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## Tornadoes and Cyclones

T. L. Rosser

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pected of us at the beginning of such an enterprise, and we have the gratification of knowing that others now firmly established, and honored by the world, alike had their day of small things, before the world in general, and the learned in particular, made them famous by recognizing the sacrifices and patience that had silently borne the early burdens through the heat of the day.

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## TORNADOES AND CYCLONES.

BY GEN. T. L. ROSSER.

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*Mr. President:*—But a short time ago our papers were filled with accounts of a "*shower of flesh*," which is reported to have fallen on the 3d of March last, in Bath county, Kentucky, from a cloudless sky.

Such occurrences, though rare, are by no means new. In 1841, it is said, that there was a shower of "*flesh and blood*" near Lebanon, Tennessee, which astonished, greatly, the simple people of that locality who witnessed it. Prof. Loomis mentions a shower of oranges which fell near Naples, in 1833, and we have numerous accounts of the fall of small fish and frogs from the skies.

My purpose in calling attention to these phenomena is simply to offer a few thoughts upon the causes thereof.

We know very well that there are no butcher-shops, frog-ponds, or orange groves suspended in the skies; and when the contents of such places are showered down from *above*, we are quite certain that the material was first taken up from *below*.

There are none of us who have not noticed on calm, warm days, or during great fires, whirlwinds that go whizzing about in every direction, picking up from the ground all light articles found in their paths. Some of these whirlwinds have a vortex of only a few feet in diameter, and are inconsiderable, while others cover great space, and are violent and destructive.

There is no doubt in my mind that this flesh, those frogs and oranges, were carried up into the clouds by large whirlwinds, but the interesting portion of the problem is, how were they transported to distant points, and precipitated in a calm atmosphere, and from a cloudless sky?

The vortex of a whirlwind enlarges as it ascends, and assumes the shape of an inverted cone, the perimeter of whose base, at a great altitude, would over-hang a region of calm atmosphere. For instance, if the elements of such a cone were at an angle of  $45^\circ$  to the horizon, in ascending to an elevation of 10,500 feet (which is about the limit of the surface winds), they would over-hang points on the ground two miles from the point where the apex might be, and objects taken by such a whirlwind and delivered into a calm, would be thrown down two miles from the points whence they were taken up, and if instead of being delivered into a calm, they should be encountered by a horizontal current, they might be carried many miles in their drifting return to the ground.

This, doubtless, is the manner in which oranges have been carried many miles through the air, The dust of Sahara is taken across the Mediterranean sea into Italy, and the Infusoria of South America across the Atlantic ocean, and deposited in showers on the coast of Europe!

On examining the daily maps of the U. S. Signal Office for March last, we find that high barometer covered almost the entire American continent, and on the 3d of March, when this shower of flesh occurred, its vortex was central over Kentucky. These maps also show that on that day, and sev-

eral days previous, low barometer was down along the coast of Florida, and south towards the West India islands.

Prof. J. Lawrence Smith, who examined this substance, is of the opinion that it *was not flesh*, as reported by those who witnessed its fall, but that it was the spawn of some batrachian reptile, and as the month of March is rather early for such deposits in Kentucky, it is most reasonable to conclude that these eggs came from a region further south, where they were sucked up by a cyclone, and drifted off north in clouds, until precipitated through the vortex of high barometer, which was over Kentucky.

There are many curious facts connected with tornadoes and cyclones, the theories of which I propose to make the subject of some future communication to this Academy.

Cyclones originate near the equatorial limits of the Trade Winds, on the edge of the zone of calms, where the winds are very irregular. Cyclones never cross the equator, but they often occur on both sides of it, and on the same meridian at the same time. Small whirlwinds, such as we witness in our streets and fields almost every calm, warm day, have a gyratory motion, either from right to left or from left to right, but cyclones, in the northern hemisphere, have an invariable gyratory motion from right to left; and in the southern hemisphere this motion is invariably the reverse.

To understand why this is so, we must examine the general causes by which winds are generated.

The 1st of these is—Unequal atmospheric pressure.

The 2nd is—Unequal specific gravity.

The 3d is—The rotation of the earth.

The normal condition of the forces of nature is that of a *state of equilibrium*, and to disturb such a condition, either an external force must be applied from without, or some chemical operations must be performed within. The atmosphere, when acted on by the force of gravity alone, assumes a state of rest, arranging itself in horizontal strata, diminishing in

density from the ocean's surface, where it is greatest, to the boundaries of the planetary space, where it is least. Heat is the great disturber of the equilibrium between the different columns of atmosphere—causing unequal pressure and unequal specific gravity. (We will say nothing at present about aerial tides). Only about one-quarter of the sun's heat is absorbed by the atmosphere while passing through it, the remaining three-quarters are absorbed by the earth, and this unequal heating soon raises the temperature of the earth above that of the atmosphere which rests upon it. The earth radiates its heat from its surface into the atmosphere which is in contact with it, and the atmosphere in its turn radiates the heat which it has absorbed into planetary space, and thus the atmosphere is heated at the bottom and cooled at the top.

The earth being most highly heated at the equator, and least at the poles, occasions unequal disturbances in the atmosphere within these limits, and produces thereby three systems of wind, viz:

The Equatorial System.

The Middle System.

The Polar System.

These three systems are more or less modified by the rotation of the earth, and by local causes, such as great deserts and inland seas. The heating of the atmosphere at the equator causes low barometer, and the surface atmosphere for about twenty degrees on each side flows in, as water seeking the level of equal pressure. The atmosphere which rises near the equator expands as it rises, and falls off towards the poles, but as space contracts towards the poles, the atmosphere banks up and gives high barometer about the parallel of  $32^{\circ}$ ; here by unequal pressure it is forced down, and the atmosphere is pushed off north and south, consequently we have the middle system, which blows *toward* the poles. The cold atmosphere near the poles give high barometer, and produces the polar winds, which blow *toward* the equator, and, meeting

the middle winds, in latitude  $64^{\circ}$ , give low barometer, where the current is again upward.

Were it not for the rotation of the earth, these winds would be directly *to* and *from* the equator, but the velocity of the earth's surface, at the equator, being 1036 miles per hour, and at the poles zero, the directions of these winds are greatly modified by the rotation of the earth,—for instance, winds moving from parallel  $20^{\circ}$  toward the equator, have an initial velocity, eastward, imparted by the rotation of the earth, of 850 miles per hour, but at every point they become mixed with atmosphere which is carried along by the earth, with a greater easterly velocity; and when they reach the equator they are traveling east with a velocity of 186 miles per hour less than the earth's surface is at that line. Had their easterly velocity not been accelerated by being *pulled* along by the atmosphere with which they mixed as they moved toward the equator, our *trade winds*, which are thus produced, would be hurricanes, and instead of being a blessing to commerce, would drive every sail from the seas! The middle winds having a greater initial velocity than those with which they mix, result in giving for the middle system westerly winds, and for the reverse reason the polar system causes easterly winds.

I have now referred to the general systems of winds, with their causes, which are more or less regular and rectilinear,—but cyclones, tornadoes, and hurricanes are gyratory winds, erratic in their nature, complicated in form, and attended by many curious phenomena, which require careful study to be rightly understood.

Cyclones, which are of the greatest magnitude of all gyratory winds, are peculiar to the tropics, but their influence is often felt in, and they occasionally visit, the higher latitudes. In 1842 one of great violence passed over the northern part of Ohio, destroying houses, uprooting trees, and in other ways devastating the country. The Barbadoes were visited in 1780 by one of the most terrific and destructive cyclones recorded in history. The strongest buildings were

destroyed, trees torn up by the roots, and it is stated that a 12-pounder gun, weighing over 1000 pounds, was picked up and carried one hundred and forty yards! But a few weeks ago we read of the dark and terrible morning when the "un-chained elements" fell with the swoop of a demon upon the fair and beautiful village of Hazel Green, in Wisconsin, destroying its buildings and the lives of many of its citizens.

The motion of these gyratory winds is spirally inward and upward, the greatest velocity is on the outer edge, and within the vortex there is often a calm. Once or twice in my life I have been in the vortex of a hurricane, and experienced almost a calm. Their translatory motion is generally slow, averaging 12 to 30 miles per hour, but their gyratory motion often exceeds one hundred miles per hour! As I stood in the vortex I could observe the great disturbance in the clouds, while within sight the furious winds were doing their destructive work; a few seconds and the vortex passed, and the wind with equal fury set in from a direction opposite to that in which it was initiated.

I have often heard ignorant people speak of the suddenness with which the wind was apt to change during a violent storm. When on the Northern Pacific Railroad, I have often watched the march of storms with painful anxiety, especially during the winter, when we were troubled with snow. These winds would set in generally from the northwest, and would first strike the line of the road at Bismarck, a distance of about 200 miles west of Fargo, where my office was situated. Their march eastward was generally at the rate of about 12 miles per hour, and they were generally from 12 to 15 hours in reaching us. When reported at Bismarck, the weather at Fargo would often be bright and beautiful, but as the storm approached, scattering clouds here and there appeared, and considerable agitation would be manifest in the upper regions of the atmosphere. As the storm rose from the west, the winds would suck in from the east, exhibiting the remarkable phenomenon of a storm coming up in the face of the wind.