Response to Alain Protat: Validation of torus mapping method for dealiasing Doppler weather radar velocities

The authors would like to thank dr. Protat for constructive comments.

As in the answer to Referee 1, the main application, which is usage of dealiased data in data assimilation for NWP, was not highlighted enough. In light of this usage, some issues raised by Referee 2 (large error rates, applicability in convective cases) are of a lesser concern than if the goal was validation of a new method.
The error estimation provided in the paper is not comparable to the estimation cited by the Referee, as the methods of estimation are different and are done on very different datasets. In the absence of relevant truth data, a colocation technique used in the study allows for a relative intercomparisons of observation quality using PDFs, which is often used to validate new datasets in data assimilation. As datasets included in our validation are provided by OPERA and are not preprocessed by us, they can still contain unwanted characteristics, such as a large amount of noise, ground clutter, etc., all of which contribute to error estimation in the paper. On the other hand, error estimates quoted in publications mentioned by the referee evaluate the error rate of the method in idealized conditions, often on synthetically aliased datasets, where measurement errors are neglected, have short validation periods and preprocessed or reduced datasets (denoising, exclusion of data under 1 m/s, etc.),
In NWP, convection is only partly resolved, so the details of convective situations are not fully extracted from radar measurements by the assimilation scheme, because winds can only be assimilated at scales that the model can resolve. Given the current resolutions of operational limited area NWP models, the goal is to describe mesoscale and larger convective weather systems. In most of these situations, a method using a linear wind assumption in dealiasing is satisfactory.

1. Responses to general comments

(1) We agree that methods that produce identical equations to the ones in the torus mapping method are derived in papers cited by the referee (see section 4 in response to RC1). Our method of choice was the torus mapping by Haase et al, 2004, which was cited, but we agree that citations of these papers should be included.

(2) We agree and will add descriptions of cases where the torus mapping method does not work well and simulations showing inadequacy of the method for nonlinear winds. As explained in the response to general comment (1) of Referee 1, an extra step should be implemented to correct these situations, but we decided not to employ this extra step to reduce computing time.

(3) We will include the suggested references in the paper.

(4) Figure (3) in the paper shows exclusion of events that happen because of three reasons. First is the exclusion because of the centre-difference scheme, which excludes points without two neigbours in the azimuth direction. As the case shown in figure (3) contains a large amount of noise which consists of points without neighbours, which are rejected. Second and third reasons for rejection are noncovergence of the wind model minimization or too few points in the height interval. Both reject points from the whole interval, which is seen in regions further away from the radar site. While the exclusion percentage is high, this is not a problem for assimilation purposes, as radar measurements present a very high number of dense observations, which need to be thinned considerably in order to satisfy computational limitations when assimilating them into the model.

(5) While we agree that aircraft avoid areas with severe convection, we note that aircraft measurements used in the validation are from vicinity of precipitation areas, where radial wind measurements are avalable. These areas likely include stratiform and convective cases.

(6) While we combined radars into datasets based on similar values of Nyquist velocities to study the relevance of dealiasing, we also performed the validation on radars for

each country/provider, which typically have the same Nyquist velocities. Nevertheless, wrongly dealiased data for each Nyquist velocity produce a distinct peak in the PDF, as shown in e.g. figure (7).

As explained in the answer to specific comment (14) and (15) to RC1, we cannot use the error rate as a metric to estimate the accuracy of the technique as we do not have a proper truth reference. For the torus mapping technique Haase et al. cite error rates of the method as 0.2% for stratiform and 4.2% for convective cases, counting just cases where dealiasing was needed.

(7) Our goal is to apply the dealiasing algorithm on a large heterogenous dataset provided by OPERA for use in data assimilation. We do not perform any individual preprocessing, as preprocessing is provided operationally by OPERA. For this reason, the datasets included in our validation can still contain unwanted characteristics. Furthermore, the 10% error rate is expected to decrease significantly during the quality control step before assimilation as shown in figure (8). As explained in the previous answer, the error rate as used in other analyses is not applicable in our case, as we do not have the proper truth reference values. Our error rate estimation covers all mentioned effects, collected on data in 1 year.

(8) We would like to emphasize that in this comparison, NWP is not used as a truth, but as a reference for a relative intercomparison with other data types. We agree that the convection is not fully resolved in this intercomparison, as it is not resolved by aircraft and radiosonde data. On the other hand, all these datasets resolve mesoscale circulations. We will add this discussion to the paper.

2. Revision of paper

Given the very relevant questions raised by Referee 1 and Referee 2, we propose a revision of the paper, where we would:

- Since the purpose of our work is to show that the torus mapping method provides dealiased data of sufficient quality for use in NWP, we will make a slight change in the title and revise the text of the paper to make this purpose clearer.
- Will add descriptions of cases where the torus mapping method does not work well and simulations showing inadequacy of the method for nonlinear winds.
- We will include more recent references that Referee 1 and Referee 2 suggested, with more discussion and compare our method to the similar V-IVAP method.
- We will include individual case studies to show the performance of the algorithm in high shear cases.
- To explain our choice of datasets, we will include analyses from all radar networks and justify our reasons for choosing a subset of data for detailed analysis and revise the text accordingly.
- Improve algorithm implementation description (performance, specifications).
- Correct the figures and other smaller errors as suggested.