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Interactive Comment

Interactive comment on "Aspect sensitivity of VHF echoes from field aligned irregularities in meteor trails and thin ionization layers" *by* Q. H. Zhou et al.

Anonymous Referee #2

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Using a modeled spatial structure of electron density variation and numerical simulation, the authors theoretically investigate the aspect sensitivities of VHF backscatter from field-aligned irregularities within meteor trails and thin plasma layer. They found that substantial power can be obtained off the magnetic line direction if the ionization trail/layer is thin. The altitude smearing effect of the ionospheric thin layer on FAI echoes is also studied and the result showed that an altitude smearing effect of about 4 km will be generated if the layer thickness is as thin as around 100 m. Although the topics investigated in this paper might be interested to the community of the radar remote sensing meteor trail and ionosphere, a fundamental flaw in the development of the mathematical relation between echo power and the plasma irregularities at Bragg scale is found, leading to the results presented in this paper are questionable and in-

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convincible. The key problem is that the electron density of the spatial Fourier component of the FAI responsible for the radar returns is assumed to vary in a sinusoidal form with deterministic property. Although this kind of mathematical treatment of the target has been employed successfully in the development of the radar-acoustic sounding system (RASS) (Clifford and Wang, 1977, IEEE Trans. Ant. Prop., AP-25, 319-326) for the atmospheric temperature measurement, it is not a valid assumption for the radar returns from random fluctuations of the atmospheric refractivity. This is because the spatial variation of the atmospheric refractivity at Bragg scale for RASS is forced by the acoustic wave transmitted by a powerful acoustic radar so that a long-lasting sinusoidal structure in the vertical profile of the atmospheric refractivity with quasi-constant amplitude can be generated and sustained in the scattering volume. However, there is no external forcing applied to the plasmas of the meteor trail and ionospheric layer, which are random and irregular in nature, to compel the electron density to form a sinusoidal structure, and, as a result, the RASS condition cannot be applied to the case of random fluctuations of the electron density within the meteor trails and ionospheric layer. For a random medium, the fluctuations in refractivity cannot have a finite amplitude in an infinitesimal region of k-space. Mathematically a stationary random process cannot be represented by a conventional Fourier transform, in which the amplitude of each Fourier component is assumed to be constant and deterministic over the domain that the Fourier spectral components are decomposed. In order to have valid Fourier transform representation, the stochastic Fourier Stieltjer integral is introduced to represent the stationary random process, in which the amplitude of each spectral component is treated to be non-deterministic random variable. By doing this, it can be shown that the conventional Wiener-Khinchin theorem, namely, the autocorrelation function and power spectrum of the stationary random process forms a Fourier transform pair, is applicable to the stationary random process, and the DirichletŠs condition will be satisfied because the integral of the autocorrelation function will be finite. Therefore, it is irrelevant to assume that the amplitude (or power) of the radar returns from random fluctuations of the electron density of FAI is a deterministic function. The correct way to handle the theoretical derivation of the echo power from random fluctuations of the electron density is to do the ensemble average of the electron density fluctuations in the meteor trail with specific spatial structure and geometry relative to the radar. This will not be an easy task. However, it is worth to try.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 731, 2004.

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