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Exploring the boundary-layer cloud-climate feedback through Single-Column Model in Radiative-Advective Equilibrium

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Boundary-layer clouds remain the major contributor to the inter-model spread in future climate predictions. Although light has been shed on the low-level cloud feedback, much remains to be understood about the physical mechanisms at the basis of the response of these clouds to climate warming. In the present study, EC-EARTH Single Column Model (SCM) is used to explore the boundary-layer cloud-climate feedback by imposing a Radiative-Advective Equilibrium, namely a balance between the radiative cooling and the advection of warm air. 30-year simulations are performed with the SCM forced by high-frequency cfSites outputs of the CMIP5 simulations of the host General Circulation Model (GCM) for both the AMIP and AMIP4K experiments. As this study exclusively focuses on marine low-level cloud regimes, the simulations are performed at the Barbados Cloud Observatory in the so-called "dry period", when the large-scale forcing are representative of subtropical marine trade-wind conditions. A first step is to assess how representative long-term SCM simulations are of their host GCM. Subsequently, the SCM is forced by different GCMs within the same framework. In this way, the contribution of the physical parameterization to the boundary-layer cloud feedback is isolated from the dynamics, and systematically evaluated. Finally, a procedure to integrate Large-Eddy Simulations and observations into this framework is discussed.