Review AMT Manuscript amt-2022-36 entitled High-resolution satellite-based cloud detection for the analysis of land surface effects on boundary layer clouds

General comments

This article describes an approach for using high resolution satellite data to investigate land surface driven modifications of cloud occurrence. Two cloud masking algorithms are introduced, one local using pixel-based thresholds with a very high cloud detection skill and another one with a slightly smaller cloud detection skill but with the feature of being relatively independent of variations in the surface reflection. Both are based on the high-resolution visible channel of MSG SEVIRI which allows to study very small-scale cloud responses/adjustments to land surface changes. In my opinion, this topic is highly relevant to a wider community, as the interaction between biosphere and atmosphere comes more and more into focus. The presented approach in this study provides a tool for e.g., studying the effect of deforestation/forest decline, drought or urban expansion on cloud clover and thus the radiative balance. The article is generally very well written. However, some aspects could be explained a bit more detailed, especially the conclusions of the results and what the study means for future research, which are listed below. All of my comments are more or less text edits and therefore, no major changes are required in my opinion.

Abstract:

The first 8 lines are more like an introduction and motivation. The sentence line 9-10 is good and should come earlier in the abstract. Afterwards you go into too much detail in my opinion. I would not mention the Heidke Skill Score here (too much technical details) but focus more on the added value of the regional cloud mask algorithm in order to study how cloudiness is influenced by land surface type and albedo. I think that if the abstract includes some more results or conclusions (e.g. that with the regional cloud mask you can confirm the city's effect on fog dissipation).

Conclusions:

Some ideas which could be addressed in future:

What could be expected if the tool is applied to other regions of the world (raising cities, forest stress…)?

How could this method be applied in synergy with future satellite missions (e.g. FLEX and Biomass)? When we have knowledge on the state of the surface (forest health etc.), we want to know how this effect the occurrence of clouds. This could be a point to mention for future research on your topic.

Detailed comments:

Line 41: small scale ~3 km features…

> The effective resolution of the pixels is smaller due to two reasons. First, due to the viewing angle, the pixel area is more something like (3.1x6.1 km2), which is addressed at a later stage of the paper, when the parallax correction is described. The second effect is that the real optical resolution of MSG is lower as characterized by the modulation transfer function (MTF) and the pixels are oversampled in the image rectification process by a factor of about 1.6 (Deneke and Roebeling, 2010).

Thus the effective area of a pixel is slightly larger than the actual sampling resolution and this makes the features bigger as well.

Line 67: …unbiased with respect to surface properties.
maybe it becomes clearer when: is independent of variations in the surface properties, like spectral albedo. In one sentence, it could be added what is the gain of the development of another cloud detection algorithm, after all the different approaches are well described in the introduction.

Line 68-72:
I would mention here in one sentence the reason for choosing the month November and that the results are validated against a Cloudnet station. It comes in the next paragraph, but this is more an overview of the structure of the paper.

Line 95 and other places:
25km → The unit is often directly behind the value. I think that there should be half a space in between.

Line 101: 719 heights
What is the vertical resolution of the Cloudnet data, how important is the vertical resolution for your study? Or is it just mentioned to introduce Cloudnet in general?

Line 104 ff.
Could you provide some more details how you apply ERA5 data on Meteosat scenes? Do you reproject ERA5 data onto MSG or do you rather use the four criteria to be valid in your whole box around Paris?

Line 115: … most frequent land cover class…
Do you exclude cases, if the land cover class variability is too high? For your 2d maps, taking the most frequent one might be fine, but for your cloud fraction statistics, maybe exclude cases if "most frequent" is less than 50%? But maybe this is not really relevant and just a detail which does not need further attention. (Just thinking on sub grid scale variability like we have when comparing MSGs low resolution channels to 3x3 HRV pixels…)

Line 186:
Fig. 1b) → the bracket can be removed

Line 195:
How would you deal with RECDA, if T_loc max is a very bright artefact? Maybe a snow surface which is not detected by the snow flagging? Would it be maybe better

to have a compromise in between that would be maybe the 95th percentile of T_loc, but still being independent of land surface anomalies?

Line 199: ~~however~~

Line 206:

As mentioned in line 41, maybe take into account the pixel oversampling factor of 1.6?

Line 216: below an altitude of 3 km

What is the reason that you use the target classification only below 3 km?

Line 218: Cloudnet cloud fraction is above 0.9

How is this in relation to line 224 "If more than 1 out of 9 are cloudy the matrix…"? You justify that high threshold for Cloudnet to ensure only cloud persistent cases, but if a 3x3 HRV pixel is cloud contaminated, the low-resolution cloud mask will likely give "cloudy" as well. I am not familiar enough with cloud mask validation against Cloudnet, but intuitively I would consider cloud fractions also above 0.5 as cloud for the scene.

Line 261: from easterly direction

In your ERA5 criteria list, you don't have the wind direction? But I would assume that especially because of the location of Paris and the rivers around, the wind direction plays a significant role as well. Or can this be neglected when using winds below 10 m/s only?

Line 266-274:

This is an interesting analysis of the different cloud fraction anomalies, although not every result is very significant (CF increase over pastures). It would be very interesting to investigate the CF anomalies for land surface changes over years. I made some examples before (deforestation, city expansion, drought). If I get it right, you limit the analysis on the spatial variability, not the temporal. You state that the multi-year period makes the results robust under the assumption that the long-term surface variability is small. I find it very interesting to understand how human made surface modifications impact the cloud occurrence.

Fig. 6: blh and msl

Boundary layer height and mean sea level are mentioned but the acronym is not introduced before

Line 289: The main outcome is that…

This could be something mentioned in the abstract in other words.

Line 319: over and to the west

Better: over the urban area of Paris and west of it.