



EGUsphere, referee comment RC1
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Comment on egusphere-2022-203

Samuel Kristoffersen (Referee)

Referee comment on "Meteor radar vertical wind observation biases and mathematical debiasing strategies including the 3DVAR+DIV algorithm" by Gunter Stober et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-203-RC1>, 2022

This paper discusses the measurement of vertical winds using meteor wind radars, and addresses potential errors which can be introduced by either assuming 0 vertical wind, or by not accounting for the relative motion of the meteor trail in the wind field. Two methods are introduced to Tikhonov regularization and the 3DVAR-DIV retrieval algorithm.

Given that the two algorithms provide different vertical wind results, it is not clear to me which are considered the 'correct' results. My understanding is that the 3DVAR-DIV is being demonstrated to show de-biased horizontal and vertical winds, and therefore this new algorithm is quite useful to the community. It is, therefore, my opinion that the paper is suitable for publication, pending some clarifications regarding, in particular, the Tikhonov regularization.

Here are my major comments/questions regarding the content and the results.

- Given that the two methods provide different vertical wind results (std~0.2 m/s for the Tikhonov regularization and ~1-1.6 m/s for 3DVAR-DIV), are the authors able to conclude which method is providing the correct (or most accurate) vertical wind results? This was not clear to me in the paper.
- The Tikhonov regularization is tested on real data, and synthetic data with no vertical wind. Given that synthetic data is created using tides, planetary waves, and gravity waves, which should have vertical components, are these synthetic data physically realistic? Additionally, I think it would be worthwhile to do a test on synthetic data which has known vertical winds. Currently, the assumption is there are no vertical winds, and that is observed. But can the known vertical winds of synthetic data be retrieved? This would help to clarify if the small vertical winds are real, or simply the result of the assumption that the vertical winds are small.
- Since the Tikhonov regularization effectively filters the vertical winds, are these results different than making the 0 vertical assumption, which is typically made with meteor radar winds?

- Regarding the apparent motions of the specular scattering point, you mention that the radial velocity measurements are representative of a short time period (line 472). For times of less than a second, I would expect the air parcel motion to be no more than a few 10s of m/s. If the size of a voxel is on the order of kilometres, do these scales result in significant deviations in the observed radial winds?

I also have a few minor questions/comments (typos etc.)

- The left quotation marks appear as right quotation marks. If you are using some version of Latex, you can generate the left quotation mark using ```, e.g. ``A'`.
- Line 109: I think it would be useful to define what WGS84 is.
- Line 115: change `'visualizes'` to `'visualize'`
- Line 116: should `'radial velocity'` be `'vertical velocity'`?
- Line 134: should `'standard variation'` be `'standard deviation'`?
- Line 164: change `'later'` to `'latter'`
- Line 164: re-write sentence from `'Due to the more slant incident radiowave, the scattering section along the trail is much longer'` to `'Due to the larger slant of the incident radiowave, the scattering section along the trail is much longer.'`
- Line 138: change `'to consider'` to `'considering'`
- Figure 3: What year are these winds from? If these are means of several years, what years?
- Line 200: include `'the'` before `'end of April'` (i.e. `'the end of April'`)
- Line 203: similarly, include `'the'` before `'end of May'`
- Line 219: Referring to equation 2, you mention `'superscripts denote the Euclidean norm'`, however, no superscripts appear in this equation.
- Line 224: You state that you used the unit matrix for the Tikhonov regularization. What was the rationale for using the unit matrix? Do you get different results using a different Tikhonov matrix?
- Line 237: change the line `'The larger the statistical uncertainties the stronger and more important becomes the right hand term, which often results in smaller vertical velocities.'` to `'The larger the statistical uncertainties, the stronger and more important the right-hand term becomes, which often results in smaller vertical velocities.'`
- Line 246: remove `'already'`
- Line 248: add a comma after `'the scale analysis described above,'`
- Line 249: Remove `'however'`
- Line 260: Define `'R2B4'`
- Line 308: change `'... which permits to obtain ...'` to `'... which permits us to obtain ...'`
- Line 339: Change `'... which allows to achieve high spatial resolution.'` to `'... which allows for a high spatial resolution to be achieved.'`
- Line 327: change `'physical'` to `'physically'`
- Figure 9: The difference between the left and right panels is not clear. Does (div) mean this is the incompressible case? Please include a comment in the caption describing the difference between the left and right panels.
- Line 393: remove `'as well'`
- Line 449: Change `'to be considered'` to `'consideration'`
- Line 452: Change `'We tested also domain means and other options.'` to `'We also tested domain means and other options.'`