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Atmospheric Measurement Techniques Discussions

Interactive comment on "Probabilistic analysis of ambiguities in radar echo direction of arrival from meteors" *by* Daniel Kastinen and Johan Kero

Anonymous Referee #2

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An array that has a grating lobe with it has a "perfect ambiguity" between the directions of main lobe and the grating lobes. In that case, one cannot distinguish between the true and the ambiguous angle-of-arrivals (AoAs). With random noise added, the true AoA cannot then be discriminated from the directions of grating lobes and side lobes, depending on the SNR. In this manuscript the authors tries to formulate the nature of ambiguity in AoA estimation in mathematical ways together with numerical calculations on the occurrence of ambiguous estimations using the Monte Carlo approaches. Although there are still some significant concerns about the mathematical treatment, the work can be a nice reference for future engineering works of the kind. I recommend it for publication after significant consideration about the issues below.

Major comments: 1. The primary concern is the treatment of the difference in sen-

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sor responses, defined in Eq. 6. Consider the case each element response has 180 degree turn from the original. As per the definition, the d(k) exhibit the largest difference. However, a constant phase rotation applied to all elements does not change in direction. This is a fundamental difficulty attached to Eq. 6 as definition of difference in sensor responses with respect to two difference physical directions. In the conventional framework, the difference is defined using inner product. Please elaborate this part and clarify how one can avoid this problem in your framework.

2. Section 2.5 is not clear enough to understand. It is hard to grasp the relations among the variables (k_i, k_0, Omega_x, ...etc). Please consider the following comments. 2-1. It is recommended to illustrate the relations using block diagrams. 2-2. As the authors do not cover the continuous probability distribution but merely discretized distributions based on rather small number of MC trials. As a result, every probability is overestimated because minor events (that do not appear in the limited MC trials) are not involved. Considering this fact, "considered as algorithm failure" (L.203), "If there are no individual..." (L.218-221) becomes incorrect. Did you evaluated the impact of ignoring the probability due to rather limited MC trials? 2-3. L.204: It is unclear that "P_ij" is joint probability or conditional probability. 2-4. L.208-210: "We then know...Omega(k_0) is the source.", is it true? It seems "Omega(k_0)" is the set of ambiguity directions given "k_0". Isn't it the logic inverted?

3. The mathematical formulation in Section 2.6 looks strange. Usually likelihood function is defined as a function of model parameter x given an observation D; thus L(x|D). Also, in L.253, the sentence "L(D|x) is read as the likelihood of observing D given the parameter x" is strange in the same way. This line talks about PROBABILITY but NOT likelihood. Eq. 18 is probability too. I guess L(x|D) in Eq (17) should be replaced with P(x|D). Please check out and validate them.

Here is a small list of some minor comments. Minor comments: L.14: extra "the" L.101: r_i -> r_j L.129: Is "a_i" a set of wave number vector? Eq (9): please define Psi_i. Also the difference to Phi should be clarified. L.310: Inconsistent spelling, "maximise" but

"minimize". L.422: What does "instead" mean? Figure 5 and later on: Please add explanations how the intensity scaled [0, 2] as shown in the color bar. L.431: On what reasons the three configurations (I-III) have been chosen? Can you provide some explanations on it?

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