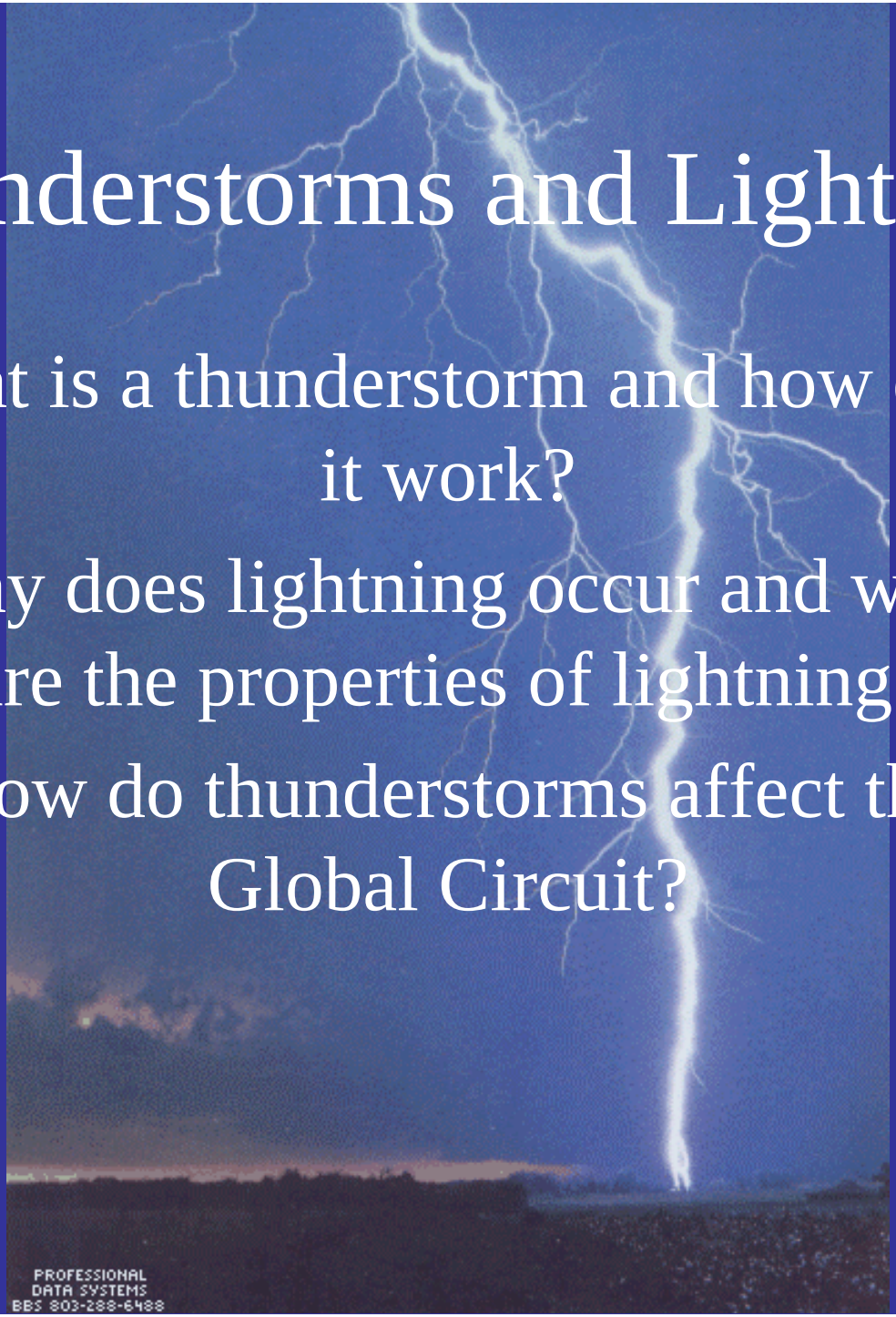
Thunderstorms and Lightning



What is a thunderstorm and how does it work?

Why does lightning occur and what are the properties of lightning?

How do thunderstorms affect the Global Circuit?

What is a thunderstorm?

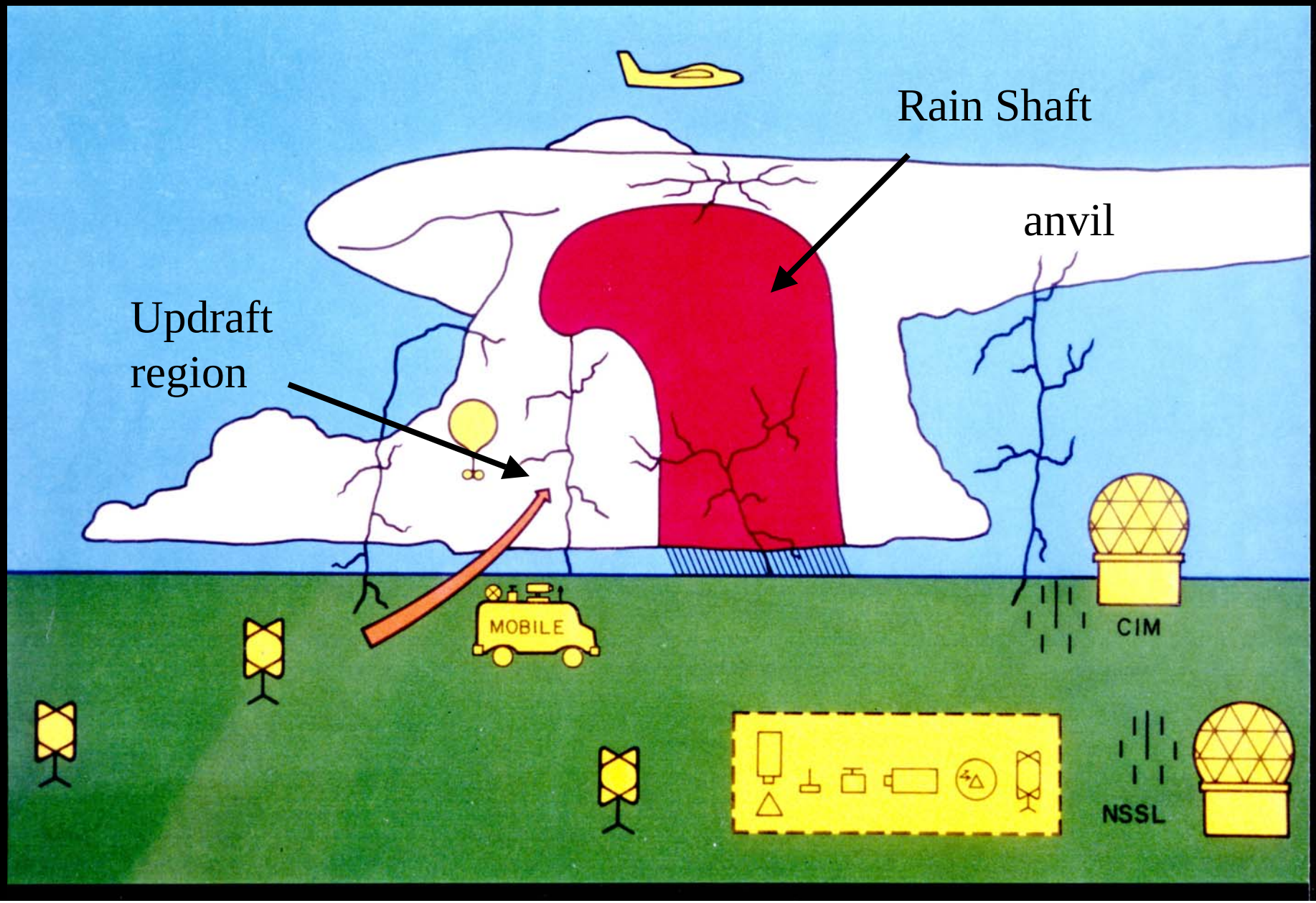
- Differential surface heating
- warm, moist updraft
- vigorous convection
- ice-ice interaction → charge separation
- vertical separation
- Lightning!

(figure courtesy of NMT)

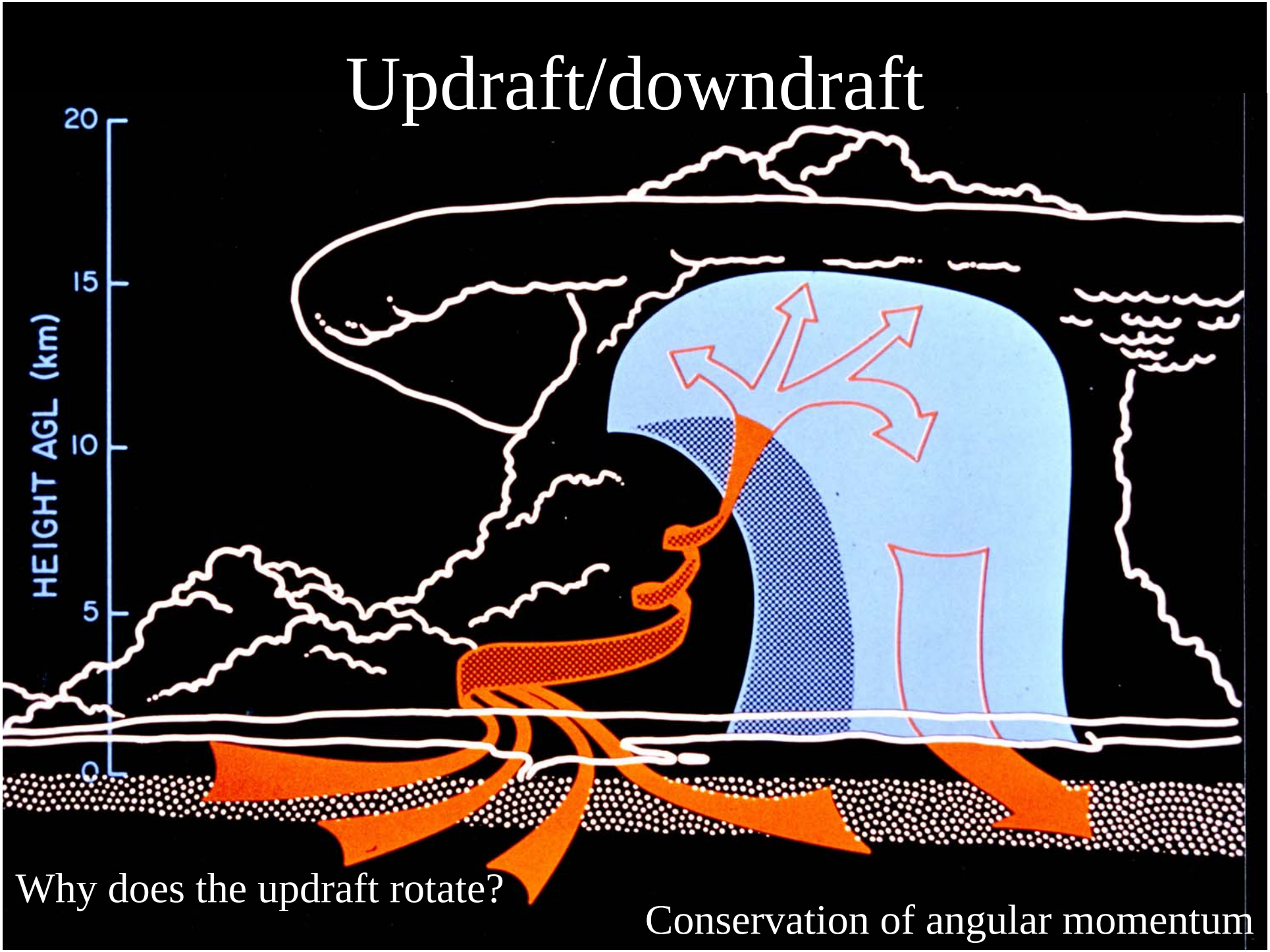
What happens when warm, moist air rises?

- water in the air freezes
- the heat that was in the water goes into heating the air, making it less dense (hot air rises)
- this keeps the air warmer than it would be without the water
- so it goes to much higher altitude than warm but DRY air.
- This process drives vigorous atmospheric convection

Mature Thunderstorm



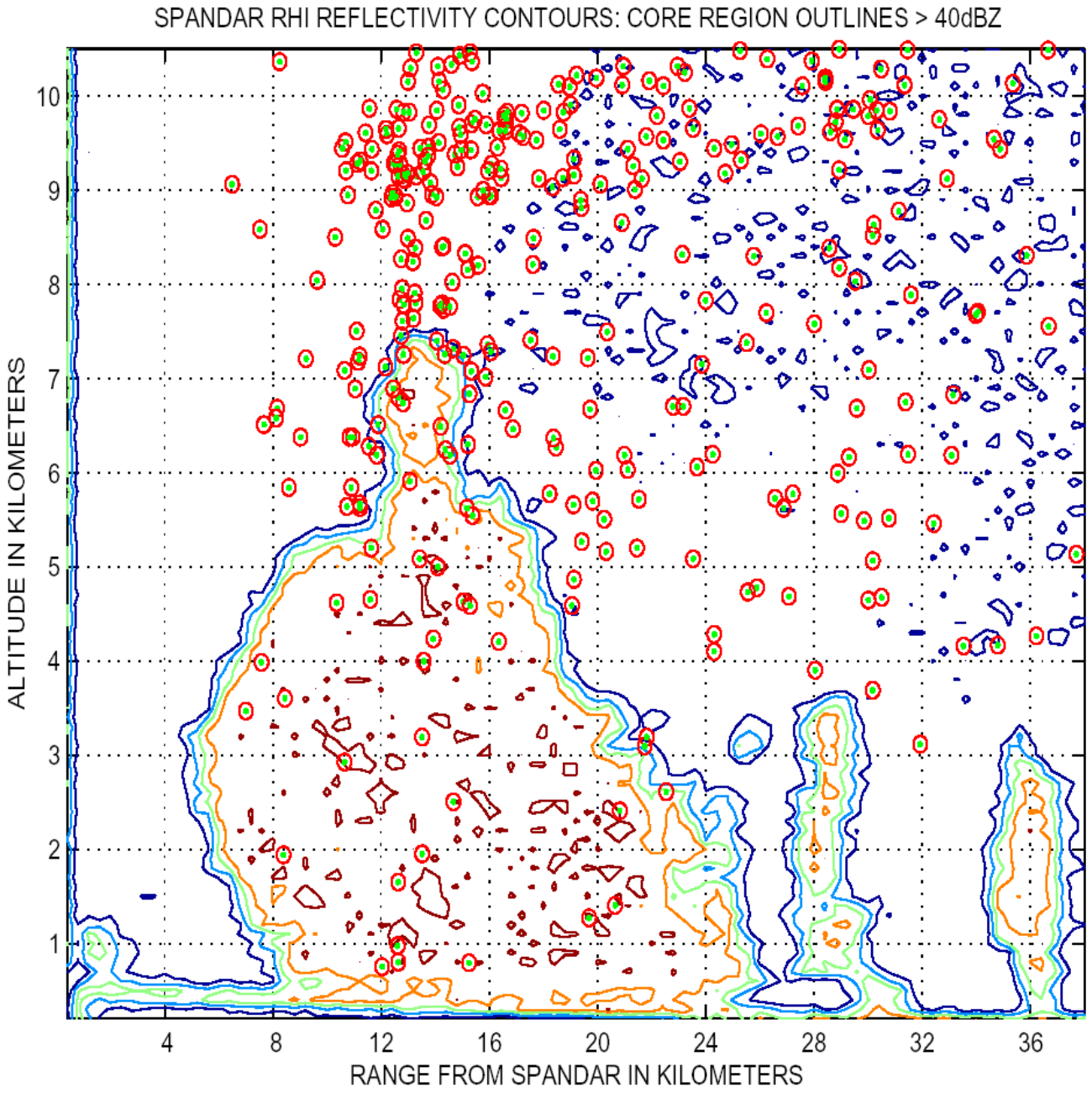
Updraft/downdraft



Why does the updraft rotate?

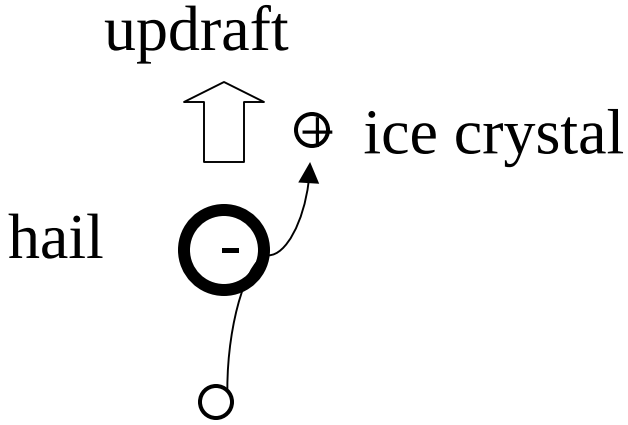
Conservation of angular momentum

Spandar radar contours



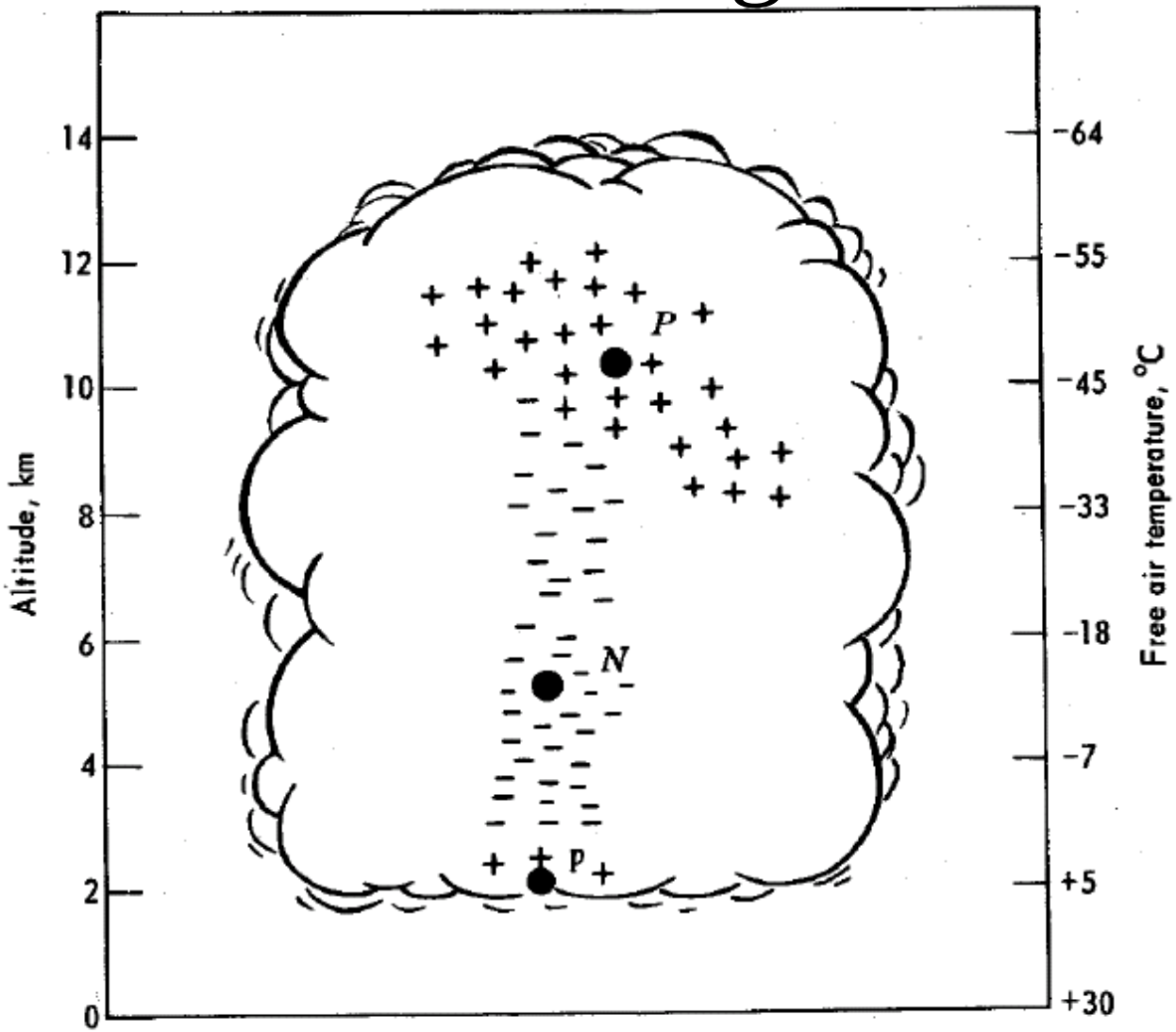
How do thunderstorms charge up?

- Charge is separated when two kinds of ice have a collision
- kinds of ice: snowflakes and ice crystals, soft ice, hail stones, frozen rain (sleet), ...
- Each has different surface electrical properties



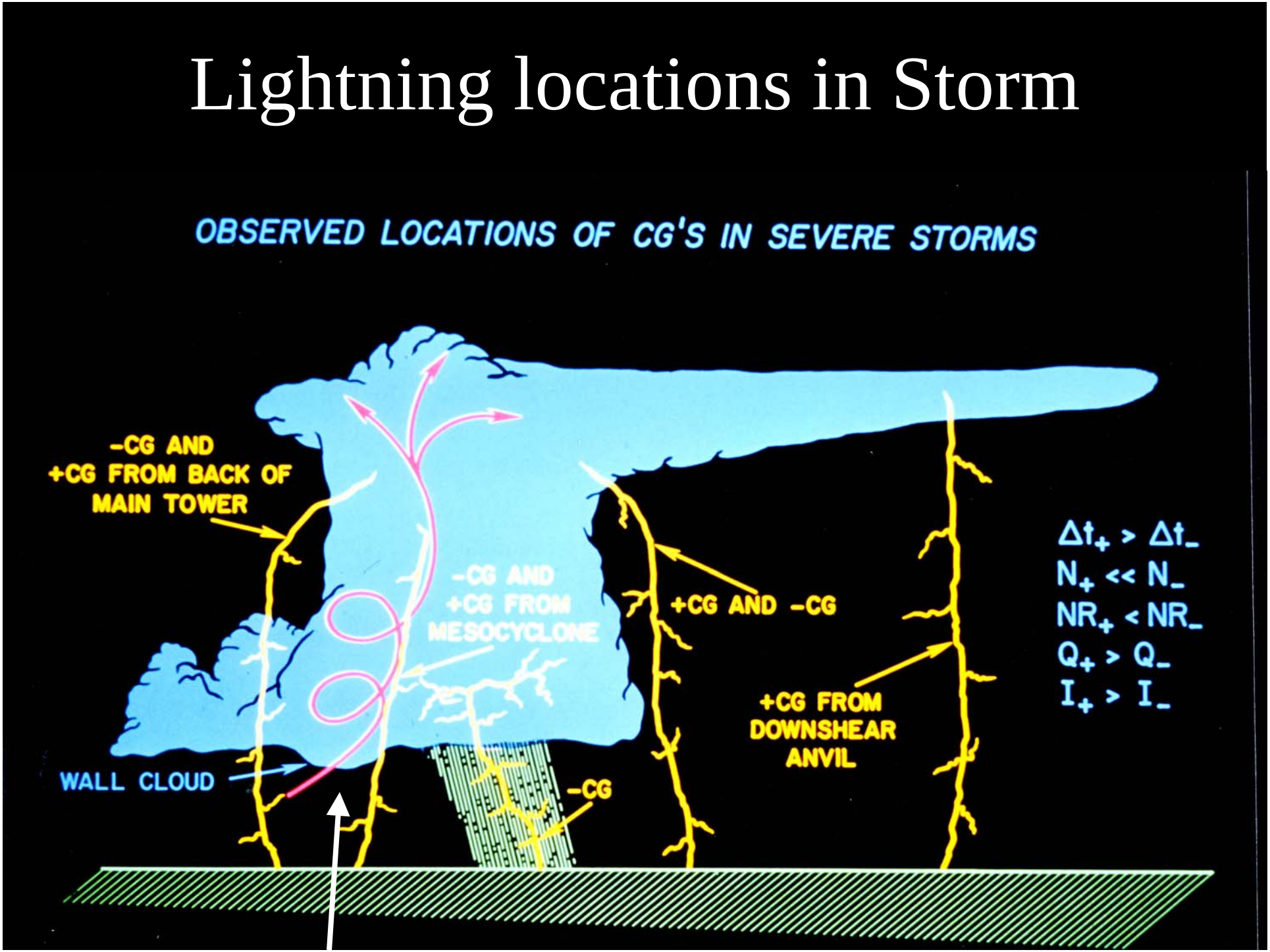
thunderstorm charge structure

10^9 to 10^{11} volts!

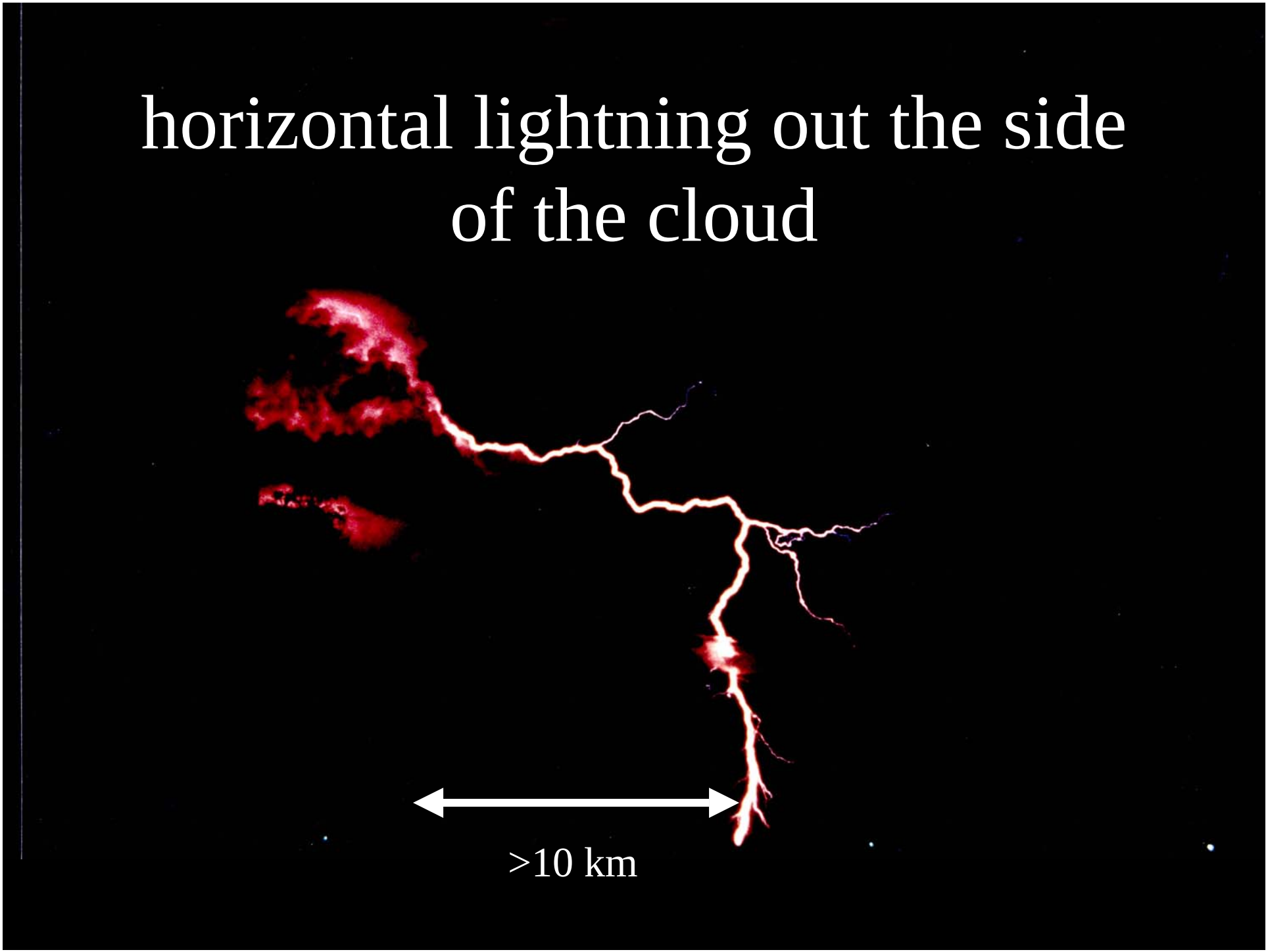


Pilot in F106 fighter during lightning strike

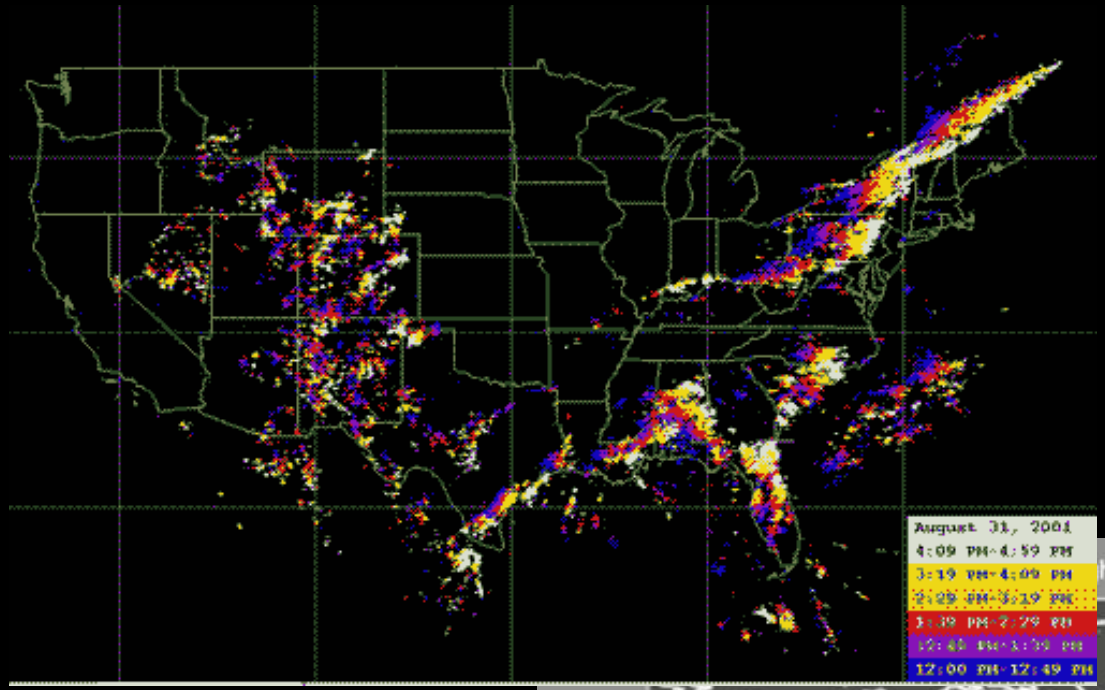
Lightning locations in Storm



horizontal lightning out the side of the cloud



Lightning Networks



NLDN – National Lightning Detection Network
(data – last summer)

Global Lightning WWLL network
UW is a node
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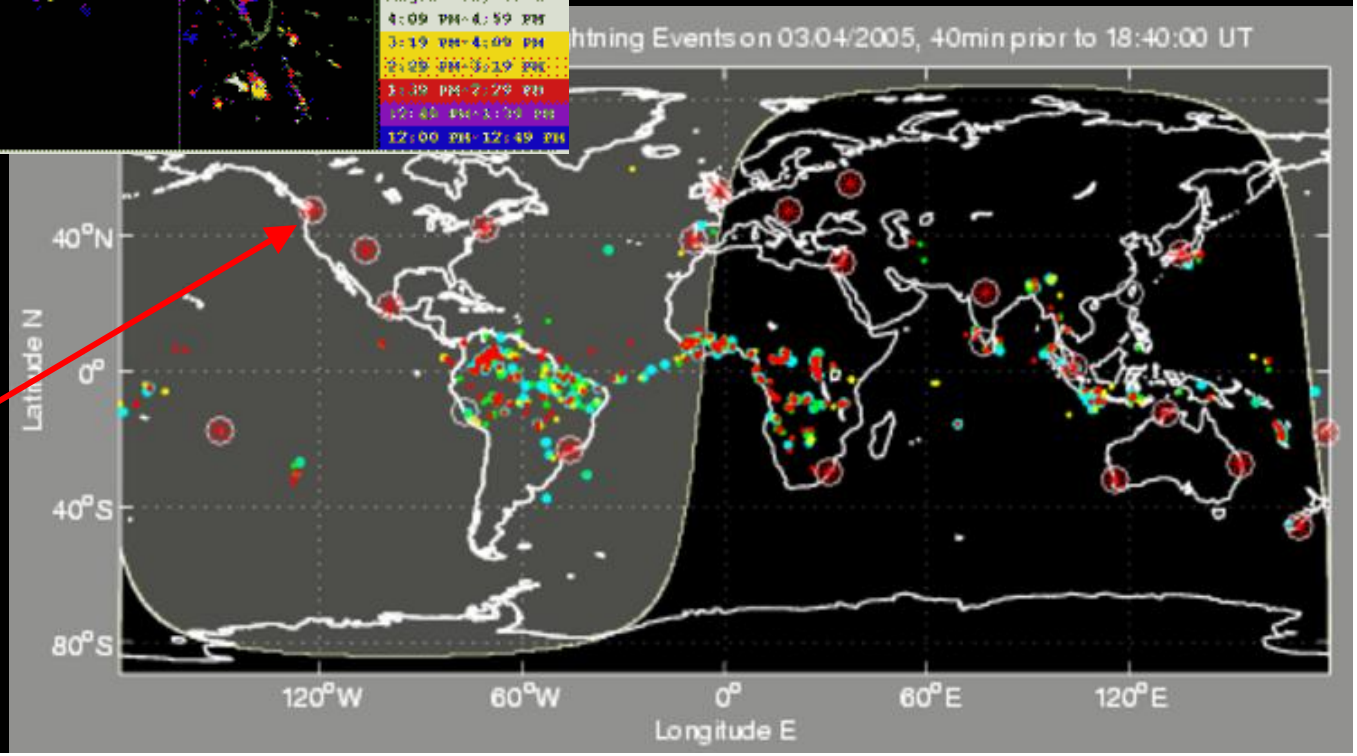

In-situ Instrumentation

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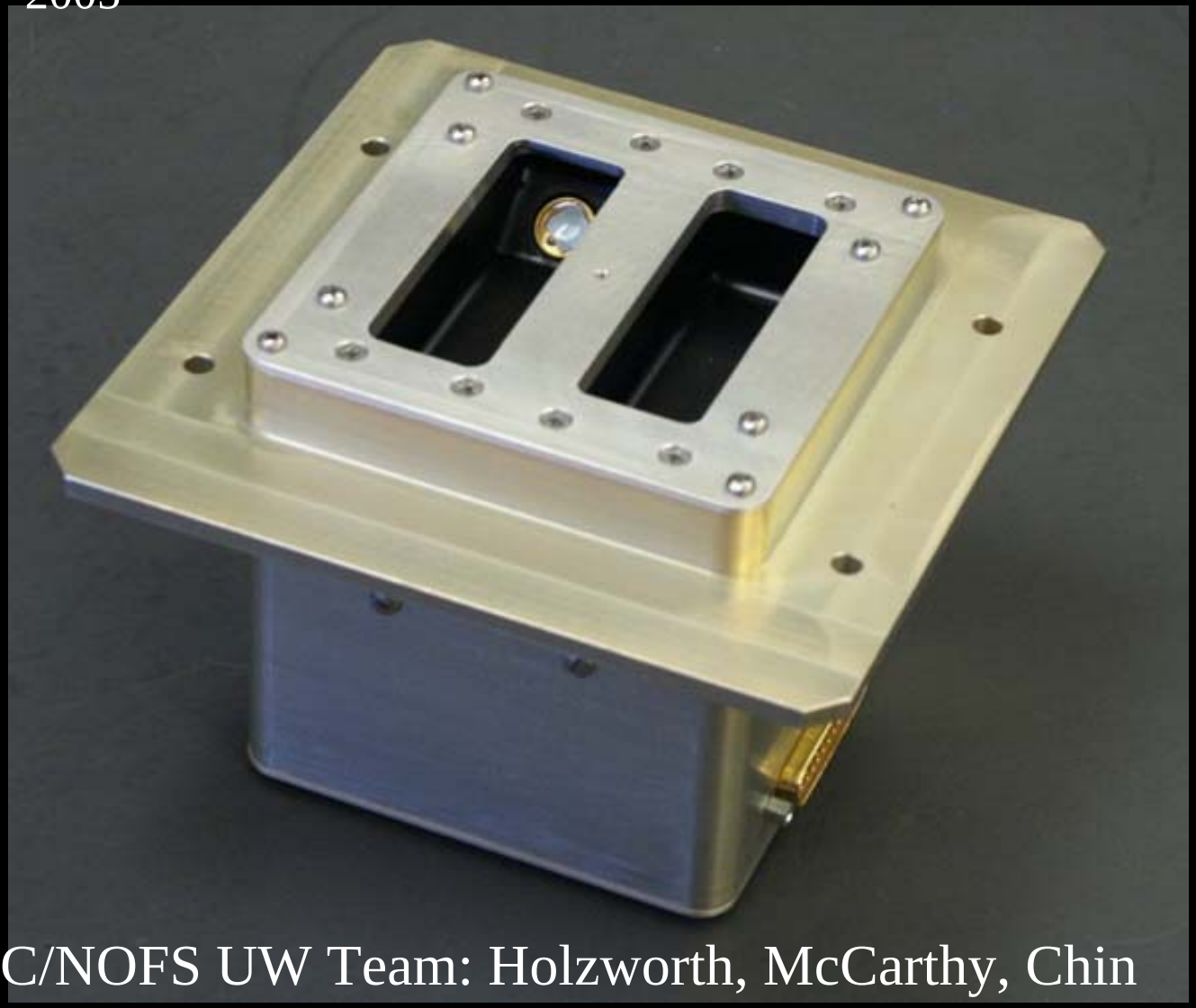

LD/VEFI/C/NOFS UW Team: Holzworth, McCarthy, Chin

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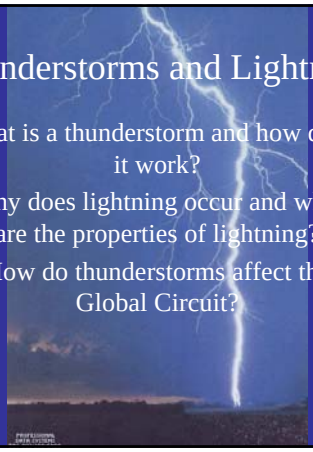

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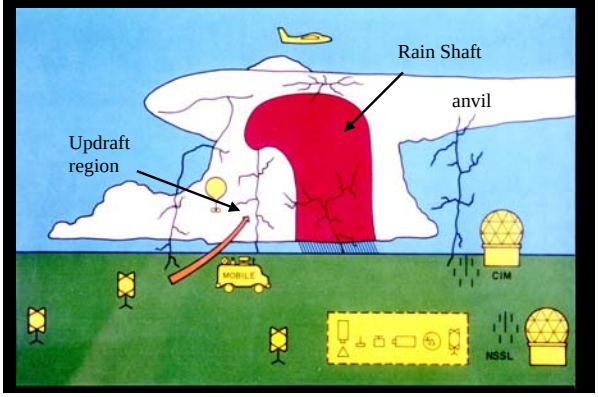

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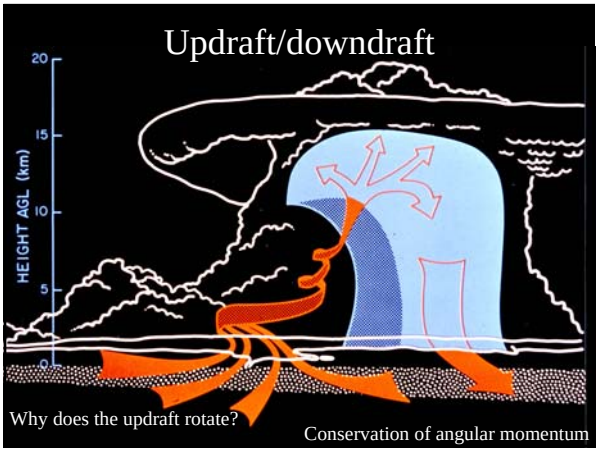

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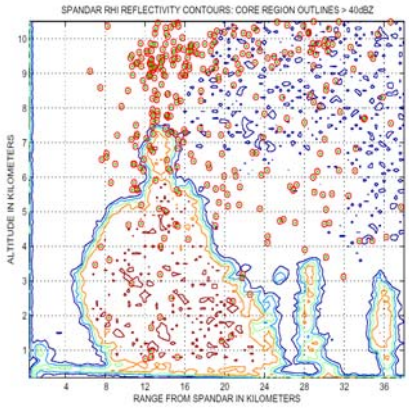

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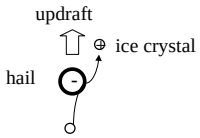

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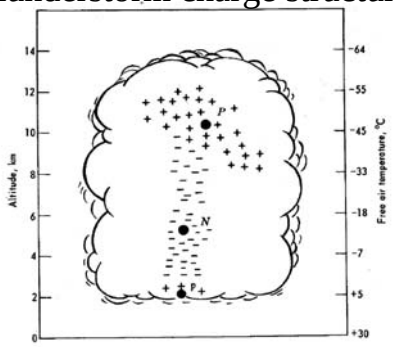

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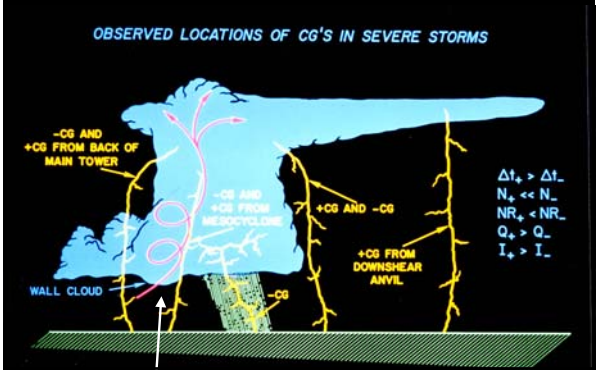

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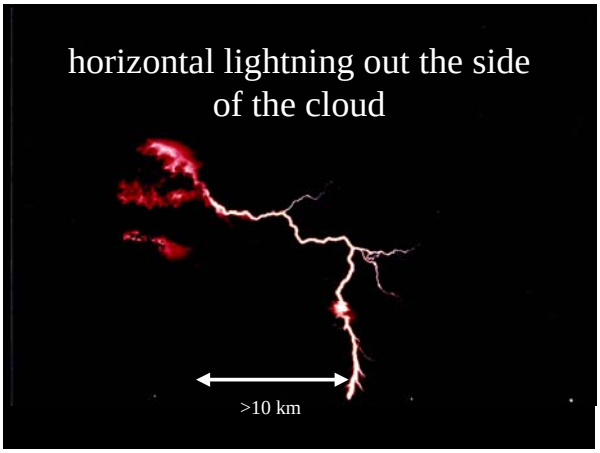

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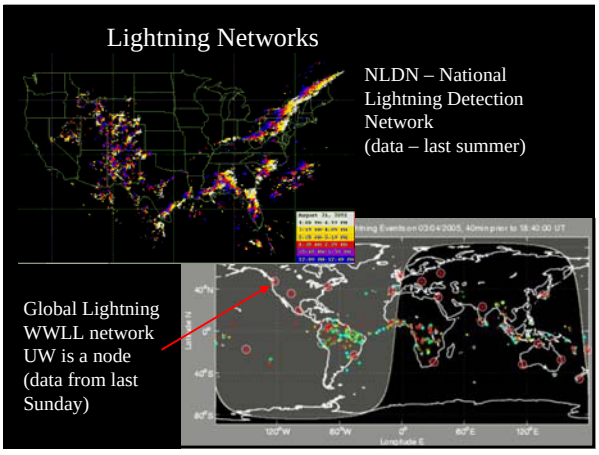

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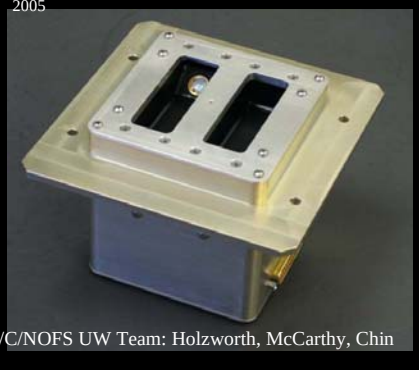

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