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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.

Anonymous Referee #2

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General comments:

The manuscript has two major themes regarding horizontal wind retrieval, namely: 1) the use of multi-static meteor radar observations giving both an increased wind field area compared to single specular meteor radars (SMR) as well as more meteor trail measurements from the volume, and 2) the use of regularization for retrieval of the horizontal wind velocities and improving the spatio-temporal resolution. The first objective required mapping the radar observations to the geoid of the Earth ('full Earth geometry') to properly describe the now increased wind field coverage area. The latter objective allows for smaller scale studies previously not possible with SMRs, such as gravity wave studies.

The manuscript achieves these objectives and is of significant scientific interest to the

field. This manuscript is a scientific advancement definitely of publication quality. However, there are some points which need clarification to better present the significance of this research.

Specific comments:

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.

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?

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.

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

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.

P7, l.16: For the variance \sigma_i^2, why not just use the measurement error?

P8, l.3: What do the authors mean by "optimal solution" for the regularization parameter \alpha? And how was the regularization parameter \alpha value obtained/ justified by being "estimated through several iterations"? Also, this optimal value of 0.014 is not

the global value typically used (which is \alpha = 0.1). Why is this?

P8, lines 3-5, Fig. 4: I like how the authors used extreme values of the regularization parameter \alpha 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 \alpha = 10^{-6}, not being scaled between the images. Why is this? And can they be re-scaled. Explain and clarify.

Also, for the \alpha = 10^{-6} case, is this weak regularization essentially the 'normal' or 'standard' fitting method as \alpha goes to zero? Once again, this relates to comparing the regularization technique to the other two fittings techniques ('normal' and VVP).

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

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?

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.

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.

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.

Technical corrections:

There are a number of grammatical errors, but these will be corrected in the copy editing stage.

P.5, l.27, Equ. 2: For 2nd term on RHS of equation it should be \sin(\phi_i) ^^^ P.7, l.25: Do you mean "focus on horizontal winds", not "vertical" winds?

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