The relationship between cloud thermodynamic structure and the surface precipitation – assessing ground-based and spaceborne perspectives

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Motivation

Towards a better understanding of precipitation initiation

- identification of dominant precipitation formation pathways is key
- potential influence of aerosol regime → regional differences expected
- **cloud-top temperature** as indicator for hydrometeor nucleation and as constraint for precipitation formation processes

Fig. 1: Ground-based remote sensing observational sites for which measurements were analysed. For yellow-marked sites, EarthCARE data were also analysed.

Ground-based supersites for high-resolution perspective

- ACTRIS-provided remote sensing supersites such as LACROS (Fig. 2)
- instrument synergies enable development and application of state-of-the-art retrievals

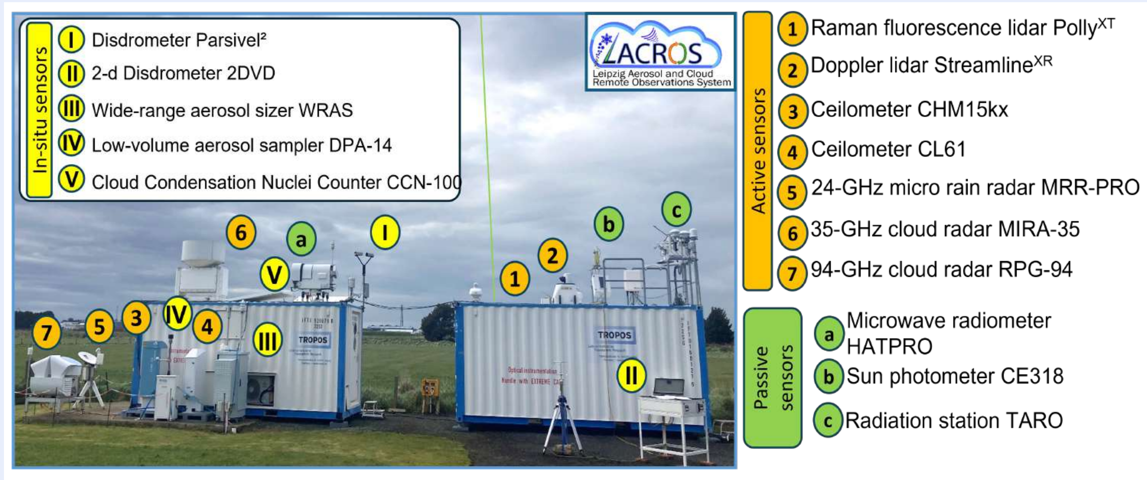


Fig. 2: The mobile platform LACROS operating during goSouth-II in Invercargill, New Zealand.

The CLOPPER method

CLOPPER: CLOud Properties versus PrEcipitation Rate

- combination of disdrometer, cloud radar (Ka-band), and ECMWF IFS model (ACTRIS Cloudnet)
- cloud top biased in profile-based approach → fallstreak tracking required
- temperature at cloud top taken from model and assigned to surface precipitation rate (Fig. 3)
- [Gaudek et al., in prep.]

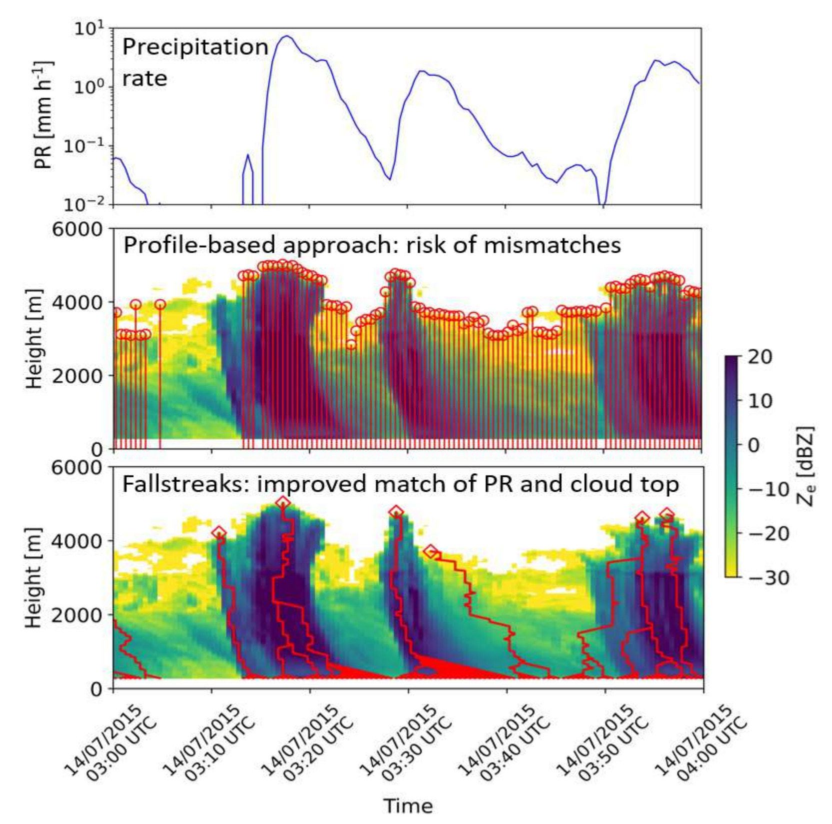


Fig. 3: Analysis steps for CLOPPER.

EC-CLOPPER from space

Method

- similar analysis steps as with CLOPPER (profile-based)
- baseline: currently BA
- precipitation: derived from ACM-CAP
  - 6th height bin → „near-surface" rain and ice mass fluxes (~600 m)
- reflectivity: synergistic target classification (AC-TC)
- temperatures: model data (xmet files)

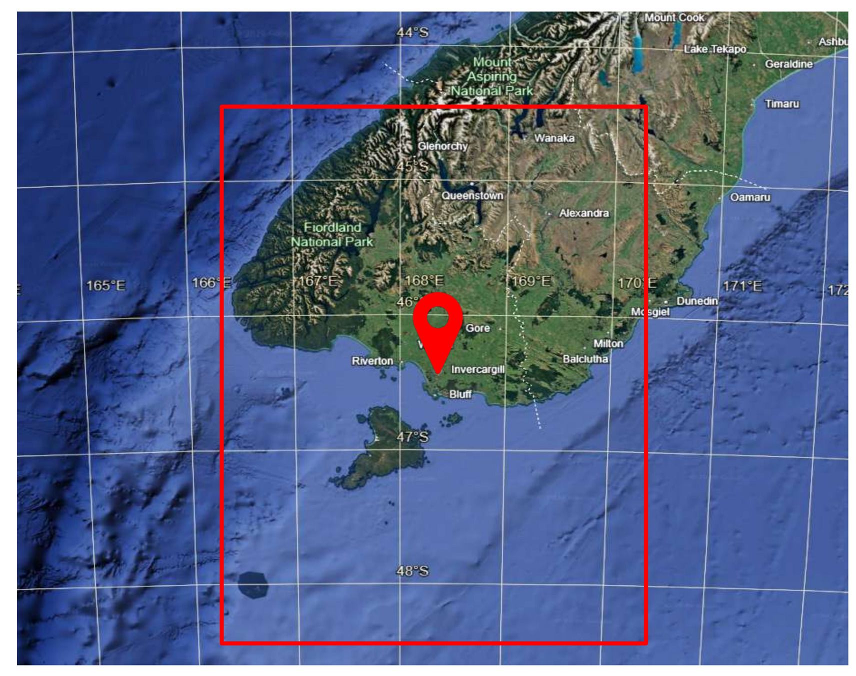
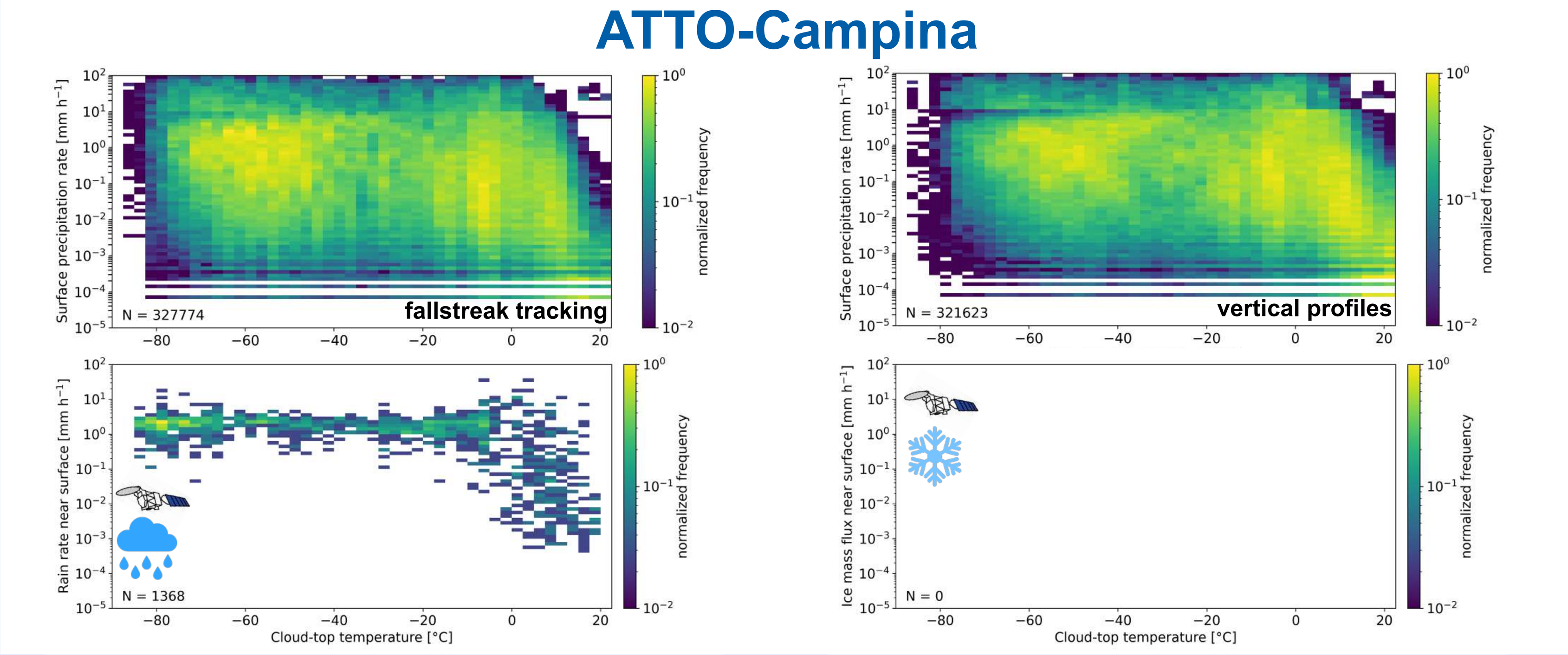


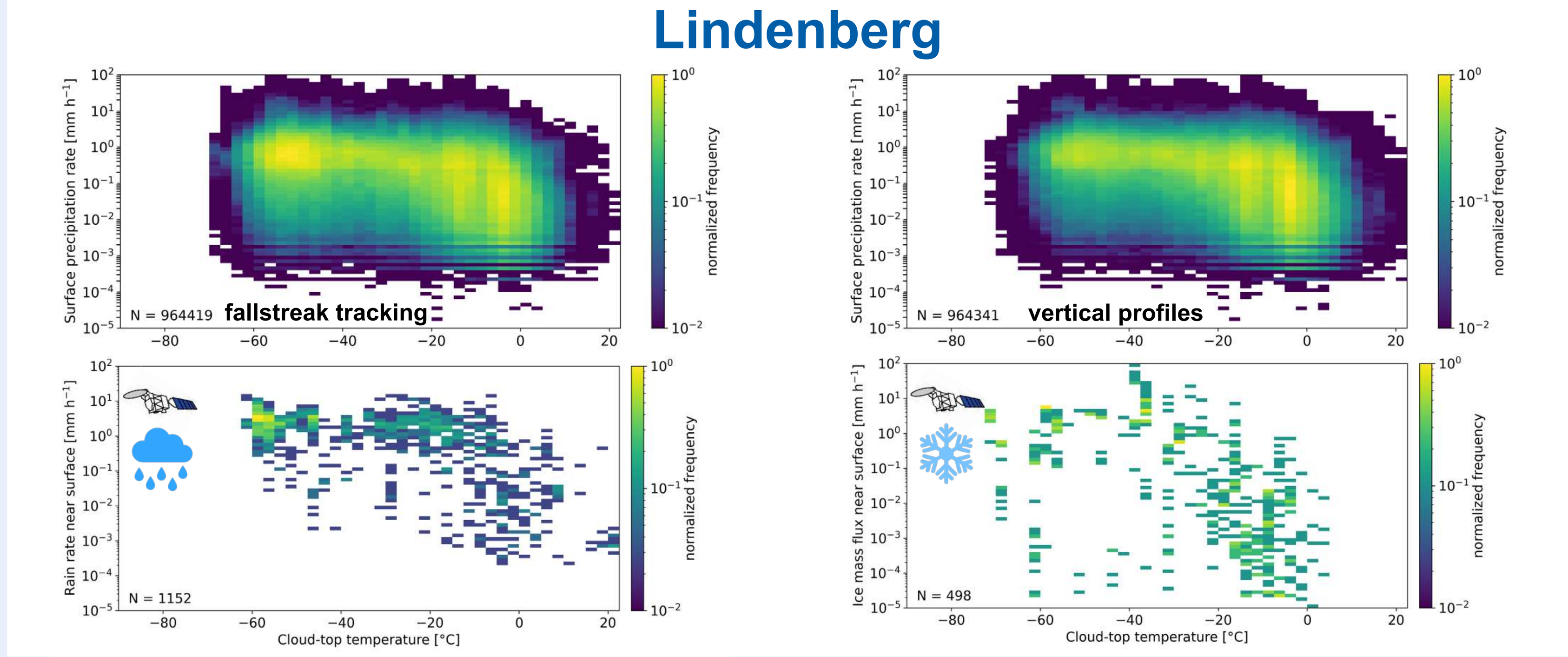
Fig. 4: For each station, all EarthCARE profiles from a surrounding 4°x4° grid box are accounted for the analysis (red). For Invercargill, the test of an alternative area with less orographic influence led to similar results.

Results from CLOPPER: ground versus space perspective

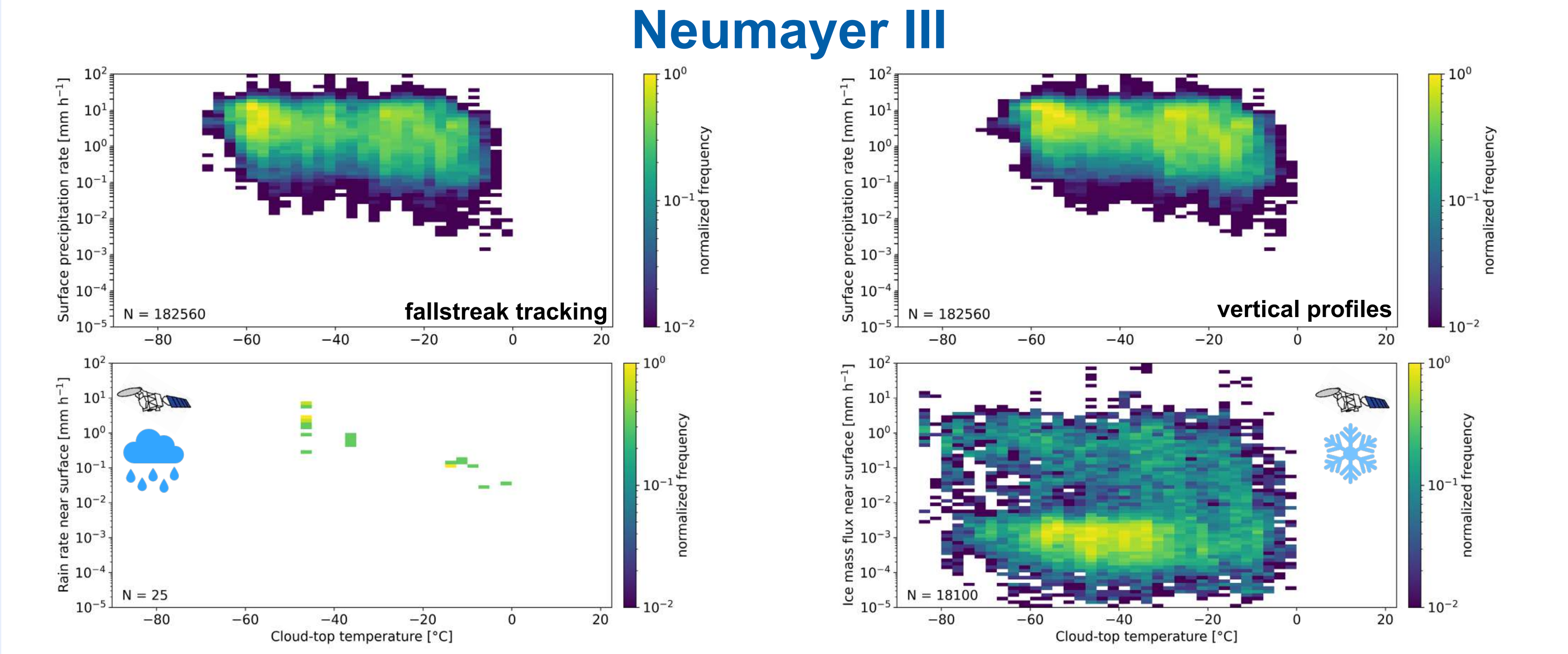
ATTO-Campina



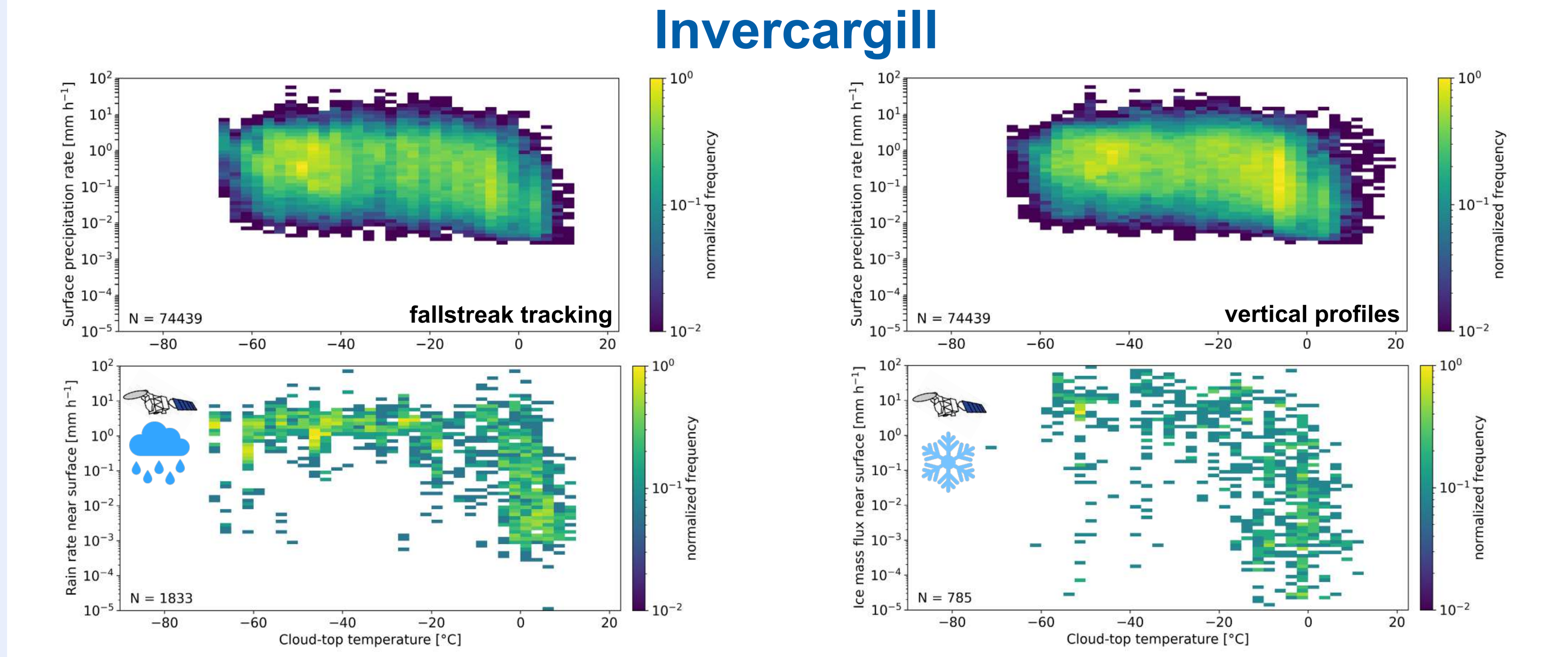
Lindenberg



Neumayer III



Invercargill



Conclusions and Outlook

Conclusions

- CLOPPER resolves features of primary precipitation regimes but EarthCARE still lacks statistics (even for 4°x4° grid boxes)
- generally good agreement between ground and space perspective → magnitude of rain rates, distribution of temperature maxima
- challenging environments: snow measurements at Neumayer, deep cloud systems at ATTO-Campina

Next steps

- attribute differences between baselines → casestudies!
- more overpasses allow for reduced grid box size
- estimate temperature bias of EC-CLOPPER
- implement additional constraints: Doppler velocity, melting layer, surrounding aerosol