Nat. Hazards Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/nhess-2018-357-AC1, 2019

Natural Hazards and Earth System Sciences
Open Access
Discussions

Interactive comment on "The effect of increased resolution of geostationary satellite imageries on predictability of tropical thunderstorms over Southeast Asia" *by* Kwonmin Lee et al.

Kwonmin Lee et al.

kwonm1n@naver.com

Received and published: 4 March 2019

Dear. open reviewer.

Thanks for your comments and sorry for my late reply. Your sincere comments are helpful to revise this paper. The answers to the questions are as follows.

1) L15, page 3. How did you convert and smooth data by the time dimension? Is it the average of four 2 km pixels and 30 min?

Yes, Himawari-8/9 and MTSAT-1R/2 have different resolution-imager. Therefore, we have to do convert data. It is calculated as the average of four 2 km pixels every 30

min. We called this a virtual MTSAT. Four pixels of 2 km were converted into one pixel of 4 km. Also, the time interval was increased from 10 min to 30 min, which is the same as the MTSAT's spatial resolution and time cycle.

2)L26, page 3. Why did you convert brightness temperature to integer?

Brightness temperature at 10.45 μm can be expressed as BT11 for readability. The sentence was modified as follows. "Among 16 bands, brightness temperature at 10.45 μm (hereafter, BT11 for readability) is used for monitoring the vertical growth of clouds."

3)L4, page 4. The definition of lead time is from an initial point to a mature point. The initial point is the moment thunder pixels (BT11 decreases more than 5 K in 10 min) are detected. Since the region is 5âŮę-20âŮęN and 100âŮę-110âŮęE, if the thunderstorm like MCS happens near this area and moves in, this method may not work. It's better to filter out these examples and expand the data to three months (JJA).

Thank you very much for your nice comment. I think we need to think about this in depth. Although many cloud detection technologies have been developed through satellites, it was agreed that improving the satellite's spatial resolution and observation time could have a positive effect, but it was difficult to find a direct quantitative response. The curiosity of this motivated this research. To sum up, this shows that higher spatial and temporal resolutions of satellite observations are more effective for warning people of severe weather from convective clouds over Southeast Asia with the validation using eight clouds, over a small range, during daylight hours. Of course, adding other examples to this paper is good for publicizing the conclusion of the paper. Nevertheless, the conclusion of the paper which suggests the lead time differences due to resolution would be sufficient with cases of night and day since the rapidly developing cloud systems in the tropical region are spatially small and their lifetimes are generally short (< 3 h). I believe that increasing the case will not significantly change the quantitative improvement of early cloud detection, which is the essence of the conclusion.

Since the region is 5°-20°N and 100°-110°E, if the thunderstorm like mesoscale convective system happens near this area and moves in, this method may be useful. But, one thing we should consider is this method is not based on the movement of cloud objects one of the popular methods in mesoscale convective system. If mesoscale convective system could be firstly filtered out from the initial point where BT11 should be over than 270 K, there might be enough problems, such as other developing cloud objects entering the original interested domain. In order to more accurately examine the length of time between the initially detected cumulus and the mature deep convective with heavy rain, validation with precipitation data based on ground observation is further required. Thus, it is premature to assure the lead time for forecasting deep convective clouds over Southeast Asia by this study. In addition, the lead time can differ depending on the region, since the lead time can be affected by various environmental factors such as wind direction and speed, atmospheric profiles, and the characteristics of the geolocation. However, the point that we addressed here is that improved spatial and temporal resolutions of satellites clearly give benefits for enhancing the accuracy of the now-casting forecast.

4)For Figure 2(a), it's better to add longitude and latitude lines. The colorbar looks superfluous at both ends. Maybe you use the colorbar for all examples. But, for the specific one, it's better to set it close to the maximum and minimum of data.

Yes, truly. I'll update it like that. Thank you for telling me a good point!

5)I can't figure out why the lead time of 4 km and 30 min imager is 0 for No. 2. Do you plot the figure of that? Because from 05:00 UTC to 05:40 UTC, many pixels are thunderstorm pixels which should be captured by 4 km and 30 min imager.

*Please look at Fig. 4. (New figure is added for your question.)

As a result, in the cases of the 2 km and 10 min imager, the lead time is from 100 min to 180 min. In contrast, the 4 km and 30 min imager only began to detect cloud pixels up to 30 min before. Of the eight clouds, two made the 30 min prediction, and six clouds

had zero lead time. (Here, a zero lead time means that the 4 km and 30 min imager failed to detect the cloud pixel when the cloud observed at 2 km and 10 min imager reached the mature point.) Figure 4 demonstrates the lead time varies in case of the spatial resolution which is 2 km or 4km and the time interval which is 10 min or 30 min. Each a, b, c shows a change in the minimum value of BT11, that in the average value of BT11 and that in the number of cloud pixels for about 3 hours. The results followed by Figure 4 show the difference of 100 min in lead time when the time interval (10 min) is the same and the spatial resolution (2 km or 4 km) is different, while the difference in lead time depending on time interval (10 min or 30 min) is equal to 30 min when the spatial resolution is equal (4 km). One interesting thing is that the difference in resolution has a greater impact on lead time than on time interval. Especially, as shown in Figure 4c, the spatial resolution has a large impact on the number of cloud pixels. This suggests that the effect of spatial resolution on the observation for early-stage clouds and the near-future cloud development process is very important. At the same time, the impact of improving time intervals cannot be ignored. The reason is the short time cycle, the more precisely the change rate of minimum BT11 is per pixel. For example, only one cloud pixel can be reflected on the area of 16 km in the case of the 4 km resolution imagery; in contrast, four cloud pixels can be reflected on the same area in the case of the 2 km and 10 min imager. In particular, we could not ignore either the influence of the resolution on the boundary of the cloud or the initial stage of cloud growth, when the temperature change is rapid. As the time interval gets shorter, it is possible to observe the movement of the cloud in real time, and this helps the accurate prediction as well as the accumulation of data. In particular, the 4 km and 30 min imager cannot detect initial clouds whose scale is between 2 km and 4 km, so it is difficult to track the whole development process of thunderstorms. Therefore, the prediction of initial clouds through Himawari-8 shows the possibility of detection about two hours earlier than the MTSAT-1R.

6)Some reference format looks wrong: L22, page 3: (Schmit et al., 205). L15, page 4: (Houze, 204).

Yes, these are my mistakes. Schmit et al., 2005 & Houze, 2004 are right.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2018-357, 2018.

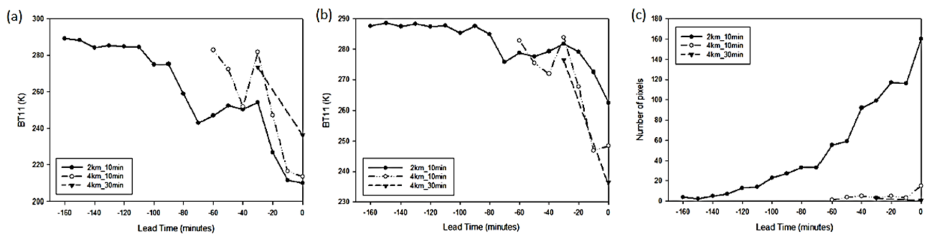

Figure 4. Results of detected cloud pixels based on spatial resolution and observation time cycle; (a) Minimum BT11, (b) Mean BT11 and (c) Number of pixels

Fig. 1.