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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Multi-static spatial and angular studies of polar mesospheric summer echoes combining MAARSY and KAIRA" *by* Jorge L. Chau et al.

Anonymous Referee #3

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This is a very interesting manuscript. Although I am not familiar with the literature dealing with the use of KAIRA in conjunction with the EISCAT systems, this is the first paper I am aware of describing its use in conjunction with an MST radar. This leads to results that could not be obtained from an MST radar operating in isolation.

I have no fundamental problems with the scientific content of this manuscript. However, there are a large number of places where I was not sure what the authors were trying to say or thought that their ideas could have been expressed more clearly. These are indicated below. I do not expect the corrections to signficantly change my view of the manuscript.

Note that there is typically a mismatch between the indicated line numbers and the actual ones. I have tended to use the actual line numbers for parts of the manuscript that appear at the top of the page, but the indicated ones for parts lower down.

- page 3, line 17. I presume that the symbol nu in the formula for Schmidt number should have a subscript a? For completeness, the units for each of the parameters involved in equation 1 should be stated here. I realise that these are given at the bottom of page 3 when specified values are quoted.

- In Figure 1, the value of RCS is shown along in the y axis in the main plot, but along the x axis in the inset plot (1b). It would be more consistent if these values were shown along the same axis in both cases.

- page 3, line 25. It would be better to use the words "lowest and largest" rather than "lower and larger" in the following sentence: "The vertical dashed-dot-dashed lines represent the lower and larger . . ."

- page 4, line 5 and Figure 1. The units for sigma_v (presumably m s-1?) should be shown for completeness. As a more general point, Doppler shifts and spectral widths are sometimes shown in units of Hz (e.g. Figure 4) and sometimes in units of m s-1. It would be better to use m s-1 units throughout.

- page 4, lines 5 - 15. Points 1 and 4 both refer to high values of Sc, but are separated by points about moderate (2) and low values (3). This summary would read more clearly if points 1 and 4 were shown adjacent to each other.

- Figure 2. I initially found this figure confusing with the the Bragg wavenumbers shown at the mid-point between KAIRA and MAARSY since MAARSY is being operated with a vertical beam, i.e. with k_i vertically directed. It is only later in the manuscript, when the idea of MAARSY sidelobes is introduced, that this makes sense. It would be useful to make some forward reference to this when Figure 2 is first mentioned (page 4) so that the reader understands why it is shown as it is.

- page 6, line 25. The symbol G_r is described as the receiver antenna pattern whereas G_t (line 18) is described as the transmitter antenna gain. I realise that the term gain implies antenna transmit/receive pattern, but it would better to stick to the word gain for consistency.

- page 7 line 1: "Recently Latteck and Strelnikova (2015) have reported observations of polar mesospheric echoes during all seasons and pointed out the type of echoes that were not observed previously with less sensitive systems, e.g. coexistence of PMSE with lower mesospheric echoes around equinoxes." Is this last part true? I would have thought that there is more than a month between the spring equinox and the first PMSEs and between the last PMSEs and the autumn equinox.

-Figure 7. It would be better to use the y-axis label "Total range" - rather than "range" to avoid confusion with horizontal - separation. I realise that this is stated at the bottom of page 7, - but it is not indicated in the figure caption.

- page 8, line 4: "This time the echoes are clearly observed to vary with time both in duration and intensity." I am not sure what the authors mean by "varying with time in duration".

- page 8, line 5. I think that the word "systematic" would be better than "predominant" in the following sentence: "In the case of range, there is a PREDOMINANT dependence."

- in the relation to figure 6, the authors should state at what total range/altitude the velocity and SNR data are taken. Presumably the 3 point smoothing is in time rather than altitude/total range?

- page 8, line 21. Do the authors really mean "time-range" or just "time" in the following sentence: "We can see that in general there is a good correspondence between the two SNR TIME-RANGE variations . . ."

- page 8, line 22. What does the following sentence mean: "To observe this feature better, in Figure 6b we plot MAARSY vs KAIRA peak values". Peak with respect to

what?

- page 8, line 23: "In this plot we can identify an approximate difference in signal between the two of 30 dB, which we have marked with a vertical dashed line." Surely this difference represents the intersect of the solid back line with the y-axis (or rather, where MAARSY SNR is equal to 0.0 dB). The dashed black line does not represent this.

- Figure 6b. It would be better to use the same lengths for the x and y axes since they both cover the same intervals between minimum and maximum values.

- page 8, line 25. "Given that the spectral widths shown in Figure 6c are almost constant". I would say that that the spectral widths cover a large range, so I am not sure what the authors were intending to say here.

- page 8 line 26. "The great majority of echoes have a strong variability in SNR with small changes in spectral width." I understand the point that the authors are trying to make here, in defining a population. However, SNRs and spectral widths are very different things and so their values cannot be compared simply.

- Figure 7. Why have different ranges of range been used for the y-axes in panels c and d? It would make more sense to use the same.

- page 9 line 5. "Having defined an empirical RCS difference between the KAIRA bistatic and MAARSY monostatic of $\sim$ 30 dB . . ." It would be more consistent to refer to this as an SNR difference (as in Figure 6) rather than an RCS difference. I realise that one implies the other.

- page 9, line 11. "In the case of the horizontal velocity, the estimates are consistent when a single drifting structure occurs . . ." What exactly do the authors mean by this? That the observed velocity pattern is consistent with a structure moving at a single speed?

- page 10, line 9. "Our results also show that these PMSE structures with high Sc have

a limited volume of approximately 5 - 15 km of horizontal extent in the KAIRA-MAARSY direction." Could the authors explain in more detail how they infer this - and the "cloud" separations.

- page 10, line 20. "KAIRA is only able to observe the red clouds . . .". There is nothing in Figure 2 that I would describe as "red". If I understand the authors correctly, I would describe these structures are "light brown", "buff", or "beige".

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