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Interactive comment on "A simplified method for the detection of convection using high resolution imagery from GOES-16" *by* Yoonjin Lee et al.

Anonymous Referee #1

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Review of "A simplified method for the detection of convection using high resolution imagery from GOES-16", by Yoonjin Lee et al.

The short manuscript tests some new and some not so new ideas for detection of thunderstorms in early and in mature stage in geostationary satellite data and compares it with ground-based radar results. A Gaussian cooling shape detection in water vapour GOES-16 imagery should provide the early stage detection, while a visible channel texture test should provide the mature stage detection. These ideas are not completely new, but in this manuscript they are applied to the new GOES-R data. Resolution of this data in time and space is much higher than that of many other geostationary satellite data. For this reason and because of some new aspects (Gaussian cooling detection) the manuscript is of interest for the community. My suggestion is to publish

the manuscript after major revision of the presentation.

The presentation has to be revised to make clear that not a full method nor a full verification is shown here, but just some experiments on details. Goals and limitations of the presented aspects have to be discussed in a more balanced way.

Major issues:

1. The literature overview is limited. Especially the cloud detection in satellite imagery over the last 20 years is widely ignored although ideas from this earlier work have found their way, at least indirectly, into this manuscript.

2. In some parts, the understanding of the underlying physics has to be discussed in more detail. For the first core concept, the information content of the WV channels 8 and 10, the discussion has to be improved at several places throughout the manuscript. Perhaps this method could even be further simplified by skipping the use of the less sensitive channel 8 data. For another central method, the visible channel texture, its limitations (at least for this manuscript's purpose) have to be evaluated and introduced in more detail.

3. Although the argument of convective precipitation information for data assimilation is touched upon in the beginning and shortly mentioned in the end again, the goal of the manuscript stays unclear. For quite some pages, the text seems to present a new, complete, very simple solution for a thunderstorm detection and early warning task. A task on which the satellite community has been working on for quite some 20 years. Major improvement seems to be reachable, because of the new GOES capabilities. Only when it comes to test cases and systematic verification, the limitations become obvious. This is where the simple solution presented would have to become more complex – as many working detection codes are. These limitations have to be discussed in the light of existing detection and nowcasting methods in literature as well as possible integration of the investigated aspects in such tools.

4. The “statistical results” section is not well presented up to now. Definitions and basis are not given clearly. Some of the statements and numbers seem questionable, in part, because of the limitations of the presentation.

Specifics and Minor:

l.20ff: In the light of the many questions left by the presentation of the statistical evaluation/tuning chapter, the numbers here are not useful. Either present some details of the used definitions and scoring basics or leave them out. I do not understand why there is one set of values for two independent methods (major 4).

l.28: Maybe you want to add something general like Gustafsson et al. 2018 or something very close to your motivation point like Scheck et al. 2020. (major 1)

l.84: The use of geostationary VIS and IR texture signals was introduced in automatic detection already by Zinner et al. 2008 (WV texture, Zinner et al. 2013). Another important tool forming an early reference for the use of IR and WV imagery and time trends in it is the EUMETSAT RDT algorithm (Morel and Senesi, 2002, Autones et al. 2009, Guillou et al 2011, see below). (major 1)

l.112ff: You state that Channel 2 data is “normalized by solar zenith angle”. Please tell us how you do that. This is not a simple or straightforward task. You could normalize reflectivity, but for the texture signal cos(SZA) will not do the trick. The apparent lumpiness increases following a complex dependence on SZA and is strongly dependant on the cloud top structure. (major 2)

l.114f: Are you aware of Mueller et al 2019 “A Novel Approach for the Detection of Developing Thunderstorm Cells”. That should be discussed somewhere. (major 1)

l.141: “GOES-R CI algorithm”. Can you please give a reference?

l.145: Shouldn’t “grids” be “grid cells”. This sounds like lab slang to my non-native English ear.

l.155ff: “. . .updrafts of water vapour. . .”, “. . .GOES-ABI . . . can.” – You seem to formulate a misconception here. You cannot really see the rising water vapor. The signal is not strong enough. In a WV channel, you do see the water vapor background in mid-troposphere. You cannot see low-level dry-convection below condensation level. If you start to see convection cells in this data, it is the cloud body itself you see. Only once the cloud has formed, the emissivity is large enough to dominate the thermal signal in the WV channel. The cloud top “punches through” the background water vapor. Unless the mid-troposhere is very dry, you cannot see what’s going on at lower. Please clarify and adjust the discussion here. (major 2)

l.176: “the difference between two matrices will be small.”. Which two? Please clarify.

l.185: “smaller than -1K/min for channel 10 or -0.5K/min for channel 8”. Why is there a difference? A growing cloud top is cooling at the same rate in both channels. Unless there still is considerable (colder) WV above it. Thus, it first shows up in the channel 10, later in the channel 8. You will increase the sensitivity of channel 8 to match channel 10 detections by lowering the slope threshold. You will earn a lot of uncertainty without adding any additional insight. Once the cloud top reaches the upper mid-troposphere above WV background, they will show exactly the same temperatures and trends. Please discuss, perhaps revise. (major 2)

l.221ff: Once more . . . What about low sun lumpiness? Shadows cast onto the cloud itself might dampen VIS reflectivity below 0.8. Please discuss. (major 2)

L.270: “. . . most of convective regions align well with high reflectivity regions in Fig. 2c. . .”, You should not only talk about false alarms, but also about the POD. You are missing large regions with coldest temperatures and, thus, a quite obvious signal just next to the region you detected along 43 N and 93 W to 94 W! These regions shows up clearly in a cold absolute 11.2 mu data and in 11.2 lumpiness! This is opposed to your above statement on IR lumpiness and is a large area completely missed by your mature storm detection. Please discuss. (major 3) l.281: “Growing clouds. . .” Are these boxes result of your method or did you place them by hand as marker to talk about certain areas. You are talking about the purple and blue boxes next. What about yellow and green? Did you miss them? Please make clear. (major 4)

l.295, Section 4.3, Statistical results: Please start this chapter with a clear definition of the “truth” you compare to, of a hit, miss, false alarm and false positive, all derived skill scores. What is the basic element of your scoring? Is it a grid point, a storm, or a 5x5 window? Please state that for all scores you derive for the early convection as well as the mature convection steps. Right now, this important information is (in part) hidden in the following chapter, but the reader has to guess most of the time. (major 4)

l.298ff: Again, it is still unclear for the reader, why you use both WV channels? Are there any channel 8 detection windows not contained in the channel 10 detected windows already? Please clarify or simplify.

l.303ff: “Future MRMS convective flags up to 30 minutes were included . . .” I do not fully understand. It was your goal to detect convection before the radar, wasn’t it? That means, it is just logical to check the next 15 minutes/30 minutes. You should check the lliterature on MRMS and give us some details here. Using it, you have to discuss the choice of the future time span . . . the longer it is, the better your scores. (major 4)

l.306: Where do you get the “constant speed” from? Please add information.

l.310: What is the “accuracy” you are talking about? You have to introduce it. It seems to be the correct positives. Please clarify in the beginning of the chapter. (major 4)

l.311: “because most of early convection does not have such a strong updraft”. No. It’s because it is detected late. See my comment on the WV channels misconception above. In some situations, convection has to reach a considerable height before it can be detected. This is the reason why Mecikalski, Zinner or Guillou did not just use a WV channel to detect early stages. (major 2)

l.315f: The reasoning here is unclear. What about virga? I would just say, it is the typical turbulent, highly statistical nature of the chances of convective cells. Some just do not do it the moment latter.

l.335: For the reader, in order to be able to understand the impact on data assimilation, you have to give proper references or explain a lot more.

l.333f: “improvements in both FAR and POD (lower FAR and higher POD) when later data are included.” This is not surprising and it is just tuning values. It would improve further, if you would include another 10 minutes, or even -10 minutes. Unless you can tell us a very good reason resulting from the function of the MRMS algorithm, I would suggest not showing the alternative numbers. They are not much different anyway. (major 4)

l.345ff: Checking of just one of the two examples you show, it is obvious how to improve it. In addition, the missed regions there are neither cirrus covered nor in decaying mode. You should accept and talk about shortcomings of your very simple method. There are good reasons out there that full detection and warning schemes are far more complex than your approach. Please discuss that. (major 3)

l.356: Where do these numbers come from? I cannot find them anywhere. They just show up here and in the abstract!?

l.366: Also, the next sentence is unclear. Are you talking about the early convection detection now? For the “early stage” detection, it makes sense to included “+30 min”. For the "mature" detection, this would not be allowed.

Additional literature:

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