

Interactive comment on “Daedalus: A Low-Flying Spacecraft for the Exploration of the Lower Thermosphere - Ionosphere” by Theodoros E. Sarris et al.

Anonymous Referee #2

Received and published: 28 October 2019

The manuscript “Daedalus: A Low-Flying Spacecraft for the Exploration of the Lower Thermosphere - Ionosphere” presents a mission proposal to investigate Lower Thermosphere and Ionosphere (LTI) region in the altitude range of ~ 120 -200 km. The primary research goal of the planned Daedalus mission is in situ measurements of the strength of the Joule heating.

In the science part of the manuscript, basic physical processes in the LTI region concerning atmospheric neutrals, charged particles, electromagnetic fields and chemical processes, and also how the LTI region is connected space weather phenomena, are presented.

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In the mission and instrument part, the manuscript describes what kind of instrumentation and orbits are required to investigate Joule heating.

Overall, the manuscript includes many interesting topics both in terms of science and space technology. However, the manuscript requires substantial improvements in many issues listed below before it can provide useful, accurate and balanced information for a reader.

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General remarks:

It is obvious that it is a challenging task to write a paper about a full mission with numerous instruments and spacecraft. For example, it is natural that authors have to make compromises of which materials are presented in a manuscript. It is also clear that a mission description presented in the manuscript is complicated by different design phases and, therefore, by the varying level of details. The level of details increases naturally with the progress of the project. Nevertheless, major improvements are called for the manuscript. The referee hopes that suggestions below help authors to pinpoint parts, which require improvements.

1. Make it a real scientific paper

Although the discussed research questions and mission challenges are highly interesting topics, the work has certain basic problems in terms of a research paper. In fact, one cannot avoid obtaining an impression that the text and material may be based on an instrument proposal, which spirit and goals are focused on selling the mission concept. A research paper should have a more analytical and quantitative compared to the current manuscript.

-> Suggestion: Authors should make major improvements in the manuscript to build it up into a scientific paper. The apparent proposal behind the manuscript is only a good starting material.

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2. Include proper references of earlier very important work

Aforementioned “proposal-research paper” dilemma arises in many places in the manuscript. For example, the science case is justified by introducing relatively old Joule heating studies. At the moment a reader cannot be sure have other previous MHD modelling studies like

- Slinker et al., Comparison of global MHD simulations with AMIE simulations for the events of May 19–20, JGR, 1996, <https://doi.org/10.1029/1999JA900403> - Lopez et al., Coupling between the solar wind and the magnetosphere during strong driving: MHD Simulations: IEEE Transactions on Plasma Science August 2004, Vol. 32(4), pp.1439-1442 - Hernandez et al., Ionospheric joule heating during magnetic storms: MHD simulations, Advances in Space Research, 2005, Vol.36 (10), pp.1845-1848

and some of the most recent global modelling studies of the topic e.g.

- Connor et al., et al. Modeling the ionosphere-thermosphere response to a geomagnetic storm using physics-based magnetospheric energy input: OpenGGCM-CTIM results, Journal of Space Weather and Space Climate; Vol. 6, (2016). DOI:10.1051/swsc/2016019)

not been cited in order to make the science case more dramatic and attractive, or is it really so that not much has happened in the global modelling field in a decade?

-> Suggestion: Authors should include proper references of earlier important works and put the science case into a wider research context.

3. Elaborate instrument and nanosatellites descriptions

There is no quantitative enough comparison between properties of the proposed instruments and the previous instruments neither instruments onboard forthcoming missions.

The description of nanosatellites is also quite vague. At the moment, the idea of a mis-

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sion consisting of a mothership and nanosatellites is not alone an innovative idea, but rather a standard starting point. The main question when nanosatellites are proposed to support the mission is how useful information, in practice and in reality, a nanosatellite can provide, taking into account its typically poor – and highly challenging – attitude control as well as its limited resources in terms of mass, energy, volume, telemetry etc. all of which cause strong limitations to nanosatellite’s instrumentation. Furthermore, at the moment the paper does not state clearly what are the properties of the instruments onboard nanosatellites and how useful they can be.

-> Suggestions: Authors should strengthen the payload and nanosatellite descriptions in the manuscript as well as show more clearly how the payload is different from earlier and forthcoming missions.

4. Concretize the mission analysis

Comparison of the mission described in the paper to other missions lacks enough comprehensive quantitative analysis. There are several highly “selling” superlatives and statements, which are acceptable – and also needed - in a proposal, but which requires detailed scientific justification in a research paper. There are also several bulleted lists of text and statements and overly short subsections, which do not fit smoothly to the manuscript.

When the mission analysis is considered, an interested reader would appreciate, or even anticipate, to see even rough simulation results that show what kind of plasma and field parameters the mission could provide along the suggested orbits and how the parameters will be used to fulfill the science requirements, especially, to quantify Joule heating. Such a simulation should also include inaccuracies in the measured parameters caused by limitations of instruments. At the moment, it is questionable how inaccurate the values of Joule heating, which depends on numerous plasma and field parameters - which also should be measured simultaneously (Eqs. 1-4) - might be and, consequently, how accurate new quantitative information about Joule heating

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the mission really could provide.

An interesting question, which is not addressed in the work, is how the instruments on the nanosatellites - especially their magnetometers- combined with more comprehensive instruments on the mothership can increase the science return. Especially, what advantages arise from different orbits and orbital evolution of the nanosatellites and the mothership.

-> Suggestion: Authors should provide more detailed mission analysis, especially, analyze more in-depth the impact of the payload on the scientific mission and the nanosatellites. The presentation style should be that of a research paper.

5. Improve figures

Another example of the “proposal type” material includes some of the figures. Especially, Figs. 1 and 15 are suitable figures for a presentation or for a proposal, but their information content is so low that it is highly questionable why such plots should be included into the paper.

-> Suggestion: Author should justify the importance of Figures 1 and 15.

Moreover, in many plots, units are not given and it is unclear from where the plots come from. A reader should be aware of whether the plot is a result of a new analysis - in this case the analysis should be described in detail - , or is it taken from some previous publications – in this case there should be a reference to the work. Moreover, font sizes are often too small and some lines are practically invisible.

-> Suggestion: Authors should check all figures and, for example, make sure that units and original sources of the plots are given clearly.

6. Make minor improvements

The paper includes several places requiring minor fine-tuning in order for the work to fulfill typical research paper standards. For example, acronyms are now presented but

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described only later, even several times, units are not given and figures miss information.

-> Suggestion: Authors should proofread the manuscript and add missing scientific details.

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Interactive comment on Geosci. Instrum. Method. Data Syst. Discuss.,
<https://doi.org/10.5194/gi-2019-3>, 2019.

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