

Let us use the IO model proposed in [12] against the background of a current with a constant velocity shear for a qualitative interpretation of some features of these currents recorded over the shelf of the Peter the Great Bay, excited by Typhoon Lionrock, keeping in mind that the background current with a velocity shear is the near-slope jet Primorskoe current intensified by the same typhoon.

According to the model, u , v are the meridional and zonal projections of the current velocity vector and satisfy the relations

$$u = -\alpha \left(y + \frac{q_x}{f} \right) + \frac{\alpha + f}{f} q_x \cos(ft) + \frac{\alpha + f}{f} q_y \sin(ft), \quad (1)$$

$$v = q_y \cos(ft) - q_x \sin(ft). \quad (2)$$

When deriving relations (1) and (2), it was assumed that at $t < 0$ the fluid moves in such a way that $u = -\alpha y$, $v = 0$, and at $t = 0$, a pulse action $q = (q_x, q_y)$ uniform in space and depth is applied to the fluid causing it to move.

From relations (1), (2) it follows that in the absence of a shear current, i.e. at $\alpha = 0$, the velocity vector at each point rotates in a clockwise direction with a frequency equal to the parameter f . The presented solution (1), (2) also shows that the current with a shear velocity, in contrast to the results of [19–21], does not affect the frequency of its velocity vector IO.

In accordance with the data from Tables 1 and 2, we came to a similar conclusion that at all stages of the typhoon impact on the near-slope Primorskoe current, the frequency of mesoscale oscillations of the velocity vector of this current in the inertial range against its background remains stable and close to the Coriolis parameter.

The velocity hodograph is one of the most important characteristics of inertial currents. In accordance with expressions (1), (2), the velocity hodograph of this current is set by the relation

$$\frac{u'^2}{(1 + \alpha f^{-1})} + v^2 = q_x^2 + q_y^2, \quad (3)$$

where $u' = u + \alpha y$ is a projection of the inertial current velocity vector onto the abscissa axis.

According to formula (3), the hodograph of inertial currents in the presence of a current with a velocity shear is an ellipse, the shape of which essentially depends on this shear. In other words, if the background current has a cyclonic vorticity that is equal to or exceeds the absolute value of the Coriolis parameter f , then the anticyclonic rotation of IO velocity vector is replaced by the opposite, cyclonic rotation. It is in this way that the authors of [10, 12] explain the rotation of IO velocity vector observed in some cases in the counterclockwise direction.

According to the measurement data, the Primorskoe current vorticity under the effect of the typhoon acquires a cyclonic character, changes and reaches a value that, apparently, exceeds the Coriolis parameter f . Against this background, under the effect of a gust of wind, the inertial oscillations are excited with a cyclonic direction by rotation of the current velocity vector, which was recorded by the Seawatch system.

Conclusion

We are to formulate the main results of the work. According to the measurements carried out via the Seawatch system, it was found that oscillations of current velocity vector with a frequency close to the Coriolis parameter, excited by Typhoon Lionrock in the southwestern region of the Peter the Great Bay, develop against the background of the near-slope Primorskoe current, significantly enhanced by the same typhoon. The spectral analysis of the rotational components of these current velocity fluctuations revealed the following:

- frequency stability, which accounts for the maximum spectral density of the kinetic energy of currents with rotation at a frequency close to the Coriolis parameter, at all stages of typhoon evolution;
- presence of inertial currents with counterclockwise rotation of their velocity vector, with the semi-major axis of the velocity hodograph of these currents parallel to the Primorskoe current core at all stages of the typhoon development;
- presence of subharmonics in the frequency of inertial oscillations of current velocity with both cyclonic and anticyclonic directions of rotation at the stages of maximum and final typhoon development.

The noted anomalous phenomena in inertial currents in the region of the Seawatch system deployment: stability of IO frequency, anomalous values of the eccentricity of IO velocity hodograph, change in the direction of rotation from the anticyclonic to the cyclonic one of the IO velocity vector – received a qualitative explanation within the framework of the model of inertial oscillations in the presence of a shear current. To interpret the non-stationary nature of the IO caused by amplitude modulation, as well as subharmonics of the frequency of these oscillations, it will apparently be necessary to use a nonlinear model of intense IO on a shear current.

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