This article presents an Ozone Profile Retrieval Algorithm using atmospheric limb scattering of solar UV and visible radiances measured by OMPS Limb Profiler (LP), to produce high vertical resolution ozone profiles in the stratosphere and upper troposphere. This algorithm is based on a Tikhonov regularization, which was originally developed for the SCIAMARCHY Limb instrument. Therefore, the application of the similar retrieval scheme to these measurements will offer a great opportunity of long-term trend analysis if the consistency of two dataset could be well demonstrated with the cross-calibration using the overlap period between OMPS and SCIAMARCH. In this study, ozone profiles are retrieved in the unit of VMR at altitude-based vertical levels from surface to 60 km from OMPS-LP L1B v2.5 data for seven months from July 2016 and January 2017. The vertical resolution of retrievals vary from ~ 2.5 km at lower altitude levels (< ~ 30 km) and ~ 1.5 km to upper altitude levels (from 40 km to just below top levels). The theoretical retrieval precisions are estimated to be 1-5 % above 25 km, but rapidly increase to 15 % at 20 km. In order to evaluate the developed algorithm seven months of retrieved ozone profiles are compared to OMPS LP Version 2.0 daily ozone product, MLS v4.2 stratospheric ozone profile standard product and global ozonesonde measurements.

General Comment

The overall parts of the paper are written unclearly and illogically. For example, vertical grids where OMPS ozone profiles are retrieved and the unit of ozone should be introduced in the algorithm description section, at once. However, I need to search from.

-In line8 on page 9, the vertical range between 12 and 60 km

-In line3 on page 10, unit of ozone: **VMR**

-In line13 on page 14, authors described "MLS are converted from VMR vs. pressure into **number density** vs. altitude, interpolated at the regular altitude grid of OMPS", in addition, the regular altitude grid is not mentioned before.

- In line 10 on line 16, 2.6 km corresponding to an average vertical resolution of the retrieval scheme.

This article should be checked line-by-line to become more scientific. For example, in abstract, authors mentioned "ozone in the 12-60 km can be retrieved due to using spectral window in the Hartley, Huggins and Chapais ozone absorption band" In the view of the spectral window, this instrument is optimized to detect ozone over the troposphere including surface rather than the stratosphere. Limb measurements has lack sensitivity to troposphere due to its viewing geometry. In addition, authors described the OMPS-LP official algorithm as an inversion scheme with a priori constraints and a Tikhonov regularization, but in OMPS documentation, it is based on an optimal estimation based regulated by a set of a-priori constraints. These two schemes are not same. Please change "Level 1" to "Level 1b" because these two product are not same.

Insufficient analyses on retrieval/validation were performed, which is commented in the main comment section. I found the text not be precise enough concerning unformatted types, grammatical error, English usage, which is commented in the minor comment section.

The following is the main suggestions for improvements.

0. Abstract

- Remove "this algorithm was originally developed ~~ to produce a combined data set" in the abstract part and add more about the retrieval related description or results. For example, the vertical resolution of retrievals vary from ~ 2.5 km at lower altitude levels (< ~ 30 km) and ~ 1.5 km to upper altitude levels (from 40 km to just below top levels). the theoretical retrieval precisions are estimated to be 1-5 % above 25 km, but rapidly increase to 15 % at 20 km.
- "The optimization of the retrieval algorithm ~~. ➔ This algorithm use altitude-normalized radiances in the UV and VIS wavelength range.
- indicating a good agreement ➔ specify the altitude range showing a good agreement e.g.) a demonstrating a good agreement from 15 km to 58 km.
- did not mention about the comparison with OMPS/NASA product.

1. Introduction

- Authors mentioned that the main objective of the study is to create the long-term dataset using OMPS and SCIAMARCH. To do this, how to overcome the discrepancy of two instrument calibration? It is very difficult because of little overlapping period between OMPS and SCIAMARCH. Please add shortly how to overcome the discrepancy of two instrument calibration.
- Authors too much simplified the summery of the previous studies related to your data product, compared to the history and importance of ozone chemistry. It might be better to remove the ozone chemistry-related party (this part is unclearly written) and to focus on 1) history of satellite ozone observation using limb instrument, 2) why we need limb instrument compared to nadir instrument for ozone observation 3) why we need solar scattered limb measurements compared to infrared/microwave emission limb measurements for ozone observation, 4) history of SCIAMARCHY limb ozone profile product; algorithm development/ validation, the long-term stability of both instrument and ozone dataset, 5) OMPS LP ozone profile product from OMPS science team at least and others if possible (e.g. Daniel et al. 2017 recently submitted to AMT), 6) the effort of this study to optimize the SCIAMARCHY algorithm for OMPS.
- Line 33-35, page 2: the limb combines the advantage of the other two techniques ~~ with relatively high vertical resolution and horizontal coverage; reader who have no idea about satellite instrument could be confused that which instrument has higher vertical (horizontal coverage) resolution compared to Limb.

2. OMPS LP instrument

2.1 General features.

- Line 25 (page 3) "The main objective of the mission is to monitor the ozone vertical distribution within the Earth middle atmosphere at high accuracy level" ➔ it is not true because the mission mentioned belongs just to the SNPP.
- Move line 23-27 to introduction and focus just on OMPS LP.
- line 1, page 5: the spectral range between 280 nm and 1000 nm ➔ the spectral range of 290 nm to 1000 nm.
- line 5-8, page 5: The use of such a technology (observation at the same time without vertical scanning and CCD) pose a great challenge as regards the SNR; indeed, scattered solar radiance from the Earth limb decreases by at least five orders of magnitude along the considered vertical range, due to the decrease of atmospheric density. ➔ It is illogically written, about the cause-and-effect.

2.2 Calibration and main issue.

- This party should be simplified or removed and then move some parts in other sections. Example, 1) In algorithm description, we can delivery some calibration issues related to the treatment of this algorithm to overcome these issues 2) In lines 8-9 on page 15, authors mentioned the disagreement between OMPS and MLS can be partly related to pointing issues, due to the solar heating of the instrument at high latitudes or stray light in section 4.2. In this paragraph, this paper can provide more detailed calibration issues related to this discrepancy.
- Line 2 on page 6: Delete "Level 1B data are provided by NASA team" because the data is publically available.
- Line 24 on page 7: delete "In the preparing time of this paper the new data version was not fully released and only seven consecutive months were available." This kind of sentence is not suitable in the scientific article. Move or re-mention "Retrievals were performed using data from the central slit of the instrument only because the lateral slits can still suffer from pointing issues" in the algorithm description or in the beginning of 4. Results.

2.3 OMPS-LP geometry of observations.

- line 31 on page 7: Azimuth angles could be defined separately as solar azimuth angle and satellite azimuth angle.
- line 34 on page 7: positive angles are East of the north, so that values are inside the -180 to 180 range ➔ it is hard to understand this sentence.
- Why this paper need this section? The information given in this part is never mentioned in other sections.

3. Retrieval method

3.1 The retrieval algorithm

- Describe the theoretical inversion scheme first including from line 25 on page 9 to line 18 on page 10, generally and then describe how this algorithm prepare the measurement vector, measurement error vector, forward model vector, and state vector, it might be better to describe them in separated two sections.
- Move the retrieval characterization and error analysis including Figure 6 in section 4.1 with the changed section title from 4. Satellite data set comparison to 4. Results; <u>4.1. Retrieval Characterization and Error Analysis</u> 4.2 Comparison with OMPS-LP Ozone Product 4.3 Comparison with MLS 4.4 Comparison with Ozonesonde. This study described that "The information content of the measurements as well as the sensitivity of the retrieval can be analyzed using ~~ and the covariance of retrieval noise". It is true for AK, but not true for retrieval error. Sm is generally called "solution error covariance" including random-noise retrieval error covariance and smoothing error covariance. It should be detailed in the paper and an example should be presented in the right panel of Figure 6. It is useful to add the retrieval characterization and error analysis for mid/high latitudes due to the dependence of the sensitivity of solar measurements on solar zenith angles.
- The DFS and solution errors of OMPS LP seems to be much better than OMI UV nadir viewing sensors in the troposphere (Liu et al., 2010). If it is true, we should use OMPS LP measurements for tropospheric ozone retrievals, but it is know that the limb measurements has lack sensitivity to lower troposphere, due to its viewing geometry. I think that the DFS and Retrieval errors are over/under estimated.
- The definition of normalized radiance is unclear ➔ Measurement vector is defined as the logarithm of the altitude-normalized radiances to an upper TH for canceling calibration errors and reducing the effect of surface/cloud reflectance. Table 1 summaries ~~. In this paragraph, this paper should mention that this algorithm rejects the wavelength between 580 and 670 nm and between 620 and 630.0 to remove the effect of water vapor and O2 absorption when you describe which wavelengths are implemented in this algorithm.
- Describe that ozone profiles are retrieved at which vertical grids; the number of levels, the vertical intervals, the unit of the grid in the same paragraph.
- Authors described that ozone retrievals are retrieved from 12 and 60 km in the all sections, but analyzed the retrievals from surface and 60 km.
- Line 20-24, page 9: "A shift and squeeze correction is applied in the Chappuis band to the modeded spectrum with respect the measured one: this pre-processing is performed for each observation at each TH independently" ➔ a. describe why the wavelength calibration is implemented just for VIS wavelengths. b. Probably the modele spectrum is high resolution solar reference data?
- line 23-25, page 10: ➔ surface albedo is simultaneously retrieved with ozone using two spectral fitting windows (~~) where ozone absorption is weak.

4. Satellite data set comparison

4.1 NASA retrieval and comparison

- Line 15: " At the moment of the submission of the paper, only version2 of Level 2 (L2) NASA product was available, so a comparison with the most recent retrieval could not be performed"

This description is not suitable. This study should use the version 2.5 or should confirm from OMPS science team that there is insignificant difference between v2.0 and v2.5 product. This paper mentioned that OMPS/NASA algorithm is based on an inversion scheme with a prior constraints and a Tikhonov regularization, which should be changed to "an optimal estimation based regulated by a set of a-priori constraints".

-Based on Figure 8, there are significant differences between OMPS/NASA and OMPS/IUP products, which different implementations between algorithms causes these differences? Based on Figure 9, it seems that MLS shows better agreement with OMPS/IUP in the stratosphere (ozone peak layer) and with OMPS/IUP in troposphere. Both OMPS and MLS has lack sensitivity to lower troposphere so the retrievals determine mostly from a priori information, the similarity between two product might come from the similarity of a priori data between two algorithms.

- OMPS/NASA should be compared with MLS and ozonesonde to see which one provides better retrieval qualities

4.2 MLS comparison

- change the reference of Waters et al. (2006) to MLS v.2 data quality and description documentation. This doc specifies how to use MLS product as following. This study use this data screening method?

Data screening

Pressure range: 261 – 0.02 hPa.

Values outside this range are not recommended for scientific use.

Estimated precision: Only use values for which the estimated precision is a positive number.

Values where the *a priori* information has a strong influence are flagged with negative precision, and should not be used in scientific analyses (see Section 1.5).

Status flag: Only use profiles for which the `Status` field is an even number.

Odd values of `Status` indicate that the profile should not be used in scientific studies. See Section 1.6 for more information on the interpretation of the `Status` field.

Quality: Only profiles whose `Quality` field is greater than 1.0 should be used.

Convergence: Only profiles whose `Convergence` field is less than 1.03 should be used.

Clouds: Scattering from thick clouds can lead to more systematic effects in the UTLS.

Most of the affected profiles are removed by the `Quality` and `Convergence` screening recommendations (although `Convergence` issues occur only rarely).

One should *reject* profiles with odd `Status` *or* even `Status` profiles with `Convergence` above the convergence threshold *or* `Quality` below the quality threshold. Conversely, one should *keep* profile values with even status *and* good `Convergence` *and* good `Quality`. These criteria typically remove 1 to 2 % of global daily data, with tropical latitudes showing somewhat larger data removal fractions of about 5%. This screening generally maintains sufficient coverage for a near-complete daily map (for any given day), even in the UTLS.

Compared to data screening recommendations for past data versions, the screening of v4.2*x* data generally removes somewhat fewer ozone profiles on a typical day.

- In this section, we firstly give a description of the vertical grid and the unit of ozone profile used in comparison, but this part should be moved before comparison with OMPS/NASA. I think that this paper create one section to describe the comparison methodology.
- This paper mentioned "an increase of the smoothing parameter is expected to partially attenuate the latter problem", about the large difference between OMPS and MLS profiles around 50 km. This explanation is so vague. Smoothing parameter indicates smoothing errors?
- Figure 10 could be re-analyzed for several months (July and Dec or summer and winter) due to sufficient collocation.
- This paper can mention about the validity of OMPS retrievals above ~ 15 km and below 58 km based on comparison with MLS.
- Line 4 page 14: What is the modified potential vorticity?
- Line 9 page 15: "not screened polar mesospheric clouds" ➔ based on the cases provided in this paper, it is hard to relate the large difference between OMPS and MLS to polar mesospheric clouds (PMC). That is because the presence of PMC is limited to polar summer season, but your analysis is performed for all seasons. This article did not mention that why the presence of PMC is important for OMPS retrievals and why MLS could be not impacted by PMC, maybe need some reference.

5. Ozonesonde comparison

- Convolution process of higher resolution profiles with averaging kernels could be described after equation (4).

- This paper mentioned Figure 12 (a) as "averaging kernel smoothing and (b) as "vertical averaging". Please correct this way to "Comparison of OMPS ozone profiles with ozonesonde smoothed with OMPS averaging kernel and (b) without smoothing, respectively".

- This paper can add about insignificant impact of the smoothing of ozonesonde profiles to OMPS vertical resolution on the comparison results in the stratosphere due to the comparable vertical resolution of OMPS LP ozone profile retrievals to ozonesonde, compared to the comparison between nadir UV ozone product and ozonesonde. This fact can emphasize the importance of limb instrument on the stratospheric ozone observation.

- Should summarize the validation conclusion about the validity of OMPS retrievals above **15 km** based on comparison with ozonesonde measurements.

- This paper should discuss the difference of comparison results between 2016 and 2013. The comparison with MLS provide same results between 2016 and 2013?

The following is the minor suggestions for technical corrections (I just suggest a few)

1) Please change "facilitate, overarching, exploit" to more proper words.
2) Many sentence is unnecessarily formatted like "very long subject" + "passive verb".
   e.g) ozone concentrations in the 12-60 km altitude range can be retrieved ➔ ozone concentrations can be retrieved from 12 to 60 km with valid precisions.
   e.g) Observation at altitude where the measurement are contaminated by clouds are rejected by applying a cloud filter ➔ We screen out cloud-contaminated measurements using the color Index ratio of the radiance at 754 and 997 nm.
   e.g) the following molecular specifies with spectral signatures in the selected spectral ranges are considered. ➔ The radiation calculation take account of NO2 and O4 other than ozone.
   e.g) ozonesonde data from WOUDC and SHADOZ archives are used in this analysis ➔ ozonesonde data is collected from WOUDC and SHADOZ archives.
3) Line 3, page 1: SCIAMACHY instrument ➔ SCIAMACHY limb instrument
4) Line 10, page 1: Results for seven months ~~ ➔ OMPS ozone profile retrievals are validated against both satellite-based and balloon-borne measurements for seven month from July 2006 to January 2007.
5) Line 14, page1: those from ozonesondes ➔ ozonesondes or ozonesonde measurements
6) Line 23, page 1 : a stratospheric ozone layer -> the stratospheric ozone layer
7) Line 24, page 2: result in the depletion of stratospheric and mesospheric ozone ➔ lead to the destruction of stratospheric ozone.
8) Line 25, page 2: both from ground-based instrument and satellite observations ➔ from both A and B.
9) Line 34, page 2: the former instruments point downward while the latter look directly into the solar disk : "whereas" is better than "while"
10) Line 35, page 2: The same geometry of observation <u>can also be</u> ➔ has been
11) Line 1, page 3: ~ limb emission measurements. With this latter technique a day and night

coverage of the globe is feasible. ➔ limb emission measurements can be taken during both day and night.

12) Line 5, page 3: launched in March 2002 ➔ launched in March 2002 on board the ESA ENVISAT satellite. Line 7 page 3: In early 2012 ground communication with the ESA ENVISAT satellite, carrying SCIAMACHY among other ozone science relevant instruments, was lost ➔ SCIAMARCHY ended its operation in early 2012 due to the loss of their platform with ground communication.
13) Indents when a paragraph changes. e.g in the lines 3, 22 on page 2, 14line on page 6
14) Edit the usage of reference: e.g line 5 on page 3, (Burrows et al. (1995, Gottwald and Bovensmann (2011))➔ (Burrows et al, 1995; Gottwald and Bovensmann, 2011). These unformatted types are often found in this article.
15) Lines 11-13, page 3➔ This paper presents ozone profile retrievals from OMPS limb observations. This algorithm was adapted from the SCIAMACHY v3.0 ozone retrieval algorithm (Jia et al., 2015) developed by the University of Bremen.
16) Line 13, page 3: For a description of SCIAMACHY v3.0 ozone retrievals refer to Jia et al. (2015) ➔ readers are referred to Rodgers [2000] for more detailed description of ~.
17) Line 14, page 3: delete "of this paper" after In sect.2
18) Line 16, page 3: The applied cloud filter, the retrieval of aerosol extinction profiles and of the surface albedo ➔ The applied cloud filter and the retrievals of aerosol extinction profiles and surface albedo
19) Line 20, page 3: In the latter section and in the conclusions ➔ in the conclusions
20) Line 21, page 3: OMPS-LP is not mentioned in the introduction before the title name of OMPS-LP instrument.
21) Line 27, page 3: A Nadir Mapper, a Nadir Profiler and a Limb profiler (LP) => the Nadir Mapper, Nadir Profiler, and Limb Profiler.
22) Line 9, page 5: slower that ➔ slower than
23) Line33, page 7: positive angles are East of the North : change from "are" to "represent"
24) Line 11, page 9: get rid of ➔ remove
25) Cross section of these gases are respectively taken from ~~ ➔ taken from ~~, respectively.
26) Line 18-19, page 9: delete "used in the radiative transfer mode" and "provided by the NASA team together with OMPS-LP L1 radiances"
27) Line 8, page 14: the geographic distance <u>is required to</u> be whine 1 deg. ➔ limited to be
28) Line 15, page 14: The number is in the order of 5000. ➔ The number is ~ 5000.
29) Line 1, page 15: ➔ the positive difference of larger than 30 % in the tropical lower stratosphere.
30) Line 15, page 15: Looser collocation criteria <u>than for</u> MLS ➔ compared to MLS
31) Line 16, page 15: because of the sparseness of the data set ➔ because of the sparseness of ozonesonde station. / In particular ➔ Therefore
32) Line 18, page 15: remove "generally for each sonde profile ~ found using these loose criteria"
33) Line 4, page 16: with respective standard deviations ➔ with corresponding standard deviations.
34) Line 14, page 16: for tropical and northern mid-latitude bands, around 120 and 160 sonde profiles, respectively are considered. ➔ , which is ~ 120 and 160 for tropical and northern mid-latitude bands, respectively.
35) Line 1, page 17: As can be seen also from Fig.11 ➔ As shown in Fig. 11, the excellent agreement is also found at northern mid-latitudes, with ~~.