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Atmospheric Measurement Techniques Discussions

Interactive comment on "Retrieving horizontally resolved wind fields using multi-static meteor radar observations" *by* Gunter Stober et al.

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The authors thank the reviewer for reading the manuscript and his suggestions. We updated the manuscript accordingly and the changes are labelled with the track changes in latexdiff. We are grateful for the provided review also spotting our mistake in the attached videos.

Comment: P.2, lines 8-18 (2nd paragraph) and Section 2: The new application of regularization to fitting horizontal winds is to be compared to: 1) the 'normal' or 'standard' (all-sky?) meteor radar wind retrieval technique, and 2) volume velocity processing (VVP) technique. Section 2 is to summarize the 'normal' or 'standard' meteor radar wind retrieval process while there is no summary of the VVP technique. Clarity of

this over arching objective would be greatly benefitted if both the 'normal' and VVP techniques were summarized in Section 2 and contrasted with the new regularization method (obviously with the in-depth details of regularization presented in Section 3). That is, what are the differences between the fitting methods and what will the new regularization method add.

Reply: The different algorithms are now 'named' and we expanded the discussion on the VVP. We introduced the 'all-sky' fit or standard analysis, the volume velocity processing as well as a 'packed' and 'full' wind retrieval, which differ in the way the weights are estimated and whether we employ a mesoscale regularization.

Comment: P.3, lines 13-16: What is a typical number of meteor trails which gives statistical uncertainty of 1-6 m/s at altitudes between 82 and 95 km?

Reply: We expanded this part of the paragraph and added some numbers. However, this numbers should not be taken as absolute measure as the obtained statistical uncertainties of the obtained winds are also reflect some other geophysical processes.

Comment: P.4, l.21: This is the first time azimuth and zenith are mentioned. The azimuth and zenith (elevation) angles, along with angle of arrival should be defined earlier with respect to the defined axes systems of: a) the radar(s)/links, and b) the local co-ordinates.

Reply: We added the convention used in this paper, after we introduced the angle of arrival.

Comment: P.5, l.20: How are values for p and ngamma_x determined for Equ. 1?

Reply: We added our reasoning behind those numbers in the paragraph. The value of p and also ngamma was estimated to ensure that a meteor at the edge of a grid cell enters the retrieval with a non-negligible weight. As the distance is measured in meteor a value of p=1 would give a meteor at 30 km distance already almost no weight.

Comment: P.6, l.22, Equ. 6: The terms defining the spatial derivative, time derivative?, etc. in the smoothness matrix L are unclear. Please define and clarify.

Reply: We expanded the description of the L matrix and inserted a scheme outlining what we want to achieve. The matrix L is constructed based on the scheme shown for each wind component. The shown L –matrix here in just shows the spatial component. The temporal weight is inserted as weight in the sigma matrix.

Comment: P7, l.16: For the variance nsigma_iËĘ2, why not just use the measurement error?

Reply: We now describe in more detail what are the differences between both approaches and compare both retrievals.

Comment: P8, l.3: What do the authors mean by "optimal solution" for the regularization parameter nalpha? And how was the regularization parameter nalpha value obtained/ justified by being "estimated through several iterations"? Also, this optimal value of 0.014 is notthe global value typically used (which is nalpha = 0.1). Why is this?

Reply: Thanks for pointing at this inconsistency ion the first version. As we have two different retrieval algorithms called 'packed' and 'full' wind retrieval we looked for different strategies to find an optimal alpha. However, as it turned out with the 'full' retrieval that alpha=0.1 seems to be more robust, whereas for the packed retrieval sometimes also 0.01-0.02 provided reasonable solutions. The value of 0.1 seems to be more on the save side with respect to outliers or erratic measurements. The corresponding paragraph was updated to avoid this inconsistency.

Comment: P8, lines 3-5, Fig. 4: I like how the authors used extreme values of the regularization parameter nalpha to show different fits, but I have some concern on how different the fits appear. Although this may mostly be due to the winds in the plot on the right, with nalpha = 10ËĘ{-6}, not being scaled between the images. Why is this? And can they be re-scaled. Explain and clarify. Also, for the nalpha = 10ËĘ{-6} case, is this weak regularization essentially the 'normal' or 'standard' fitting method as nalpha

goes to zero? Once again, this relates to comparing the regularization technique to the other two fittings techniques ('normal' and VVP).

Reply: The alpha values shown here were really just picked to show extremes. In the case of the horizontally resolved wind solution there is no 'normal' fitting or standard solution in a least squares sense. The value of alpha= 10ËĘ{-6} more or less presents the radial solution for each grid cell without a neighbor cell. We found not yet a solution to scale the arrows in a more consistent way. As the reviewer already pointed out, part of that is the arrow scaling.

Comment: P8, l.10, supplementary movies: Should not the regularization parameter nalpha be the same for all fits? Please justify and explain selecting different values of the regularization parameter.

Reply: The movies are redone. Somehow images from different runs using different alphas or estimated alphas were mixed. We are sorry for that mistake.

Comment: P9, l.10, Fig. 8: One would assume that the "all-sky fit as described above" and then presented in Fig. 8 would be the new regularization technique, but according to the Fig. 8 caption it is the 'standard' mean wind analysis. If this is the case, why is the new regularization technique not used?

Reply: We updated the figures and labeled the axis according to the introduced names.

Comment: Then on P9, l.28 the "all-sky fit" clearly refers to the 'normal' or 'standard' fit. Again, please clarify and standardize terminology to different fitting methods.

Reply: This is now clarified in the manuscript.

Comment: P.9, l.27 to P.10, l.7: This text validates that the mean 2D wind fit (regularization fit I assume) agrees well with previous accepted fitting techniques (all-sky or 'standard' and VVP fits). If the new regularization is the same as the accepted fits, what has been gained by this new technique. This should be related back to Section 2 and the benefits of using regularization should be elaborated.

Reply: This comparison should just underline that the retrieval does not add or change the mean wind estimates, which are also using many of the implemented techniques of the 2D wind retrieval. As suggested by the reviewer we added some more benefits of the new retrieval in the discussion and conclusion to underline the benefits of the new analysis.

Comment: P.10 Discussion Section, P.11, lines 25-29: Are there any other benefits to the small scale structures that are detectable using the new regularization scheme besides the behavior of the GW spectral slope? If so, list a few.

Reply: We expanded the list of potential benefits of the new technique. In particular, the synergy to other observations dealing with smaller scale structures is now also pointed out.

Technical corrections: Comment: P.5, l.27, Equ. 2: For 2nd term on RHS of equation it should be nsin(nphi_i) ĔĘĔĘĔĘ P.7, l.25: Do you mean "focus on horizontal winds", not "vertical" winds?

Reply: The mistake is corrected.

Please also note the supplement to this comment:
https://www.atmos-meas-tech-discuss.net/amt-2018-93/amt-2018-93-AC2-supplement.pdf

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