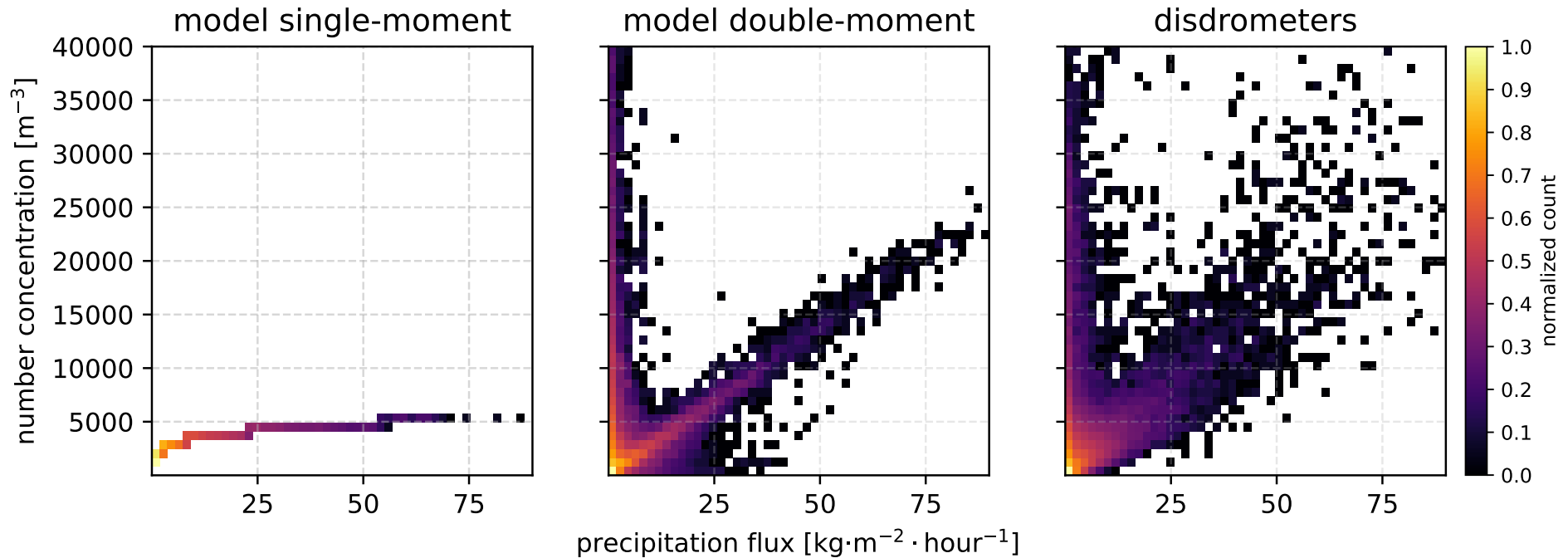


Incorporating Ice-Phase Hydrometeors into the ALARO Double-Moment Microphysics Scheme

David Němec (CHMI, Prague)

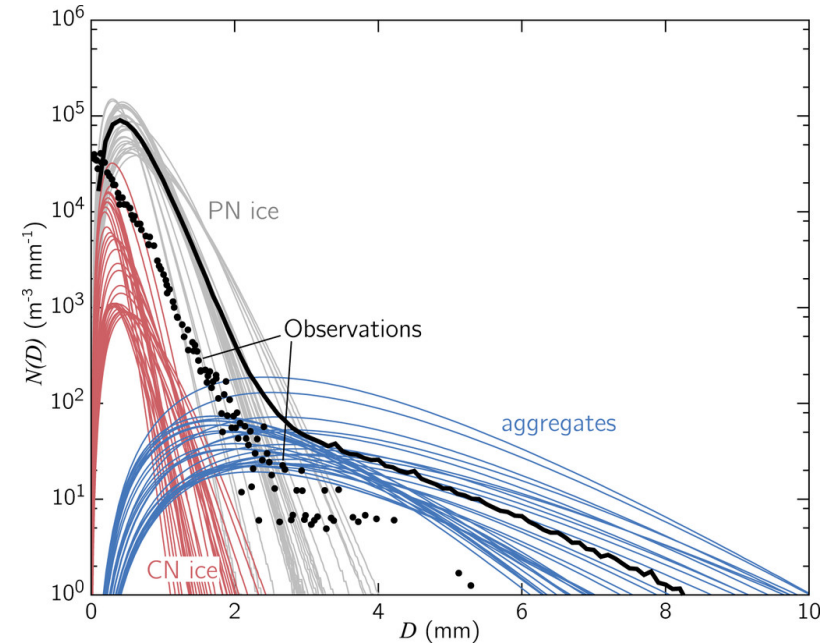
Introduction: why a double-moment scheme?

- 1-mom: mass
- 2-mom: mass + number



Why is ice phase challenging?

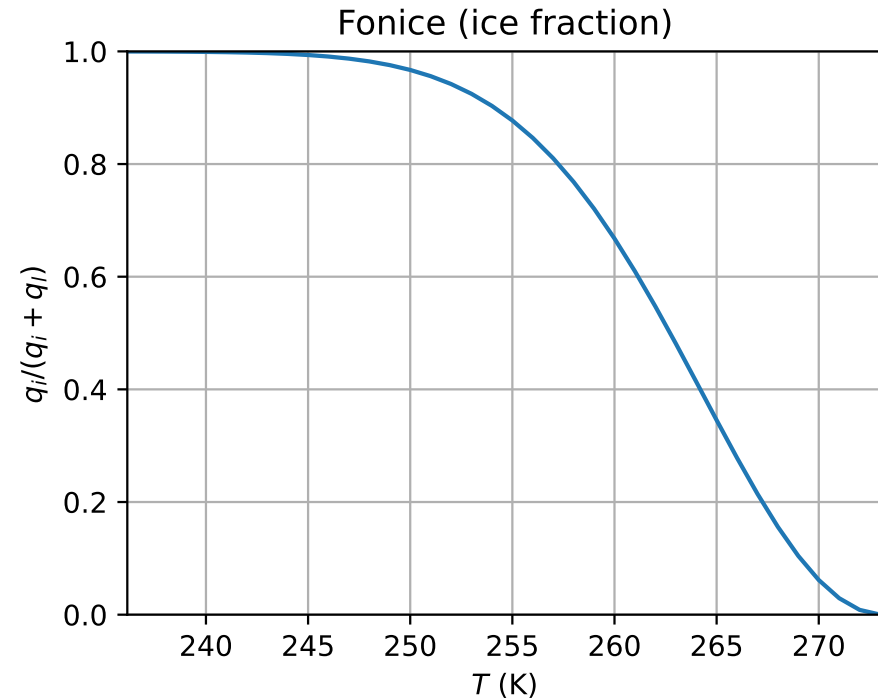
- fine line between ice species
- size-distributions
- uncertain shapes
- variable densities
- values of sticking efficiencies
- phase split



Source: Jensen, A. A., Harrington, J. Y., & Morrison, H. (2018).

Phase split

- 1-mom: split by $f(T)$
- 2-mom + CAMS aerosols: IFNs
- 2-mom: complex treatment



Cloud ice processes

- activation
- deposition
- homogeneous freezing
- heterogeneous freezing
- freezing of small raindrops
- SIP (HM process)

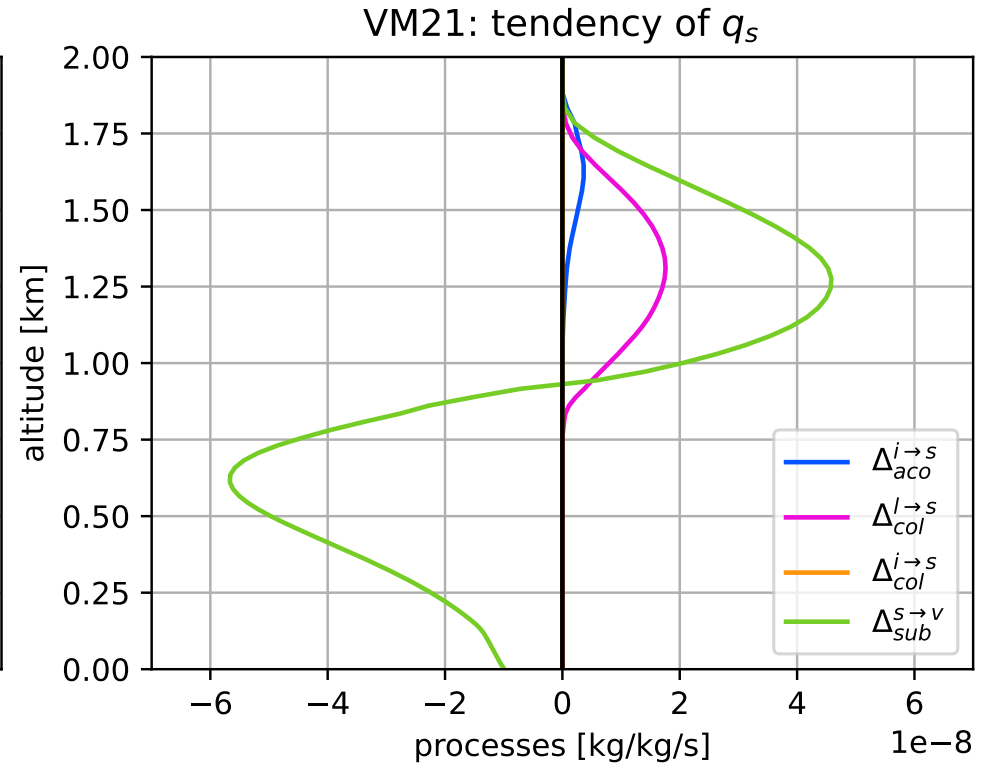
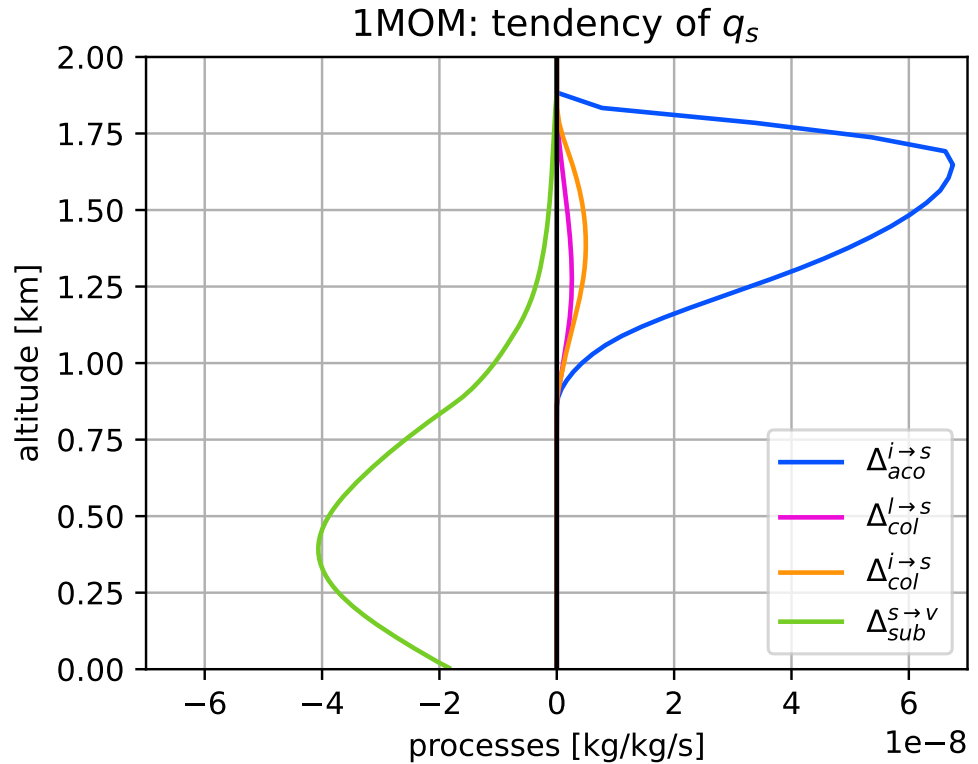
Snow mass-diameter relation

- typically: $m(D) \sim D^2$
- Vázquez-Martín et al. (2021): $m(D) \sim D^{2.61}$
- the latter used:
 - more physically based
 - better precipitation maxima
 - better reflectivities

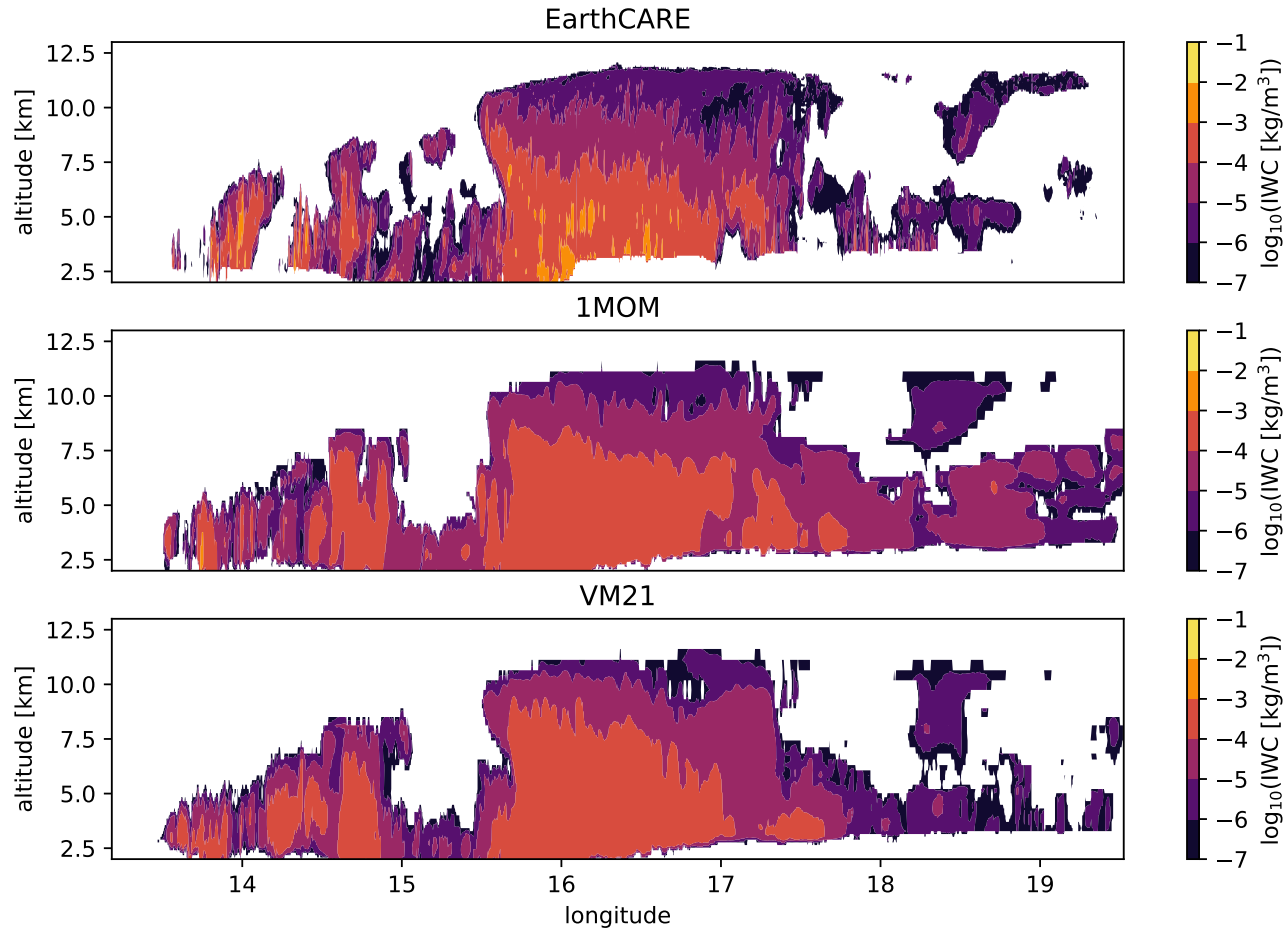
Snow and graupel single vs double-moment

	1MOM	VM21 (2-mom)
size distributions	negative exponential	gamma
snow shape	$\sim D^3$	$\sim D^{2.61}$
snow density	61 kg·m ⁻³	variable
graupel shape	$\sim D^3$	$\sim D^3$
graupel density	400 kg·m ⁻³	500 kg·m ⁻³

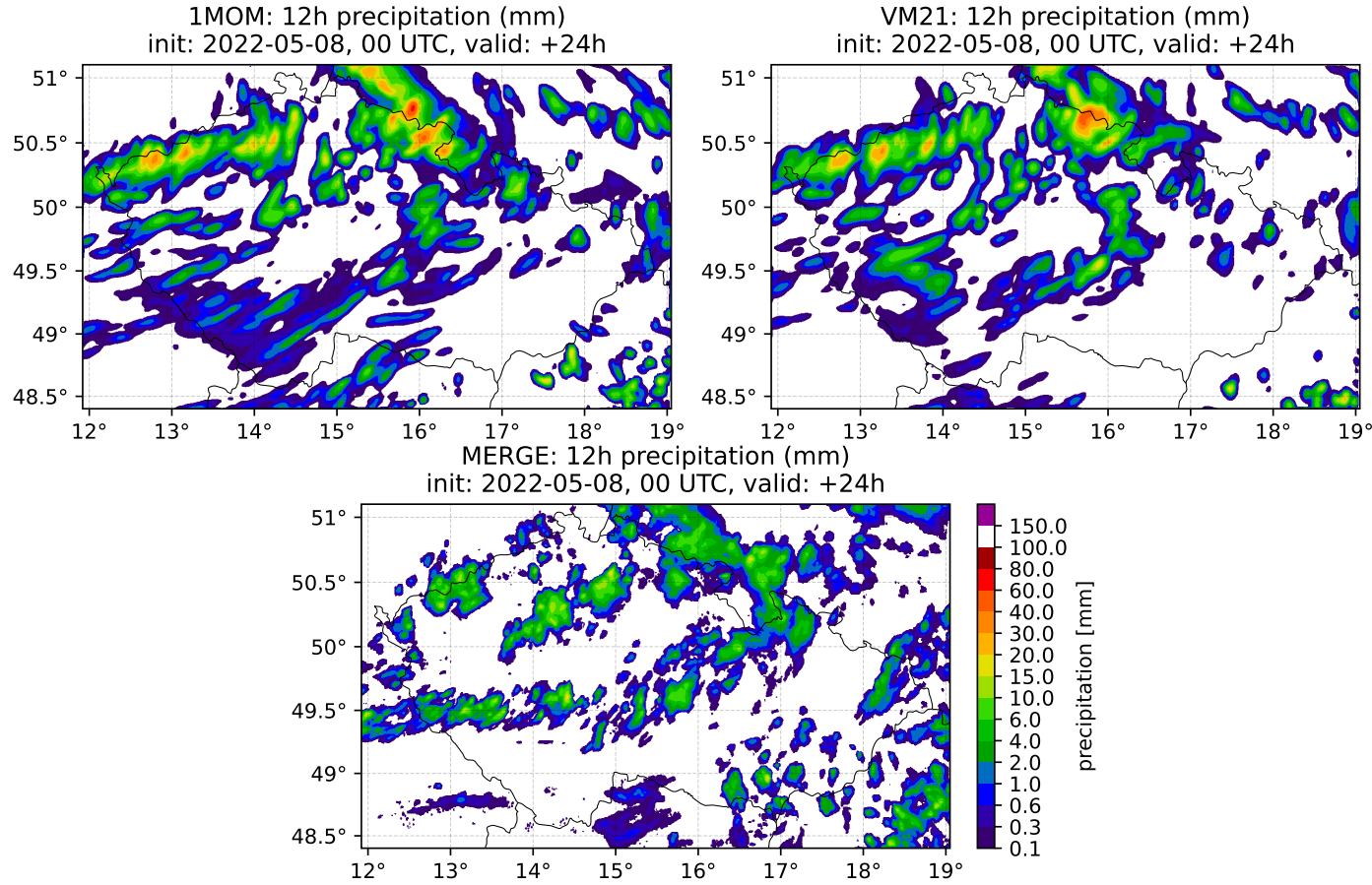
Selected snow processes from the MPACE 1D case



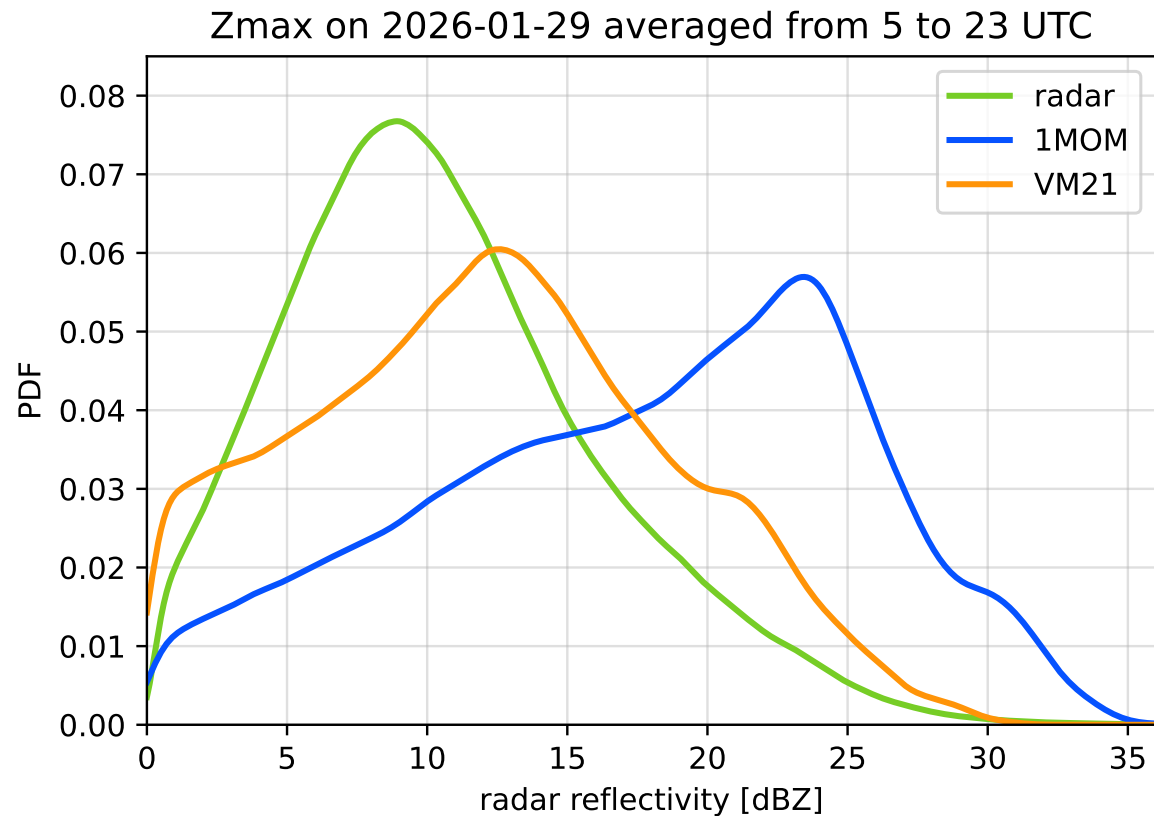
Ice water content in storm Boris (2024-09-13)



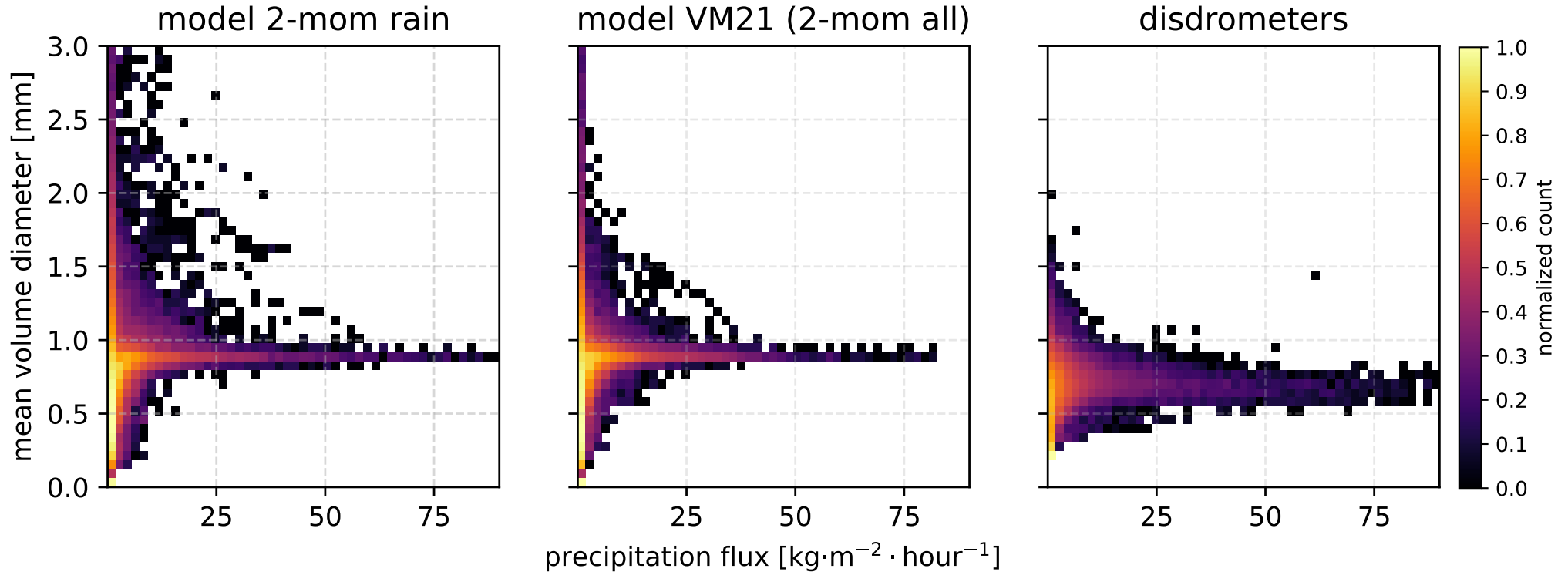
Precipitation line 2022-05-08



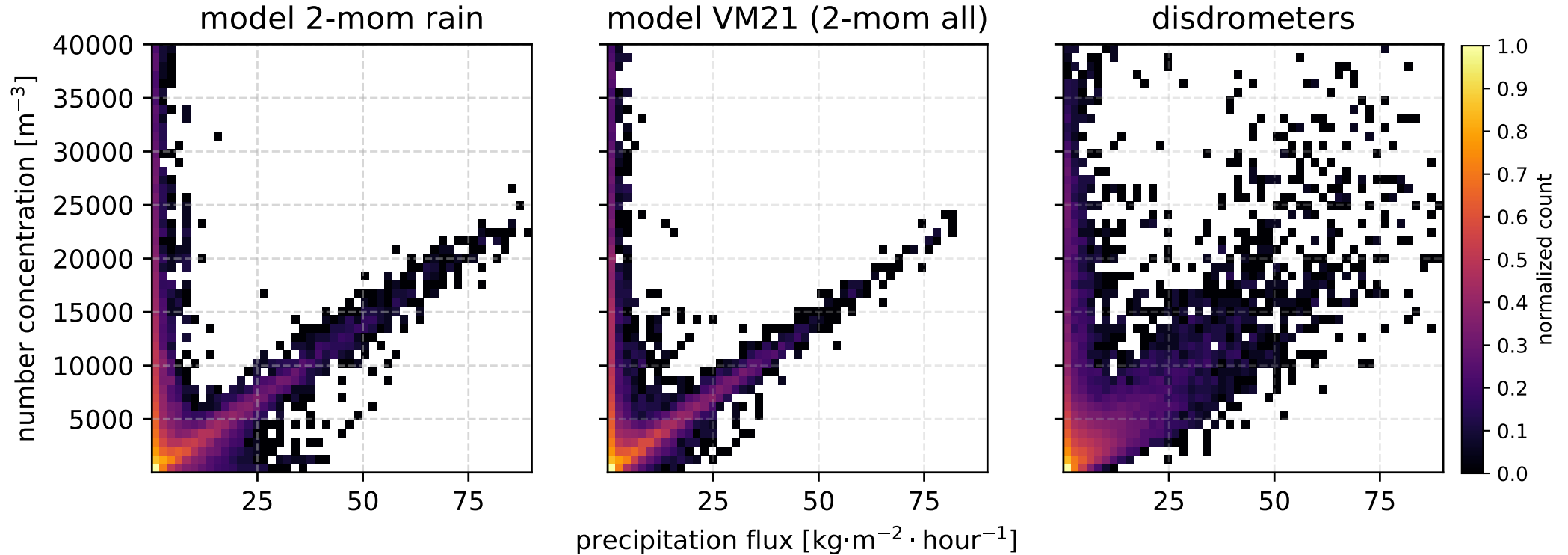
Zmax for a snow case (2026-01-29)



Can 2-mom for all species improve 2-mom rain MVD?



Number concentration of rain



Summary and outlook


- complex cloud ice processes
- “more spherical” snowflakes
- different dominant processes with 2-moment ice particles
- improved radar reflectivities of snow
- not much influence of 2-mom snow and graupel on 2-mom rain properties
- new processes to be added

Thank you for your attention.

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