Behaviour of ensembles in a rotating field
(numerical experiment)

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Weather variability is connected with the origination, evolution, interaction of flows and vertical systems in the atmosphere. The huge Antarctic is a real “forge” of vortices systems. When observing, using satellite imagery, the dynamics of chains of cyclones, as if streaming down the Antarctic, one can see that these vortices interact with each other, catching up one another, merging, moving apart, pumping one another energetically, strengthening and weakening one another.

In the present paper the evolution of ensembles of distributed vortices in a rotating field is studied using a numerical model /1/. The rotating field was simulated as a large vortex (a “vortex-field”) with its center being located in the center of the system under investigation.

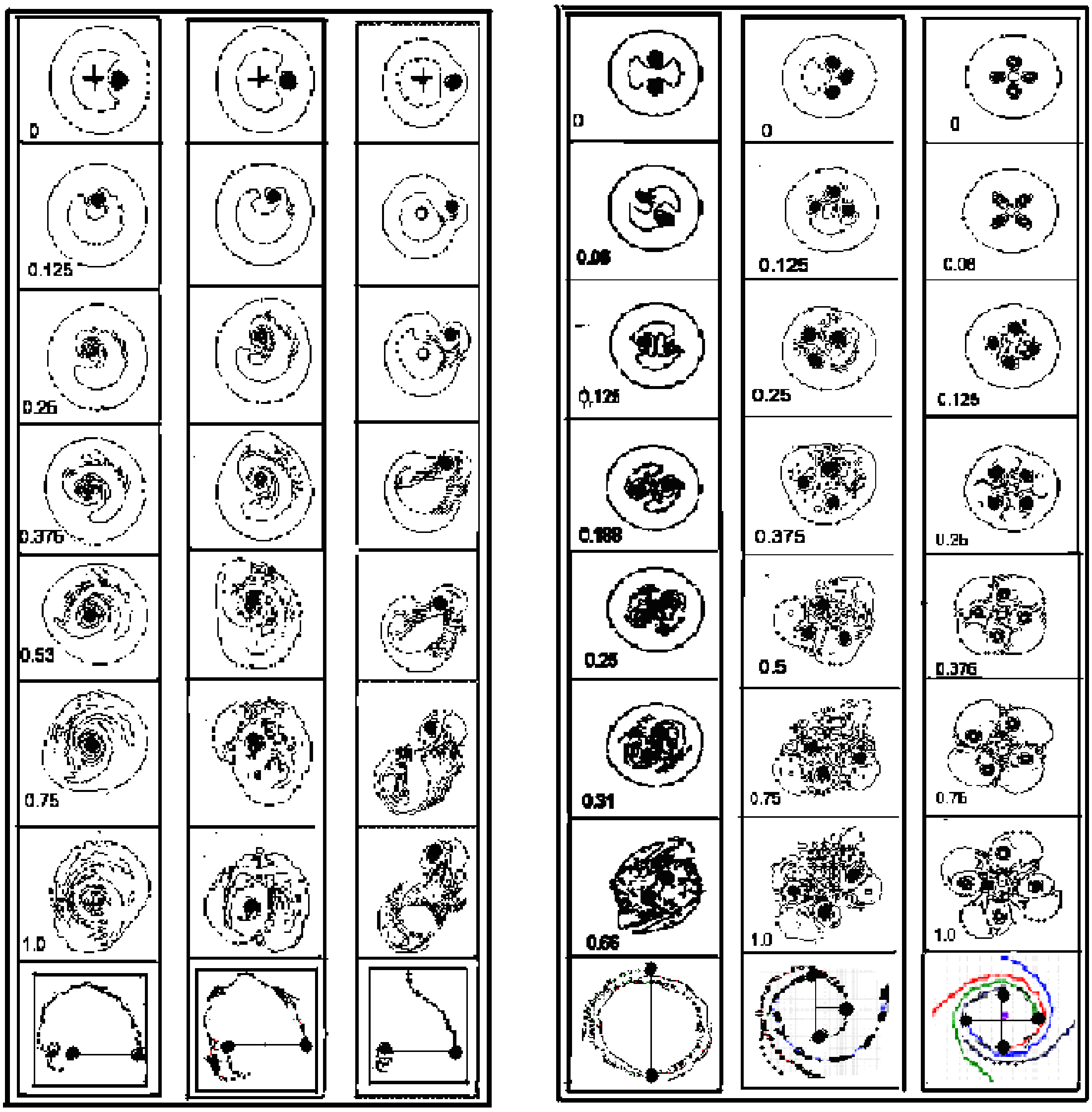
A few series of experiments were carried out in order to estimate the influence of different parameters of the system under investigation (from one to six vortices) on their behavior. The present short study is a part of the whole investigation.

1st series. The change in the interaction of the “vortex-field” and a “small” eddy with the change of the distance between them is studied.

When placing a “small” eddy into the rotating field, we observe the change of the structure of the eddy itself and of the resulting wind field (Fig.1), since positive and negative velocities of the two vortices sum up. When placing the “small” eddy at different distances from the center of the “field-vortex” (Fig. 1 a,b,c), the velocities and the gradients of velocities in the area of its location are different, and the distortion of the shape of the vortex and the field are different, respectively. This changes the kind of their interaction and the trajectories of their centers motion (Fig. 1, below). In the case “a” the center of the “vortex-field” during the integration remains in the initial position, whereas the “small” eddy rotates around the system center, gradually approaching it. When it approaches it closest, its trajectory describes a loop, and then both the “small” eddy and the “vortex-field” form a structure with a common center. In the experiment “b” at a certain moment the vortex and the eddy form an integrate vortices system, whose center turns out to be somewhat displaced with respect to its initial position. Such trajectories were observed in our previous studies /2/. During a certain time period the “small” eddy moves following a cyclonic orbit towards the edge of the field, forming a series of “secondary” vortices in its rear.

2nd series. The interaction of two, three and four vortices in a rotating field is studied (Fig. 1 d,e,f). In the experiment “d”, where the location of two “small” eddies, at a certain distance from one another, is symmetrical with respect to the field center, we observe steady balance in the interaction of vortices (practically at the same, constant, distance) with cyclonic rotation. In the experiment “e”, “f” (Fig. 1 e,f) secondary “small” eddies form /3/. As a result of this the centers of the initial eddies move apart (are “pushed one away from the other”). In the case “e” at the beginning of the experiment the system tries to bring the eddies to equilibrium (locating the centers of the eddies in the form of an isosceles triangle), but, further on, the system dynamics breaks down, and we see that they move apart (are “pushed away from each other”) with different speeds.

So, introducing a rotating field leads not only to the displacement of the system of small eddies to a certain distance at a certain speed (which depends on the relationship between the characteristics of the central vortex and small eddies and on their number), but it displaces different parts of small eddies with different speeds deforming them. Owing to the deformation small eddies begin: a) to interact with each other more intensely or weaker, b) in certain conditions secondary eddies form behind them, which also makes their contribution to the motion and the interaction of small eddies.



a b c d e f

Fig. 1 a – f. Dynamics of the vortices of a group of eddies and the trajectories of the motion of their centers (in the lower part of the figure). The calculations are made using model [1]. Figures indicate the relative time of integration.
a, b, c – a small eddy placed at different distances from the system center.
d, e, f – experiments with two, three and four eddies.

References

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