Response to Referee #3

We thank reviewer for his energy to review our paper. We greatly acknowledge his comments and suggestions that helped us to improve the quality of our paper. Below, we present the detailed replies to each comments. Note: original comments of the referee are given in bold.

General comment:

The paper describes two (one annual and one monthly) nighttime climatologies of OClO slant column densities (SCDs). Why did you use SCD and not vertical profile of OClO concentration since apparently the spatial inversion of OClO SCDs into concentration profiles is easy to do (you did it for the comparison to balloon observations)? Using vertical profile of OClO concentration could increase the number of potential users of these climatologies, especially in the modelers community.

Response:

The question of the use of slant column densities instead of vertical profile of concentration is quite relevant. You are right to say that the use of OClO concentrations profiles would increase the number of potential users. However, we have decided to keep the SCD in the revised version of our manuscript for several reasons that we detail hereafter. First of all, even though it was originally intended to retrieve OClO using single GOMOS measurements, it turned out impossible to do it because of the low signal-to-noise ratio of a single GOMOS measurements. Thus, OClO is not retrieved with the operational processor and has never been included in the official distribution of GOMOS level 2 data. Our OClO product is an off-line product and, as such, to deliver them in the form of SCD with "reasonable" error bars appears to us to be the best thing to do. Secondly, the retrieval of the OClO product is based on a statistical analysis of several co-located GOMOS measurements. We have to keep this in mind. The retrieval is not based on a single measurement, a preliminary step is required to build a "virtual" measurement that we will use to retrieve OClO. This additional step is a first source of uncertainty. The second step is the spectral inversion (DOAS) used to retrieve the SCD of the different species involved in the attenuation of the radiations. Here again, this step implies some uncertainties. Thereafter, it is always possible and easy in the case of GOMOS to perform a spatial inversion to retrieve vertical profile of concentration but the error bars become too large. It is difficult to be confident with a product with very big error bar. We are at the limits of the possibilities of the GOMOS instrument. Only the SCD provides error bars that make the product usable for seasonal studies, latitudinal studies,… The SCD relative errors extend from about 5% to 70% at some levels. A second panel inserted to Figure 5, shows the vertical profile of the SCD relative errors. On the other hand, the relative errors concerning the vertical profiles of OClO concentrations are generally greater than 60% and can reach about 180%. These values are too important to use scientifically the OClO concentrations. Nevertheless, we have used vertical profiles of concentration to perform the comparison with the balloon observations (Fig. 6) because we have only the concentration profiles derived from these balloon measurements. A

warning has been added in the text explaining the limitations of this comparisons which is in fact a simple verification. Moreover, Figure 9 has been removed because it shows the anti-correlation between NO_2 and OClO in terms of concentration. It is a nonsense to keep this figure in the text and to affirm that OClO concentration is not a "good" product.

A small paragraph has been added at the end of section 3 to explain why we do not use the vertical profile of concentrations. We have also decided to change the title of our manuscript: "OClO slant column densities derived from GOMOS averaged transmittance measurements".

Specific comments:

Page 3517, lines 23-24: it is not clear for me how do you determine the exact location of the averaged measurements. Maybe you can elaborate a bit more on this.
Response: The averaged measurement is calculated by using single GOMOS measurements located in a specified latitude band (the latitude bands used are detailed page 3518, lines 9-12 in the discussion manuscript). Then, the averaged measurement is supposed to be representative of this latitude band.

Page 3521, line 25: 'the retrieval errors are generally better than 50%.' What are the different components of the retrieval error ? Also in Figs. 5 and 6, we don't know what represent the error bars. More generally, including a detailed error budget in the paper would be very useful since this new OClO SCD product is described for the first time.
Response: You're right. We have defined more precisely the way we extract the retrieval error. Once we have found the slant column densities of each species by using a minimization of the chi-square function defined in the text, we derived the random retrieval error using the hessian matrix of the chi-square function as explain in Press et al. (2007). We have added a sentence in the section 3 explaining this calculation: "Once the SCDs retrieved, the errors made ΔN_{gas} are given by the root square of the diagonal elements of the error matrix (the inverse of the curvature matrix which is equal to one-half times the Hessian matrix of the chi-square function)". We thank the referees because thanks to their comments about the retrieval error we have found a small error in our computation of the error. It has been corrected and the new error bars appear in the revised version of our manuscript.

Since we have add relative error profiles in Fig. 5, we have modified the phrase you quoted by this one: 'The left panel of figure 5 shows the vertical profiles of the relative error for these 3 profiles. The range of the relative errors extends generally from about 5% to 70%'. In Figs. 5 and 6, the error bars represents the retrieval random errors.

Sect. 4: I think comparing your retrievals with only two balloon profiles is not a validation but a simple verification. Could you please modify the text accordingly. Also on this topic, you mentioned in the Introduction that vertical distributions of OClO are also available from limb-

scattered sunlight instruments like OSIRIS and SCIAMACHY. Why don't you use these measurements to check your retrieval by combining them to a photochemical box-model, ensuring by this way the photochemical matching between GOMOS and SCIAMACHY or OSIRIS observations. This has been done in the past for BrO and NO2 (see e.g. Millan et al. (2012) and Bracher et al. (2005)) and it would make the verification - which is currently the weak part of the study - more robust.

Response: Yes, you are right. We have modified the text to explain that these comparisons are not a validation but just a verification. Secondly, it is planned to make comparisons using limb-scattered measurements and photochemical box-model but because of lack of time we have decided to make this study later and, for the time being, we settle for these simple direct comparisons with balloon-borne measurements.

Pages 3525-3526: The presence of an OClO stratospheric equatorial layer is a very interesting result. Did 3D-CTM models have confirmed the presence of this layer since the first publication by Fussen et al. in 2006?

Response: for the time being, we have checked only few years between 2003 and 2011 (2003, 2006 and 2009) and the presence of OClO at about 35 km is well confirmed by the model on a global scale (but not with the same amplitude). Further studies are required and this will be probably the subject of another article.

Technical corrections:

All technical corrections have been taken into account in the revised manuscript