Field test of a new type of lightning - dispelling rocket against cumulus electric field

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Abstract. Based on the field test of 48 new lightning dissipating rockets launched by cumulonimbus and stratus, we preliminarily draw the following conclusion: the new lightning dissipating rockets can reduce the absolute value of the electric field inside and outside cumulonimbus; The greater the electric field value of cumulonimbus (the stronger the convection), the greater the influence of the new rocket on the electric field, and vice versa. The rocket has little effect on stratospheric electric field. This method can eliminate or reduce the lightning activity, so as to provide effective active lightning defense means for ships at sea, rocket launching and forest areas, and thus effectively reduce the disasters caused by lightning to human beings.

1. Introduction
Lightning disaster is listed as "one of the ten most serious natural disasters" by the United Nations [1]. The first successful artificial lightning experiment was carried out by Newman over the Florida sea in 1966, after which he successfully induced lightning by sending thin metal wires into a thunderstorm cloud [2]. France, Japan, the United States and China are the artificial triggering lightning experiments and comprehensive measure, since the 1990s, and further perfect the so-called "trigger" air lead thunder technology, such as the thin metal wire is after the rocket into the air, in the joint of the top and bottom and nylon thread will inspire, respectively, in thunder cloud electric field under the action of the ascending and descending the forerunner, their environment under the action of an electric field to the thunder cloud and the ground two-way transmission [3]. As for lightning tests used to weaken thunderclouds, no relevant literature has been found.

Although the lightening rocket with copper wire can trigger lightning, thus affecting the electric field inside and outside the thunderstorm, but at present the lightening rocket has a serious shortage: (1) because of the towing wire, it can only be vertical launch, so the launch Angle is very small, and do not maneuver. There are great security risks. If the lightning is not successful, the copper lead can cause serious damage if it is attached to a power line or a pedestrian during the landing.

Based on the above cable rocket triggered lightning is insufficient, we developed a new type of wireless rocket, the rocket by seeding agents to influence cloud internal and external electric field, thus to eliminate or weaken the lightning activities, thus for naval ships, the rocket launch, and forest...
provide effective active lightning defense, so as to effectively reduce the thunder and lightning disasters to human beings.

2. Experimental equipment

2.1. Rocket and launch system
Xl-1 new type of thunder dispelling rocket and 8-tube mobile launch and control system jointly developed with xinyu guoke.

2.1.1. Rocket structure. The new rocket has three parts: the rocket engine part, the self-destruction part and the working part (as shown in Figure 1).

Dynamic system: provides the rocket power, can make the rocket maximum vertical height of more than 7 km.

Self-destruct system: after the rocket completes its work, the remaining part of the rocket explodes in two parts, making the residual debris smaller and less dangerous.

Work system: in the front of the rocket for the chamber, the side has four air holes.

![Figure 1. A new type of mine eliminating rocket b new type of mine eliminating rocket structure.](image)

2.1.2. Working principle of rocket. After the rocket is fired to fly out of the gun tube, through the setting of the time system inside the rocket (12 seconds in the north), after entering the cloud began to spread conductive agent (metal powder or graphite powder), and the rocket skin brush has the conductive effect of metal powder, so that it can neutralize the positive and negative charges in the cloud, so as to reduce the lightning activity in the cloud. After the dispensing of the agent is completed, the rocket debris can be detonated in two times by the self-detonation system (set up a good time in advance) to form smaller debris and reduce the secondary damage caused by the landing.

2.2. Atmospheric electric field instrument
EFI type atmospheric electric field instrument produced by Beijing huayun dongfang exploration technology co., LTD. (as shown in Figure 2)

2.3. Vehicle-mounted radar
Scrxd-01m vehicle-mounted x-band fully coherent doppler weather radar produced by anhui sun create electronics co., ltd.
3. Experimental process
In August 2019, the new rocket was delivered to our province, and the field test of the new rocket on the inner and outer cloud electric field was carried out in yichun tieli for 24 days in August.

(1) morning of August 21: field experiment in weiguo village. Weather: heavy rain
Experimental conditions:
First graphite rod rocket fired at 7:55:05,
The second rocket, at 7:55:13,
The third rocket fired a metal bar at 7:56:20. After a minute, the rain increased significantly.
The fourth 8:16:03 graphite strip rocket,
The fifth rocket, at 8:18:27, fired a powder rocket.
The sixth 8:50:48 rocket launches a powder rocket,
The seventh 8:56:34 launches a strip rocket.
The data recorded by the atmospheric electric field instrument, Shown in Table 1

Table 1. Influence of the new rocket on the surface atmospheric electric field on the morning of August 21.

| Launch the order          | Launch time | Electric field value at launch(kv/m) | Inflection point | The peak point(kv/m) |
|---------------------------|-------------|-------------------------------------|------------------|---------------------|
| The first graphite bar    | 7:55:05     | -19.57                              | 7:59:00          | -6.06               |
| The second metal powder   | 7:55:13     |                                     |                  |                     |
| The third metal bar       | 7:56:20     | -14.93                              | 7:59:00          | -6.06               |
| The fourth graphite bar   | 8:16:03     | -23.34                              | 8:17:13          | -26.73              |
| The fifth metal powder    | 8:18:27     | -23.26                              | 8:19:36          | -18.02              |
| The sixth metal powder    | 8:50:48     | -2.55                               | 8:54:16          | 3.02                |
| The seventh metal bar     | 8:56:34     | 1.1                                 | 8:59:23          | -1.1                |
Sorted out to get the Figure 3 below.

![Figure 3](image)

**Figure 3.** Effects of New Rockets on Surface Atmospheric Electric Field in the Morning of 21 August.

August 21 afternoon: field experiment in Tieli Village. Weather: sunny to rainy

Experimental conditions:

Issue 8 13:47:27 launches metal bar rockets, issue 9 13:48:20 launches metal powder rockets; issue 10 13:48:52 launches metal powder rockets.

As can be seen from the above radar map, the target cloud is far from the launch point, so the electric field measured at the launch point is also small, and the rocket launch has little impact on the electric field near the launch point.

Eleven 19:34:40 fired graphite strip rockets, and twelve 19:36:41 fired graphite powder rockets. The data recorded by the atmospheric electric field instrument, Shown in Table 2

**Table 2.** Influence of the new rocket on the surface atmospheric electric field on the afternoon of August 21.

| Launch the order | Launch time | Electric field value at launch (kV/m) | Inflection point | The peak point (kV/m) |
|------------------|-------------|---------------------------------------|-----------------|----------------------|
| The eighth metal bar | 13:47:27   | -0.64                                 | 13:50:08        | -1.39                |
| The ninth metal powder | 13:48:20   | -1                                    | 13:50:08        | -1.39                |
| The 10th metal powder | 13:48:52   | 13:50:08                              |                 |                      |
| The 11th graphite bar | 19:34:40   | -0.19                                 | 19:36:23        | -0.34                |
| The 12th metal powder | 19:36:41   | -0.34                                 | 19:38:36        | -0.38                |

Sorted out to get the Figure 4 below.

![Figure 4](image)

**Figure 4.** On the afternoon of 21 August, the impact of the new rocket on the surface atmospheric electric field

(2) September 1 morning: field experiment in Tie Li Workers and Peasants Township. Weather: light rain to cloudy

Experimental conditions:
The first 11:29:29 launch of the graphite strip rocket,
The third 11:32:40 launches a powder rocket.
The data recorded by the atmospheric electric field instrument, Shown in Table 3

**Table 3. Influence of the new rocket on the surface atmospheric electric field on the morning of September 1.**

| Launch the order       | Launch time | Electric field value at launch (kv/m) | Inflection point | The peak point (kv/m) |
|------------------------|-------------|--------------------------------------|------------------|-----------------------|
| The first graphite bar | 11:29:29    | 38.58                                | 11:34:10         | -31.93                |
| The second graphite powder | 11:30:25 | 34.77                                | 11:34:10         | -31.93                |
| The third metal powder | 11:32:40    | 8.93                                 | 11:34:10         | -31.93                |

Sorted out to get below Figure 5.

**Figure 5.** The effect of a new type of rocket on the ground atmospheric electric field on the morning of September 1.

It can be seen from the Figure that after the launch of 3 rockets around 11:29, the ground electric field changed from positive to negative, showing a significant drop.

September 1 afternoon: tieli workers and peasants township

Experimental conditions:
The fourth 16:24:23 rocket fired graphite powder;
The fifth 16:27:36 graphite strip rocket;
The sixth 16:28:37 graphite strip rocket;
7 16:29:26 graphite strip rockets fired;
The eighth 16:31:30 rocket fired graphite powder;
The ninth 16:31:45 rocket fired graphite powder;
The 10th 16:32:08 rocket launches powder metal;
The 11th rocket fired graphite powder at 17:38:52;
The 12th rocket fired graphite powder at 17:40:37.

The data recorded by the atmospheric electric field instrument, Shown in Table 4
Table 4. Influence of the new rocket on the surface atmospheric electric field on the afternoon of September 1.

| Launch the order | Launch time | Electric field value at launch (kv/m) | Inflection point | The peak point (kv/m) |
|-----------------|-------------|--------------------------------------|-----------------|-----------------------|
| The fourth      | 16:24:23    | 28.42                                | 16:31:25        | 1.16                  |
| graphite powder |              |                                      |                 |                       |
| The fifth       | 16:27:36    | 18.99                                | 16:31:25        | 1.16                  |
| graphite bar    |              |                                      |                 |                       |
| The sixth       | 16:28:37    | 11.36                                | 16:31:25        | 1.16                  |
| graphite bar    |              |                                      |                 |                       |
| The seventh     | 16:29:26    | 9.38                                 | 16:31:25        | 1.16                  |
| metal powder    |              |                                      |                 |                       |
| The eighth      | 16:31:30    | 1.16                                 | 16:34:16        | 9.05                  |
| metal powder    | 16:31:45    |                                      |                 |                       |
| The ninth       | 16:31:30    |                                      |                 |                       |
| metal powder    |              |                                      |                 |                       |
| The 10th        | 16:32:08    | 5.47                                 | 16:34:16        | 9.05                  |
| metal bar       |              |                                      |                 |                       |
| The 11th        | 17:38:52    | -5.12                                | 17:39:14        | -4.82                 |
| metal bar       |              |                                      |                 |                       |
| The 12th        | 17:40:37    | -5.12                                | 17:43:36        | -3.62                 |
| metal bar       |              |                                      |                 |                       |

Collate to get the following Figure 6.

![Figure 6. Effect of New Rocket on Surface Atmospheric Electric Field In Tieli Gongnong Township on 1 September.](image)

It can be seen from the Figure that after the launch of 7 rockets at 16:24, the ground electric field changed from positive to negative, and there was a significant drop for many times. Therefore, the change value of the ground electric field is small.
Experimental site (see Figure 7)

Figure 7. Field test site of a, b, c and d new type mine eliminating bombs.

4. Experimental analysis

4.1. Theoretical analysis
Because of the strong convection of thunderstorm clouds, the high charge rate [4] will form a very strong positive and negative charge area in a short time. Once the positive and negative charge reaches a certain intensity, it will break through the air between the positive and negative charge area and cause the discharge, forming the discharge between the clouds or between the clouds and the ground, making the electric field inside and outside the cloud instantly significantly reduced.

It is theoretically possible to neutralize all (or part) of the positive and negative charge in the cumulus cloud before lightning is formed by the conductive properties of the rocket skin and the conductive agent spread between the positive and negative charge areas in the cumulus cloud, so as to eliminate or reduce the lightning activity. The key here is to master the timing and path of the rocket so that it passes right between the positive and negative charge zones in the cumulus cloud.

4.2. Experimental analysis

4.2.1. Impact of new rocket on thunderstorm electric field. The amount of conductive agent in each rocket is not very much, and the energy is very limited, but its effect is to reduce the air resistance between the positive and negative charge areas, and induce the formation of a lightning spillway, and
once the spillway formed, there will be a lot of electric charge will pass through the channel in a moment, thus neutralizing a lot of positive and negative charge in the cumulus cloud.

4.2.2. Influence of new type rocket on stratocloud electric field. Because there is usually only one charge (or positive or negative) in the layer cloud and the strength is very weak[5], and the new type of rocket is started to spread the conductive agent after entering the cloud, so it is impossible to establish the lightning discharge channel between the layer cloud and the ground, so the new type of rocket basically has no effect on the layer cloud electric field.

4.2.3. Objective analysis of measurement data of ground atmospheric electric field instrument. The electric field measured by the surface atmospheric electric field meter is a direct reaction of the electric field value at the bottom of the cumulus cloud. If the electric field at the bottom of the cumulus cloud is weakened by the effective action of the new rocket, the electric field data measured by the surface atmospheric electric field meter will also change. Therefore, the surface atmospheric electric field instrument can objectively reflect the change of electric field inside and outside the cumulus cloud.

4.2.4. Whether the electric field change measured by the ground atmospheric electric field meter can confirm the analysis of the impact of lightning dissipating rocket. In addition to deducing the connection between A and B events based on mature theories, the exploration of the relationship between A and B events is mostly established through experiments.

There must be b, if there are a, then A is B sufficient condition for relations, their relationship is sufficient. If there are n sufficient conditions, the mathematical expression is:

$$B = \sum_{i=1}^{n} A_i$$

(1)

In the above formula, $\sum_{i=1}^{n}$ is the continuous addition sign, $A_i$ is the events that satisfy the sufficient conditional relation that A is B.

If there is no A, there must be no B, then A is a necessary condition for B. If there are n necessary conditions, it can be expressed mathematically as:

$$B = \prod_{i=1}^{n} A_i$$

(2)

In the above formula, $\prod_{i=1}^{n}$ is the sign of continuous multiplication, $A_i$ is the events that satisfy the necessary condition relation that A is B.

If A is A sufficient and necessary condition for B, it can be expressed mathematically as:

$$B = \prod_{i=1}^{n} \sum_{i=1}^{n} A_i$$

(3)

For example, if i =3, then:

$$B = A_4 A_2 A_3 (A_4 + A_2 + A_3)$$

(4)

Now, the event of the effective launch of the new lightning dissipating rocket to cumulus cloud (the lightning dissipating rocket passes through the positive and negative charge area of cumulus cloud) is denoted as A, and the electric field value measured in the ground atmospheric electric field is denoted as event B.

Through the test, it is found that the value of the ground atmospheric electric field meter changes regularly (positively and negatively) after each effective firing of the lightning rocket, and changes in the direction of the decrease of the absolute value of the electric field. Of course, this change can also be caused by other factors, such as the evolution of the cloud itself. However, if every (or most)
effective emission of cumulus cloud can cause the ground electric field value to change regularly, it shows that A and B are necessarily related.

Through field observation, it is found that when no lightning dispelling rock is launched against cumulus cloud, the value of the ground atmospheric electric field also changes, which indicates that A is not a necessary condition for B. In other words, A and B are sufficient conditions, and they only meet the relation (1). In this test, i can be the number of rockets correctly launched on cumulus clouds (which can have an impact on the electric field of thunderstorm clouds).

That is, the relationship between the effective launch of the mine-elimination rocket and the change of the ground electric field satisfies the following equation:

\[ B = A_1 + A_2 + A_3 \]  

(5)

5. Conclusion
Through the field test of 48 lightning dissipating rockets launched by cumulus and stratus, we draw the following conclusion: the new type of lightning dissipating rockets can reduce the absolute value of the electric field inside and outside cumulus; The greater the internal and external electric field value of cumulus cloud (the stronger the convection), the greater the influence of the new rocket on the electric field value of cumulus cloud; conversely, the smaller the internal and external electric field value of cumulus cloud (the weak convection), the smaller the influence of the new rocket on the electric field value of cumulus cloud. The rocket has little effect on stratospheric electric field. Powder is better than strip type precipitation effect; of course, here is only a preliminary conclusion, and this conclusion needs to be further confirmed by more extensive experiments. This paper just hopes that more people will pay attention to this field.

Reference
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