Authors Response to Interactive comment by Anonymous Referee #2 on "Development and validation of satellite based estimates of surface visibility" by J. Brunner et al.

The authors would like to thank Anonymous Referee #2 for their valuable comments to this manuscript.

General comments: This study presents surface visibility retrieval by using MODIS data as a proxy for the new geostationary sensor, GOES-R/ABI. Validation also reported that an overall success rate was 64.5% by comparing satellite and ground observation data. The paper presents information that is valuable to the remote sensing community, it should be published after some corrections/improvements. Some significant deficiencies of this paper are found in the analysis of the visibility retrieval equation and its accuracy range. Although parameters used in Eq (3) are the most important for determining the visibility from AOD, it is currently explained by reference journal papers. They should be explained and discussed with sensitivity tests. Because AOD cannot be expressed as an integrated form by a simple extinction (σ) value and fixed layer thickness (x), complex extinction profiles (by different aerosol extinction coefficients as a function of aerosol size and chemical composition) should be exploited and their effects on visibility determination. Also, providing tolerable ranges of the accuracy of retrieval is an important to the audiences.

Authors Response: The authors acknowledge that actual aerosol extinction profiles are complex and vary depending on aerosol size and composition, however satellite aerosol retrievals from passive sensors can only provide estimates of total column extinction with limited information on aerosol size (fine and coarse mode) and no information on aerosol chemical composition. The GOES-R ABI visibility retrieval begins with a "first guess" retrieval based on the assumption that the aerosols are well mixed and confined to the PBL. Under these assumptions Eq. (3) is simplified as discussed in the manuscript. The retrieval then uses meteorological parameters within the PBL to try to account for situations where the aerosol extinction profile is not uniform, primarily based on the relative humidity and static stability within the PBL. We have added additional discussion of the basis for the retrieval algorithm as well as more detail regarding the multiple regression approach in response to Reviewer 1 in the revised manuscript. Comparison between the visibility obtained with the satellite retrieval to surface visibility under situations with complex extinction profiles to explore the sensitivity to aerosol size and composition would require airborne in-situ measurements of these quantities and is beyond the scope of this manuscript.

Specific comments: p. 11260, line 15: The GOES-R ABI visibility algorithm assumes that the aerosol resides within the PBL, However, some aerosols are still exists above PBL and transported through the upper troposphere. In these cases, the visibility at the surface is measured as high although the AOD is measured as higher. Consequently, the retrieved visibility from the GOES-R ABI visibility algorithms is not suitable for these cases. The author needs to explain the assumption or limitation of the method in detail.

Authors Response: Added in discussion on p. 8 lines 166-171 that if aerosols exist above the PBL, the visibility at the surface will be underestimated in the satellite retrieved visibility. If the PBL is stable and the aerosols are not well mixed within the PBL, which may occur during the morning, then the visibility at the surface could be overestimated in the satellite retrieved visibility. We could assume an exponential profile of extinction under stable PBL conditions but this has not been implemented in the current version of the algorithm.

p. 11260, line 25: The ASOS measurement data were used to validate the retrieved surface visibility. If possible, visibility error vs. AOD error could be interesting and this supports how AOD can affect visibility retrieval.

Authors Response: Uncertainty in the ASOS visibility is not provided with the measurement so this is not possible.

p. 11260, line 25: Explanations of the collocation between satellite and ground observation data are missing.

Authors Response: Added in a sentence on p. 8 lines 180-181 explaining the collocation between satellite and ground observation data. The ASOS data must be within a 5 km radius of the MODIS retrieval and within a minute of the MODIS overpass time to be collocated.

p. 11263, line 20: The author describe the variation of the Heidke Skill Score values according to the monthly mean time series of the ASOS validation statistics for the GOES-R ABI visibility algorithm. The GOES-R ABI visibility algorithm performs the best from the June through September. In contrast "use with caution" skill scores occur in April and May and from October through December. More discussions on these results are required.

Authors Response: Added a discussion on p. 12 lines 268-271 describing acceptable Heidke Skill Score values based on previous peer reviewed manuscripts (Hyvarinen, 2014 and Murphy, 1996). Also, added these to the References section on p. 27-28.

p. 11261, line 5: As mentioned in the manuscript, increment of RH leads to increased aerosol extinction and overestimates in the frequency of Low and Poor visibility relative to ASOS. Please show the changes in the results of CSR when the author removes the cases for the higher RH. The author may remove the cases of the AOGS visibility having large uncertainty.

Authors Response: We conducted RH sensitivity studies on the results of CSR for May and June 2010 to address this. A paragraph was added on p. 12 lines 253-263 which confirms that the CSR is degraded for the higher RH cases and is improved for the lower RH cases. We do not have uncertainty estimates for individual ASOS measurements though so the analysis of the sensitivity to ASOS uncertainty is not possible.

Figure 3: Please, combine the top panel and bottom panel to see the relation between variation of the surface visibility and the fire occurrence in time series.

Authors Response: For Figure 3, combined together the top and bottom panels to show the relation between variation of surface visibility and fire occurrence in time series better. Updated the caption for Figure 3 on p. 31 lines 686-690 as well as the text associated with Figure 3 on p. 14 lines 314-315 and on p. 17 line 369.

Please, unify the form of number in y-axis of the figures (decimal or scientific etc.)

Authors Response: The y-axis on Figure 1 ranges over 6 orders of magnitude and so we feel that scientific notation is appropriate for this figure. We have updated the top panel of Figure 4 to show normalized frequency in decimal form. All other figures are in decimal form.