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Boundary-layer diabatic processes, the virtual effect, and convective self-aggregation

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The atmosphere can self-organize into long-lasting large-scale overturning circulations over an ocean surface with uniform temperature. This phenomenon is referred to as convective self-aggregation and has been argued to be important for tropical weather and climate systems. Here we present a linear boundary-layer model to study the initiation of convective self-aggregation. The model equations are identical to a set of shallow water equations, with diabatic processes as mass sources or sinks. This model suggests that boundary-layer diabatic processes can produce available potential energy and are, therefore, necessary to initiate a large-scale circulation. This model further suggests that boundary-layer radiation, convection, and surface buoyancy flux help convection self-aggregate, and evaporative cooling in the boundary layer inhibits convective self-aggregation. This model successfully predicts that the enhanced virtual effect of water vapor can lead to convective self-aggregation.