



## Instability of surface quasigeostrophic spatially periodic flows

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The surface quasigeostrophic (SQG) model is developed to describe the dynamics of flows with zero potential vorticity in the presence of one or two horizontal boundaries (Earth surface and tropopause). Within the framework of this model, the problems of linear and nonlinear stability of zonal spatially periodic flows are considered. To study the linear stability of flows with one boundary, two approaches are used. In the first approach, the solution is sought by decomposing into a trigonometric series, and the growth rate of the perturbations is found from the characteristic equation containing an infinite continued fraction. In the second approach, few-mode Galerkin approximations of the solution are constructed. It is shown that both approaches lead to the same dependence of the growth increment on the wavenumber of perturbations. The existence of instability with a preferred horizontal scale on the order of the wavelength of the main flow follows from this dependence. A similar result is obtained within the framework of the SQG model with two horizontal boundaries. The Galerkin method with three basis trigonometric functions is also used to study the nonlinear dynamics of perturbations, described by a system of three nonlinear differential equations similar to that describing the motion of a symmetric top in classical mechanics. An analysis of the solutions of this system shows that the exponential growth of disturbances at the linear stage is replaced by a stage of stable nonlinear oscillations (vacillations). The results of numerical integration of full nonlinear SQG equations confirm this analysis.

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