

## ***Interactive comment on* “Retrieval of three-dimensional wind fields from Doppler radar data using an efficient two-step approach” by C. López Carrillo and D. J. Raymond**

### **Anonymous Referee #1**

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This manuscript is concerned with the description and testing of a variational dual-Doppler radar wind retrieval algorithm. The constraints imposed in the analysis procedure are: observational constraints, which incorporate data from two or more Doppler radars (and possibly other data sources, e.g., dropsonde or sounding observations), a mass conservation constraint (sometimes referred to in the literature as a mass continuity constraint), and spatial smoothness constraints. The procedure is general enough to incorporate data from two or more stationary Doppler radars or from a so-called “pseudo-dual-Doppler radar”, that is, data from an airborne-radar that, when appropriately processed, are equivalent to data gathered from two stationary Doppler radars.

The observational and mass conservation constraints are standard in dual-Doppler analysis procedures. The use of smoothness constraints is standard in variational (e.g., 3DVAR) analysis techniques. The new aspect of this study is a data gridding/reduction step designed to minimize loss of information and to generate estimates of the variances of the reduced velocities. Any improvements made in these directions would be of interest to radar and mesoscale meteorologists as it could potentially improve dual-Doppler analyses of a variety of convective and non-convective weather phenomena.

The new retrieval is tested with pseudo-dual-Doppler radar data from a tropical depression. Unfortunately, the results from these tests are inconclusive. A comparison of the retrieved horizontal wind vectors with the horizontal wind vectors from an independent data source (dropsondes) does indicate a qualitatively good agreement (Fig. 8). But there is relatively little challenge in obtaining qualitatively reasonable horizontal wind components from dual-Doppler or pseudo-dual Doppler data, especially on the coarse analysis grid indicated on that figure. A more challenging problem – and one of prime interest to mesoscale meteorologists – is the analysis of the vertical wind component. Apparently it was not possible to evaluate the accuracy of the retrieved vertical wind component in this test case. In the future it would probably be better to consider a more stringent test of the algorithm, perhaps using high-spatial-resolution data from a numerical prediction model, in which the accuracy of all three retrieved velocity components (and especially the vertical component) could be evaluated. A high-resolution test case would also allow one to see how well structures of progressively higher wavenumber could be retrieved by the procedure.

Concerning the structure of the manuscript, readers new to the subject of dual-Doppler wind retrieval would benefit from a more thorough and critical review of the literature. For instance, in the discussion of loss of information at large elevation angles, the authors state that "The loss happens because, in a traditional method, the horizontal velocities are obtained first on a regular grid and then used for the vertical integration of the mass continuity equation." However, that statement only applies to the simplest

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of the traditional methods; there are also iterative traditional procedures conducted in Cartesian coordinates (i.e., not the COPLANE coordinate system) in which the mass conservation equation and the complete relation between the radial wind and the horizontal and vertical velocity components are satisfied (e.g., Brandes 1977; Ray et al. 1980; Hildebrand and Mueller 1985, Dowell and Shapiro 2003). It would probably also be good to discuss some of the other variational approaches of dual-Doppler radar wind analysis (e.g., Protat and Zawadzki 2000, Protat et al. 2001, Liu et al. 2005, Shapiro et al. 2009, Liou and Chang 2009). More importantly, however, a thorough discussion of the literature would help the reader understand what the main impediments are to obtaining accurate horizontal wind and vertical velocity fields. At the very least, there should be a discussion of problems stemming from the non-simultaneous nature of the observations and the impact of missing data, especially at lower and/or upper levels where the boundary conditions are applied.

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