JGR-2022-218
Responses (highlighted in red) to Referee#1
20 Jan. 2023

Review "High Resolution 3D Winds Derived from a Modified WISSDOM Synthesis Scheme using Multiple Doppler Lidars and Observations"

General remarks:

The authors took all of the major suggestions into consideration and added substantial analyses to the evaluation of the algorithm. The additional figures containing the comparison to the observational data now support the conclusions. However, I recommend to add to Figures 13, 15 and 17 b and c the control run as well. It is deemed to be the best performing setting, and this would greatly facilitate the comparison to the other experiments. If the control run is absent from the evaluation, it is still difficult to compare, whether the experiments in A, B and C performed better or worse than the control.
Moreover, the documentation and explanation of the algorithm has improved significantly. While the language has improved substantially, there are still a number of phrasing issues and the manuscript would benefit from further language editing. Some of these are highlighted in the specific remarks.

We appreciate Referee#1 reading our manuscript carefully, which help us to improve the manuscript substantially. In this round, the comparisons between the control run and observational data have been added in Figs. 13, 15, and 17b and c. We also provided the descriptions associated with the intercomparison in this revision. The language has also been corrected per your comments. A set of responses to your comments is provided below. Specific locations of modified portions (marked as underlines) were also noted as the number of lines in the revised manuscript.

Revised figures and brief descriptions related to the comparisons between the control run and observational data can be found in the following:
L645-647. The discrepancies of sounding observation and control run in u- and v-component winds reveal relatively small values than the A-3 but similar to the other designs (purple lines in Figs. 13b).
L650-653. The QVP winds and control run discrepancies in u- and v-component winds show similar values for all designs, but relatively small values can be obtained in w-component winds (purple lines in Figs. 13c).

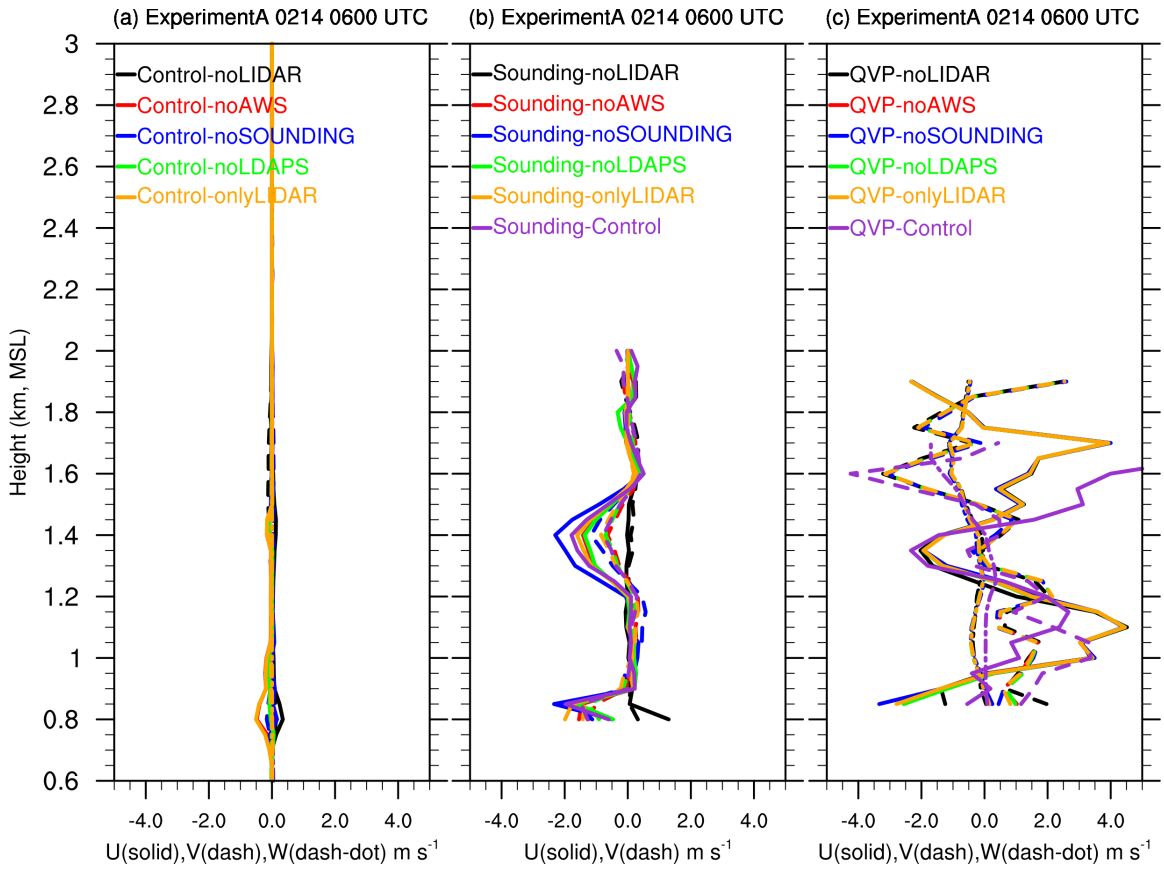

Figure 13. (a) Vertical profiles of averaged discrepancies of 3D winds for each design in Experiment A at 06:00 UTC on 14 Feb. 2018. The averaged discrepancies of u-, v- and w-component winds were plotted by solid, dash, and dash-dot lines, and the black, red, blue, green and orange lines indicate A-1, A-2, A-3, A-4 and A-5, respectively. (b) The same as (a) but for the discrepancies of sounding observations and u-, and v-component winds and control run (purple lines). (c) The same as (b) but for the discrepancies of QVP and w-component winds.

L702-704. Figs. 15b and 15c show the discrepancies of derived 3D winds between the sounding observations, QVP, and control run. Their patterns are similar to A-1~A5 (cf. Figs. 13b and 13c),...

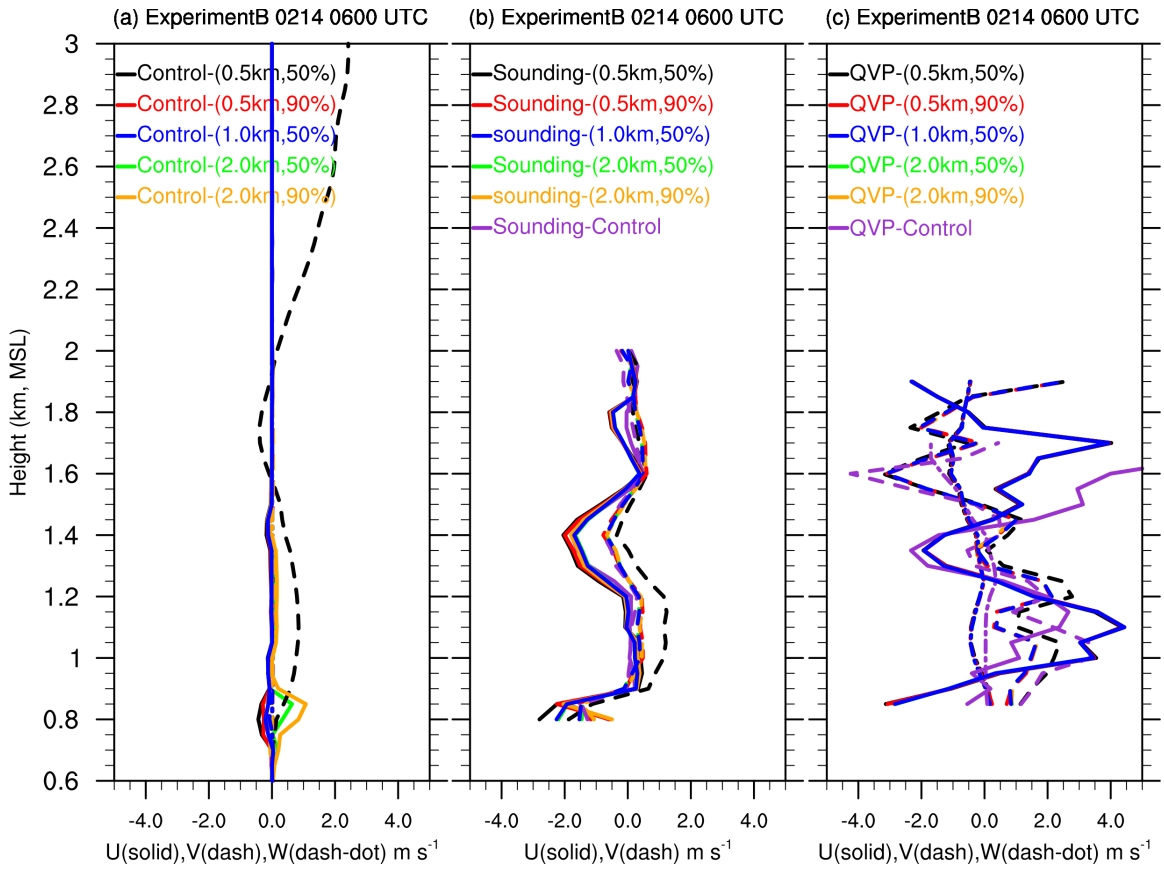

Figure 15. The same as Fig. 13. but for B-1~B-5.

L752-753. The discrepancies of sounding observations, the QVP winds, and the control run were more minor than all designs in Experiment C (purple lines in Figs. 17b and 17c).

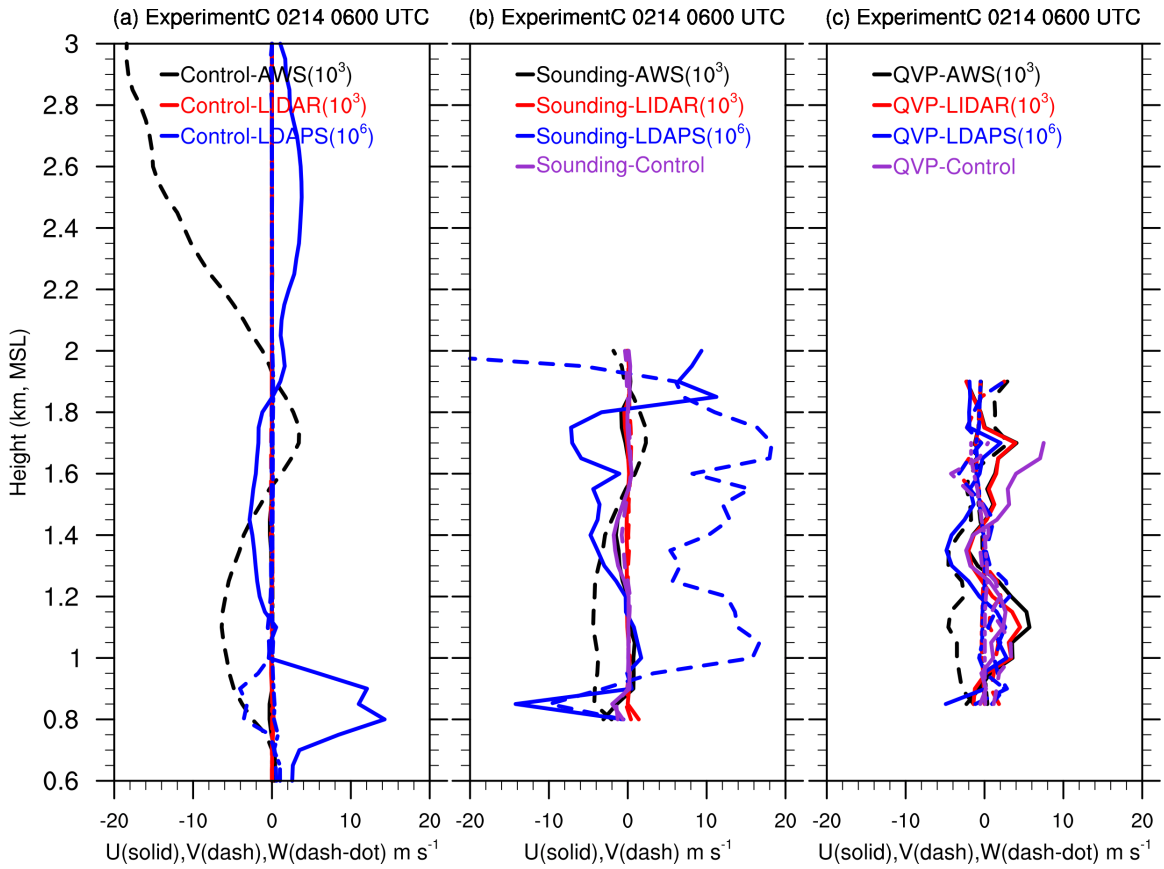

Figure 17. The same as Fig. 13 but for C-1~C-3.

Specific remarks:

The following line references highlight minor remarks. The line numbers refer to the revised, marked-up manuscript.

General language remarks:

- Many sentences begin with “Note that”, in most cases this can be eliminated and the meaning stays the same. Sometimes “note that” has been replaced with “notably”, which does not necessarily have the same meaning.
- It is often written that WISSDOM is “performed”. This is a rather unusual formulation for the use / execution / running of an algorithm.
- In the description of the results, the tense switches in between past and present.
- The sentences containing many brackets to show many different properties in the same sentence are hard to follow.

Those language problems have been checked and corrected throughout the manuscript. Please see the detail below.

Line 16: The WISSDOM (…) synthesis scheme

Corrected.

Line 49: consider associating the scale directly with the phenomenon, e.g. from thousands (cold fronts and low pressure systems) over hundreds (tropical cyclones and typhoons) to a couple of kilometers (convective lines and TC rainbands) For the TC rainband this naturally depends on whether it is the length or width of the rainband

The sentence has been revised as the suggestion.

L47-52. Most comprehensive applications of the derived winds were adopted to document kinematic and precipitation structures associated with various weather systems or phenomena at different scales from thousands [cold fronts and low-pressure systems (LPS)] over hundreds (tropical cyclones and typhoons) to a couple of kilometers [convective lines and tropical cyclone rainbands (it naturally depends on the length and width of the rainbands)]…

Line 80: "Liou and Chang is the first purposes of this algorithm." This sentence does not make sense. The following sentence (Furthermore, they performed IBM…) does not read smoothly either.

The sentence has been rephrased clearly.

L78-84. Recently, Tsai et al. (2018) utilized the measurements of six Doppler radars to document precipitation and airflow structures over complex terrain on the northeastern coast of South Korea via Wind Synthesis System using Doppler Measurements [WISSDOM, Liou and Chang (2009)]. The scientific studies and applications of WISSDOM were well documented in Liou et al. (2012) and Liou et al. (2016). In addition, Immersed Boundary Method (IBM, Tseng and Ferziger, 2003) was applied in WISSDOM.

Line 112: … can be used in the modified WISSDOM.

Corrected.

Line 113: …, which is an essential benefit over Doppler radar data.

Corrected.

Line 134: "In addition, the modified WISSDOM was performed…" performed seems awkward in this context, perhaps execute, ran or used could be alternatives.

The word has been replaced by "used".

Line 136: The reliability of the derived 3D winds was also evaluated and discussed with respect to conventional observations.

Corrected.

Line 145: utilized instead of performed

Corrected.

Line 148: the effect of the non-flat surfaces? The topography itself is not generally affected by the algorithm, on the contrary, it affects the results of the algorithm.

The sentence has been rephrased clearly.

L142-143. Liou et al. (2012) applied the IBM in WISSDOM to consider the topographic effect on the nonflat surfaces.

Line 157: Note that Vt is first estimated based on the background of the sounding observations used in this study. In the absence of background observations, the first guess of Vt is set to 0.

The sentence has been revised as the suggestion.

Line 188: "In addition, individual constraints…" This sentence is difficult to read, please rephrase.

The sentence has been rephrased clearly.

L182-183. In addition, individual constraints were calculated in two time steps if the temporal resolution of the inputs was high enough.

Line 216: "In this study, the time steps in WISSDOM…" -> In this study the time steps in WISSDOM are set to 12 min, corresponding to the temporal resolution of the primary input lidar data.

The sentence has been revised as the suggestion.

Line 304: "Notably, that the wind directions…" This sentence does not make sense.

This sentence has been removed to avoid confusion.

Line 366: The Cartesian coordinate system

The word has been added.

Line 425: They put more weight on observations and less on modeling inputs.

The words have been corrected.

Line 428: variations instead of variances (unless you are referring to statistical variance)

The word has been corrected.

Line 464: Remove "so-called"

The word has been removed.

Line 471: Do the 2.5 m/s refer to both horizontal and vertical wind deviation? For vertical velocities, this would be a rather large deviation.

No, the 2.5 m s^{-1} is only referred to as horizontal wind deviation by Kim et al. (2022).

Line 514: …relatively larger IQR and median values can only be found at the lowest level…

The sentence has been revised as the suggestion.

Line 520-525: Example of switching tenses in the description.

The tenses have been corrected for consistency.

Line 605: An additional test was designed, where only Doppler lidar data are used …

The word has been modified.

Line 656-664: The distinctions made in the brackets here are rather confusing and hard to follow – it would be easier to read, if differing statements were made in separate sentences.

The redundant brackets have been removed, and the different statements have also been made in separate sentences.

L638-645. The maximum discrepancies of u-component winds are exceeded by approximately –2 m s^{-1} , and v-component winds are exceeded by approximately –1 m s^{-1} if the WISSDOM synthesis lacks sounding observations. However, small discrepancies (nearly 0 m s^{-1}) were presented when the sounding data were implemented, and the lidar was not implemented at all levels in A-1. The peaks in the discrepancies manifested the potential impacts from the lidar and AWS. This may result from lidar and AWS having higher data coverage at ~1.4 and 0.8 km MSL, respectively (cf. Fig. 4).

Line 665: More critical than what?

More critical than the LDAPS. The words have been added to this sentence.

L652-654. In summary, the results of this experiment (cf. Fig. 13) show that the lidar, sounding, and AWS data are more critical inputs than the LDAPS in modified WISSDOM.

Line 719: “The conclusions indicated that the moderate setting…” Switching tenses, unclear conclusion -> is this the case with the smallest differences? B3 in blue cannot clearly be identified in Fig. 15. While naturally it is difficult to see all scenarios when they are so similar, it would be helpful to set B3 on top, if you want to highlight it in your discussion.

The tenses have been corrected. These are smaller differences in this case. The B3 was emphasized in the figure.

L706-708. The conclusions indicate that the moderate setting (i.e., RI is 1 km) would

be helpful to obtain smaller differences with the control run, sounding observations, and the QVP in this case.

Line 722: helpless cannot be used in this sense

The words have been modified in this sentence.

L708-709. On the other hand, the limited setting in experiment B (i.e., B-1) was not suitable.

Line 742: Significant differences often exist in between the observations and reanalysis dataset due to the differing spatio-temporal resolutions.

The sentence has been revised.

Line 246: Superposed?

The redundant word has been removed for clarity.

Line 761: The discrepancies in between the derived 3D winds in Experiment C and the sounding observations and QVP, respectively, were also examined.

The sentence has been revised.

Line 763: exceeding 20 m/s

The word has been revised.

Line 764 and 767: This would be easier to follow, if AWS, LDAPS and lidar impact were described in separate sentences.

The sentences have been revised as the suggestion.

L747-750. Compared to the sounding observations, more significant discrepancies in the u- and v-component winds (exceeding ~20 m s–1) can be obtained when reducing the weighting coefficients of the AWS and increasing the weighting coefficients of the LDAPS data (Fig. 17b).

L753-755. The conclusions reveal that the weighting coefficients of the AWS and LDAPS are significantly sensitive to the derived winds, and the lidar is moderately sensitive to the retrieved winds.

Line 768: “not necessarily changed much” – in the context of a conclusion, this does not make a lot of sense here, please rather state if and how much they were changed.

The descriptions have been revised for clarity.

L757-757. Therefore, the weighting coefficients of LDAPS and AWS are better to be 10^3 and 10^6 in this case.

Line 779: Emphasize the replacement of radar data and the separation of background wind information.

The descriptions have been revised as the suggestion.

L765-768. The main difference from the original version is that multiple lidar observations were used in the modified version, replacing radar data. High-resolution 3D winds (50 m horizontally and vertically) were first derived in the modified WISSDOM scheme. In addition, the wind information was separated from the background in the modified version.

Line 806: Consider moving the reference to the DGW site to the sentence before. Interquartile range -> IQR

The sentences have been revised as the suggestion.

L790-794. Compared with lidar QVP (sounding observations) above the DGW site, the median values of the wind speed are approximately –1~3 m s^{-1} (–1~0.5 m s^{-1}), and the vertical velocity is within –0.2~0.6 m s^{-1}; the IQR of wind directions is –10~5 (0-2.5) degrees, the wind speed is approximately –4~4 m s^{-1} (–1~3 m s^{-1}), and the vertical velocity is –0.8~0.8 m s^{-1}.

Line 827: raising -> rising

The word has been revised.

Lines 828ff: Please summarize your final settings in one clear sentence and highlight that they are the same as in the control run.

The summaries have been revised as the suggestion.

L813-815. Relatively reasonable winds can be derived with the setting of 1 km in RI and 90% in VE over complex terrain (i.e., the same setting as the control run).