

where ω is the angular velocity of the earth's rotation.

The formulas for changing from one coordinate system to another have the form

$$\begin{aligned} x &= x_1 \cos \omega t - y_1 \sin \omega t, \\ y &= x_1 \sin \omega t + y_1 \cos \omega t, \\ z &= z_1, \end{aligned} \quad (20)$$

$$\begin{aligned} x_1 &= x \cos \omega t + y \sin \omega t, \\ y_1 &= -x \sin \omega t + y \cos \omega t, \\ z_1 &= z. \end{aligned} \quad (20a)$$

If we convert from equations (1) to a rotary spherical system of coordinates (r, φ, λ) , where r is the radius vector, φ is latitude and λ is longitude, we get, as is known,

$$\begin{aligned} \frac{dv_r}{dt} &= -\frac{1}{\rho} \frac{\partial p}{\partial r} + 2\omega v_\lambda \cos \varphi + \frac{v_\varphi^2 + v_\lambda^2}{r} - \frac{\partial}{\partial r} \left(\Phi - \frac{\omega^2 r^2}{2} \cos^2 \varphi \right), \\ \frac{dv_\varphi}{dt} &= -\frac{1}{\rho r} \frac{\partial p}{\partial \varphi} - 2\omega v_\lambda \sin \varphi - 2 \frac{v_r v_\varphi}{r} - \frac{v_\lambda^2}{r} \operatorname{tg} \varphi - \frac{1}{r} \frac{\partial}{\partial \varphi} \left(\Phi - \frac{\omega^2 r^2}{2} \cos^2 \varphi \right), \\ \frac{dv_\lambda}{dt} &= -\frac{1}{\rho r \cos \varphi} \frac{\partial p}{\partial \lambda} - 2\omega v_r \cos \varphi + 2\omega v_\varphi \sin \varphi - 2 \frac{v_r v_\lambda}{r} - 2 \frac{v_\lambda v_\varphi}{r} \operatorname{tg} \varphi - \frac{1}{r \cos \varphi} \frac{\partial}{\partial \lambda} \left(\Phi - \frac{\omega^2 r^2}{2} \cos^2 \varphi \right). \end{aligned} \quad (21)$$

The formulas for the transition from an immobile system of coordinates to a rotary spherical system have the form

$$\begin{aligned} x &= r \cos \varphi \cos (\lambda - \omega t), \\ y &= -r \cos \varphi \sin (\lambda - \omega t), \\ z &= r \sin \varphi. \end{aligned} \quad (22)$$

Using (3) and (5) let us find the formulas for the transition from a rotary Cartesian coordinate system to a rotary spherical system:

$$\begin{aligned} x_1 &= r \cos \varphi \cos \lambda, \\ y_1 &= -r \cos \varphi \sin \lambda, \\ z_1 &= r \sin \varphi. \end{aligned} \quad (23)$$

Relationships (23) make it possible to convert from system (19) to system (21) and vice versa. Let us note that the relationships

$$\begin{aligned} u_1 &= v_r \cos \varphi \cos \lambda - v_\varphi \sin \varphi \cos \lambda - v_\lambda \sin \lambda, \\ v_1 &= -v_r \cos \varphi \sin \lambda - v_\varphi \sin \varphi \sin \lambda - v_\lambda \cos \lambda, \\ w_1 &= v_r \sin \varphi + v_\varphi \cos \varphi, \\ v_r &= u_1 \cos \varphi \cos \lambda - v_1 \cos \varphi \sin \lambda + w_1 \sin \varphi, \\ v_\varphi &= -u_1 \sin \varphi \cos \lambda + v_1 \sin \varphi \sin \lambda + w_1 \cos \varphi, \\ v_\lambda &= -u_1 \sin \lambda - v_1 \cos \lambda. \end{aligned} \quad (24)$$

occur between the velocities in these two systems. Thus we will assume that we are given a system of differential equations (21) in a spherical coordinate system. Using formulas (20a) and (24a) let us convert it to system (19) in rectangular coordinates.