Response to Reviewer Comment #4

Thank you very much for your valuable suggestions that have helped to improve the manuscript. Taking into account comments from all reviewers, we reorganized the sections. The following contains our detailed responses to your comments, with our responses in plain text given underneath your original comments in bold type.

The paper has a thorough introduction explaining the importance and current understanding and well presented graphics. The paper answers many questions I initially would ask – e.g. the attenuation issues and need for S-band in these cases. I appreciated the descriptions of the cases in section 5.2. However, I feel there are some "holes" that need to be filled for publication.

We hope we can address some of the reviewer comments in our responses below.

- Page 4 – the calibration and processing is essentially stated as standard, yet these practices are certainly far from universal and require more detail on what calibration, processing and quality control has occurred.

This question has come up with other reviewers. We have revised section 2 and added an improved description of radar data processing. Of most importance to this study, aliased radial velocity measurements from all radars were corrected using the four-dimensional technique described in James and Houze (2001). Similar to Collis et al. (2013), this technique was applied iteratively using multiple wind profiles from the MC3E radiosonde network to produce robust results (e.g., Jensen et al., 2015b). Finally, each radar volume was manually inspected to check for conspicuous errors and artifacts.

- Equation 1 requires weights, which are subsequently mentioned, but the chosen values are never given – for repeatability they are important.

Weights calculated by Eq. (1) are used to map the radar data to the Cartesian coordinate domain. The weights decrease with distance between the grid point and a radar data point. Figure 3 in the revised manuscript shows nearest neighbor distance at each gird point and its weights. We also used the nearest neighbor weights as the observation constraint weights of the cost function in the 3DVAR retrieval (section 3.1).

- I found section 3 hard to follow, some symbols seem unspecified (at least until later) or inconsistent (notably don't match the plots) which is I believe the source of my initial difficulty.

Thank you for pointing these issues out to the authors. We defined the physical constraints of radial velocity observations (J_o), anelastic mass continuity (J_c), surface impermeability (J_p), background wind field, (J_b), and spatial smoothness (J_s) in the beginning of section 3. We also revised descriptions about $\mathbf{\Lambda}$. In the manuscript, capital lambda ($\mathbf{\Lambda}$) represents a $n \times n$ matrix of constraint weights where n is identical to the number of analysis points, while lower case lambda represents diagonal element of the matrix $\mathbf{\Lambda}$, which is treated as adjustable parameters. Although the matrix $\mathbf{\Lambda}$ has a number of elements, this study uses a constant values of λ for $\mathbf{\Lambda}_c$, $\mathbf{\Lambda}_p$, $\mathbf{\Lambda}_b$, and $\mathbf{\Lambda}_s$. We specified this in section 3 and revised text, tables, and figures appropriately.

- the beginning of section 7 suggests "X-, C-, and S-band scanning radars have been used together to pseudo simultaneously", yet the S-band seems only used for reflectivity in the case where attenuation is thought to be significant, and it isn't clear if it is used at all in other cases.

Reflectivity and Doppler velocity measurements from a NEXRAD WSR-88D S-band radar (KVNX) are used for all retrieval cases.
We rewrote section 7 and have decided to leave out the sentence from the text.

- I'd like to see the S-band radar in table 2 if it is intended to be used together as in the previous point.

Done.