Review of "Cloud sensitivity studies for stratospheric and lower mesospheric ozone profile retrievals from measurements of limb scattered solar radiation" by T. Sonkaew, et al.

AMTD Criteria:

1. This paper addresses a very relevant scientific question regarding the effect of clouds upon retrieved ozone profiles. This fundamental question has been asked since the advent of the limb scattering technique and is clearly within the scope of AMT.
2. These studies are one of the first done systematically for ozone profile retrievals.
3. Many results are presented for various aspects of the problem, but the level of explanation and discussion could be more in-depth.
4. Assumptions are clearly outlined.
5. The results are sufficient to support the limited conclusions made.
6. The authors have done a good job of detailing the conditions and assumptions of the calculations. Thus, enabling others to repeat these same studies.
7. The authors clearly indicate their own original contributions.
8. The title clearly states the content of the article.
9. The abstract is clear and concise.
10. Overall, the presentation is well structured and clear.
11. The language is fluent.
12. For the most part, the math is correct.
13. Several figures could be re-done to enhance readability.
14. The references tend to be SCIAMACHY-centric and not necessarily the most appropriate, but maybe representative of what the authors have read.
15. Appendix A could be eliminated without much loss of information.

GENERAL:
This article examines a question that has existed since the advent of the limb scattering technique, i.e. how does scattering by clouds cause errors in profile retrievals. A systematic approach is used to study the problem and many results are generated. The use of an approximate model to gain better physical insight into the problem is a wise choice. The depth of the explanations should be increased, but overall the article is an important one

in the field of limb scatter observations and subsequent ozone profile retrievals.

Specific Comments:
Page 381, line 2: Is the cloud fraction truly equal to 60%? Some studies say as high as 80%. Cloud coverage is dependent upon the threshold of what constitutes a cloud, i.e. optical depth limit, and the 'pixel' size. What is really relevant for limb scatter?

Page 381, lines 15-19: Yes, the limb scatter observation geometry can be complex due to multiple scattering, but not simply because there is multiple scattering. The same observation geometry is fairly straight forward for wavelengths with strong atmospheric absorption, i.e. less than 300 nm, and single scattering is the primary pathway for sunlight to reach the observer. While multiple scattering also occurs for the nadir observation geometry, at wavelengths greater than 300 nm, it is less complex than the limb scatter geometry for two main reasons: scattering must be modeled in a 'spherical' atmosphere, not a plane-parallel atmosphere, and the major source that diffusely illuminates the observation line of sight is not directly observed. For the later factor, this region of influence in the Earth's atmosphere can be 1000km in length and 500 km or more in width [Oikarinen et al., 1999], as a consequence heterogeneity of the region 'around' the tangent point becomes an issue. While scattering in a spherical atmosphere and the 'adjacency' effect do occur for the nadir geometry, generally one can do quite well in modeling with scattering in a plane parallel atmosphere occurring within the field of view (pixel).

Page 384, Line 16: Need to state upfront that you are referring to limb scatter measurements here.

Page 386, line 10: I'd classify 675nm as within the Chappuis band (400-700 nm).

Page 386, last paragraph: Does y_c(h_i) represent the combined measurement for all the wavelengths, but a single tangent height (the reference tangent height aside)?

Section 7 & Figure 1: Since the Chappuis triplet is actually created in two steps: normalization and wavelength ratioing, it would be instructive to add additional plots to Fig. 1. Curves for both independent processes should show reduced errors, but not necessarily the same reduction or altitude dependence.

Page 394, line 23: You should go a little deeper here in the explanation. Where have the pathlengths been changed that lead to increased absorption? Is it due to scattering within the cloud and subsequent absorption by ozone within the cloud? This has long been a suspect for error in total ozone estimation from nadir observations. The motivation for the approximate model was to better understand what is physically happening in the retrieval process. So, please discuss, even in a qualitative fashion, why the curves look that way they do. For example, the absolute radiance plot where the absorption error term is positive because the cloud-free model needs more larger ozone concentrations to match the increased path-absorption. Likewise, the scattering term (first term in Eq. 21) is negative because the clouds increase the observed 602 nm radiance, but the only way the cloud-free model can match the observed radiance is to decrease the ozone concentration.
Why does the 'gaseous absorption term' or second term have a negative sign when the Chappuis triplet is used? You make the case that the approximate model is similar, although not completely robust, to the more rigorous method. So, make the most of it and gain as much physical insight about the problem as you can. I really feel that understanding Fig. 1 will go along ways toward understanding the root of the error, rather than just saying the problem is that clouds aren't modeled properly, i.e. not at all.

The other key to the problem can be found in Fig. 9, where the errors approach zero for an albedo in the cloud-free case that matches the cloudly Chappuis value, by definition. The triplet/pair approach outlined in Flittner et al. (2000) and expounded upon in Loughman et al. (2005) stresses the need for an estimate of the surface albedo based upon the particular scene in order that the upwelling diffuse light in the retrieval process be modeled in a more appropriate manor. The estimate of the scene albedo is needed in the inversion process to better estimate the mix of multiple vs. single scatter for each tangent height for an individual wavelength and to refine the spectral dependence of the radiance. Whether this is done with a cloud or a Lambertian surface with a variable albedo should be a minor issue. The authors certainly have the means to test the validity of using a Lambertian surface with a variable albedo. The use of a Lambertian surface with an albedo estimated directly from the limb radiances has been used in the analysis of data from SOLSE/LORE, SAGE III and OSIRIS, and is the baseline approach for the future OMPS instrument.

Table 3: The ‘Figs.’ column is extremely helpful in navigating the article. Great idea!

Fig. 1: I found it hard to discern the symbols. Maybe if each particular symbol was a constant color, i.e. ‘X’ always red.