Review: Validation of torus mapping method for dealiasing Doppler weather radar velocities

Summary:

This manuscript introduces a dealiasing method based on torus mapping and evaluates this with a larger dataset. Torus-mapping requires assumptions about the linearity and homogeneity of the wind field that limit the potential applications of this method.

General comments:

1. The main application is a bit unclear. Is the target data assimilation? There is little to no discussion of particularly challenging dealiasing situations, such as high-shear situations, or when data is sparse. A plethora of algorithms handle large-coverage linear wind situations very well, so the added benefit here is rather unclear.
2. What are advantages over existing methods? There are very few references to current dealiasing methods, especially also for the countries that the data stems from (e.g. DE, CH, FR). How do the assumptions and limitations of torus-mapping compare to VAD-based methods such as IVAP (Liang et al., 2019)?
3. The specifications of the used data are unclear. Why introduce the data of CH, GB, PL, HR, HUN if they are not used? Fig. 4 misleadingly implies that all of this data was used for evaluation. How are the dual- and triple PRF data from DE and FR dealt with? Do they deliver the multi-PRF extended Nyquist range product? These are known to have problems with noise and errors that require different corrections than Nyquist-interval-based dealiasing. If dataset A only contains Slovenian radars, how is it different from dataset SI – apart from the filtering for events?
4. The paper would benefit from having at least one explicit data example for the low Nyquist velocity datasets. E.g. instead of just showing the areas in Fig. 3, the actual velocity values would be very helpful.
5. Given the potential operational implementation, what are the computational requirements and estimated runtime of the algorithm for a full volume?

Specific comments:

1. Line 3: In **the** central part of Europe
2. Lines 27-35: This fails to include more recent advances in dealiasing (see reference recommendations below). In addition, some of these methods rely on the VAD, which is also derived from the radar itself and hence not an external data source.
3. Line 48: More recent methods apply this criterion only very locally. How does your approach fair in high-shear situations? How does it depend on having large data coverage?
4. Section 2: How does this compare to the VAD method (Germann, 1999 and Tabary et al., 2001) and VAD-based dealiasing, such as the IVAP method (Liang et al., 2019)?
5. Lines 84ff: What does this imply for the use of this method? What is your target application and how does it suffer from this limitation? E.g. it appears that this method would not work very well in high turbulence / high shear situations, as e.g. found in mountainous countries or convective situations.
6. Line 89: So do you divide each elevation into areas that are within 100m altitude slices or do you add data from other elevations?

7. Section 3.2: Here you introduce the complete OPERA dataset, but you only use a fraction for the actual validation. This is misleading.
   Given that most countries that deliver Doppler data already have operational dealiasing, there should be a discussion of the novel method vs. the existing ones. Do countries also deliver dealiased data or only raw aliased velocities? Evidently some processing is applied to the dual- and triple PRF data of DE and FR before data delivery.
8. Line 151: Given that you exclude the majority of low-Nyquist radars, a more detailed explanation would be appreciated. Why do you introduce them in the first place?
9. Figure 5 and following: It would help a lot to include the labels Dataset A, Dataset B, aliased and dealiased in the figure itself. (I.e. over the columns and next to the rows).
10. Figure 5 and following: The hatching in the panels covering +-80 m/s makes it difficult to see the details. Could you remove the vertical lines in the histogram?
11. Fig. 6: Presumably you also have peaks at multiples of the Nyquist velocity in log-space?
12. Fig. 7: Please use the same scale for both panels here, there is no evident reason to change the scale here.
13. Line 226: The generally more interesting application is to low-Nyquist velocity datasets, where you only evaluate 2 radars – this is not a large European dataset. The evaluation of the high-Nyquist velocity radars is of course still beneficial, but the error rates are much lower in the first place.
14. Line 229: How does this improvement in acceptance rate compare to other methods? E.g. how high is the dealiasing failure rate?
15. Line 238: The evaluation is very indirect and based on external wind measurements that are fundamentally different from Doppler velocity measurements. Did you also check the number of apparent folds in e.g. the gate-to-gate-velocity difference?
16. Line 253: Given the noise in multi-PRF data, are they even suitable here? How about applying denoising techniques prior to dealiasing?
17. Line 256: **The** algorithm …
18. Line 256ff: If all of these situations are excluded, what is the main application for this method and why is it to be preferred over others that handle high-shear situations better? 10% failure rate seems extremely high, given that dealiasing failure rates are usually <1% (Louf et al., 2020 and Feldmann et al., 2020).

Suggested references:

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- Hengstebeck, T., K. Wapler, D. Heizenreder, and P. Joe, 2018: Radar Network–Based Detection of Mesocyclones at the German Weather Service. *J. Atmos. Oceanic Technol.*, **35**, 299–321, https://doi.org/10.1175/JTECH-D-16-0230.1.
- Tabary, P., F. Guibert, L. Perier, and J. Parent-du-Chatelet, 2006: An Operational Triple-PRT Doppler Scheme for the French Radar Network. *J. Atmos. Oceanic Technol.*, **23**, 1645–1656, https://doi.org/10.1175/JTECH1923.1.
- Feldmann, M., C. N. James, M. Boscacci, D. Leuenberger, M. Gabella, U. Germann, D. Wolfensberger, and A. Berne, 2020: R2D2: A Region-Based Recursive Doppler Dealiasing

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- Louf, V., A. Protat, R. C. Jackson, S. M. Collis, and J. Helmus, 2020: UNRAVEL: A Robust Modular Velocity Dealiasing Technique for Doppler Radar. *J. Atmos. Oceanic Technol.*, **37**, 741–758, https://doi.org/10.1175/JTECH-D-19-0020.1.
- James, C. N., and R. A. Houze , 2001: A Real-Time Four-Dimensional Doppler Dealiasing Scheme. *J. Atmos. Oceanic Technol.*, **18**, 1674–1683, https://doi.org/10.1175/1520-0426(2001)018<1674:ARTFDD>2.0.CO;2.
- Germann, U., 1999. Vertical wind profile by Doppler radars. *MAP Newsletter*, *11*(2).
- Tabary, P., G. Scialom, and U. Germann, 2001: Real-Time Retrieval of the Wind from Aliased Velocities Measured by Doppler Radars. *J. Atmos. Oceanic Technol.*, **18**, 875–882, https://doi.org/10.1175/1520-0426(2001)018<0875:RTROTW>2.0.CO;2.