ANALYSIS OF ATMOSPHERIC CONDITION ON HAIL EVENT AT PELALAWAN (CASE STUDY: SEPTEMBER 23RD, 2019)

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ABSTRACT

In Pulau Muda Village, hail occurred on September 23rd, 2019 when the entire Riau area was covered by smoke due to forest and land fires phenomenon. The hail was not accompanied by extreme rain and did not cause material harm. However, a study of atmospheric conditions before, during, and after hail occurred is needed to reference for the early warning of future events. The identification of hail cloud stage used the C-Band Radar Reflecticity, Himawari-8 Satellite, and Rain Gauge data. Model data processed by GrADS are used to support the analysis of meteorological parameter. The surface condition are the opposite to the previous study that the surface air temperature increases 2ºC and RH decreased 10% from h-1 caused by dry air of the smoke phenomenon. The hail occurred from one single cell CB cloud that developed within 30 minutes reaching the mature stage with its maximum reflectivity core was 65 dBZ and cloud top temperature decreased to -75ºC at 06.00 UTC. The convective activity with maximum updraft -1.9 $Pa.s^{-1}$developed the cloud as the CAPE index increased from 150 to 700 $J.kg^{-1}$ from 05.00 to 06.00 UTC. The decrease of specific ice water content with maximum downdraft 0,2 $Pa.s^{-1}$ from 06.00 - 07.00 UTC evidenced that the cloud ice layer produced the hail at the mature to dissipation stage of the cloud. Further study is needed by providing chemistry model data in order to understand more about hail in tropics especially in this unique situation that is among the smoke phenomenon.
Keywords: Hail, Atmosphere Condition, Radar, Himawari-8, ERA5

1. Introduction

Hail is an extreme weather event in the form of precipitation of ice pellets called hailstones that can occur in environments with relatively low freezing levels [1] when a thick convective cloud called cumulonimbus (CB) has a strong updraft, whereas an intense hail can have 10-50 ms^{-1}[2]. Hail can be accompanied by extreme rain and significant material loss if the hailstone diameter is more than 2 cm. In general, freezing level in tropics tend to be higher than in extra-tropical areas where hail is common [3], so generally, hail occurs in high elevations tropic areas. Uniquely, the deep convection which forms graupel and small hail in the tropics causes the signal to be similar with typically large hail in the subtropics [19].

There are three types of the cumulonimbus cloud, which have the potential to produce hail, that is a single cell, multicell, and supercell. For single-cell cloud, after developing, the cloud will mature in 15-30 minutes, and then it will enter the dissipation stage [1]. Airflow inside the cloud will be dominated by updraft during the development stage, while during the mature stage it consists of updrafts and downdrafts, and it is dominated by downdrafts during the dissipation stage. The downdraft in the mature and dissipation stage indicates the precipitation. [4].

A study of atmosphere conditions several hours before, during, and after hail is needed to be used as a reference for early warning of future events [5], as well as the study on the characteristics of the atmospheric condition of hail event. Research on hail analysis has been carried out in several regions of Indonesia by utilizing Himawari-8 satellite, radar, and atmospheric conditions data. Case study in Bandung prove that there had been 4 ºC surface air temperature decrease and 10% to 20% surface air relative humidity increase at h-1 before the hail event [6]. The best data source for hail analysis is weather satellites, where Himawari-8 satellite RGB images are used to analyze CB cloud and the time series graphs of cloud top temperature are useful to predict the timing of hail events [7]. Study proves that the hail cloud temperature reaches < 70 ºC in Jakarta [10] and < 75 ºC [5] in Cianjur and < 80 ºC in Surabaya [7]. Hail cloud is a very cold CB cloud because there is a significant cloud top temperature decrease during hail, which is seen by IR1 (B13) time series [5,7,10]. The cloud top temperature decrease indicates the cloud rapid growth supported by the strong updrafts [2], which can be interpreted by the Day Microphysics Technique images. The hail cloud consists of ice particles inside, which can be interpreted by the Day Convective Storm Technique images [8]. Because hail is one of the high variability events in time and space, radar data is very useful to capture the hail where ground weather stations can't always accurately do it [9,8]. Hail indicates high radar reflectivity, which is associated with precipitation volume in the atmosphere [8]. Study in Jakarta proved that by using reflectivity CMAX (Column Maximum) and VCUT (Vertical Cut) product, the rapid growth of the cloud is observed that the hail cloud is getting mature within 10 minutes [7,10] with the maximum reflectivity measured by radar reached 60 dBZ [10].

Several previous studies have presented analysis of the hail occurrence in different region of Indonesia, but study in Riau had not conducted yet. There were reports from society accepted by the Indonesian Agency for Meteorological, Climatological and Geophysics (BMKG), which occurred on September 23rd, 2019 on 13.00 Local Time (06.00 UTC), in Pulau Muda Village, Pelalawan, Riau Province [17]. The hail that occurred in this coastal area was not accompanied by extreme rain and did not cause material harm to the area's citizens due to the small size of the hailstones. However, the hail occurred when the Riau area was covered with smog due to forest and land fires. Therefore, the purpose of this research is to be one of references for future hail nowcasting in Riau and also to see the atmospheric conditions during hail on the smoke phenomenon on September 23rd, 2019 using Himawari-8 satellite, radar, and also observation data of ground and atmosphere weather parameter in the Riau area, which is focused on Pulau Muda Village, Pelalawan Regency.

2. Data and Methods

The location of study area is Pulau Muda Village, Pelalawan Regency, Riau Province, with coordinates between as seen in Figure 1. The research procedure is:

1) Raw data from EEC Radar in (Volume Coverage Pattern) VCP21 and has 10 minutes of time resolution which installed at Pekanbaru (0,456° N 101,464° E) obtained from the Weather Radar Center of BMKG formatted .vol. Rainbow V5.9 Application is used to get the image of reflectivity CMAX product to see the maximum reflectivity measured in a vertical coloumn [11] for hail precipitation indication and also reflectivity VCUT (Vertical Cut) product to analyze the atmosphere condition within the hail cloud [10, 11]. Hail returns reflectivity signal that looks like extremely heavy rainfall. When it reaches 60 dBZ, hail is likely to be present [18].
2) Himawari-8 satellite data with 10 minutes timescale resolution and up to 1 km spatial resolution which has 16 observation channels (4 visible (VIS) channels and 12 infrared (IR) channels) [12] obtained from BMKG produced by

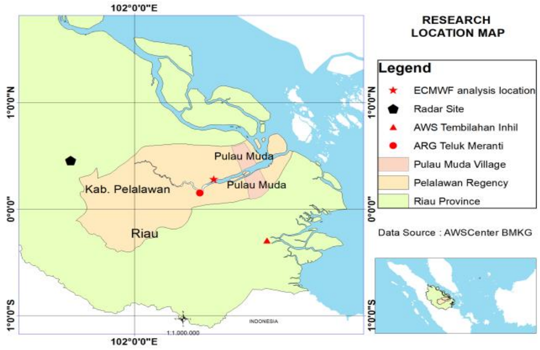


Figure 1. Location of study area, radar site, the nearest AWS and ARG. Source: Indonesian Agency of Geospatial Information (BIG)

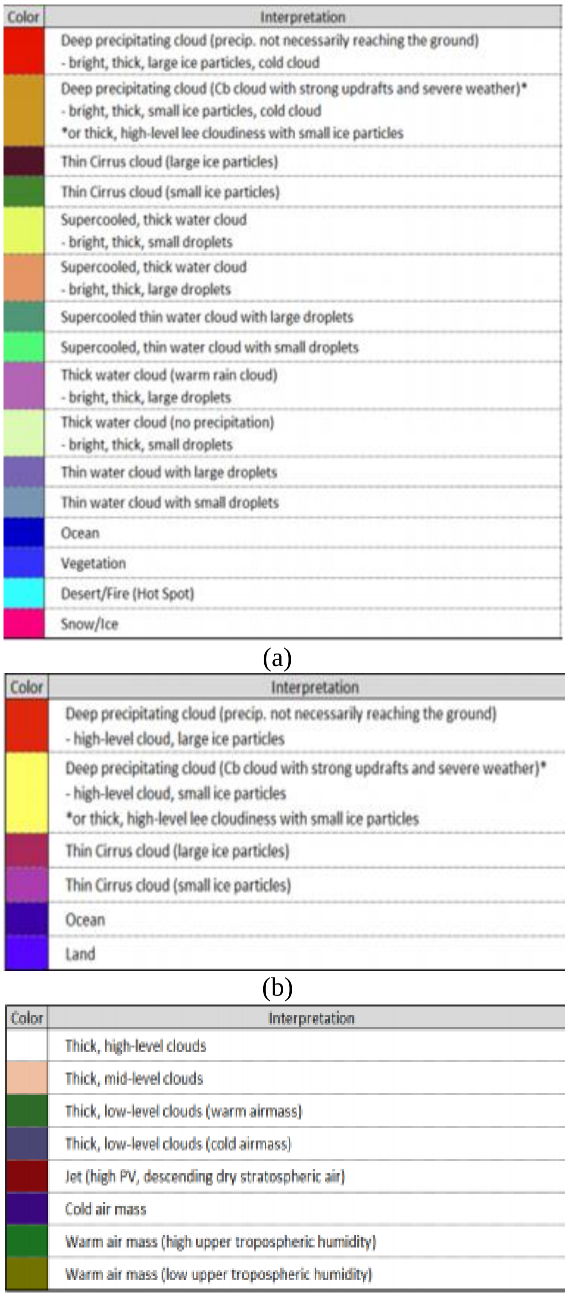
Japan Meteorological Agency and processed by SATAID. Infrared chanels represent the brightness temperature of up-welling radiances at the top of the atmosphere or can be called Black Body Temperature (T_{BB}) [12] where the blue beam of B13 chanel of Himawari 8 Satellite provides information on surface and cloud top teperatures [13]. Channel IR1 (Band 13) data, was used to display cloud top temperature time-series graph every 10 minutes [7]. IR1 data is also visualised using GrADS application to show the cloud top temperature images and hovmöller [20] in order to evidence hail cloud stage. The significant decrease of cloud top temperature indicates the development stage while its increase indicates the mature stage until the dissipation stage in the cumulonimbus cloud [5,6]. Channels B01-B16 is used to display hourly RGB images of hail cloud [8] from 04.00 UTC to 09.00 UTC. RGB technique is a method by displaying colors using three primary colors properties of light (red, green, blue), so that the image can detect different objects or atmospheric phenomena according to the channel ability based on its adjustment to the threshold. There are 10 types of RGB techniques commonly used [13]. In this research, Day Microphysics, Day Convective Storms, and Airmass techniques were used. The Day Microphysics technique is the RGB technique for detailed cloud particle detection [9] associated with the structure of CB cloud, which produces hail. The Day Convective Storms technique is an RGB technique for the detection of convective clouds with strong updrafts [12] associated with the atmosphere condition within the CB cloud, which produces hail. And the Airmass technique is one of the RGB techniques used for air mass analysis and descending dry atmospheric air [13] associated with the atmospheric moisture condition, which produces hail. The images of the three techniques mentioned above are interpreted with conditions as seen in Figure 2.

3) Hourly rainfall data from the nearest automatic rain gauge (ARG), which is Teluk Meranti ARG (0.149°N and 102.56°E), obtained by BMKG AWS center converted into a graph to assess the precipitation time. Rainfall determines that there are downdrafts inside the cloud's cell, which indicates the mature and dissipation stage of the CB cloud [4,11]. Because the nearest AWS, Tembilahan Indragiri Hilir AWS, is far from the hail location, which is located at 0.297°S and 103.1°E so ECMWF data was used to support the analysis of meteorological parameter.
4) ECMWF ERA5 Reanalysis Data of hourly single-level data at 00.00 LT to 23.00 LT that are the surface temperature (°C); RH (%); pressure (hPa); and CAPE index ($J.kg^{-1}$ accessed via https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-pressure-levels?tab=form with 0.25° x 0.25° resolution and the hourly vertical profile data from 1000 hPa to 1 hPa that are divergence (s^{-1}); vertical velocity (Pas^{-1}); and Specific Cloud Ice Water Content ($mgkg^{-1}$) in 0.25° x 0.25° spatial resolution accessed via https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-pressure-levels?tab=overview. Those model data are visualized using the GrADS.

Analysis of hail extreme weather events can be done by analyzing the time series graph to see the patterns of the time when hail occurs and it doesn't. On a day condition with significant weather phenomena such as extreme weather, hourly time series of surface temperature, relative humidity (RH), and air pressure will have different patterns than days without significant weather [14]. Surface relative humidity obtained by the Eq. (1) [15]:

$$RH = 100 - 5(T-Td) \quad (1)$$

Table 1 shows the CAPE index corresponding to atmosphere stability. The cloud's updrafts and downdrafts can be analyzed using a vertical velocity profile in $Pa.s^{-1}$. The negative value of vertical velocity indicates updraft while the positive value indicates downdraft [6]. In general, vertical velocity in lower troposphere of 100hPa per 24 hours or 0.118 $Pa.s^{-1}$ is equal to 0.01 $m.s^{-1}$ [15]. Vertical velocity is strongest in the middle troposphere, where divergence changes sign and is lowest in the lower troposphere [15]. The divergence (s^{-1}) is used to analyze the air masses concentration, where positive value indicates diffuse air masses movement. In contrast, negative value indicates concentrated air masses movement. Specific Cloud Ice Water Content Parameters are used to analyze ice particles mass per kilogram of humid air mass in the atmosphere ($mg.kg^{-1}$)[14]. The research flow chart is shown in Figure 3.



Color	Interpretation
	Deep precipitating cloud (precip. not necessarily reaching the ground) - bright, thick, large ice particles, cold cloud
	Deep precipitating cloud (Cb cloud with strong updrafts and severe weather)* - bright, thick, small ice particles, cold cloud *or thick, high-level lee cloudiness with small ice particles
	Thin Cirrus cloud (large ice particles)
	Thin Cirrus cloud (small ice particles)
	Supercooled, thick water cloud - bright, thick, small droplets
	Supercooled, thick water cloud - bright, thick, large droplets
	Supercooled thin water cloud with large droplets
	Supercooled, thin water cloud with small droplets
	Thick water cloud (warm rain cloud) - bright, thick, large droplets
	Thick water cloud (no precipitation) - bright, thick, small droplets
	Thin water cloud with large droplets
	Thin water cloud with small droplets
	Ocean
	Vegetation
	Desert/Fire (Hot Spot)
	Snow/Ice

(a)

Color	Interpretation
	Deep precipitating cloud (precip. not necessarily reaching the ground) - high-level cloud, large ice particles
	Deep precipitating cloud (Cb cloud with strong updrafts and severe weather)* - high-level cloud, small ice particles *or thick, high-level lee cloudiness with small ice particles
	Thin Cirrus cloud (large ice particles)
	Thin Cirrus cloud (small ice particles)
	Ocean
	Land

(b)

Color	Interpretation
	Thick, high-level clouds
	Thick, mid-level clouds
	Thick, low-level clouds (warm airmass)
	Thick, low-level clouds (cold airmass)
	Jet (high PV, descending dry stratospheric air)
	Cold air mass
	Warm air mass (high upper tropospheric humidity)
	Warm air mass (low upper tropospheric humidity)

(c)

Figure 2. Interpretation of (a) the Day Microphysics technique, (b) the Day Convective Storms technique, and (c) the Airmass technique [13].

Table 1. CAPE index [16]

CAPE ($J.kg^{-1}$)	Stability
0	Stable
0-1000	Slight, Unstable
1000-2500	Moderate, Unstable
2500-3500	Unstable

3. Result and Discussion

Hail Cloud Stage Identification. The identification of hail phenomenon is obtained from C-Band Radar reflectivity data and Himawari 8 satellite data [5,7,9,10], and the rain gauge data.

Figure 4 shows the maximum reflectivity (CMAX product). Figure 5 shows the cloud top temperature of the IR1 images. Figure 6 shows the RGB satellite images. Figure 7 show the hovmoller diagram of the cloud top temperature at 0.28 N and 102.3 E - 103.3 E. Figure 8 shows the VCUT product. Figure 9 shows (a) cloud top temperature of the IR1 data and (b) timeseries of the recorded rainfall in ARG Teluk Meranti. Figure 10 shows the graphs of (a) surface air temperature, (b) surface air relative humidity, and (c) surface air pressure.

From 04.00 UTC to 06.00 UTC in Pulau Muda area, the reflectivity value in the CMAX product was increasing (Fig. 4.a, b, c).

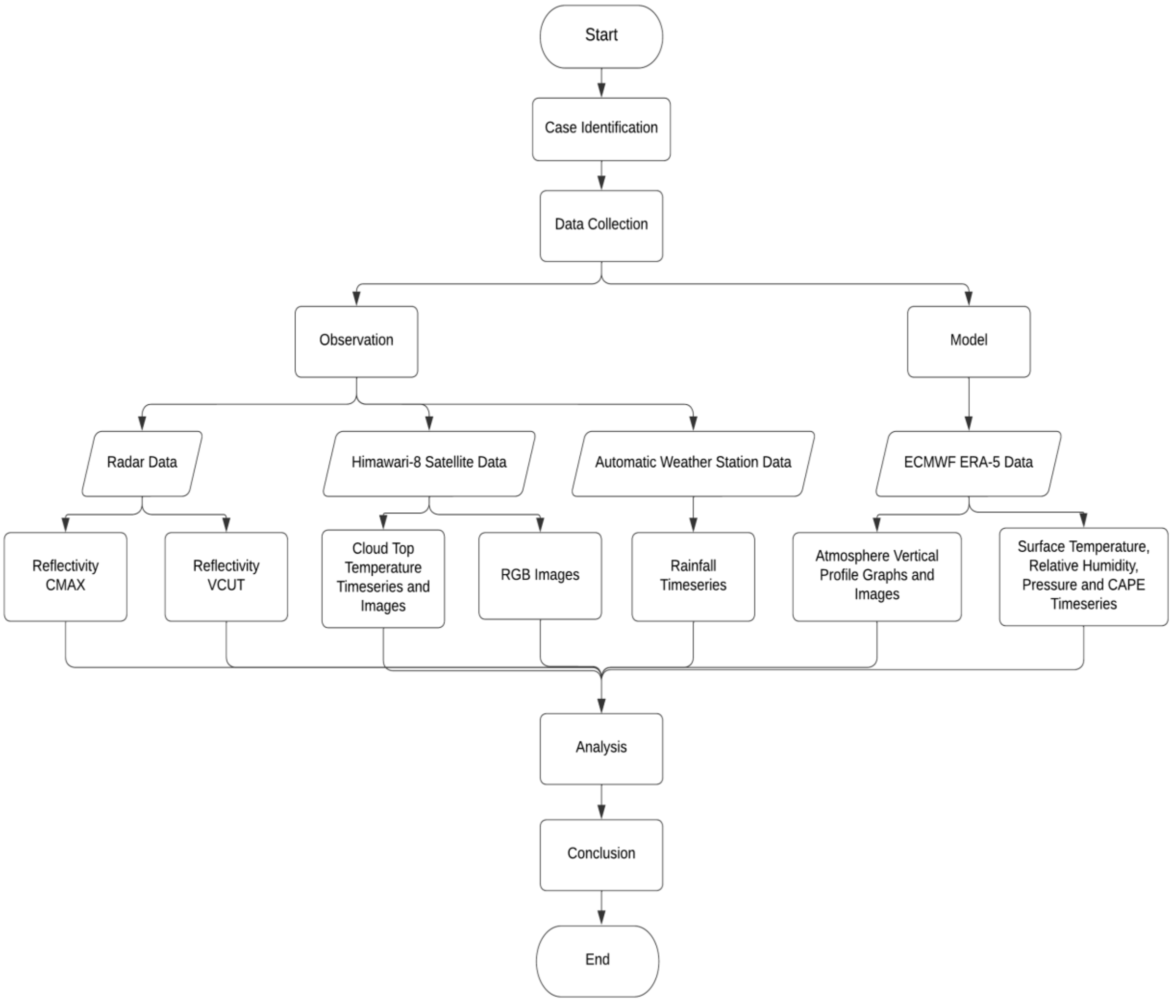


Figure 3. Research Flowchart.

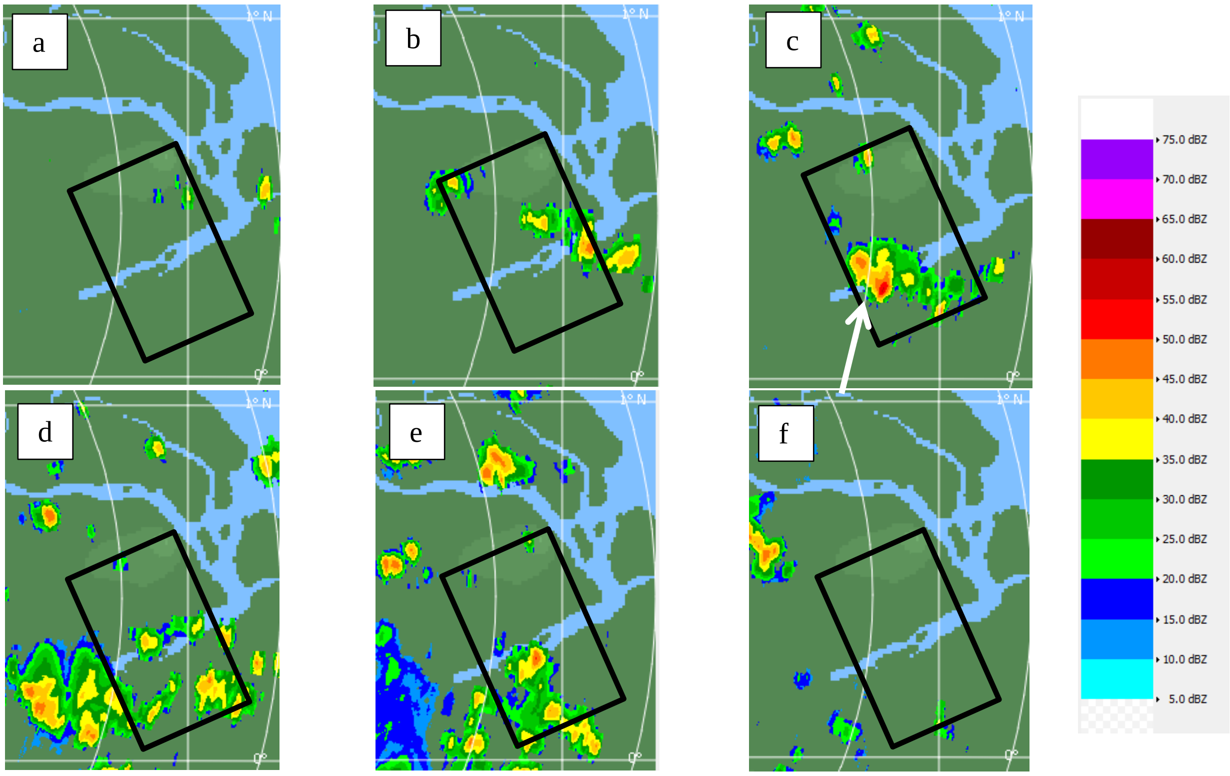


Figure 4. MAX product at (a) 04.05 UTC, (b) 05.08 UTC, (c) 06.02 UTC, (d) 07.04 UTC, (e) 07.58 UTC, and (f) 09.02 UTC where Pulau Muda Village area is denoted by black box.

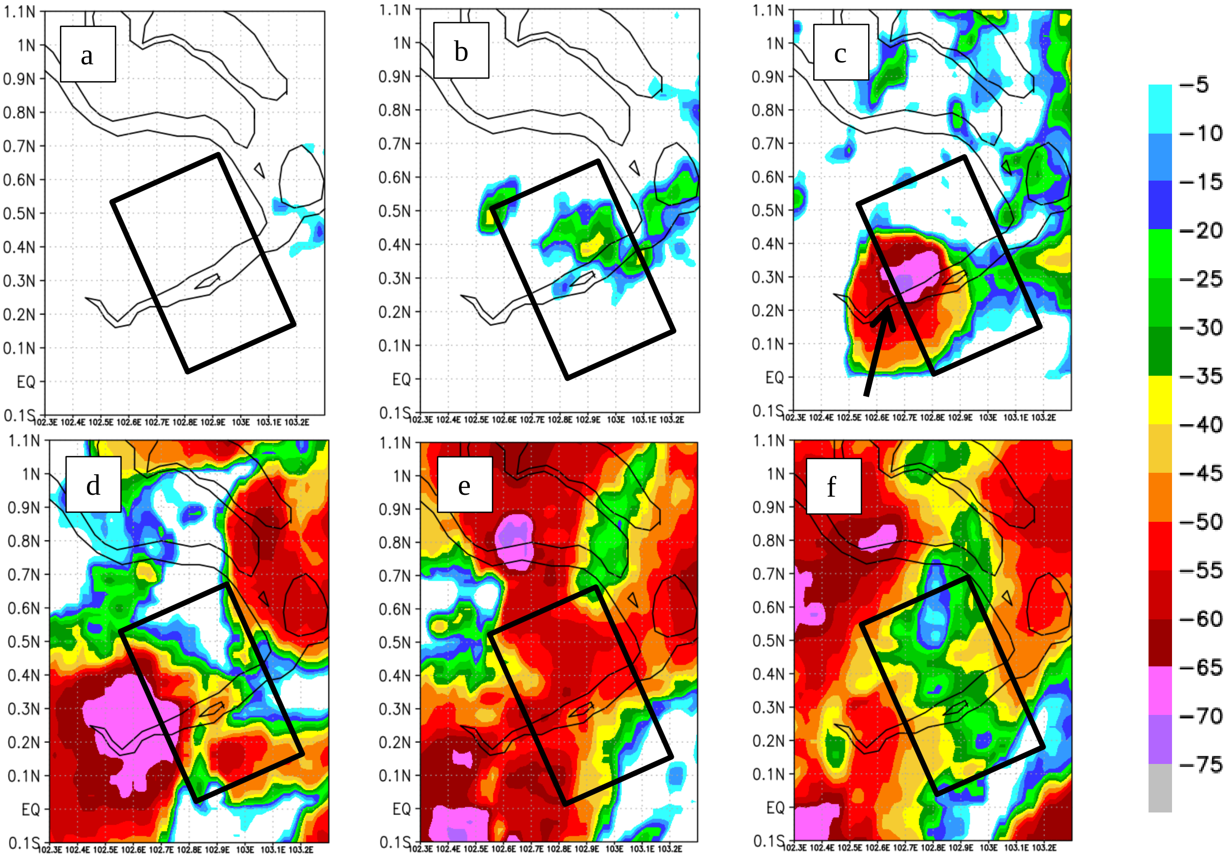


Figure 5. Cloud top temperature in ^{O}C at (a) 04.00 UTC, (b) 05.00 UTC, (c) 06.00 UTC, (d) 07.00 UTC, (e) 08.00 UTC, and (f) 09.00 UTC where Pulau Muda Village area is denoted by black box.

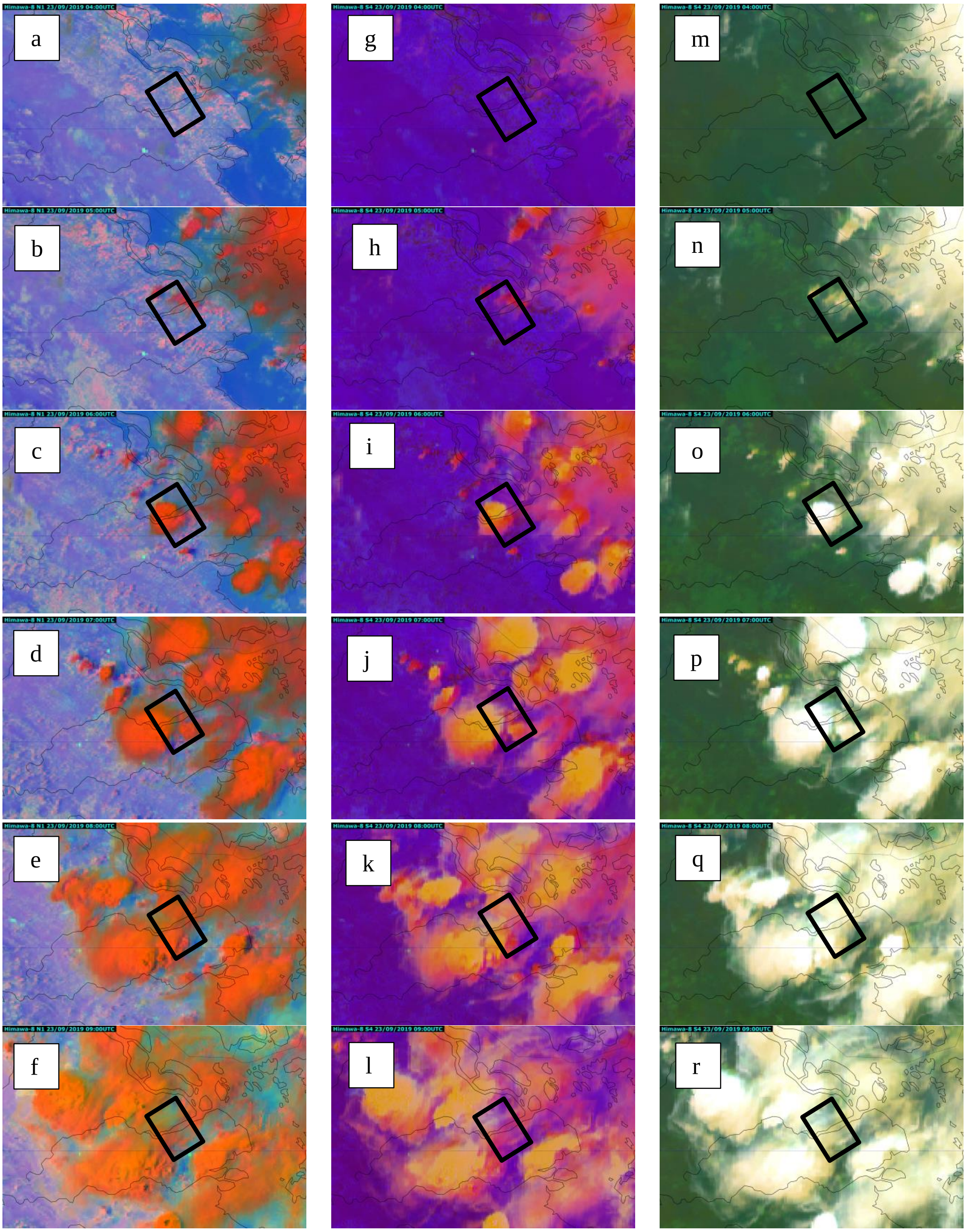


Figure 6. **RGB day microphysics technique images at (a) 04.00 UTC (b) 05.00 UTC (c) 06.00 UTC (d) 07.00 UTC (e) 08.00 UTC (f) 09.00 UTC, RGB day convective storm technique images on September 23rd 2019 (g) 04.00 UTC (h) 05.00 UTC (i) 06.00 UTC (j) 07.00 UTC (k) 08.00 UTC (l) 09.00 UTC and RGB airmass technique images on September 23rd 2019 at (m) 04.00 UTC (n) 05.00 UTC (o) 06.00 UTC (p) 07.00 UTC (q) 08.00 UTC (r) 09.00 UTC on September 23rd 2019 where Pulau Muda Village area is denoted by a black box.**

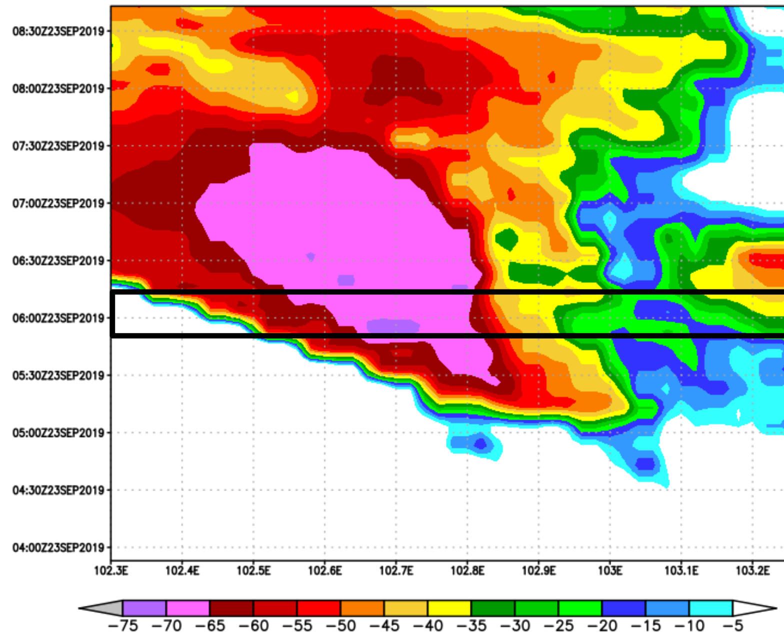


Figure 7. **Hovmöller diagram of cloud top temperature in ^{O}C at 0.28 N and 102.3 E - 103.3 E from 04.00 to 09.00 UTC, the black box shows the time of the hail occurence.**

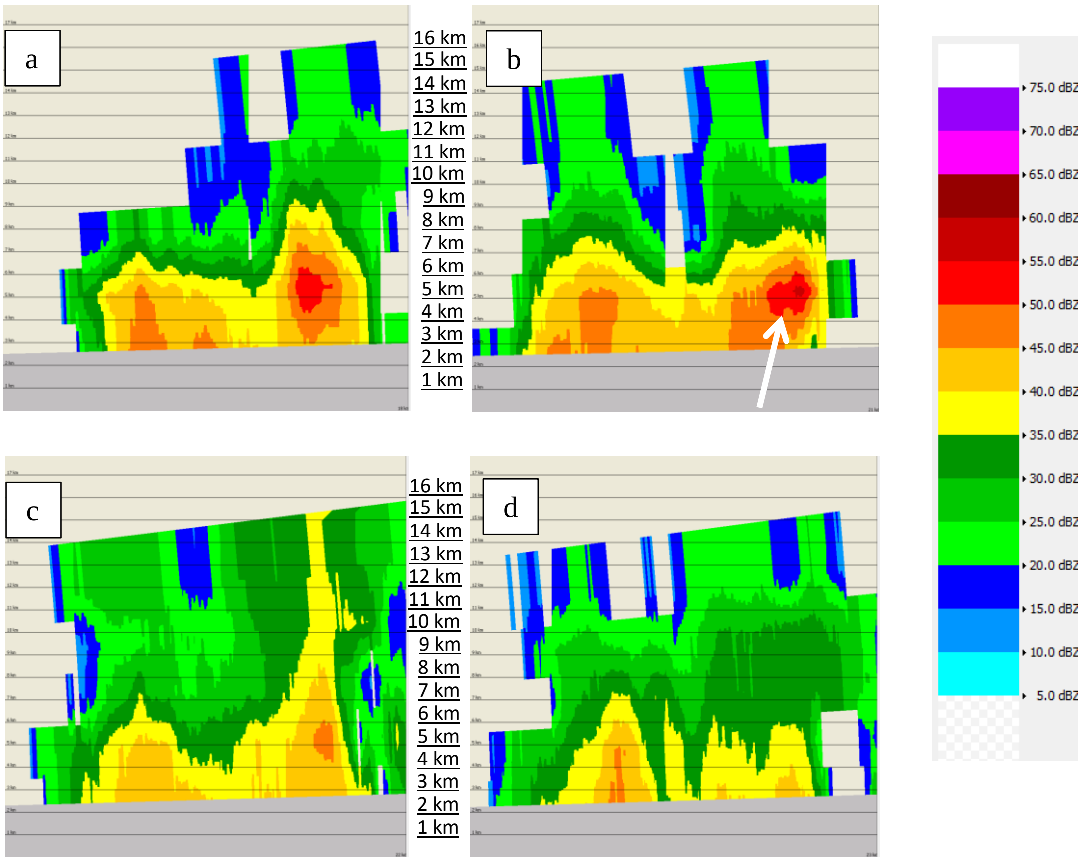


Figure 8. **VCUT product at (a) 05.53 UTC, (b) 06.02 UTC, (c) 06.10 UTC, (d) 06.19 UTC.**

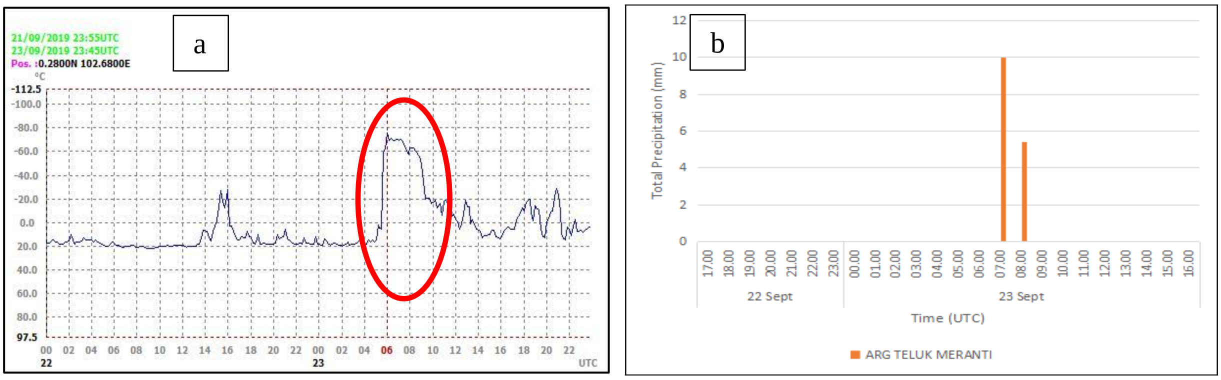


Figure 9. (a) Timeseries of cloud top temperature on September 22nd-23rd 2019 and (b) timeries rainfall graph at 17.00 UTC on September 22nd 2019 - 16.00 UTC on September 23rd 2019 or 00.00-23.00 LT on September 23rd 2019.

In the other side, the cloud top temperature was continiously decreasing as seen in Figure 5 (a,b,c). RGB images in figure 6 also show that the (a,b,c) red color, (g,h,i) yellowish-orange color, and (m,n,o) olive color are getting bolder. The steeply decrease of cloud top temperature in timeseries graph (Figure 9.a) which also can be indicated by the tight color differences in hovmöller diagram at 05.30 to 06.00 UTC in Figure 7 indicates the cloud development in Pulau Muda area.

To see inside the cloud further, the VCUT product is obtained. It captures the cloud top, which was reaching 16 km height, but the reflectivity value from surface to 2 km is not captured due to the far distance of hail location from the radar site (the distance is 120 km). The cloud vertical slice shows that by strong updraft, the cloud reached the mature stage within 10 minutes [7,10] from 05.50 to 06.00 UTC where the reflectivity at 5 km reached to 65 dBZ. At 06.00 UTC, cloud top temperature reached -75°C (Figure 5. c) and the colour in RGB images become very bold (Fig. 6.c, i, o). This indicates that there was a thick cloud containing solid particles and ice, which caused hail [8,10].

In the next 20 minutes, at 06.10 UTC and 06.20 UTC (Fig. 8.c, d), the reflectivity value decreased to 50 dBZ and later to 40 dBZ where the high reflectivity area fell down which indicates precipitation supported by the downdraft [7] at the end of the cloud mature stage. From 07.00 to 09.00 UTC, the reflectivity value decreased (Fig. 4.d, e, f) while the cloud top temperature increased (Fig. 5.d, e, f) and the colour in RGB images are getting faded (Figure 6 d, e, f, j, k, l, p, q, r). It shows the dissipation stage of the cloud.

As shown in figure 9 (b) the recorded rainfall in ARG Teluk Meranti at 07.00 UTC and 08.00 UTC were each 10 mm and 5,4 mm. This indicates that the rain intensity at 06.00 - 07.00 UTC and 07.00 - 08.00 UTC were each 10 mm and 5.4 mm where rain occurred from the CB mature to dissipation stage.
Figures 1,4,5,6,7,8 and 9 show that hail occurred from one single cell CB cloud that needs 30 minutes for the mature stage [1] and it was only the Teluk Meranti ARG that was affected by rainfall due to CB cloud that produced hail on the Pulau Muda area. Therefore, surface weather that will be used to support the analysis of the meteorological parameter with the model atmosphere condition data were not taken from Tembilahan Inhil AWS, but from ECMWF reanalysis data.

Meteorological Parameter Analysis. The location used for ECMWF data is located at the Pulau Muda Village at 0.28 N 120.68E, which refers to the point location of the cloud top temperatures time series. Based on hail cloud stage identification, the period for atmosphere vertical profile (Fig. 12 and Fig.13) analysis using GrADS is 05.00 - 07.00 UTC, to see the atmosphere vertical profile h-1 to h+1 of hail occurrence.

Figure 10 shows that surface air pressure pattern on September 22nd,2019 is not significantly different from September 23rd 2019 and also (Fig. 12.a) there was no change in the 0° C point (freezing level) where it remained at the 600-500 hPa altitude. However, there are a difference of the CAPE index 5 hours before the hail occurrence that the CAPE index was 1350 (moderate unstable [16]) on September 23rd and 900 on the day before (slightly unstable [16]).

Intense updraft is favorable to support CB cloud development reaching the tropopause, that the tropopause exist between 70 hPa (≈18 km) and 400 hPa (≈6 km) [21]. There is intense updraft from the warm air mass at the bottom of troposphere which denoted by the olive color in RGB images (Fig. 6n) that support the hail cloud development to the mature stage. It is synergize by the +3° C increase of the surface temperature and 20% decrease of the surface RH within one hour [6] from 05.00 UTC to 06.00 UTC (Fig. 10.a, b).

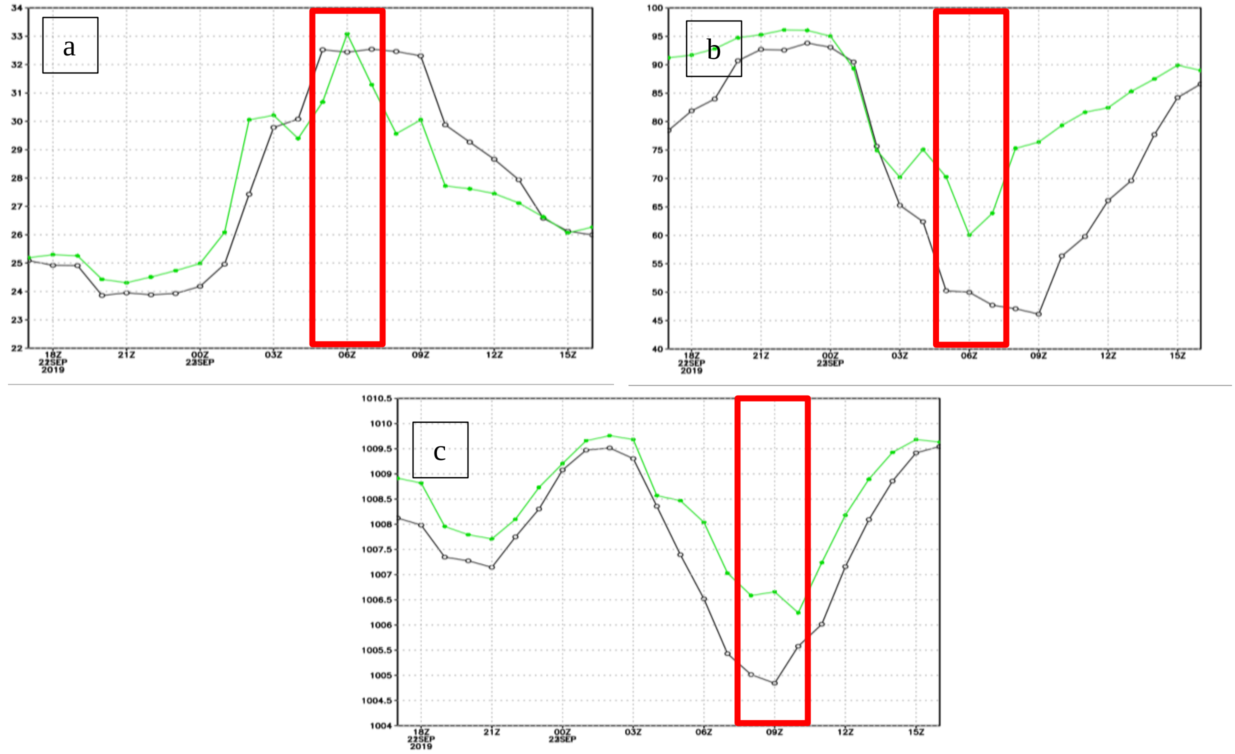


Figure 10. Graphs of (a) surface air temperature (b) surface air relative humidity (c) surface air pressure on September 22nd 2019 (black line) and September 23rd 2019 (green line) at 00.00-23.00 LT, the red box denotes 05.00-07.00 UTC period.

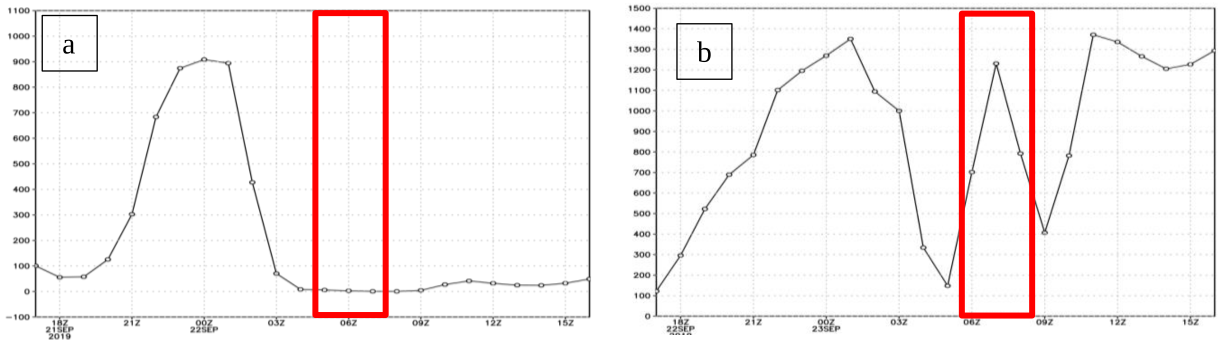
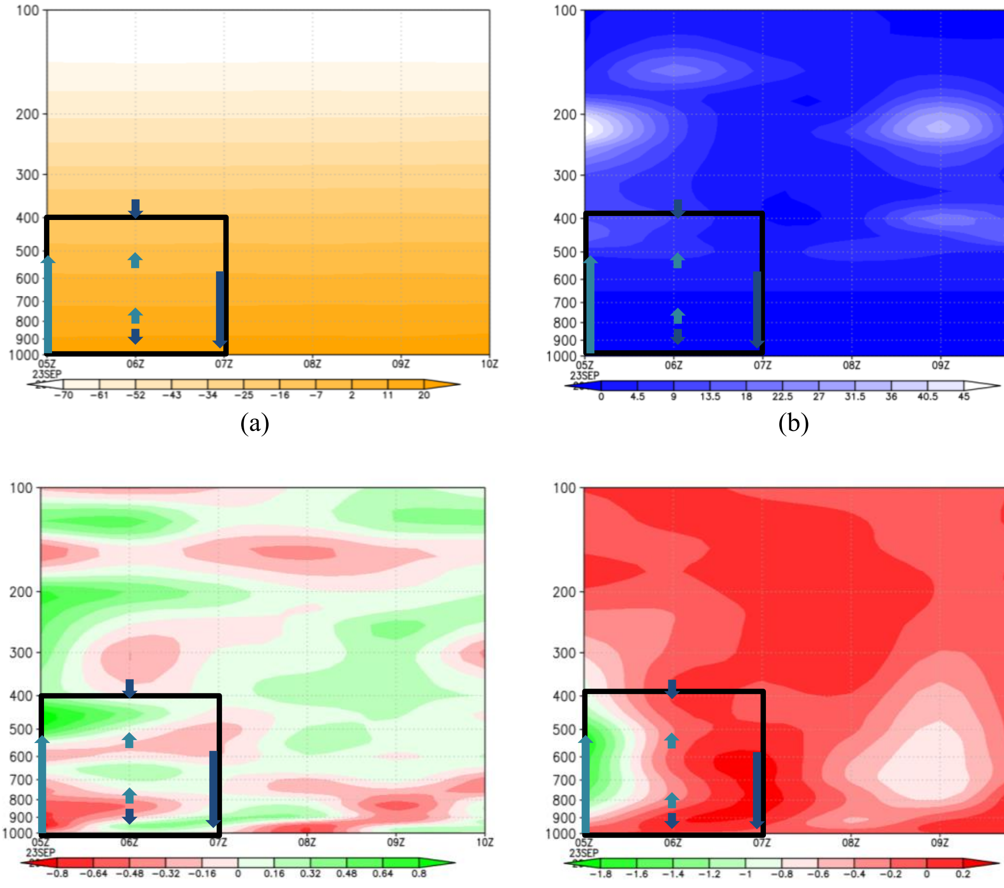


Figure 11. CAPE Index on (a) September 22nd 2019 and (b) September 23rd 2019 at 00.00-23.00 LT, the red box denotes 05.00-07.00 UTC period.

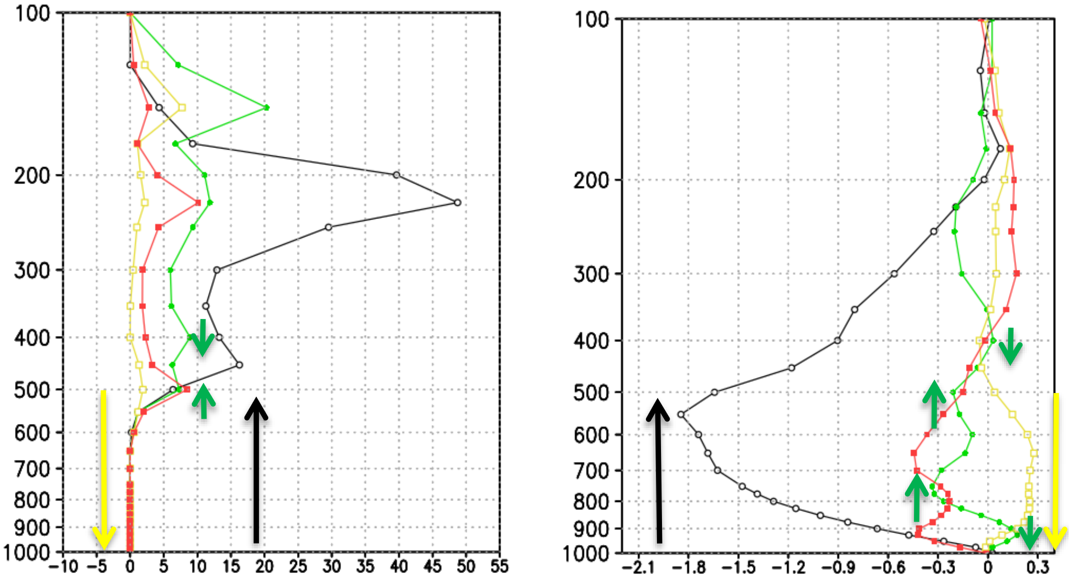
The updraft was pushed by the convective energy that the CAPE value at 05.00 to 06.00 UTC increased from 150 $J.kg^{-1}$ to 700 $J.kg^{-1}$ (slightly unstable [16]) (Figure 11.b). The updraft existence is corresponding to the upper-level divergence with lower-level convergence and its vertical velocity value [4,15]. At 05.00 UTC, the 450 hPa level divergence reached 0.8 x 10^{-5} s^{-1} while there is surface convergence that is indicated by the negative divergence value reached -0.8 x 10^{-5} s^{-1}. The updraft from surface to 550 hPa level support the cloud to grow up to the low lower tropopause forming an anvil shape on the top [15] with the 550 hPa vertical velocity reached -1.9 Pa^{-1} (20.2 $cm.s^{-1}$). The cloud development resulted in the higher value of specific ice water content that is 45 $mg.kg^{-1}$ at 450 hPa level (Fig. 12 and Fig.13).

In the hail cloud mature stage, at 06.00 UTC, RGB images show that the cloud was in the form of thick medium clouds (Fig. 6.o) and a few thick high clouds with large particles of ice (Fig. 6.c) and intense updrafts which produced intense precipitation (Fig. 6.i). Mature cloud consists of the updraft and also downdraft [4]. From Figure 12 and 13, it is seen that the downdraft was formed at 400 hPa that reached 0.05 Pa^{-1} (0.503 $cm.s^{-1}$) and also from 925 hPa level to the surface that reached 0.2 Pa^{-1} (2.12 $cm.s^{-1}$). The downdraft is supported by the positive divergence that reached 0.8 x 10^{-5} s^{-1} at the surface and at the 400 hPa. The downdraft triggers the hail precipitation so that the specific cloud ice content value decreased at 06.00 UTC.



(a) (b) (c) (d)

Figure 12. **Atmosphere vertical timeseries profile (a) Temperature in °C, (b) specific cloud ice water content in mg.kg^{-1} , (c) divergence in 10^{-5} s^{-1}, and (d) vertical velocity in Pa^{-1} on September 23rd 2019 05.00-10.00 UTC, the black box denotes 05.00-07.00 UTC period, the blue arrow denotes the air vertical movement.**



(a) (b)

Figure 13. **Atmosphere vertical graph profile (a) specific cloud ice water content in mg.kg^{-1} and (b) vertical velocity in Pa^{-1} at 23rd September 2019 05.00 UTC (black line), 06.00 UTC (green line), 07.00 UTC (yellow line) and 08.00 UTC (red line), the blue arrow denotes the air vertical movement.**

The ice content amount was minimal that almost near 0 $mg.kg^{-1}$ at all level at 07.00 UTC (Fig.13a) which indicated that the cloud is already dissipated in the form of liquid with very tiny ice left. At 07.00 to 09.00 UTC, RGB images show the faded red color (Fig. 6.d, e, f); also the yellowish color which (Fig 6.j, k) became purple at 09.00 UTC (Fig. 6.l); and white color which (Fig. 6.p, q) became primarily tan (Fig. 6.r) in the Pulau Muda Village. It indicated that the CB dissipation stage left thin cirrus cloud (Fig. 6.l) and medium-low cloud with warm air masses (Fig. 6.r) as a residue from the CB cloud dissipation. The remaining medium-low cloud released the downdraft which has the maximum value at 650 hPa level of 0.3 $Pa.s^{-1}$ (3.2 $cm.s^{-1}$) that spread to the surface at 07.00 UTC (Fig. 12 and 13). The downdraft releases the water from the dissipation into precipitaion which the rain gauge track at 08.00 UTC (Fig. 9.a). The precipitation induced the air being colder and wet that the hourly surface temperature decreased while the surface RH increased from 07.00 UTC to the end of the day (Fig. 11.a, b) [15,16].

This evidences that the hail occurrence in Pulau Muda Village came from the cloud ice layer, which there was a decrease of specific ice water content from 06.00 - 07.00 UTC at 500 to 175 hPa. In figure 14(b), it can be seen that at 07.00 UTC (yellow line), the downdraft was at all levels, which indicates the final stage of the cloud dissipation.

4. Conclusion

Hail is not a rare phenomenon in Indonesia but not hail within smoke phenomenon as it occurs in Pulau Muda Village, Pelalawan, on September 23rd 2019 so that this research was conducted to study its atmosphere condition. This study provides comprehensive analysis from Radar and Himawari-8 satellite images combined with Rain Gauge and ECMWF ERA5 data that are an associative combination to capture the hail phenomenon. One single CB cell had developed since 05.30 UTC with maximum updraft -1.9 $Pa.s^{-1}$ or 20.2 $cm.s^{-1}$ that induced by the favourable condition of the CAPE index increase from 150 to 700 $J.kg^{-1}$ from 05.00 to 06.00 UTC. It matured at 06.00-06.20 UTC with maximum downdraft 0,2 $Pa.s^{-1}$ or 2.12 $cm.s^{-1}$ and the CAPE index that was still increasing to 1350 at 07.00 UTC. The dissipation stage started since 06.30 UTC leaving thin cirrus and medium-low clouds as the residue. The hail occurred at mature to dissipation stage of the cloud that its maximum reflectivity is 65 dBz that is synergize to the previous studies in other several places [7,10]. From h-1 to the hail occurrence, surface air temperature and RH are the opposite to the previous study [6] that the surface air temperature increases 2°C while RH decreased 10% caused by the dry air of the smoke phenomenon. Further study is needed by providing chemistry model data that in order to understand more about hail in tropic especially in this unique situation that is among the smoke phenomenon.

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