# LIGHTNINGS & THUNDERS HIT SOROAKO ON 27 APRIL 2000

***By: M. Karmini***[1]

## Abstract

*Soroako is a small town in South Sulawesi closed to lake Matano. Based on its rainfall hystorical data, April has the highest rainfall amount in Soroako and the vicinity. Rain occurs mostly during night hours in April. Lightnings and thunders hit Soroako & the vicinity and struck the telephone lines in the INCO's dormitory on 27 April 2000. Even it was not the highest rainfall event, let's take a look closely the weather condition based on several data on the day. The clouds developed rapidly at late afternoon and produced an intense thunders and lightnings at early evening. The rain itself was not too hard and the rainfall amount was only 28.3 mm (the average of the area). This paper will discuss the weather condition in Soroako and the vicinity on 27 April 2000.*

## Intisari

*Soroako merupakan kota kecil di Sulawesi Selatan berdekatan dengan danau Matano. Berdasarkan data curah hujan historis, bulan April mermpunyai nilai curah hujan tertinggi di wilayah Soroako dan sekitarnya. Hujan kebanyakan terjadi pada malam hari di bulan April. Kilat dan guntur menerjang Soroako dan sekitarnya dan mampu merusak saluran telepon di Dormitory milik PT. INCO pada tanggal 27 April 2000. Meskipun hujan yang terjadi pada tanggal 27 April bukan yang paling deras, marilah kita pelajari kondisi cuaca berdasarkan beberapa data pada hari itu. Awan-awan berkembang sangat cepat pada sore hari dan menimbulkan kilat dan guntur yang bertubi-tubi pada petang hari. Hujannya sendiri tidak terlalu deras dan tercatat hanya sebesar 28,3 mm (merupakan rata-rata wilayah). Tulisan ini akan membahas kondisi cuaca di Soroako dan sekitarnya khususnya pada tanggal 27 April 2000.*

**Key words:** Weather radar, lightning, rain.

## 1. INTRODUCTION

Soroako is a small town in which PT. INCO (nickel mining and production) has nickel factory. To provide its electricity, PT. INCO has built its own hydro electric power plant utilizing the three cascade natural lakes, Matano, Mahalona, and

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Towuti. During warm episode (El Ñino) in 1997, lake Towuti's water level decreased quite significant. Realizing this situation, PT. INCO had requested Weather Modification Technical Service Unit (UPT Hujan Buatan) under the Agency for the Assessment and Application of Technology (BPPT) to carry out weather modification or cloud seeding over the three cascade lakes.

UPT Hujan Buatan has realized then that overseas agencies that do cloud seeding have performed a new technique, cloud seeding using flares techniques. In line with those mentioned above, UPT Hujan Buatan has proposed a collaborative program in implementing cloud seeding using flare technique between Indonesia (BPPT), the Emabassy of Canada, and the Embassy of United State of America in Jakarta. Accordingly, there has been an operational research program in Soroako to implement cloud seeding using flares since 1998. This year is the third year in the collaborative program.

As a technology transfer, the first year was to understand how to construct hygroscopic flare; the second year was to produce several flares and to test them both on the ground and onboard; and this year (the third year) will be using hygroscopic flares that burned in flace produced by UPT Hujan Buatan and applaying its strategy to carry out cloud seeding. The test will be conducted in May 2000.

The author was in Soroako in preparing the program as a part of the technology transfer when the lightnings and thunders hit Soroako & the vicinity. The lightnings struck the telephone line of the INCO's dormitory and caused in communication problems for few days. April 2000 had a lot of rainfall even it was not the highest rainfall amount compared to hystorical rainfall data. However, the rainfall amount recorded in April 2000 was much higher than it was predicted by NOAA (National Oceanic and Atmospheric Administration – USA), IRI (International Research Institute – USA), and ECMWF (European Centre for Medium range Weather Forcast – Europe).

This paper will discuss weather condition in Soroako and the vicinity on 27 April 2000 based on several data.

## 2. LIGHTNING

What is lightning? According to Houze (1993), lighting is the transfer of charge from one region of a cloud to another or between the cloud and the earth. There are so many forms of lightning, within cloud, cloud to cloud, and cloud to the earth. Repeated lightning will occur when cloud top reaches above level of about –15 to –20$^{o}$ C. In the case of 27 April 2000, because the lightning struck the telephone lines, the lightning should be formed from cloud to ground.

Thunderstorm contains very strong electrical charges. Within comulonimbus cloud there are various charge distributions. The most common distribution is negative charges that are sandwiched between positive charge at lower part of the cloud and at the upper part of the cloud (Houze, 1993). For cloud to ground lightning, the lower part of the cloud gains negative charge, and the ground gains positive charge. Because the force of attraction between ground and cloud becomes very large, the lower part of the storm will discharge its negative charge to the ground, known as lightning.

According to Wallace and Hobbs (1977), the discharge (*called stepped leader*) from cloud base travels downward with discrete steps. Each step takes about 1 µs in which the discharge advances of about 50 m and the time interval between steps is about 50 µs. As the negative charge closes to the ground, it induces positive charge on the ground, and when it is about 10 – 100 m from the ground a travelling spark moves up from the

ground to meet it. After contact between stepped leader and the spark occurred, a large number of electrons flows to the ground and visible lightning stroke propagates upward continuously from the ground to the cloud along the path tracked by the stepped leader.

As the air is heated by lightning (of about 30,000 K), the air may not expand suddenly, therefore, the pressure in the canal of steeped leader increases by an order of magnitude or two. The high-pressure canal then expands quickly into the surrounding air and produces a shock wave and sound wave. This sound wave is audible and called as thunder (Houze, 19993). According to Wallace and Hobbs ( 1977), the thunder could not be heard at the distance more than 25 km from a lightning discharge, because for a greater distance the thunder will be already refracted upwards.

## 3. DATA

In this paper, data of weather radar, rawinsonde, satellite image, and rainfall will be exercised. Those data were taken and collected in conjunction with the reaserach program in Soroako.

## 4. WEATHER CONDITION

### *4.1 General weather condition*

Soroako is just south of the equator and at longitude of about $120^{o}$ E. The weather as other regions in Indonesia has two seasons, rainy and dry seasons. Rainy season is between December – May, while dry season is July – October. The peak of rainy season is in April. In April, the sun position is just passing the equator towards northern hemisphere. Within the equatorial belt (tropical region), there is so called Inter Tropical Convergence Zone (ITCZ) that has lag time behind the sun position relative to the earth.

The area overlaps with the ITCZ, it usually has high rainfall amount due to active cloud formation as a result of horizontal convergence. Even the ITCZ is not very significant within Indonesian region, the rainy season in Indonesia seems to follow the ITCZ except for certain reagions that have significant topography such as the Barisan mountains.

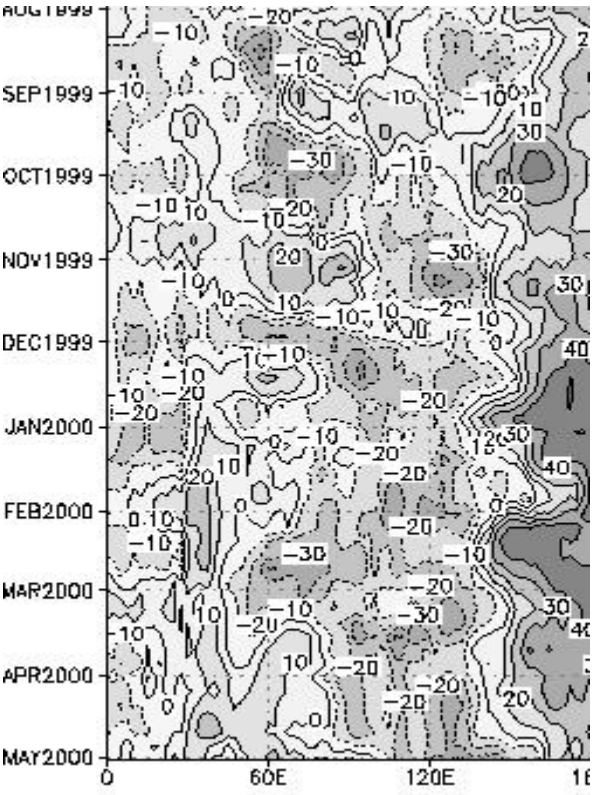


Figure 1. Time longitude cross section of the OLR anomaly within region between ($5^{o}$ N and $5^{o}$ S). Negative signs indicate that convective system is much more intense than normal while positive signs show that convective system is much weaker than normal. The numbers indicate the value of IR radiation intensity (W $m^{-2}$). Taken from http://www.cpc.ncep.noaa.gov.

During April, winds over Soroako and the vicinity were mostly easterlies. Airmass came from the Malukus (western Pacific) and brought some moistures. The cloud formations were quite intense as indicated by negative out going long wave radiation (OLR) as seen in Fig. 1. Long wave radiation (infra red) will be absorved by convective system so that the OLR, detected by the satellite, will be very low. Should the convective system be

much intense than normal situation, the anomalous will indicate negative sign. During April 2000, the OLR anomaly indicated – 20 W $m^{-2}$ while in March was much lower. However, the rainfall in Soroako and the vicinity was much higher in April than that was in March 2000, as indicated by the water level of lake Towuti. In April, the water level was increased almost 0.57 m until 28 April compared to only about 0.30 m in March, while the hydro electric power plant was operated in same capacity.

### *4.2 Weather on 27 April 2000*

Realizing the fact that rainfalls were high in April and there were several weather data on 27 April 2000, it would be very worthy of note to look closely weather condition in Soroako and the vicinity. Weather on 27 April at morning hours was not so interesting and almost boring. It looked like quite dry. In early afternoon, the weather looked the same within visual observation from the airport. However, weather radar observation at 12:40 LT spotted cloud formations over region of about 20 NM (about 36 KM) from radar site as seen in Fig. 2.

The weather situation changed drastically in late afternoon as indicated by radar display at 17:39 LT in which Soroako and vicinity was almost covered by storm. Fig. 3 shows three dimensions of radar display. Precipitations in the clouds as indicated by the radar reache as high as about 25.000 feet, with intensity ranged from moderate to severe.

The radar depiction is not indicating the depth of the storm. The storm top (depth of the storm) may reach level much higher than what we see from the radar display. Because the radar captures precipitation, the radar displays precipitation within cloud or storm. Therefore, all collors on radar display are related to rain intensity within the cloud. How accurate the information is, it depends on how good the calibration of the radar especially in the related area.

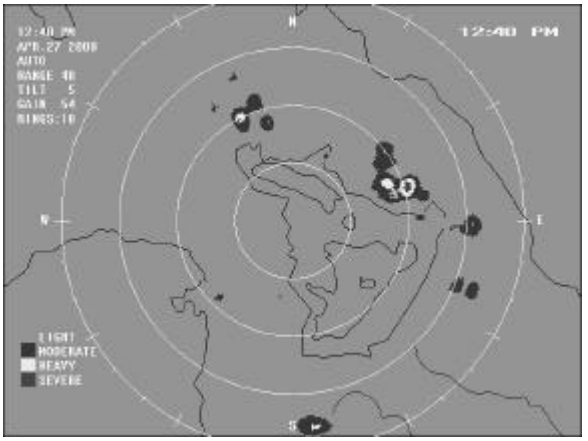


Figure 2. Radar display on 27 April at 12:40 LT. Clouds observed in northeast and northwest of radar site.

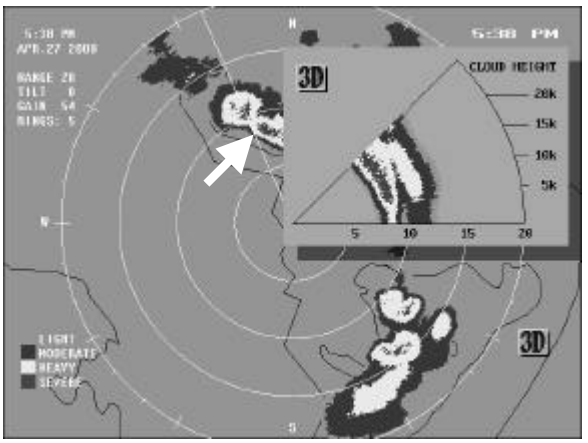


Figure 3. Three dimension radar display on 27 April at 17:39 LT. The display is actually full color. Light green is associated with light rain; dark green is moderate rain; yellow is heavy rain; and red is severe (accompanied by thunders and lightnings). White bold arrow pointed out part of the storm displayed in three dimension.

Ellason E400 – X band weather radar has been utilized in the operational research program to observe cloud's development and movement. It has range up to 40 NM with rings of 10 NM. To avoid ground clutters, the radar was tilted of about $5^{o}$. The radar observes precipitation within clouds and provides rain rates of the clouds. There are four categories of rain rates observed by the radar: light rain indicated by light green; moderate rain specified by dark green; heavy rain indicated by

bright yellow; and severe rain displayed by red collors. In this paper (gray scale) is hard to point out the colors, however, light green is usually at the outer boundary of cloud (hard to be identified), then followed by dark green (looks like black), then bright yellow (looks like white), and red collor is at the middle (dark color within white color) (if there is any).

To see atmospheric condition within the area, rawinsonde was launched at about 15:00 LT from the airport. The reason for launching rawinsonde in the afternoon was because weather condition changed rapidly. Moreover, rains mostly occurred in night hours in April. Rawinsonde data may inform atmospheric instability that has relation with convection or cumulus formation. Therefore, we expected some hints that might be able to be detected from rawinsonde data.

The result was not so encouraging to have interesting weather condition on 27 April 2000. CCL was found at level of 6902 feet above ground level; temperature of convection (Tc) was about $33^{o}$ C; saturation mixing ratio was about 25 gr/kg while actual mixing ratio was only 15 gr/kg, therefore the air needed more water vapour to reach saturated state; freezing level was at level of about 570 mb; the air was quite dry (indicated by the distance between temperature profile (T) and dew point profile ($T_D$) at almost all level); and the winds might be considered calms and homogen from east. Because the atmosphere was conditionally unstable and the air was not reaching saturated state yet, we might expect that if some moist air went through the area, the atmospheric condition would become very unstable in the research area. Accordingly, we suspected that the storm and some moisture came into the area from northeastern of Soroako. This moist air stimulated the atmospheric condition so that the storm was much more energetic in Soroako and the vicinity. The result of rawinsonde can be seen in Fig. 4.

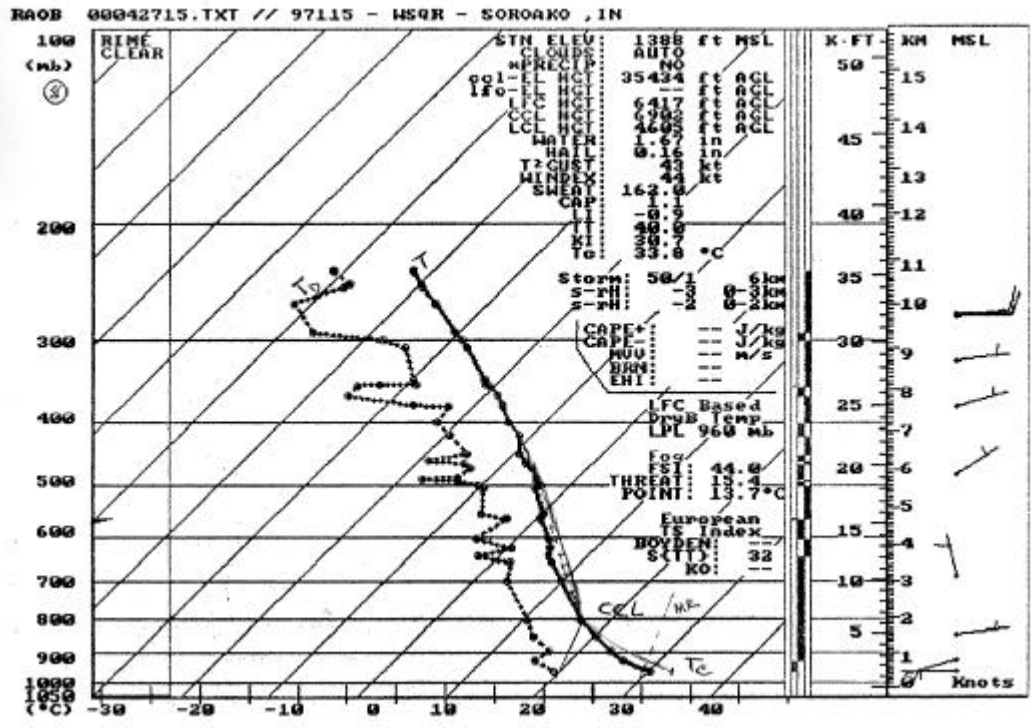


Figure 4. Rawinsonde data of 27 Aprill 2000 charted at Skew T-log P diagram. Atmospheric condition was conditionally unstable and had small bouyance energy. Winds were calm and mostly easterlies.

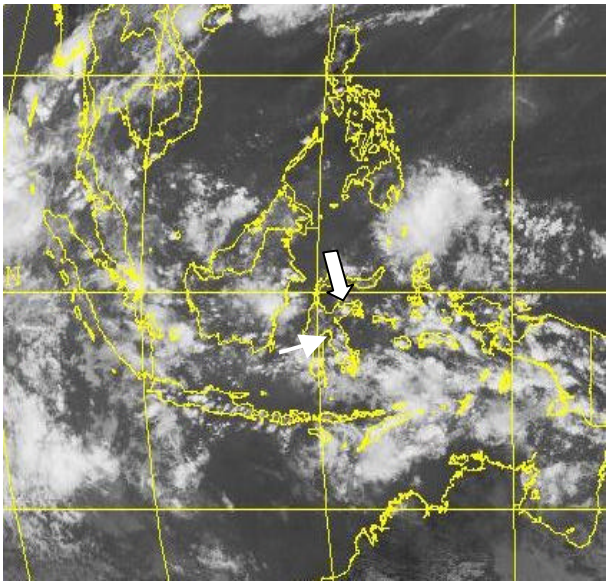

Figure 5. Satellite image on 27 April 2000 at 13:30 LT. A small arrow points out about Soroako and the vicinity, while bold white arrow points out the cumulus cell. (Taken from web site of: http://www.npmoc.navy.mil.)

To see cloud coverage on the day, we can see satellite image on 27 April 2000 at 13:30 LT (Fig. 5). There was no significant cell on the image. However, in the northeast of Soroako and the vicinity there was spotted a cumulus cell. Based on rawinsonde data, we might expect that the cell (pointed by bold white arrow) spotted in northeastern of Soroako moved into Soroako and the vicinity area.

## 5. DISCUSSION

Lightnings and thunders were very intense on 27 April in the period of 18:00 – 20:00 LT. To understand what was happening in that late afternoon, the author invite the readers to see Fig. 6. Figure 6 is an assembling of consecutive radar depictions between 16:00 to 17:50 LT. The display was taken of about 9 to 11 minutes difference. Observation was stopped at about 18:00 LT because there was no plan to flight for cloud seeding after that hour. (The radar observation was conducted in accordance with cloud seeding research program.) Each radar depiction was cropped for region between the center of radar display (radar site) to the north of about 25 NM distance.

It is noticeable that the storm was in motion from the northeast toward the southwest of radar site. The storm passed the PT. INCO's dormitory at about 19:00 LT. Two cells were spotted at the display at 16:00 LT. The cells moved at the same direction, however, they developved at different rate. The cell of slower development rate was to the east of the cell of faster development rate. The faster development cell moved at about 10 NM/110 minutes (9.6 km/hr) and so did the slower development cell. The cells seemed to unite and be more severe as they were close to the Soroako and the vicinity area at about 17:10 LT. This situation might be induced by atmospheric condition in Soroako and the vicinity as indicated by rawinsonde data analysis. According to Wallace and Hobbs (1977), violent convection develops in regions in which storming of warm, moist air at low levels while dry, conditionally unstable air prevails aloft.

The rain started at about 18:00 LT (observed at the PT. INCO's dormitory). The rain could not be categorized as severe rain rate. It was confirmed by rainfall data recorded on 27 April 2000 (Tabel 1). There are several automatic and manual raingauges in the target of operational research program (Fig. 7). In this paper, rainfall data were taken from 8 raingauges. The average of rainfall data was 28.3 mm.

Tabel 1. Rainfall Data on 27 April 2000

| Raingauge Sites | Rainfall (mm) |
|---|---|
| Airport | 16.0 |
| Hydro Power Plant | 13.0 |
| Dam Site | 26.5 |
| Timampu | 43.2 |
| Salonsa | 16.0 |
| Lawewu | 16.0 |
| Plant Site | 14.2 |
| Wawondula | 81.2 |
| **Average:** | **28.3** |

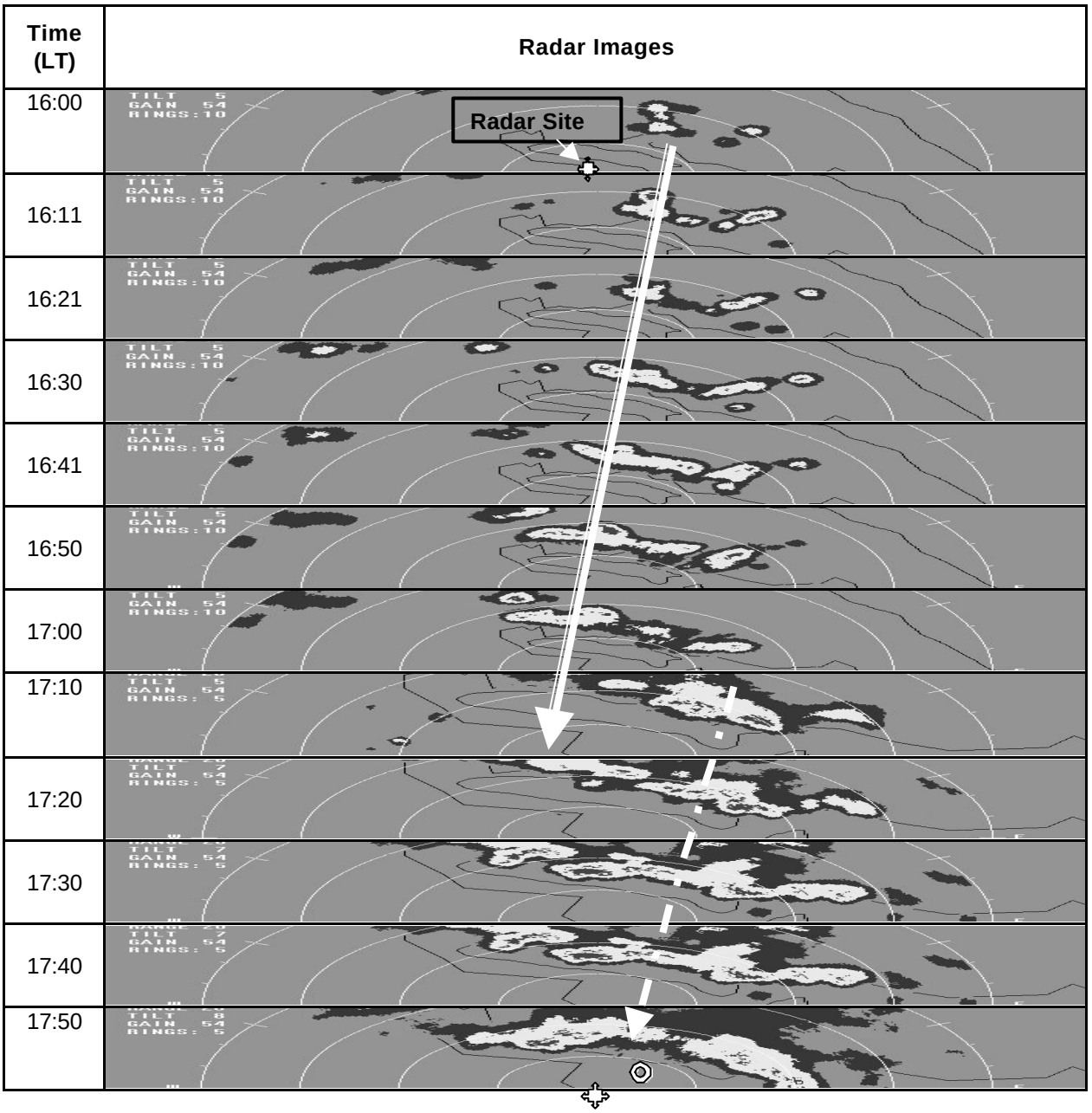


Figure 6. Radar echoes of cells and its movement. The data taking was stopped at 17:50 LT, therefore, we couldn't tell what its look like after the hours. One thing could be said was that the storm was passing the dormitory (circle mark) quite fast. Lightnings and thunders hit many times, however, the average of total rainfall amount for the area was not very high (28.3 mm).

## 6. CONCLUDING REMARKS

We may conclude that:

1) Because the lightning hit Soroako and vicinity many times, we may assume that the comulonimbus cloud top reached a level higher than –15 to –20$^{o}$ C level.
2) The 27 April thunderstorms that passing Soroako and vicinity area were not developed within Soroako area.
3) The moistures came from the sea east to northeast of Sulawesi island which has warm sea surface temperature.

4) Even the lightning and thunder were very intense, the average rainfall area was only 28.3 mm.

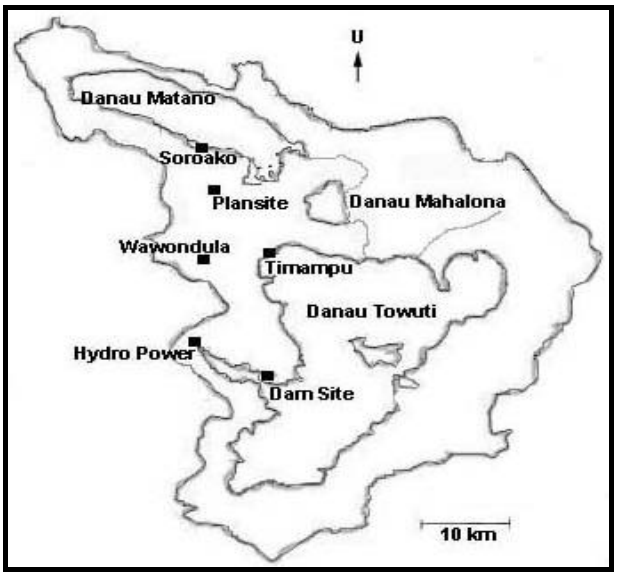


Figure 7. Target area of operational research program. The town of Soroako (close to lake Matano) and several raingauges are mapped.

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Web site: http://wvlightning.com/descript.html

Web site: http://www.npmoc.navy.mil

## The author data.

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