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Impact of entrainment and of the diurnal cycle of convection on the simulated tropical climate

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Accurately simulating convection with global climate models remains a nagging challenge. Many parameterizations share similar deficiencies and it is often difficult to trace biases in simulated precipitation back to specific details of a convection scheme. This study aims to better understand the impact of the misrepresentation of the convective diurnal cycle on the simulated tropical climate and to assess the role of entrainment and detrainment rates in this misrepresentation. The general approach is to try forcing the convection scheme to rain when and where it should rain by controlling its entrainment and detrainment rate. Simulations are performed with the ECHAM global climate model with prescribed sea surface temperature and using diurnally varying entrainment and detrainment rates.
Over land, forcing in this way a late precipitation peak yields a drastic reduction in amplitude indicating that the wrong timing of precipitation is a closure/triggering rather than entrainment/detrainment problem. This is not true over ocean, where convection can be easily triggered throughout the day. Comparing simulations with different phases and amplitudes of the convective diurnal cycle reveals a limited impact of the timing of precipitation on the simulated tropical climate. Significant differences can be found over the maritime continent and over some land areas but not in the Pacific and Atlantic ITCZ. The amplitude of the diurnal cycle on the other hand seems to have a stronger impact on the precipitation distribution, with a more pronounced diurnal cycle yielding a more realistic precipitation pattern.