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Evaluation of marine stratocumulus simulated by the CNRM-CM6 model using the Transpose-AMIP framework

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Most of coupled climate models exhibit large surface temperature biases over the eastern part of ocean basins, particularly over the tropical south-eastern Atlantic and Pacific oceans. These biases significantly impact the simulation of the tropical climate. Their physical origin still remains to be fully elucidated, even though several possible origins have been highlighted : overestimate of solar incoming radiation reaching the surface related to a lack of low clouds, underestimate of equatorial surface easterly winds, moisture excess in the atmospheric boundary layer, misrepresentation of the ocean upwelling dynamics… In the last decade, a new version of the atmospheric physics has been developed and implemented, which includes a new boundary-layer scheme based on a prognostic equations of turbulent kinetic energy, a more detailed representation of the microphysics and a new convection scheme that aims to represent continuously dry, shallow and deep convection. These developments have al large impact on the representation of tropical low clouds. They are evaluated here with a focus on the tropical south-eastern Atlantic ocean.

First, we evaluate the simulated zonal transition between stratocumulus and cumulus. The comparison with observed clouds from the active remote sensor embedded in CALIPSO highlights an important lack of stratocumulus. Second, short-term hindcasts, following the Transpose-AMIP framework, are used to better assess the timescales associated with the cloud bias growth and highlight processes leading to them. It is shown that these biases appear within only a few hours, independently of errors in the large-scale circulation that set up within the first few days. Key processes underlying the lowcloud formation are thus local and do not imply at first order any feedback between the model physics and dynamics. Specifically, the drivers for this low-cloud underestimate are further discussed to shown that they are likely to arise from errors in cloud scheme input coming from the boundary-layer thermodynamics (e.g. turbulence) and structural errors from the cloud parameterization itself (e.g. assumptions of sub-grid variance of thermodynamical variables). This study provides guidance for future improvements of stratocumulus representation in the CNRM-CM model.