TORNADO LIFE CYCLE

Visual Clues of Tornado Formation

1. Large, rounded rain-free base – suggests mesocyclone is present.

2. Increasing spin in wall cloud and cloud base around wall cloud – suggests low-level rotation is increasing.

3. Clear slot forms – bright cloud-free "notch" eroded in rain-free base. Suggests rear-flank downdraft, possible mechanism for tornado formation.

4. Rapid vertical motions – scud rising into wall cloud, sinking motion around wall cloud from rear-flank downdraft.

5. Local burst of heavy rain/hail just west or southwest of wall cloud – another possible tornado formation mechanism.

Tornado may form within a few minutes, of these clues appearing. Or, gust front/outflow will spread out from storm and cut off the formation process.

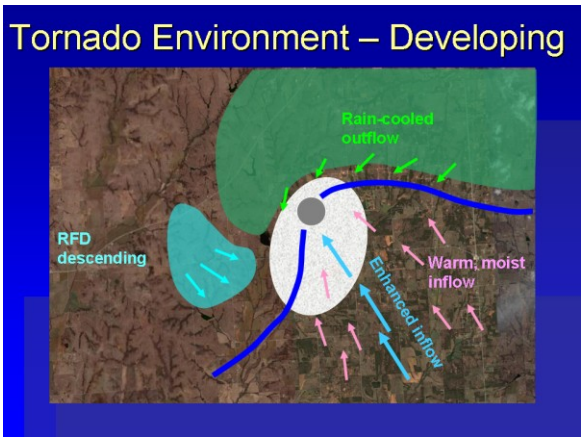
Developing Stage

* Tornado circulation sometimes begins in mid-levels, with gradual development down toward the ground. development upward and downward.

* Rear-flank downdraft/clear slot and precip burst southwest of wall cloud may help tornado circulation get established at the ground.

* Some circulations start in low levels, near cloud base, with rapid
* Watch closely! The first sign of tornado development may be a dust whirl at the ground.

- Look for evidence of connection from the dust whirl to the cloud base...a funnel or tight rotation in the wall cloud/cloud base.



Developing tornadoes. Views to west or northwest. Note visual clues of rotation, clear slots at southwest edges of wall clouds, and developing condensation funnels. Photos – Mike Umscheid; Alan Moller; Mike Umscheid.

Mature Stage

* Potentially the strongest and most dangerous stage of the tornado's lifetime.

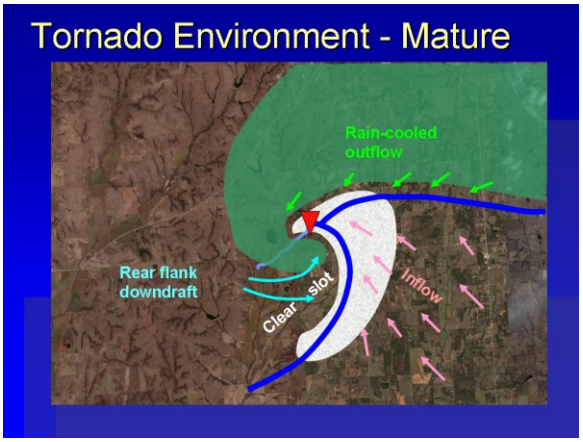
* Funnel often has a near-vertical orientation.

* Visible funnel may not extend all the way to the ground!

* RFD/clear slot gradually wrap around south and east side of wall cloud, gradually cutting off original inflow air.

* Rain-free base may take on a horseshoe-shaped appearance, with tornado and wall cloud at the north end of the "horseshoe".

* RFD air may be fairly warm and moist. If the tornado ingests RFD air, it may not be harmful to the tornado.



Mature tornadoes. Views to north and northwest. Note near-vertical orientation of condensation funnels and clear slots advancing around wall clouds. Photos – Holly Melver/James Bass; Rodger Booth/WDIV; Mike Umscheid.

Dissipating Stage

* Rear-flank downdraft wraps around tornado, completely cuts off original inflow air.

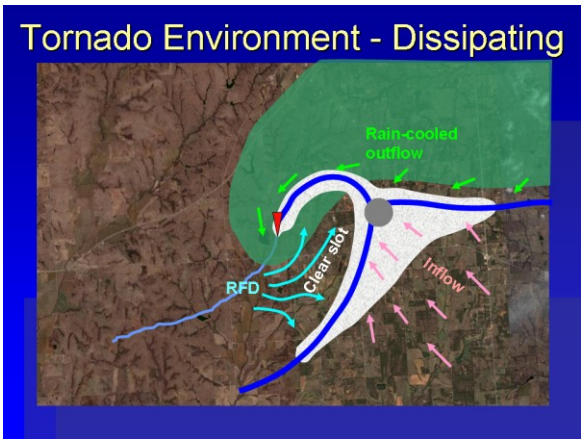
* Tornado ingests RFD and, more importantly, cold outflow air from the precipitation area.

* Funnel shrinks, tilts, takes on contorted snakelike shape, sometimes called the “rope stage”.

* Still dangerous, just not as large or strong as mature stage.

* Some tornadoes, especially large ones, may not go through a rope stage.

* Inflow may be re-focused a few miles east of the dissipating tornado. Watch for development of a new wall cloud.



Dissipating (“rope stage”) tornadoes. Note surface debris clouds indicating continuing damaging winds. Note also the tilted, contorted appearance of condensation funnels. Photos – Howard Blum; Mike Umscheid; courtesy KCBD-TV.

Cyclic Supercells

* With some supercells, inflow may be re-focused a few miles east of the dissipating tornado.

* If the environment is favorable, a new mesocyclone and wall cloud will form. This is the gray circle in the dissipating tornado diagram above.

* The new mesocyclone and wall cloud will become the dominant part of the storm, and a new tornado may form.

* Spotters close to the storm should frequently check for redevelopment!

Cyclic supercell, view to east. Note old tornado and clear slot in left foreground, new tornado in right background. Photo – Scott Blair.

Tornado Variations

Not all tornadoes go through a normal life cycle from a super-cell thunderstorm. Some tornadoes proceed from the developing stage directly to dissipating stage, with little time spent in the mature stage. As can be seen in the following images, tornadoes may take on different appearances as they develop, mature and decay.

Large “wedge” tornado near Enterprise, Alabama, March 1, 2007 (photo courtesy of J. Bary Mott).

Large tornado near Girard, Kansas, May 4, 2003. (photo by Chuck Robertson).

Descending cone shape tornado located south of Collyer, KS 5/22/08 (photo by Derek Deroche).

Cone shaped tornado located south of Douglas, OK looking west on 5/24/08 (photo Derek Deroche).

Spencer, SD tornado May 30, 1998.

Descending tornado with debris and/or damage occurring
on the ground southwest of Knob Noster, MO.

Tornado with dirt whirl 2 miles east of Hitschmann, KS looking west, 6/11/08 (photo Derek Deroche).

Narrow tornado near Friona, TX, 4/17/07 (photo courtesy: Dr. Gary Cash (DVM) - per the "Friona Star" newspaper).

Nighttime tornado near Oxford, MS 2/5/08.

“Multi-vortex” tornadoes have two or more circulations (vortices) orbiting about each other or around a common center.

Multi-vortex tornado in Knox County, MO, 5/10/06 (photo courtesy of Earl Huber).

Multi-vortex tornado south of Glen Elder, KS 5/24/08 looking west-northwest (photo Derek Deroche).

“Rope” tornadoes often signify a tornado that is weakening or dissipating.

Rope tornado from Eureka, NV, 6/9/06 (photo by Lt. Rob Cutler of the Eureka County Sheriff's Department).

Tornado during rope out and dissipation stage 9 miles southwest of Perry, OK 5/24/08 (photo Derek Deroche).

Rope tornado taken near Twentynine Palms in the Morongo Basin of California, 9/4/03 (photo courtesy of T.J. Williams of Marine Airbase).

Tornadoes sometimes develop along squall lines as opposed to the supercell variety. This is an example of a wall cloud along the leading edge of a squall line taken west of Springfield, IL near Interstate 72. (photo courtesy of Jarrod Cook).

“Landspout” tornadoes are tornadoes that do not arise from organized storm-scale rotation or super-cell thunderstorm, and therefore are not associated with a wall cloud (visually) or a mesocyclone (on radar). Landspouts typically are observed beneath cumulus clouds (often as no more than a dust whirl), and essentially are the land-based equivalents of waterspouts.

Landspout over White Sands Missile Range, NM, 5/2/07
(photo courtesy of Dennis Page).

Landspout near Kalispell, Montana 4/8/08 (photo courtesy of Suzanne Johnson).

A **"waterspout"** is a tornado occurring over water. Specifically, it normally refers to a small, relatively weak rotating column of air over water beneath a cumulus cloud. In most cases the term is reserved for small vortices over water that are not associated with storm-scale rotation (i.e., they are the water-based equivalent of landspouts). But there is sufficient justification for calling virtually any rotating column of air a waterspout if it is in contact with a water surface.

Waterspout near Neskowin, OR 4/2/03 (photo from Tillamook County Emergency Manager, Tom Manning).

Waterspout on Black Lake, MI, 10/18/07 (photo courtesy of Nathan Krinsky).

A **"Dust Devil"** is usually a small, rapidly rotating wind that is made visible by the dust, dirt or debris it picks up. Also called a whirlwind, it develops best on clear, dry, hot afternoons.

Dust Devil over a field near Glendale, Kentucky in Hardin County September 20, 2007. The whirlwind formed on a hot sunny day over a field that had just been burned (photo *Steven Townsend, Code 3 Images Photography)*

Dust Devil causing damage at a construction site near Fayette Mall, Lexington, KY September 2005 (photo courtesy of Chief Meteorologist, Bill Meck at WLEX-TV).

Tornado/Funnel Cloud Look-a-likes: Several atmospheric and man-made features may be mistaken for tornadoes. Some of the most common are:

-Scud Clouds
-Rain Shafts
-Gustnadoes
-Tail clouds
-Smoke
-Communication Towers
-Grain Elevators

To distinguish between a real tornado or funnel and one of the above look-a-likes, watch the feature for several (3+) minutes and ask these questions:

1. Can I see it clearly?
2. Is the feature rotating about a vertical axis (like a spinning ice skater)?
3. Is the feature attached to a thunderstorm base?
4. Is the feature located in the proper section of the storm where tornadoes/funnels typically develop (i.e. the rear of the storm near the updraft)?
5. If it appears to be a tornado, is there debris?

If your answer to any of these questions is "no", then the feature is likely ***not*** a tornado. If you have doubts, continue to observe the feature.

Scud clouds near Albuquerque, NM. Courtesy Van Truan.
Scud clouds are low cloud fragments that drift around storms.

"Gustnado" near Milwaukee, WI. Courtesy NWS.

Circulation at the ground that is highly transient in nature and ***not attached*** *to a parent cloud. Often associated with the gust front or outflow of a thunderstorm.*

Rain Shaft near Millersburg, IN. Courtesy Sam Lashley.

Tail cloud. Courtesy Steven Johnson.

(see Supercell Storm Structure for explanation)

Steam cloud. Courtesy Jeffrey Towers.

Cold Air Funnel in north Texas. NOAA Photo Library/NSSL.

Cold air funnels typically occur in the spring and fall, often following a cold front when the air near the surface is stable and cloud bases are high. They are typically short-lived and weaker than funnel clouds produced by thunderstorms.

Smoke near Meade, KS. Courtesy Andrew Revering.