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ON THE SENSITIVITY OF BAROCLINIC WAVE GROWTH TO DEEP CONVECTION

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en salle Joël Noilhan

Résumé :

The impact of latent-heat release on baroclinic wave growth has been studied for decades, with the nearly unanimous finding that this heating enhances the system growth rate. However, few if any studies have systematically addressed the role of moist convection on these waves. Given that such convection is itself a major source of latent heating, one might expect faster wave growth in more convectively active systems. To address this question, this study performs idealized simulations of baroclinic waves in a periodic channel, using varying initial environments that are identical in all respects except for their background temperatures. Although the relative humidities and dry stabilities are identical in all cases, the specific humidities and moist stabilities differ greatly, with the warmer cases more moisture-rich and conditionally unstable. Whereas the dry versions of these simulations show virtually identical wave growth in all cases, the moist versions reveal slower wave growth and faster decay at the higher temperatures, despite their increased water-vapour contents. Analysis of this seemingly counter-intuitive finding begins with the Lorenz energy budget, which shows that the reduced eddy kinetic energies at higher temperatures are linked to reduced domain-wide correlation between vertical motion and zonal temperature perturbations. This correlation is decomposed through an inversion of the quasi-geostrophic omega equation, which reveals that the so-called differential-vorticity-advection term largely underlies the energetic differences between the different cases. Analysis of upper-level vorticity indicates that, as the environment warms, so does the amplitude of upper-level short waves that propagate downwind of the storm core. Rather than remaining phase-locked to the system, these waves interfere with ridge development downwind of it, which ultimately weakens the elevated forcing for ascent that drives system growth.

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