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Nonlinear analysis of attractor describing aerodynamic state of the rotating flows in atmosphere

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It is well known that there is chaos in convective process in atmosphere and ocean. In particular, dynamic model of Lorenz [1] describes the Rayleigh-Benard convection phenomenon.Phase trajectories of Lorenz equation system are characterized strange alternative properties: on the one hand, they diverge (because of positive Lyapunov exponents), on the second hand, they attract to the limited domain of phase space called an attractor [1]. An analogous behavior we can observe in the case of Couette-Taylor stream [1]. If velocity of rotationg flow reach certain value the Taylor whirlwinds appeared in the stream. The computational simulation of rotationg flows in athmosphere (including tornado,waterspout etc.) is very important problem with aim of their study and prediction.In this work, the program system STAR-CD is used for computer modeling such aerodynamic flows in the athmospheric medium. In this connection the aim of this work is development of nonlinear analysis of an attractor describing aerodynamic state of rotating flows based on the proposed nonlinear decomposition into matrix series [2]. This analysis permits to estimate the values of characteristic parameters (including control one) of attractor and predict its evolution in time. Using results of matrix decomposition [2], it is not difficult to see that the change of vector function (describing the obtained attractor) can be approximated by only linear and quadratic terms [3]. Because values of the first and second order derivatives can be calculated by means of numerical methods we can estimate the change of the vector function from computational experiment. In result, the values of parameters of this attractor can be estimated. This permits us to solve the identification task of the current dynamical state of a rotating aerodynamic flows. Moreover, using the results of matrix decomposition we can estimate the minimal embedding dimension [4] for the this attractor based on numerical data from the computational experiment by

means of STAR-CD. References: [1] P.Berge,Y.Pomeau and C.Vidal. L'ordre dans le chaos: Vers une approche deterministe de la turbulence. Hermann:Paris,1988. [2] A.M.Krot, "Matrix decompositions of vector functions and shift operators on the trajectories of a nonlinear dynamical system", Nonlinear Phenomena in Complex Systems,vol.4, N2, pp.106-115, 2001. [3] A.M.Krot and P.P.Tkachova,"Investigationof geometrical shapes of hydrodynamic structures for identification of dynamical states of convective liquid", Lecture Notes in Computer Sciences,Berlin,Germany:Springer, 2003, Part1,vol.2667,pp.398-406. [4] A.M.Krot and H.B.Minervina,"Minimal attractor embedding estimation based on matrix decomposition for analysis of dynamical systems", Nonlinear Phenomena in Complex Systems, vol.5, N2, 2002, pp.161-172.