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The relationship between cloud thermodynamic structure and the properties of precipitation from cloud radar and disdrometer observations

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Dominating precipitation formation processes vary in different climate regions. Cloud ice particles, which are involved in most of these processes, are usually formed at the uppermost cloud layer. As underlying formation processes strongly depend on temperatures of the ambient air, cloud top temperatures may indicate the initial formation process of precipitating hydrometeors. Therefore, several temperature regimes can be defined and assigned to dominant formation processes. Warm-rain formation, for example, can be allocated to cloud top temperatures above 0℃. Between 0℃ and -25℃, freezing processes with contributing liquid water such as immersion or contact nucleation may occur additionally. Below around -30℃, deposition freezing may happen as well, and below around -40℃, cloud ice can also form homogeneously.

The goal of this study is to connect precipitation events on the ground with the ambient temperature at their area of formation at the cloud top in order to retrieve a statistical overview on the relevance of the abovementioned key ice nucleation processes for the precipitation budget. Exemplarily, a long-term dataset of cloud radar and disdrometer observations of the mobile Cloudnet station LACROS (Leipzig Aerosol and Cloud Remote Observations System) was used for this study. Temperature information were obtained from the ECMWF IFS model, provided via Cloudnet. Each precipitation event detected by the disdrometer is assigned a cloud top height from the radar measurements. For this purpose, the application of a fallstreak algorithm was applied as the cloud top height detected by radar may change between the formation of the hydrometeor and its detection on the ground. The fallstreak propagation is based on the reflectivity values of the single radar bins. The method presented in this study was applied to a multi-year dataset which allows to create statistics of dominating cloud top temperature regimes during precipitation formation over contrasting sites such as Leipzig, Germany, Limassol, Cyprus, and Punta Arenas, Chile.

The results show that precipitating clouds can be categorized into different cloud top temperature regimes which can be associated with different precipitation formation processes. If the method is applied to datasets of stations in different climate zones, potential results may reveal varying dominating formation processes. Therefore, this method may have great potential to contribute to cloud research in a global context, for example, by evaluating cloud models. Moreover, the frequency of precipitation formation events under different aerosol and dynamics conditions can be investigated, if the method is extended.

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Session

Enhancing Process Understanding: New observations for modeling and parameterization development

Preferred Contribution Type

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Presenting Author

Tom Gaudek

Email Address of Presenting Author

gaudek@tropos.de

Affiliation of Presenting Author

TROPOS

Address of Presenting Author

Permoserstraße 15, 04318 Leipzig

Author: GAUDEK, Tom

Co-authors: Prof. BÜHL, Johannes (Hochschule Harz, TROPOS); Dr OHNEISER, Kevin (TROPOS); Dr RADENZ, Martin (TROPOS); SEIFERT, Patric (TROPOS)

Presenter: GAUDEK, Tom