

Review of AMT\_2021\_377 “DARCLOS: a cloud shadow detection algorithm for TROPOMI” by Trees et al.

This paper discusses the DARCLOS cloud shadow detection algorithm, and applies it to TROPOMI radiances. The algorithm is clearly explained and the paper is well written, and should be published after minor revisions.

### General comments

The DARCLOS algorithm relies on a longitude-latitude monthly climatology of cloud heights. The authors need to discuss the errors associated with the climatology that is applied in the paper. What are the standard deviations (state 1 or 2 sigma) of the cloud heights compared to cloud height validation data? The authors should discuss this by reference to the content in the Koelemeijer et al., 2001 and Wang et al., 2008 papers.

It is confusing to read on page 6, line 145 that “ $h_c$  is the 145 FRESCO cloud height”, while on page 20, line 430 that “With a future implementation of the effective cloud fraction from FRESCO which uses the TROPOMI DLER climatology..”. On page 6, line 145, add a phrase “applied using the DLER climatology (discussed below)” to tell the reader FRESCO currently uses DLER, and that the cloud fraction portion of FRESCO uses LER climatology (page 20, line 429, “The surface albedo input for the effective cloud fraction calculation in the NO<sub>2</sub> product is the LER climatology”).

On page 21, line 433, it is stated that “DARCLOS has not been tested at regions covered by ice and/or snow, nor at sunglint geometries over ocean.” Over the ocean of course a longitude-latitude climatology of clear ocean is problematic since glint reflectance is dependent on the 10m ocean windspeed. For a given ocean scene, however, it is possible to create a PDF of radiances, from which a cloud radiance threshold can be calculated which can be used to identify clouds. Did you try such a technique in the development of DARCLOS? It would be useful in the Conclusions section to briefly discuss how you will treat ocean glint scenes in future developments.

Mention in the Conclusions if / how ACSF and SCSF data will be stored in TROPOMI data files. Will this be done in already existing files or in new separate data files?

### Specific comments

The term “in close constellation with TROPOMI” could be reworded to “in close proximity to TROPOMI”.

The term “raise” is a bit confusing since equation (1) “raises, alters the height of”  $h$  in proportion to  $h_c - h_{sfc}$ , while the algorithm “raises, identifies” PCSF to ACSF values. “Raise” is used with different meanings in the text. To lessen the confusion, it is suggested to revise the following phrases:

Page 1, line 6, revise to “DARCLOS raises (identifies) potential cloud shadow flags”

Page 5, line 128, revise to “with a raised (identified) cloud flag (CF) and..”

Page 6, line 147 to “which assigns the cloud height  $h$  proportional to  $h_c - h_{sfc}$ .”

Page 7, line 171 to “in which PCSFs are to be raised (identified), based on”

Equation (1) has a C factor, set to 0.5. How was the value of 0.5 determined? How did the F1 scores vary as C varied? I did not see a discussion of C in Section 4, while line 148 on page 6 implies that this topic would be discussed in Section 4.

Page 2, line 35. How did the ground pixels change from 7.2 x 3.6 to 5.6 x 3.6 on 6 August 2019? The sentence implies that the actual physical dimensions changed. Please clarify.

Page 7, line 107. The phrase “inside but near the edges of the cloud pixel” was not clear in my first reading. The word “inside” makes sense if the cloud pixel is larger than the TROPOMI pixel size. An additional sentence is suggested to clarify the situation.

Page 7, line 172. The term “cloud-free” was at first confusing with regard to point Q in Figure 3, since point Q is shaded, but point Q is not untouched by cloud effects (it is in fact the cloud shadow). There are some readers who consider a “cloud-free” pixel to be a pixel not perturbed in radiance value by the presence of a cloud – which can yield a radiance enhancement (point O) or a radiance dimming (the point Q cloud shadow). An additional sentence can be added to clarify and lessen any confusion.

Page 9, line 231. Explain the rationale for using the “the 10% lowest SCNLER measurements”.

Page 9,. Line 241. Specify what Adler is.

Page 10, line 250 – Page 11, line 283. Consider moving these lines to Page 12, line 290. I found this text to be out of place, and perhaps better placed in an organizational sense in the next Section.

Page 11, Figure 5. It would be helpful for the reader to have  $\lambda_{\max}$  identified in the figure caption for both panels.

Page 13, line 302. Revise to “Only a few shadows of small isolated clouds are detected by the ACSF”.

Page 13, line 312. Replaced “temporarily” by “mischaracterized”. You don’t know if the error is due to a temporal problem, so “mischaracterized” is suggested.

### Criteria

1. Does the paper address relevant scientific questions within the scope of AMT? Yes
2. Does the paper present novel concepts, ideas, tools, or data? The paper focuses on a technique which has not been previously discussed in the literature.
3. Are substantial conclusions reached? Yes
4. Are the scientific methods and assumptions valid and clearly outlined? Yes
5. Are the results sufficient to support the interpretations and conclusions? Yes, the F1 test values in Table 1 are convincing.

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? Yes
7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? Yes, the Introduction does a good review of the literature.
8. Does the title clearly reflect the contents of the paper? Yes
9. Does the abstract provide a concise and complete summary? Yes
10. Is the overall presentation well structured and clear? Overall, Yes. I do have one organizational suggestion (move Page 10, line 250 – Page 11, line 283 to Page 12, line 290).
11. Is the language fluent and precise? Overall, Yes. The comments above point out a few word choices (such as “raise”) which can be altered and/or clarified.
12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? Yes.
13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? The General Comments section above points out a few places of suggested clarifications.
14. Are the number and quality of references appropriate? Yes
15. Is the amount and quality of supplementary material appropriate? Not applicable.