Reply to comments by reviewer #2:

(our replies are boldfaced)

Reviewer 2: amtd-8-C2871-2015

Q2.1: The authors need to better explain all of the features seen in both the spectra (Figure 3) and the parameters derived (Figure 5) from this limb scan.

- **We changed the figure 3 adding more information and reference to text.**
- **An extended explanation is given for figure 5.**

Q2.2: My first look at the spectra shown in Figure 3 led me to believe that there were two clouds present in this scan. The closeness in magnitude of the spectra measured at 18.68 km and 15.43 km naively indicate a scattering layer not consistent with a Rayleigh background atmosphere. Then of course the behaviour of the spectra measured at the lowest tangent altitudes definitely indicates a cloud. The CIR and CI clearly indicate a cloud at 12.13 km, using a threshold of 1.4, but to a naïve reader the behaviour of the CIR and CI might also indicate a cloud one tangent altitude higher. This simple analysis that was supposed to convince the reader that the technique works raised questions about how many cloud tops it was missing. More explanation is required.

- **It should be kept in mind that the y-axis is logarithmic. So between 15 and 18 km is no minor gap in radiance. Also is the slope for both tangent heights the same pointing towards a Rayleigh atmosphere. The first 4 tangent heights with higher radiances show a bright limb view with a low slope between the wavelength bands, which means that Rayleigh scattering is not the major contributor.**

Q2.3: I had difficulty understanding why the authors included the discussion on limb optical thickness (page 8308) and horizontal sampling (page 8314). I believe this is to setup the comparison with nadir measurements that is done later in the paper. However, it was not clear that this was the case and I feel these sections need some work to better clarify their usefulness. As mentioned above the presentation of the simulation studies was not convincing. The following three points need to be addressed to increase reader confidence in the final results.

- **One section is now moved to the appendix and referenced in the main section as add-on information.**

Q2.3: I believe that SCIATRAN is an excellent radiative transfer model and can be used for a variety of simulations. However, within section 4 the authors did not convince me that SCIATRAN has the required accuracy to effectively analyse the systematic biases associated with choosing a threshold of 1.4 for the entire SCIAMACHY data set. This is not an indictment of SCIATRAN but a statement related to how the authors presented it as a tool. The only statement of SCIATRAN's accuracy comes on line 11 of page 8310 and this is a general unconvincing statement that referred to a study presented in 2003 and is valid only for clouds of optical depth greater than 5. I believe SCIATRAN is up to the task, the authors just need to better demonstrate its utility for this particular problem. This can be done through more references and specific simulations of relevant SCIAMACHY limb spectra.

- **One single threshold cannot be optimal for all possible cases, as was shown already for MIPAS cloud detection (Spang, 2012, Sembhi, 2012). For our study we added now more simulations to show that 1.4 is good enough for most scenarios that we are interested in.**
- **The 2003 paper is not state of the art anymore and reference is deleted. SCIATRAN and the modelling of clouds is best described in Rozanov (2014). Also the validation with some other models is given there. The accuracy of SCIATRAN is not limited by the optical thickness of clouds or aerosols. Comparisons to DISORT including Mie Scattering gave differences in the sub-percent range.**
- **SCIATRANs accuracy with respect to clouds was e.g. tested indirectly for retrieval of ozone profiles. Highest COT lead to the largest errors in the order of 6% in the upper troposphere.**

Q2.4: The discussion around Figure 6 was somewhat confusing. I believe the authors were attempting to demonstrate that the two specific clouds they used for their simulations are detected with SCIATRAN simulations for some subset of SCIAMACHY viewing geometries. This needs to be tightened up and more comprehensive to help interpret the results.

- **We added 2 more scenarios (+one figure in the supplements) and extended the explanations.**

Q2.5: I believe the paper will be much better if many more simulation results are included that better illustrate the points the authors are trying to make on pages 8312 and 8313. On these pages a subset of extra results are mentioned, but not in a fashion that gives the reader enough information to accurately assess the systematic biases associated with the results that are presented later in the paper.

- **Done**.

Minor comments

Q2.6: Line 12 page 8296: "scattering of : : :" needs to be changed
Throughout the paper the notation tau_N (read as tau subscript N) and many other tau_X's are used. I think N here refers to nadir but I'm not certain. Also, sometimes no subscript is used. This needs to be tightened up.

- **N means nadir. Corrected: defined at beginning of paper**

Q2.7: Line 4 page 8297: Nabro is later mentioned to have erupted in June, 2011

- **True, error was corrected.**

Q2.8: Line 5 page 8297: Is "particle top height" a good term to use?
The expression "in the order of" appears in a few places. This should be "on the order of".

- **Particle -> Aerosol layer top height**
- **I tend to mix that up. But all my dictionaries say: in the order of**

Q2.9: On line 23-page 8298 a cloud with an optical depth greater than 0.3 is called opaque while on the next page, line 13, a cloud with an optical depth less than 1 is called thin. I think I understand that these are different types of clouds but how can one be thin and the other be opaque if they have the same optical depth?

- **Corrected, this was confusing, deleted the sentence.**

Q2.10: Line 8-page 8300: I believe the authors meant the SAGE instruments.

- **Rephrased the sentence and added citation (Wang, 1996).**

Q2.11: Line 5-page 8303: The blue numbered circles do not give the tangent heights of SCIAMACHY. This needs to be reworded.

- **Corrected. "The blue circles depict the tangent heights for each LOS, which are numbered from the bottom to the tropopause."**

Q2.12: I believe that the tangent height knowledge mentioned on page 8304 is for the occultation mode and the 50 m accuracy is not relevant for the limb scatter work presented here.

- **This only applies to the occultation mode, while for limb the pointing knowledge has an accuracy of less than 170m. Corrected.**

Q2.13: The word "colour" is used sometimes and "color" shows up at other times in the figures.

- **Corrected.**

Q2.14: Line 6 page 8308: cloud index should be colour index.

- **Corrected.**

Q2.15: In Figure 5 the order of plots a) and b) should be changed as a) is derived from b).

- **Changed**

Q2.16: In Figure 6 it needs to be explained that T_C and T_A in the plot are the taus referred to in the caption and that these subscripts are different within the text. Also, a colour scale would be nice.

- **Corrected and colour scale added.**