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Atmospheric Measurement Techniques Discussions



# *Interactive comment on* "Detection of non-linear effects in satellite UV/Vis reflectance spectra: Application to the Ozone Monitoring Instrument" *by* Nick Gorkavyi et al.

**Anonymous Referee #1**

Received and published: 22 October 2020

General Comments:

The paper describes a threshold method to detect anomalies in Level 1 radiance data, that may be difficult to identify in instrument radiance calibration, such as detector blooming. Flagging thresholds are given for the OMI instrument, and the authors claim that the method is applicable, with probably different thresholds, to other instruments as well. The paper is suitable for publication in AMT, as it shows a way to improve the flagging of suspicious radiance data in (satellite) spectrometers.

However, I am missing some important pieces of information:

1) how to calculate the Decorrelation Index DI exactly



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2) a systematic discussion of what influences DI and why

3) how were the threshold values for DI in each spectral interval derived?

The first point could easily be mended by providing a mathematical formula for DI.

The second point is treated dispersed through the paper, with some information only anecdotically. The authors state that aerosols, Rayleigh scattering, blue water give rise to changes / increases in DI, and provide a few examples, without explicitly telling why DI is influenced. Without providing an exact calculation method of DI that is difficult to understand at first. Assuming that "r" is the Pearson's correlation coefficient, the slope of the spectrum also enters the equation. However, that also implies that the threshold reacts different to anomalies for ascending and descending spectral slopes. This should be discussed at the beginning, after introducing "r". Also it should be mentioned explicitly that perfectly normal spectral features, such as atmospheric absorption lines, give rise to enhanced DI. Several other aspects on the behaviour of DI are stated but may require reading between the lines to understand; in general statements should explicitly explained and without the need to reread sentences several times. Insight in the meaning of DI would be much clearer if all influences were discussed in one place, e.g. Section 2.2, instead of providing something in the introduction and letting others develop along the line as examples are given.

It remains intransparent how threshold values for DI were derived. But that is important if the reader wishes to apply the method to other instruments. Were thresholds derived based on radiative transfer calculations (including Raman scattering, aerosols, generic spectral surface albedos?) or was this a trial-and-error process until some credible results were obtained?? Was there any deliberate matching to OMI saturation flags?

Specific Comments:

Title (and abstract): the use of the word "non-linear" is not appropriate if also straylight is included (assumed is spatial straylight??). It may be that straylight has a non-linear

effect on calibrated radiances compared to TOA, but for the instrument the amount of straylight is linearly proportional to the amount of input light into the telescope (for a certain geometry). The same for obstruction due to MLI. Also a cosmic hit may (statistically) be linear with particle flux (for a given particle type/energy/angle). It would be more precise to use the word "anomaly". (in line 73 this is correctly used for OMI flags)

Line 35: I understand this introduction is the standard advertising for OMI, but OMI NRT/VFD dissimination is really irrelevant for this paper - please remove.

Line 48: it is not clear that the term "blooming" is explained by the first part of the sentence. This is then better done in line 65. Please move and integrate line 65 to here.

Line 54: this may suggest all GOME-2 (2A, 2B, 2C) sensors have an issue with clouds. As far as I recollect the issue was solved by introducing coadding. Please rephrase or leave this out, since you make abundantly clear that saturation effects are common. Maybe mention that saturation is simply a common effect due to the much larger dynamic range of TOA radiance compared to detector dynamic range.

Line 80-86: this is a general statement on radiance versus irradiance. While it is OK to make such a statement in the introduction, it is not sufficient to regard this as explanation of the behaviour of DI (see general comment).

Line 83-85: ...depends mainly on the strength(depth) of solar Fraunhofer features... The depth of the solar lines by itself doesn't change DI. What you want to say is that the low radiance in line cores makes them more susceptible to additive effects. Please rephrase. I wonder if the sentence is not better moved to a section that describes DI more in detail (see general comment).

Line 116-119: a mathematical formula for the calculation of DI should be given here.

Line 124: is DI not always >= 0 if atmospheric absorption is present ? (formula for

DI needed !) and what is the influence of a non-flat spectral albedo on DI ? (again: formula for DI needed). In general, would DI not always be >= 0 unless the reflectivity decreases with wavelength? As per my general comment, I propose to discuss that here, together with noise effects, and the resulting behaviour on parameters currently discussed in lines 80-86.

Table 1: the comment "strong spectral lines" is unclear. And why does this coincide with low DI thresholds?

Table 1, DI thresholds: see my general comment 3). Even if DI thresholds may depend on application, it must be described how the thresholds in this paper were derived, such that users may get a handle on how to set the threshold (for their application or for other instruments). "We just take these values and it works" is not enough. IMPORTANT: The paper is not acceptable without a proper description here. Scientific results must be reproducible and traceable. (as you know of course... I don't expect pages with analysis but say what you did so others can replicate)

Line 269-280: this is one of those examples where it is left to the reader to guess why exactly DI is deviant. The basics of this (spectral slope ?) should have been laid out before (see comment to line 124) and it would not harm to remind here why Rayleigh scattering has an effect ("contributes significantly to the top-of-atmosphere radiance" is a bit non-descript..)

Line 302: Why does scattered light from the thermal blanket "leads to the significant decrease of DIs". Not increase? And does "the blocking of the incoming Earth shine" result in distortion of the spectral shape ??

Line 321: why does low reflectivity (solar eclipse) increase DI but scattered light (line 301-303) lowers DI (should that also be: increases)? Is the solar eclipse effect due to noise or due to spatial straylight from around the occultation zone? Is scattered light not spatial straylight?

Line 329-332: I wonder if a high-pass filtering (e.g. dividing radiance by a local polynomial fit) would not largely remove the effects of aerosol and surface reflectivity on DI, and provide better sensitivity to anomalies in Vis. Also the "search for areas of clear ocean water" could probably just as well be done using a "slope index" based on 2 (continuum) wavelengths. Please comment / address.

Typographical comments:

The figures provide important visual information. However, most are disproportionally large compared to the text and to the required resolution (it is really not necessary to visually locate every single pixel). Especially figures [2,] 3,5,6,[8,9,] 10,11 should be reduced in size.

Also the font size in Table 1 is disproportionally large and should be reduced.

Typos:

double dots in lines 51, 94

double white space in line 169 ?

Dis -> DIs (?) line 301, 303

missing space line 303 (Fig. 11.Figure 11)

(otherwise kudos for a well-edited syntax !)

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