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## **Ray-based parameterization of orographic gravity waves in NASA GEOS5 GCM**

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Ray-based parameterization can give more reality to gravity wave parameterization (GWP) in that effects of unresolved gravity waves are incorporated in GCMs through the explicit calculation of the finite-time and three-dimensional propagation of gravity waves (GWs). Based on a recent attempt for convectively forced GWs (Song and Chun 2008, JAS, in press), we apply the ray-tracing technique to the orographic GWP of NASA GEOS5 GCM. Since Song and Chun's ray-based GWP was implemented in GEOS5 GCM, the ray-based GWP has been improved in the aspects of accuracy and efficiency, and it now complies with energy and angular momentum conservations. For comparison with column-based GWP, GWs in ray-based orographic GWP are launched in the same way as in the column-based GWP. Through this comparison, we investigate relative effects of ray-based and column-based GWPs on the structure and strength of orographic GW drag. In addition, as a part of validation, we examine how much finite-time and three-dimensional propagation of orographic GWs launched near the Andes can account for strong GW variances observed along 60°S in the southern winter seasons.