Review of Thompson et al. 2020 submitted to AMT
by David K. Adams
dave.k.adams@gmail.com

Recommendation: Minor Revisions

General Comments:
The authors present a study employing an airborne VSWIR imaging spectrometer to examine very high spatial resolution (sub-kilometer scale) column water vapor. The technique is presented with sufficient detail and the results argue for similar structure function scaling exponents that are observed over many decades of scale; a perhaps somewhat surprising result. As a proof of concept, the manuscript is more than adequate for publication. Perhaps one weakness would be the need to expand the literature a bit to include some examples of more meteorological/climatological applications focusing on column/precipitable water vapor spatial/temporal structure. This would help better motivate the study and draw greater interest for a broader community. This broader literature review wouldn´t need to be more than one paragraph. One other point to address is to clarify some of the langauge. It is confusing at times, for example, which spatial scales you are referring to. See below in my minor comments.

Minor Comments:

Line 13. Water vapor and cloud formation are important for all numerical models of the atmosphere, not just General Circulation Models (GCMs). Even at very high resolutions where deep convection is resolved (i.e. ~ km-scale) such as “Cloud-Resolving models” or “Convection-Permitting Models” and even for “Large Eddy Simulations” (~100m-scale), cloud microphysical processes which critically depend on water vapor are still parameterized.

Line 19-20 You should be clear as to what spatial scales you’re referring to. Convective and non-Convective systems would typically be 10s of kms to maybe 100km and quasi-geostrophic motions would be 1000km and greater from Edwards et al., (2019).

Line 24 “but in general water vapor variability is considered horizontally isotropic.” This idea is a bit unclear, what exactly do you mean horizontally isotropic particularly with respect to spatial scales?

Line 35 “consistent with 2/3 over distances of multiple kilometers.” Do you mean several kilometers here?

Line 41 "at scales above 11 km" I assume you mean at scales greater than 11km. " Above 11km" sounds as if you are speaking in the vertical sense.

Line 49 Just write "...compared them to GCMs, ..."

Line 58. “These studies contribute to a growing body of literature on water vapor scaling.”
I think it would be good to include a paragraph on some of these studies. Not only techniques for measuring PWV, but theoretical as well as applied studies to meteorology/climate. Are there modelling studies which have used these scaling arguments as metrics? PWV is certainly a critical if not “the” critical variable for deep convection in the Tropics. There are numerous studies observational, modeling and theoretical which focus on this relationship, including temporal and spatial scaling arguments. This would help motivate this study a bit more and why it has more “global” importance.

Line 85 Write “... build upon these results.”
Line 105 Write out RTM. I assume you mean Radiative Transfer Model, but just to be clear for the reader.
Line 155 “We solve it with a trust region gradient descent optimization.” You might want to clarify what this is.

Line 183 I think it would be clearer to write “leave-one-out cross-validation”

Line 203 Spell out “AFGL”

Line 213 Write “Some discrepancies in the optical paths remain, which become larger for column water vapor in the free troposphere than in the planetary boundary layer.”

Line 251 Write “This artifact, indicated by a white arrow, may be related to pathological effects from the sun glint bidirectional reflectance distribution or the aircraft shadow. Therefore, it was excluded from the statistics.”

Line 258 Write “second-order”

Figures:

Figure 1. Left: ... with gray arrows. The arrows look red to me.

Figure 2. Left: Write “.... In reality, the sun ...”

Figure 6. Left: flightine is mispelled.