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On the transition from stratocumulus to cumulus toped boundary layers

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Large areas of the subtropical and tropical oceans are dominated by moist convective boundary layers. These boundary layers are often associated with different types of low-level cloud regimes, including stratocumulus (Sc), shallow cumulus (Cu) and deep convective clouds. Since these boundary layers (in particular Sc) play a key role in modulating the Earth's global climate through radiative forcing, understanding the Sc to Cu transition is of paramount importance for simulating present day and future climate change. Although numerous studies examined the possible physical mechanisms that lead to the transition from Sc to Cu dominated boundary layers, there is still no agreement on which are the key processes responsible for the transition.
In this study we combine single column modeling results, reanalysis and observational data to derive a simple model that describes the transition from Sc to Cu. This model is based on vertically integrated bulk equations. We show that the simplification of these equations leads to some of the well-known criteria for the transition, including ones involving lower-tropospheric-stability and top-entrainment-instability parameters. We further propose to use the results of this study to investigate the realism of the Sc to Cu transition in the global climate models.