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Global quasi-geostrophic theory

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The quasi-geostrophic theory of large-scale atmospheric motion occupies a central position in the conceptual framework of dynamic meteorology. The theory has been developed by Charney in the late forties of the previous century. He developed the theory in the context of the beta-plane approximation, an approximation that is valid for small flow domains in which the geometry of the Earth can be assumed flat and the variation of the Coriolis parameter to be linear with latitude. Charney's use of the beta-plane approximation might have contributed to the impression that quasi-geostrophic theory depends for its validity on the beta-plane approximation and that it is not applicable at the equator. We will argue that this is not the case and that a quasi-geostrophic theory can be formulated that is valid globally. The basic idea is to base the theory on an assumption that makes sense globally: a small horizontal divergence of the velocity field, instead of a near balance between Coriolis force and pressure gradient force. This alternative approach to quasi-geostrophic theory will be illustrated by deriving a global quasi-geostrophic approximation of a simple atmospheric model and by discussing how the approximation performs compared with the original model.