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Linear and nonlinear sensitivity to convective parameterization and resolution in simulations over Central America

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The Central America - Caribbean domain of the CORDEX experiment is a challenge for climate simulations. The region's complex topography implies a need for fine resolution, while its tropical latitude means that precipitation is predominantly convective. We examine the effect of both convective parameterization and resolution through a matrix of simulations using four convective parameterizations, performed both at the CORDEX standard 50 km grid spacing and at 25 km spacing. The four convective parameterizations tested are the Kuo-Anthes scheme; two versions of the Grell scheme, one with quasi-equilibrium closure and the other with a fixed time scale for release of convective instability; and the Emanuel scheme. Each simulation spans a 20-year (1989-2008) period using ERA-Interim initial and boundary conditions. Comparisons of simulated precipitation to gridded observational data sets show that the Kuo-Anthes scheme and Grell scheme with quasi-equilibrium closure are much too dry, while the Emanuel scheme is more realistic over South America but too wet in Central America. The Grell scheme with a fixed time scale for convective adjustment produces results between the drier and wetter schemes. The simulation matrix performed here also permits quantitative evaluation of the nonlinear interaction between grid spacing and convective parameterization. Specifically, we assess this interaction using factor separation, which identifies the nonlinear interaction term as a residual from the effects of individual influences. The interaction term is especially noticeable for the Grell scheme when the closure type is changed from quasi-equilibrium to fixed relaxation and resolution also changes. These results indicate that evaluations of the influences of different physical parameterizations on simulation skill cannot reliably be extended to simulations at different resolutions.