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IceCloudNet: 3D reconstruction of cloud ice from Meteosat SEVIRI input

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Remote sensing observations of cloud ice in cirrus and mixed-phase clouds have been playing a crucial role in advancing our understanding of cloud processes and validating climate models. On the one hand, many studies have used polar-orbiting active satellite instruments like CALIPSO's lidar and CloudSat's radar to analyze microphysical properties of ice clouds. These instruments are able to provide a vertical profile of cloud structures and thus allow a detailed view on cloud microphysical properties. But, due to their long revisiting times it is impossible to study the evolution of individual clouds. On the other hand, passive geostationary satellite instruments such as SEVIRI onboard the Meteosat satellites retrieve every 15 minutes a top-down view of Earth's surface by measuring intensities of the reflected solar radiation and terrestrial infrared radiation but only in 2D.

IceCloudNet is a novel machine learning model that fuses the benefits of passive geostationary and polar-orbiting active satellite instruments to create a new vertically resolved (3D) data set of cloud ice in cirrus and mixed-phase clouds with high spatio-temporal coverage and resolution. To this end, we train IceCloudNet to predict the vertical structure of cloud ice from SEVIRI input data and co-located vertically resolved cloud ice retrievals from DARDAR as target data. Despite being only supervised with sparsely available DARDAR reference data, IceCloudNet shows good performance in predicting complex cloud structures including multi-layer clouds, when tested on independent validation data. The new data set created by IceCloudNet will enable the scientific community to conduct novel research on ice cloud formation and improve the understanding of microphysical processes by tracking and studying cloud properties through time and space.