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Inferring the Cloud Vertical Distribution from Geostationary Satellite Data

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Clouds and their radiative feedback mechanisms are of vital importance for the atmospheric cycle of the Earth regarding global weather today as well as climate changes in the future. Climate models and simulations are sensitive to the vertical distribution of clouds, emphasizing the need for broadly accessible fine resolution data. Although passive satellite sensors provide continuous cloud monitoring on a global scale, they miss the ability to infer physical properties below the cloud top. Active instruments like radar are particularly suitable for this task but lack an adequate spatio-temporal resolution. Here, recent advances in Deep-Learning models open up the possibility to transfer spatial information from a 2D towards a 3D perspective on a large-scale.

By an example period in 2017, this study aims to explore the feasibility and potential of neural networks to reconstruct the vertical distribution of volumetric radar data along a cloud's column. For this purpose, the network has been tested on the Full Disk domain of a geostationary satellite with high spatio-temporal resolution data. Using raw satellite channels, spectral indices, and topographic data, we infer the 3D radar reflectivity from these physical predictors. First results demonstrate the network's capability to reconstruct the cloud vertical distribution. Finally, the ultimate goal of interpolating the cloud column for the whole domain is supported by a considerably high accuracy in predicting the radar reflectivity. The resulting product can open up the opportunity to enhance climate models by an increased spatio-temporal resolution of 3D cloud structures.