

amt-2015-118. Munro et al. "GOME-2 instrument on the Metop series of satellites: instrument design, calibration, and level 1 data processing – an overview".

Response to Anonymous Referee #2 Comments RC C3742

Thank you for the time taken to review the document and the helpful comments. Please note that the pages referenced do not equate to those in the discussion paper. They appear to correspond to a first version which was subsequently modified (including some reorganisation) in response to the associate reviewer comments, prior to publication for discussion. This complicates the response to the review somewhat but we will do our best to match the comments to the discussion paper.

Reviewer Comment (1)

Section 1. The authors should provide a high-level list of requirements (more than just spectral range and resolution) that govern the instrument design and characterisations. The various requirements can be distributed in the various subsections, but are needed to motivate why the instrument is designed, characterised, operated, and corrected in a particular way.

Response (1)

The list of requirements that the reviewer is requesting do not exist in the way that they do for more recently designed instruments. The requirements that do exist are relatively limited and would add little to this paper. The GOME-2 instrument was essentially a copy, with improvements, of the original GOME/ERS-2 instrument. GOME/ERS-2 was an experiment (as the name suggests) and the available documentation on instrument requirements reflects that fact.

Reviewer Comment (2)

The authors neglect to discuss the accommodation of GOME-2 on their respective spacecrafts. How is the instrument oriented? Data rate? etc.

Response (2)

The requested information has been added.

Reviewer Comment (3)

Page 2, Lines 21-24. Please indicate along-track and cross-track for dimensions.

Response (3)

Text updated.

Reviewer Comment (4)

Page 3, Line 20 It might be helpful to the reader to mention that the dispersion direction is across-track. Then, in Section 2.4 this can be referenced as a reason why there is no concern over inhomogeneous slit illumination.

Response (4)

Clarification added, and a comment added to what is now Section 3.4.

Reviewer Comment (5)

Page 3, Line 26 The authors might consider indicating that the 3rd beam bypasses the prism.

Response (5)

Text updated.

Reviewer Comment (6)

Page 4, Line 8 It is not entirely clear what an open-loop temperature control is and how that determines the ultimate PMD temperature.

Response (6)

The text has been updated. I would refer the reviewer to Callies et al., 2000.

Reviewer Comment (7)

Page 5, Line 4 Please refer to Band 4, or Bands 1b and 4.

Response (7)

Here the text states Bands 1B to 4 this is correct as the intention is to indicate Bands 1B, 2A, 2B, 3 and 4. This has been expanded for clarity.

Reviewer Comment (8)

Section 1.3, paragraph 1 Documents that are not publicly available are not generally cited as references. If these are available, please cite a location. If not available, please remove.

Response (8)

In general all cited publications should be available from the website path provided but upon checking it seems four documents are missing from this location – they will be added.

Reviewer Comment (9)

Page 6, Lines 5-12 Unnecessary information. Can't the authors simply say that the slit function is characterised at sub-pixel resolution pre-flight? Does the reader need to know that this work was somehow "additional"?

Response (9)

The intention was to indicate that this activity was not part of the nominal on-ground characterisation activities and was indeed not performed for earlier instruments of this class. However the text will be adapted.

Reviewer Comment (10)

Section 1.6, Line 23 It is not clear what is meant by "scanning the ground at constant speed". Do the authors mean across-track speed? Perhaps if they explain very briefly how the scan mirror actually operates (continuous vs. stepped motion) in Section 1.5.1 it will help the reader to understand this discussion. How are the photons collected that make up a reported spectrum?

Response (10)

The text has been modified to indicate "scanning the ground across-track at constant speed" and a reference to Section 1.7 has been added where more information is available on data packet structure and the relation to the scan.

Reviewer Comment (11)

Page 10, Line 1 The pronoun "Their" should be replaced with its antecedent.

Response (11)

Agreed – done.

Reviewer Comment (12)

Page 13, Line 19 Please explain how dark currents can be calculated for different integration times without separating the offset and time-dependent components. Is it because Earth-view timing is employed when measuring darks in eclipse? If so, this should be mentioned somewhere (Section 1.5.2?).

Response (12)

Yes – the fact that dark current measurements are made for operational integration times and temperatures in use during nominal operations was implied at the beginning of what is now Section 3.2. The text has been further expanded to make this clearer.

Reviewer Comment (13)

Page 13, Line 25. Can the authors cite comparable performance results to back up this claim? Or at least be more specific about what aspect of this detector makes the quoted rate normal.

Response (13)

The text has been expanded to refer to GOME/ERS-2 and a reference provided.

Reviewer Comment (14)

Page 13, Line 26 Can the authors be more specific what they mean by "noise pattern"? Is this the standard deviation of a single pixel's signal, or is it a measure of DSNU (dark signal non-uniformity)?

Response (14)

The text has been modified to say "In addition the noise is very stable across the spectrum and slightly below 2 BU"

Reviewer Comment (15)

Section 2.3 Please motivate the need for a PPG correction. Why doesn't the pixel-by-pixel ground calibration obviate the need for such a correction? And why does this need to be monitored if the primary cause of PRNU is pixel size?

Response (15)

The PPG characterisation on ground is used to characterise the performance of the instrument at the time of instrument build however an in-orbit correction is applied to accommodate small changes in the PPG during the lifetime of the instrument which have been observed and are mentioned at the end of this section.

Reviewer Comment (16)

This paper does not discuss the type and wavelength of the LEDs. So it is not clear from the discussion here that the LEDs are capable of accurately detecting changes in photon response for a given channel.

Response (16)

The LEDs are placed directly in front of the detectors as noted in Section 1.1 and are not dispersed. They provide output in the green part of the spectrum (~570nm). The PPG correction relies on a relative assessment of the pixel-to-pixel variation in photon response across the linear photo-diode array to the LED light which is uniformly illuminating the detectors. PPG is not expected to be dependent on the wavelength of the incident light (resulting mainly in small differences in pixel width as noted). The comment from the reviewer is not well understood.

Reviewer Comment (17)

Page 14, Line 8 Please clarify what is meant in this sentence. Would it be clearer to say "changes" rather than "increases"? Increases in what?

Response (17)

Increases in the size of the PPG correction. The PPG is a measure of variability so the variability has increased slightly. The text will be clarified if possible.

Reviewer Comment (18)

Page 15, Lines 2,3 Please explain or rephrase this sentence.

Response (18)

The sentence has been rephrased to:

“Overall the spectral calibration stability is well within the spectral range of a sub-detector pixel range.”

Reviewer Comment (19)

Page 16, Lines 3 Is there a way that temperatures from Figure 10 can be instead included in Figure 9?

Response (19)

Whilst we understand the intention we fear that this may lead to a very busy plot which in the end may be difficult to interpret.

Reviewer Comment (20)

Page 16, Line 17 Change the word Four to For.

Response (20)

Agreed – done.

Reviewer Comment (21)

Page 17, Lines 11,12 The authors provide a tantalizing reference to sun-normalized radiances, but go no further. Is this ratio something that's provided in the Level 1 product? If not and the user is expected to perform this calculation, how is he expected to do it? For example, the authors have previously discussed the spectral instability through an orbit. I assume that the spectral scale is provided for each Earth spectrum. I also assume that a separate scale is provided along with the SMR. Is it the user's responsibility to adjust the two spectra to the same scale?

Response (21)

There would be the option to output the sun-normalized radiances in the level 1b product however this is not done specifically because users request access both the earth and sun measurements to be provided separately. The sun measurements and the spectral calibration measurements are performed once per day as noted in what is now Section 1.4. The users typically make fine adjustments to the spectral scales during the level 2 product generation.

Reviewer Comment (22)

Page 21, Lines 24-27 Can the authors speculate why this may be occurring? Do they think it plausible that increased contamination on a specific optical surface or surfaces may be to blame? Since the optics prior to the entrance slit are usually the ones that degrade, how do they explain an increase in spectrometer stray light?

Response (22)

Contamination is a possible cause of increasing stray light as degradation in GOME-2 most likely has two origins: contamination of the primary scan mirror, the most exposed optical element, which was expected based on GOME/ERS-2 experience; and contamination in the region of the detectors themselves which has not been observed with GOME/ERS-2, as noted in Section 4. This is under investigation and will be addressed in a future publication with a focus on degradation evaluation and correction.

Reviewer Comment (23)

Page 26, Lines 23-26 The authors mention stable scene results as a validation of changing Earth radiance calibrations. It would be very informative to provide a comparison of those results with the changes observed through the calibration approaches discussed in this paper. At the very least, the authors should cite references for that work.

Response (23)

This work has not yet been published. As noted in Section 4. “The analysis of the GOME-2 degradation is on-going for all operational instruments with the aim of characterising the degradation in reflectivity, in spectral, angular and temporal space, in order to provide a degradation correction to users. Note however that signal to noise cannot be recovered. The degradation analysis and correction will be the subject of a dedicated publication.” The target journal is not yet known.

Reviewer Comment (24)

Page 27 This would seem an opportune place to go into a little more detail regarding in-flight calibration errors that can affect the accuracy of the Level 1b product. The authors describe various degradations and inconsistencies in qualitative terms but do not provide plots or hard numbers. How is the reader supposed to evaluate the potential uncertainties in the Level 1b radiance product? My comment here may or may not be relevant depending on the authors’ intent for this paper (something that is not entirely clear to me; see next comment).

Response (24)

The quantitative evaluation that the reviewer is looking for is better placed in the upcoming publication on degradation correction (see Response (23)) as degradation correction is an essential component to the evaluation of the final level 1b product quality. See also below.

Reviewer Comment (25)

Page 27, Lines 26-28 The abstract states that the quality of the Level 1 data product will be presented. That appears inconsistent with these lines of text. It is also inconsistent with what I have read throughout the paper, esp. in Section 4. This paper appears to be an instrument/algorithm description paper rather than a Level 1 product paper. The authors should remove any suggestion in the introduction that this paper deals with product performance.

Response (25)

Agreed – the reference to “quality” will be removed in the Abstract and replaced with “current status”.