DYNAMICS OF TROPICAL CYCLONE

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Annotation

Considered causes of tropical cyclones. It is shown that tropical cyclones occurs as a result of interaction between the two media: hydrodynamic - hydrodynamic vortex and electronic - quantum electron vortex. The mechanism of the formation of the eye of the storm is analyzed.

Introduction

The dynamics of the atmosphere includes the basic laws of the motion of the atmosphere, the formation of cyclones and anticyclones, jet streams, waves of different nature, convection, turbulence. In the XX century, significant progress was made in studying the dynamics of the Earth's atmosphere. Mathematical models of the general circulation of the atmosphere were developed, which made it possible to implement a weather and climate forecasting system. And if the equations of geophysical hydrodynamics give acceptable solutions for the general circulation of the atmosphere, then for some objects, such as tropical cyclones, polar mesocyclones, tornadoes, etc., special mechanisms of formation must be introduced. These objects fall out of the general description scheme. It seems that when considering these objects is not taken into account, something important is missing. This is something important is the electronic environment in which all electromagnetic processes are carried out. This is the environment from which in the early XX century, under the influence of the theory of relativity of Einstein, physics refused. The theory of relativity of Einstein abandoned the ether. It was shown in [1] that ether is an electronic medium in which electrons retain a short-range order. That is, the Earth's atmosphere consists of two media: gas and electronic. The failure of the electronic environment leads to those errors and errors in the prediction of tropical cyclones, which we observe today.

Therefore, to describe the physical processes taking place in the Earth's atmosphere, it is necessary to involve two systems of equations for the gas and electron media: the equations of hydrodynamics and the equations of the dynamics of vacuum obtained in [1].

Tropical cyclones (TC)

Tropical cyclones (called typhoons on the east coast of Asia and the islands of the Pacific, and in hurricanes in North America and the Atlantic islands) arise over a warm sea surface and are accompanied by powerful thunderstorms, rainfall precipitation and winds of storm force. Tropical cyclones have tremendous destructive power.

1. The reasons for the appearance TC

In the process of occurrence tropical cyclones pass a number of stages, replacing each other. These stages are as follows [2]:

- tropical perturbation;
- tropical depression;
- tropical storm;
- a hurricane stage.

In the fourth stage, there is a significant increase in the tropical cyclone, there is the so-called "storm eye", which is the most phenomenal and mysterious phenomenon in the tropical cyclone - Fig. 1.

Fig. 1. Hurricane Irma September 6, 2017. In the center of the hurricane is clearly visible the eye of the storm. The figure is taken from the site http://rusvesna.su/

But the hurricane stage does not occur in all cases. As noted in [3]: "However, despite the intensive development of science and technology, the mystery of the emergence of tropical cyclones is not fully understood. Why, from the many depressions that arise in the tropical zone of both hemispheres, on average, one in ten gets its further development and reaches the stage of a tropical storm or a hurricane? The question is not fully understood and remains open. Therefore, the accuracy of predicting the occurrence of tropical cyclones remains at a sufficiently low level and is the subject of intensive research".

At present, there are a number of mathematical models [3,4,5,6] that accurately describe the behavior of tropical cyclones. But their essential disadvantage is a purely hydrodynamic approach in describing tropical cyclones and not taking into account the electronic environment. The hydrodynamic approach is acceptable at the initial stage of cyclone generation, at the stage of tropical perturbation and tropical depression. In mathematical weather forecasting, the vortex transport equation derived from the general hydrodynamic equations is widely used A.A. Friedman, C. Rossby, E.N. Blinova, A.M. Obukhov et al. [7,8]

$$\begin{gathered}\frac{\partial \Omega_z}{\partial t}+\left(u\frac{\partial \Omega_z}{\partial x}+v\frac{\partial \Omega_z}{\partial y}\right)+w\frac{\partial \Omega_z}{\partial z}+\left(\Omega_z+2\omega_z\right)\left(\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}\right)+ \\ +\beta v+\left(\frac{\partial w}{\partial x}\frac{\partial v}{\partial z}-\frac{\partial w}{\partial y}\frac{\partial u}{\partial z}\right)=\frac{1}{\rho^2}\left(\frac{\partial \rho}{\partial x}\frac{\partial p}{\partial y}-\frac{\partial \rho}{\partial y}\frac{\partial p}{\partial x}\right).\end{gathered} \tag{1}$$

Here $\Omega_z=\partial v/\partial x-\partial u/\partial y$ – is the vertical projection of the velocity vortex relative motion; $\beta=2\partial\omega_z/\partial y=2\omega\cos\varphi/R$ – is the Rossby parameter; ω – is the angular velocity of the Earth's rotation, ω_z – is the vertical projection of the angular velocity of the Earth's rotation; φ – is latitude, R – is radius of the Earth.

The vertical projection of the angular velocity of the Earth's rotation depends on the latitude of the terrain

$$\omega_z = \omega \sin \varphi. \qquad (2)$$

Here φ – is latitude of the terrain.

That is why tropical cyclones originate in latitudinal zones from 10^0 to 20^0 southern and northern hemispheres, where the vertical projection of the Earth's rotation speed ω_z becomes important – Fig. 2.

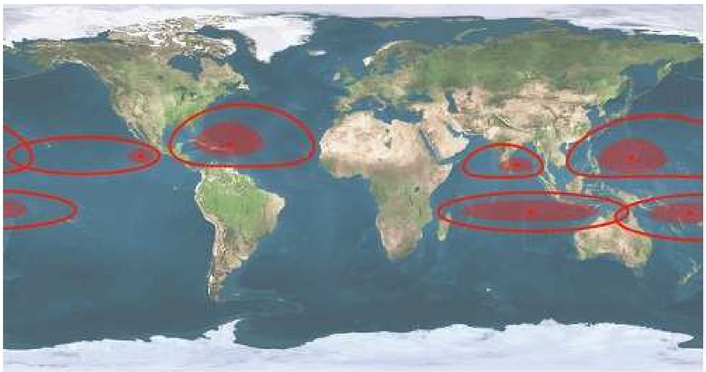


Fig. 2. Areas of origin of tropical cyclones. The centers of small circles here are the mathematical expectations of the geographical coordinates of the origin of the TC in the region. The colored ellipses around the circles correspond to the root-mean-square deviations of the coordinates from the center. The outer ovals are drawn through the initial coordinates of the TC originating in the region, which are as far from the center as possible. The figure is taken from the site http://meteoinfo.ru/tropicyclonesdatab

Another important factor affecting the regions of origin of tropical cyclones, established Luchkov [9]. He established the connection between the formation of tropical cyclones with coronal plasma emissions on the Sun. Under the influence of coronal emissions, the Earth's radiation belts no longer hold high-energy particles, and they break into the Earth's atmosphere. As noted in [9]: "There is a hopping of particles inside the magnetosphere, to lower ones located closer to the equator of the shell and, eventually, precipitation of the accelerated flow into the atmosphere along the geomagnetic equator. High-energy relativistic HRE (highly relativistic electrons) fluxes that appear with the arrival of coronal emissions were recorded by SAMPEX and POLAR (NASA) satellites".

The locations of the precipitations of particle flows invading the atmosphere "indicated" the experiment with the AMS spectrometer (atomic mass spectrograph) aboard the shuttle Discovery (1998) [9] – Fig. 3.

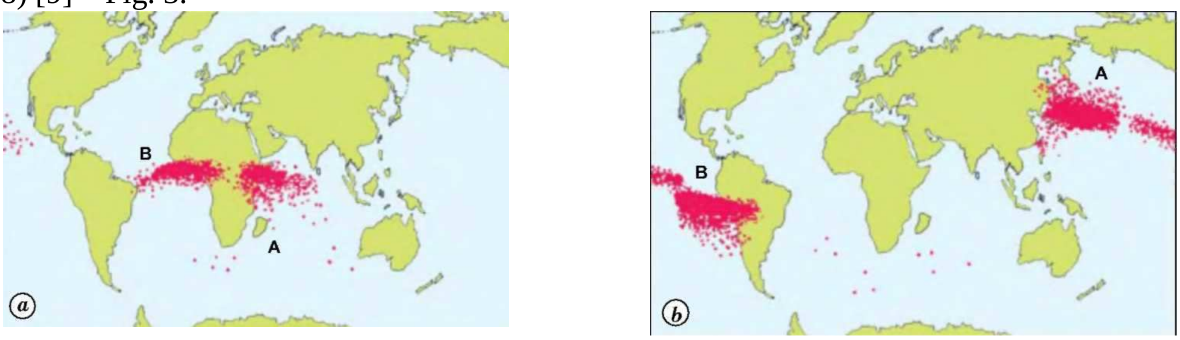


Fig. 3. Maps of precipitation from the radiation belt of electrons e - (a) and positrons e + (b) from the data of the AMS experiment (atomic mass spectrograph) aboard the shuttle Discovery (1998). The figure is taken from [9].

Comparison of Fig. 2 regions of origin of tropical cyclones with Fig. 3 maps of the precipitation from the radiation belt of electrons and positrons indicate their correlation.

2. A system of equations describing the emergence TC

We write out the system of equations of the dynamics of vacuum, obtained in [1], in the approximation of the Schrödinger equation

$$\left.\begin{aligned} &\frac{\partial^2 \mathbf{V}}{\partial t^2} - \frac{\nabla^2 \varphi}{2\eta}\mathbf{V} = c^2 \nabla^2 \mathbf{V}, \\ &\frac{\partial^2 \varphi}{\partial t^2} - \eta\left(\frac{\partial \mathbf{V}}{\partial t}\right)^2 = c^2 \nabla^2 \varphi, \end{aligned}\right\} \tag{3}$$

where **V** – is the velocity vector of the electron medium, φ – is the electric scalar potential, η – is the density of the electron medium, and c – is the speed of light.

The Earth's atmosphere consists of two media: gas and electronic. At the micro level, the electronic medium is immobile and is a dielectric. But at the macro level, this environment is mobile, which makes it "invisible". This medium is a part of atoms, molecules, and bodies. The mass of the body is manifested through interaction with this environment.

It was shown in [1] that the Schrödinger equation describing processes at the microlevel is contained in the system of equations (3). This same system of equations describes the occurrence of a tropical cyclone, that is, the appearance of a tropical cyclone can be regarded as a quantum effect, manifested at the macro level.

To analyze the formation of a tropical cyclone, we draw the first equation of system (3)

$$\frac{\partial^2 \mathbf{V}}{\partial t^2} - \frac{\nabla^2 \varphi}{2\eta}\mathbf{V} = c^2 \nabla^2 \mathbf{V}. \tag{4}$$

From the analysis of equation (4) it follows that the influence of the second term on the left side of the equation will be significant when $\nabla^2\varphi$ at least, it is different from zero. We take the operation rot from the left and right sides of equation (4). Then, taking into account that $\mathrm{rot}\mathbf{V} = \mathbf{\Omega}$, we get

$$\frac{\partial^2 \mathbf{\Omega}}{\partial t^2} - \frac{\nabla^2 \varphi}{2\eta}\mathbf{\Omega} = c^2 \nabla^2 \mathbf{\Omega}. \tag{5}$$

Where: $\mathbf{\Omega}$ – is the vector of the angular velocity of rotation of the tropical cyclone with projections $\omega_x, \omega_y, \omega_z$ on the axis of the Cartesian coordinate system x, y, z, respectively. The z axis is perpendicular to the Earth's surface and is directed upwards.

The vector equation (5) is the three scalar equations in the projections on the x, y, z axis:

$$\begin{aligned} &\frac{\partial^2 \omega_x}{\partial t^2} - \frac{\nabla^2 \varphi}{2\eta}\omega_x = c^2 \nabla^2 \omega_x, \\ &\frac{\partial^2 \omega_y}{\partial t^2} - \frac{\nabla^2 \varphi}{2\eta}\omega_y = c^2 \nabla^2 \omega_y, \\ &\frac{\partial^2 \omega_z}{\partial t^2} - \frac{\nabla^2 \varphi}{2\eta}\omega_z = c^2 \nabla^2 \omega_z. \end{aligned} \tag{6}$$

Taking into account that the angular velocity of rotation of a tropical cyclone ω_z satisfies the conditions

$$\begin{aligned} \omega_z &>> \omega_x, \\ \omega_z &>> \omega_y, \end{aligned} \tag{7}$$

it suffices to restrict ourselves to the third equation in (6)

$$\frac{\partial^2\omega_z}{\partial t^2} - \frac{\nabla^2\varphi}{2\eta}\omega_z = c^2\nabla^2\omega_z. \tag{8}$$

We seek a solution of (8) in the form

$$\omega_z = \omega_z^0(r)\cdot e^{-i\omega t}. \tag{9}$$

Here $\omega_z^0(r)$ – is the function that determines the angular velocity distribution of the tropical cyclone along the r axis; e – is an exponent; ω – is circular frequency; $i = \sqrt{-1}$.

Substituting (9) into equation (8), after the transformations detailed in [1], we obtain an equation that coincides, to within a constant, with the Schrödinger equation for the quantum harmonic oscillator

$$\nabla^2\omega_z^0 + \frac{C_1 m_e}{\hbar^2}(E - \frac{m_e\omega_0^2 r^2}{2}C_2)\omega_z^0 = 0, \tag{10}$$

where m_e – is the electron mass, $\hbar$ – is Planck's constant, ω_0 – is the eigenfrequency of the oscillator, E – is the oscillator's energy, C_1 и C_2 – is the constants.

Indeed, we write out the Schrödinger equation for a harmonic oscillator [10]

$$\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}(E - \frac{m\omega_0^2 x^2}{2})\psi = 0, \tag{11}$$

where m – is the mass of the particle, ω_0 – is the eigenfrequency of the oscillator, ψ – is the wave function, E – is the oscillator energy.

Let us write down the differential operator

$$\nabla^2\omega_z^0 = \frac{1}{r}\frac{\partial\omega_z^0}{\partial r} + \frac{\partial^2\omega_z^0}{\partial r^2}, \tag{12}$$

For significant r, which are valid for a tropical cyclone, the first term on the right-hand side of (12) can be neglected. Then equation (10) can be rewritten

$$\frac{d^2\omega_z^0}{dr^2} + \frac{C_1 m_e}{\hbar^2}(E - \frac{m_e\omega_0^2 r^2}{2}C_2)\omega_z^0 = 0. \tag{13}$$

In the future, instead ω_z^0 of writing ω_z.
Taking into account the coincidence of equations (11) and (13), we use the well-known solution of equation (11) to find the solution of equation (13).

We write out the solution of equation (13), using the solution of the Schrodinger equation for the harmonic oscillator (11) [11]

$$\omega_{zn}(r)=\frac{1}{\sqrt{r_0}}\frac{e^{-\frac{1}{2}(\frac{r}{r_0})^2}H_n(\frac{r}{r_0})}{\sqrt{2^n n!\sqrt{\pi}}}, \tag{14}$$

$$E_n=\hbar\omega_0(n+\frac{1}{2})\ \ (n=0,1,2,...), \tag{15}$$

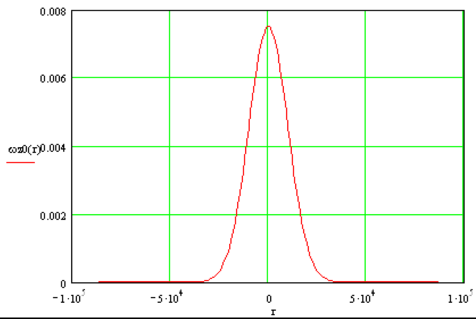
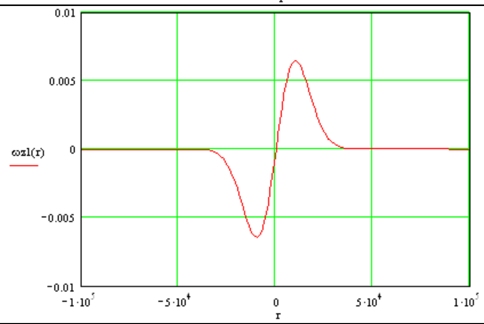
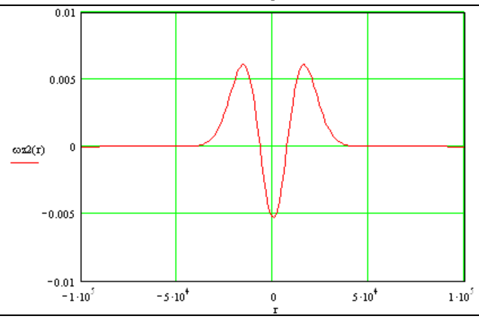
where $r_0=\sqrt{\dfrac{\hbar}{C_1C_2m_e\omega_0}}$, H_n – Chebyshev-Hermite polynomials, n – is the principal quantum number.

What should be understood as the eigenfrequency of the oscillator for equation (10)? This is the vertical projection of the angular velocity of the Earth's rotation, since the electronic medium, together with the gaseous medium, participates in the rotation of the Earth around its axis

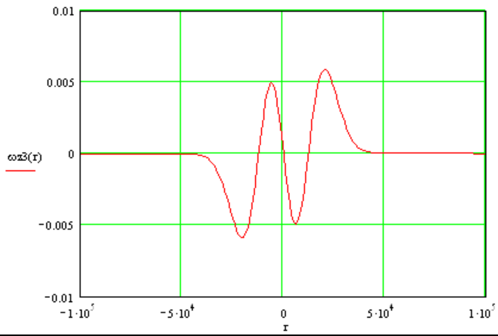
$$\omega_0=\omega\sin\varphi. \tag{16}$$

Here ω – is the angular velocity of the Earth's rotation, φ – is the latitude of the terrain.

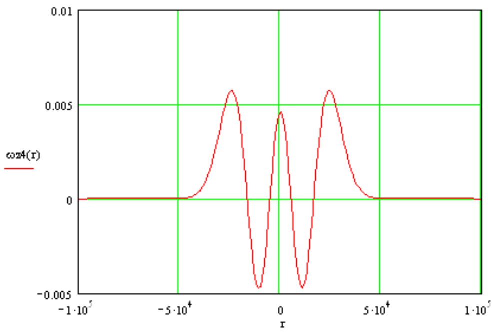
Let us give the formulas and solutions (14) for different quantum numbers, taking and calculating the values of the Chebyshev-Hermite polynomials

$\omega_{z0}(r)=\dfrac{1}{\sqrt{r_0\sqrt{\pi}}}e^{-\frac{1}{2}\left(\frac{r}{r_0}\right)^2}$,	
$\omega_{z1}(r)=\dfrac{1}{\sqrt{2r_0\sqrt{\pi}}}e^{-\frac{1}{2}\left(\frac{r}{r_0}\right)^2}2\dfrac{r}{r_0}$,	
$\omega_{z2}(r)=\dfrac{1}{\sqrt{2^2 2r_0\sqrt{\pi}}}e^{-\frac{1}{2}\left(\frac{r}{r_0}\right)^2}\left(4\left(\dfrac{r}{r_0}\right)^2-2\right)$,	

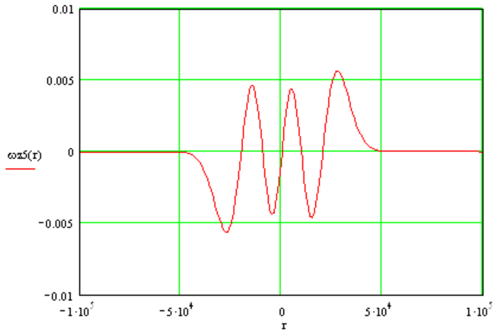
$$\omega_{z3}(r)=\frac{1}{\sqrt{2^{3}23r_{0}\sqrt{\pi}}}e^{-\frac{1}{2}\left(\frac{r}{r_{0}}\right)^{2}}\left(8\left(\frac{r}{r_{0}}\right)^{3}-12\frac{r}{r_{0}}\right),$$



$$\omega_{z4}(r)=\frac{1}{\sqrt{2^{4}234r_{0}\sqrt{\pi}}}e^{-\frac{1}{2}\left(\frac{r}{r_{0}}\right)^{2}}\cdot$$
$$\cdot\left(16\left(\frac{r}{r_{0}}\right)^{4}-48\left(\frac{r}{r_{0}}\right)^{2}+12\right),$$



$$\omega_{z5}(r)=\frac{1}{\sqrt{2^{5}2345r_{0}\sqrt{\pi}}}e^{-\frac{1}{2}\left(\frac{r}{r_{0}}\right)^{2}}\cdot$$
$$\cdot\left(32\left(\frac{r}{r_{0}}\right)^{5}-160\left(\frac{r}{r_{0}}\right)^{3}+120\frac{r}{r_{0}}\right),$$



$$\omega_{z6}(r)=\frac{1}{\sqrt{2^{6}23456r_{0}\sqrt{\pi}}}e^{-\frac{1}{2}\left(\frac{r}{r_{0}}\right)^{2}}\cdot$$
$$\cdot\left(64\left(\frac{r}{r_{0}}\right)^{6}-480\left(\frac{r}{r_{0}}\right)^{4}+720\left(\frac{r}{r_{0}}\right)^{2}-120\right).$$

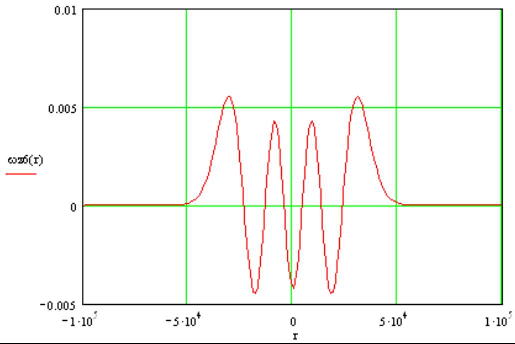


Fig. 4. Particular solutions of equation (13), found for different values of the principal quantum number $n=0;1;2;3;4;5;6$.

The general solution is defined as the superposition of particular solutions

$$\omega_{zs}(r)=\sum_{n}c_{n}\omega_{zn}(r), \qquad (17)$$

where c_n – are constant coefficients.

We find the values of the coefficients c_n from the physical statement of the problem. The solution must be symmetric about the z axis. Consequently, coefficients with odd quantum numbers must be assumed to be zero. Selecting the coefficients for even quantum numbers, we obtain for the circular frequency of the quantum electron vortex

$$\omega_{zs}(r) = 1 \cdot \omega_{z0}(r) + 0 \cdot \omega_{z1}(r) + 0 \cdot \omega_{z2}(r) + 0 \cdot \omega_{z3}(r) + \\ +1 \cdot \omega_{z4}(r) + 0 \cdot \omega_{z5}(r) + 0{,}8 \cdot \omega_{z6}(r).$$

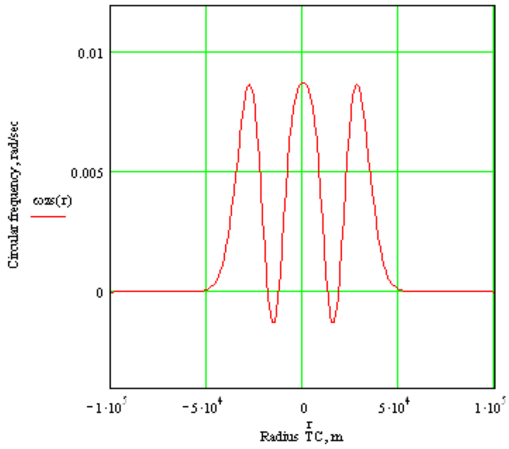


Fig. 5. The general solution for the quantum harmonic oscillator described by equation (13).

Consider the solution in Fig. 5 in more detail. A quantum vortex with a circular frequency ω_{zs} appears in the electronic medium. In contrast to the hydrodynamic vortex, in which the circular frequency is constant, in the quantum vortex the circular frequency changes its value along the radius. This leads to the fact that the electronic medium rotates only in certain narrow zones, from which the gas medium is displaced. This leads to the appearance of an eye of storms and zones free of water vapor. In areas where $\omega_{zs} \approx 0$ the gas medium and water vapor are concentrated – the eye wall and rain bands are formed – Fig. 6.

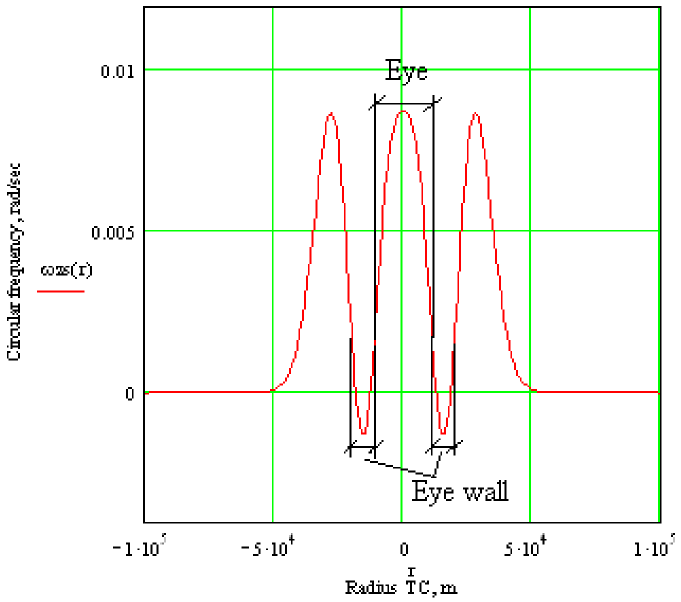


Fig. 6. Formation of the eye of the storm.

The structure of the tropical cyclone is shown in Fig. 7.

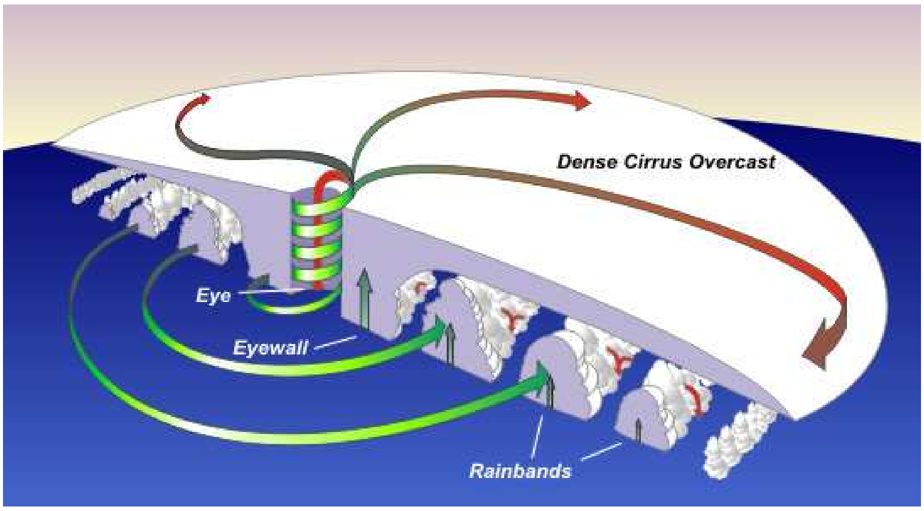


Fig. 7. The structure of the tropical cyclone. The figure is taken from Wikipedia. https://ru.wikipedia.org/wiki/

3. Sequence of formation TC

The formation of a tropical cyclone can be divided into several stages. Consider them.

First stage. Let's call it: hydrodynamic. At this stage, a tropical outcry and tropical depression are formed. This stage has been sufficiently well studied and the theory actually existing today for the tropical cyclone corresponds to this stage. The hydrodynamic vortex arising at this stage is described by the vortex transport equation (1).

Second stage. At this stage there is a loss of stability of the electronic environment under the action of relativistic electrons, "dropping out" from the radiation belts of the Earth. In fact, as follows from equations (4) and (5), the stability of an electronic medium is affected by the quantity $\nabla^2\varphi$. The second equation of system (3) is given in the quantum mechanics approximation, which is linear. If relativistic electrons are taken into account, then it is necessary to refine this equation.

To take into account in the system of equations (3) the relativistic electrons established by Luchkov [9], we take into account in the second equation the additional terms of the complete system of equations [1]

$$\frac{\partial^2\varphi}{\partial t^2} - \eta\left(\frac{\partial \mathbf{V}}{\partial t}\right)^2 + \mathbf{V}\cdot \mathrm{grad}(\mathbf{V}\cdot \mathrm{grad}\varphi) = c^2\nabla^2\varphi. \tag{18}$$

Taking into account that relativistic electrons "enter" into the atmosphere in the direction of the z axis perpendicular to the Earth's surface, we rewrite equation (18) in the form

$$\frac{\partial^2\varphi}{\partial t^2} - \eta\left(\frac{\partial \mathbf{V}}{\partial t}\right)^2 = \left(c^2 - V_z^2\right)\nabla^2\varphi. \tag{19}$$

By averaging equation (19) with respect to time, we obtain for the average Laplacian of the scalar potential $\nabla^2\varphi$

$$\nabla^2\varphi = \frac{\eta}{c^2 - V_z^2}\left(\frac{\partial \mathbf{V}}{\partial t}\right)^2. \tag{20}$$

For relativistic electrons, the velocity V_z tends to the speed of light c and, accordingly, $c^2 - V_z^2$ will tend to zero, which, according to (20), leads to a significant increase in the Laplacian of the scalar potential. If a certain threshold value $\nabla^2\varphi$ is exceeded, the electronic environment becomes unstable, and it comes into rotation.

Third stage. At this stage, an electronic vortex is formed. The peculiarity of the electronic vortex lies in the fact that it obeys quantum laws. The circular frequency of a quantum electron vortex ω_{zs} is not constant, as in a hydrodynamic vortex, but depends on the radius of a tropical cyclone. The electron vortex is "superimposed" on the hydrodynamic vortex, and their interaction arises. In zones where the circular frequency has the maximum value, an eye of the storm and zones free from rain bands are formed. Out of these zones, the gas and water environments are forced into the wall of the eye and into the rain bands. This leads to a significant reduction in the area occupied by the hydrodynamic vortex and the intensification of large-scale turbulence in the wall of the eye and in the rain bands, through which an electronic vortex is maintained. Indeed, in the wall of the eye, the Laplacian $\nabla^2\varphi$ is supported by a volumetric charge induced in a thundercloud. We write out the equation of electrostatics for a thunderstorm cloud in the form

$$\nabla^2\varphi = \frac{\rho}{\varepsilon_0}, \tag{21}$$

where $\varepsilon_0 = 8{,}85\cdot 10^{-12}\ \mathrm{C/(V\cdot m)}$ – is the electric constant, ρ – is the density of the volumetric electric charge induced in the wall of the eye.

Let us imagine the density of electric charge as a sum of two components

$$\rho = \rho_к + \rho_т, \tag{22}$$

where $\rho_к$ – is the density of electric charge on droplets and crystals, $\rho_т$ – is the density of electric charge arising under the action of large-scale turbulence.

As noted in [8], the role of turbulence in the creation of a space charge is twofold. On the one hand, if small-scale turbulence is amplified, the conduction current increases and, as a consequence, the electric field of the first scale decreases (over the cloud as a whole). On the other hand, sufficiently large turbulent volumes, detached from the total flow and approaching with equally large volumes containing charges of the opposite sign, increase the field strength.

At the third stage, there is an active interaction between the hydrodynamic and electronic vortices.

Conclusion

1. The Earth's atmosphere consists of two media: gas and electronic. The analysis shows that for an exhaustive description of the origin of tropical cyclones, it is necessary to take into account the electronic environment. The theory of relativity of Einstein, which abandoned this environment at the beginning of the XX century, hindered the development of science and caused it significant damage.
2. The dynamics of a tropical cyclone can be divided into three stages. The first stage is hydrodynamic. The second stage consists in the loss of stability of the electronic medium and is bifurcational. In the presence of relativistic electrons, it arises, in the absence of relativistic

electrons, it does not. At the third stage, a quantum electron vortex appears, which actively interacts with a hydrodynamic vortex.

3. The established patterns of the occurrence of tropical cyclones allow us to work out new methods of combating them.

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