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Atmospheric Measurement Techniques Discussions

Interactive comment on "Mirror contamination in space I: approach" *by* J. M. Krijger et al.

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The authors would like to thank both referees for their comments.

Below we shall address each comment, both general and specific.

Comments from Anonymous Referee 1:

General:

- The statements about general applicability of method do not follow from the paper

We will add a section in the discussion of the paper, where we will go into detail in which cases the method is applicable, including the limitations.

Suggested changes:
For application to in-flight satellites several properties must be known; the instrument

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response to polarisation, the mirror optical properties (along with its initial contaminations) and the in-flight contaminant optical properties. The model is not wavelength-limited, as long as the optical properties of the mirror are known for the wavelength of interest. Issues like low signal or other instrument limitations will be the limiting factor for the application of the model. Especially the in-flight contaminant optical properties are often unknown and assumptions will have to be made. In the follow-on paper we will present how this can be done for SCIAMACHY.

- The title does not cover the paper's content

The paper is the first of a series, which focuses on mirror contamination in space. In this first paper the modeling of the mirror is described. We agree with the referee, this can be confusing. We will make this clear in the introduction and in order to avoid confusion retitle the paper to: *"Mirror contamination in Space: Mirror Modeling"*

Suggested change to introduction:
As the first paper in a planned series on in-flight mirror contamination, this initial paper focusses on the mathematical modelling of the mirror with possible contaminants. Further application to in-flight measurements and how to derive optical properties of in-flight contaminations will be presented in a follow-up paper.

This study was initiated to investigate the wavelength and scan-angle-dependent degradation as observed by SCIAMACHY, on-board ENVISAT, which affects long term data records. The optical behaviour of the scan mirror of SCIAMACHY has been simulated based on this model and was compared with measurements during on-ground calibration and dedicated laboratory measurements, which show that the model performs very satisfactorily under those early on-ground conditions. Analyses of in-flight SCIAMACHY contaminations and its behaviour over time will be presented in a follow-up paper.

p1214, l12

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We will remove the reference to orbit, and discuss the applicability. In addition we will upgrade the model to an N-layer model, instead of 4-layer model.

Suggested changes:
To expand the model to any desired number of layers, the total reflectance $r_{i,j}$ to medium i for a surface of material $j+1$ with a layer medium j, becomes:

$$r_{ij} = \frac{r_{i,j} + R_{j,j+1}e^{(-2i\delta_j)}}{1 + r_{i,j}R_{j,j+1}e^{(-2i\delta_j)}} \quad (1)$$

$$\delta_j = 2\pi\frac{d_j}{\lambda}n_j\cos(\phi_j) \quad (2)$$

$$\cos(\phi_j) = \sqrt{1 - \left(\frac{n_i}{n_j}\sin(\theta)\right)^2} \quad (3)$$

p1215, l6

We will remove the *due to*, as requested.

p1222

The reference for the formulae is given at the start of the section (Azzam and Bashira, 1987), but we'll repeat the reference closer to the formulae, as requested.

p1228

We will remove the mentioned sentence, as requested.

p1230, l12

The choice for light oil originates from a discussion with engineers that were present during the initial calibration measurements of SCIAMACHI and who claimed to have witnessed an oily residue. Other options have been investigated but were not consis-

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tent with the measurements. We will replace 'is needed', by 'would be consistent' as requested.

p1230, l26

Assumption 1: we will include the suggested description of the SCIAMACHY miror. Studies show the Al coating to be more than 100 nm thick (TPD-SCIA-ADMDIFF-MRB1), which effectively shields the underlying material. Grain size also does not play a role.
Assumption 2: We follow the work of van Harten (2009) which shows that all Al mirrors form a 4.1 nm thick layer of Al2O3, hence we feel safe to make the assumption here that the almost identical mirrors also have this 4.1 nm Al2O3 layer.
Assumption 3: We assume both layers have identical thickness of oil, this is indeed an assumption based upon the similar conditions the mirrors were kept. It is possible to have different oil layers. We will add a comment to point this out.

Suggested change:
As both mirrors were kept in similar conditions we assume a similar contamination of oil on both.

p1232, l12

We will expand the formulae to a N-layer model, which include the requested 4-layer model.

p1232, l14

We shall remove this sentence to avoid confusion.

p1232, l15

We shall remove this sentence to avoid confusion.

S2.2, s5

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We indeed give no method how do derive the contamination in space, this will be the focus of the next paper. We agree that the title *Approach* does not cover the extend of this paper. We shall rename it *Mirror modelling* and describe the approach to derive the optical properties of the contamination in space, in the next paper.

Comments from R. Lang (Referee)

Specific Comments:

1) We shall add a section in the discussions on the limitations of the model (see first comment referee 1)

2) In this first paper in the series, we do not yet show any contaminations obtained in space or how the optical properties of the contamination can be derived. We will most certainly include the suggested figure in the next paper in the series. However please find in these author comments a figure showing a single mirror throughput change for both polarisations: S (black solid curve) and P (red dashed curve) as a function of light oil contamination thickness (going from 0 nm to 10 nm in steps of 0.5 nm).

3) We shall follow the suggestion of the referee, namely to include a general applicable method in the companion paper. Limitations are addressed in the suggested change in the discussion (see first comment referee 1).

Editorials: All editorials will be incorporated in a revised manuscript.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 1213, 2014.

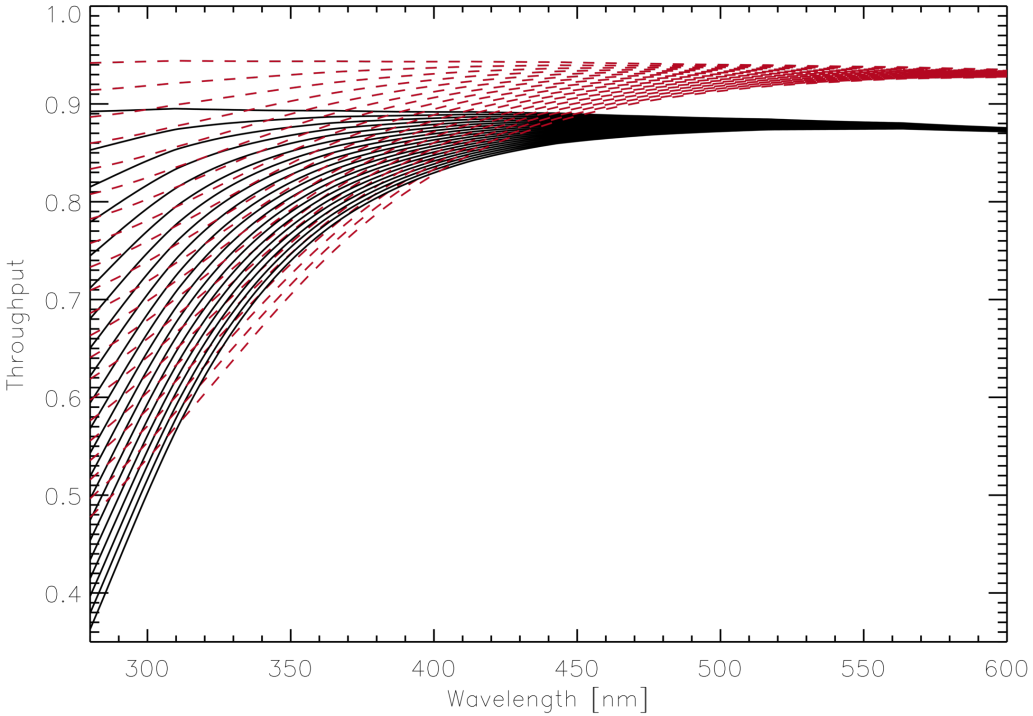

Fig. 1.

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