Vertically-resolved cloud and drizzle retrievals during MAGIC

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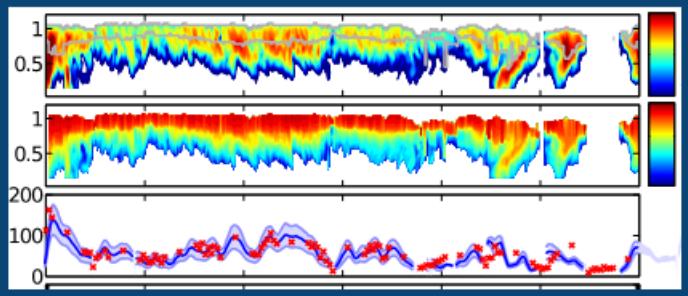
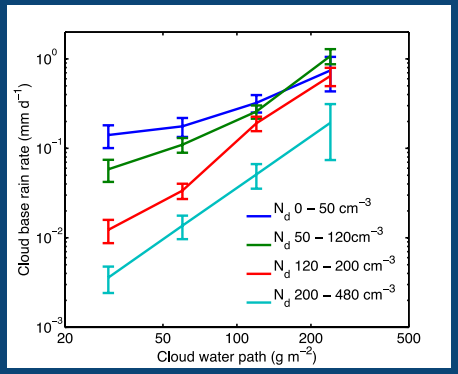
Thanks: Graham Feingold, Ed Eloranta, Maria Cadeddu, Ewan O'Connor

Outline

Overview of ENCORE retrieval method



1st June 2013 case study



Preliminary retrievals for legs 11–13 (June 2013)

ENCORE retrievals of cloud and drizzle properties

- Combines KAZR/WACR, HSRL and zenith radiances
- Uses the Iterative Ensemble Kalman Filter as an optimal estimation framework (full error statistics)

Key **cloud** droplet retrievable variables:

- Water content, W_c, g m^{-3}
- Effective radius, $r_{e,c}$, (μm)
- Number concentration. N_d,

Key **drizzle** drop retrievable variables:

- Water content, W_d, g m^{-3}
- Effective radius, $r_{e,d}$, (μm)
- Rain rate, RR (mm day^{-1})

ENCORE operates in two modes

Mode 1 – non-precipitating cloud (Zcb < –17 dBZ)

- Cloud properties constrained by radar and shortwave radiance only

Mode 2 – precipitating cloud (Zcb > –17 dBZ)

- Drizzle below cloud base constrained by lidar and radar
- Cloud properties constrained by shortwave radiances
- Drizzle properties within cloud are constrained by radar

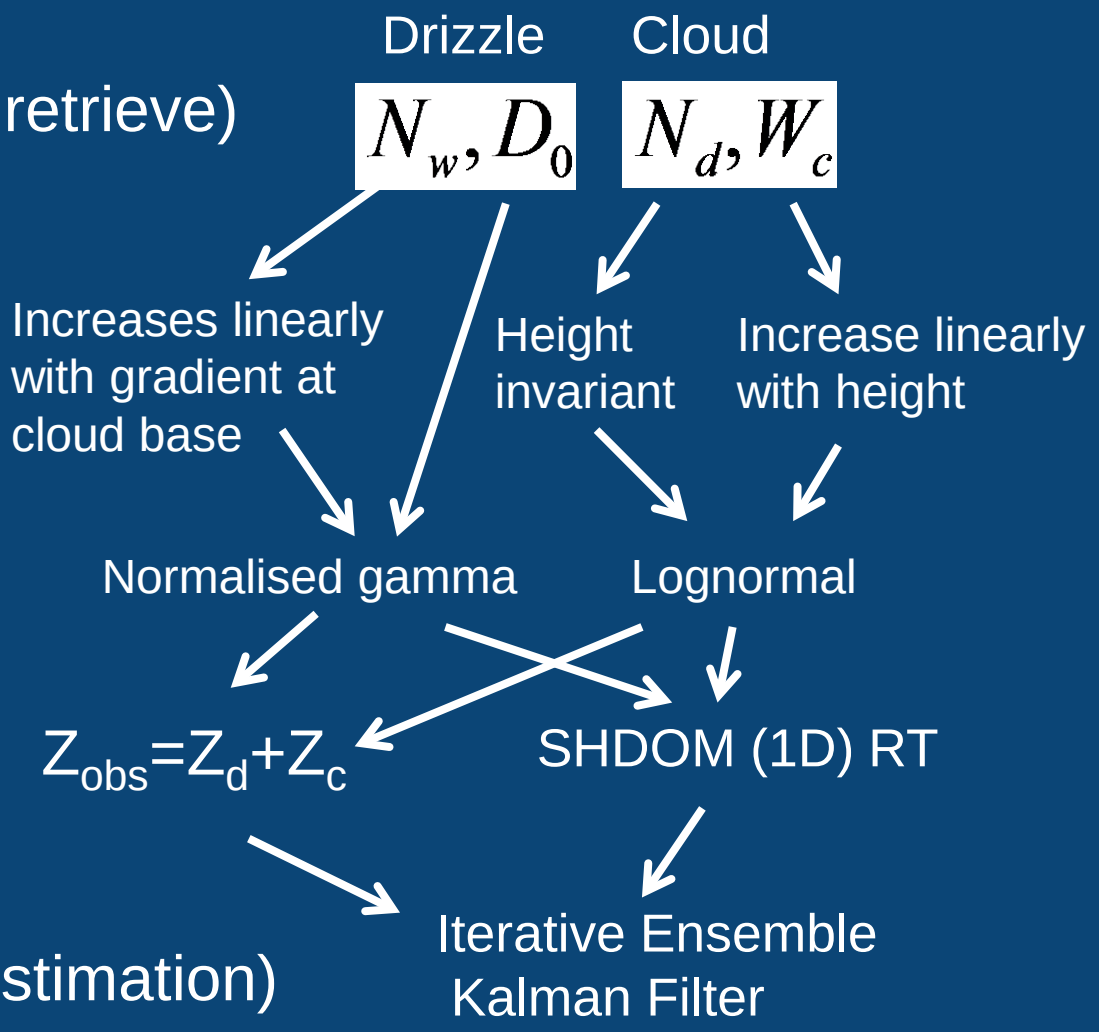
ENCORE within precipitating cloud

State (what we wish to retrieve)

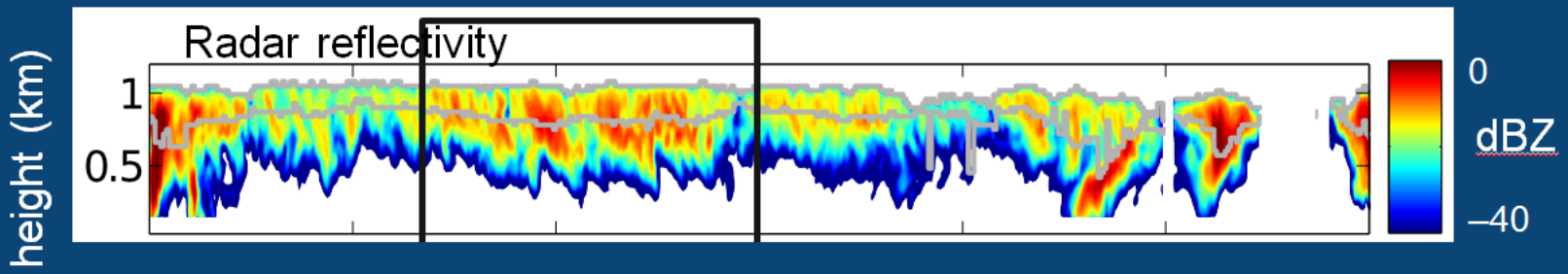
Assumptions

Forward models

Minimization (optimal estimation)



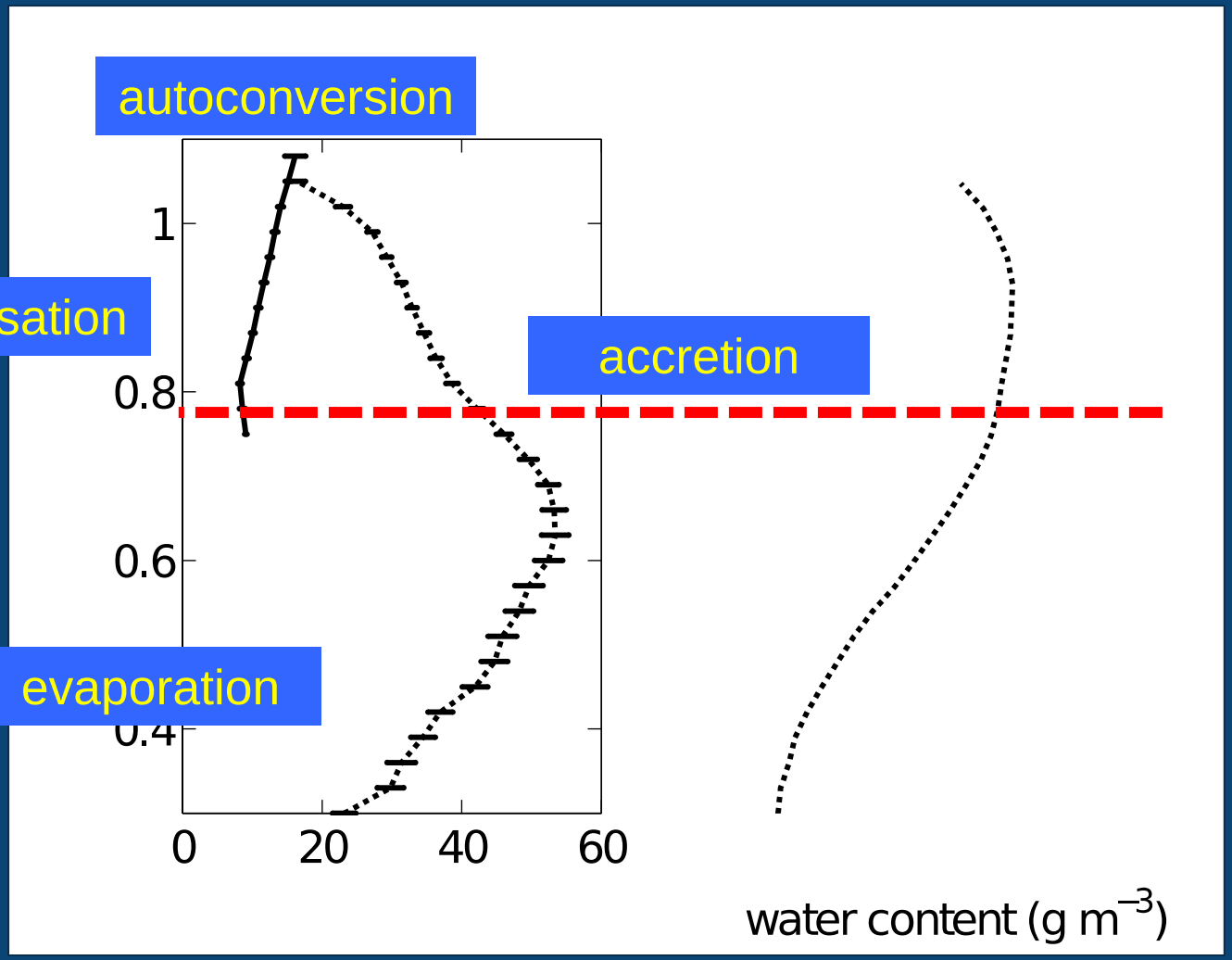
1D ENCORE reveals cloud water / drizzle water covariance (1st June 20–21 UTC)



Fielding et al. (2015, AMTD)

1D ENCORE reveals cloud water / drizzle water covariance

Fielding et al. (AMTD, 2015)



Climatology for legs 11–13 (June 2013)

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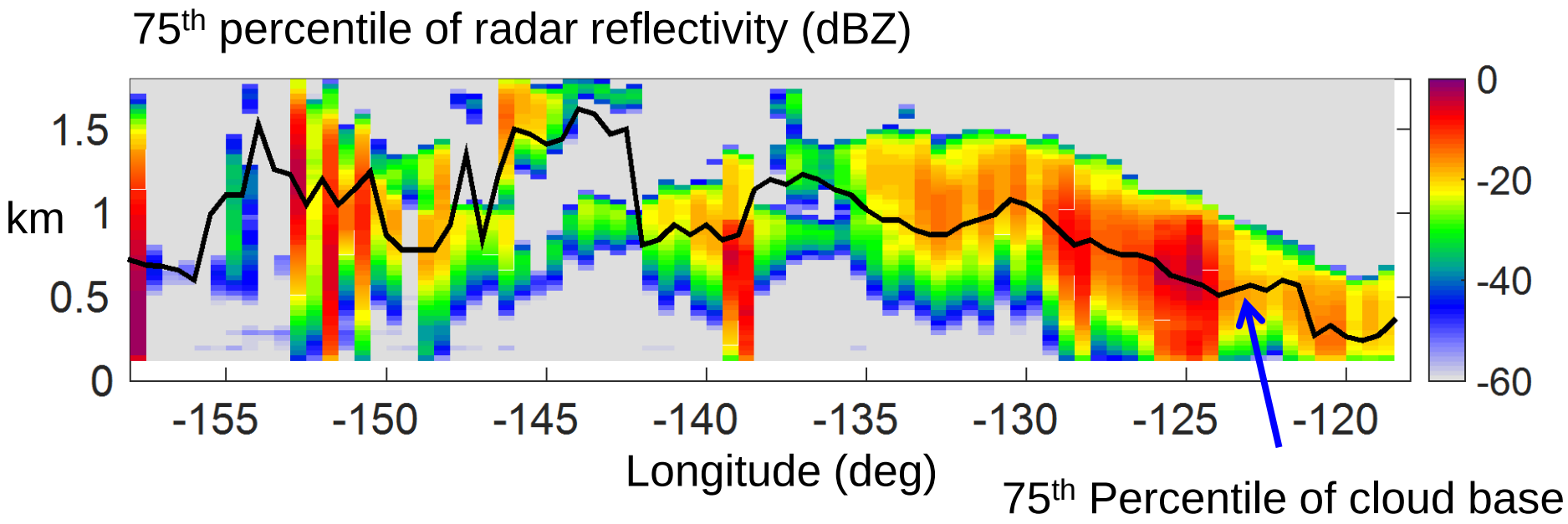
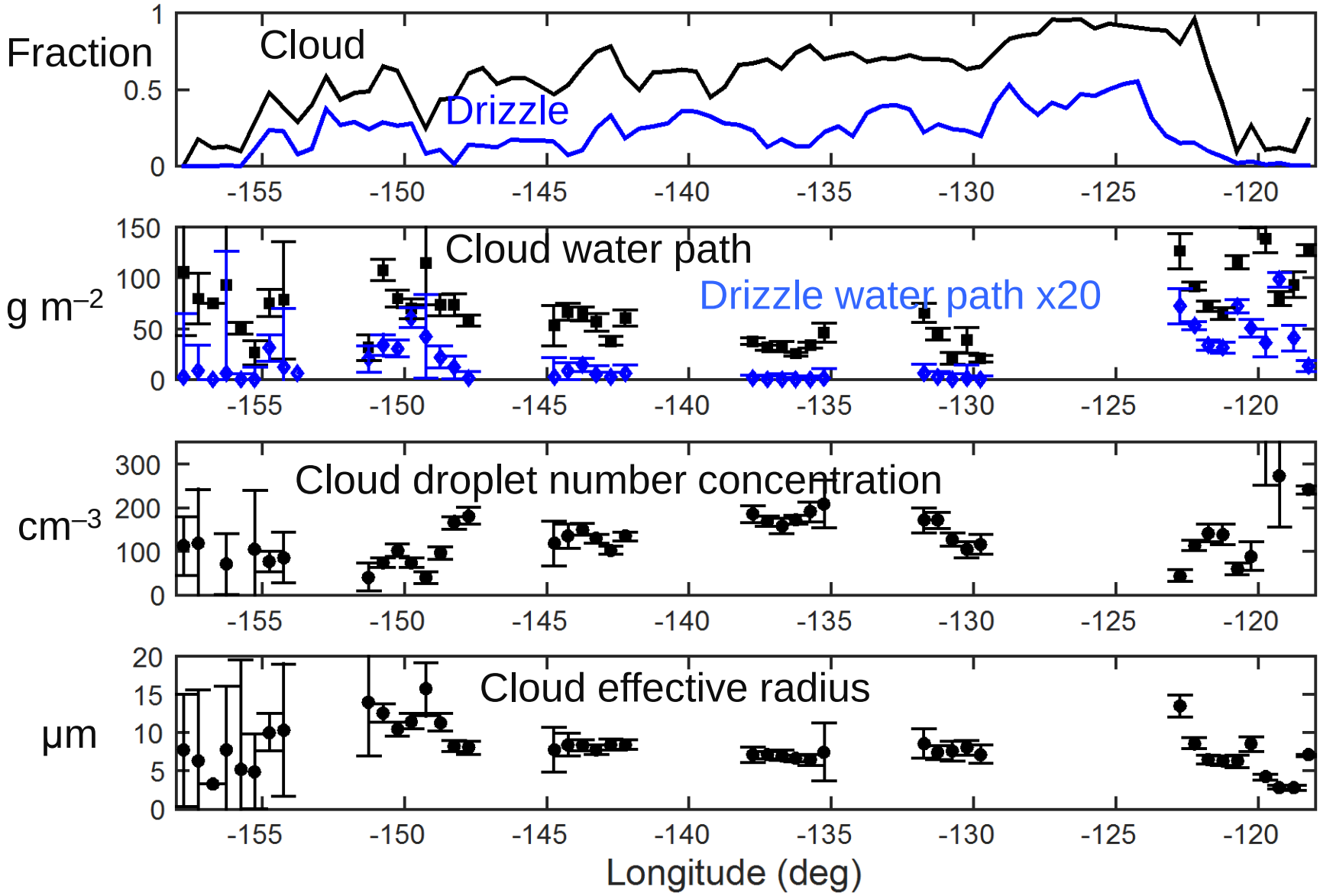
- Bin retrievals to 0.5° longitude
- 30 m vertical resolution

Limitations:

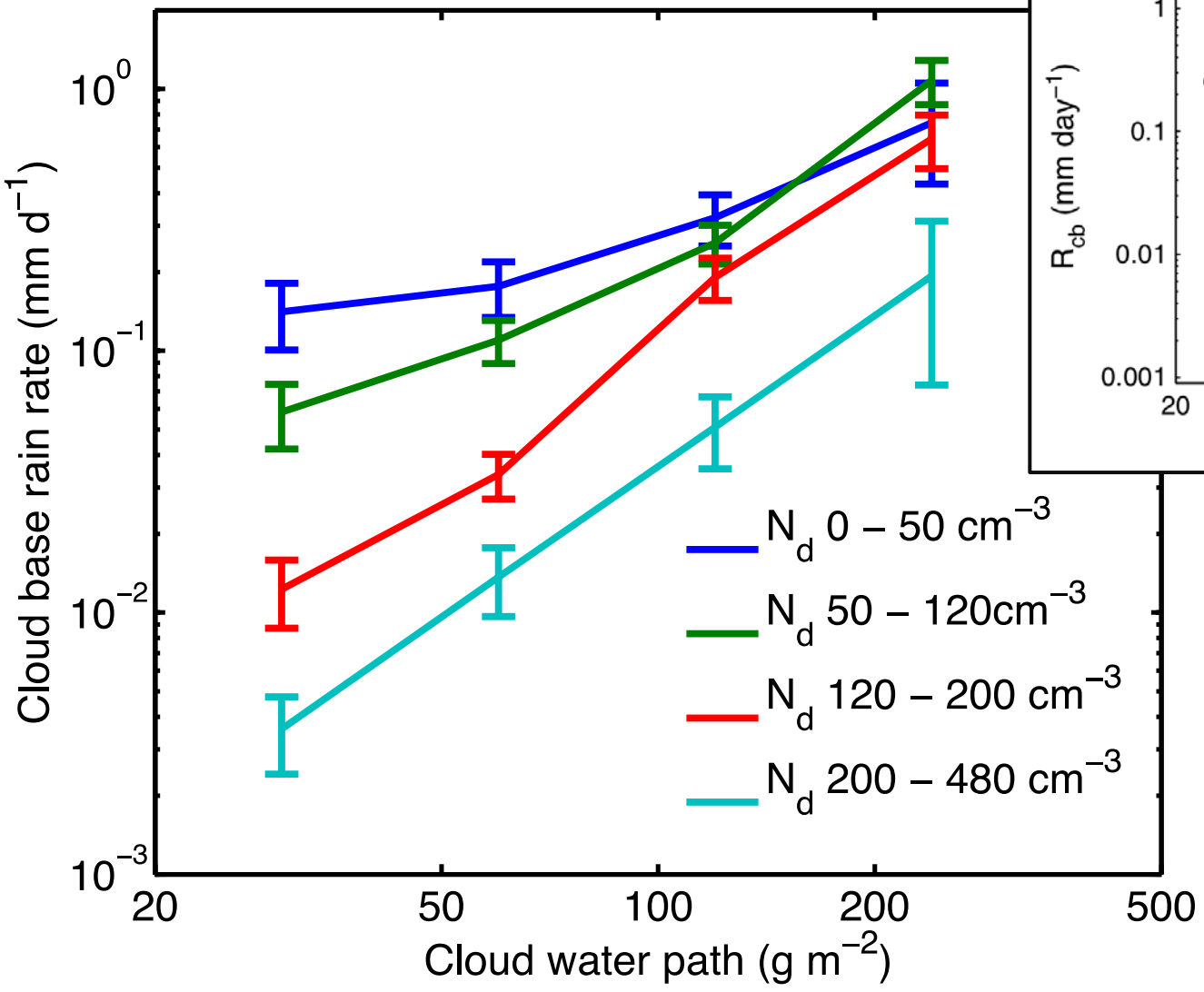
- Instrument availability
- Daytime only

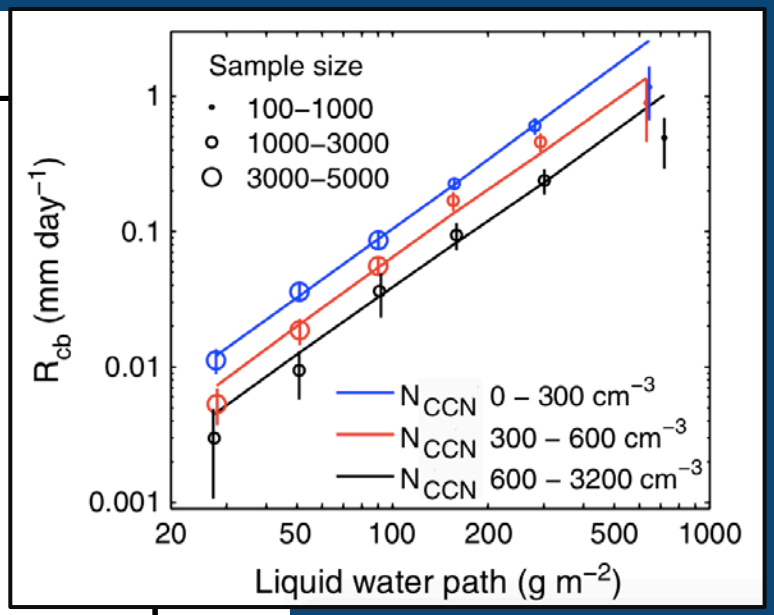


Vertically integrated cloud and drizzle properties along transect



Rain rate decreases with cloud droplet number concentration and increases with cloud water path





Mann et al. (2014, JGR)

Summary

- ENCORE can separate cloud and drizzle vertical structure to investigate microphysical processes
- Stratocumulus regime has a mean cloud droplet effective radius (r_e) of 8 μm, whereas trade cumulus has r_e of 12 μm, but with greater variability.
- Analysis of temporally and spatially matched retrievals of rain rate, cloud water path and cloud droplet number concentration shows apparent aerosol suppression of drizzle.