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Understanding the tropical warm temperature bias simulated by climate models

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The state-of-the-art coupled general circulation models have difficulties in representing the observed spatial pattern of surface tempertaure. A majority of them suffers a warm bias in the tropical subsiding regions located over the eastern parts of oceans. These regions are usually covered by low-level clouds scattered from stratus along the coasts to more vertically developed shallow cumulus farther from them. Models usually fail to represent accurately this transition.

Here we investigate physical drivers of this warm bias in CMIP5 models through a near-surface energy budget perspective. We show that overestimated solar insolation due to a lack of stratocumulus mostly explains the warm bias. This bias also arises partly from inter-model differences in surface fluxes that could be traced to differences in near-surface relative humidity and air-sea temperature gradient.

We investigate the role of the atmosphere in driving surface biases by comparing historical and atmopsheric (AMIP) experiments. We show that some differences in boundary-layer characteristics, mostly those related to cloud fraction and relative humidity, are already present in AMIP experiments and may be the drivers of coupled biases. This gives insights in how models can be improved for better simulations of the tropical climate.