

Thunderstorm associated with lightning-A general study based on West Bengal, India

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Abstract

Thunderstorm a severe atmospheric phenomena causes huge damage and losses of resources at geographical environment. It is an electrical storm, characterized by huge rainfall and lightning. Lightning is a leading cause injury and death from weather related hazards. These are dangerous storm that include powerful winds over 50 mph, Hail and flash flooding. Lightning is one of the primary killers from thunderstorms. In West Bengal mainly different parts of the region is affected by such hazards recently. Viability, instability and death is gradually increasing in West Bengal. So, therefore this paper is mainly focused on general characteristic of Thunderstorm as well as their distribution, mechanisms, intensity, Impact, measure in different pockets of West Bengal, India.

Keywords: thunderstorms, lightning, raindrops, squall line, landslide

Introduction

Thunderstorms are meteorological events that bring heavy rains, strong winds, hail, lightning and tornadoes (J. A Bullock and D. P Coppola, 2021). A thunderstorms is classified as severe if wind velocity overcome 58mph. Lighting is an important threat associated with thunderstorms. Generally thunderstorms is classified into four types - a. The single cell. b. The Multi cell. c. The Squall line. d. The super cell. (A. Kozak, 2021). A thunderstorm is a storm with lightning and thunder. They are caused by an updraft, which occurs when warm, moist air rises vertically into the atmosphere. The updraft creates a cumulus cloud, which will eventually be the thunderstorms cloud (E. Friedl, 2021). Lighting is natural spark discharge. On discharge a highly electrically conductive plasma channel is created within the air and when current flows within this channel, it rapidly heats the air up to about 25000°C (C. Rodger, 2003). There are two types of lightning produced by thunderstorm-cloud to ground (CG) and intra cloud (IC) (Vavrdk, Kittil, Holle, Allsopp and copper). The effect of lightning by several like- visual effect, acoustic effect, electrochemical effect, electrodynamic effect and effect on a living (S. Shivalli, 2016). Different safety measures are taken to protect from thunderstorms or lightning. There is several indoor or outdoor risk reduction techniques used to protect from lightning.

Background

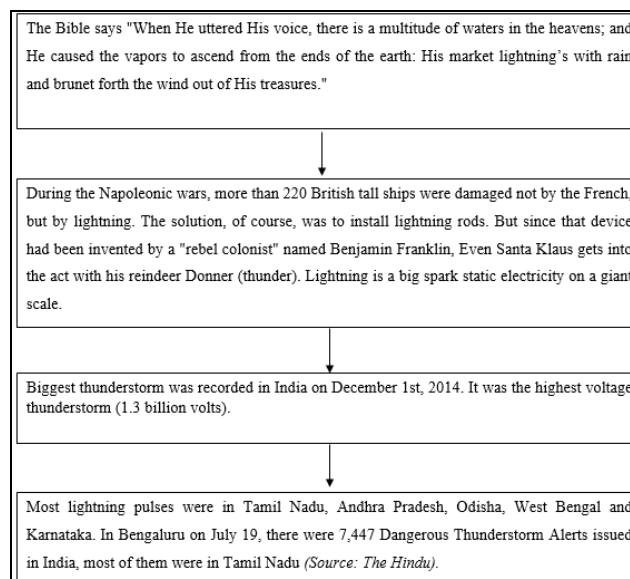


Fig 1

Structure

The fully developed and strong thunderstorms comprise a few convection cells which may vary from 5 to 8 in number.

These convective cells are characterized by strong updraft of air. The updraft of moist and unstable air is in the form of a chimney. Most thunderstorms form with three stages: the cumulus stage when storm clouds form, the mature stage when the storm is fully formed, and then the dissipating stage when the storm weakens and breaks apart.

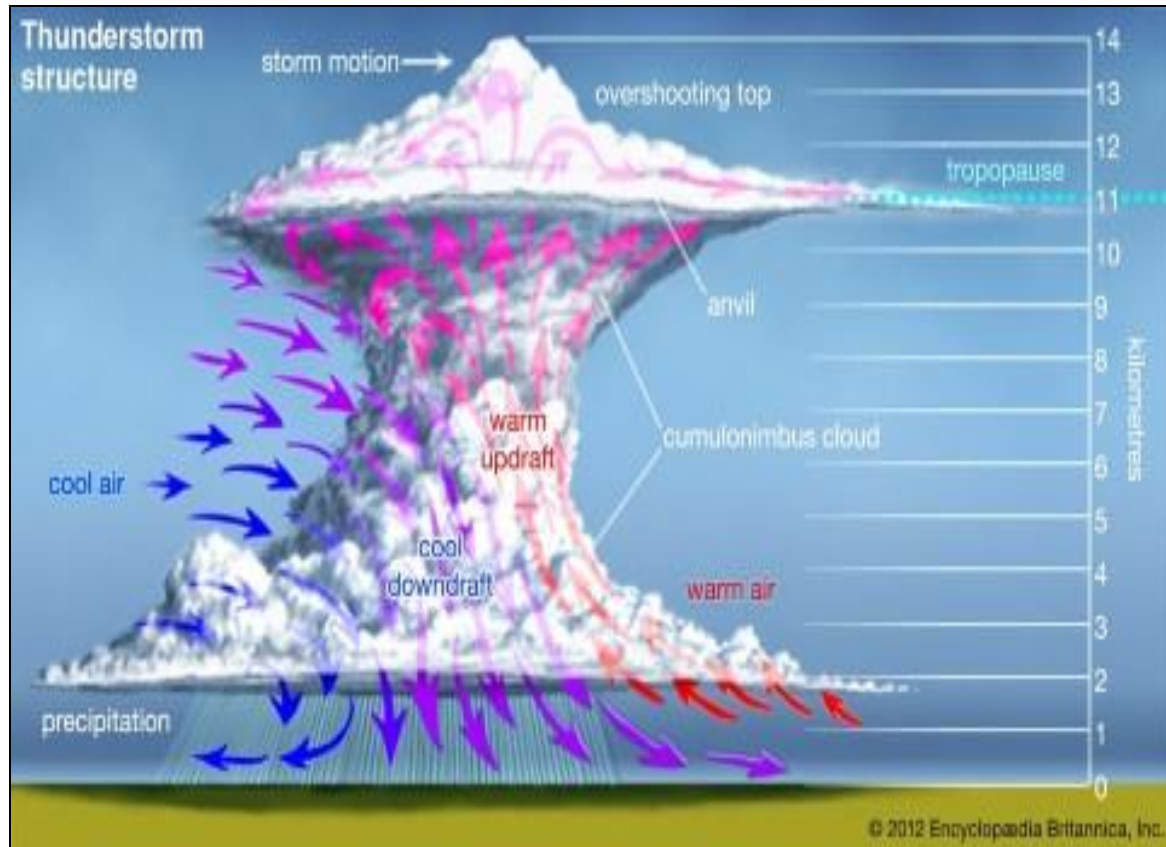


Fig 2: (Structure of Thunderstorm)

▪ The Cumulus Stage

The first stage of the life cycle of the thunderstorm, is also called youth stage, when ground surface is intensely heated, the moist air coming in contact with heated ground surface is also heated, expand and rises upward as strong convective current losing temperature at the dry adiabatic lapse rate of 10°C per 1000 meters, reaches its condensation level and thus helps in the formation of clouds having precipitation particles. The updraft of moist air becomes stronger due to trigger effects. Consequently the cumulus clouds become thick cumulonimbus clouds.

▪ The Mature Stage

The second stage of the thunderstorm development characterized by the cumulus cloud continues to grow; the tiny water droplets within it grow larger too as more water from the rising air is added to the droplets. The cloud starts to look dark and grey as more water is added to it. And the growing droplets that make up the cloud become heavy. Raindrops start to fall through the cloud when the rising air can no longer hold them up. Meanwhile, cool dry air flows downward in the cloud, called a downdraft, pulling water downward as rain. With an updraft, downdraft, and rain, the cloud is now called a cumulonimbus cloud and the cycling of air up and down is called a thunderstorm cell.

▪ The Dissipating Stage

This stage is the senile stage of thunderstorms and characterized by movement of winds which laterally spread over the ground surface and stop vertical movements of winds.

Clouds spread in the sky in umbrella shape and become altostratus and cirrostratus resulting into dissipation of thunderstorm as these clouds is rainless.

The whole process takes about one hour for an ordinary thunderstorm. Severe thunderstorms like super cells and squall lines are much larger, more powerful, and last for several hours.

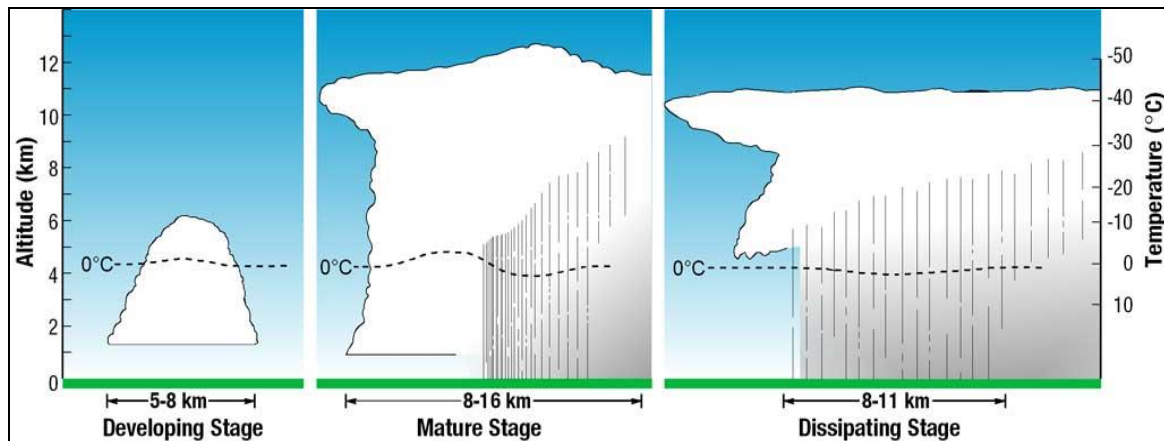


Fig 3: Diagram of a thunderstorm forming

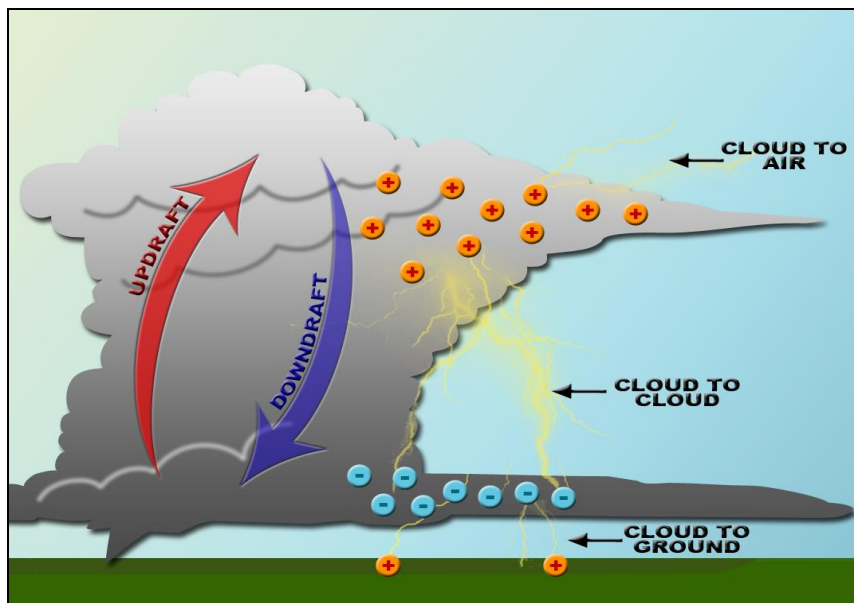


Fig 4: (Mechanisms of Thunderstorm)

Mechanisms

The sound emitted by rapidly expanding gases along the channel of a lighting discharge is called thunder. A lighting stroke produces tremendous heat along its path. Thunderstorms arise when layers of warm, moist air rise in a large, swift updraft to cooler regions of the atmosphere. It can consist of just one convection cell, multiple convection cells, or even one extremely large and powerful convection cell. Below is a description of three types of thunderstorms, classified by their structure: single-cell, multi-cell and super cell.

Single-cell Thunderstorms: single-cell thunderstorms are small, brief, weak storms that grow and die within an hour or so. They are typically driven by heating on a summer afternoon. Single-cell storms may produce brief heavy rain and lightning.

Multi-cell Thunderstorms: Some thunderstorms are made from many convection cells moving as a single unit. These are called multi-cell thunderstorms. Convergence, or when air flows collide, and orographic lifting as air moves over a mountain are two common ways strong updrafts develop. A lot of the time when a cold front is involved, more than one thunderstorm develops along the edge of it. These are called multi-cell thunderstorms.

Super cell Thunderstorms: Severe weather occurs disproportionately with super cell thunderstorms. The largest hail, the strongest straight-line winds, and the strongest tornadoes occur with super cells.

Distribution

The annual average no. of days with thunderstorm in different regions of the world shows a wide variation. In the northern and southern hemisphere from latitude 60° poleward the frequency of the thunderstorm is the least. In this situation lightning and thunderstorm continued to hit some districts; while the India Meteorological Department said that the southwest monsoon is likely to advance into some parts of West Bengal. Nearly twenty seven people have been killed across districts of West Bengal. Eleven people died in Hooghly, nine people in

Murshidabad, two people each in East and West Midnapore and Bankura each and one in Nadia died and several people left injured.(Published on Jun 10, 2021 India news).

Table 1: Storm Project – 2021 Thunderstorm Activity / Rainfall Report of Kolkata Region dated 10th June, 2021 (24 hours’ weather from 0830 IST of 09.06.2021 to 0830 IST of 10.06.2021)

METEOROLOGICAL OBSERVATORY	THUNDERSTORM		HAILSTORM			THUNDER SQUALL			LIGHTNING		RAINFALL	
	Time of Comm.	Time of End	Time of Comm.	Time of End	Diameter of Hail stone	Time of Comm.	Time of End	Wind Direction	Max wind speed	Time of Comm.	Time of End	Past 24 hours endingat 0830 IST today
	(IST)	(IST)	(IST)	(IST)	(cm)	(IST)	(IST)		(kmph)	(IST)	(IST)	(mm)
GANGETIC WEST BENGAL (GWB)												
ALIPORE	NIL	NIL	--	--	NIL	--	--	NIL	--	NIL	NIL	0.0
DUM DUM	NIL	NIL	--	--	NIL	--	--	NIL	--	NIL	NIL	Trace
CANNING	NIL	NIL	--	--	NIL	--	--	NIL	--	NIL	NIL	0.0
DIAMOND HARBOUR	NIL	NIL	--	--	NIL	--	--	NIL	--	NIL	NIL	0.0
HALDIA	NIL	NIL	--	--	NIL	--	--	NIL	--	NIL	NIL	0.0
DIGHA	NIL	NIL	--	--	NIL	--	--	NIL	--	NIL	NIL	0.0
ASANSOL	1400-1700	NIL	--	--	NIL	--	--	NIL	--	NIL	NIL	20.5
BANKURA	1640-1930	NIL	--	--	NIL	--	--	NIL	--	NIL	NIL	26.4
SRINIKETAN	NIL	NIL	--	--	NIL	--	--	NIL	--	NIL	NIL	6.2

Source: Indian Metrological Department

A Low Pressure Area lies over Northwest Bay of Bengal and adjoining Odisha & Gangetic. West Bengal coasts with the associated cyclonic circulation extending up to mid tropospheric levels persist.

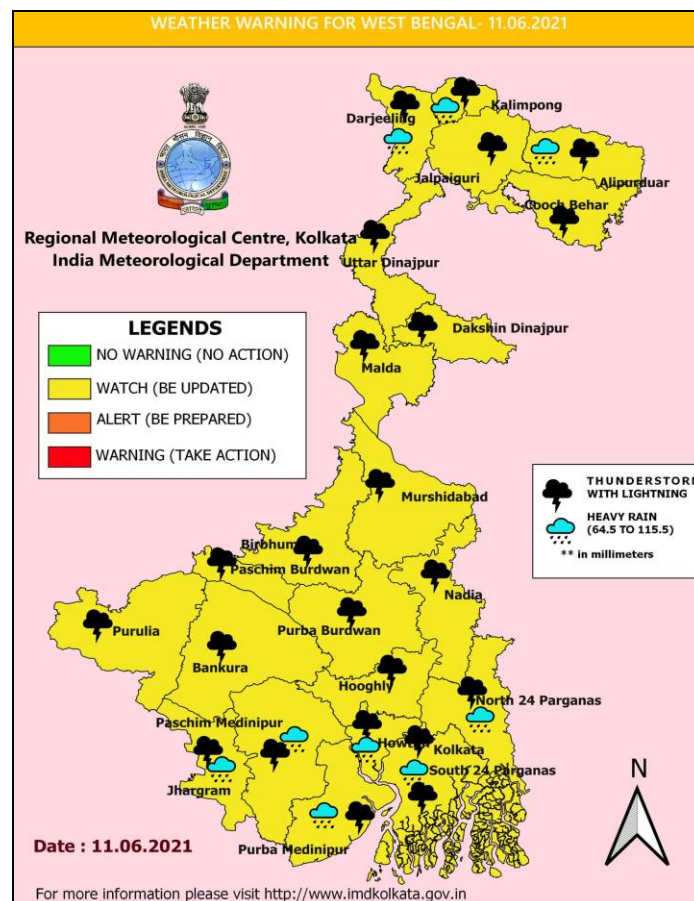


Fig 5: (Weather Map, Source: Indian Metrological Department)

Factors of Intensity

Some atmospheric conditions are favorable for the origin and growth of thunderstorms:

- Atmospheric instability
- Lifting of potential unstable air
- Thickness of clouds
- Large supply of warm and moist air.

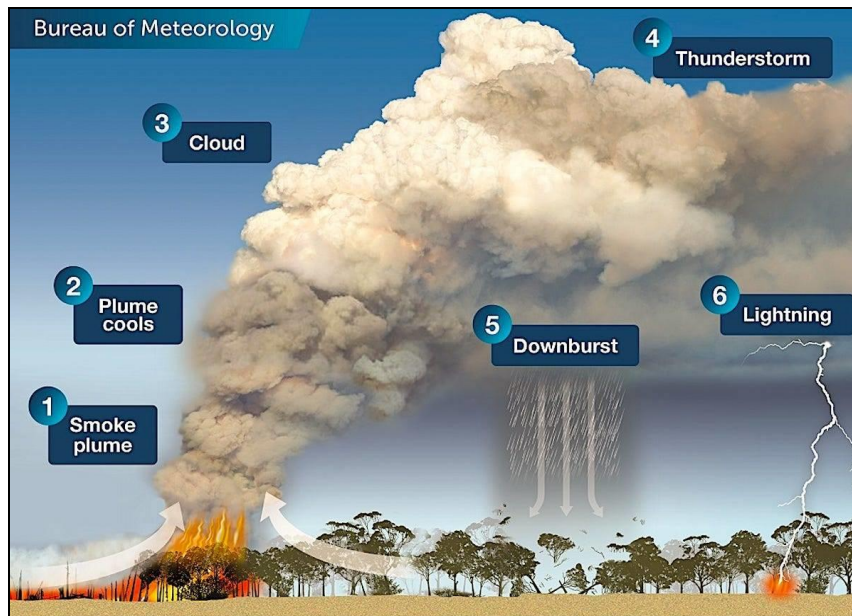


Fig 6: (Factors of Intensity)

Impact

- Each year, many people are killed or get seriously wounded by severe thunderstorms.
- Animals are also affected due to thunderstorms.
- Localized Landslides/Mudslides are also created.
- Damage to horticulture and standing crops in some areas due to inundation.
- Destroy structure of houses, big buildings, tower and transformers in cities and villages.

Safety Measures

- Avoid open areas and stay away from isolated trees as lightning tends to strike the tallest object in an area.
- Avoid using electronic equipment of all types.
- Stay away from concrete floors or walls.
- Water pipes also conduct electricity, so taking a shower or using the plumbing must be avoided during a storm.
- Avoid current traveling between group members or postpone your trip or activity.



Fig 7: (Safety Measures)

Conclusion

Severity of thunderstorm was influenced by vertical extension of wind shear causing loss of life and damage to property. It is a complex metrological event characterized by the presence of electrical discharges followed by thunder. Forecasters can use weather satellites, like those in NOAA's GOES – R series, to moister clouds as they grow into thunderstorms. It can help people stay safe during thunderstorm.

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