

THUNDERSTORM WINDS EXPLAINED

When severe weather occurs, there is often much discussion about the types of thunderstorm winds that can cause damage. Terms frequently mentioned are "tornado," "microburst," and "straight-line winds." Unfortunately, the phrase "straight-line winds" is often used as a catch-all for all non-tornadic winds, which is not entirely accurate. In actuality, downdraft winds CAN exhibit rotation on occasion. Descriptions of the different types of winds associated with thunderstorms are included here to shed light on this subject.

Every thunderstorm has an updraft - that's what creates the thunderstorm. Every thunderstorm also has a downdraft - that is where precipitation - rain and hail - falls from the storm. At the most basic level, there are two types of thunderstorm winds: 1) those associated with the UPDRAFT, and 2) winds associated with the DOWNDRAFT.



A gustnado taken from Western Kentucky University on April 11, 2011 (*credit: Dr. Josh Durkee*)

UPDRAFT-ASSOCIATED WINDS:

- **Tornado** - a violently rotating column of air, extending from the base of a thunderstorm, and in contact with the ground. Tornadoes are rated between 0 and 5 on the Enhanced Fujita Scale, with estimated winds ranging from 65 mph (low end EF0) to 200+ mph (EF5). To be classified as a tornado, the rotation must exist both inside the thunderstorm and at the earth's surface. This rotation may occur with or without a visible funnel cloud.
- **Inflow Winds** - air being sucked into the updraft of a thunderstorm. While these usually peak well below severe limits, they can occasionally cause minor damage.
- **Dust Devils** - while these aren't associated with storms, they ARE associated with small, rotating updrafts that occur on days where the air near the ground is much higher temperature than air aloft (usually on cloud-free days). The wind speeds associated with dust devils top out in the 35-45 mph range.
- **Waterspout** - like a tornado, waterspouts are vertical columns of rotating air. They reach between the water surface (as opposed to land), and connect to rotation within a parent cumulus cloud.

Technically, a tornado that occurs over a large body of water (i.e., a lake, reservoir, ocean) is a waterspout while it's in contact with the water.

DOWNDRAFT-ASSOCIATED WINDS:

- **Downbursts** - if a downdraft becomes intense enough to cause damage when it reaches the ground, it is classified as a DOWNBURST. Downbursts are further subdivided based on their areal coverage; downbursts less than 2.5 miles in diameter are called MICROBURSTS, while those larger than 2.5 miles in diameter are referred to as MACROBURSTS.
- **Gust Front** - the leading edge of outflow winds created by a thunderstorm downdraft reaching the ground and spreading out along or AHEAD of the precipitation.
- **Rear Flank Downdraft** - in storms with rotating updrafts (Supercells), part of the thunderstorm downdraft area can wrap around and occur behind the updraft area. Rear flank downdrafts have been known to exceed 70 mph.

There IS a “hybrid” type of wind that is created by a downdraft, but which exhibits updraft characteristics:

- **Gustnado** - these are rotating winds that can occur when strong outflow winds "spin up" but do NOT reach into any rotation inside the parent thunderstorm. The peak wind speeds with these short-lived areas of intensified, rotating winds can equal that of a weak (EF0-EF1) tornado, and doing similar damage (e.g., snapping tree trunks). Given the right conditions (strong outflow winds into an unstable environment (warm, moist air at the ground with cooler air aloft), virtually any severe thunderstorm (with winds exceeding 60 mph) is capable of producing a gustnado. This is why every Severe Thunderstorm Warning should be taken seriously.

Put another way,

STRAIGHT-LINE WINDS	ROTATING WINDS
Inflow winds	Tornado
Downburst (both Microburst and Macroburst)	Dust Devil
Gust Front	Waterspout
Rear Flank Downdraft	Gustnado

Another form of straight-line winds - “Gradient Winds” - occur outside of thunderstorms, when there is a large change in barometric pressure over a short distance

When the NWS surveys thunderstorm damage to determine its cause, we look at all evidence available - debris patterns, radar imagery, available photos/videos, and eyewitness accounts. In the absence of conclusive evidence of rotation extending from the ground into a parent thunderstorm, storm damage is considered to be "non-tornadic" and caused by one of the other winds - regardless of rotation - associated with the thunderstorm.