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Atmospheric Chemistry and Physics Discussions

Interactive comment on "CALIPSO observations of stratospheric aerosols: a preliminary assessment" *by* L. W. Thomason et al.

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Referee Comment on "CALIPSO observations of stratospheric aerosols: a preliminary assessment" by L. W. Thomason et al.

General comments

The paper by Thomason et al. describes a new methodology for the retrieval of a stratospheric aerosol data product from the CALIPSO measurements and discusses its results. The authors highlight the importance of such a product in the framework of past, current and future satellite observations and prove by numerical simulation that a quality comparable to existing but close to end of mission measurements (e. g. SAGE II) could be achieved in principle by rigorous averaging of the CALIPSO data. They demonstrate that the method has substantial deficits when applied to CALIPSO measurements using the state of the art instrument calibration that assumes purely molecular backscatter at an altitude between 30 and 34 km. Their sensitivity analysis reveals that the result can be improved significantly by assuming an aerosol backscatter ratio of 5 % instead of zero for the calibration, which might be a realistic assumption. While this approach is fully adequate for "a preliminary assessment", it remains unresolved how the challenging task of a physically based recalibration can be achieved. To stimulate future discussion on this issue, the authors are encouraged to develop some perspective in the conclusions. The paper is well suited for the publication in ACP. The following comments should be considered.

Specific comments

p 5599, ll 15 – 24, and p 5603, ll 7 – 9:

The sentence on page 5599 as written might lead to the misconception that the backscatter ratio profile peaks with values between 1.03 and 1.06 at the level 5 to 6 km above the tropopause where most of the aerosol is located. Due to the air density profile the backscatter ratio can maintain high levels well above the maximum aerosol abundance. It should further be stated that the values cited are measured at mid latitudes. This could resolve the contradiction with page 5603 where a backscatter ratio between 1.03 and up to 1.10 in the tropics is quoted for an altitude between 30 and 34 km. However, the inconsistency of using this altitude region as calibration reference assuming purely molecular scattering whereas it is known to have – at least locally – aerosol backscatter contributions comparable to the stratospheric aerosol layer (if expressed as backscatter ratio, i. e. the quantity that directly enters into the calibration) should be used to emphasize how difficult it is to establish a reliable calibration in the vicinity of the molecular backscatter level. Further aspects of this issue could be discussed in the conclusions (see specific comment to page 5605).

p 5600, ll 4 – 6:

This sentence puzzles the reader for multiple reasons: The extinction coefficient to backscatter coefficient ratio should read in units of str, not str^{-1} (see corresponding technical correction below). Why is the 1020 nm extinction coefficient to 532 nm backscatter coefficient ratio used to compare with the 525 nm SAGE II optical channel? Can one not assume 525 nm to be sufficiently close to 532 nm and use the 532 nm extinction coefficient to 532 nm backscatter coefficient ratio instead? Combining 6 $\times$ 10^{-5} str^{-1} column total backscatter with a 20 str extinction to backscatter coefficient results in 1.2 $\times$ 10^{-3} optical depth – which is only 40 % of the value quoted from SAGE II. It is worth noting that the 532 nm extinction to 532 nm backscatter ratio given by Jäger and Deshler in the 2003 correction to the cited paper (see corresponding technical correction below) varies between 20 and 50 str.

p 5602, ll 18 – 19:

The reference of Jäger and Deshler (2002) does not provide the 1020 nm extinction to 532 nm backscatter ratio, not even in its 2003 correction. Please specify the right reference.

p 5605, ll 20 – 21:

The paper makes it very clear that an improved calibration near to the molecular backscatter level is the key requirement to make the method described a valuable tool for stratospheric aerosol monitoring. Thus the reader would like to learn in more detail how future “releases of the CALIOP calibration process will incorporate aerosol corrections into the calibration process.” Does the instrument stability allow for applying individual weights to the calibration points to reflect our regionally dependent knowledge of the aerosol backscatter contribution? Is it feasible to introduce data known more precisely on a local scale into the overall global calibration? Is there a potential to link the CALIPSO calibration to ground-based LIDAR networks?

p 5609, Table 2, lowermost two rows:

Is there really an overlap between –500 m and +500 m? If so, the vertical resolution is ambiguous in that range. Should the altitude range in the second to last line read "(+)0.5 — 8.2" instead of "–0.5 — 8.2"?

p 5611, Fig. 2:

Scaling of the vertical axes should be the same for panels (a) and (b). I suggest to include the aerosol test profile ("top hat") serving as input to the simulator analysis in panel (b). From my understanding it is zero below 16 km and above 22 km altitude, and 1.0 $\times$ 10^{-5} km^{-1} str^{-1} in between. Why does the simulated data retrieval exceed this level by 20 to 30 %?

p 5612, Fig. 3:

The calibration procedure forces the aerosol backscatter values retrieved in the 30 to 34 km altitude range to zero - at least one would expect small numbers with zero average if integrated in this altitude band over all latitudes. Panel (a) clearly suggests a negative bias on average. This might be a misperceptions induced by the negative values not being distinguishable in magnitude. If so, it could be avoided by continuing the contour lines inside the red area at the same absolute values as in the positive region. In panel (b) a zero average between 30 and 34 km over all latitudes appears more likely. However, the SAA influence is most prominent in the calibration altitude -

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should the orbital calibration not compensate for the instrument disturbance?

Technical corrections

p 5596, l 4: replace “observation” (fist instance) by “monitoring”

p 5596, l 7: replace “observation” by “monitoring”

p 5596, l 18: add “arguable and” before “most”

p 5596, l 19: add “and even negative” before “values”

p 5597, l 3: replace “under go” by “undergo”

p 5597, l 8: replace “makes it into” by “can reach”

p 5597, l 10: replace “make it to” by “attain”

p 5598, l 21: replace “is” by “are”

p 5600, l 5: replace “20 str^{-1}” by “20 str”

p 5600, l 17: replace “are” by “have”

p 5601, l 5: I suggest starting a new section here (e. g. “2.3 Application to CALIPSO measurements”) to indicate the transition from simulation to data analysis.

p 5601, l 23: add a space between “1” and “backscatter”

p 5602, l 18: replace “Jager” by “Jäger”

p 5604, l 11: replace “looked at” by “applied it to analyze”

p 5606, l 25: add the correction: Geophys. Res. Lett., 30(7), 1382, doi: 10.1029/2003GL017189, 2003

p 5608, Table 1, First row: replace “Nd: YAG” by “Nd:YAG”

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p 5613, Caption Fig. 4: clarify final sentence (remove “had events”?)

p 5615, Caption Fig. 6, line 8: replace “cloud” by “clouds”

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 5595, 2007.

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