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Interactive Comment

Interactive comment on "Small scale density variations of electrons and charged particles in the vicinity of polar mesosphere summer echoes" *by* M. Rapp et al.

Anonymous Referee #1

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This is another paper by the authors in an exciting series about the phyical mechanisms behind PMSE. The most important paper in this series is the recent "Rapp and Lübken (2003), On the nature of PMSE..." There is reason to regard that paper as "the solution of the PMSE mystery". The present paper builds on the previous one by applying small-scale in situ data to test the proposed theory. The present paper also extends the theory by providing a description of the time-dependent spectral shape of the charge fluctuations in PMSE.

The paper is well written. It starts out with a good summary of the PMSE problem, previous approaches and the current theory.

However, I have a major problem with the chain of arguments in section 4 that relates the charge fluctuations to observed PMSE radar signal:

The radar reflectivity is proportional to the electron density Ne squared and the power spectral density of the relative electron fluctuations PSD at lambda/2 (equation 1). The authors suggest then a similar proportionality in terms of the particle charge number density ZaNa (equation 2). It is correct that there is a proportionality dNe ˜ dZaNa for small perturbations. However, this proportionality does not apply to the total number densities Ne and ZaNa. The radar reflectivity is proportional to Neˆ2, not to (ZaNa)ˆ2 as equation 2 suggests. In my opinion, equation 2 cannot be expected to give a measure of the radar signal.

As an example, think of a strong electron bite-out (Ne very small, ZaNa large). In this case, as there are hardly any free electrons left, the radar reflectivity will be small no matter how strong relative fluctuations there are in Ne or ZaNa.

This leads to a deeper question about the data presented here: The authors themselves refer to the case of an electron bite-out when they try to explain the discrepancy between equations 1 and 2 at 85-86 km in figure 5. But I see a more basic problem: How can there be a strong radar reflectivity at all when free electron are absent (as shown in figure 2 at 84.5-85 km and 87.5-88 km)? Possible explanations are that figure 2 does not show common-volume measurements or that the electron bite-outs are measurement artifacts. In both cases the data would not be useful as a test of the theory.

An additional comment: Figure 5 needs clarification. What is plotted? Is it log(PSD) as the upper abscissa suggests or log(Nˆ2*PSD) as the figure caption suggests?

In summary, based on the present argumentation and data, I cannot agree with the conclusions in the last two paragraphs in section 4.

Finally, a small comment relating to section 5. Below equation 6 it is noted in parantheses that there is no transfer of power spectral density between the Fourier modes once

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the neutral turbulence has stopped. This is a central idea for the understanding of the R&L theory. It would be very instructive for the reader to expand on this a little more. A half sentence in parantheses is not enough.

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 3469, 2003.

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