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Dynamics and parameterization of gravity waves excited from baroclinic jet-front systems

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Gravity waves, mostly unresolved in GCMs, have long been recognized to play a significant role in global circulation and climate. The leading sources of these waves include topography, convection and baroclinic jet-front systems. While most GCMs use rather comprehensive schemes to treat topographically and convectively generated gravity waves, parameterization of the impacts of jet-front gravity waves is almost nonexistent except for the recent study of Charon and Manzini (2002) which used a frontogenesis function to identify the gravity wave forcing from fronts. The difficulty reflects our lack of understanding of the characteristics, dynamics and climatology of the gravity waves generated from the non-stationary baroclinic jet-front systems.

Recent studies of both real-data and idealized simulations with state-of-the-art high-resolution mesoscale models begin to give unprecedented understanding of mesoscale gravity waves excited during baroclinic life cycles. Spontaneous balance adjustment, as a generalization of the geostrophic adjustment hypothesis, is proposed to be the likely mechanism in generating mesoscale gravity waves in the unbalanced tropospheric jet-front systems. In this hypothesis, the flow can become increasingly unbalanced after the gravity waves are being generated if the production of imbalance by the background flow outweighs the reduction of imbalance through the radiation of gravity waves. It is shown that the residual of the nonlinear balance equation can be used as an index of large-scale flow imbalance that spontaneously forces the gravity waves.

We plan to develop a gravity wave parameterization based on the recent results from mesoscale simulations and process studies. More specifically, we proposed to use the residual of the nonlinear balance equation to identify the sources of the transient jet-

front gravity waves and to use the high-resolution mesoscale simulations as a guidance to specify the spectrum of the gravity waves generated herein. Such a proposed treatment of jet-front gravity waves will be implement in the Whole Atmosphere Community Climate Model (WACCM). If successful, we will further assess the impacts of the jet-front gravity waves on the global circulation and climate.