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The Role of 1D and 3D Radiative Heating on the Organization of Shallow Cumulus Convection and the Formation of Cloud Streets

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Shallow cumulus convection often organizes in banded structures aligned with the background wind.
Explorations with idealized, high resolution Large-Eddy simulations reveal that radiative heating also stimulates shallow cumulus cloud dynamics, leading to the enhancement or destruction of these cloud streets.
Here, we present the role of radiative transfer with respect to the generation of such cloud structures.
Particularly the shortcomings of 1D radiative transfer, where the shadow always falls directly beneath the clouds, have a detrimental influence on the development of cloud-radiative feedback mechanisms (as clouds always cast their shadow onto their updraft region). In contrast, 3D radiative transfer allows to continually heat the surface in the cloud's updraft region which prolongs the cloud development and induces a secondary circulation that leads to the formation of band-like structures perpendicular to the incident radiation.
We present an analysis on the competing effects of dynamically and radiatively induced organization. The strength of convective organization shows to be dependent on the background wind speed, the surface conditions, as well as the sun's azimuth and zenith angle.