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A continuous and prognostic convection scheme based on buoyancy, PCMT

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A new and consistent convection scheme (PCMT: Prognostic Condensates Microphysics and Transport), providing a continuous and prognostic treatment of this atmospheric process, is described. The main concept ensuring the consistency of the whole system is the buoyancy, key element of any vertical motion. The buoyancy constitutes the forcing term of the convective vertical velocity, which is then used to define the triggering condition, the mass flux, and the rates of entrainment-detrainment. The buoyancy is also used in its vertically integrated form (CAPE) to determine the closure condition. The continuous treatment of convection, from dry thermals to deep precipitating convection, is achieved with the help of a continuous formulation of the entrainment-detrainment rates (depending on the convective vertical velocity) and of the CAPE relaxation time (depending on the convective over-turning time). The convective tendencies are directly expressed in terms of condensation and transport. Finally, the convective vertical velocity and condensates are fully prognostic, the latter being treated using the same microphysics scheme as for the resolved condensates but considering the convective environment.
A Single Column Model (SCM) validation of this scheme is shown, allowing detailed comparisons with observed and explicitly simulated data. Four cases covering the convective spectrum are considered: over ocean, sensitivity to environmental moisture (S. Derbyshire) non precipitating shallow convection to deep precipitating convection, trade wind shallow convection (BOMEX) and strato-cumulus (FIRE), together with an entire continental diurnal cycle of convection (ARM). The emphasis is put on the characteristics of the scheme which enable a continuous treatment of convection. Then, a 3D LAM validation is presented considering an AMMA case with both observations and a CRM simulation using the same initial and lateral conditions as for the parameterized one. Finally, global evaluation is shown both in NWP and coupled climate mode.