Observational constraints on precipitation formation and evolution in cloud-resolving model simulations

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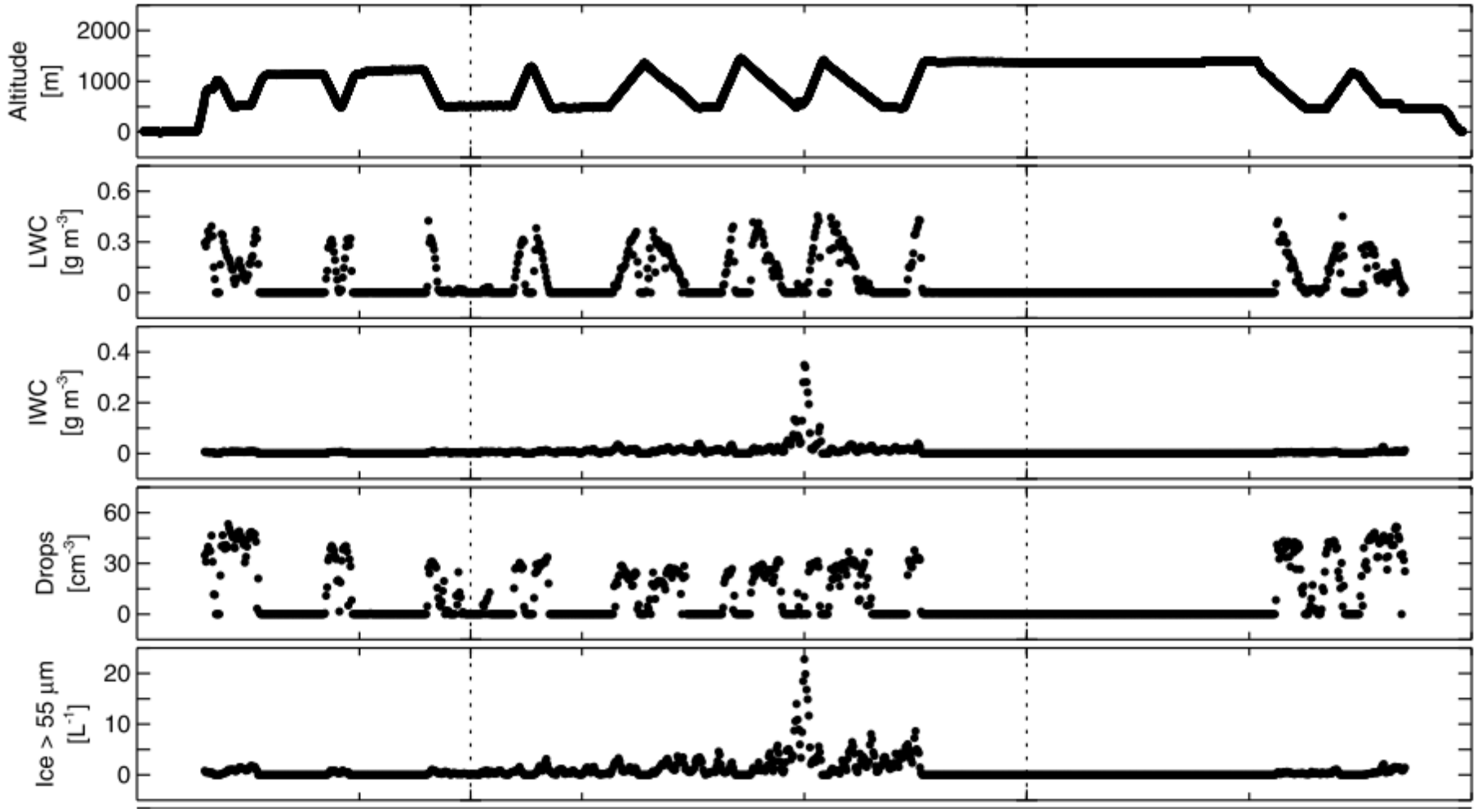
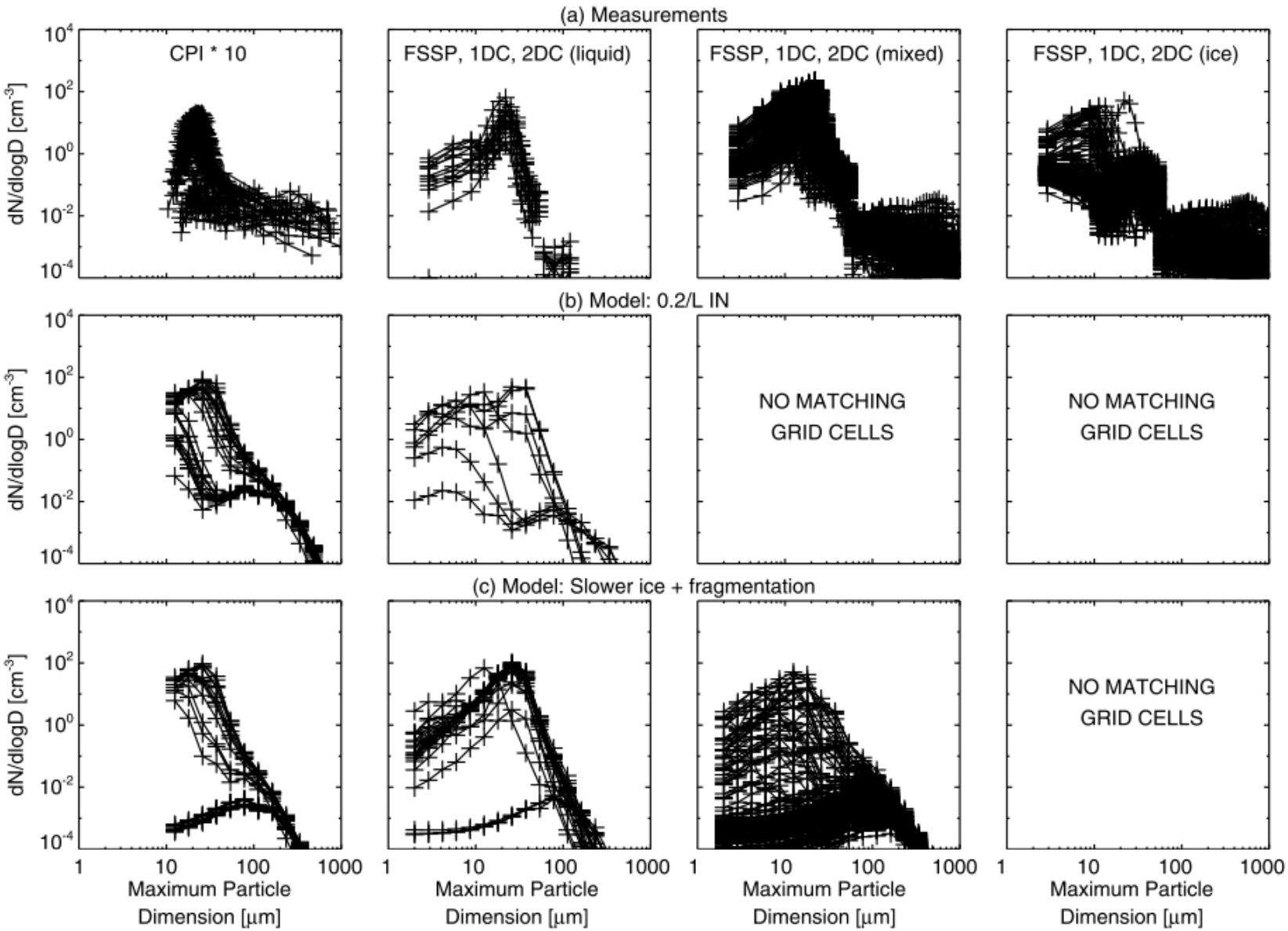
M-PACE

Fridlind et al. [*2007*]





Fridlind et al. [*2007*]

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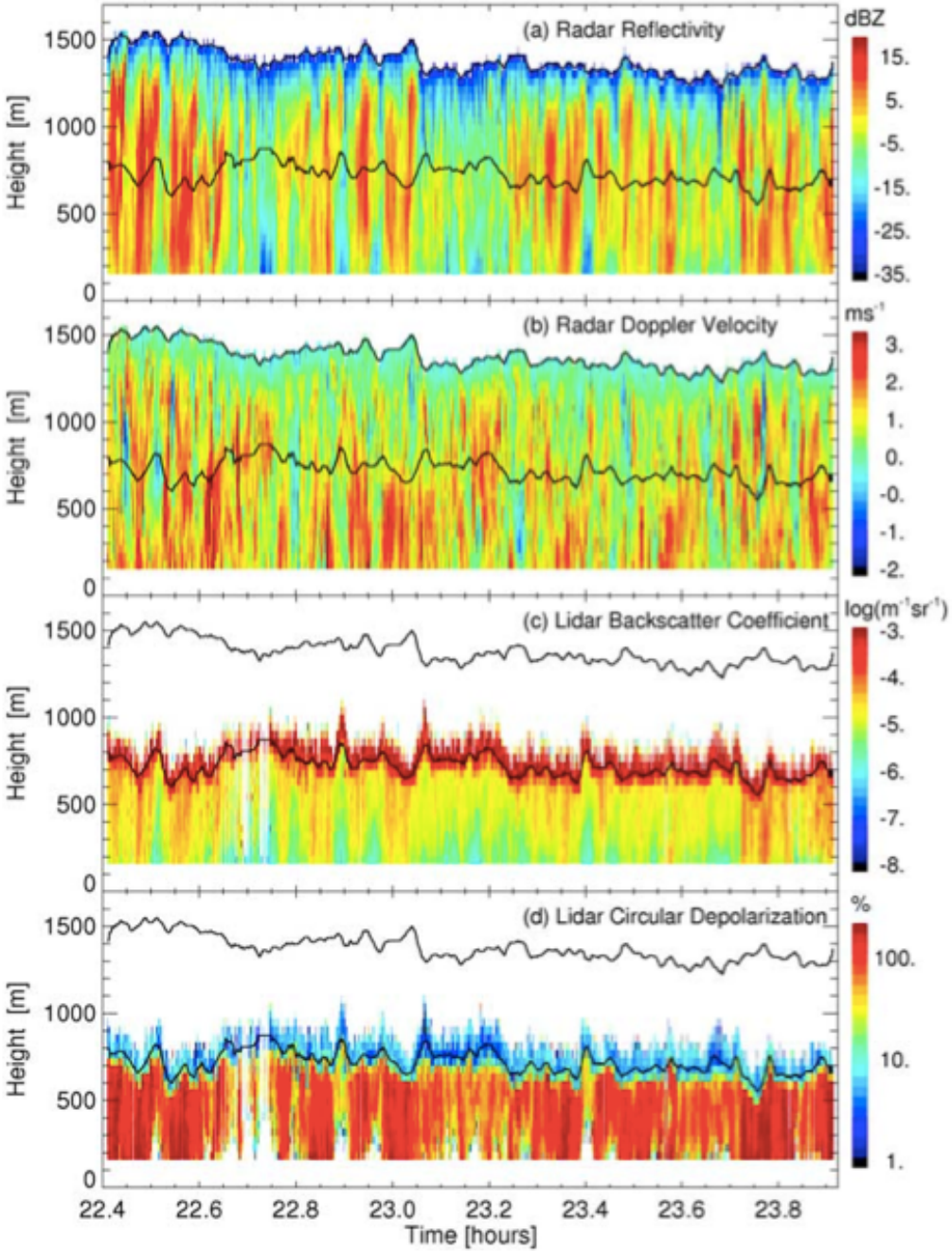

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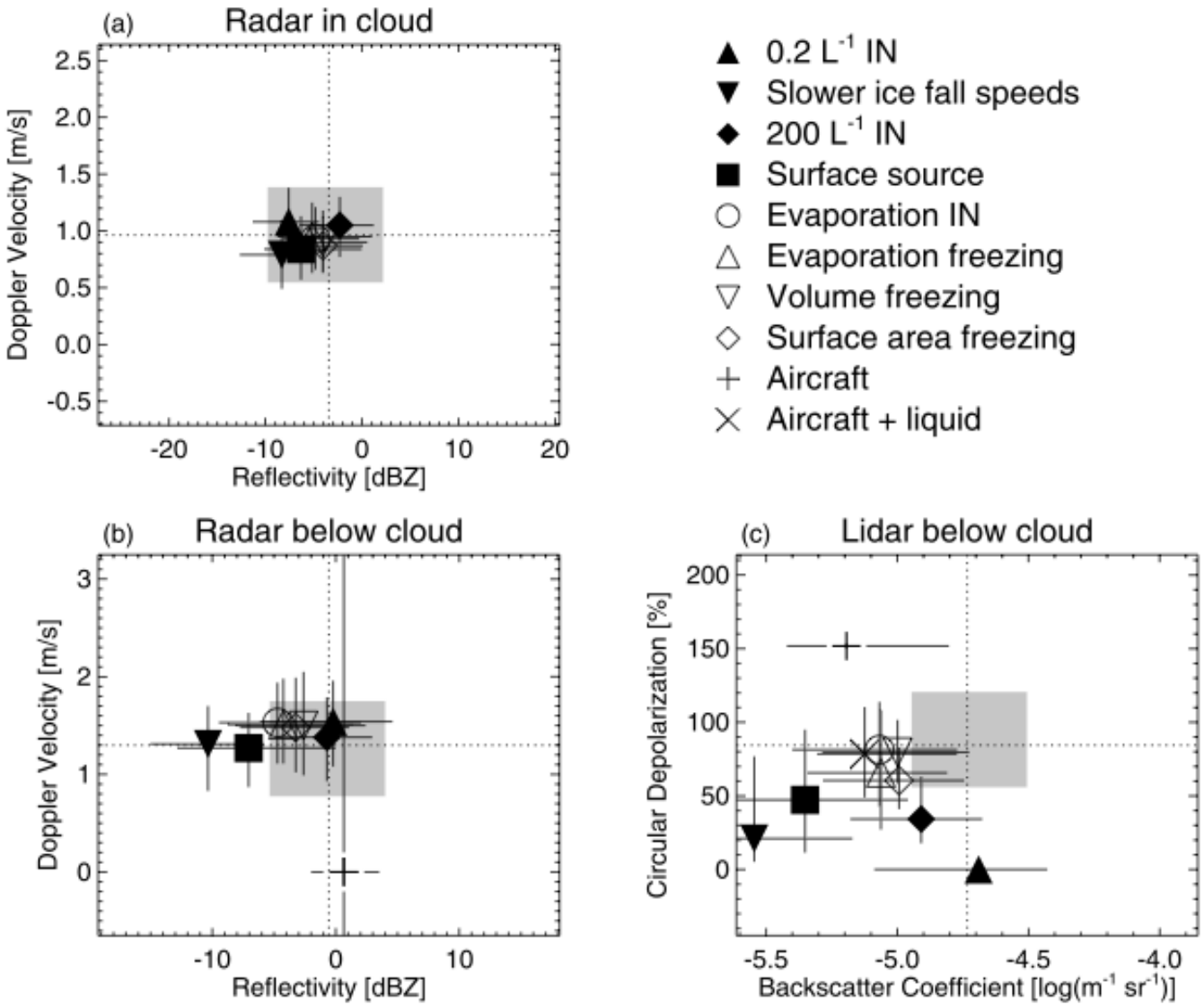


SHEBA

van Diedenhoven et al. [*2012*]

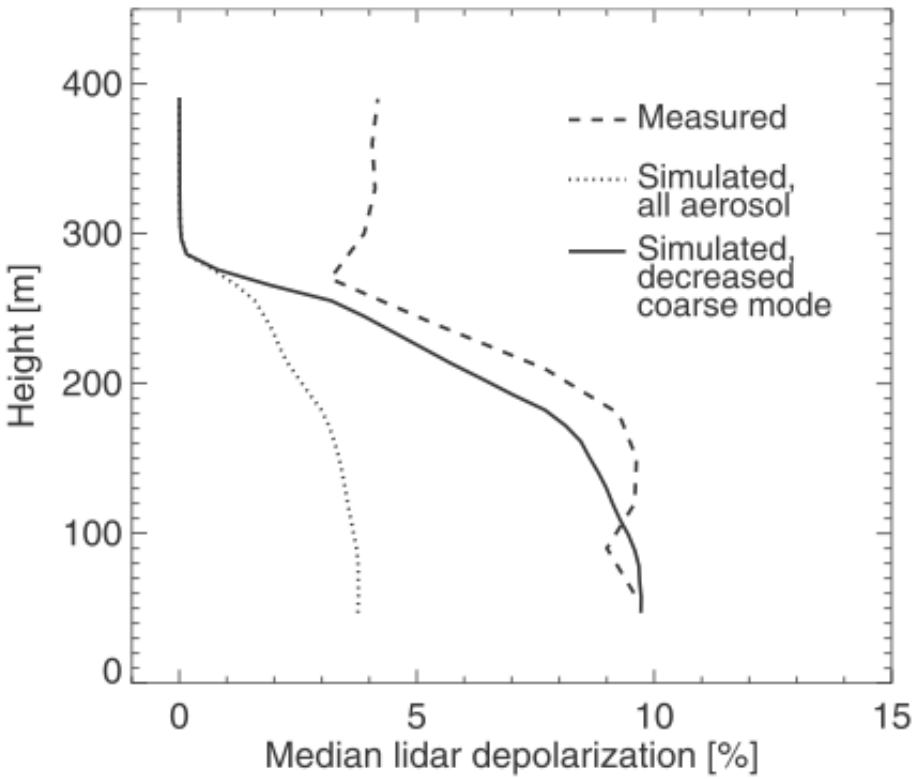


FIG. 5. Median depolarization values measured between 2200 and 0000 UTC as a function of height (dashed), and the corresponding simulated depolarization profiles including all humidified aerosol (dotted), and including humidified aerosol with the number concentration in the coarse mode decreased by a factor of 5 (solid).

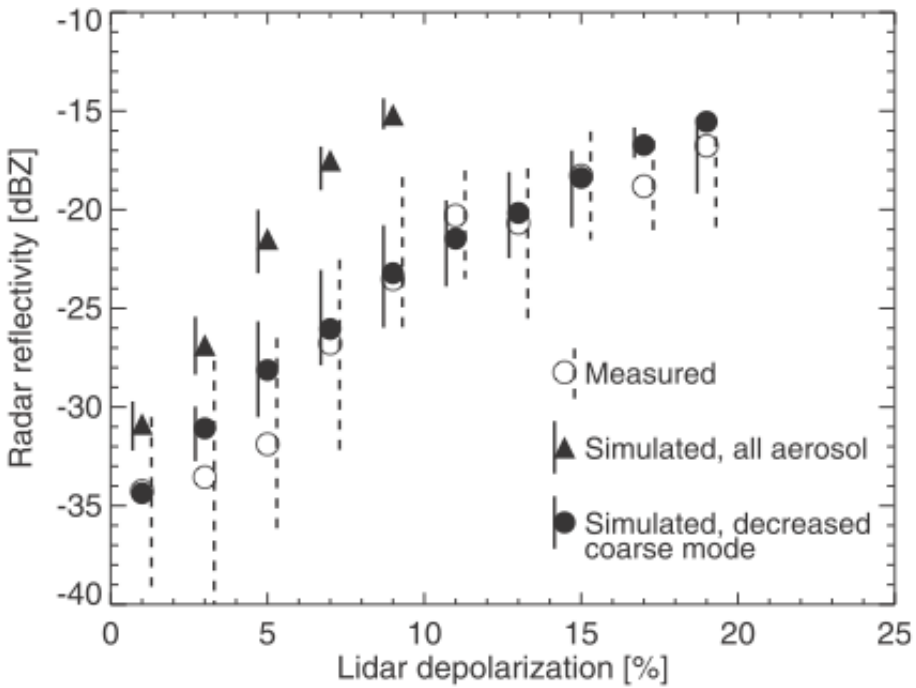
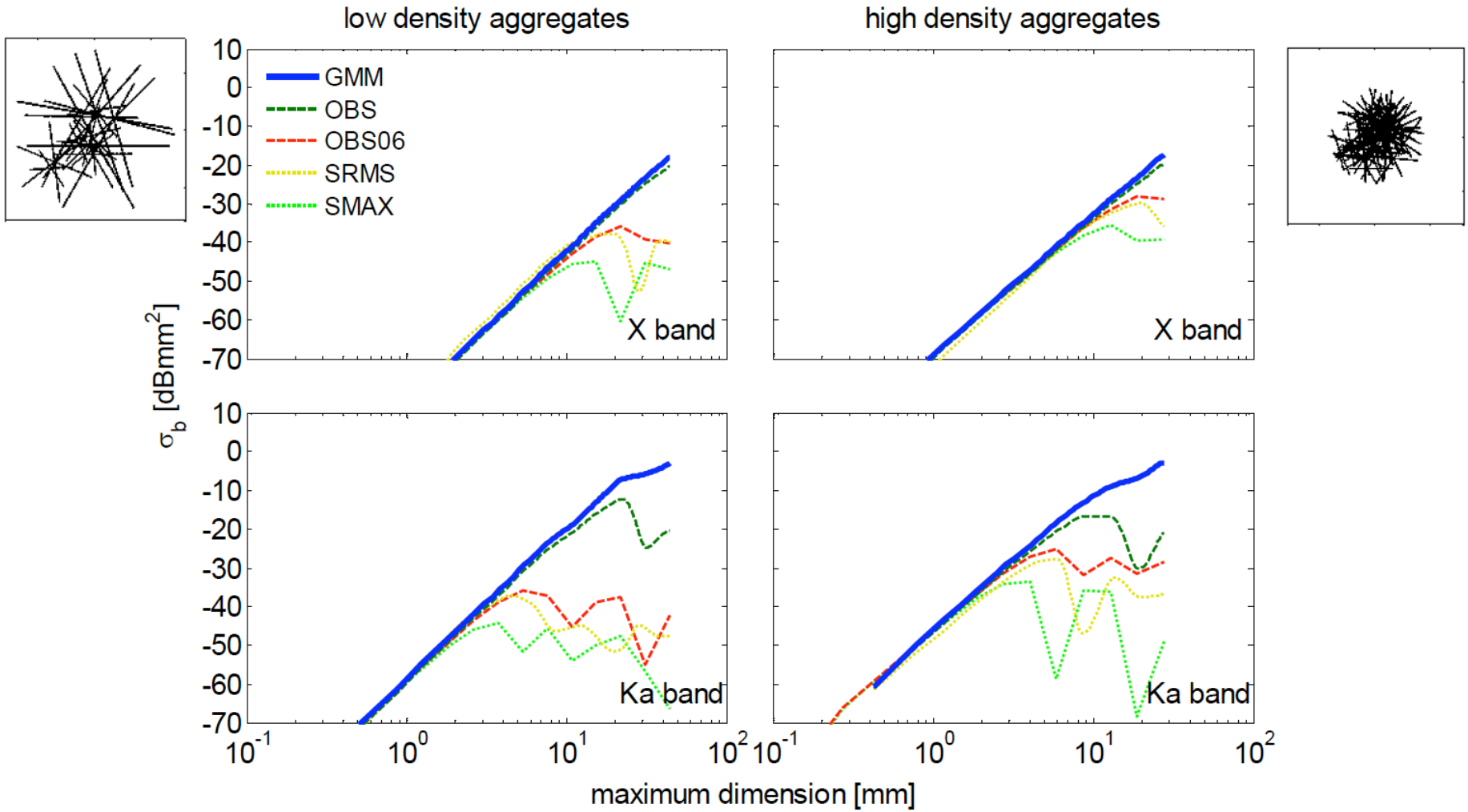


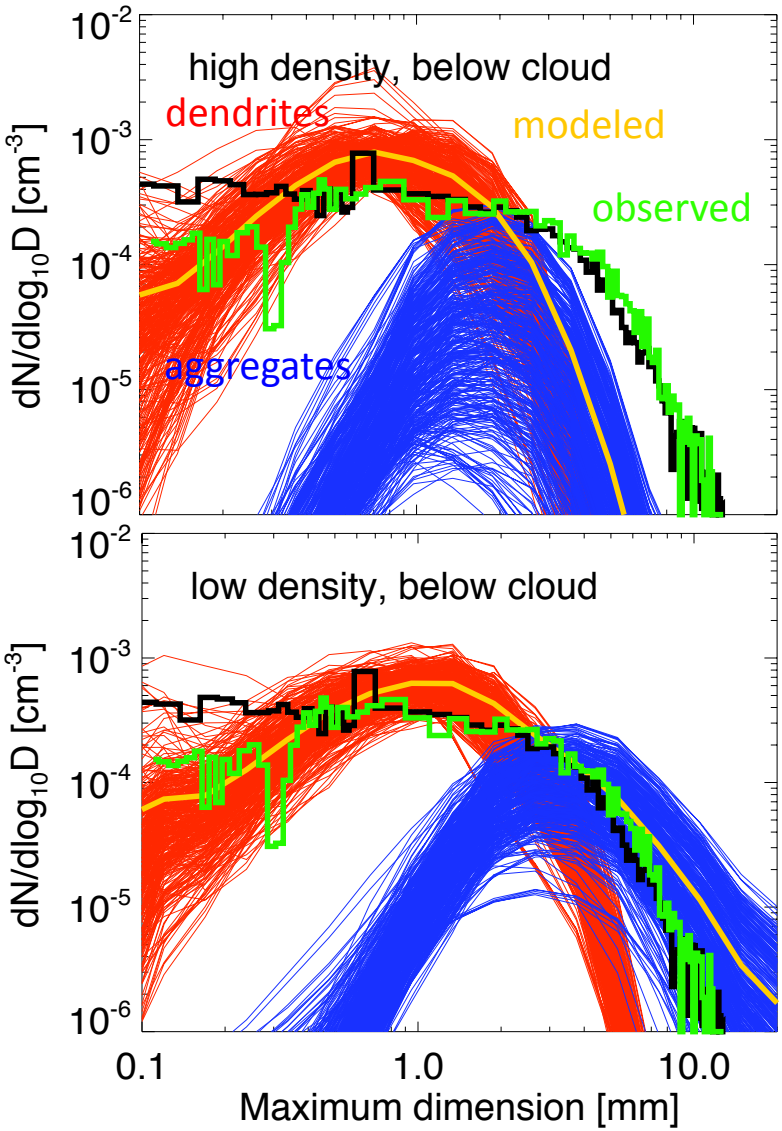
FIG. 6. Median and IQR of radar reflectivities within 2% depolarization bins measured between 2200 and 0000 UTC (open circles and dashed lines, respectively), and modeled including all humidified aerosol (triangles and solid lines, respectively), and humidified aerosol with the number concentration in the coarse mode decreased by a factor of 5 (closed circles and solid lines, respectively). Values are averaged over 140–240-m altitude.

ISDAC

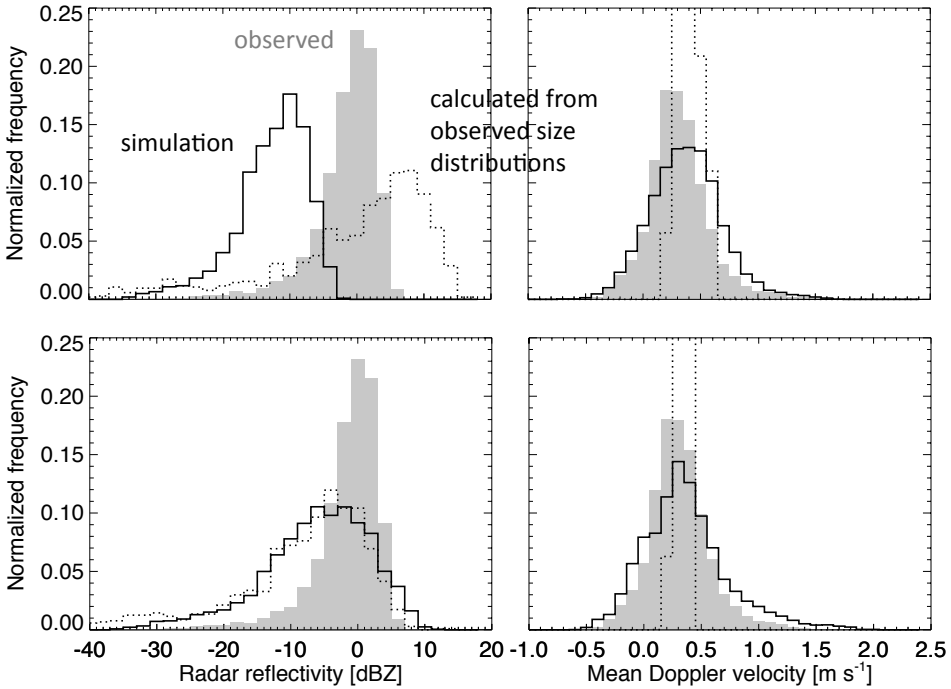
Botta et al. [*2011*]



ISDAC



high density
pristine and
aggregates



low density
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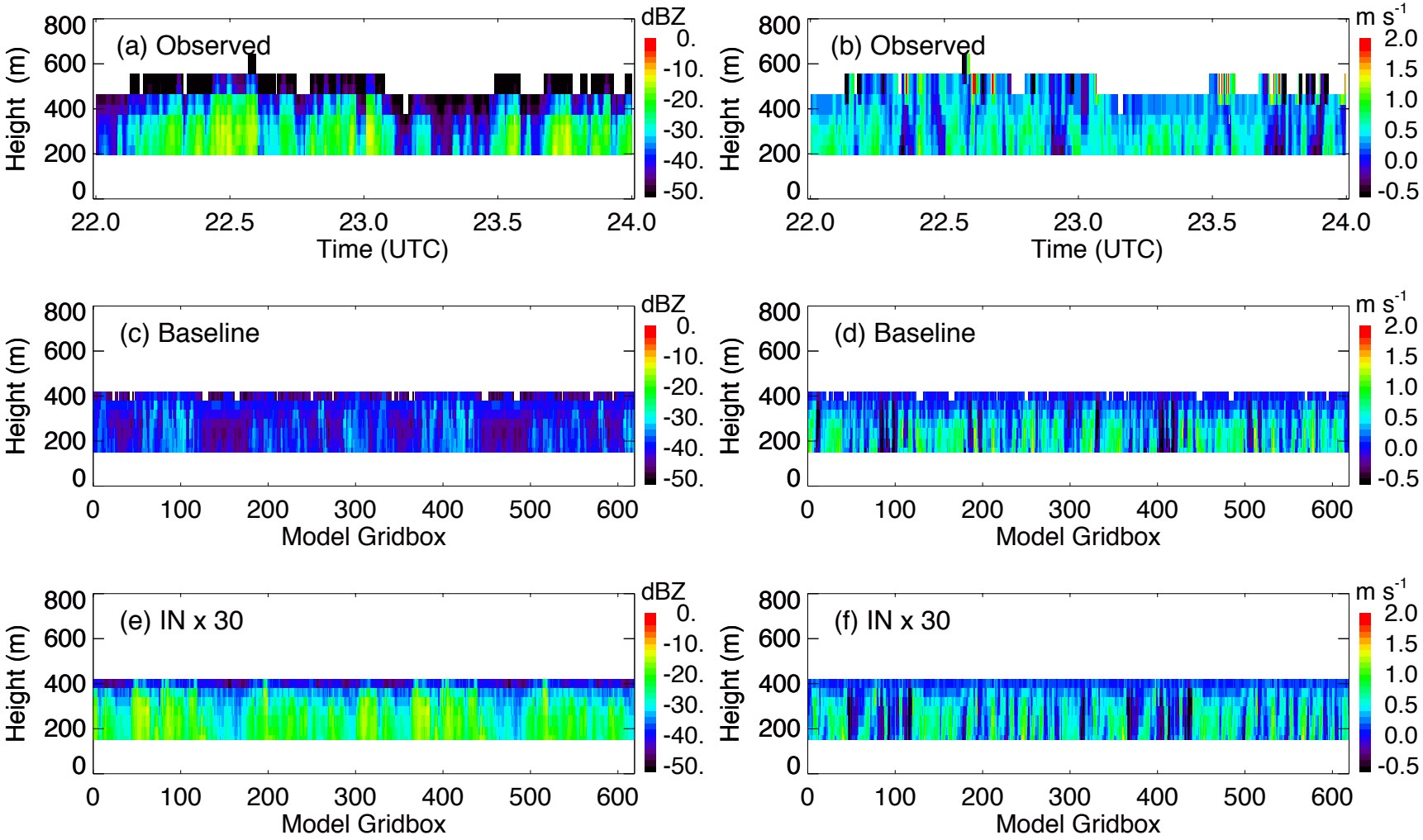
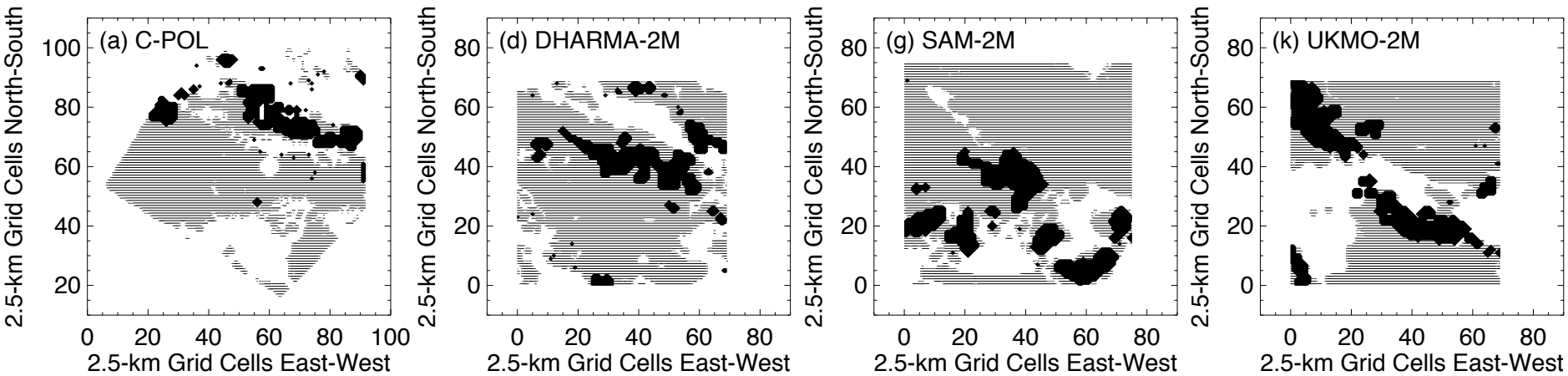
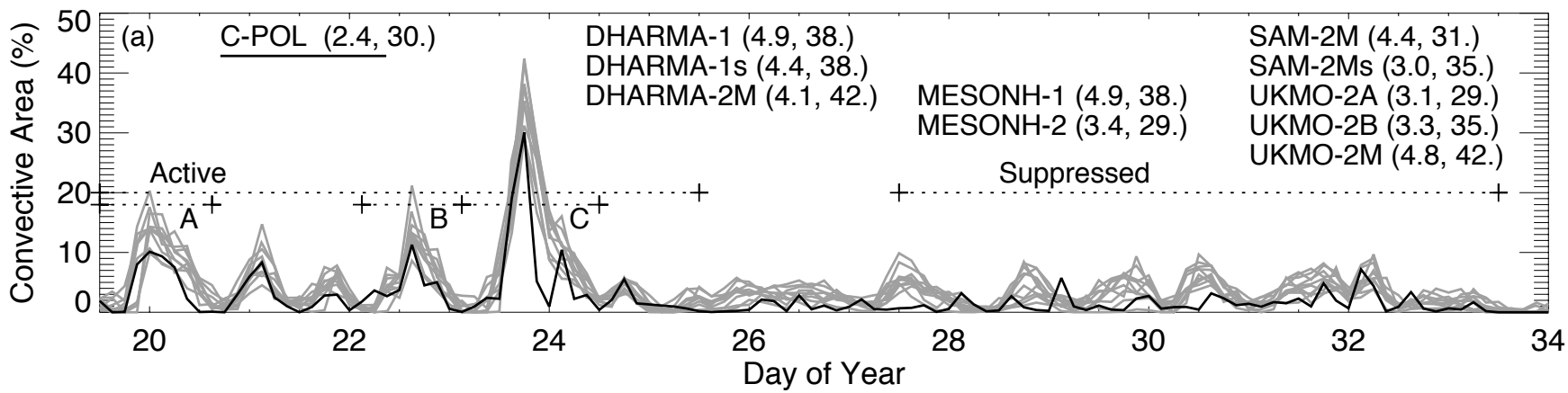
Fridlind et al. [*2012*]



TWP-ICE



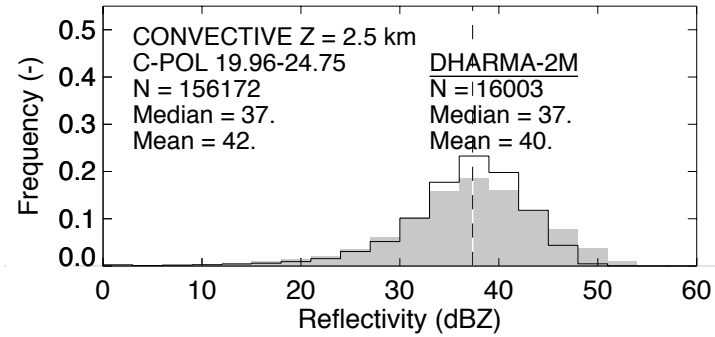


Fridlind et al. (2012)

TWP-ICE convective region (C-POL)

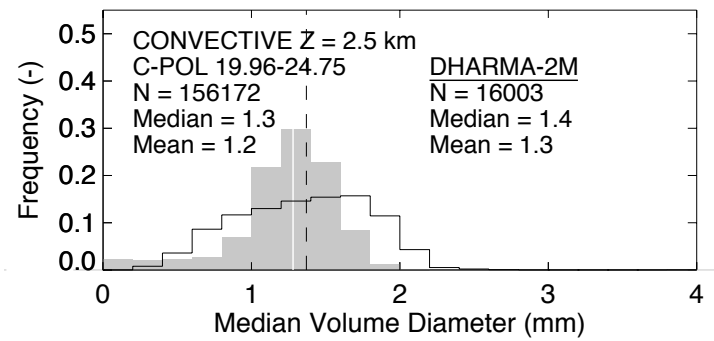
convective

radar reflectivity



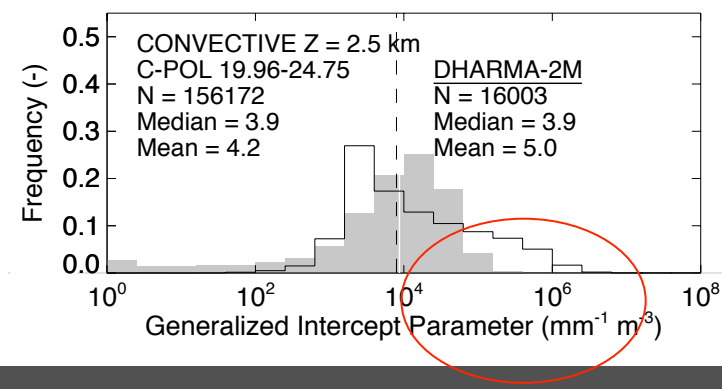
- C-POL provides sampling of the convective region that is not achieved with profiling or point instruments

median volume diameter



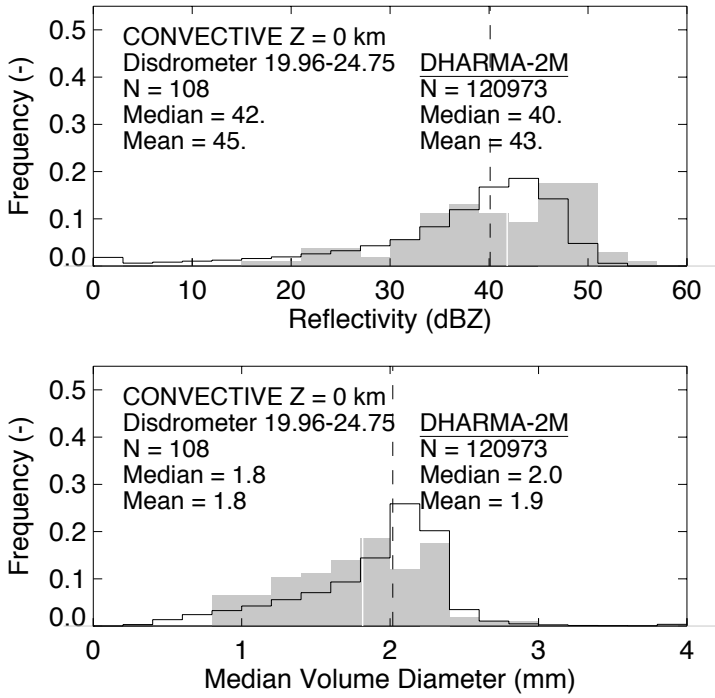
- why don't we see break-up equilibrium in model (D_0 = 2.2 mm)?
- we also don't see it in retrievals

generalized intercept parameter



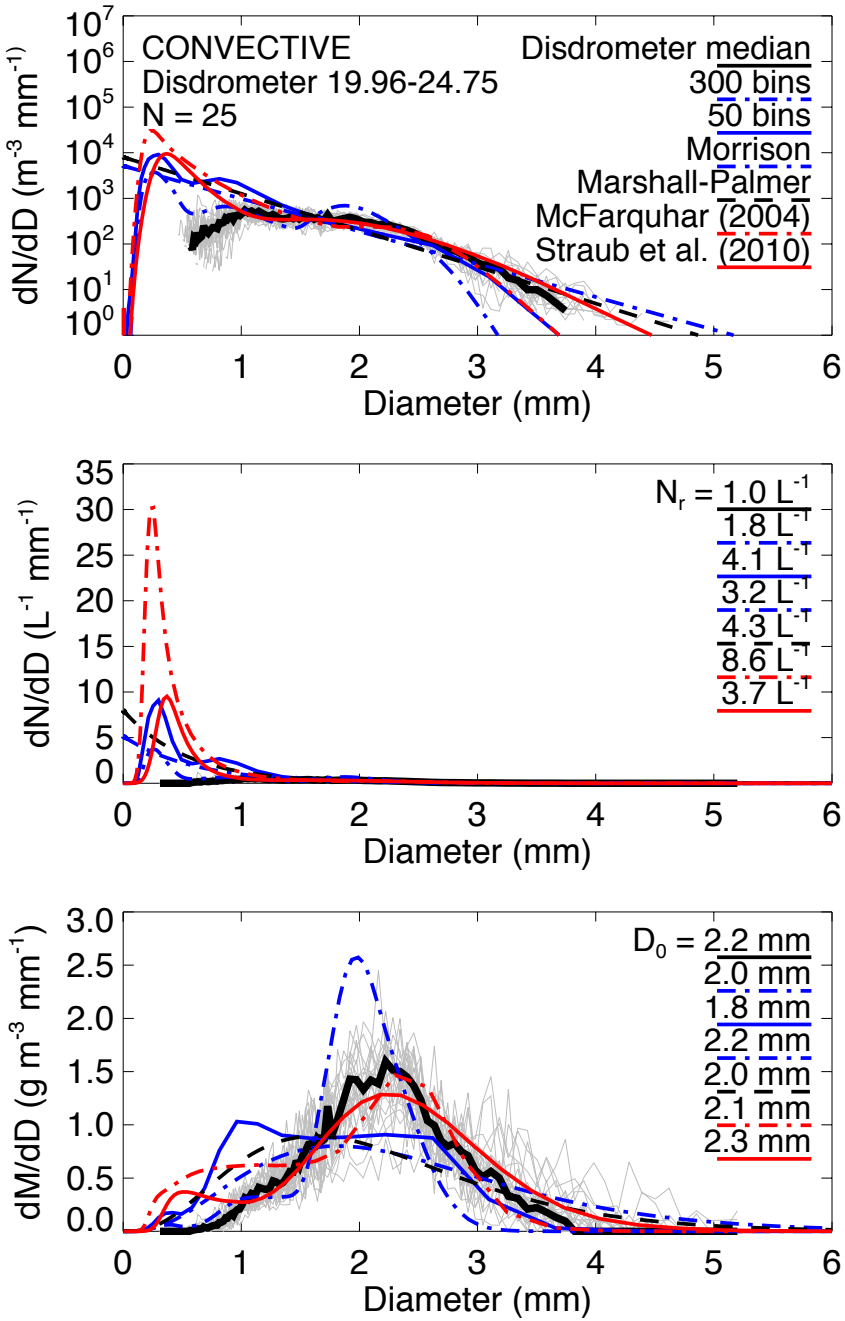
- what is the source of high raindrop numbers?
- where are they?

TWP-ICE convective region (C-POL, disdrometer)

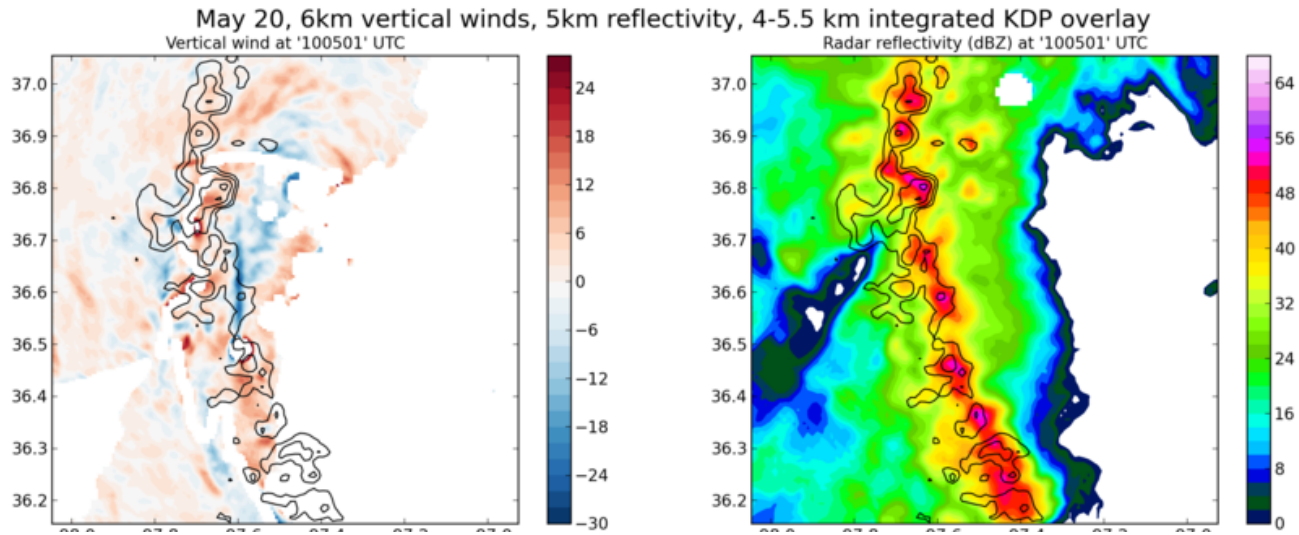


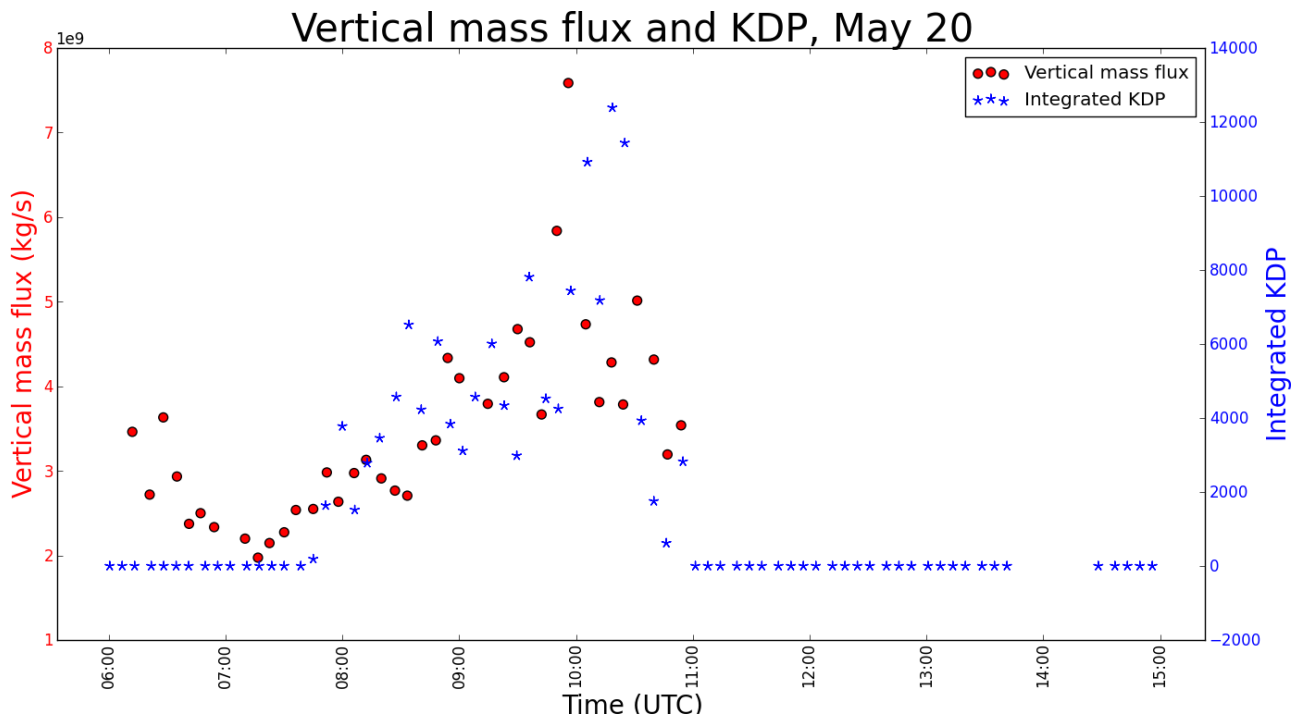
- only 108 disdrometer samples but Z distribution resembles model, C-POL aloft
- abrupt frequency drop-off at D_0 = 2.2 mm in disdrometer does provide observational support for break-up equilibrium occurring at the surface

TWP-ICE convective region (C-POL, disdrometer)



MC3E





Source: Marcus van Lier-Walqui, Scott Collis, Kirk North, Pavlos Kollias

Summary

- Objective
  - observational constraint of cloud properties in high-resolution simulations
    - mass mixing ratios (phase)
    - number concentrations (ice properties)
    - hydrometeor size distributions
- Approach
  - in situ observations (no quantification of uncertainty)
  - remote-sensing observations (radar, lidar, ...)
    - retrievals (robust ones)
    - forward modeling
      - where no robust retrievals (multiple signals but rich information)
      - to avoid assumed hydrometeor size distributions that are inconsistent with simulations (e.g., bin)