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2D radiative processes near cloud edges

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Because of the importance and complexity of dynamical, microphysical, and radiative processes taking place near cloud edges, the transition zone between clouds and cloud free air has been the subject of intense research both in the ASR program and in the wider community. One challenge in this research is that the one-dimensional (1D) radiative models widely used in both remote sensing and dynamical simulations become less accurate near cloud edges: The large horizontal gradients in particle concentrations imply that accurate radiative calculations need to consider multi-dimensional radiative interactions among areas that have widely different optical properties.

This study examines the way the importance of multidimensional shortwave radiative interactions changes as we approach cloud edges. For this, the study relies on radiative simulations performed for a multiyear dataset of clouds observed over the NSA, SGP, and TWP sites. This dataset is based on Microbase cloud profiles as well as wind measurements and ARM cloud classification products. The study analyzes the way the difference between 1D and 2D simulation results increases near cloud edges. It considers both monochromatic radiances and broadband radiative heating, and it also examines the influence of factors such as cloud type and height, and solar elevation. The results provide insights into the workings of radiative processes and may help better interpret radiance measurements and better estimate the radiative impacts of this critical region.