

## ***Interactive comment on “Characteristics of layered occurrence ratio of polar mesosphere summer echoes observed by EISCAT VHF 224 MHz Radar” by Shucan Ge et al.***

### **Anonymous Referee #2**

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General comments: Present study characterize the layered polar mesospheric summer echoes (PMSE) occurrence ratio (OR) using EISCAT VHF radar data from 2004-2015. They found that mono and double layer OR is higher than the tri-layer OR, in addition they also noticed a seasonal variation of the OR between these three layers. Further, to estimate the characteristics of the layered PMSE OR a new method has been proposed. Output obtained from the new method is used to understand the solar cycle dependency and geomagnetic variation dependency of the layered PMSE OR. From which it has been concluded that PMSE layered OR is positively correlated with the K index. The correlation between PMSE mono and double-layer OR and F10.7 is relatively weak, and PMSE tri-layer OR has a negative correlation with F10.7.

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11 years of EISCAT radar data is used for the characterization, this data covers almost two solar maxima (~2004 and 2012-2014) and a solar minimum (2006-2009) period. I can understand that the authors put large amount of time and effort to processes the data and the new method. However, I have some serious concern about the new method and the discussion part. In the new method the authors used the altitude information based on this they also try to explain the long term variations (in particular solar and geomagnetic influences on the PMSE OR) but there is no detailed description about this method and how it can take care of the data missing? And the discussion part should be rewritten with citing previous reports and how obtained results are differing from the earlier reports. Thus, I recommend for a major revision prior to the publication.

Specific comments:

1. Section 4.1, the authors introduced a new method for characterize the PMSE OR, they claimed that the new method will avoid the data discontinuity problem? But there is no detailed explanation or justification about how this will compensate the data discontinuity issue? ... Page12, In this section, the day when the first occurrence of PMSE in 2004 (regardless of duration) was recorded as 1 and the day with the later occurrence of PMSE increased by sequence. . . , from these lines what I understood is that they have taken number of occurrence days rather than hours (used in the earlier studies), if it is so, what is the role of altitude and how the OR percentage calculated? Instead of hours if you're taking the number of occurrence by day earlier method (based on time) also may give the same result! Justify it.

2. Figure 2 clearly shows a solar cycle variation, e.g., maximum during solar maxima years and minimum during solar minimum years. But the authors claimed that as a sinusoidal wave! This may mislead the readers. From my understanding if we follow the existing method the influence of solar radiation on PMSE is positive (Bremer et al., 2006). Clarify it.

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3. Section 2, There is no a single reference about the EISCAT radar and its data quality! It will be useful if you can include some information about GUIDAP with references. Of course, the radar experiment details are given in table2, however please include the vertical resolution of the data and give brief information about based on which criteria the multiple layers are identified and what is the average occurrence altitude of each layer (i.e., mono, double and tri layer)? 4. To find the characteristic of PMSE occurrence ratio (OR), a computing method and threshold must be defined. First of all, . . . , the threshold of electron density ( $N_e > 2.6 \times 10^{11} \text{ m}^{-3}$ ) was calculated (Hocking and Röttger, 1997). Not clear, modify the sentence. During the PMSE time the electron density will be bite-out (Kelly 2010) so one can expect decrement in the electron density. Here what the authors meant to say? They have taken only above this limit ( $N_e > 2.6 \times 10^{11} \text{ m}^{-3}$ ) or below? 5. It may look good if you change the title as, "Characteristics of layered polar mesospheric summer echoes occurrence ratio observed by EISCAT VHF 224 MHz radar" and discuss about the multiple layered PMSE occurrence and its possible generation mechanism in the introduction part? And brief about why the study of characterization of multiple PMSE OR is important? 6. Page1 line 15, solar cycle, can be used. . . , modify the sentence. 7. Page1 line 18, PMSE layered. . . , use only one term either Layer PMSE or PMSE layered throughout the manuscript, my suggestion is use Layered PMSE. 8. Page1 line 20, it can be obtained. . . , write as, it is obtained. . . , 9. Page2 line 1, write as, possible indicator of global climate change. 10. Page2 line 5, 2003 is not recent year, change the sentence. 11. Page2 line 7, even though this theory has been presented incompletely. . . , why? Please give a brief about the incompleteness. 12. Page2 line 23, Yi et al., 2011 citation is irrelevant for this context, they discuss only about the density variation not PMSE. According to Smirnova et al., 2010 F 10.7 is negative but not significant, please mention it. 13. Page3 line 5, spacing are missing 14. Page3 line 11, The correlation of PMSE. . . , research of 224MHz radar. Sentence not clear. 15. Page3 line 19, The PMSE OR calculation. . . solve the defects that of measurements. . . How? What is the demerit of the existing method and how the new method is useful? 16. Antenna beam width in the table and

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the text is differs? Write the correct value. 17. Page5 line 6, write as, till now. . . , 18. Section 3.1 modify the subtitle as, Layered PMSE OR calculation method 19. Page6 line 15, . . . , algorithm based on grid partitioning. It will be useful for the readers if you provide little bit detail about this algorithm. 20. In table 3 column 2, is that total observation time for whole year or only the summer time (May-August)? If it is whole year, better to show only from the operation hours of summer months and see is there any difference in the statistics or not? Put the % in row1 and column 6-9, 21. Page8 line 28, write as, explain the occurrence mechanism of PMSE. 22. Page10 line 7, write as, not understood well. 23. Section 4.1, subtitle change as, A new method for layered PMSE OR calculation 24. Page10 line 24, when the PMSE is known to be present. How you decide the PMSE is present or not? Explain it here. 25. Page10 line 24, The ratio between the. . .calculated respectively. Why the ratio is calculated and what is its significance? Brief it. 26. Page12 line 9, We get their variation trends to be largely consistent. . . , rates are reliable. Sentence is not clear. Above the Hocking et al., threshold level the variation is not consistent! Check it. 27. Solar cycle 23, the minimum condition was extended from 2006-2009. 28. Page12 line 15, In other words, no correlation. . . , However, the earlier method shows very clear positive variation with the solar cycle (see figure 2)? Justify it. 29. Page15 line 5, P value less than 0.5, 30. Use the same terminology throughout the manuscript, "either dual layer or double layer, and tri or triple or multi-layer". 31. Page15 line 21, Interestingly, we found that. . . , a negative correlation with F10.7. . . , However, the negative correlation is less than 0.5 and similar kind of result already reported by Smirnova et al. (2010). Why the authors want to highlight this point though the K value also shows similar kind of positive correlation with layer PMSE OR? 32. Page16 line 4, It indicates. . . , how it can indicate? 33. Page16 line 8, the positive correlation between. . . , enhanced magnetic activity caused precipitating particles increase in the mesosphere. Earlier the authors claimed that they removed the precipitation events! 34. Page16 line 8, write as, but still we. . . 35. Page16 line 22, write as, reference or earlier report. 36. Page16 line 23, write as, it is maximum in mid-July. . . , 37. Page16 line 27, under different electron

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density threshold conditions are largely consistent. I feel above  $N_e > 2.6 \times 10^{11} \text{ m}^{-3}$  this threshold the consistency is not significant (see fig., 9). 38. Page 16 line 27, write as, it is found that. . .,

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