# Gravity waves and precipitation in high-resolution models and observations

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Gravity waves are an important dynamical coupling mechanism between tropospheric processes and the middle and upper atmosphere, with the spectrum of wave pseudomomentum flux identified as a key quantity for understanding wave effects on the circulation. Convection is a well-recognized source for gravity waves at tropical latitudes, and some climate models include a parameterization for gravity waves that is explicitly tied to latent heating in moist convection. Such parameterizations have demonstrated value in simulating tropical circulations like the quasibiennial oscillation. Parameterizations of waves at higher latitudes have more commonly been characterized with frontal sources or dry dynamical imbalance in the jet stream.

More recently, summertime convection at midlatitudes has been revealed as an important source for gravity waves observed in satellite data. Moist processes in winter and springtime baroclinic jet-front systems have also been shown to be extremely important for describing the properties and amplitudes of vertically propagating gravity waves above these systems. These results suggest that latent heat release in precipitating systems may be an very important source for gravity waves, not only in the tropics, but globally. A variety of model studies have demonstrated a clear relationship between the spectrum of latent heating variability within precipitation systems and the spectrum of gravity waves above. Linear models (like those that underlie parameterizations of convective sources in climate models) tend to predict a realistic spectrum, but they do not predict realistic wave amplitudes. However, realistic latent heating in nonlinear models has shown excellent agreement to waves in observations.

In addition to summarizing some of the above developments, we focus on recent work on high-resolution simulation of gravity waves. Observational validation of these simulations with satellite observations of waves reveals model strengths and limitations. Additional results provide attribution of vertical flux of horizontal momentum near the tropopause to wave sources in the troposphere below.

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