Characterization and correction of stray light in TROPOMI -SWIR
Paul J. J. Tol et al.
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Summary Comment

This is an important paper bench-marking the performance of the TROP-OMI instrument in the SWIR band. The results of the laboratory testing are significant in their use in reducing on-orbit observations and test data. The paper should be published. However, the methodology is complex and the information provided is not sufficient for an outside evaluation to adequately assess the success of the test analyses reported. The reported performance of the instrument is not clearly stated, as different presentations of the information lead the reader to form different conclusions: the raw corrected data, the plotted slit function behaviour and the corrected data. These seem to range from a dynamic range of 1.0E-7 to 1.0E-4 or 1.0E-5. The different presentations and their implications should be clearly described to the reader.

General comments

In some 2-D detector systems it is very difficult to separate optical stray light effects from artifacts generated by the readout and resetting operations. There should be some discussion added to address these issues in order that the stray light effects documented are considered in the correct context. 1.0E-7 as a far-wing stray light rejection is good performance for a double monochromator. Accepting that kind of performance in a single monochromator with a array detector should be done with the greatest care.

The description of the testing and analysis, and especially the attribution of systematic affects in section 3, is not likely to be accessible to a wider audience. The terms and methods for drawing the conclusions presented should be more fully explained. In particular, separating blooming and resetting from the effects of stray light is an important issue.

It might be instructive to illuminate more than one pixel in a ‘two-source’ test to examine the separation of stray light effects and effects from other sources such as blooming and charge carry-over (incomplete pixel resetting).

Some detailed comments listed by PDF page number.

Page 1 Line 1	Suggest: “... Short-Wave InfraRed ...”
Page 1 Line 3	Suggest: “... are needed that are minimally contaminated by instrumental stray light.”
Page 1 Line 5	“... seven orders of magnitude by making measurements with some saturated and some unsaturated detector pixels ...”
Page 1 Line 7	“... signal, for example in a dark forest scene close to bright clouds, by ...”

Page 1 Line 8	"It is expected that this reduces the stray-light error sufficiently for accurate gas-column retrievals." Can a stronger statement be made?
Page 1 Line 10	".. long-term, in-flight ..."
Page 1 Line 12	Suggest: "... (TROPOMI) is the only instrument on board the ..."
Page 1 Line 16	Suggest: "... sampling interval of 0.1 nm."
Page 1 Line 20	"To achieve the required accuracy of the measurement of spectral radiance, an accurate correction for the stray light must be included in the analysis."
Page 2 Line 4	"Examples of corrected measurements are..."
Page 2 Line 7	If possible, a simplified diagram of the optics would be welcome to readers. Describe what is meant by an 'immersed grating'.
Page 2 Line 13	The methodology for reading out the detectors should be described. Is it CCD, random addressed, multiple amplifiers, A/D(s) etc.?
Page 2 Line 17	"... calibration were performed ..."
Page 2 Line 32	"... shutter in front of the spinning mirror ..."
Page 3 Line 5	"... the instrument was reduced ...". This description of the attenuation and gain setting indicates that all but the shortest integration time will be saturated. It is suggested that the reason for this be stated explicitly (i.e.: the sensitivity needed to measure the weak stray light on remote pixels) and some indication of the results of tests done to show that the signals are from stray light and not electronic artifacts.
Page 3 Line 12	The methodology here seems strange. One would expect that the dark signal would be a minimum at the smallest integration time and grow larger at the longest integration time. The analysis described here seems to be neglecting dark count and concerning itself only with 'background' whatever that encompasses. Perhaps some more detail here would be appropriate. There are a number of phenomena which must be characterized or shown not to be important: electronic readout noise, charge carry-over from reset (and any spreading to other pixels) and actual dark count (thermal generation).
Page 3 Line 23	'absolute signal' should be defined
Page 4	Figure 2. "Background-corrected light peak at different exposure times: (a)

0.2ms, (b) 4.6ms, (c) 106ms, (d) 1998ms. Only at the shortest exposure time are there no pixels saturated."

Page 4 Line 8 — The quantity proportional to intensity after the integration time is taken into account is probably proportional to current but more likely presented in terms of A/D counts per second. The wording should be made more precise to make the information clear to the reader.

Page 4 Line 9 — "...the dynamic range of the signal current is *theoretically* larger than seven orders of magnitude." This does not automatically mean stray light can be characterized to that level. The later figures suggest that the stray light is on the order of 4 orders below the peak intensity at distant pixels. The discrepancy between these two numbers - if the background subtracted includes effects additional to stray light - may lead to a non-linearity in the stray light correction process.

Page 4 Line 12 — "... saturated by light, not dark current .." It is not clear what this is to mean given that the generation of electrons by light and by heat is essentially the same.

Page 4 Line 13 — It is not clear what correction has generated the change from figure 2 to figure 3. It suggests a very effective reduction of stray light signal. However, this must be taken in the context of the earlier comments about line 9. It would be helpful if the correction procedure were described fully and more clearly.

Page 5 Line 4 — The unknown agent leading to alternating values of signal level is somewhat concerning. One question here is whether a study has been done to see if all combinations of pixel readout values are statistically likely. A problem with the analog and A/D circuitry can cause strange effects in the observed measurements. Perhaps a comment about this might be a useful addition. In the RETICON there is a potential for this kind of effect because of the way charge is shared between pixels. The gain pattern can be seen where it is clear that small differences in the mask used to define the electrodes causes the issue.

Page 5 Line 5 — "Second, in the conversion to signal current, exposure time 0.2 ms is actually replaced by 0.14 ms." Is this a statement that measurements were done again at a different integration time or is this the determination of a corrected integration time for measurement nominally made at 0.2 ms? Does this perhaps feed into the high bias of the model stray light cureve relative to the data?

Page 5 Line 11 — It is not clear to this reviewer what is mean by "... Gaussian and block distribution."

Page 8 Line 11	"(across-track and along-track)". This description seems somewhat misleading. The detector has cross-track imaging but the other direction is spatial. Better to leave the "along-track" description out to avoid confusion.
Page 10 Line 15+	The equations were very difficult to read because of problems with formatting in the PDF. A description of the methodology which is more accessible to a wider audience would be a great addition to the paper. It is left to the authors to ensure that the equations are correct.
Page 7 Line 9	Is the 2.1 spread compared to the 1.1 degree source in agreement with the instrument design model? It would be more informative to convert the 1.1 degrees to the expected pixel size. It is just quibbling,nn but the bump reported in the next line looks more like 0.6 or 0.7 %.
Page 7 Lin 10	The comment concerning the Xe lamp should be explained. It is not clear why once source should spread spatially while the other does not.
Page 8 Line 2	"... at the peak positions used ..." "The ISRF was determined ..."
Page 8 Line 6	"... contain more stray light than any diagonal cross section .." Can electronic contributions be ruled out?
Page 8 Line 8	"... Once the general behaviour of the stray light was examined, ..."
Page 8 Line 11	"the point response function (PRF)" "point spread function (PSF)" is more commonly used.
Page 19 Line 5	"We have developed and applied a novel method ..." While the work presented is thorough and makes use of a very useful algorithm, this may be overstating the situation somewhat...