

Interactive comment on “Validation of the Sentinel-5 Precursor TROPOMI cloud data with Cloudnet, Aura OMI O₂-O₂, MODIS and Suomi-NPP VIIRS” by Steven Compernelle et al.

Anonymous Referee #3

Received and published: 9 August 2020

This paper compares different OCRA/ROCINN and FRESCO cloud products to several auxiliary satellite data from other sensors as well as ground based data. It furthermore describes the ongoing efforts to improve the reliability of both official product branches. The content of the paper is clearly in line with the topics of AMT. Publication, however, is only encouraged after the following comments and those detailed by the Referees #1 and #2 are considered.

Major comments:

1) Actually, I got the impression to read two merged papers. On the one hand, the actual operational algorithms are described and somehow verified – validation without

C1

knowing the actual truth may be exaggerating - and, on the other hand, significant problems of the algorithms are identified and possible fixes are presented. What I miss is the link: Why are the future algorithm versions that are proposed to fix many issues of the actual algorithms not included in the verification exercises? From the manuscript as is, I get the impression that this paper is actually an algorithm presentation of somehow improved algorithms within a paper extensively using outdated data.

In order to bridge this gap, I would like to suggest to options: a) Split the paper in two, one verifying the actual operational algorithms and another one (or two for both algorithm branches each) introducing the future versions of the algorithms – then with a verification as well. b) Treat both algorithm versions (actual and future) of both OCRA/ROCINN and FRESCO similarly in the verification section so that an actual user may judge for himself either to use what is already available or to wait for an algorithm update being applied in the future without knowing, when this will be.

2) I found the structure of manuscript quite confusing. Descriptions of the algorithms appear at several locations. I suggest to first introduce all data, then describe the conducted studies and finally discuss the results.

Minor comments

1) The abstract contains many acronyms, which are not described at their first appearance, e.g. the difference between ROCINN_CRB and ROCINN_CAL are not clear from the beginning. I suggest to restructure the whole abstract. Maybe it is possible to collapse both ROCINN branches to one. Furthermore, the outlook on future mitigations (page 1, line 8) should be moved to the end the abstract as suggested in the guidelines.

2) Please add more references: page 2, line 6: for the trace gas products, please also add H₂O page 2, line 16: Please add reference and name pollution page 2, line 28: both HICRU and MICRU are also using PMD data, please add references below page 3, line 7: Please add a reference to the FRESCO algorithm applying “a directional surface albedo”. I could not find this feature described in the cited references. page

C2

3, line 13: Ref to FRESCO-S page 4, line 10: Reference to OCRA page 7, line 17: Reference to OCRA page 12, line 2: Are these “geographical patters” also discussed in Lutz et al., 2016? Please add a reference to the S5P verification report.

3) Please homogenize the acronyms and formulae. For example, O2 is sometimes written with subscript and sometimes not. Also TROPOMI/S5P is not consistently spelled. Sometimes its lower case and sometimes it is in caps.

4) page 3, line 2: What about GEMS and TEMPO? In what respect is S4 the first of its kind?

5) page 7, line 27: The choice of resolution seems a bit arbitrary. Please provide a rationale for both. Page 7, line 28: What is the rationale behind taking monthly mean reflectance data.

6) Please include a description of the treatment of snow and ice surfaces in the description of the OCRA/ROCINN and FRESCO.

7) page 9, line 3: “no official documentation is currently available for FRESCO-S” If this is true, I strongly would like to encourage the co-authors, that are developing this product, to provide official documentation to fill this gap for a potential user of the product.

8) page 16, line 9 and following: It seems to me that the statistics of the different data sets are based on different subsets (eg. MODIS versus the others). I strongly suggest to use the same subset to compute statistics in order to avoid biases.

9) page 17, line 27: Would it be possible to assess the effectiveness of this “compensation”?

10) Figure 9: These plots are really not easy to perceive. A particular feature I would like to have discussed is that there seems to be a significant number of C(T)H=0 values for the S5P algorithms as opposed to the OMI data in the upper left plot, which does not show not a single zero reading. What can be the reason behind this behaviour?

C3

Furthermore, why are there significantly more CH0=0 values than CTH=0 values for ROCINN_CAL?

11) The conclusions (page 25) start off with two statements what will be better in the future. Please move these statements to the end of the discussion (compare major comment 1).

Specific comments

page 1, line 7 “were” → “are”

page 2, line 33 omit “easy”

page 3, line 4 omit “fast”

page 3, line 30: NPP-VIIRS etc. are instruments, not satellites

caption of figure 1: omit “, while S5P FRESCO is merely a backup”

page 4, line 3: omit “finally”

page 4, line 5: please rephrase this sentence

table 1: the superscripts are appearing at an odd order: b, d, a, c → please sort please also add $f_{rc,0.8}$ to that table

page 5, line 4: A verb is missing somewhere after “In general”

page 5, line 6 and following: please add a short comment on the rationale behind 0.8 as the fixed cloud albedo

page 5, line 16: please use metres to avoid confusion: 7668m

table 2: please sort superscripts please add column with references

page 6, line 6: omit “among else”

page 6, line 8: omit the entire sentence

C4

page 7, line 1: 20% bias on cloud fraction is a lot, please discuss the possible influences on the validation exercises in the paper

page 8, line 2: What is a significant set? How many did you use? Please omit “smart”

page 8, line 8: “spherical particles” → “spheres”

page 8, line 12: What is a “GE_LER”? Please specify.

Page 8, line 14: “RPRO” is not introduced yet

page 10, line 2: Please rephrase so that it is easier to perceive, that there are two MODIS instruments of different platforms.

Page 10, line 3: omit “from north to south” and “from south to north” as this is redundant information

page 10, line 12: omit “Dutch-Finnish”

page 10, line 13: omit “NASA’s”

page 10, line 29: please specify what a “pixel” denotes in the context of a ground based measurement in order to avoid confusion with a “satellite pixel”

page 11, line 6: “much less” → please be more specific

page 11, line 14: Why is there a shift in tenses? “were” → “are”

figure 3: Please indicate the “sharper contrast” in the figures

page 13, line 12 and following: Please also discuss here, that aerosols may as well have a different impact on the RT than clouds.

Figure 4: Please also discuss why there are steps (depending on the row) in the lower right figure. Is this an artifact/interference or a signal? This is critical, because right now it seems as an error in the proposed FRESKO-A wide algorithm.

Page 15, section 4.2: Which version of OCRA/ROCINN is applied? Is this version 1 or

C5

the proposed future version? If it is version 1, please add a similar figure for version 2 (see major comment 1)

page 17, line 10: omit “as it was stated earlier” → So why state it again?

Figure 7: If this is regridded VIIRS data, I would like to suggest to also show a scatter plot (2D histogram) in order to support a more quantitative comparison.

Figure 8: I guess “TROPOMI” indicates OCRA/ROCINN. Please be more specific in order to avoid confusion with FRESKO. How would these plots look for version 2?

page 20, line 12: Please provide a rationale, why also OMI data are included in this study.

Figure 11: Please improve image quality.

Page 25, line 23: Please be more quantitative.

References

Grzegorski, M., Wenig, M., Platt, U., Stammes, P., Fournier, N., and Wagner, T.: The Heidelberg iterative cloud retrieval utilities (HICRU) and its application to GOME data, *Atmos. Chem. Phys.*, 6, 4461–4476, <https://doi.org/10.5194/acp-6-4461-2006>, 2006.

Lutz, R., Loyola, D., Gimeno García, S., and Romahn, F.: OCRA radiometric cloud fractions for GOME-2 on MetOp-A/B, *Atmos. Meas. Tech.*, 9, 2357–2379, <https://doi.org/10.5194/amt-9-2357-2016>, 2016.

Sihler, H., Beirle, S., Dörner, S., Gutenstein-Penning de Vries, M., Hörmann, C., Borger, C., Warnach, S., and Wagner, T.: MICRU background map and effective cloud fraction algorithms designed for UV/vis satellite instruments with large viewing angles, *Atmos. Meas. Tech. Discuss.*, <https://doi.org/10.5194/amt-2020-182>, in review, 2020.

Interactive comment on *Atmos. Meas. Tech. Discuss.*, [doi:10.5194/amt-2020-122](https://doi.org/10.5194/amt-2020-122), 2020.

C6