Author Comments as a response to Referee Comments #1, Ian McDade

Thank you for the fruitful and constructive comments. We address all the comments in the notes below.

Major points:

This is an interesting paper ostensibly demonstrating the potential of satellite limb tomography for studies of Polar Mesospheric Clouds (PMCs.)
The manuscript does not contain much new about the mathematical aspects of satellite limb tomographic recovery other than that already in the literature (see Degenstein, 1999, and key references therein.)

A major concern of this referee is that the authors appear to assume that PMC scattering of sunlight is isotropic in nature and repeatedly associate an isotropic 'volume emission rate' to the source limb radiance. The geometry of the OSIRIS 'in track' observations, particularly in the Figure 7, orbit 56235 case (observed close to June solstice), must involve a considerable range of scattering angles along the line-of-sight at every tangent height.
The authors should provide more details on this complication and its possible impact or explain why it should not be a concern.

Response to comment: Thank you for noticing this. The matter should certainly be explained in a better way. We have made a substantial revision of this in the manuscript. "Volume emission rate" is not a good quantity to use when describing scattering from PMC since this involves a phase function and is not isotropic. Instead, the values have been converted into a "volume backscatter coefficient", beta, in units m^{-1} str^{-1}. Inputs to the tomography algorithm are OSIRIS limb radiances in units ph cm^{-2} s^{-1} str^{-1} nm^{-1}. In applications of tomography to airglow or auroral studies, volume emission rate in units ph cm^{-3} s^{-1} is a convenient retrieval product (Degenstein et al., 2003). This is not the case for studies of PMCs as the scattering phase function introduces anisotropy to the radiance field. Therefore, we describe local scattering from a cloud element in terms of the volume scattering coefficient β_λ in units m^{-1} str^{-1} that includes the dependence on the scattering angle. β_λ is obtained by normalizing measured radiances to the incident solar irradiance in the spectral interval of interest. The use of β_λ also facilitates comparison to lidar studies that describe local cloud properties in terms of a volume backscatter coefficient in the same units. When interpreting cloud structures as shown in Figure 7 one has to keep in mind that the absolute value of the local scattering depends on the scattering angle of the observations and that the scattering angle slowly varies along the satellite orbit. This phase function effect on the retrieved PMC structures remains minor. During the PMC season poleward of 60°N, the solar scattering angle typically only changes from 70° to 100° from the ascent to the descent part of the flight.

What does Figure 7 tell us about PMCs? What are the ordinate units? Can the abscissa scales be modified to indicate latitude, longitude, solar zenith angle and scattering angle in some way? This would greatly help with meaningful interpretation of the observational data. See also Figs 5 & 6.

Response to comment: The figures will be updated with more information, including the units described above.

The adopted MART solver approach miserably fails to provide any error statistics on the recovery – the authors should acknowledge this very serious limitation of their proposed methodology - perhaps we can move forward and apply derivatives of OE to provide some objective recovery statistics. It would be most worthwhile, and much more worthy of publication in Atmos. Meas. Tech. Discuss., if the authors considered this option.

Response to comment: Thank you for commenting on the lack of error statistics on the recovery. This is really a weakness of the MART method. Optimal Estimation methods would give internal error statistics but would also demand a completely new tomography algorithm, which is beyond the scope of this project and this paper. This, however, does not mean that we ignore errors. It's because of this matter we investigate noise levels and how these influence the retrievals. All of this will be better explained in the revised paper, including the noise levels.

Minor points:

What is the relevance of Table 1? Only the 15–17 Jun 2011 56233–56261 period seems relevant (see above).

Response to comment: Table 1 is relevant for people to be able to look-up which orbits Odin was set to run in the tomographic mode. Since this is the first time this is ever made and since these orbit numbers are not listed elsewhere, we suggest keeping Table 1 for reference purposes.

Fig. 1 This provides very little to the potential readership.
Fig. 2 This also provides very little to the potential readership.
Fig. 4 This also provides very little to the potential readership.

Response to comment: We can admit that Figures 1, 2, and 4 are not needed to understand the paper. However, we find it necessary to keep them by pedagogical reasons due to that they facilitate reading.