Response to reviewers
Multipurpose incoherent scatter measurement and data analysis techniques for EISCAT3D

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The authors thank the reviewer for constructive comments. We propose changes that we believe address these comments and improve the manuscript. In this response letter, the original comments are written in bold, our responses are listed below each question, and changes to the manuscript are written in blue. Line numbers refer to the revised manuscript.

Reviewer 1

1. **For the synchronous mode mentioned, do you consider the time delay of the signals between the transmitter and the receivers in the processing?**

   The time delay is considered when generating the synthetic radar signal and in the ACF deconvolution process. In the latter, the time delay gives us information about location of the scattering volume when the transmit and receive beam directions are known. As the total delay is a few ms, and difference in delays to different receivers from any given plasma volume is always less than 0.3 ms, the delay is not considered in plasma parameter fits, which are performed with considerably coarser time resolution. We have clarified how the synthetic incoherent scatter returns are delayed in the text.

   Lines: 358–360: For each beam, the synthetic return signal was delayed according to the signal travel time, which was calculated from the measurement geometry.

2. **The amplitude of signal from the same common volume is affected by the beam geometry and the different state of the transmitter and receivers. Do you calibrate the data from different sites individually before the joint fitting and does the SNR level of the receivers affect the fitting results?**

   Effects of beam shapes, beam directions, and core site transmit slots are carefully taken into account in generation of the synthetic radar signals and in the data analysis as follows.

   When generating the synthetic radar signals, the beam shapes and scattering volume dimensions are modelled with the e3doubt/ISgeometry package and the SNR of the synthetic data is set accordingly, as explained in lines 369–375 of the manuscript.

   The beam shapes are not considered in the ACF deconvolution process, as is mentioned in lines 115–117 of the manuscript. The reduced number of data samples from certain ranges in the core site data due to signal transmission slots is automatically taken into account in lag profile inversion. We have added a note about this in Section 2.2.

   We do not calibrate the remote site data, but unknown scaling factors for each beam and altitude are included as additional unknowns in the plasma parameter inversion process. The scaling factors and the reason for not making an absolute calibration of the remote receiver data are mentioned in lines 491-495 of the manuscript. For details of the multistatic plasma parameter fit technique, which is not the main topic of this paper, we refer to Virtanen et al. [2014].

   SNR level of the receivers affects statistical accuracy of the plasma parameter estimates. Ratio of SNRs at the core site and at the remotes also depends on electron density and the radar mode, affecting also the relative importance of the remote site data in the plasma parameter fits. This is discussed in lines 518–524 of the manuscript.

   Lines: 154–155: All deconvolved lag profiles $\hat{\mathbf{x}}_j$ are readily available in the same units, and additional scaling factors are not needed for different ranges and time lags.

References

I I Virtanen, D. McKay-Bukowski, J Vierinen, A Aikio, R Fallows, and L Roininen. Plasma parameter estimation from multistatic, multibeam incoherent scatter data. *Journal of Geophysical Research: Space Physics*, 119(12):528–543, 12 2014. ISSN 2169-9380. doi: 10.1002/2014JA020540. URL https://onlinelibrary.wiley.com/doi/abs/10.1002/2014JA020540.