Chapter 15, Part 3

Tornadoes

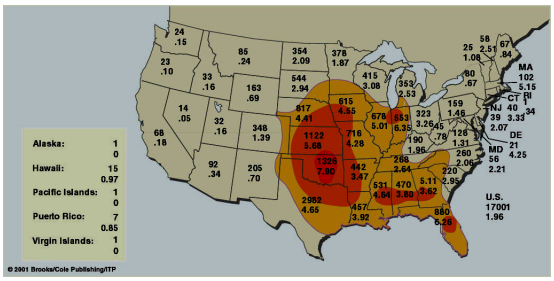
Tornadoes

- Tornadoes are rapidly rotating winds that blow around a small intense low pressure.
- Typical diameter = 100 to 600m
- Typical speed = 20 to 40 knots
- Typical duration = few minutes
- There are exceptions to all of these.

Typical Stages of Evolution

- Dust-whirl – dust swirling on surface and a short funnel extends down from the cloud
- Organizing – winds increase with overall extent of funnel
- Mature – most severe, funnel greatest width and almost vertical
- Shrinking – funnel's width decreases and tilts
- Decay – funnel stretched into shape of a rope

Tornado Occurrence



- US averages 900 annually with most occuring in tornado alley in Central Plains (central Texas to Nebraska).

Tornado Alley

- The Central Plains are most susceptible to tornadoes because atmospheric conditions correct for severe thunderstorms:
- Warm, humid surface air overlain by cooler, drier air aloft.
- ¾'s of all tornadoes in the US develop from March to July with May greatest number and April most severe.
- Most common time is 4-6PM.

Examples of Tornado Damage

- Destroy buildings, uproot trees, hurl objects
- On average 100 people die per year in tornadoes, with 45% in mobile homes
- A railway coach with 117 people was moved 25 m away.
- Showers of toads and frogs
- Chickens losing all their feathers

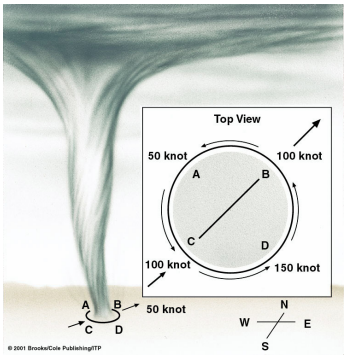
Tornadoes and Buildings

- Winds typically less than 125 knots, but may be up to 220 knots.
- Low pressure can lift roofs.
- Opening windows can actually increase pressure on opposite wall and increase changes building will collapse.

Safety Tips

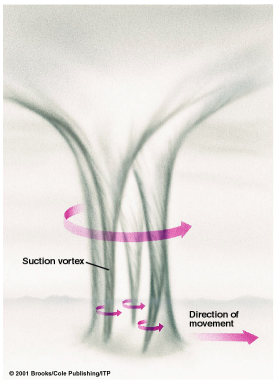
- Take shelter in a basement.
- Stay away from windows.
- If no basement, seek a small interior room or hallway.
- In a mobile home, leave immediately.
- Don't try to outrun an oncoming tornado.
- If caught outdoors in an open field, seek a ditch or streambed and lie flat with head covered.

Wind Speeds



- Approaching from southwest.
- Maximum wind speeds on SE side.
- SW side of building receives maximum impact.
- Most tornadoes rotate counter-clockwise when viewed from above.

Suction Vortices

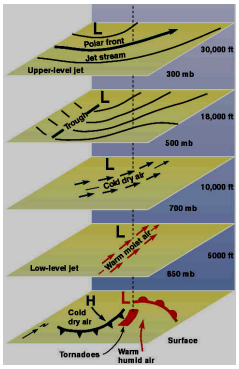


- Violent tornadoes with winds exceeding 180 knots contain smaller whirls.
- Only 10m in diameter, but rotate very fast and do great damage.

Fujita Scale

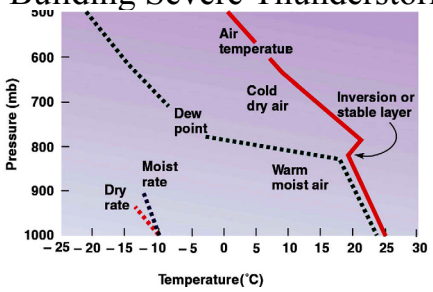
Scale	Miles/Hour	Damage
F0	40-72	Branches broken
F1	73-112	Trees snapped, windows broken
F2	113-157	Large trees uprooted, weak structures destroyed
F3	158-206	Cars overturned, walls removed from buildings
F4	207-260	Frame houses destroyed
F5	261-318	Cars moved over 100m, steel reinforced structures damaged

A Possible Tornado Storm



- Open wave middle latitude cyclone on surface
- Warm moist air rising behind warm front
- Cold dry air above warm air
- Correct positioning of upper level low (trough) and polar jet stream to offer vertical support.
- Boxed area on map is where tornadoes are most likely to form.

Building Severe Thunderstorms



- An inversion acts like a lid on rising warm air so that only small cumulus clouds form. Eventually, rising air breaks through and clouds build rapidly.

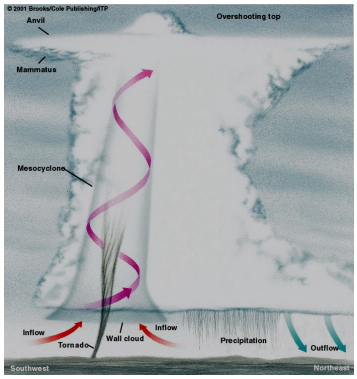
1. Creation of a Tornado

- Once inversion is punctured, upper level jet stream rapidly draws moist air up into cold unstable air.
- Severe thunderstorm builds to great heights.
- Updraft may rotate due to strong vertical wind shear. (mesocyclone)
- As air rushes into low pressure, rotational winds increase with smaller diameter.

2. Creation of a Tornado

- A spinning vortex of increasing wind speed appears in the middle of the cloud and gradually extends to the cloud base (tornado cyclone).
- Air rushing in expands and cools forming a funnel cloud.
- The funnel cloud extends to the surface where it picks up dirt and debris.

Features of a Tornado Thunderstorm



- Anvil
- Overshooting
- Mesocyclone
- Wall cloud
- Inflow
- Tornado

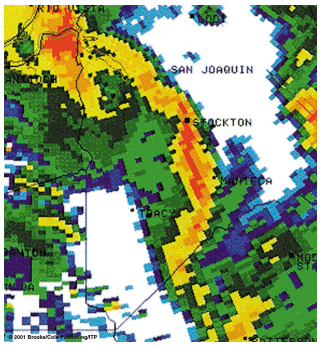
Observing a Tornado

- First sign is rotating clouds.
- Rotating clouds lowering becomes a wall cloud.
- Smaller rapidly rotating funnel cloud extends to the surface. (May not be visible.)
- Sound like a freight train.
- Tornado watch – conditions right for tornadoes
- Tornado warning – tornado spotted

Doppler Radar

- Remember radar sends out a microwave pulse which is reflected back by precipitation particles.
- Can tell location and intensity of rain.
- Doppler radar can also tell the wind speed away or towards detector.
- Look for rotating winds (hook echo).
- Tornados are too small to measure wind speed within using Doppler radar.

Doppler Radar Image



- Line of thunderstorms bent in shape of a bow.
- Sometimes the left (northern) end of the bow will develop cyclonic rotation and produce a tornado.

Waterspouts

- A waterspout is a rotating column of air over a large body of water.
- Tornadic waterspout – tornado that started on land and traveled to water
- Fair weather waterspout – form over water, smaller with diameters of 3-100m, and less intense winds (< 45 knots).
- Form when air is conditionally unstable and clouds are developing.

Summary

- Tornadoes are rapidly rotating winds that blow around a small intense low pressure.
- They form in severe thunderstorms when warm air rises, and there is wind shear.
- Tornado alley in the Central Plains is the most common location for tornadoes, although they may occur anywhere.
- Tornadoes cause immense damage and destruction. Beware!