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Interactive comment on "Structural characterization of the equatorial F region plasma irregularities in the multifractal context" *by* Neelakshi Joshi et al.

Anonymous Referee #2

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General comments:

In this paper a multifractal analysis of in situ data of ionospheric irregularities obtained from two experiments is performed. The analysis includes a comparison with the theoretical p-model and confirms the presence of inhomogeneities in the ionospheric plasma. It is also claimed that their results characterize the multiplicative energy cascade in the ionosphere.

Overall, the analysis presented is interesting and the results seem consistent. However, I think that the physical interpretation of the results can be improved, and the grammar needs to be carefully checked. For these reasons I think that this paper can

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be published after a major revision is done. A list of general and specific comments, and suggested corrections follows.

1) The authors claim that their results are related to the energy cascade of the turbulent ionospheric plasma. However the paper does not show the presence of an energy cascade in the data. I suggest to include a new figure showing the power spectral density of the data, and indicating the range of scales in which a power-law is observed. In hydrodynamic and solar wind plasma turbulence the power-law has a spectral index around -5/3 $\sim$ -1.67, however it is known that the spectral index of ionospheric turbulence can deviate from this value.

2) The results are interpreted in terms of small-scale and large-scale fluctuations with respect to the average. Do you mean the average value of the data, or the average of the fluctuations? How are these fluctuations and their scale related to plasma fluctuations arising from the generalized Rayleigh-Taylor instability?

3) The grammar needs to be improved. For instance, there are missing articles such as “the” and “a” throughout the text. I indicate some specific examples in the technical corrections below. It is not an exhaustive list though, so please revise the grammar of your manuscript carefully.

Specific comments:

4) The figures should appear on the manuscript in sequential order. For example, on page 6, the analysis jumps from Fig. 1 to Fig. 3.

5) Check the format of citations in the manuscript. For example, in page 3, line 16, “Muralikrishna P. and Abdu M. A. (2006) should be “Muralikrishna and Abdu (2006)”.

6) Page 3, line 18: This paragraph should be rewritten to clarify that the key results are from the literature review and not from the present study.

7) Page 4, equation (1): Please define “y” and “y_n”.

8) Page 4, equation (2): Why F_q(s) does not depend on “n”? Why the k index does not appear in the summation?

9) Page 4, equation (4): What is h prime?

10) Page 4, line 24: the “&” symbol in “p1&p2” and “l1&l2” represents a special notation? If not, replace with “and”. If possible, use “p_1”, “p_2”, “l_1” and “l_2” to improve the text.

11) Page 5, equation (6): Please explain the “m” and “n” parameters, and rewrite the symbols for the natural logarithms, for example, “lnp1” by “\ln(p_1)”.

12) Page 5: line 28: The description of the singularity spectra in terms of a truncated shape, or in terms of left-skewness or right-skewness as done in page 6, needs to be improved. A detailed description will aid potential readers to interpret and understand your results. For example, does it mean that the points accumulate near a certain \alpha value? Why a spectrum truncated to the left indicates insensitivity to large local fluctuations?

13) Page 6, line 15: How is it evident? Please detail.

14) Page 7, line 30: I think that the purpose of this paragraph is to indicate that fractal formalisms can bring about new information wirh respect to classical tools such as the power spectral density. This is a fact that should be stated in the introduction, instead of the conclusions section. Therefore, I suggest the authors to move this paragraph to the introduction. Before that, please clarify what do you mean with “conclusively substantiated the occurrence of [the] energy cascade process in turbulent sites”.

15) Page 8, line 3: The following references have also applied fractal and multifractal techniques to characterize the turbulence in the solar and the interplanetary medium. Please consider including them in your literature review.

Abramenko, V. I., Yurchyshyn, V. B., Wang, H., Spirock, T. J. and Goode, P. R. Scaling behavior of structure functions of the longitudinal magnetic field in active regions of the

Sun. Astrophys. J. 577, 487, 2002.

Carbone, V., Bruno, R., Veltri, P. Scaling laws in the solar wind turbulence. Lecture Notes in Physics 462, 153–158, 1995.

Grauer, R., Krug, J., Marliani, C. Scaling of high-order structure functions in magnetohydrodynamic turbulence. Phys. Lett. A 195, 335–338, 1994.

Chian, A. C.-L., Mu\∼noz, P. R. Detection of current sheets and magnetic reconnections at the turbulent leading edge of an interplanetary coronal mass ejection. Astrophys. J. 733, L34, 2011.

Miranda, R. A., Chian, A. C.-L., Rempel, E. L. Universal scaling laws for fully-developed magnetic field turbulence near and far upstream of the Earth's bow shock. Adv. Space Res. 51, 1893, 2013.

16) The description of the results in the conclusions section needs to be improved. In particular, the paragraph starting on line 15 of page 8 is difficult to understand. What is a "left skewed with right truncated" spectrum?

17) Page 8, line 26: the final paragraph of the conclusions section presents a result which is not mentioned in section 4. Please move the description of Fig. 5 to section 4, and leave the interpretation here.

Technical corrections:

18) In order to improve the presentation of the paper I can suggest the following list of text corrections. Please re-check the grammar carefully.

Page 1, line 3: insert "a" before "multifractal".

Page 1, line 5: insert "The" before "first experiment", and "the" before "second experiment".

Page 1, line 6: insert "The" before "multifractal" and before "p-model", and replace "is"

by “are”.

Page 1, line 7: insert “The” before “result”.

Page 1, line 8: insert “the” before “first experiment”.

Page 2, line 10: insert “and” before “multispectral”.

Page 2, line 17: replace the “-” with “such as”.

Page 2, line 18: remove the “-”.

Page 2, line 24: replace “emphin situ” by “\emph{in situ}”.

Page 2, line 25: insert “In the” before “first experiment”.

Page 2, line 25: remove “is chosen as”.

Page 2, line 27: replace “. Whereas” by “, whereas in”

Page 2, line 27: remove the sentence “is chosen as during the experiment”.

Page 3, line 6: insert “The” before “SONDA”.

Page 3, line 9: insert “A” before “rocket”.

Page 3, line 13: insert “The” before “rocket”.

Page 3, line 25: rewrite the sentence “Ground equipment, digisonde, near launching station...”.

Page 3, line 13: move the sentence “where \alpha represents...” after Eq. (4).

Page 5, line 14: replace “by (Ihlen E. (2012), Table 2)” by “by Table 2 of Ihlen (2012)”.

Page 6, line 2: move the sentence “represent the deviation...” after Eq. (8).

Page 8, line 1: replace “model” with “modelling”.

Page 8, line 5: remove “past”.

Page 8, line 7: remove “altogether”.

Page 8, line 8: please rewrite the sentence “supposedly in or near the irregularities”.

Page 8: line 8: replace “1.5 > h(q) > 0.9” by “0.9 < h(q) < 1.5”. It is easier to read.

Page 8, line 18: remove “(considered in this study)”.

Page 8, line 33: replace “in line” with “in agreement”.

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