The authors would like to thank the referee for his/her valuable comments on the paper. The detailed response to the reviewer comments is provided below. The revised version of the manuscript will be prepared once the final decision is made.

Review of the manuscript titled "Neutral air turbulence in the mesosphere and associated polar mesospheric summer echoes (PMSEs) " by Mahmoudian et al., General Remarks The present study reports the multi-frequency radar (930, 224, 56 and 7.9 MHz) observations of Polar Summer Mesospheric Echoes (PMSE) using EISCAT observations. The authors by employing the numerical simulations attempt to explain the physical mechanism responsible for the observed coherent radar echoes. The numerical simulations include the time evolution of electron density perturbations, which are respon sible for observed radar echoes, in the presence of dust layers in the mesosphere. Various dust parameters such as size, density and initial turbulence amplitudes are varied to estimate the electron density fluctuations. The results show that neutral air turbulence modulated dust particles known as fossil turbulence is responsible for the PMSE observed at four radar frequencies. This is the first time that results from radars operating at four frequencies are simultaneously employed to study the PMSE along with numerical simulations. The results discussed in the manuscript are of interest to Annals of Geophysicae community and I therefore recommend it for the publication. However, the authors have to implement the following suggestions before the manuscript becomes acceptable for publication. Specific Comments

1.The units of the radar intensity maps are different for figure 1 as compared to figure 2 and 3. Authors have to change the units such that all the figures are comparable.
We agree with the referee comments. Unfortunately, the MORRO radar is out of commission and the raw data is no longer available. While the units for the radar echoes at 8, 224 and 930 MHz can be changed to be consistent with the Figures 2 and 3, the 56 MHz data cannot be changed. Therefore, with all due respect, the authors prefer to keep Figure 1 in the current format. Please also note that the present paper provides the qualitative comparison of the data with the numerical simulations. Therefore, the suggested modification will not affect the conclusion of the paper. As mentioned by the referee this paper presents the first true common volume observations of PMSE source region with 4 radars.

2.How the neutral turbulence is related to the dust fluctuations is not clear. Authors have to discuss whether the spectrum of neutral turbulence and the dust particle fluctuations are same or not?
This has been addressed in an early work by Scales, 2004. Moreover, the neutral turbulence coupling with the dust cloud has been investigated in the previous work by Mahmoudian et al. (2017).

The following explanation has been added to the paper:

The effect of dust particles on density fluctuations in PMSE region was first investigated using a computational model by Lie-Svendsen et al. (2003). Their model treats plasma as fluid including arbitrary number of charged, and neutral particle species and dust/aerosol particles are modeled as particle in cell (PIC). Transport due to gravity, multipolar diffusion, and discrete charging model were also used (LieSvendsen et al., 2003). This model was used to explain the correlation and anticorrelation between electron and ion density fluctuations in the mesopause region. Scales (2004) developed a similar hybrid model including fluid plasma and particle in cell (PIC) dust with continuous dust charging process. This model is the first comprehensive model capable of studying the full physics of the PMSE. Continuous charging

model based on the Orbital-Motion-Limited (OML) approach has been used for the time varying charge on the dust particles. It should be noted that the difference between the continuous charging model and discrete charging model based on statistics is negligible in this circumstance. The summer mesopause temperature for both ions and electrons is taken to be $T_e = T_i =$ 150 K.

The collision of charged dust with neutrals is implemented by using a Langevin method (Winske and Rosenberg, 1998) and the dust-neutral collision frequency is denoted by ν_{dn}. The initially uncharged dust is taken to have density given by

\begin{equation}
n_d(x) = n_{d0} \left(1+ \frac{\delta n_{d0}}{ n_{d0}} \sin(2\pimxl)\right)
\end{equation}

Where $ n_{d0$ is the undisturbed density, $\deltan_{d0}$ is neutral dust irregularity amplitude, m is the mode number, l and is the system length of the model. In the current model, the plasma irregularities ultimately result from charging of the electrons onto this irregular dust density. The mechanism for the generation of the dust irregularities is presented in Mahmoudian et al. (2017).

D. Winske and M. Rosenberg, “Nonlinear development of the dust acoustic instability in a collisional dusty plasma,” IEEE Trans. Plasma Sci., vol. 26, pp. 92–99, Feb. 1998.

Mahmoudian, A. , Mohebalhojeh, A. A.2 , Mazrae Farahani, M.2 and Scales, W. A., On the source of plasma density and electric field perturbations in PMSE and PMWE regions, Journal of the Earth and Space Physics, Vol. 42, No. 4, Winter 2017, PP. 63-71

Lie-Svendsen, Ø., Blix, T. A., Hoppe, U. P. and Thrane, E. V., 2003, Modeling the small-scale plasma response to the presence of heavy aerosol particles, Adv. Space Res., 31(9), 2045-2054

3.How the authors explain the absence of echoes at 930 MHz, based on fossil turbulence theory? The explanation given by the authors should be substantiated with further discussion.
The whole discussion of the fossil turbulence is removed from the paper. This has also been requested by another referee.

4.The authors state that “Fluctuations in dusty plasma may also be generated by “fossil turbulence” when neutral air turbulence is absent”. However they discuss the coupling of neutral turbulence and initial amplitude of irregularities within dust density. If fossil turbulence forms in the absence of neutral turbulence then how the coupling between them is justified.
We have revised the paper and removed the application of the fossil turbulence in the absence of neutral turbulence to the present study. It should be noted that the fluctuations in the dust and plasma density created through neutral turbulence may exist even when the initial turbulence is dissipated. This can be justified through reduced diffusion as a result of heavy dust particles. To keep the focus of the paper on neutral turbulence coupling and be consistent with the title of the paper the fossil turbulence is removed from the paper.

5.The discussion of the results is not very coherent and there are repetitions. Authors have to carefully go through the manuscript and try to avoid repetitions and firm up the discussion.
We agree with referee that the organization of the paper requires improvements. We have already incorporated in the revised version of the manuscript.

Minor Comments

line 145: evolution nor steady state → evolution of steady state
This has been corrected as requested by the referee.

line 191:low density → low dust density There is a scope for improving the English Grammar in the manuscript.
We have gone through the paper carefully to remove the grammatical mistakes.