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Statistical Retrieval of Thin Liquid Cloud Microphysical Properties Using Ground-Based Infrared and Microwave Observations

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In this study, liquid water cloud microphysical properties are retrieved by exploiting passive remote sensing techniques in the microwave and infrared spectral regime. Liquid water clouds are highly frequent in various climate regimes and play a significant role in terms of interaction with radiation. Small perturbations in the amount of liquid water contained in the cloud can cause large variations in the radiative fluxes. This effect enhances for thin clouds with a low liquid water path (LWP), which requires accurate retrieval information on the cloud properties.

Retrieving low LWP values using the microwave spectral regime reveals large relative errors, whereas the potential for infrared methods is high. Therefore robust and computationally low demanding synergistic retrievals based on a multivariate regression and a neural network are derived to estimate LWP and cloud effective radius. While the regression-type synergy retrievals are strongly influenced by the nonlinearities of saturating signals in the infrared regime for higher LWP, the neural network retrieval is able to retrieve LWP and cloud effective radius with a higher accuracy than the single instrument retrievals. This is achieved by examining synthetic observations in the low LWP range. Furthermore, the performance of the retrievals is assessed in a radiative closure study for the downwelling shortwave flux, using measurements of a microwave radiometer, a broadband infrared radiometer and a spectrally highly resolved Atmospheric Emitted Radiance Interferometer (AERI).