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Atmospheric Measurement Techniques Discussions

Interactive comment on "Aerosol and cloud top height information of Envisat MIPAS measurements" *by* Sabine Griessbach et al.

Anonymous Referee #1

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Review of: Aerosol and cloud top heigt information of Envisat MIPAS measurements

by Griessbach et al. August 2019

Overview

The estimate of cloud (or aerosol) height from MIPAS spectra follows a fairly crude system of identifying the highest altitude spectrum which has cloud-like continuum features and assigning that nominal altitude as the cloud top height.

The paper starts with model simulations for a variety of aerosols which demonstrate that this method will overestimate the height for optically thick aerosols and underestimate the height for optically thin aerosols (as would be expected), but also that this does not depend significantly on the type of aerosol. It is argued that this can explain

the seemingly contradictory results found in previous studies of MIPAS cloud/aerosol heights.

The main part of the paper then focuses on measurements of sulfate aerosol from the Nabro eruption in 2011, comparing the MIPAS-retrieved aerosol height with colocated measurements from the CALIOP instrument as well as various ground-based observations. Considerable attention has been paid to defining the top of the aerosol cloud in each of the datasets, as well as the scaling of measured extinction to infrared region observed by MIPAS.

The general conclusion is that, as the plume is optically thin, MIPAS underestimates the height and as the plume ages, becoming even thinner, the discrepancy gets worse. A useful by-product of this study is an assessment of the sensitivity of the various instruments to the detection of sulfate aerosol.

General Comments

1) Assuming any detected cloud is assigned the nominal tangent height at the centre of the MIPAS FOV, I think it is fairly clear why thick cloud at the bottom of the FOV will result in an overestimate of about half the FOV width, ie 1.5km, which is confirmed by the points at the top right of Fig 1b. It is also clear why progressively thinner cloud will result in a gradually decreasing estimate of cloud top height until the cloud is so thin that no cloud is detected.

The chosen diagnostic, cloud volume in FOV, is difficult to interpret. If I understand its definition, then halving the horizontal width of the MIPAS FOV would halve the volume but still produce the same plot, suggesting an arbitrary scaling.

Noting that the detection sensitivity depends on both the extinction coefficient and cloud-covered field-of-view fraction (P20 L625), a better diagnostic might be something like average aerosol absorption integrated over the MIPAS FOV, where absorption is defined as 1 - exp(-X) where X is the cloud extinction integrated along the line-of-sight of any FOV sub-element. This would have a value between 0 for cloud free and 1 for thick cloud filling the FOV.

It also seems to be more naturally related to the threshold that actually triggers cloud detection. This would provide a more meaningful y-axis for Fig 1a and, I would expect, a more linear plot if used as the x-axis for Fig 1b. This would probably also explain the equivalence of the 1km v 6km layers discussed on P17 L530.

2) Given that the Nabro aerosol seems to lack a well-defined upper altitude, any comparison of height between two instruments will clearly be a sensitive function of the chosen thresholds. However while different thresholds are tried for the lidar instruments, the MIPAS value is fixed at ACI=7.

It would be interesting to see if higher ACI values yielded more information. For example, a plot of CALIOP values v ACI not only at the levels at which ACI reaches a value <=7 but also for the MIPAS tangent heights one or two levels above to see if there is any correlation.

3) Is the MIPAS instrument noise included in the sensitivity study? Also what is the impact of any residual radiometric offset after the calibration? Presumably this would have some effect on detection sensitivity if it produced a non-zero offset. Perhaps the Kleinert report has something on this?

Minor Comments

P1 L15: 'In the fresh to two months ...'. I would suggest rephrasing as 'For plumes up to two months old ...'

P2 L50: I am surprised that there is no mention of ACE/SCISAT among the solar occulation instruments. However, perhaps they just focus on deriving molecular concentrations.

P4 L96: 'index cloud detection' - should this be 'cloud index detection'?

P4 L119: Mention Envisat's sun-synchronous orbit so that the concent of a fixed mean local solar time makes sense.

P5 L125-135: Presumably the pairs of number in brackets refer to the wavenumber range rather than a pair of spectral points, so I'd suggest using '–' (LaTeX) rather than a comma. It would be helpful to have a diagram showing the spectra signatures being detected using these windows. Also, these all lie within the band A, so how is band B used?

P5 L136: 'that has flown ... since' rather than 'that flies ... since'.

P5 L149: Either 'between ... and ...' or 'from ... to ...'

P6 L166: 'on average' rather than 'in average'

P7 L189: Suggest 'where, potentially, cirrus clouds ...'

P7 L205: If using 'the' for dates, then 'the 4th and the 25th'

P8 L224: Either 'These ... are ...' or 'This ... is ...'

P9 L268: Comparing Fig 1b and Table 2 it looks as if Fig 1b shows the differences after transferring to the coarser MIPAS sampling, whereas the text seems to imply Fig 1b is before the transfer.

P14 L445: 'discrepancy'

P18 L562: 'contradictory'

Table 2: hard to distinguish between '-' indicating a range of values and a negative sign. In LaTeX use either '–' or '$-$'.

Fig 7: Not clear what CALIOP aerosol maximum extinction means. If this is the maximum value of extinction in the CALIOP profile (equivalent to that found by the subsequent gradient method) then that may be lower in altitude than the part of the profile which MIPAS is detecting. So perhaps something else is meant by 'maximum'?

Fig 8 caption: on the right hand plots, what are the grey boxes and beta numbers?

Fig 9 caption: 'Only for the twilight measurements is there ...'

Fig 13: given the standard representation is to scale aerosol extinctions to 550 or 532nm, I think it would be useful to add a second x-axis along the top with this scaling as well.

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