TORNADOES IN GEORGIA

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Summary: *The concept of tornado, conditions and causes of occurrence, types of tornadoes are given. Fujita scale introduced. A tornado in Kobuleti is described, illustrations are shown. The question of a more detailed study of tornadoes in Georgia is being discussed.*

Key Words: *Natural disasters, tornado.*

A tornado is an atmospheric vortex that occurs in a cumulonimbus (thunderstorm) cloud and spreads down, often to the very surface of the earth, in the form of a cloud sleeve or trunk tens and hundreds of meters in diameter. Usually, the transverse diameter of a tornado funnel in the lower section is 300-400 m, although if the tornado touches the water surface, this value can be only 20-30 m, and when the funnel passes over the land, it can reach 1.5-3 km.

It is believed that the speed of the vortex inside exceeds 18 m/s and can, according to some indirect estimates, reach 1300 km/h. The tornado itself moves along with the cloud that generates it. This movement can give speeds of tens of km/h, usually 20-60 km/h. Tornadoes arise in the following way. From the central part of a powerful thundercloud, the lower base of which takes the form of an overturned funnel, a gigantic dark trunk descends, which extends towards the surface of the Earth or the sea. Here, a wide funnel of dust or water rises to meet him, into the open bowl of which the trunk, as it were, plunges its end. A solid column is formed, moving at a speed of 20-40 km/h. The narrowest part of this pillar falls approximately in the middle, its height reaches 800-1500 m. Several tornado funnels can descend from a thundercloud [1–3].

A tornado is a Benard vortex in which the magnitude of the centripetal force is greater than the magnitude of the centrifugal force. This property of the vortex leads to the fact that its trunk constantly throws out part of the mass outward, and does not transfer it to the periphery of the vortex. With the ejected mass, energy also leaves, which reduces the value of the energy of the vortex itself. Therefore, like any other single Benard vortex, a tornado cannot exist without energy from the outside entering it.

As you know, tornadoes arise from powerful thunderclouds with sufficient moisture reserves. The cloud itself does not pose any danger: the moisture of the cloud must still be condensed to the size of drops. This is what the trunk of the Benard vortex, which appears in the cloud, is engaged. The Benard vortex occurs when there is a temperature gradient along the height. As a rule, thunderclouds appear at the border of a warm and cold fronts. Therefore, after the emergence of clouds, their bottom should be heated from the surface of the earth. And only after the appearance of a temperature gradient, a Benard vortex can appear in the cloud.

The vortex has appeared, but in order to transform it into a tornado, it must increase its energy. Energy can only come from moisture condensation. The rotation of the humid environment in the trunk condenses moisture, while releasing energy. And the more moisture is contained in a cloud, the more energy is released during moisture condensation [4, 5].

The cause of classic tornadoes is the strongest, prolonged thunderstorms, which exist due to the oblique and constantly rotating ascending air stream. The width of this stream reaches 16 -18 km in diameter and 15 -16 km in height. It takes 20 to 60 minutes for a tornado to form. If this rotation begins to appear on the screen of the Doppler weather radar, then it is called a mesocyclone. Tornadoes are an extremely small part of this large-scale circulation. The most powerful tornadoes are caused by severe thunderstorms.

Three conditions must be met for the formation of a funnel:

- the mesocyclone should be formed from cold dry air masses, which provides a particularly large temperature gradient along the height;

- the mesocyclone should go to an area where a lot of moisture has accumulated in the surface layer 1-2 km thick at a high air temperature of 25-35 ˚C, which allows the mesocyclone to suck in moisture from large spaces and throw it to a height of 10-15 km.

- ejection of masses of rain and hail. Fulfillment of this condition leads to a decrease in the flow diameter from the initial value of 5-10 km to 1-2 km and an increase in velocity from 30-40 m / s in the upper part of the mesocyclone to 100-120 m / s in the lower part.

The temperature inside the meso cyclone increases abruptly along the entire height due to the heat brought in by moisture, accumulated not only by saturated vapor, but also by water droplets.

What kind of tornado are there - the most common type of tornado is whip-like, in which the length of the funnel usually significantly exceeds its radius. Usually seen over the sea. Above the land, the so-called blurry - shaggy, rotating clouds reaching the ground are more often observed. Usually the diameter of such a tornado even exceeds its height. They are very powerful and capable of causing tremendous damage due to their high speed inside the vortex and their large size, more than 500 meters in diameter. Often so-called composite tornadoes can be observed both over the sea and over land. when one or several other tornadoes appear around the main central one. Such tornadoes can be of any power, but they are usually very powerful, with great destructive power. And finally, fire tornadoes that arise as a result of powerful fires or volcanic eruptions. A vivid example is the fiery tornado that arose in Dresden after the massive bombing at the end of World War II and practically wiped it off the face of the Earth.

The strength of a tornado is determined according to the so-called Fujita scale [1]:

Fujita scale F	Wind speed (km/ h)	Impact on the average (e.g. brick) European home
F0	64 - 116	(Almost) no damage
F1	117 - 180	Slight to moderate damage to the roof
F2	181–253	Significant damage to the roof / roof is missing
F3	254–332	The roof has disappeared / some walls have collapsed
F4	333–418	Most of the walls have collapsed
F5	419–512	Blown up and possibly blown in the wind

Fig. 1. Tornado in Kobuleti [8].

Fig. 2. Tornado in Poti [11].

Tornadoes are mainly observed in the temperate zone of both hemispheres, from approximately 60th parallel to 45th parallel in Europe and 30th parallel in the United States. Likewise in the southern hemisphere. Here, tornadoes are often observed in Argentina, South Africa, Australia, etc. The largest number of tornadoes is observed in the United States - more than 1200 per year; in Europe it is less, on average about 300 per year [6]. Tornadoes are also observed in the Black Sea waters, occasionally coming ashore. One of such cases was observed recently, at the beginning of September, in Kobuleti, accompanied by a heavy rain, the Smerch came ashore from the sea, blew off roofs from several houses, uprooted several trees, one of which fell on a car (fig. 1). The gas pipeline was also damaged [8].

Earlier, several cases of tornadoes ashore were noticed in the Poti area, for example, on November 24, 2017. In 2021, tornadoes were also seen in Poti and Khobi municipalities (fig. 2). The tornado tore off the roofs of more than a dozen residential buildings in Western Georgia. The element lasted for about a minute and a half. A gusty wind blew off windows and roofs. During the tornado, trees were felled, farmland was damaged, and dozens of families were left without electricity. In two villages of the Khobi municipality - Patara Poti and Uchagari, 13 houses were left without roofs. In the Black Sea town of Poti, three families were affected. In addition, several shipping containers at the port were damaged [9].

It should be noted that the tornado in Georgia was observed not only on the coast. So, on June 12, 2007, a tornado raged in the Telavi region. Here, within a few minutes, a tornado uprooted trees, demolished roofs from houses, tore power lines and destroyed crops. According to an eyewitness, a sudden wind blew the roofs from the houses, destroyed the walls, pulled out the trees and lifted them into the air [10].

Judging by the consequences, tornadoes observed on the Black Sea coast, according to the Fujita scale, are no higher than F2 in strength, moreover, they usually occur no more than once or twice a year, or even less often. As for the tornado in Telavi, its strength corresponds to the F3 category, but after 2007 it did not appear on the territory of Georgia anymore. The question arises - how often there is a tornado in Georgia, how dangerous is it, is there an opportunity and sense to fight it? Catastrophic tornadoes are rare, so it is difficult to use statistics to predict them. It is generally believed that tornadoes can occur where they have already been. The development and improvement of the network of meteorological radars in Georgia will make it possible, as information accumulates, to make appropriate early forecasts [12-14].

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