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真实基流中非线性Rossby波演变特征(二): 能量、结构演变及初始场影响

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The evolution characteristic of nonlinear Rossby wave in the real basic flow II: The energy and structure evolution of Rossby wave and the effect of the initial field on it

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摘要

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摘要 针对非线性的准地转正压位涡方程, 利用自行设计的差分格式和高斯函数拟合得到的真实基流分布, 数值研究了线性和非线性Rossby波流场结构和总能量的演变以及初值对总能量演变的影响. 发现在非线性的真实基流中, 线性和非线性Rossby波的相对总能量出现振荡型增长或衰减, 非线性波动的振荡周期明显小于线性波动, 非线性项不仅抑制能量的快速发展, 也抑制能量的快速衰减; 线性Rossby波的流场结构一直是以标准的正弦(或余弦)方式演变, 而非线性Rossby波则是以类似椭圆余弦波的方式演变, 并会出现长波调整现象; 非线性Rossby波对初始场和基流结构具有强烈的依赖性, 在其总能量演变过程中, 可出现类似混沌的现象.

关键词: 线性和非线性Rossby波 相对总能量 结构 初始场 长波调整

Abstract: By using our difference formula and the fitted basic flow function, we investigate the evolutions of stream field structure and total energy of quasigeostrophic barotropic linear and nonlinear Rossby waves and the relation between the perturbed initial field and the evolution of relative total energy of Rossby wave. The numerical experiments demonstrate that the relative total energy of linear or nonlinear wave increases or decreases by oscillation. The oscillatory period of nonlinear Rossby wave is much less than that of linear Rossby wave. The nonlinear term not only restrains the energy rapid increasing but also restrains the energy rapid decreasing. The structure of linear Rossby wave will always keep the standard trigonometric wave during its evolution, while the structure of nonlinear Rossby wave will evolve to elliptic cosine wave from the standard trigonometric wave of initial value during its evolution and there will be the adjusted long-wave phenomenon for nonlinear Rossby wave. The evolution of nonlinear Rossby wave depends on the initial value and the structure of basic flow intensely and there may appear the phenomenon similar to chaos.

Keywords: Linear and nonlinear Rossby wave Relative total energy Structure Initial field Adjusted long-wave

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