval period, and comparing that map with our current time map (actual geography) (Figure 1 could enclose two maps: the medieval period and the current time maps).

Reply: The “hAAC” is revised as “hAAc”. The Byzantine map for the medievep period is added to Figure 1.

We thank to you and the Reviewer #1 for the constructive and helpful comments.

Sincerely,
Dr. Nafiz MADEN