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Atmospheric Measurement Techniques Discussions

Interactive comment on "Retrieval of macrophysical cloud parameters from MIPAS: algorithm description and preliminary validation" *by* J. Hurley et al.

Anonymous Referee #1

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The paper by Hurley et al. reports on a novel and effective method to derive cloud height, cloud top temperature and cloud extinction from infrared limb emission measurements by the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) on Envisat. This is important work since space-borne observations which are sensitive to optically very thin clouds are rather sparse. The new algorithm and its practical implementation is very well described and appears to be reasonable. However, the chapter about 'Preliminary validation and application of algorithm' is rather superficial and needs much improvement including a discussion of errors of the derived parameters (especially extinction but also cloud top height) which are not covered by the error

estimation from the algorithm. Details are mentioned below.

Content:

Abstract: 'From application to MIPAS data, the retrieved cloud top heights are assessed to be accurate to within 50 m, the cloud top temperatures to within 0.5K and extinction coefficients to within a factor of 15%.' As described below these values seem too optimistic and the limits of applicability should be stated.

P3879L12: 'slide' It should be explained what this is.

P3879: '1.1 Overview of MIPAS-ENVISAT' One should describe in this section also the horizontal and vertical field-of-view of MIPAS.

P3879L14: 'in the troposphere' and also in the lower stratosphere (perhaps give some altitudes here)

P3879L17: 'which could be observed by the naked eye' might be a bit loose formulation. Also when I see a cloud it is not so easy to tell the altitude. Where does cloud extinction fit here?

P3880L8: 'even the thinnest of clouds' can you make this sentence a bit more physical

P3880L13: 'for instance, microwave instruments often are not sensitive to ice cloud particles, whereas visible and infrared instruments are often limited to the first layer of cloud encountered and unable to measure below.' Can you give here a bit more explanation why this is the case and under which conditions it applies?

P3884L19: 'but since the continuum radiance is a strong function of atmospheric temperature as well as cloudiness' You should also mention the water vapor content.

P3885, Eq(2): Can you estimate the neglected contribution to the molecular emission by higher, but warmer atmospheric layers?

P3888L20: ' 1km' Can you give a reference for the assumed value of uncertainty?

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P3893L19: Why do you not use D_m/sigma_m/sqrt(number of microwindows), since this would be about the error when calculating the mean parameter error.

P3895, para: '3.1 Example results: 1 April 2003' The discussion of the given example day is by far not sufficient. In fact there is no real discussion. The sentence 'Generally, the values reported are sensible.' is just given without any explanation. Especially in case of extinction the values are not compared to any realistic data of extinction in the mid-IR. E.g. a cirrus cloud in equilibrium at the tropical tropopause of 0.0002 g/m3 ice-water content has mid-IR extinction values of about 0.05/km. Typical observed ice-water contents of cirrus clouds are about 0.001-1 g/m3 which would result in mid-IR extinction values of 0.25/km-250/km which is much larger than most of the extinction values shown in Fig. 2. Presenting such unrealistic values of extinction, the authors should more clearly discuss the validity of their extinction retrieval. E.g. that no information of the cloud-extend along the limb line-of-sight is available makes it clear that real local extinction values cannot be retrieved. It is rather a optical depth along the limb (this is only mentioned in the summary, but should be discussed more in detail here).

P3895L14: 'As the algorithm seems capable to retrieve trustworthy estimates of the simulated cloud parameters,' Especially for extinction this is questionable and should be based on a more thorough discussion.

P3895L21: 'Furthermore, ISCCP does not report extinction values, but rather optical depths, so these can really only be utilised to judge qualitatively what opacity clouds occur where.' Also the values derived here are not real extinction values due to the unknown extend of the cloud along the line-of-sight.

P3896L3. . .: Here it should be described in more detail how the cloud statistics is calculated. Are ISCCP cloud-free data dismissed? Further, there should be a discussion on the pure geometrical effects: in case ISCCP would be as sensitive as MIPAS, the mean cloud top would be smaller than the one of MIPAS since, due to its higher horizontal

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resolution, it can see lower clouds also near high clouds while MIPAS more probably samples the high clouds and cannot detect lower cloud in the vicinity of higher cloud.

P3896L9...: 'Comparing cloud opacities, it is qualitatively obvious that MIPAS sees – and retrieves – more thin cloud than does ISCCP, as supported by the relative frequency of smaller extinction values reported over the globe' Which data is used for this analysis? Only retrieval type 1 or also other types? What has been used in case of other types? In both cases, it is clear that MIPAS derived mean extinction values must be too small and extinctions of 0.1/km cannot be reached since these are already optically thick in limb-direction and MIPAS is not sensitive for those.

Fig. 3: What is the reason for the much higher cloud tops of ISCCP at southern latitudes? Since there are no PSCs in April, this should be an error in the used ISCCP dataset(?)

P3896L19: 'Generally, the retrieval is able to estimate the cloud top height within 50 m' Can you discuss the absolute accuracy of this number taking into account MIPAS pointing errors?

P3896L20: 'extinction to within 15%.' First it should be made clear for which range of extinction this value holds. Second, as discussed above, due to the unknown cloud extent along the line-of-sight the retrieval quantity is merely optical depth rather than extinction.

P3897L7: 'Figure 5 shows the results of this comparison, highlighting that the CEF scheme detects more cloud than does the CI method.' As it stands, this sentence is not correct. It applies only to the CI-setting of 1.8 which it is not intended to detect all kind of clouds, but only thick clouds affecting the trace-gas retrievals.

P3898L2: 'This study confirms that cloud top height, cloud top temperature and extinction coefficient can be successfully retrieved by' As explained above: the extinction retrieval is questionable.

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P3898L12. . .: The discussion of this error should be performed before in a dedicated section. Could you also discuss how good the separation between cloud effective fraction (CEF) and cloud extinction (CEX, or better cloud optical depth) can be achieved. What is the effect in the spectrum which allows the retrieval to distinguish between these two parameters? Further, a discussion on possible errors from distinction between water vapor spectral continuum and cloud parameters should be added. Could one make use of water vapor spectral lines which are sometimes included and in some cases excluded from the selected spectral windows (see Fig.1)?

Technical:

P3878L19: 'arguably' Is this really the right wording here?

P3880L6: 'depth' Do you mean optical depth?

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 3877, 2010.