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On the generation of large-scale eddy-driven patterns: the average eddy model. (English)

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Summary: A theoretical model is developed which illustrates the dynamics of the spontaneous generation of large-scale structures in baroclinically unstable eddying flows. Techniques of asymptotic multiscale analysis are used to identify instabilities resulting from the positive feedback of the background eddies on large-scale perturbations. The novelty of the proposed approach lies in the choice of a dynamically consistent time-dependent background eddy field, which is taken from simulations of baroclinic instability in the Phillips two-layer system. The resulting solutions differ considerably from those of traditional multiscale models, in which the background eddy field is represented by steady analytical patterns. The present formulation makes it possible to (i) test the multiscale theory against the corresponding numerical simulations, (ii) unambiguously interpret the key physical processes at play and (iii) rationalize the emergence of large-scale patterns for certain background parameters. While the proposed approach to multiscale modelling is illustrated on a particular example of the Phillips baroclinic instability model, it is our belief that the presented technique is readily adaptable to a wide range of applications.

MSC:

76F60 k-ε modeling in turbulence
76E20 Stability and instability of geophysical and astrophysical flows

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