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Interactive comment on "Ducting of incoherent scatter radar waves by field-aligned irregularities" *by* Michael T. Rietveld and Andrew Senior

Anonymous Referee #1

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General comments

This is an important contribution to several areas of radio, space, and plasma science. The identification and verification that refraction is causing incoherent scatter ion line fitting to produce spurious electron densities in the presence of field-aligned density irregularities paves the way for new studies related both to incoherent scatter as a diagnostic of those irregularities and the mechanisms by which the irregularities are generated. There are also possibly important implications for measurements in the natural ionosphere, especially at high latitude incoherent scatter radars, not only in Norway but also in Alaska, Canada, and formerly in Greenland.

Specific comments

Please note that the leading numbers below refer to line numbers in the manuscript, and ">" indicates a quote from the manuscript.

83
Should reference other HF work showing particular effects at gyroharmonics.
> This interesting frequency dependence will not be investigated further in this paper, but is an important aspect for further studies.

86
In fig 1 the residual looks mostly to be about 2. If they exist, please add a reference or two explaining the calculation and implication of its value e.g. 1, 2, 10, 0.5, etc.
> The second panel labelled 'residual', shows a parameter which should be close to 1 for a good fit of the measured spectrum to a theoretical spectrum for a Maxwellian plasma.

154
This is confusing. If it is propagating at the critical angle how can it also be parallel to the interface if the field is parallel to the irregularity? What is the geometry?
> At the critical angle, given by sin-1(n2/n1), where n1 and n2 are the refractive indices at an interface, a ray will propagate parallel to the interface and larger angles will be totally reflected if n2<n1.

184
Was does "or" mean? Was one or the other or both used?
> solved using the differential equation solver lsode.m in GNU Octave (version 4.4.1) or ode45.m in MATLAB.

Figures 6/7/8/9:
I wonder how real the wiggles shown in the lines drawn between the points might be. Does it make sense to have a curve connecting the points? Could there be detailed structure between points?

340
430-440 MHz should be 430-450 MHz. PFISR's typical tx frequency is 449 MHz and for RISR it is 442.5 MHz.
It could be pointed out that PFISR and RISR can also point field-aligned.

Technical corrections/suggestions

40
seem

62
Wording should be corrected:
> some of the features occurrence of this phenomenon

64
VHF and UHF radio waves

65
for ISR radar

90
above 220

165
therefore 14%

182
we performed some two-dimensional ray-tracing

187
on the ray, and

209
Variables are missing here:

> where is the diameter of the antenna's aperture in meters, is the radar wavelength in meters, is the angle of propagation from the boresight direction in radians, and is the first-order Bessel function.

Figures 6 and 7:
Variable W mentioned in the caption is not on these plots.

286
This is confusing, perhaps re-phrase it?:
> and the peak enhancements in Fig. 6 and perhaps in Fig7. are larger with increasing irregularity strength, A.

287
Fig. 7

314
There is off course evidence
=> There is evidence

327 Demeter
vs
332 DEMETER

366
The first two sentences repeat the same thing:
> Do natural irregularities affect ISR returns in the same way as the HF-induced irregularities?
> It is possible that naturally occurring irregularities, known to occur often in the auroral zone, may affect ISR measurements in the same way as the artificial irregularities discussed here.

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