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Atmospheric Measurement Techniques Discussions

Interactive comment on "The Level 2 research product algorithms for the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES)" *by* P. Baron et al.

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Authors would like to thank referee#2 for his comments and corrections. The corrections have been introduced in the new version of the manuscript provided along with this document (text changes are highlighted with color).

Our answer to the general comment is: Example of retrieved profiles will be presented in the paper dedicated to the validation and the quality assessment of the research products. However as demanded by reviewer #1 and the editor, we will add an example of O3 retrieved profile obtained from a simulation. This new plot will replace Figure 13

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and will be part of the discussion about the pressure-induced error on the O3 retrieved profile.

Answers to questions are given below.

– Abstract: Line 6 There is no documentation about Version 1. Version 2 is the first usable version. This note has been added to the abstract. “The objective of version 2 processing, which has produced the first usable L2r data, is the retrieval ...”

Lines 12-18: The abstract has been simplified (see corrected paper)

– Page 3596 Line 11: The discussion is about the operational chain which is not the research chain. To make it more explicit we have changed the sentence: “The SMILES ground segment ...“ by The SMILES operational ground segment ...“.

– Page 3597 Line 1-6: The text has been rephrased as follow: “ In the SMILES operational level-2 algorithm, the vertical profiles of geophysical parameters are simultaneously retrieved from the spectra measured by each spectrometer during a vertical scan of the atmospheric limb. In the L2r algorithm, the retrieval procedure has been divided into sequentially dependent processes in order to apply optimised retrieval settings to selected spectral lines in a given altitude range. Such approach allows to better characterise the spectra baseline underlying the weak spectral lines and, hence, improves the fits. Most of the prior microwave limb sounding instruments used a molecular oxygen line to retrieve the tangent points pressure (or elevation angles) which is a key parameter for limb-sounding. There is no such line in the SMILES spectra. In the operational level-2 algorithm only a mean angles offset is retrieved for each scan. In the L2r algorithm, the line-of-sight angles are retrieved in the stratosphere using a strong O3 line. ”

Line 27: A short description of the calibration data has been added as follow:

“The measurement of the emission from a hot and a cold load, and of a comb spectrum are performed at the top of each scan for the radiance and the frequency calibration,

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respectively. The cold load is the cold sky at 2.7 K measured with the antenna pointing at ∼200 km while the hot load is an internal load at ambient temperature measured with a switching mirror."

– Page 3598

Line 10-12: The line of sight velocity (∼ 4 km/s) is corrected for each scan. The latitude dependency of the line of sigh velocity is thus taken into account. However the altitude dependence is not taken into account. The same velocity is used for all spectra of one full vertical scan. We have chosen the velocity of the line of sight number 45 which corresponds to a tangent height of ∼60 km. The change rate of the LOS velocity during one scan is about 0.8 ms-1 /km. Hence the error at 90 km is less than 0.1 MHz (50 ms-1) which is small compared to the width of the AOS channel (1.4 MHz). Such error has small impact on the VMR retrieval. A future version of the L2r processing will include the altitude dependence of the line of sight velocity in order to retrieve the line-of-sight wind velocity.

Line 20: Cautions -> Caution is corrected.

– Page 3599 Lines 3-10 have been removed.

Lines 22: We do not try to detect an ice contamination before processing. Scattering is not taken into-account in the current processing and we do not try to extract relevant information for "ice-contaminated" spectra. The processing of the full spectral band which is dedicated to the lower atmosphere can be affected by scattering by ice particles, resulting in bad iteration diagnostics (initial and final cost-functions, number of iterations for convergence, final Marquardt parameter value). Other processes consider only line-of-sight with tangent heights above 16 km where scattering has a small effect. We agree that the sentence in the paper lead to a misunderstanding and the sentence has been reformulated as follow: " Ice water content in the UT can be retrieved from these observations (...), but it requires a special algorithm that is not implemented in the current processing. Inversion of ice-contaminated spectra (typically below 18 km in

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the tropical regions) gives bad retrieval diagnostics and retrieved data are not usable. ”

– Page 3600 Line 8: We believe it should be a small approximation for the version 2 of the processing since we currently target the altitudes above 18 km. At these altitudes, the temperature, O3 and pressure (line-of-sight angles) can be retrieved from the measurements themselves and the use of good a priori profiles is not required (as shown in the error analysis in the paper). In the future versions including the UT/LS region, a good a priori of temperature and pressure will be necessary. A better method for selecting the best GEOS5 profiles should be implemented. The approach proposed by the reviewer should be tested: selecting the best profiles according to the rms between the brightness temperature predicted on the GEOS5 grid points in the geographical and temporal vicinity of the measurement.

Line 15: The term “expected” is replaced by “assumed”.

Line 23: The pronoun ’us ’ is included after ’allow’: ’... allow us ...’

Line 29: The sentence has been corrected following recommendations of reviewer#1: “outside the retrieval vertical range are computed by linearly extrapolating the vertical trend of the retrieved angles. ”

– Page 3601 Line 15: The end of the line is: “ the specific intensity Iatm ”

– Page 3602 Line 10: “removed” has been replaced by “neglected”

Line 12: reviewer’s proposition has been included: ’... atmosphere is assumed to be horizontally ...’

Page 3603 Lines 9-19: The line-by-line model has been compared with the MOLIERE model before the instrument launch. The same spectroscopic data were used by both models. We have also compared our forward models with the ones from the MLS and the Odin/SMR teams to study the absorption coefficient continuum. We found out that there are significant differences on the dry and wet continua absorption computed by the models. We will continue this study and plan to summarize the results in a future

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publication dedicated to the UT/LS humidity retrieval using the SMILES data.

Page 3604: Line 7: A table (#3) has been added with the value of the laboratory data.

Line 9: The value of 0.1 K in the manuscript is an error (type). The actual threshold is 10-4 K. The threshold has been defined by comparing the forward calculation using spectroscopic file created with a threshold of 10-6 K. The manuscript has been updated with the real value of 10-4 K.

Line 10-12: We mean that the calculation is performed at 5 points distributed over the full bandwidth. (I have to find a better way to explain in the text, any propositions ?)

Line 15: The sentence has been rewritten as follow: " The line selection procedure selects a large number of relatively weak spectral lines located below 100 GHz and a set of strong O2 lines at âĹij60GHz. These lines should not been selected since the computation of their absorption is overestimated at the SMILES frequency: i) the VVW lineshape overestimates the absorption with an order of magnitude at frequencies larger than 5 times the resonant frequency (Harde et al., 1995), ii) the actual 60 GHz-O2 lines absorption is reduced by a line mixing effect which is not taken into account in the calculation. All lines below 100 GHz are not included in the line selection and, then, are not taken into account in retrieval processing. " Additional reference: H. Harde, N. Katzenellenbogen, and D. Grischkowsky, Line-Shape Transition of Collision Broadened Lines, Physical review letter, Volume 74, Number 8, 1995.

– Page 3605 Line 11: A short definition of the receiver temperature have been introduced as follow:

"with the receiver temperature (noise power generated by the receiver), Trec, between 300–350K, the atmosphere temperature received by the antenna, T, between 0–250 K, ..."

– Page 3606

When a weak line (e.g., HOCl or H2O2 line) is fitted together with a strong line (e.g.,

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O3 and HCl lines), the change of the cost function (chi2) is due to the changes of the strong line parameters and is not sensititve to the weak line parameters change. As the Marquardt parameter (gamma) value is driven by the chi2 variation, we decided to not regularise the convergence speed of the weak line parameters with gamma. Note that retrieving a VMR from a weak line is a linear problem. The "best" VMR value is then updated after each iteration according to the state of the retrieved parameters from the strong lines (temperature, O3, ...).

– Page 3607

Line 18: Figure 2 is now Figure 3.

– Page 3608 Section 5.2 title has been changed as follow "Characterisation of the errors"

– Page 3610 Lines 9-12: Here beta can be either a part of the vectors x, p and b. - The perturbation of b allows to estimate the errors on the retrieved state (x_hat) due to errors on the "fixed" parameters (b). - The perturbation of p allows to estimate the errors on x_hat due to errors on parameters retrieved in a previous process (p_hat) - The perturbation of x allows to estimate the error on x_hat due to the a priori error (xa) and due to the retrieval sub-grid size of the atmospheric variability.

The sentence "For an uncorrelated vector beta ..." has been changed as follow: " Perturbing a vector β, which can be a part of either x, p or b, with uncorrelated components gives a variance of the retrieved state vector calculated as follow: " Equation$\sim$12 is changed as follow: " .... (y(beta + epsilon) – I (y)) "

Line 23: The following subsection titles have been added: After P3608-line 8: 5.2.1 Method for the errors calculation After P3610-line 23: 5.2.2 Error assumptions

– Page 3612 Line 1: we have replaced "low" by "bad" in the manuscript.

– General comments on Figure's legend: Missing legends have been added to the plots (Figure 9,10,12,15).

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– Figure 10. The black line is the root-sum-square of individual errors. The plot has been reproduced and the total error is now consistent with the individual errors.

Please also note the supplement to this comment:
http://www.atmos-meas-tech-discuss.net/4/C1514/2011/amtd-4-C1514-2011-supplement.pdf

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