Meteorology – Lecture 22

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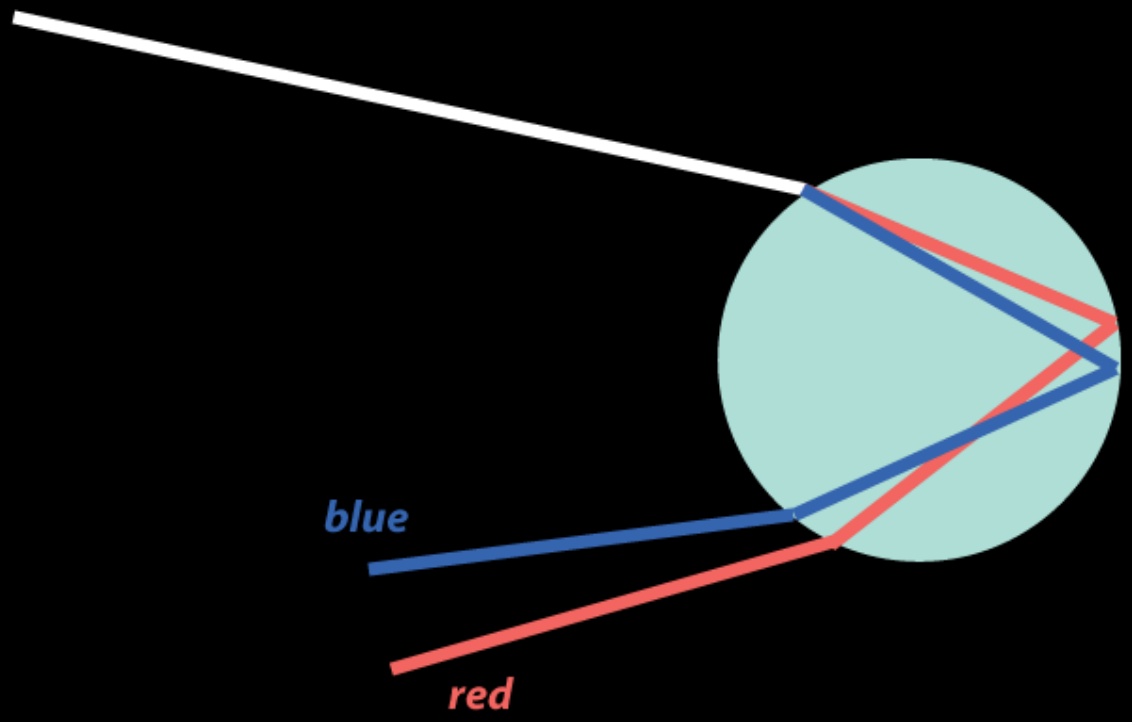
Important notes

- These slides show some figures and videos prepared by Robert G. Fovell (RGF) for his “Meteorology” course, published by The Great Courses (TGC). Unless otherwise identified, they were created by RGF.
- In some cases, the figures employed in the course video are different from what I present here, but these were the figures I provided to TGC at the time the course was taped.
- These figures are intended to supplement the videos, in order to facilitate understanding of the concepts discussed in the course. *These slide shows cannot, and are not intended to, replace the course itself and are not expected to be understandable in isolation.*
- Accordingly, these presentations do not represent a summary of each lecture, and neither do they contain each lecture’s full content.

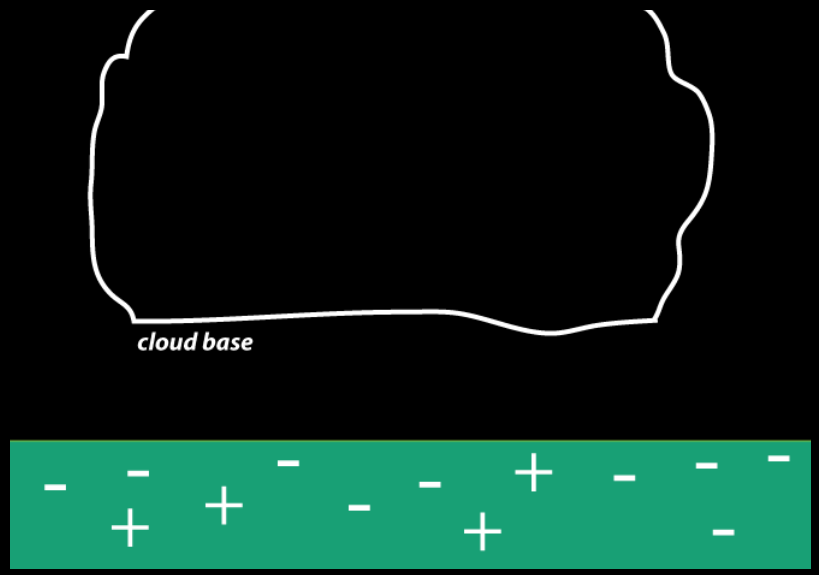
Rainbows



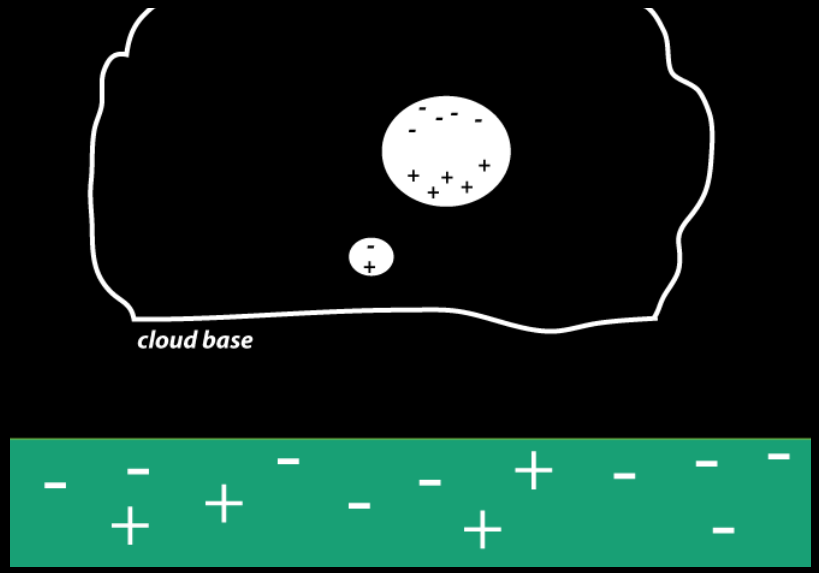
A drop of liquid water, suspended in the sky. White sunlight enters the drop. There's a large density change, so the light bends. Blue and violet are bent more than yellow and red.

This makes it appear blue would be on top of the rainbow, but from your point of view, blue's at bottom because it exited the drop at a shallower angle.

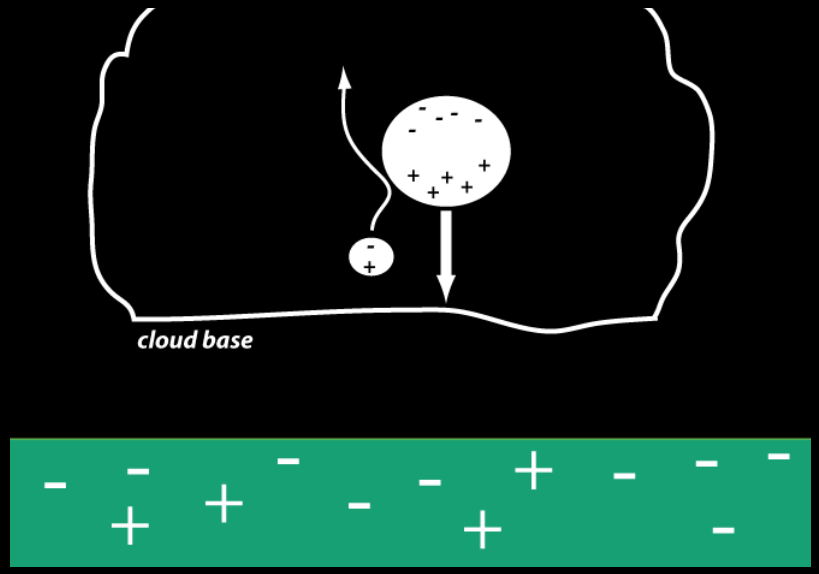
Lightning



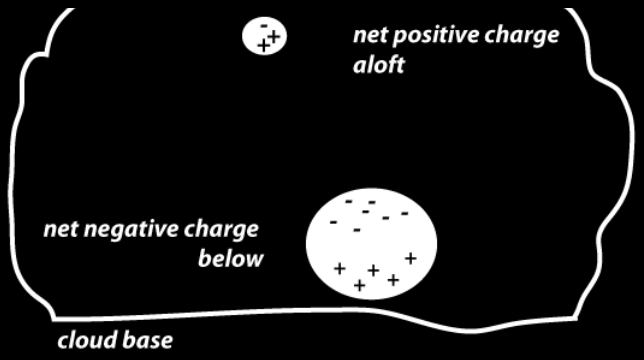
- First, recall that the ground surface typically has a surplus of negative charges
- Picture a deep cloud, miles thick, with a base a lot closer to the ground than it is to cloud top



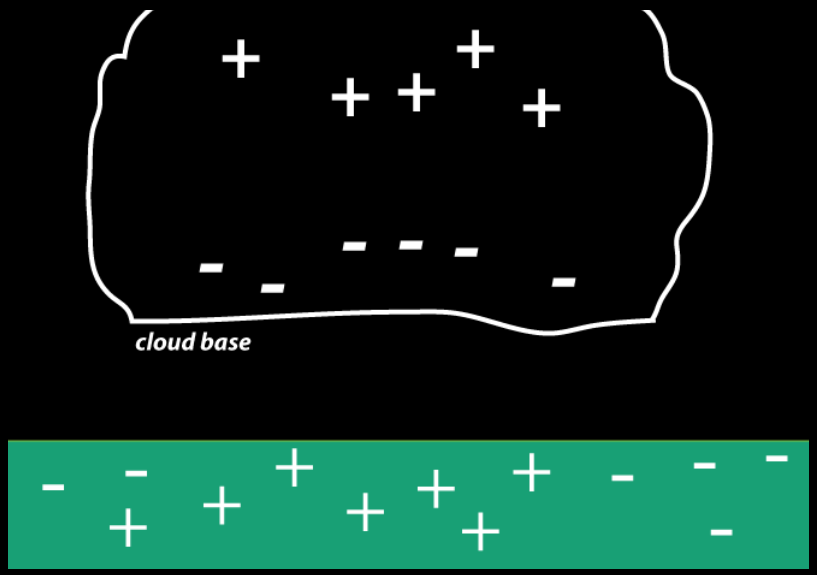
- First, recall that the ground surface typically has a surplus of negative charges
- Picture a deep cloud, miles thick, with a base a lot closer to the ground than it is to cloud top
- Picture an ice crystal and a hailstone (NOT drawn to size!)
- The negatively charged ground INDUCES positive charges at the bottoms of these particles
- These particles are NOT ionized yet
- They have NO NET charge



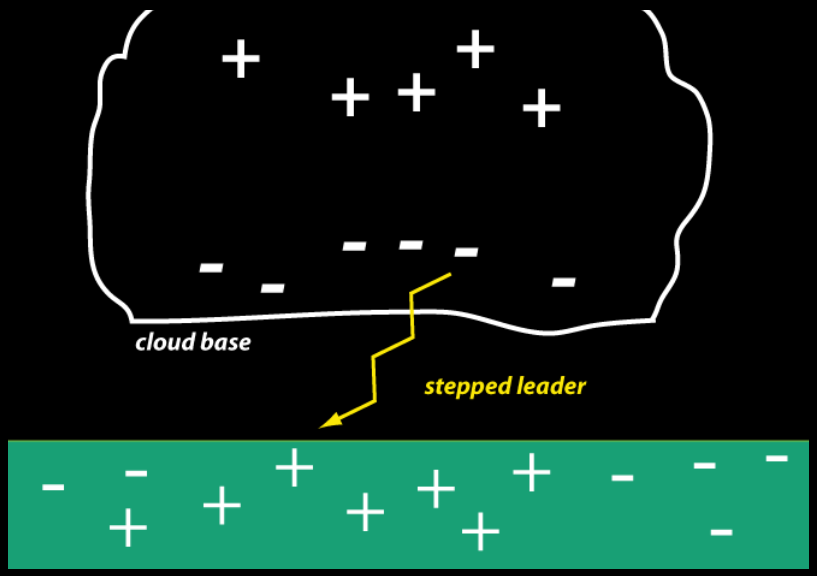
- The small ice crystals are transported upward to cloud top by the updraft
- Hailstones are HEAVY and gravitate towards cloud base, where contact with supercooled liquid helps them grow quickly
- Collisions between the small and big ice particles will occur along the way
- These collisions transfer negative charges from the ice crystal's top to the hailstone



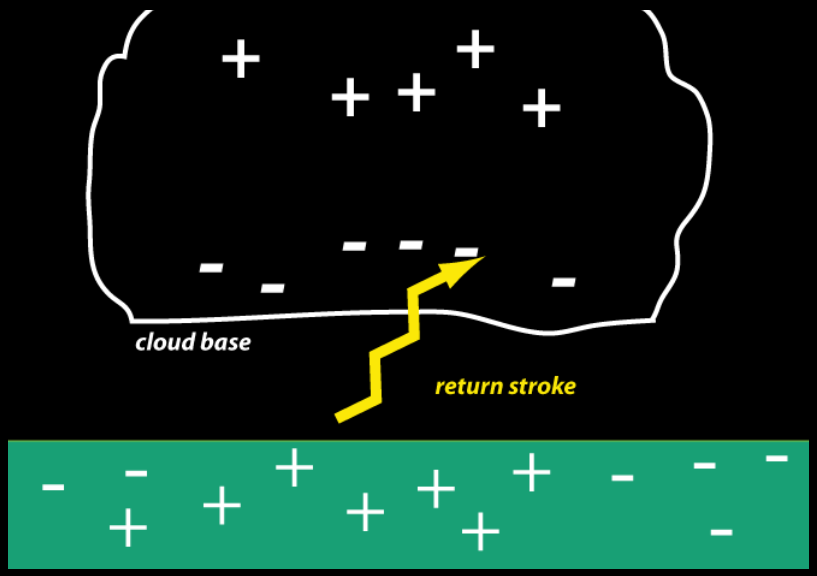
- We wind up with a surplus of positive charges at cloud top, where the ice crystals go
- Cloud base, heavy with hailstones and larger ice, becomes negatively charged



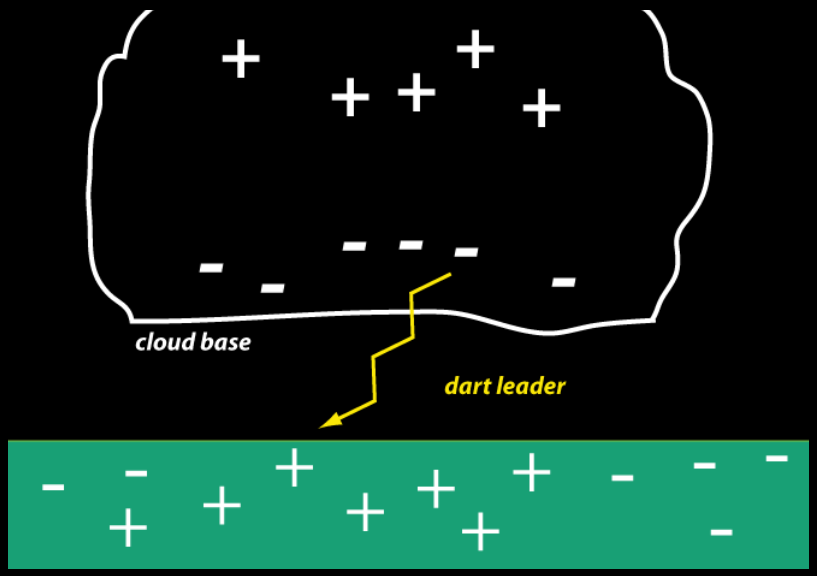
- Note we have a negatively charged cloud base facing a negatively charged ground
- Like charges REPEL
- The charge at cloud base is larger than at the ground, so the cloud “wins”
- The cloud induces a **positive charge** in the ground beneath the cloud



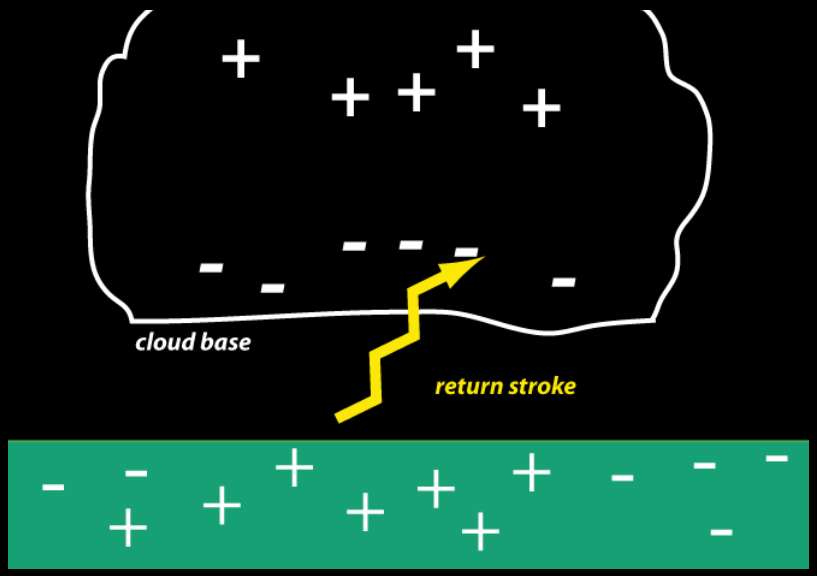
- The first part of the stroke sequence involves the creation of the **stepped leader**
- This is a little stream of negative ions looking fitfully for a path to the ground
- It steps downward in a quick series of jumps, maybe 20 m or 60 feet at a time
- It often branches out along the way



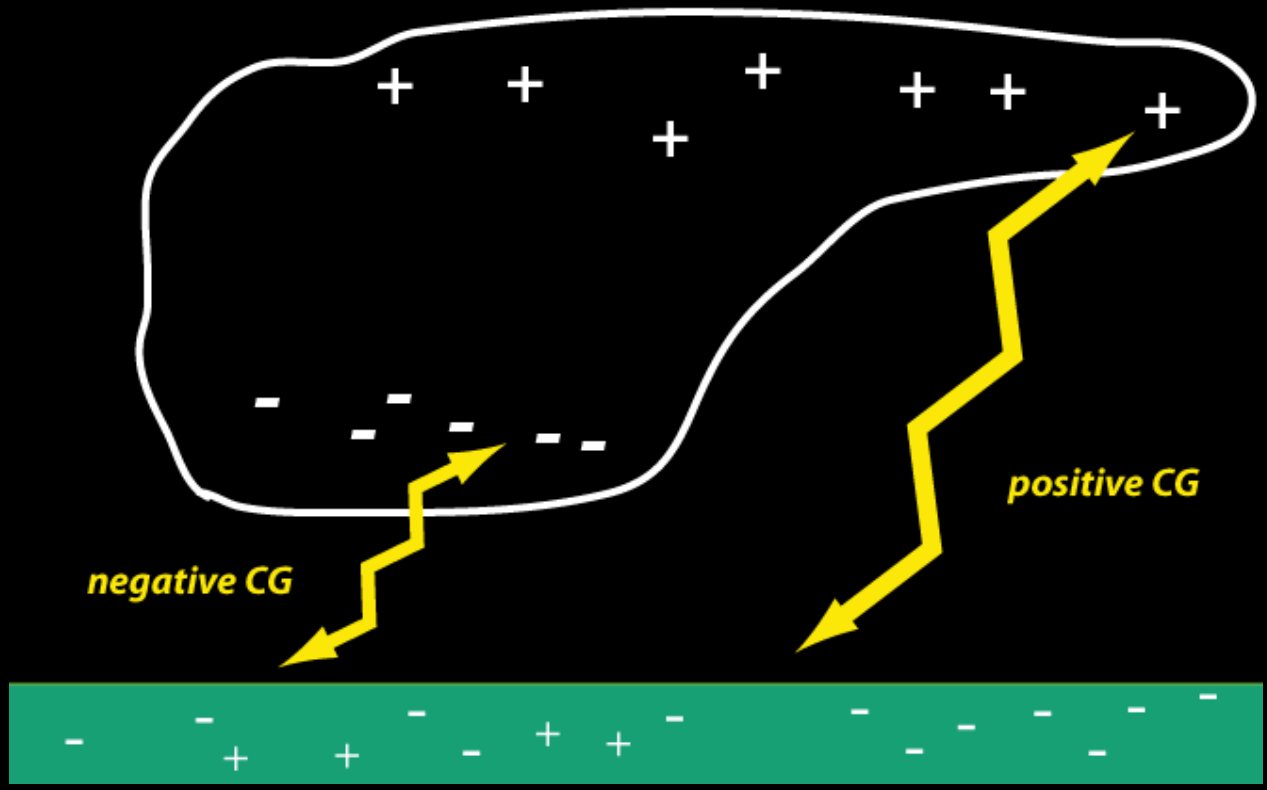
- The stepped leader is ionizing the air, smoothing the path for what's to come
- At the stepped leader nears the ground, positive ions reach upward to meet it
- The first and possibly best source of these positive ions is from tall objects that are closest to cloud base
- This sets the stage for the **return stroke**, a rush of positive charges from the ground to the cloud base
- This is bright, intense, deadly, and headed UP



- Many, if not most, lightning sequences involve TWO strikes in rapid succession.
- This likely accounts for the very familiar “strobe-light effect” we associate with lightning
- This may occur because the air channel is now more favorable to transmission of current
- This second pair starts with what is called the **dart leader**. In many ways, it’s similar to the stepped leader.

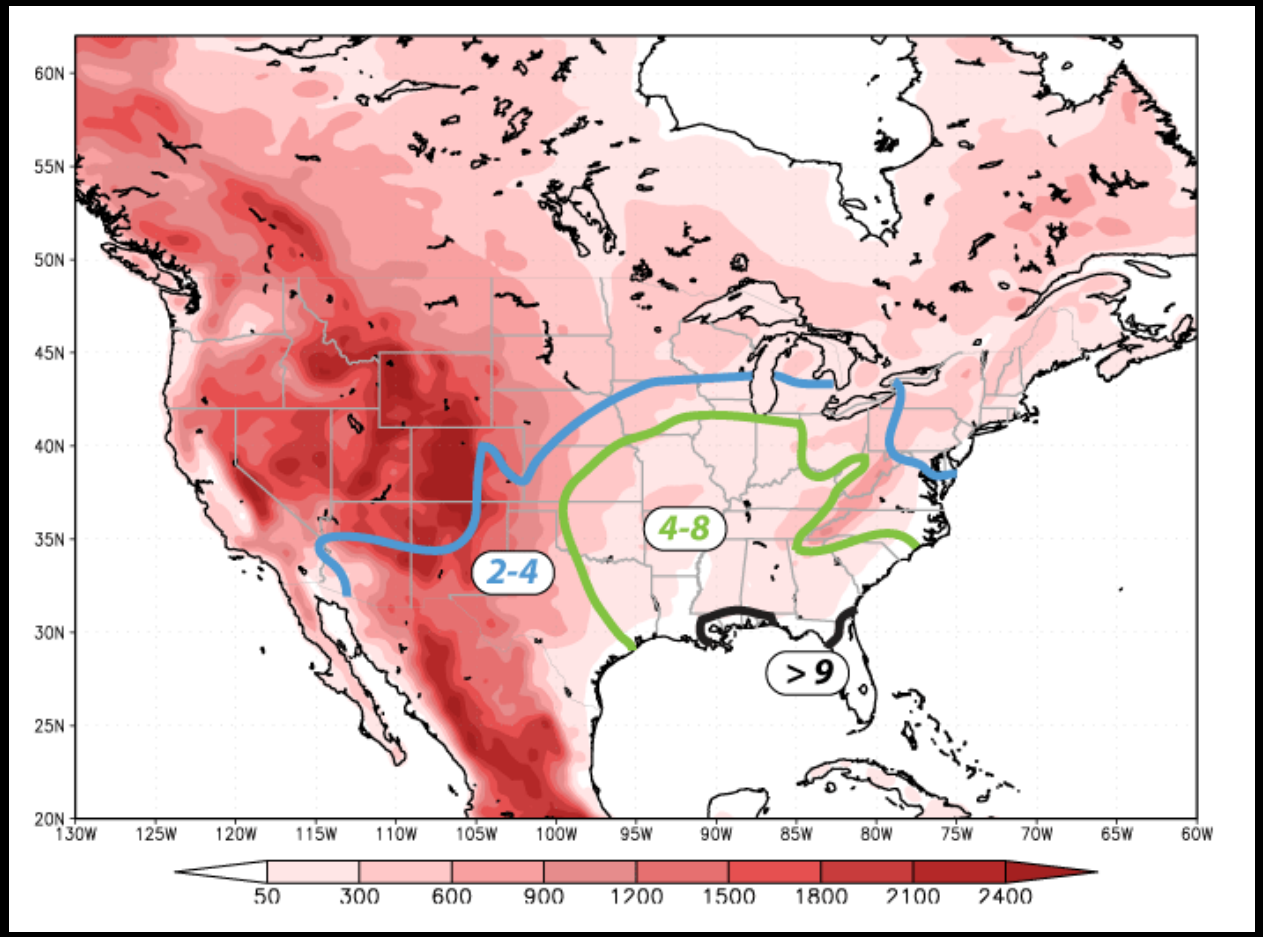


- Finally, a SECOND return stroke occurs
- Some people say lightning never strikes twice. They'rre wrong… thousands of times a day



Positive cloud-to-ground (CG) lightning is comparatively rare (8% of CG flashes) but is the deadliest variety. The reason is positive CG has to travel over the largest distance from cloud to ground. Therefore, it has to overcome the greatest amount of resistance due to air's poor electrical conductivity.

Lightning frequency (flashes/sq km/year)



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