Lecture 25  Air Mass Thunderstorms and Lightning

Air Mass Thunderstorms
• Life Cycle
• Environment
• Climatology
• Lightning
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**

Three stages in the life cycle of an air-mass thunderstorm.
Three Stages in Life Cycle of Air Mass Thunderstorm over the Colorado Rocky Mountains

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
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.

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.
Cumulus Stage

Note the rain-free cloud base

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.
Mature Stage

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
Sea Breeze

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

Climatology of Air Mass Thunderstorms
Climatology of Lightning

Climatology of All Hail Storms
Lightning

![Lightning in a storm](image1)

Lightning

![Multiple lightning strikes](image2)
Avoid High Places

Avoid high & exposed places during thunderstorms
Charges are separated in the thunderstorm cloud by up and down drafts and precipitation processes in the presence of the fair-weather electric field.
Charges are separated in the thunderstorm cloud by up and down drafts and precipitation processes in the presence of the fair-weather electric field.
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.
Earth-Based Lightning Detection

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

Pacific Lightning Detection Network

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

North-East Pacific Low 19 December 2002

5 Days of Pacific Lightning Activity
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.

Hawaiian Squall Line

28 February 2004
Timing of a Squall Line over Hawaii

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

Lightning Strikes in Katrina
Eye Wall Lightning in Javier

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

What stage is this storm in?
What stage is this storm in?

Questions?
What stage is this storm in?
What stage is this storm in?