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Conceptualizing diurnal surface warming in the tropical ocean

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Which processes cause and maintain convective organization in the tropics? Recent cloud-resolving simulations indicate that, compared to studies performed under radiative convective equilibrium, a diurnally varying boundary surface substantially changes the spatiotemporal patterns of convection. To better understand feedbacks between the atmosphere and an interactive ocean requires an accurate description of diurnal warming at the sea surface. Here we present an idealized, one-dimensional model of radiative transfer in the upper 10 meters of the ocean, forced by solar insolation and atmospheric conditions. Unlike comparable models, we treat turbulent mixing as simple diffusion combined with a second linear mixing term. This retains conceptual simplicity while resolving important processes such as wind-driven mixing, near-surface heat trapping, and skin cooling. A comparison with observations shows that the model produces key features of real diurnal temperature profiles. In turn, our results cast light on which conditions may facilitate strong diurnal surface warming of 3K and more.

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