SAMPLE

Earth's Dynamic Systems: Tornadoes

Nature's Most Violent Winds

Aira Astralis

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Conclusion

This free sample contains the Introduction and Chapter 1. The complete book contains the full contents above.

Introduction

A tornado, also known as a twister, is a rapidly rotating column of air that extends vertically from the surface of the Earth to the base of a cumulonimbus or cumulus cloud. Tornadoes are often (but not always) visible in the form of a condensation funnel originating from the cloud base, with a cloud of rotating debris and dust close to the ground.

Most tornadoes have wind speeds less than 180 kilometers per hour (110 miles per hour), are about 80 meters (250 feet) across, and travel several kilometers (a few miles) before dissipating. The most extreme tornadoes can attain wind speeds of more than 480 kilometers per hour (300 mph), can be more than 3 kilometers (2 mi) in diameter, and can stay on the ground for more than 100 km (62 mi).

Types of tornadoes include the multiple-vortex tornado, landspout, and waterspout.

Waterspouts are characterized by a spiraling funnel-shaped wind current, connecting to a large cumulus or cumulonimbus cloud. They are generally classified as non-supercellular tornadoes that develop over bodies of water, but there is disagreement about whether to classify them as true tornadoes. These spiraling columns of air often develop in tropical areas close to the equator, and are less common at high latitudes.

Similar phenomena in nature include the gustnado, dust devil, fire whirl, and steam devil.

Tornadoes most commonly occur in North America, particularly in central and southeastern regions of the United States colloquially known as Tornado Alley; the United States has by far the most tornadoes of any country in the world. Tornadoes also occur in South Africa, much of Europe (except most of the Alps), western and eastern Australia, New Zealand, Bangladesh and adjacent eastern India, Japan, the Philippines, and southeastern South America (Uruguay and Argentina).

Chapter 1: The Discovery of Tornadoes

An F5 or EF5 tornado, the strongest category, rips buildings off their foundations and can deform large skyscrapers. The similar TORRO scale ranges from T0 for extremely weak tornadoes to T11 for the most powerful known tornadoes. The International Fujita scale is also used to rate the intensity of tornadoes and other wind events based on the severity of the damage they cause.

Doppler radar data, photogrammetry, and ground swirl patterns (trochoidal marks) may also be analyzed to determine intensity and assign a rating.

The word tornado comes from the Spanish tronada (meaning 'thunderstorm', past participle of tronar 'to thunder', itself in turn from the Latin tonāre 'to thunder'). The metathesis of the r and o in the English spelling was influenced by the Spanish tornado (past participle of tornar 'to twist, turn', from Latin tornō 'to turn').

A linguistically related convective wind phenomena, that unlike the relatively small concentrated area of a tornado, is the widespread, straight- line derecho (, from Spanish: derecho [deˈɾetʃo], 'straight').

A tornado is a violently rotating column of air, in contact with the ground, either pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud. For a vortex to be classified as a tornado, it must be in contact with both the ground and the cloud base.

The term is not precisely defined; for example, there is disagreement as to whether separate touchdowns of the same funnel constitute separate tornadoes.

Tornado refers to the vortex of wind, not the condensation cloud. Tornados are sometimes colloquially referred to as cyclones. However, in meteorology, the word cyclone specifically refers to a large weather system that rotates around a center of low atmospheric pressure, spinning one way in the Northern Hemisphere and the opposite way south of the equator. Cyclones do not feature cloud funnels.

A tornado is not necessarily visible; however, the intense low pressure caused by the high wind speeds (as described by Bernoulli's principle) and rapid rotation (due to cyclostrophic balance) usually cause water vapor in the air to condense into cloud droplets due to adiabatic cooling. This results in the formation of a visible funnel cloud or condensation funnel.

There is some disagreement over the definition of a funnel cloud and a condensation funnel.

According to the Glossary of Meteorology, a funnel cloud is any rotating cloud pendant from a cumulus or cumulonimbus, and thus most tornadoes are included under this definition. Among many meteorologists, the "funnel cloud" term is strictly defined as a rotating cloud which is not associated with strong winds at the surface, and condensation funnel is a broad term for any rotating cloud below a cumuliform cloud.

Tornadoes often begin as funnel clouds with no associated strong winds at the surface, and not all funnel clouds evolve into tornadoes. Most tornadoes produce strong winds at the surface while the visible funnel is still above the ground, so it is difficult to discern the difference between a funnel cloud and a tornado from a distance. Occasionally, a single storm will produce more than one tornado, either simultaneously or in succession.

Multiple tornadoes produced by the same storm cell are referred to as a "tornado family". Several tornadoes are sometimes spawned from the same large-scale storm system. If there is no break in activity, this is considered a tornado outbreak (although the term "tornado outbreak" has various definitions).

A period of several successive days with tornado outbreaks in the same general area (spawned by multiple weather systems) is a tornado outbreak sequence, occasionally called an extended tornado outbreak.

Most tornadoes take on the appearance of a narrow funnel, a few hundred meters (yards) across, with a small cloud of debris near the ground. Tornadoes may be obscured completely by rain or dust. These tornadoes are especially dangerous, as even experienced meteorologists might not see them. Small, relatively weak landspouts may be visible only as a small swirl of dust on the ground.

Although the condensation funnel may not extend all the way to the ground, if associated surface winds are greater than 64 km/h (40 mph), the circulation is considered a tornado. A tornado with a nearly cylindrical profile and relatively low height is sometimes referred to as a "stovepipe" tornado.

Large tornadoes which appear wider than their cloud-to-ground height can look like large wedges stuck into the ground, and so are known as "wedge tornadoes" or "wedges".

The "stovepipe" classification is also used for this type of tornado if it otherwise fits that profile. A wedge can be so wide that it appears to be a block

of dark clouds, wider than the distance from the cloud base to the ground. Even experienced storm observers may not be able to tell the difference between a low-hanging cloud and a wedge tornado from a distance.

Many, but not all major tornadoes are wedge tornados.

Tornadoes in the dissipating stage can resemble narrow tubes or ropes, and often curl or twist into complex shapes. These tornadoes are said to be "roping out", or becoming a "rope tornado". When they rope out, the length of their funnel increases, which forces the winds within the funnel to weaken due to conservation of angular momentum.

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ABOUT THE AUTHOR

Aira Astralis is a science writer specializing in astronomy and space exploration. Her work spans the full breadth of humanity's relationship with the cosmos -- from the earliest naked-eye observations to the engineering marvels of modern space missions.

Her books are built on a foundation of primary sources: peer-reviewed research, mission archives, and direct engagement with the scientific community. She writes for readers who want to understand not just what we know about the universe, but how we came to know it.

She believes that the most important frontier is not out there but in the gap between what scientists discover and what the public understands. Her books exist to close that gap.