Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
https://doi.org/10.5194/amt-2021-287-RC2, 2021

Comment on amt-2021-287

Anonymous Referee #2

Referee comment on "Hierarchical deconvolution for incoherent scatter radar data" by Snizhana Ross et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-287-RC2, 2021

Review comments for the manuscript entitled" Hierarchical Deconvolution for Incoherent Scatter Radar Data" by Ross et al.

This paper describes a methodology of 1-dimensional adaptive deconvolution based on hierarchical Bayesian probability models with the aid of MCMC. When a deconvolution, or super-resolution is concerned, it is always an issue to make balance among resolution, signal to noise ratio, stability (robustness), and accuracy. The authors have achieved a good balance of these factors using a Bayesian regularization model which is hierarchically structured. The results are excellent. The proposed technique is developed and described particularly for IS radar purpose, but the concept is quite versatile and it is applicable to many other deconvolution problem as well as other radars.

While the model and the algorithm are quite complicated, the authors made a large effort to make them as clear as possible in the text. In addition, no serious errors and flaws were found. On the other hand, it is very hard to overview the whole structure of the model at a glance. For the sake of readers, I give some minor comments in what follows.

The current version of Fig. 2 simply shows the relationship between the parameters, and the model structure is described in detail part by part throughout the sections 2-4. However, the current structure requires readers to go back and forth in the text until the model is understood and this is rather painful. In my opinion, Fig. 2, or perhaps better to add another figure, should also include the model structure itself to grasp the whole structure at a glance. More specifically, it should illustrate relationship of the Gaussian Process and Matern covariance, the additive epsilon and Gaussian pdf and so on in the diagram, as well as MCMC and MAP.

In addition to the logical relationship of the model parts mentioned above, it is recommended if possible schematically to show the sequence (in time) of the procedures to show which part of the model and how to start the calculation from.

Some other points including questions:

- In L.152, which is "Here p(P_m| P, L) is the likelihood…" (L is intentionally capitalized for readability purpose in this communication), can p(P_m| P, L) be p(P_m|P)? It is because P_m is presumably conditionally independent from L given P.

- Equation (12) indicates the name of prior PDFs (Cauchy & Laplace) but does not show their mathematical forms. While this is accepted in case actual expressions are not concerned, it is recommended to show them in this paper because the definitions of ALPHA_C/TV are needed in the following discussions.

- In Figure 5, what is the reason by which the sidelobe of the left plot (PMWE) is wavy while the other (PMSE) is quite smooth?

- In Figures 6 and 8, what is the reason by which u_C and u_TV are quite different where they are higher than 4.0?

- On p. 17, the authors discuss the difference between the results from Cauchy and Laplace priors, but its underlying reason is not mentioned at all. Since the difference is very curious and interesting, it is preferable to mention some of your ideas about it if you have any.

Other minor points below.

L169: Roininen et al. (2014) corresponds to two papers in the reference list. Please identify which one it is.

L169: Is "partical differential equation" correct? (10) and (11) look like ordinary differential equations.

L177: Roininen et al. (2014) corresponds to two papers in the reference list too.

L313: out from in -> out in

L334: difference TV -> difference and TV

L395: STEL -> ISEE

Figures 3, 4, 6, & 8: Is the "unit" of length-scale function [km] or [log km]?