

Review of “An advanced spatial co-registration of cloud properties for the atmospheric Sentinel missions: Application to TROPOMI”

Comments based on <https://doi.org/10.5194/amt-2024-28> Preprint, retrieved 8 April 2024

General comments

Dear authors,

Congratulations to the achieved improvements on your cloud property retrieval algorithm.

While the described improvements in UPAS version 2.6 are important to all users of the respective TROPOMI products, the approach and techniques are interesting for a much wider group of readers. The paper describes in great detail the previous method and the new algorithm. The results are compared extensively to the previous version and also another instrument.

Although the detailed comparison is useful to understand the impact of the changes depending on the cloud situation, I think that the paper would be easier to read when some parts could be shortened and some plots would be combined. Specifically for the correlation plots and histograms it is not clear why they are shown or what the reader should learn from them. A qualitative description and an interpretation in the context of the problem would be helpful. The grouping in the categories A-K is also difficult to follow for me, the respective parameters between the groups do not show a clear correlation. Please consider discussion the observations more along the groups and combining the barplots.

In the following I list my detailed comments/questions in a table referring to page and line number of the version I retrieved on the 8th of April. In separate sections I have also listed some remarks on typos/definitions/phrasing and suggestions for the figures.

Detailed comments

Please find detailed comments in the table below.

#	Page	Line	Section	Comment
C1	1		abstract	Consider shortening the abstract and moving part of the content to the introduction
C2	1	2	abstract	The use of the word “frequently” suggests a temporal dependence, although the misregistration is a design feature and should be constant with time.
C3	1	5	abstract	Unclear: is it the UV band or the UVIS band or both of them? (see also points below)
C4	1	16	abstract	Unclear: what is meant by the first detector pixel? I think you want to refer to the outermost groundpixel of a scanline. The first detector pixel would refer to (unbinned) detector pixels at the edge of detector which is not used for L2 retrievals.

#	Page	Line	Section	Comment
C5	2	30	Intro/Table 2	Four distinct spectrometers: Table 2 lists 8 spectrometers, this is not correct. Please be very clear in your distinction between bands and spectrometers. Also ensure that your naming is consistent, which spectrometer do you mean by UV/VIS band from the abstract? I suggest you use the convention form Veefkind et al. 2012: UV, UVIS, NIR and SWIR and refer to bands 1-8 if you want to refer to a spectral range of TROPOMI.
C6	2	32	Intro	Different spectrometers/several bands/inter-band: Misalignment between groundpixels also occurs within one spectrometer, although it is much smaller than between the spectrometers (see (and cite?) https://amt.copernicus.org/articles/11/6439/2018/amt-11-6439-2018.html) . The phrasing that the misregistration is caused by having different spectrometers is therefore not accurate. Do you want to point out the misregistration between bands or between spectrometers? If you use the term bands both intra- and inter-band co-registration can be meant.
C7	2	34	Intro	'Interconnected to the spatial resolution'. What do you mean by this? If you refer to the changes in along-track resolution but later (p5 l99) dismiss the along-track impact, why refer to the along track resolution? The ground-pixel size is determined by the binning and along-track co-addition, see https://sentinel.esa.int/documents/247904/2476257/Sentinel-5P-TROPOMI-Level-1B-ATBD p 165 , the mis-alignment is an optical pointing effect, it is present for all ground-pixel sizes.
C8	3	50	2	UV/VIS: which TROPOMI bands/spectrometers do you refer to hear, see also comment above
C9	3	68/69	2	The definition for λ is missing.
C10	3	72	2	It's great to have the table with the definitions, maybe you could extend it to add all parameters and then shorten/delete the description before the formulas?
C11	4	80	3	Among others : add references to the other operational cloud products.
C12	4	88-92	3	Unclear: do you mean detector pixel size? It might be clearer if you refer to the ground pixels and nadir vs edges of the swath
C13	4	90	3	Instrument nadir angle: this phrasing is confusing. The effect is caused by a combination of instrument features (due to the large swath angle) and the Earth's curvature.
C14	4	92	3	Minimum dispersion: Do you mean the increase of the size of the ground pixels towards the edge of the swath? Dispersion is generally related to wavelength. Suggestion: with the aim to minimize the difference in ground pixel size in across-track direction.
C15	4	94	3	... this results in a ground pixel size of 15 km : this is phrased confusingly, the reduction of the binning factor doesn't increase the ground pixel size ... the binning is reduced to keep the groundpixel size at a reasonable value, it increases towards the edge of the swath due to optical limitations of the instrument and the curvature of the Earth.

#	Page	Line	Section	Comment
C16	6	109	3.1	Do you calculate the mis-registration between bd 3 and bd6 AND bd4 and bd6?
C17	7	Fig2		What is the difference between the upper and lower panel? They look almost identical. If they are, remove one of the two, if not provide a plot where the differences are clearly visible.
C18	8	163	3.3	Eq. 4: Is this a normalization i.e. is the sum of all δ_{jk}^X = equal to the sum of all pixels?
C19	8	174ff	3.3	There is a lot of description on the VIIRS data retrieval algorithm, is this needed for the paper? Consider shortening the text/replacing it by a suitable reference.
C20	10	209	3.3.1	The change in binning factor occurs twice in every scanline, or do you make a difference between 1->2 and 2->1 ?If yes, please add
C21		Fig3, Fig 5, Fig 6 Fig8-10		The images are quite large for their content. The axis(arrows) are not needed, or what is meant by the y and x axis? Suggestion: combine the three situations in one figure with 3 panels, then the labels only need to be shown once and the situations can be compared easily. Please explain the symbol used in the illustration. Otherwise it's not clear what differences the reader should see. What is the conceptual difference between Figs3-6 and Figs 8-10? It's only the source and target exchanged and other properties considered, or not? Why separate figures then? I do understand the case of 1 and 2 pixels contributing to the target, but when is it 3? Can you show this in figure 4 or 7? Or is it a along track overlap? The figures suggest only an overlap in across-track. Or does this happen when the binning changes in one of the spectrometers but not the other? This is not clear in the text.
C22		Fig 4, Fig 7		There are no horizontal magenta stripes visible. If they overlap with band 6 this should be indicated in the caption. Please combine Fig 4 and 7, then it's also clearer that the pixels are shifted about ½ pixel wrt each other and that it's not the black and magenta overlapping.
C23	12	221	3.3.2	Define h
C24	12	224	3.3.2	How are the pixels numbered 0 to ? From West to East?
C25	13	236	3.3.2	Alpha and beta are not described/defined
C26	15/16	252ff	4.1	You mean if the values in the pixels are all the same for VIIRS but not for TROPOMI? This is not phrased very clearly.
C27	16	Fig 11		What are we supposed to see in this plot? Or is it for illustration only? Please add this to the caption. What are the pixels without frames? Re-gridded VIIRS data? Would those pictures not be better suited to be included in the figures Fig3, Fig 5, Fig 6, Fig8-10?
C28	17	Fig 17		I do not see a difference between the plots cloud-top height, optical thickness and cloud albedo. Is there one? If not you could consider omitting part of the plots from the paper/moving them to the appendix. Why are you showing the plots? To indicate there's no apparent dependence on where on Earth it is? Then please mention this in the caption.

#	Page	Line	Section	Comment
C29	17	265	4.1.1	Why does it only work to a certain latitude?
C30		Figs 14-17, 267-275	4.1.1	What do you want to show with all the scatter plots/histograms? They do not seem to add to the paper. Can the information be summarized/condensed? An interpretation given? If the plots are needed please consider to group them together and decrease the size (of at least the histograms). The text is descriptive, but is there also an interpretation/understanding of the differences? It is not very clear what the conclusion is.
C31	18	277	4.1.1	It is expected: did you check that this is indeed true? In Fig 18 you show this. To make it clearer, please rephrase: The differences are exactly zero...
C32	19	284 ff Table 3	4.1.1	It is a good idea to group the differences in different categories. Could you please also add the cloudiness situation in the table? And maybe add (verbally) the different parameters as an extra row? Why did you chose 10 different categories? The discussion on the different groups is very difficult to follow and the conclusion is not clear to me. It seems to be bins for the different parameters, but is there a relation for the lowest and highest bins?
C33		Figs.18-21		Are all these plots needed to support your conclusions? Please consider omitting some plots or moving them to the appendix.
C34		Figs 22-25		Are all these plots needed to support your conclusions? Please consider omitting some plots or moving them to the appendix. The axis labels have a too low resolutions. What is the difference between the days? Why can't they be combined? And again why the different groups? It is essentially a bin. Would it not be clearer to add the bin range to the plot axis instead of introducing the groups? I cannot follow what I should learn from these plots. What is the conclusion?
C35	24	317	4.1.2	"closing the gaps" this phrasing is a bit confusing, the gap will only be reduced by one groundpixel and not closed. It should maybe be mentioned why the gap is there in the first place (and that it can't be reduced with the current orbit parameters)
C36	24	314	4.1.2	'first TROPOMI UV detector pixels'. What is meant by this? The western-most pixel? Please re-phrase, see also above.
C37	27ff		4.2	In this section individuals cases are discussed. Are the results individual observations or can they be also be supported by statistics? How do these observations connect to the barplots? It would be helpful to make a connection here.
C38	29/30	Fig. 26/27		The figures do not add much to the understanding. The point to demonstrate is only visible when clicking back and forth between the figures. Suggestion: Combine both figures, zoom into the plot from 144E to about 152E and highlight the additional available pixels.
C39	32	Fig 30		Consider zooming in on the relevant part and reducing the size of the figure.
C40	34	380-390	4.3	Not all the information on Calipso is needed to understand the paper, please consider to shorten this section.

#	Page	Line	Section	Comment
C41	35	396-398	4.3	Forward model of TROPOMI: please be specific on the model you refer to.
C42	36	410	5	Please refer to the algorithm name, as there are more TROPOMI cloud property schemes.
C43	36-39		5	The conclusion part is very clear and concise. In the detailed discussions in earlier sections it would be good to already mention these conclusions.

Technical comments/typos

General:

Capitalization of acronyms: some acronyms are capitalized and some not when written out, please be consistent and use only one of the two.

Please be consistent with your spelling, there are inconsistencies, for example:

- sunglint sun-glint
- cloud-top cloud top
- earth Earth

Detailed technical comments:

#	Page	Line	Section	Comment
T1	2	29	Intro	Window -> windows
T2	2	38/39	Intro	Have a big heritage .. which have already been applied: this sentence doesn't read well, skip 'have .. missions'
T3	3	75	2	Big Data -> big data volume
T4	4	84	3	On top -> in addition to
T5	5	Fig 1		"descibed" → described, also here: VIS-1/NIR-2 spectrometer is not correct
T6	5	106	3	UV/VIS ? What is meant here? UVIS?
T7	6	113	3.1	UV bands: what is meant here? Bands 1 & 2?
T8	6	135	3.1	Remove 'from' or change 'showed that' 'can be seen that'
T9	8	159	3.3	Well applied? Do you mean extensively? Successfully?
T10	9	192	3.3.1	UV/VIS ? What is meant here? UVIS?
T11	9	195	3.3.1	Add Y after weight
T12	10	211/212	3.3.1	Add Y1 and Y2 in the sentence
T13	15	251	4.1	Value -> values
T14	15	252	4.1	Results to -> results in
T15	16	259	4.1.1	From one day to the other -> from day to day
T16	17	269	4.1.1	Not that extended -> there is less scatter than above ...
T17	34	393	4.3	North-> northern
T18	36	413	5	Do you mean the 'following' instead of "aforementioned?"
T19	37	434	5	Columnar -> column
T20	38	438/447	5	Remove 'exercise'
T21	38	444	5	There is something wrong in this sentence, please re-phrase.
T22	39	452	5	Later ,... -> Once S-4 has been launched, ...
T23	40	468	App B	Rectangular -> rectangle

#	Page	Line	Section	Comment
T24	42	483		Unclear: One or more than one?

References:

The reference Sneep, 2015 is not available online it seems.

Figures:

On a more technical side: For people with red-green blindness or colour blind people the chosen blue, green and red hues do not work very well. Please consider to adapt your colour scheme.