

Interactive comment on “Solar-cycle, seasonal, and asymmetric dependencies of thermospheric mass density disturbances due to magnetospheric forcing” by Andres Calabia and Shuanggen Jin

Anonymous Referee #2

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Title: Solar-cycle, seasonal, and asymmetric dependencies of thermospheric mass density disturbances due to magnetospheric forcing Author(s): Andres Calabia and Shuanggen Jin MS No.: angeo-2019-78 MS Type: Regular paper Special Issue: Satellite observations for space weather and geo-hazard

General comments

The subject of the paper is the investigation of the relationship between solar and magnetospheric indices and thermosphere density disturbances associated with solar/magnetospheric forcing using GRACE observations. I believe that the analysis proposed by the authors is particularly interesting for two reasons: 1) it uses estimates

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of the thermospheric mass density derived from the high sensitivity accelerometers on board the GRACE mission; 2) analyses the extremely interesting period 2003-2013 containing the descending phase of solar activity, after the second maximum of the solar cycle 23, up to the beginning of the ascending phase of cycle 24, including the exceptional and extended minimum of 2009.

Below I list (not in order of importance) a number of comments on the results and discussed issues.

————— Specific comments:

L.33 “Different sunspots regions in the solar corona provide different speeds and densities of solar wind, forming an outward spiral with fast-moving and slow-moving streams”. Actually, open/close field regions in the corona are crucial for generation of fast/slow wind more than sunspots regions. I suggest to reformulate as, for example, “Different open and closed magnetic flux domains in the solar corona provide different speeds and densities of solar wind, forming an outward spiral with fast-moving and slow-moving streams”

L.43 “. . .in thermospheric composition, temperature, density, and winds. Please, add bibliography

L.65 “. . .showing density increases up to 800 %.” Please, specify time scale.

L.120 “. . .are computed using the methods developed in Calabria and Jin [2016], and are provided at 3 min interval sampling in the supporting information files.” I agree with the authors that it is possible to refer to another paper the detailed description of the method. However, I suggest to insert some detail to shortly illustrate the methods used to estimate the mass density.

L.124 The merging electric field E_m is introduced without any explanation, I suggest to explain why it is introduced in this point of the paper.

L.131 The authors use the PCA technique to remove “external” forcing to thermo-

sphere data. However, other techniques more suitable for non-stationary signals, e.g., wavelets or EMD, have been used by other authors. Please, shortly describe and support the choice of PCA method.

L.150 Please justify the choice of a 10d period. Why not, for example, a half solar rotation period (about 12d).

L.187 Section 3. I strongly suggest a reorganization of the whole section 3. At the moment it seems an unorganized list of figure comments related to analysis of single events (e.g., Fig.1), particular observation periods (e.g., Fig.6) or whole period (e.g., Fig.4). I would suggest structuring it with subsections, by listing the various analyses that have been carried out, the objectives and the results.

L240-L255 This part is confusing (with several references to different thermosphere regions and different figures, tables and equations). It must be rewritten by ordering the analysis and the results. Moreover in L.249 (and Fig.4 and Table 2 captions) is introduced an unknown Furrier fit. I suppose you mean Fourier fit.

L.369 Section 4: Perhaps it can be redistributed in a section 3 (Data analysis and discussion) reorganized into subsections.

L.445-450 better at the end of the section.

————— Technical corrections:

L.133 “The aim of by ‘a’ PCA technique is to determine. . .” suggested “The purpose/aim of a PCA technique is to determine. . .”

L.137 Please, reshape the sentence “The highly values of explained variance for the first modes indicate marked patterns of variability, and the correlations to parameterizations indicate high accuracy in the model.” in order to clarify the concept.

L.141/L.144 residuals (r) or residual disturbances (r)? I suggest to use the same definition for the same symbol (r).

L.150 “Density residuals at three latitude regions are...” the authors can specify here the chosen latitudes.

L.158 “...to fit the direct signal of disturbances.” do you mean “residual disturbances (r)”?

L.248 ...standard deviations (σ). => ...standard deviations (σ).

L.249 (and Fig.4 and Table 2 captions) is introduced an unknown Furrier fit. I suppose you mean Fourier fit.

L.390 magnetic dip pole and the Earth's => magnetic dipole and the Earth's

L.406 dip pole => dipole

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