Dear Dr. Schwane,

Thank you for your email including the responses of the reviewers to Manuscript 2017-10-A34107. The authors have reviewed the manuscript and have made changes according to the reviewer's comments. Within the manuscript these changes have been highlighted in red. The reviewer's comments are included below, along with the resulting modification to the manuscript.

We would like to thank the reviewers for their time, and for their comments which have helped to improve this manuscript.

Reviewer 1:

1. *[Page 13, Eqn 20] It is unclear why there is 10e5 (i.e. 1 bar) added to the dynamic pressure variation in the C2 cost function. Please explain where this comes from.*

It has been clarified that these are scaling and translating constants which improve accuracy and numerical stability under the equation on pg. 14.

2. *[Page 13, Eqn 22] It is unclear why the C2 cost function is scaled by 0.01. Please explain where this comes from.*

It has been clarified that this is a weighting factor under the equation on pg. 15.

3. *Typographical/aesthetic*
   ** Units missing in nomenclature for Lift, Time and Drag. [Page 1]*
   ** Indicate in Figure 6 that the y-axis corresponds to drag coefficient C_D. [Page 8]*
   ** Correct lift and drag symbols F_D and F_L to D and L. [Page 9, Eqn 3-4]*
   ** SQP abbreviation already used [Page 11, line 58] before written in full [Page 13, line 34].*
   ** Correct symbol F_d to D. [Page 18, line 30]*
   ** [Page 21, line 55] "Only a small variation(...)" instead of "Only small variation(...)".*
   ** Correct symbol L/d to L/D. [Page 22, line 56]*

All typographical and aesthetic errors have been corrected.

Reviewer 2:

1. *Literature review is adequate, though could be expanded in sections. For example, the reference to optimal control methods for trajectory optimisation (pg 2, para 2) only references 3 paper all from the 1990s. There has been a lot of work done more recently on more advanced single/multi-objective trajectory optimisation, including applied to combined or multi-propulsion system spaceplanes.*

The literature review has generally been expanded. Additional, more up-to-date, sources have been added in paragraph 2 pg.4, along with an extra category of vehicle which operates in combined scramjet/rocket mode. This paragraph has also been modified to focus more directly on the specific optimised trajectories of single stage spaceplanes.

Paragraph 5 pg. 4 has been expanded to include more examples of the usage of optimal control theory in trajectory calculation, as well as to define the advantages of optimal control more clearly.

2. *A later paragraph (pg 4, para 5) does reference 3 other papers that use opt control. The last one [17], "Time-optimal nonlinear feedback control for the NPSAT1 spacecraft", does use open loop*

control (solved via an optimal control problem) within a feedback control architecture, however is for spacecraft attitude and not the most relevant in the context here.

This reference has been removed.

3. *As a side note on the literature review, the reference list itself has numerous errors, missing information, duplications, and typos.*

The reference list has been improved, duplications removed and missing information added.

4. *The main issue that should be addressed is around the descriptions of the optimal control/optimisation sections. While not the sole focus of the paper, more information is necessary for the reader to understand the accuracy and optimality of the results, and to implement on their own the same approach.*

Information has been added in Sections IV.B.2,3 & 4 addressing the variation of node number within DIDO to investigate the convergence of the solution, and the variable local minima.

More information on the pseudospectral method, its relation to other optimal control techniques, and its accuracy and convergence properties has been added in the final paragraph on pg. 4.

It has been clarified on pg. 11 that the pseudospectral method is used by the first and second stages.

5. *As mentioned previously, the literature section could be expanded in terms of the breadth and current state of the art for the optimisation of spaceplane trajectories, and well as optimal control and optimisation approaches that have been developed and used.*

This point is covered in the changes made for point 1.

6. *More critically, more specifics on the optimisation settings used and on the optimality of the results presented are needed. The 3rd stage optimisation is clearer, using single shooting, direct transcription plus fmincon-sqp with 20 nodes. The 1st and 2nd stage optimisation are less clear.*

This point is covered in the changes made for points 4 & 8.

7. *What does LODESTAR add beyond DIDO? Related to this, was LODESTAR developed for this paper or does it pre-date this? It is a question mostly as there are no references provided for it.*

The description of LODESTAR has been expanded and moved to the start of Section IV.B, pg. 12. LODESTAR has been developed for this study, and does not have previous articles to reference.

8. *Could the authors please add some text stating the underpinning methods that were used, rather than referring only to a commercial package (which the readers may or may not be as familiar with). They state that DIDO uses the Gauss pseudospectral method for the transcription but nothing about the optimiser (e.g., I believe DIDO uses SNOPT which employs a SQP method for local optimisation) or first guess approach.*

A description of the optimiser has been included within the LODESTAR description at the start of Section IV.B, pg.12, clarifying that DIDO is using SNOPT, with an active-set SQP method.

9. *Since all the optimisations methods are local, can the authors add some text explaining the settings and approach they used. For example, how many runs, were/how many other local minima were discovered? Ultimately the text should address the local vs global optimality of the results presented.*

This point is covered in the changes made for point 4.

10. *General*
    1- References in text have both a space before some, and not for others, e.g., launch[1] vs launch [1]

2- References to other sections should include the full number, e.g., Sec III.A.2 rather than Sec 2. For example, see pg 23, Sec C which refers to Section 1 and Section 2.

These typographical errors have been corrected.

11. *Nomenclature*
    3- gamma is referred to as both flight path angle and trajectory angle, it would be clearer to pick only one
    4- x is termed 'primal variables', presumably in reference to the DIDO formation? A suggestion for a more general audience, in optimal control, x would more commonly be the state vector (or state variables). Primal variables in a mathematical optimisation typically refer to a duality problem, where you have primal and dual problems (which is not applicable here).
    5- for {psi, lambda, M, P}, please define these more specifically then simply "functions"
    6- please add all the dynamic state variables (e.g., lat, lon, v) to the nomenclature list

Gamma has been changed to 'flight path angle' in all instances. 'Primal variables' has been changed to 'state variables' in all instances. Nomenclature list has been updated.

12. *Text*
    7- pg 7, Sec A. "CART3D has been used successfully in a variety of aerospace applications including hypersonic launch systems [27] and has shown good agreement when compared to experimental results [28]." The last statement is a bit too general especially as it is highly dependent on the vehicle modelled and settings used. Could the authors please clarify this to refer to specific cases.
    8- Pg 8, para 2: "it is assumed that 10 angle of attack at 50kPa produces the maximum normal force", where did this assumption come from?

The previous use cases of CART3D have been expanded upon in the final paragraph of pg. 7. The assessment of the agreement of CART3D with experimental results has been changed from 'good' to 'fair' based on these additional sources. This assessment does not significantly impact the applicability of CART3D to this study.

In the final paragraph of pg. 8 it has been clarified that this maximum normal force is not an assumption, but rather an enforced limit.

13. *References*
    9- The reference list contains numerous errors. For example: [5] Vol. Advance On; [9] is missing the journal name; [11] "..Joing Propulsion Conf.."; [26] lists the paper title twice; [16] & [36] are duplicates, [31] page numbers == the year, e.g., p. 2009; [40] the paper title ends in '..'.

This point is covered in the changes made for point 3.

The authors hope that the reviewer's comments have been properly addressed.

Regards,

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