The OpenSSP Snow Particle and Scattering Property Database: Current Status and Future Plans

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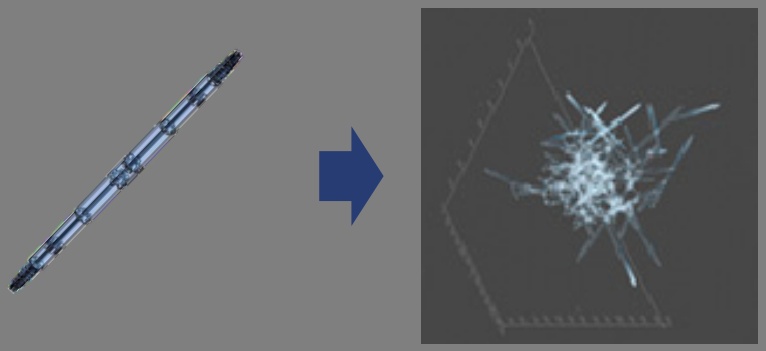
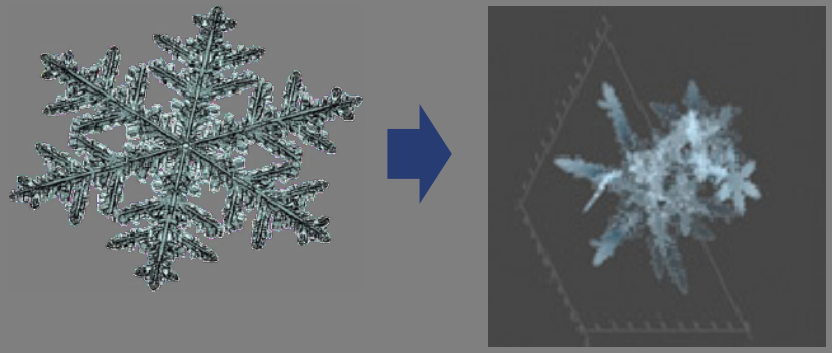
Special thanks to PPS for hosting OpenSSP

https://storm.pps.eosdis.nasa.gov/storm/OpenSSP.jsp

What is OpenSSP?





Quasi-physical synthetic particles

- Depositional growth
- Heuristic monohabit aggregation
- Currently focused on dry snow
- ~10k particles

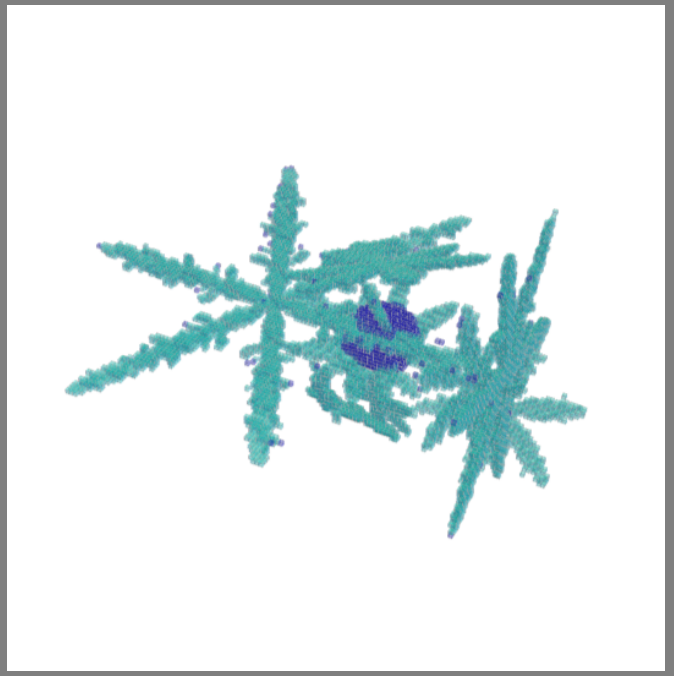
Associated scattering properties

- Discrete Dipole Approximation
- Uniformly-random orientational averaging
- 230 unique file downloads
  - Does not include database testing

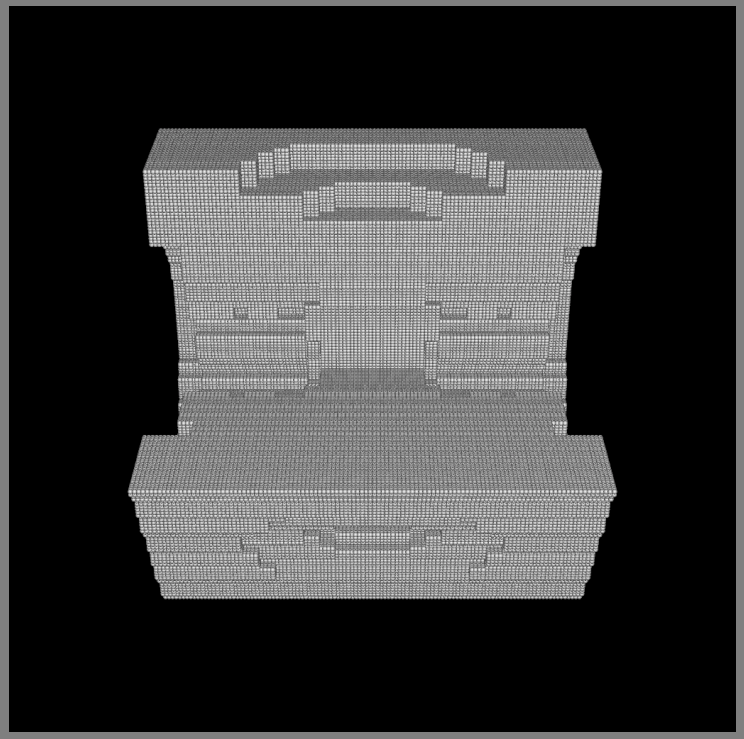
Melting Particles

Melting particles are one of the largest gaps across the various particle databases

- Currently performing scattering calculations on Dr. Ben Johnson's melted particles
  - 25 of Kuo's aggregates
  - Increased surface tension to avoid breakup
- High-resolutions particles costly for DDA
  - Blurring method to reduce resolution
  - Mass conservation?



Particle Melting using SPH



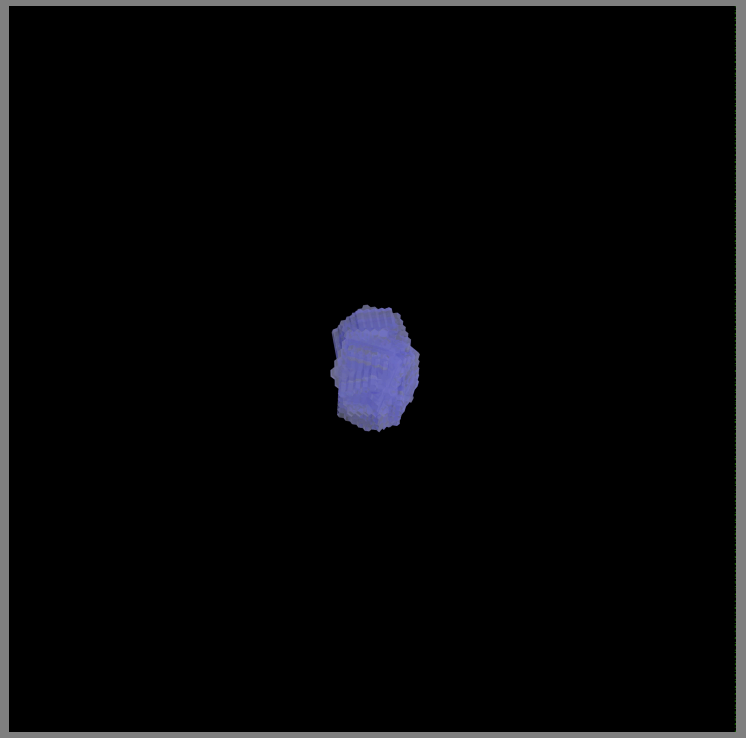
Smooth Particle Hydrodynamics (SPH) facilitates characterizing melting hydrometeors based on first principles

- Transitioning from GPU to MPI architecture
- Enforcing random ambient thermal diffusion
- Implementing penetration mitigation

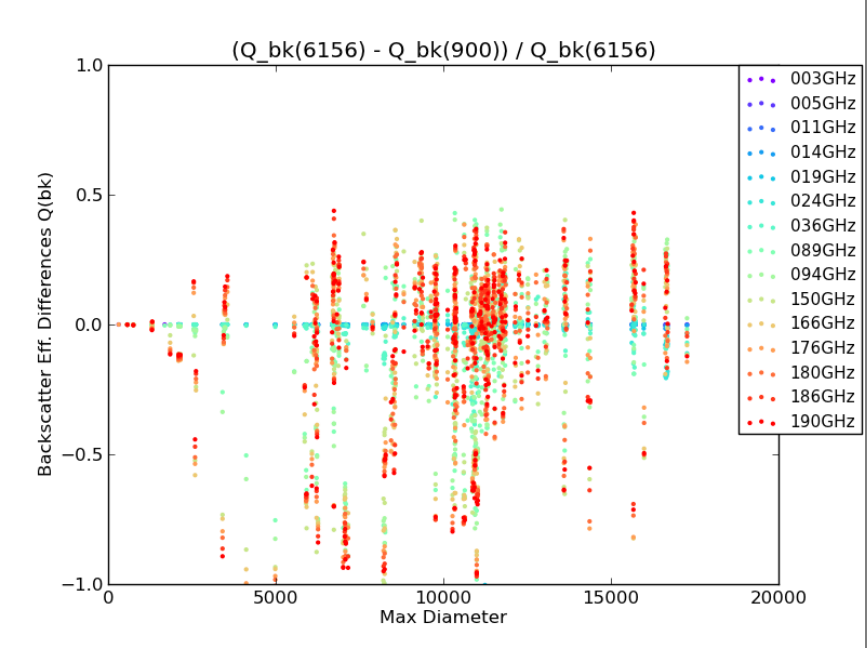
Polycrystals

A significant number of observed “pristine” particles comprise polycrystals

- Extended depositional growth model to produce quasi-physical polycrystals
  - Rosettes
  - Capped columns
- Improved growth process allows bullet structures at rosette junctures
- Currently implementing adaptive mesh for more efficient calculations



Uncertainty Analysis



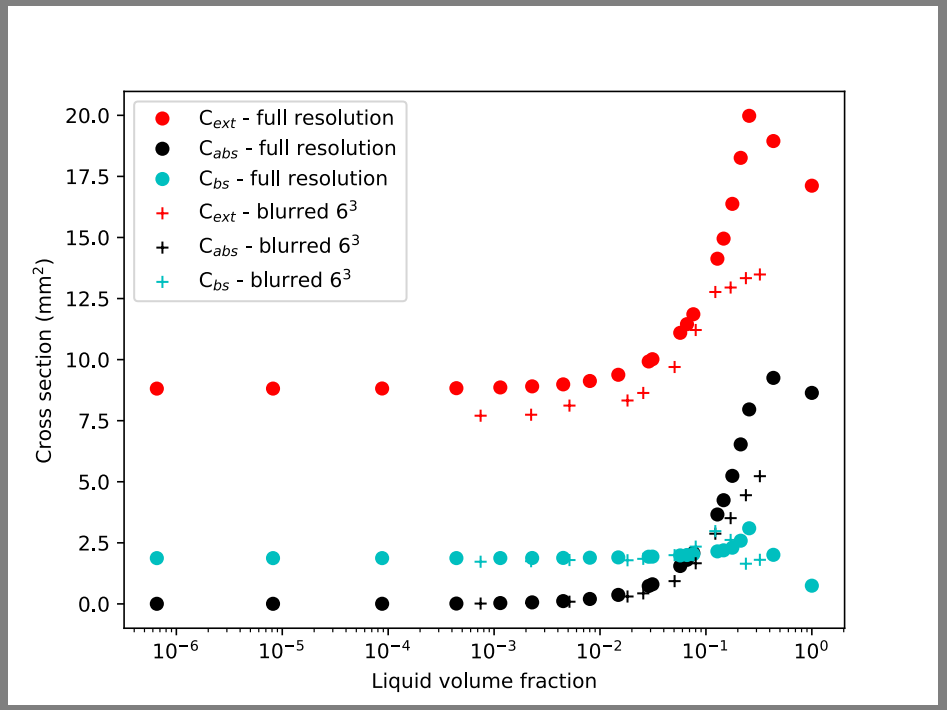
Understanding the uncertainties in particle models and associated scattering properties is key to implementing robust retrievals

- Particle properties
- Scattering model uncertainties
- Orientational averaging convergence
- Ensemble formation and representativeness

Characterizing Impacts of Resolution Reduction

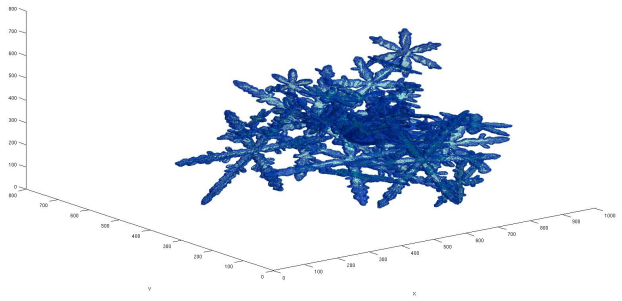
Coarsening or blurring the particles reduces runtime and improves DDA convergence; however,

- Current approach only considers complex permittivities of the three constituents
- Mass conservation is difficult
- Scattering properties are also impacted, particularly at higher melt fractions
- Presents difficulties for relating observables with target parameters

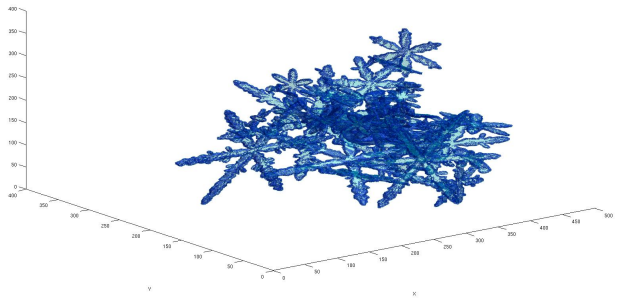


Particle Blurring

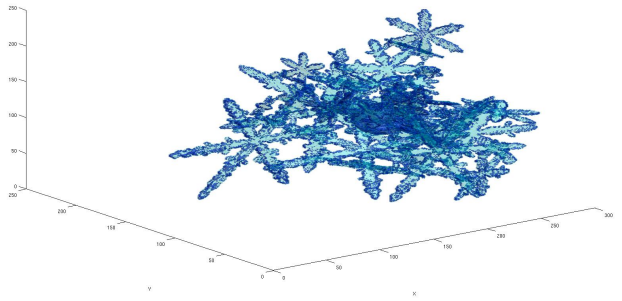
Original resolution



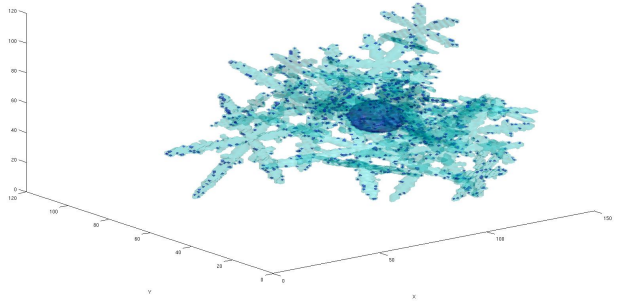
2 X 2 X 2



3 X 3 X 3



6 X 6 X 6

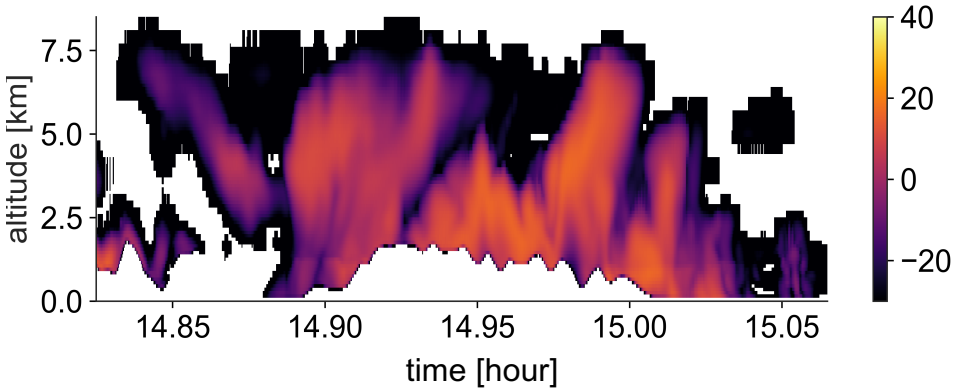


Hydrometeor Effects on Radar Multiple Scattering

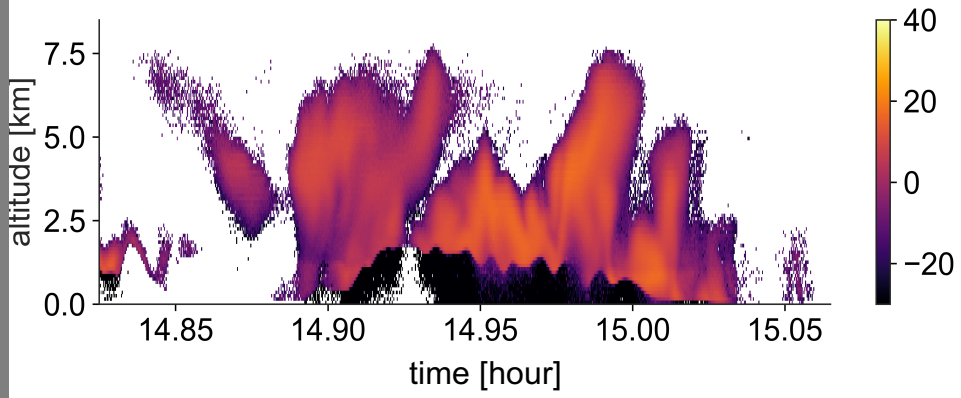
Observational studies suggest graupel is a significant contributor to multiple scattering

- Do theoretical simulations support this hypothesis?

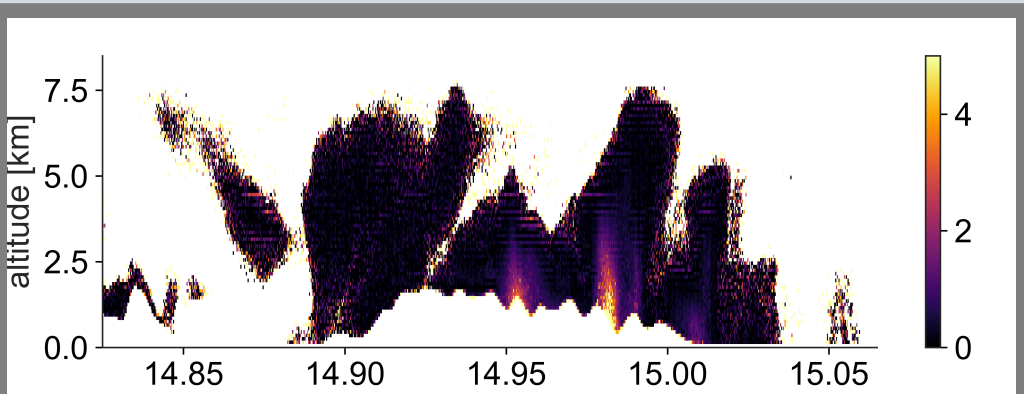
Single Scattering



Multiple Scattering

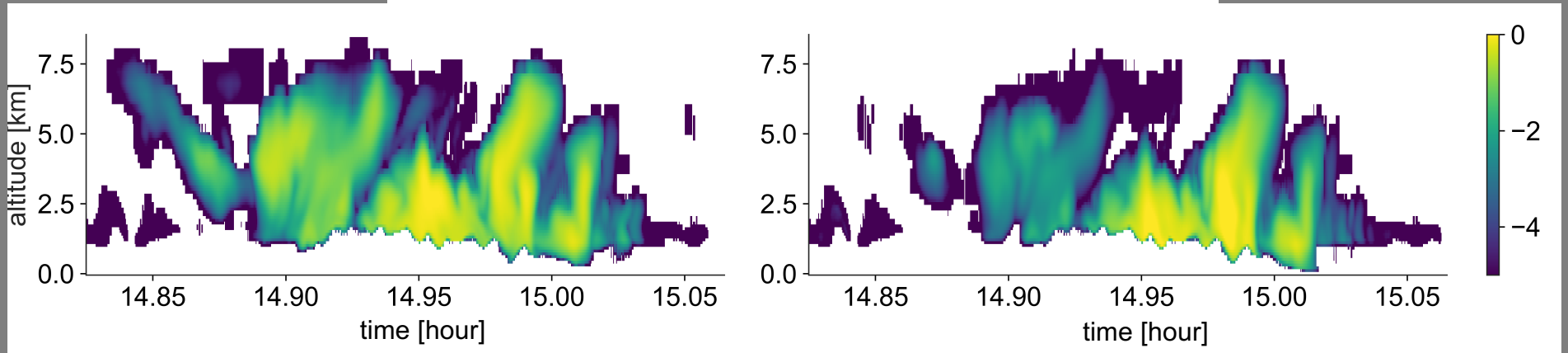


Multiple Scattering Enhancement



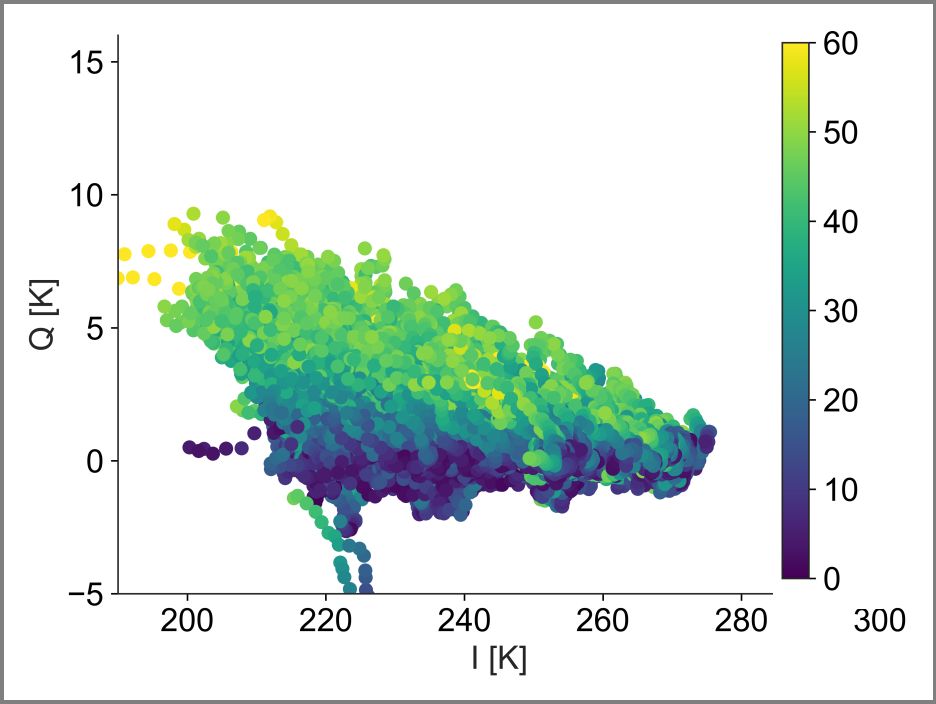
Snow Mixing Ratio

Graupel Mixing Ratio

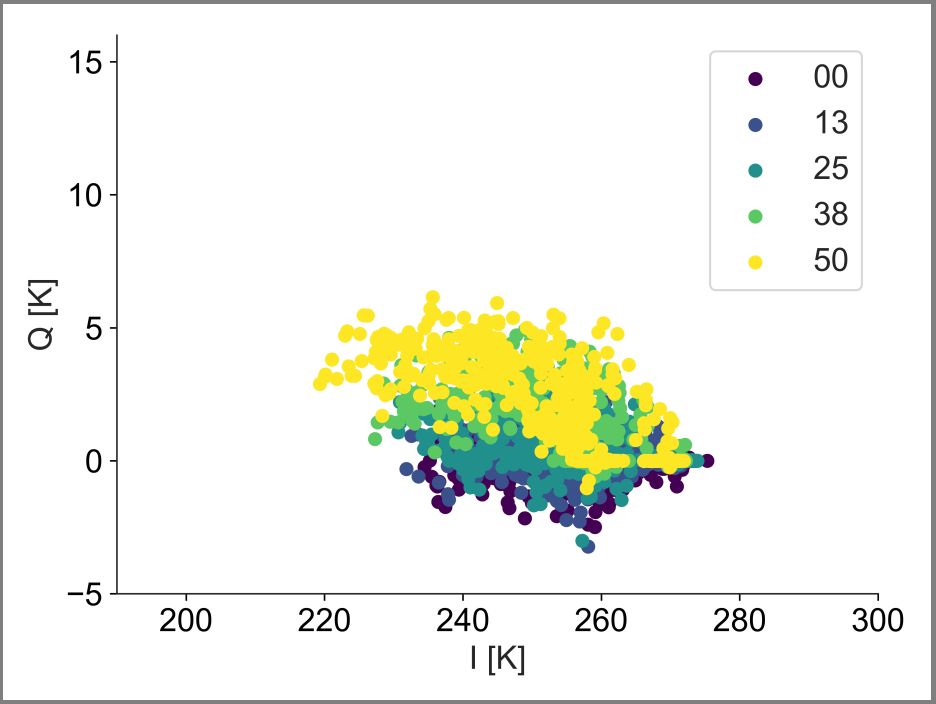


Radiometer Simulation (OLYMPEX, 20151203, 1500 UTC)

CoSMIR

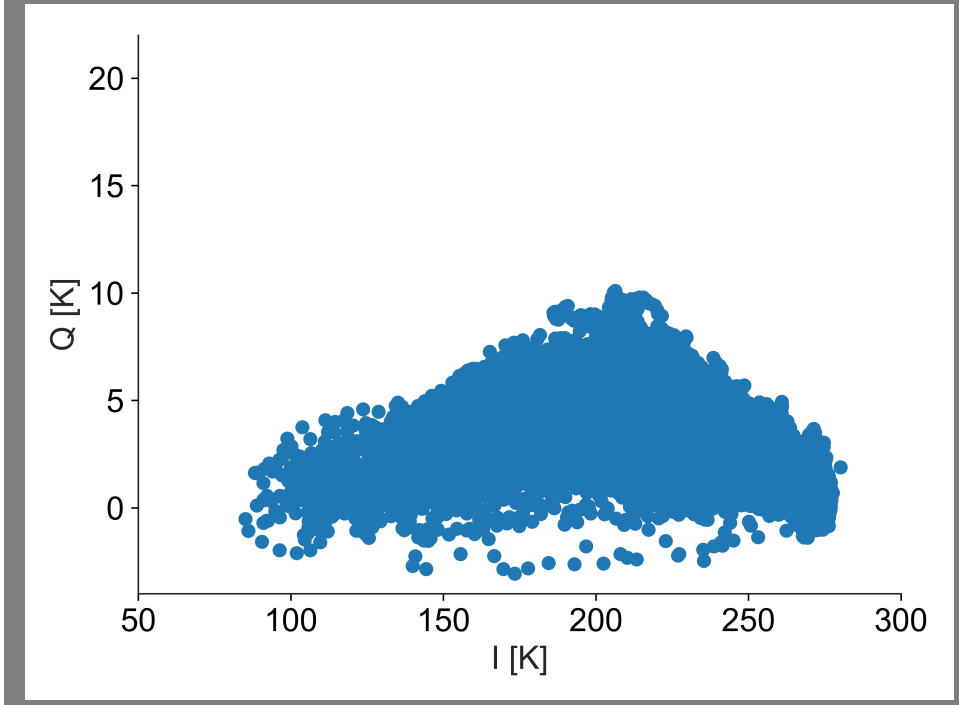


Hollow Columns Plates

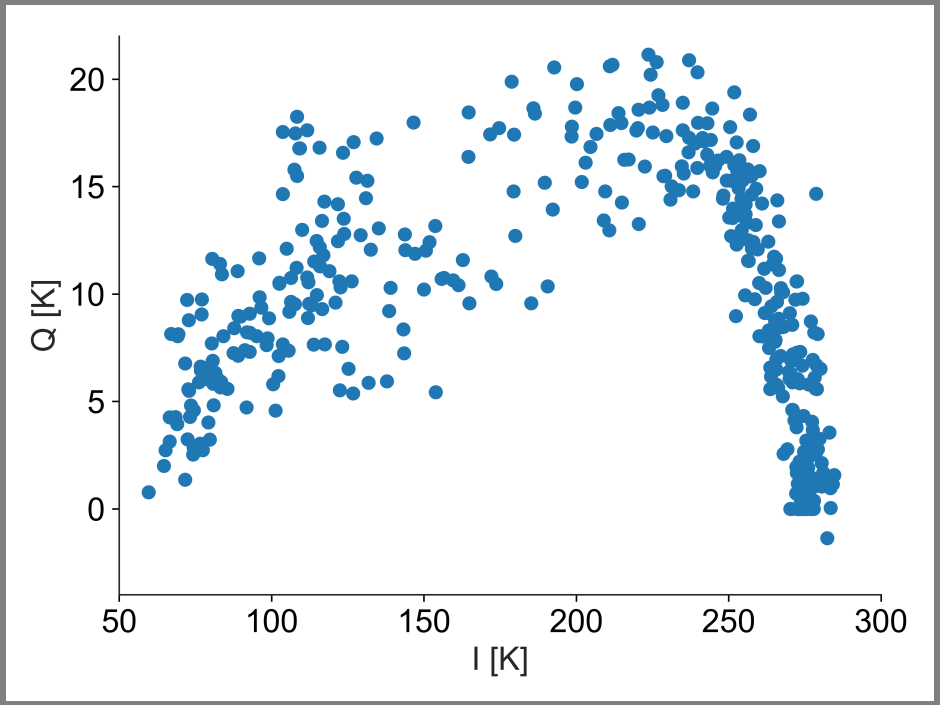


Convective Radiometer Simulations (MC3E)

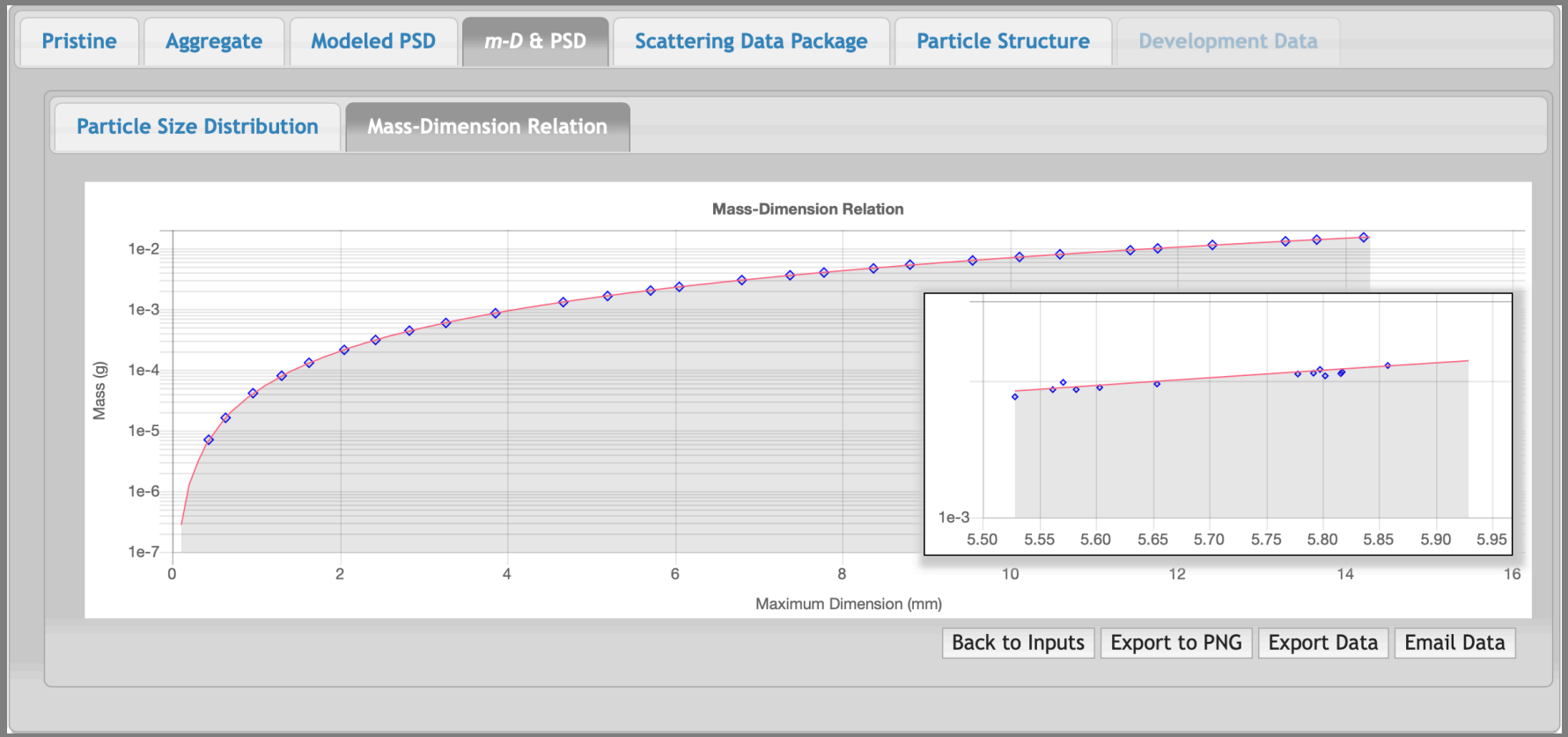
CoSMIR



Hollow Columns Plates



Web Interface Enhancements



Summary

Progress

- Characterization of uncertainties from particle resolution and orientational averaging
- Improvements to polycrystal growth
- Inclusion of aligned ice crystals in simulations

Next steps

- Implement SPH improvements
- Optimize polycrystal growth
- Address other database gaps
- Demonstrate hydrometeor partitioning