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Title: Atmospheric drag effects on modelled LEO satellites during the July 2000 Bastille Day event in contrast to an interval of geomagnetically quiet conditions

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Dear Sir,

Thank you so much for your time and for organising the effort that is taking this manuscript through the stages making it a better and quality paper. We are also thankful to the reviews for their time and helpful comments and suggestions.

We have now revised our manuscript based on your suggestions, the reviewer comments and the answers we provided. While the revision lasted, we aimed at improving the paper's quality as much as possible in order to meet the standard of your reputed Journal. The point-by-point reply to the Editor and Reviewer's comments are detailed below:

EDITOR'S COMMENTS

Based on the reviewer comments and your answers, I invite you to submit a revised version of your manuscript. Please do take into account the detailed reviewer comments while preparing your revision. In particular, make sure that it is clear which contributions of your paper are new.

Authors Response

We have now clarified the contributions in this paper that are new as much as possible. To better track the clarifications, the reviewer comments and required adjustments are also provided (below). However, we note specific portions of the manuscript, which pin-points such contributions

- 1) In the Abstract: Besides the former inclusion (e.g., line 16-19), we buttressed and/or added to the contributions in line 19-21
- 2) In Section 1.2: In addition to the important detail provided under "Relevance of the study and its application" (e.g., line 116-119) we further provided more, as well as the justification for focusing on the Bastille Day event in line 120-133
- 3) In Section 4: line 316-322.

COMMENTS BY REFEREE #1

The paper is dealing with the impact of atmospheric drag on LEO satellites, which is a complex problem. This work does not contain any new ideas and the authors already acknowledge this fact in their abstract! Their methodology and some applications have been already presented in previous work. However, some of the data presented in the paper can be considered as new since the authors examine some specific cases. Overall, the paper does not provide significant scientific contribution, especially when compared with similar work from the literature.

Authors Response

Although the reviewer admitted that some of the data we presented in the paper are new, he stopped short of acknowledging the accomplishment of this effort. The referee feels that our paper does not provide

significant scientific contribution. We respect the judgment of the referee and do not take it as being biased. However, we beg to differ on the claim. As the goal of manuscript review (by Referees) are generally to 'provide unbiased and constructive comments aimed, whenever possible, at improving the work,' we feel that a generous suggestion of content-wise inclusion or modification that will increase quality would have been a better conclusion of the referee. To address the comment of the referee, I think elucidating the new scientific contributions of this paper in clear terms (as also suggested by the Editor) is the best thing to do. We therefore highlight them below (as was done earlier via our response to RC1).

(1) This paper emphasized and/or focused on the Bastille Day great geomagnetic storm (and associated phenomena). It is hoped that efforts directed towards assessing, monitoring, modeling and/or prediction of the impacts associated with sudden severe solar energetic transients (like this one) are key to mitigating the potential threat posed by such event in future occurrence. This is the first time we are modeling atmospheric drag effect associated with the Bastille Day event (BDE). Therefore, this paper increases the visibility and better contribute to the scientific body of knowledge surrounding the BDE (as earlier stated). Please see the specific portions above where we provided the detail of this contribution (and others) in the text, as well as the justification for focusing on the BDE.

(2) In our analysis we used new method and indices to describe and estimate drag effects on the satellite trajectory when contrasting between the (i) solar active and the quiescent regimes (ii) active regime and the Bastille day storm, and (iii) the quiescent regime and the Bastille day event/storm. This analysis and the results obtained is now helping us to produce estimation model that compares effects between regimes of varying solar-geomagnetic activity. In addition to examining a specific case (different from previous study), we used a relatively new (or novel) approach/method. As much as I prefer to keep a low profile on this at this stage, I am yet to find similar approach in literature till date.

(3) This work doubles as a strong review paper. We presented extensive details/review on atmospheric drag (and its relevance) in relation to solar activity, against properly referenced background of existing work. If carefully perused, one could see a concise comprehensive connection between atmospheric drag and solar-geomagnetic activity that is particularly unprecedented when compared with our previous work (not overall literature in the area) – thanks to the proficiency of some co-authors!

In summary, our pattern of result presentation (especially in abstract) may look similar but we believe the accomplishments or contributions of this effort are replete and should not be overemphasized (especially when one carefully read beyond the abstract).

COMMENTS BY REFEREE #2

1. The goal of the paper i.e The goal of this effort was to quantify how solar-geomagnetic activity influences atmospheric drag and perturbs satellite orbits, is very clear and worthwhile. The authors focused on the Bastille event because they have done similar work in another paper. I do not agree with the use of word as the authors seem to infer that they have not done any work different from the paper they first published on the topic. I reckon that the authors should have shown distinct comparison between the current paper and the previous paper and strongly justify why they focused on the bastille event.

Authors Response

We have now revised the manuscript in the manner that buttressed the scientific contribution in this work that are new and also different from previous work (please also see the above highlight). This way the 'distinct comparison between the current paper and the previous paper' can be clearly understood. We have also justified the reason we focused on the Bastille event. The specific portions of the manuscript which pin-points such inclusions are listed below

- 1) In the Abstract: line 19-21 (in addition to line 16-19)
- 2) In Section 1.2: line 120-133 (In addition to line 116-119)
- 3) In Section 4: line 316-322.

2. I am satisfied with the response from the author. I reckon that the authors could include the response, i.e "this work also doubled as a strong review paper because it presented extensive details/review on atmospheric drag (and its relevance) in relation to solar activity, against properly referenced background of existing work. The significant number of readers who have interacted with this manuscript on this platform (and others) certainly did because of its relevance to them. I am also aware of authors have cited this paper in their new manuscript" on the introduction. This will guide readers and clearly underpin the objectives of the present communication.

Response Please see line 131-133 for the inclusion. We excluded a few lines since this is a scientific article

It will be good for the authors to spotlight the comparison of the Bastille day event to existing result right from the abstract.

Response Please see line 3-4, 18, 19-22

I advise that the part of the abstract that sort of infer that there are no new results in the paper should be taken off as it is grossly misleading if the authors claim that "this analysis motivated the development of new method and indices for description and estimation of drag effects on satellite ephemeris

Response The suggested phrase have now been removed from the abstract.

How do you justify the below within in he current paper. You are supposed to convincingly show the strength in this paper for reviewing purposes. "We are now in the process of combining satellite drag model high-fidelity atmospheric specification to produce such realistic estimation model (beginning with the results of this work".

Response In addition to examining a specific case (the BDE) that is different from previous study (with new results), one other strength of this work is that we used a relatively new approach that is now helping us to produce estimation model that compares effects between regimes of varying solar-geomagnetic activity – and such formulation is a process!

In conclusion, we have also closely perused the manuscript again to eliminate or reduce typographical errors and expressions that can make the understanding of any portion difficult for the readers (as much as possible). We believe that in its current state, our revised manuscript is now suitable for further consideration by your journal, and sincerely hope that the paper will now be accepted for publication.

Thank you very much.

Victor U. J. Nwankwo