Review of manuscript ESSD-2020-246 (1st revised version)

The paper has been streamlined, taking some parts to a supplement, some errors have been corrected and, overall, it is more readable now. However, I still have some strong concerns, especially in the description of how the correction for the stratospheric aerosol transmittance (neglected in the dataset under rescue) is carried out (section 2.4), which, in my view, has not been clarified in the revision.

Major concerns

1. Lines 175-176: the authors state that "The lidar backscattering ratio (SR(λ, z)) is commonly defined as the ratio between the total backscatter ($\beta_T(\lambda, z)$) and the molecular backscatter $\beta_m(\lambda, z)$, at the altitude z and wavelength λ", with which I agree. However I find again the next sentences, namely

"$\beta_T(\lambda, z)$ is the sum of $\beta_m(\lambda, z)$ and the aerosol attenuated backscatter ($\beta_a^A(\lambda,z)$). That definition is related to the fact that in the retrieval of SRo(z) the two-way total transmittance(T_T^2) correction was neglected (Hostetler et al., 2006)"

most confusing. That cannot be the definition of the backscattering ratio, where the aerosol backscatter coefficient should be the "true" one, not the aerosol attenuated backscatter coefficient. I could accept that Eq. (2) is what the author of **G-66**, obtained because of his neglecting of stratospheric transmittance, but not as the common definition. I think a difference should be clearly made between this scattering ratio with β_a non-corrected for atmospheric transmission and the corrected one (and transposed to another wavelength in addition), which, in my understanding, is what the authors aim to produce. The authors seem implicitly recognize that in their reply to my first review when they say "The 2 two-way transmission terms are part or the exact definition of SR(λ,z) with no assumptions about the two-way transmission". Furthermore I also find the reference to Hostetler el al., 2016 (dealing with CALIPSO inversion algorithm) misleading, as it does not support the neglect (at least I don't see how) of the two-way total transmittance in **G-66**.

2. In addition, I still cannot understand how the sunphotometer-derived AOD is used to correct for the stratospheric AOD. It would seem that an AOD-constrained inversion is attempted but it is not clear how it is achieved:

2.1. What does "sup" (the lower limit of the integral in the exponential in Eq. (8)) denote?

2.2. I have several problems with the first guess $T_a(532)$ mentioned in line 210:

a) How is it chosen?

b) It is stated it is "a unique value for all altitudes" (line 210). What does "unique" mean in this context?

c) The z-dependence seems to have disappeared. That would imply that $\alpha_a^{Ta}(532, z) = 0$.

2.3. Likewise, how is the first-guess $\alpha_a^{Ta}(532, z)_*$ chosen?

2.4. What does mean that the profile of $T_a(532,z)$ has a constant value of $T_a(532)$ from the surface to 11 km? Again, if T_a is constant it means that the extinction coefficient is 0 (Eq. (8)). I suspect that the authors mean that they don't care about the profile of T_a between the surface and the 11 km height and that they consider only the *value* of T_a between the surface and that height; but in any case, the way they express it is, in my understanding, formally wrong.

2.5. For the same reason, I suspect the $T_a(532,z)$ profile between 12 and 24 km mentioned in line 215 might not correspond to the two-way transmittance between the surface and height z, but between 12 km and the height z. The authors might have a problem with their notation, failing to indicate the limits between which the atmospheric transmittance is calculated. Note that the definition of the transmittance (Eq. (8)) involves a definite integral, so the limits should be indicated, unless one of them is always conventionally the same, which I think might not the case throughout the paper.

I would tend to agree with the other reviewer's remark in his/her first review that an iterative procedure would be in order. From the authors reply to that remark (not very clear anyway to me) it seems they justify that only one (or two?) iterations would suffice, because there are other sources of uncertainty overshadowing that one. But this should be reflected in the paper text and the way of performing the aerosol correction should be clearly stated, in a way that could be reproduced by a reader. In the present form of the explanation, I would be unable to do it.

3. Lines 203-204: the authors say, referring to Eq. (9) that "$EB_c(z, t)$ are the altitude and time dependent backscattering to extinction conversion coefficients from $\lambda = 694$ nm to $\lambda = 532$ nm" but only "532" appears on both sides of Eq. (2), and the reference given (Jäger and Deshler, 2003) shows that they actually convert from backscatter to extinction at 532 nm. The conversion from 694 to 532 nm has been made in Eq. (7) through the kb(z,t) exponent.

4. If $EB_c(z,t)$ (and kb(z,t) by the way), are time dependent, how and where is the time dependence taken into account? I suspect it is used to calculate the β_a and α_a uncertainties (Eqs. (20) and (21)), but this should be stated the first time the coefficients appear. Otherwise it is misleading, because the left-hand sides of Eqs. (7) and (9) should have a time dependence. Which are the "nominal" values used for kb(z,t) and $EB_c(z,t)$, around which their uncertainties have been used to calculate the β_a and α_a uncertainties in Eqs. (20) and (21)?

Other concerns

1. Line 143: it would be helpful to explain that SR(694,z) means the backscattering ratio at 694 nm and range z.

2. Line after Eq. (1): while $\frac{dn(z)}{dt}$ is the photoelectron flux (electrons/s) resulting from scattering at range z, defining n(z) as "the number of photons at the altitude z" does not make

much sense. In the explanation of Eq. (1), leave $\frac{dn(z)}{dt}$ as the photoelectron flux (electrons/s) resulting from the photons scattered at range z.

3. The authors say that they have eliminated the squared superscript to indicate the two-way transmittance, but this has not been done consistently. There are examples of the superscript still remaining (for example, but not only, in lines 149,150 and 177).

4. There is still one instance (line 177) where SRo(z) is used.

5. Line 215: “This profile of Ta(532,z) is applied in equation (11)”. Equation (10) is probably meant.