

Lecture 25 Air Mass Thunderstorms and Lightning

Air Mass Thunderstorms

- Life Cycle
- Environment
- Climatology
- Lightning



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Air Mass Thunderstorms



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Air Mass Thunderstorms

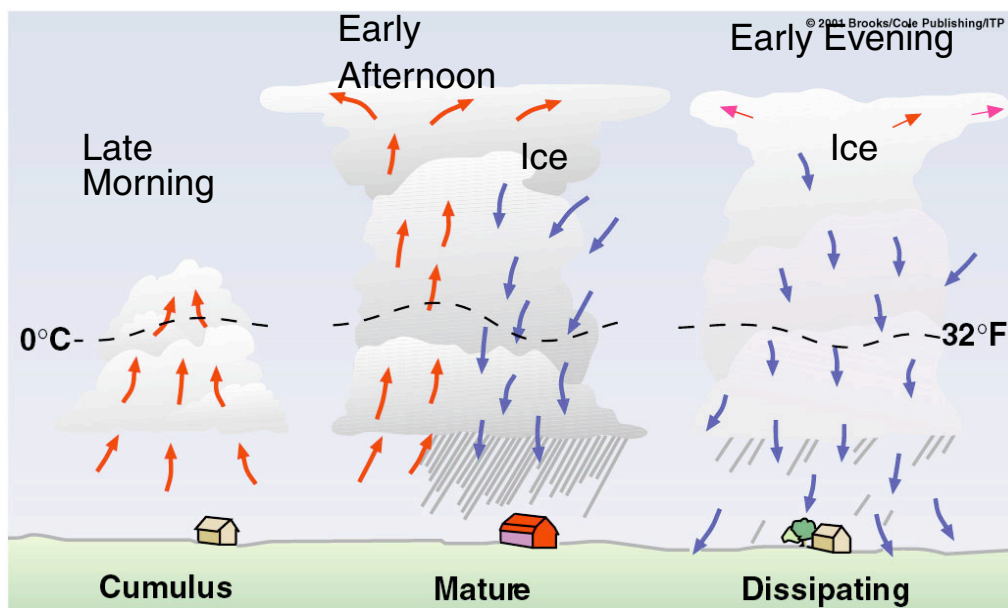
Short-lived, isolated thunderstorms that are not severe are often called air-mass thunderstorms.

There are three stages describing the life cycle of an air-mass thunderstorm.

1. cumulus
2. mature
3. dissipating

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Air Mass Thunderstorms



Three stages in the life cycle of an air-mass thunderstorm.

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Three Stages in Life Cycle of Air Mass Thunderstorm over the Colorado Rocky Mountains



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Air Mass Thunderstorms

Environment: Air Mass thunderstorms are triggered by lifting.

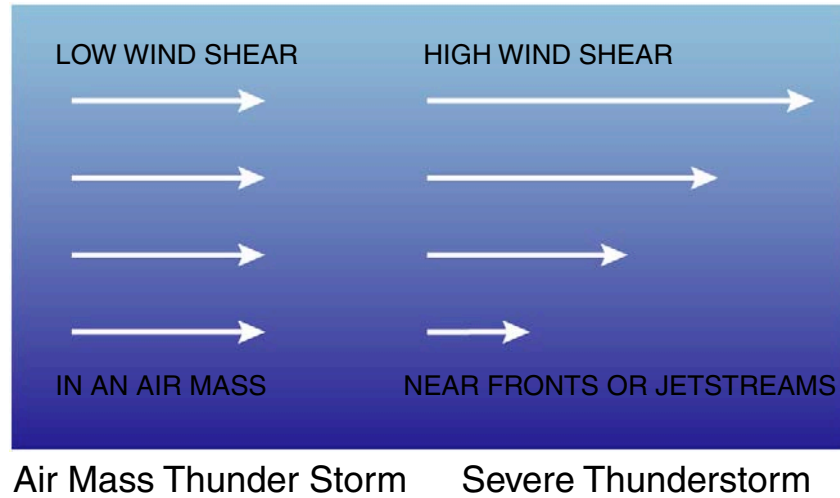
Lifting is provided by

- Sea-breeze circulations
- Land-breeze circulations
- Mountain-valley circulations
- Solar heating

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Air Mass Thunderstorms

Environment: Air Mass thunderstorms form in regions of relatively light winds and light wind shear. Thus they form away from fronts and jet streams.



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Cumulus Stage

- Growing cumulus cloud dominated by updraft - transporting warm, moist air upward
- No precip is reaching the surface at this stage, though it begins to form in the cloud
- Air parcel temperatures in the cloud are warmer than the surrounding air.



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Cumulus Stage



Note the rain-free cloud base

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Mature Stage

- Storm is most intense, cloud tops can reach tropopause - with overshooting tops, seen in satellite imagery.
- Ice and water are both present in the cloud.
- lightning and thunder may be present
- Storm is characterized by warm updraft and cold, downdraft, with precipitation reaching the surface
- Downdraft can produce strong, gusty winds at surface



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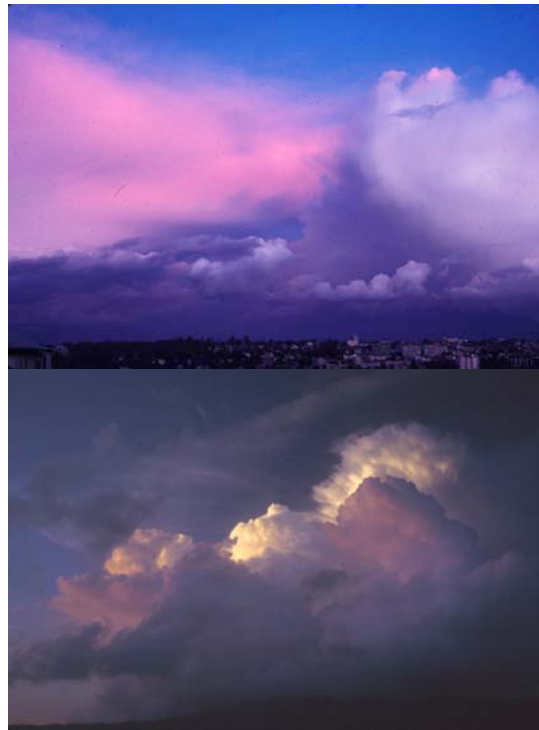
Mature Stage



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Dissipating Stage

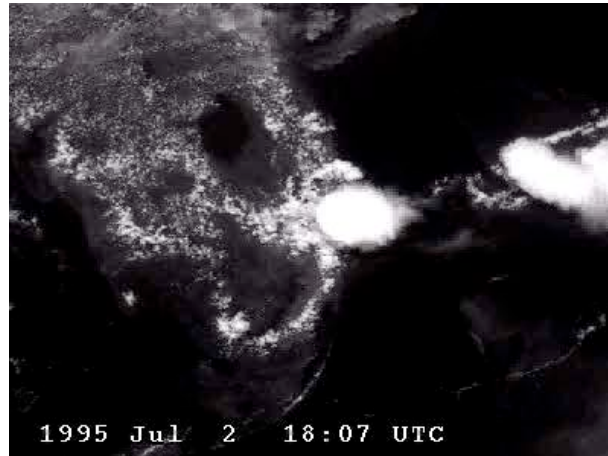
- Storm is dominated by the downdrafts.
- Precipitation intensity at the ground weakens.
- End up with a cold pool of air at the ground, warm air is now aloft.
- Hence, the storm has stabilized the environment



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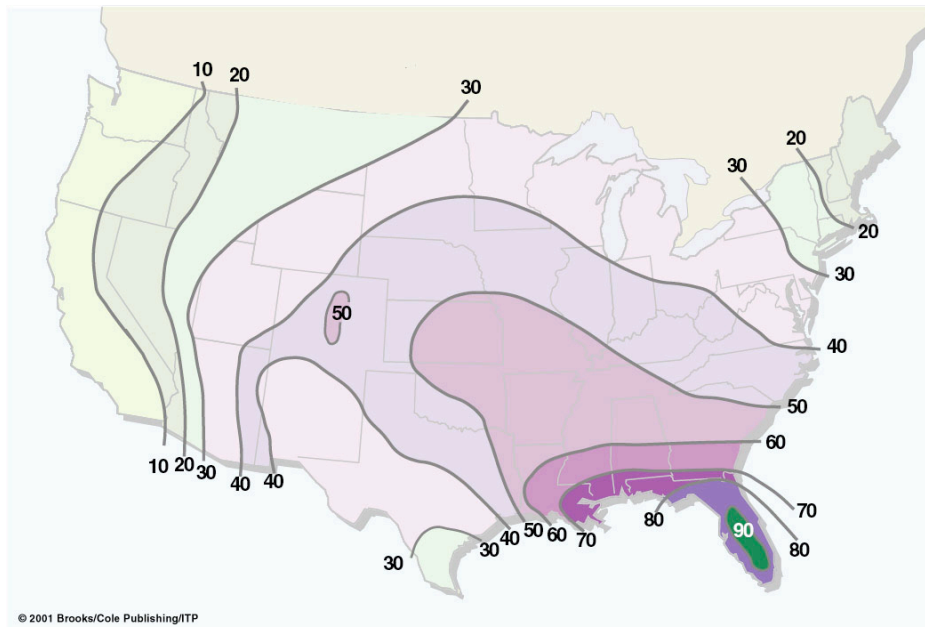
Sea Breeze

Converging Gulf of Mexico and Atlantic sea breezes produce uplift and thunderstorm development in Florida.



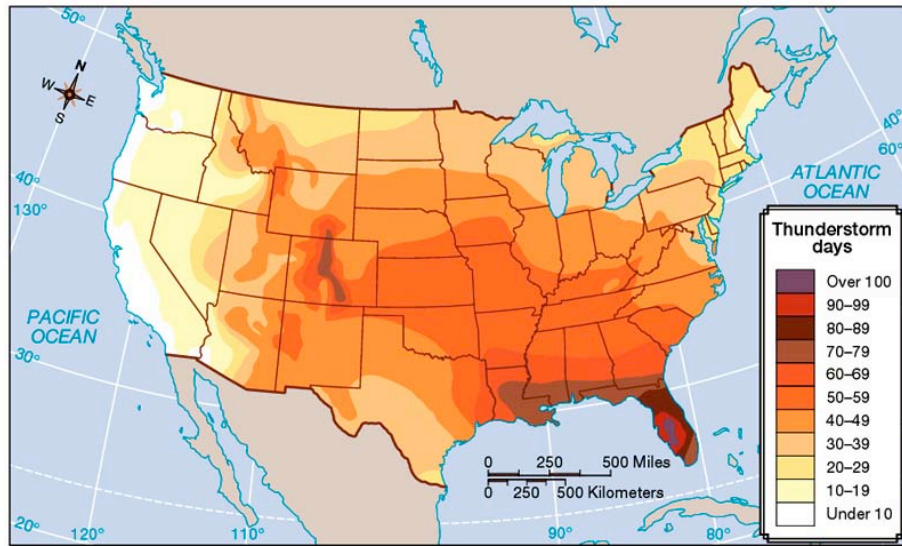
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Climatology of Air Mass Thunderstorms

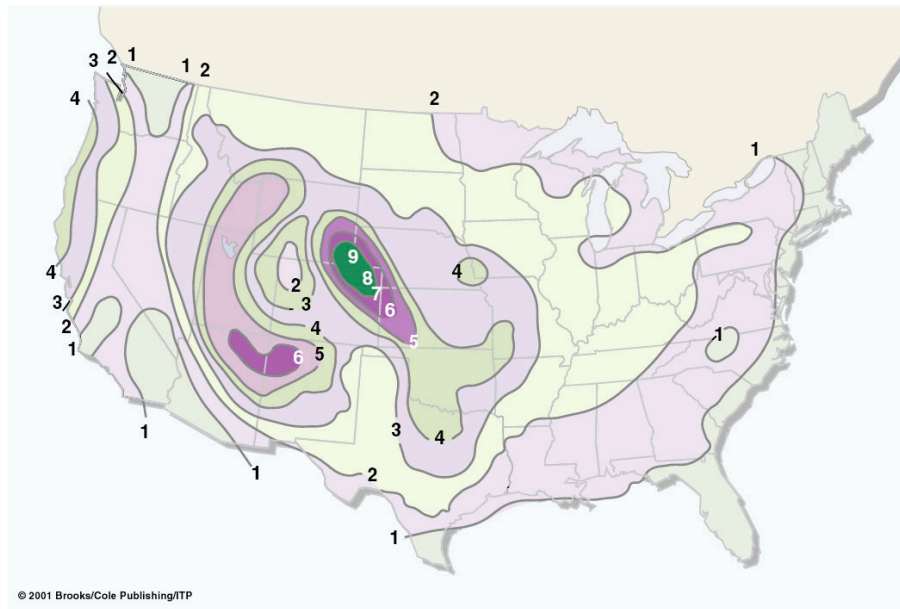


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Climatology of Lightning



Climatology of All Hail Storms



Lightning



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Lightning



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Avoid High Places



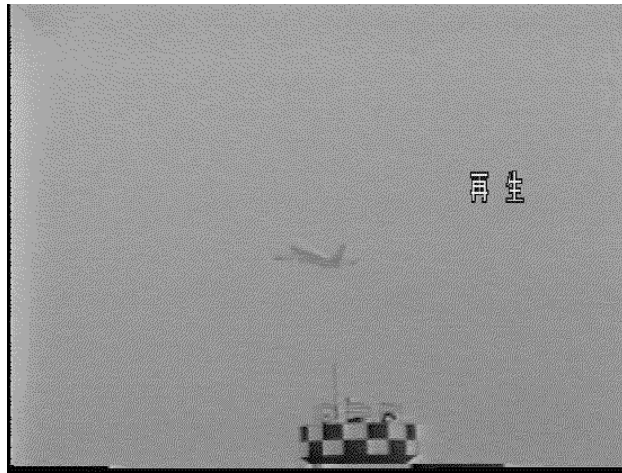
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Avoid high &
exposed places
during
thunderstorms



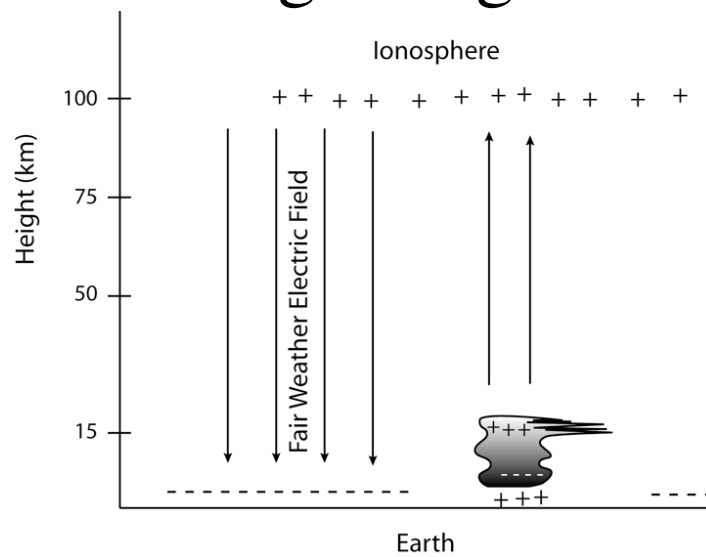
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Lightning



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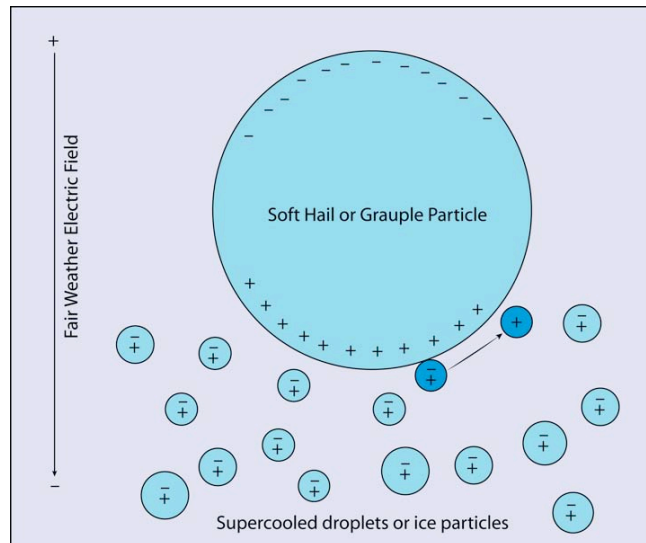
Lightning



Charges are separated in the thunderstorm cloud by up and down drafts and precipitation processes in the presence of the fair-weather electric field.

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Lightning

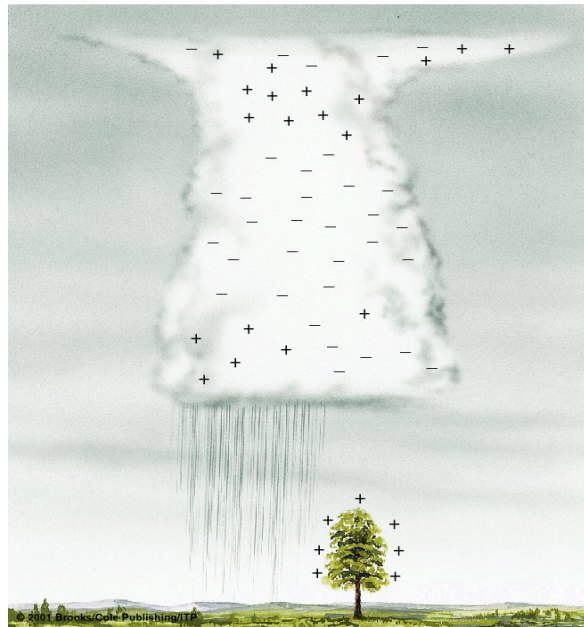


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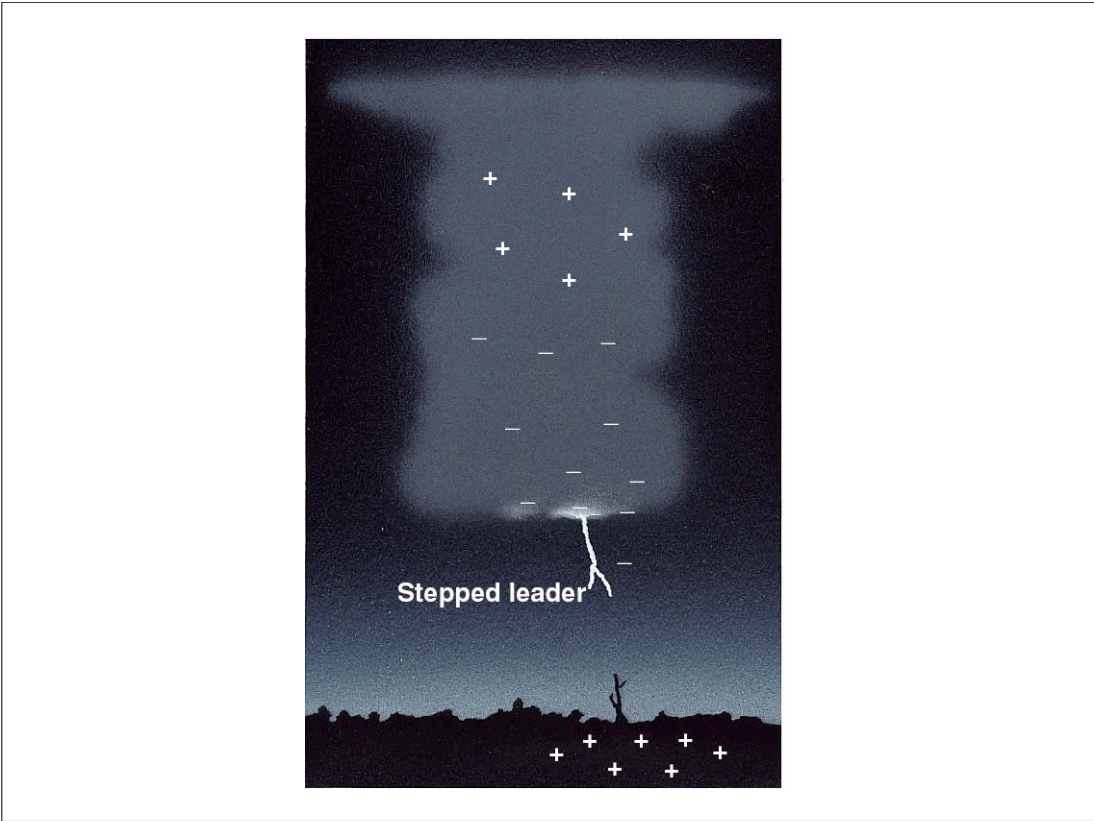
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Lightning

Charges are separated in the thunderstorm cloud by up and down drafts and precipitation processes in the presence of the fair-weather electric field.



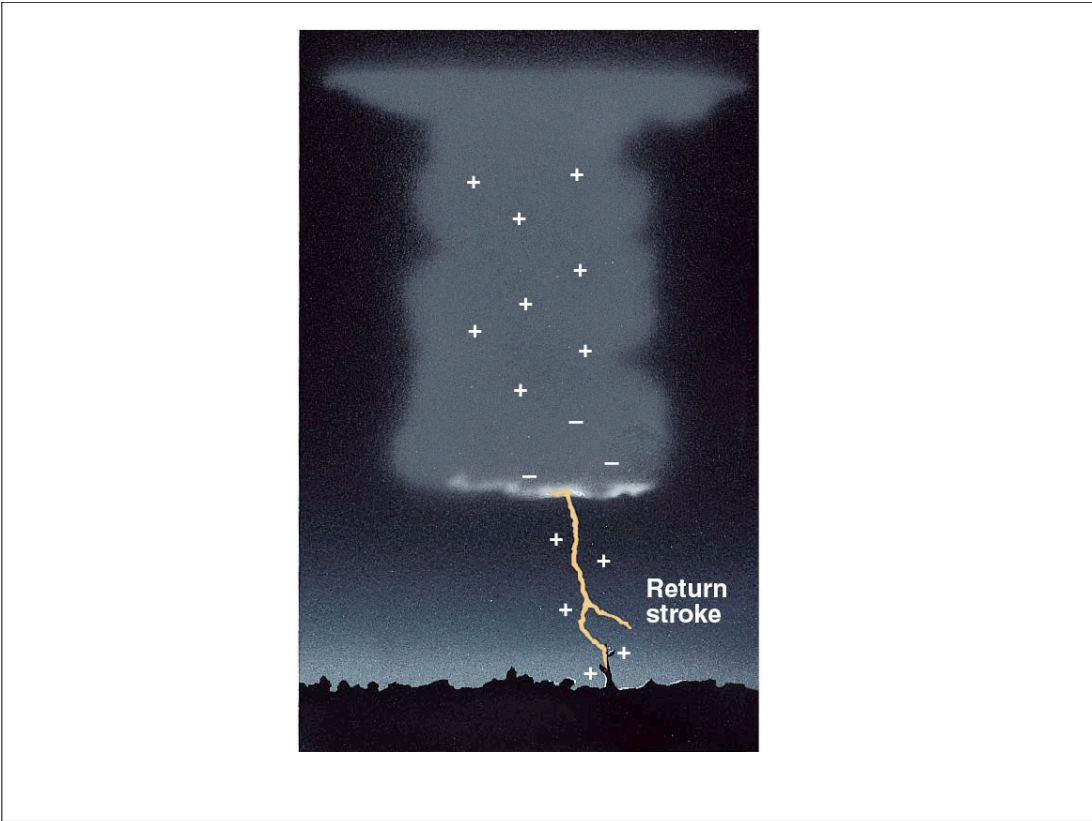
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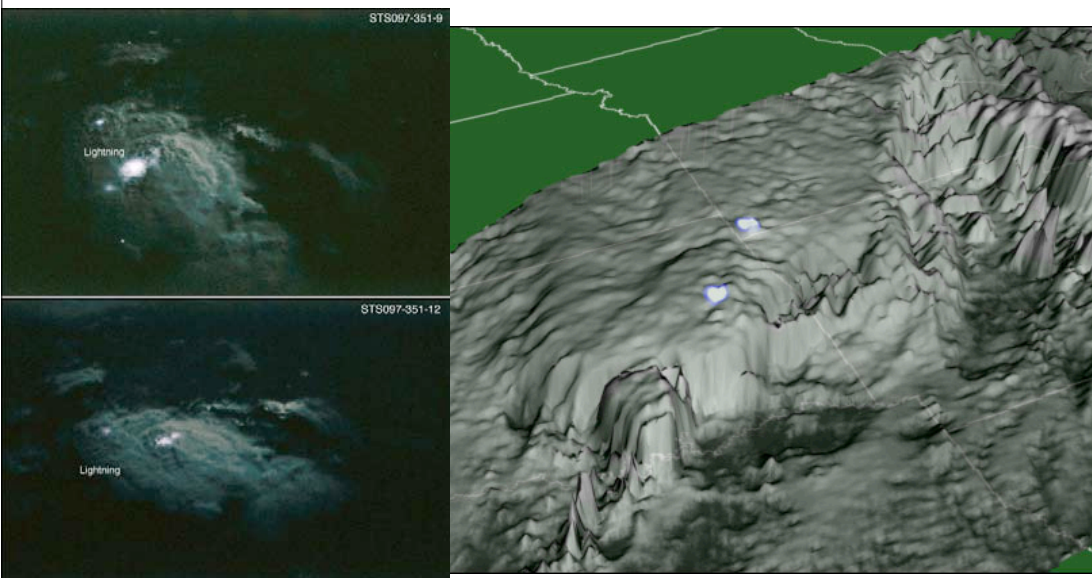


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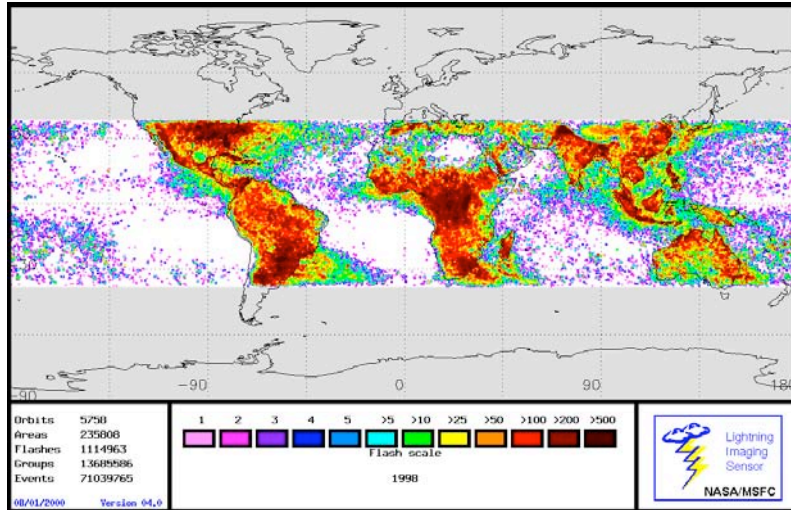
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Lightning from Space



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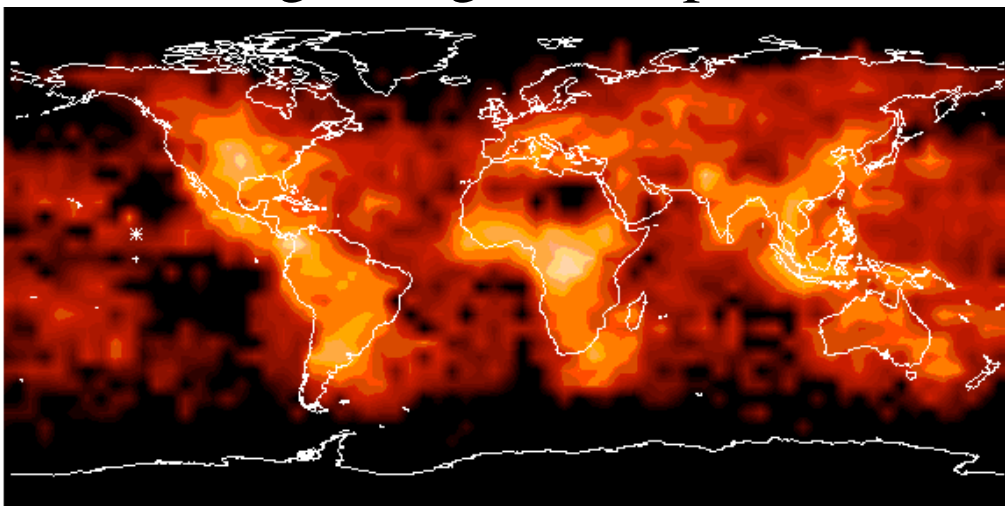
Lightning from Space



At any given moment there are more than 44,000 thunderstorms raging around the globe. The combined affect of all the lightning strikes is to bring negative charge to the ground, and positive charge to the ionosphere, resulting a charge differential and a fair-weather electric field.

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Lightning from Space



At any given moment there are more than 44,000 thunderstorms raging around the globe. The combined affect of all the lightning strikes is to bring negative charge to the ground, and positive charge to the ionosphere, resulting a charge differential and a fair-weather electric field.

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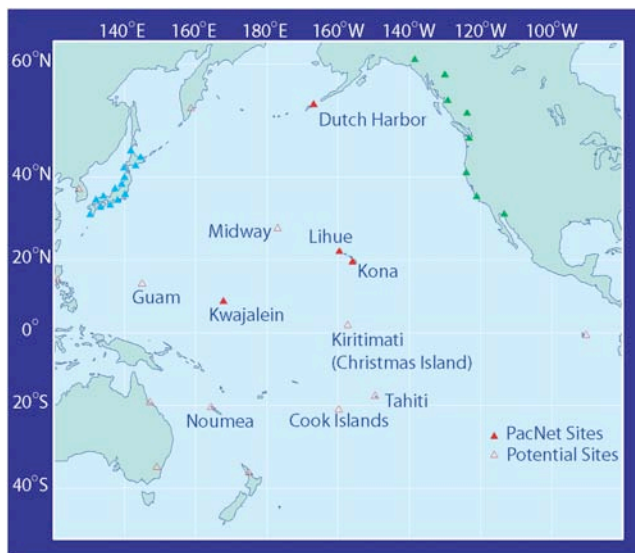
Earth-Based Lightning Detection



Earth-based lightning detectors observe radio noise created by lightning.

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Pacific Lightning Detection Network

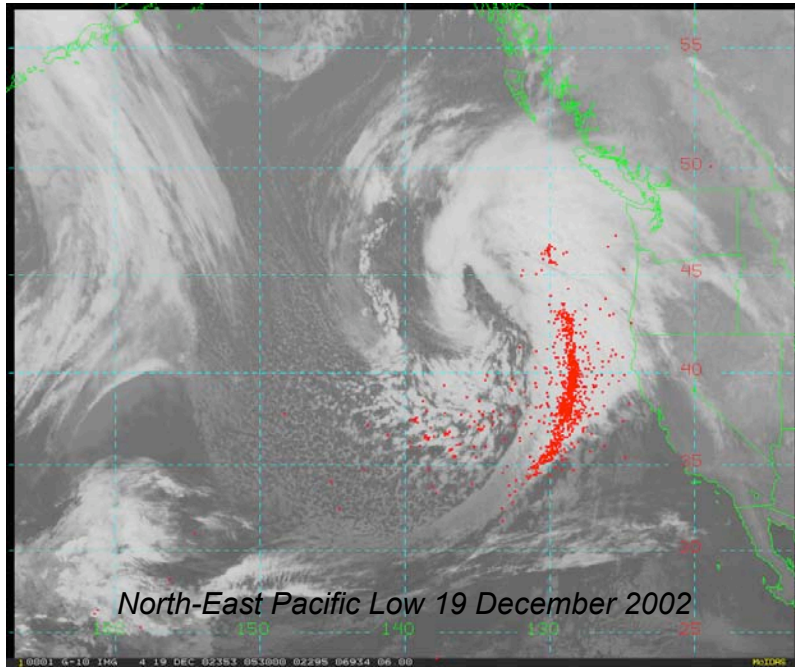


Lihue Sensor

Currently 4 sensors installed at Dutch Harbor, Lihue, Kona and Kwajalein. Sensors in North-America and Japan contribute.

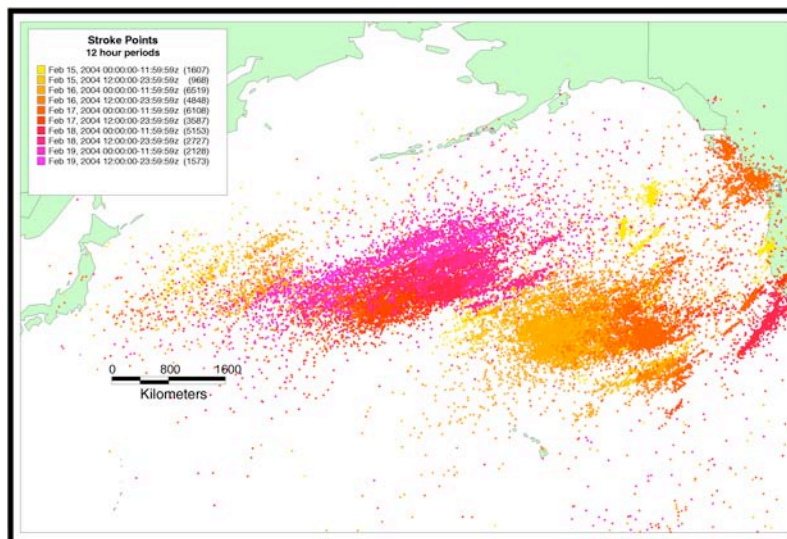
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Midlatitude Cyclone



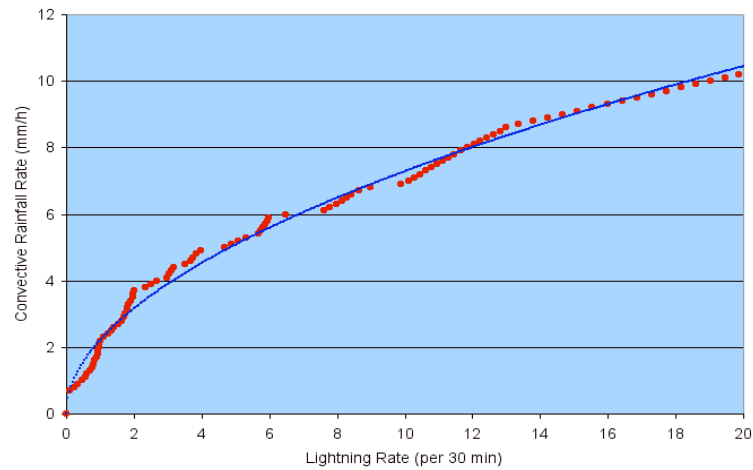
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5 Days of Pacific Lightning Activity



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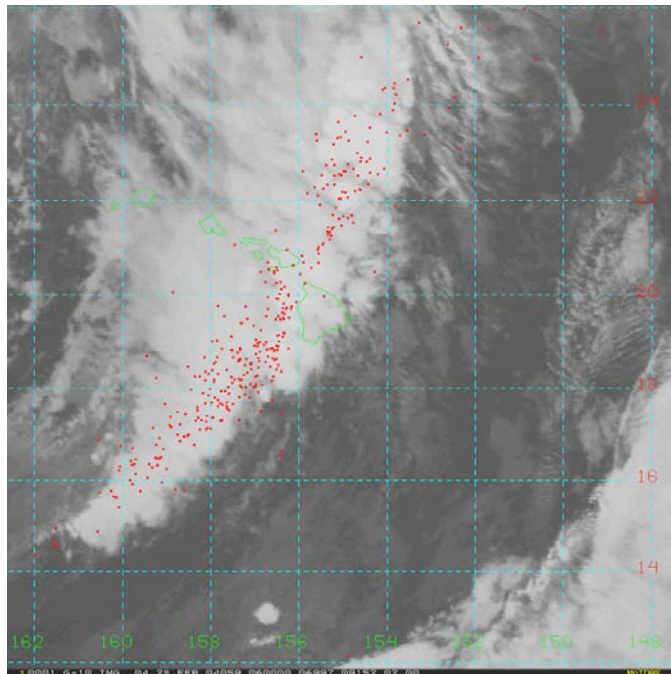
Lightning - Convective Rainfall Relationship



There is a close relationship between lightning strikes and rainfall. Thus, the observed rate of lightning flashes seen by satellite can be input in weather prediction models as rainfall.

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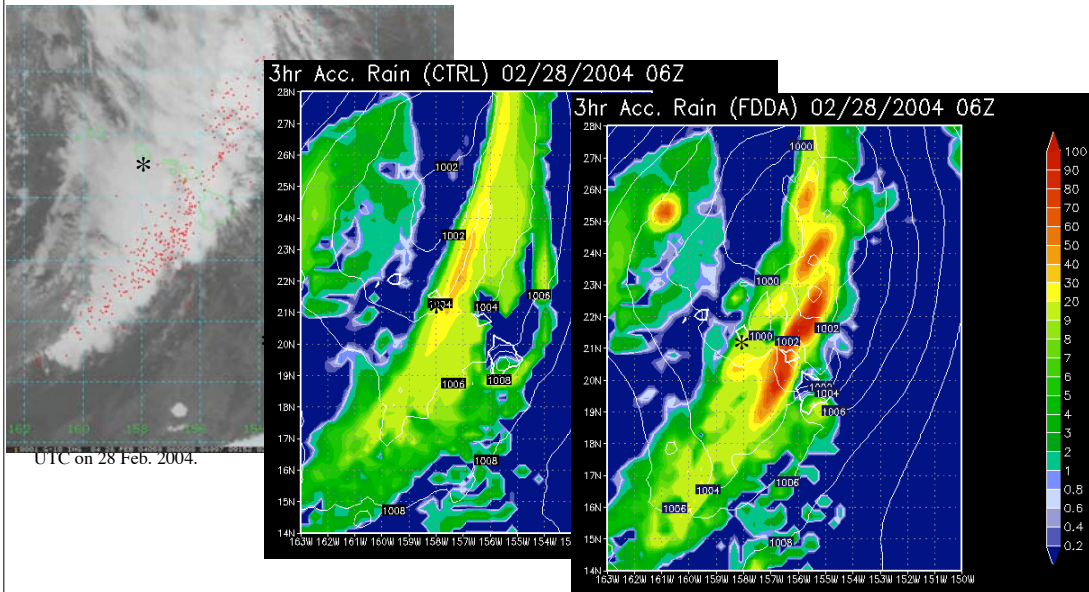
Hawaiian Squall Line



28 February 2004

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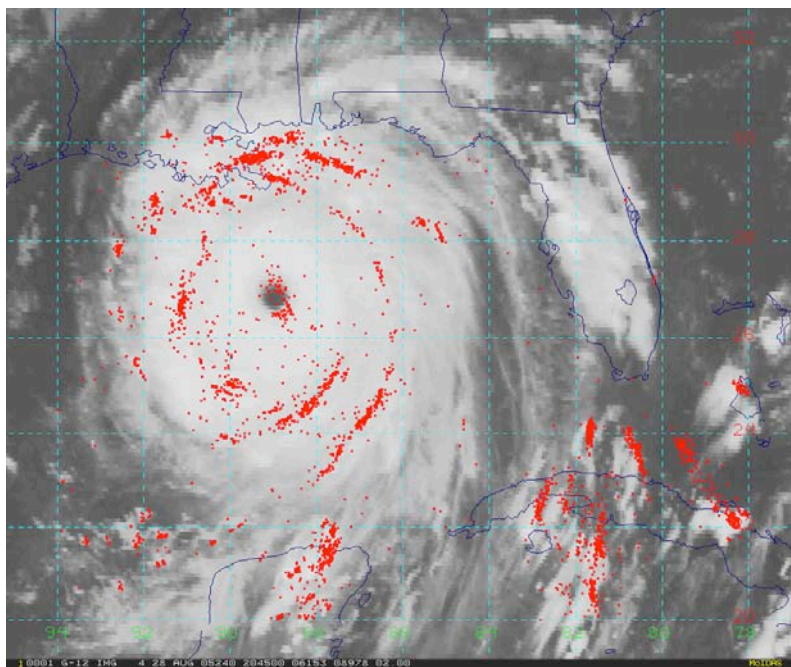
Timing of a Squall Line over Hawaii



Six-hour model forecast for rainband position was off by ~150 km at 06UTC, 28 February 2004.

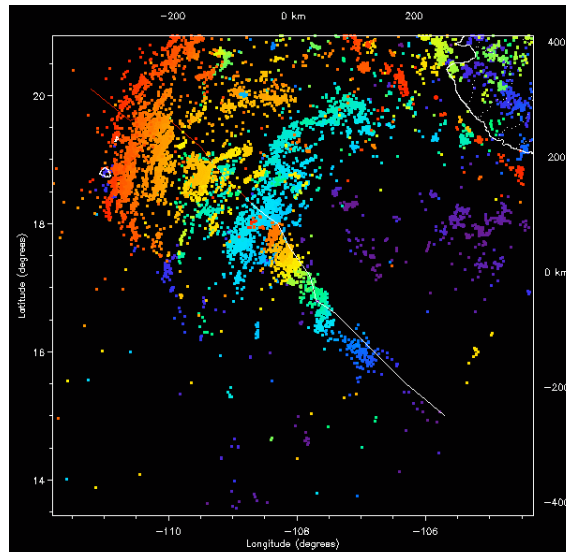
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Lightning Strikes in Katrina



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Eye Wall Lightning in Javier



Colors indicate time of strike

Eye wall lightning along the track of Hurricane Javier
13 September 2004 1500 UTC - 15 September 2004 1500 UTC

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What stage is
this storm in?



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What stage is this storm in?



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Questions?



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What stage is this storm in?



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What stage is this storm in?



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What stage is this storm in?



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What stage is this storm in?



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