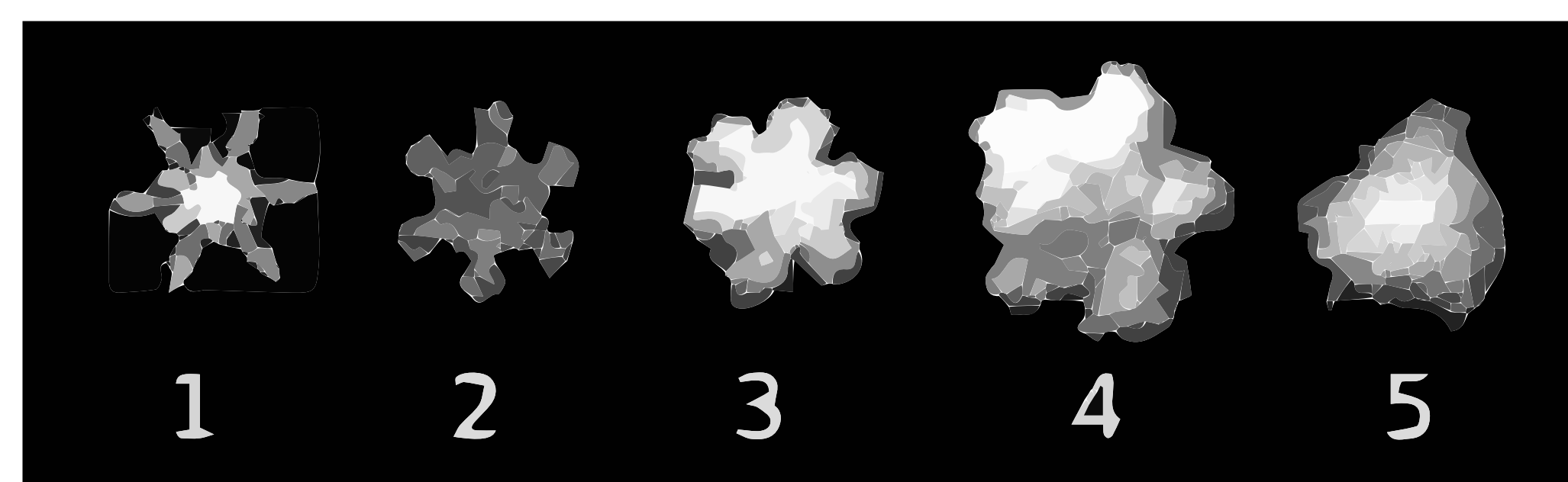
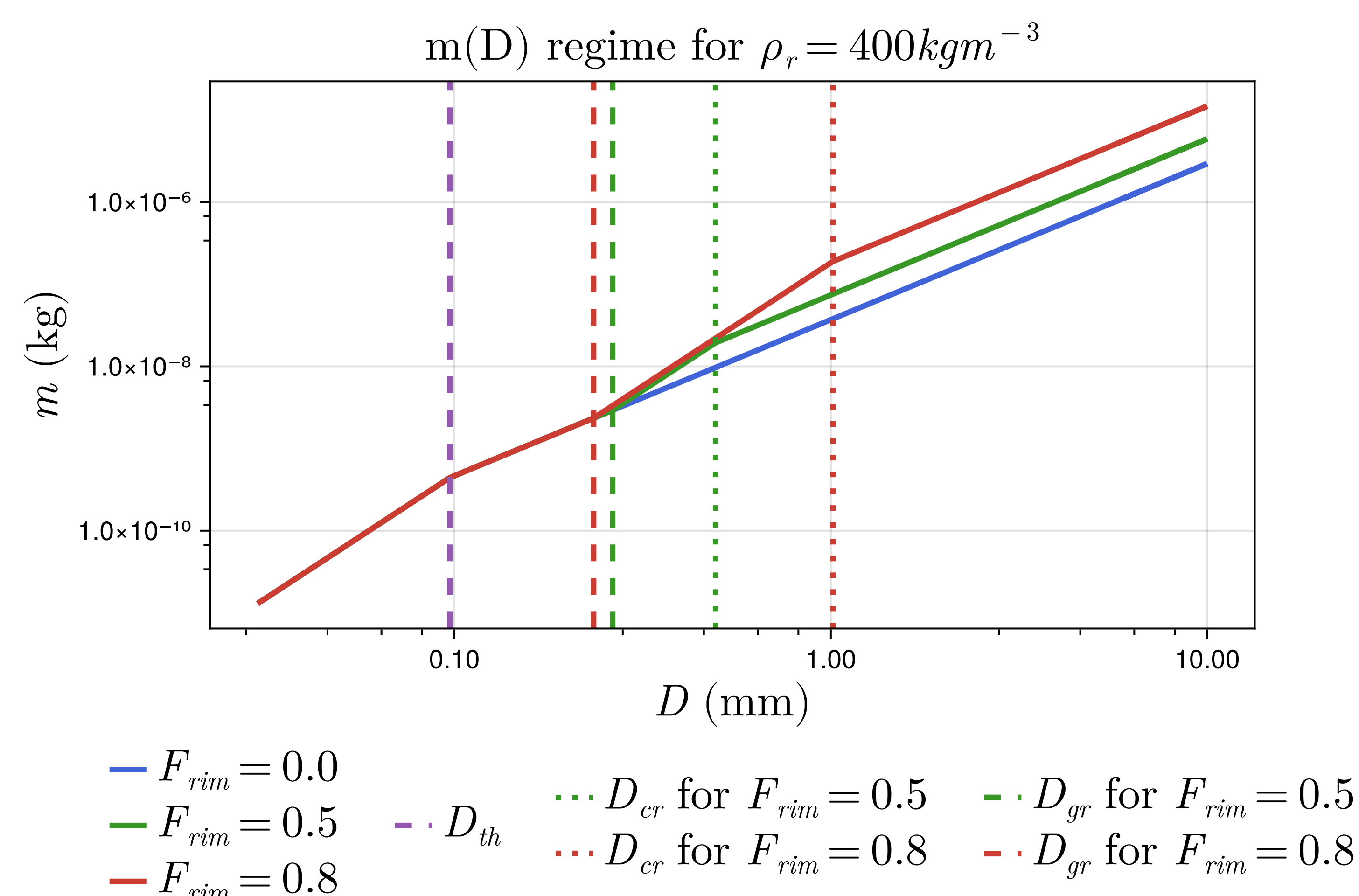


1) Introduction

- Climate Modeling Alliance (CliMA) in search of 2-moment ice parameterization for data-informed, open-source Julia global circulation model (GCM)
- Predicted particle properties (P3) scheme is a compelling candidate:
 - single ice category
 - mixed-phase particles



1) Physics-based scheme: P3 models the accumulation of rime on ice particles as pictured, accounting for varying geometry



2) Ice particle properties: a piecewise particle mass-dimension relation is an example of how the P3 scheme captures the evolution of properties across different regimes

2) Methods

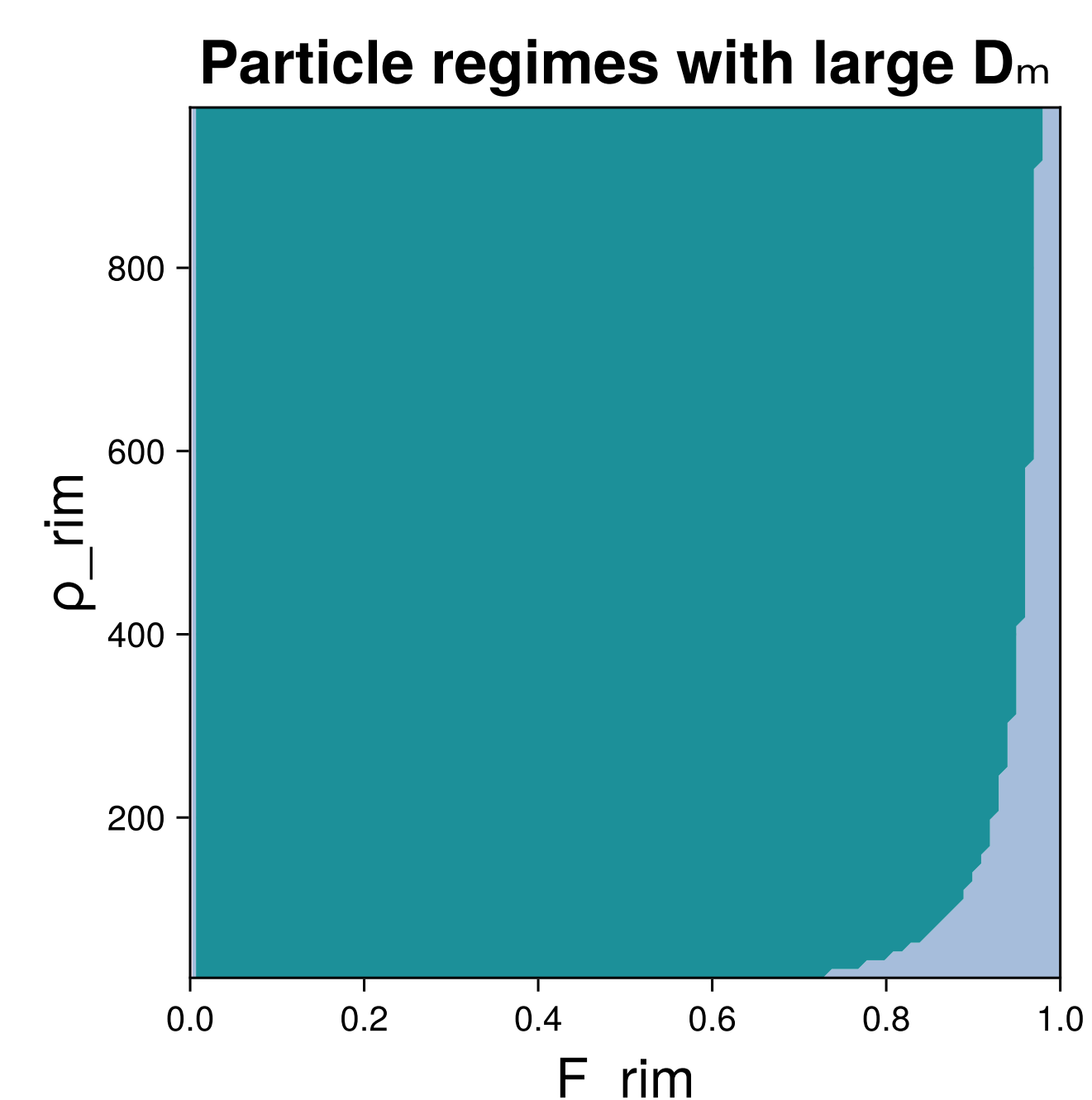
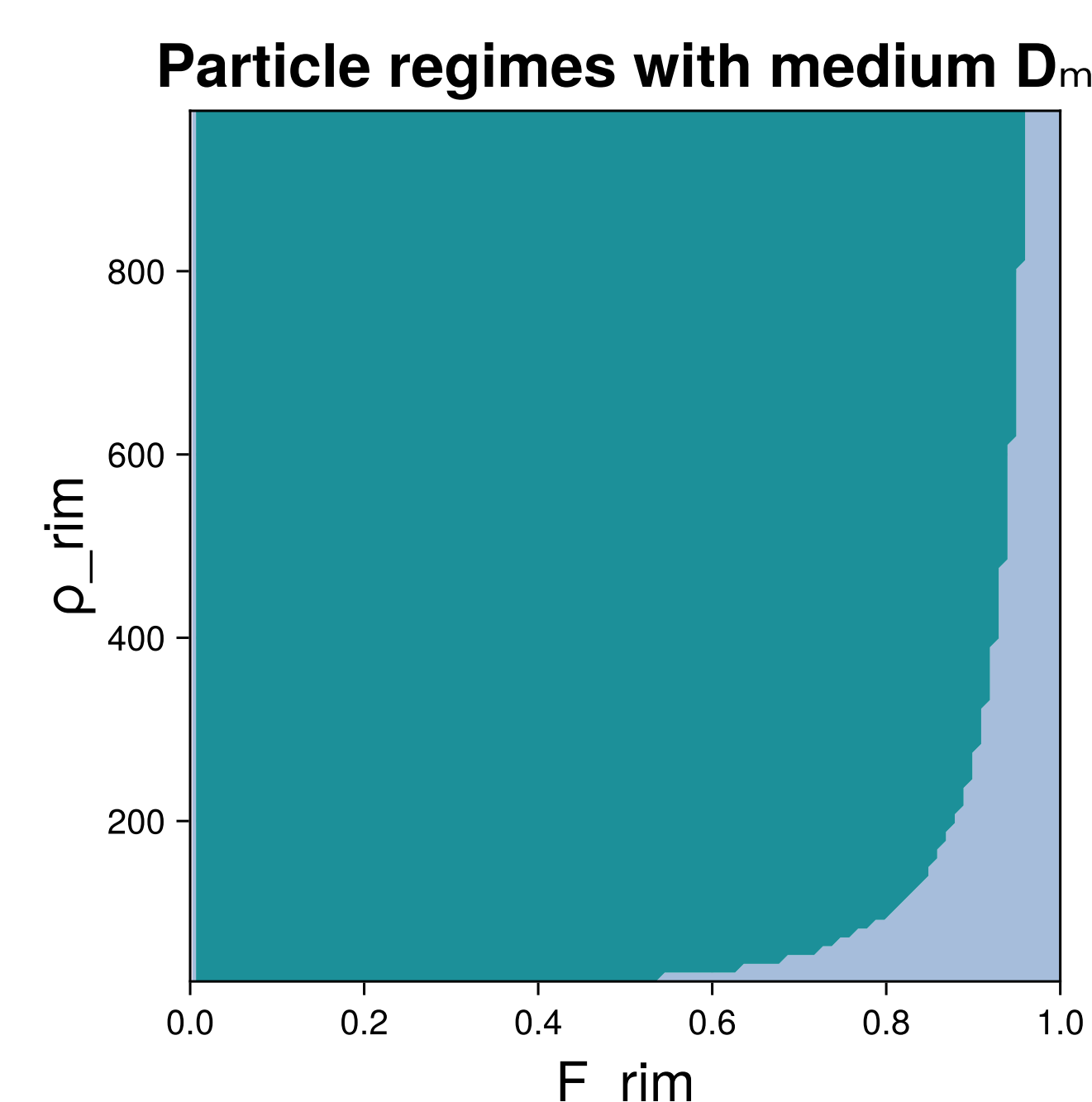
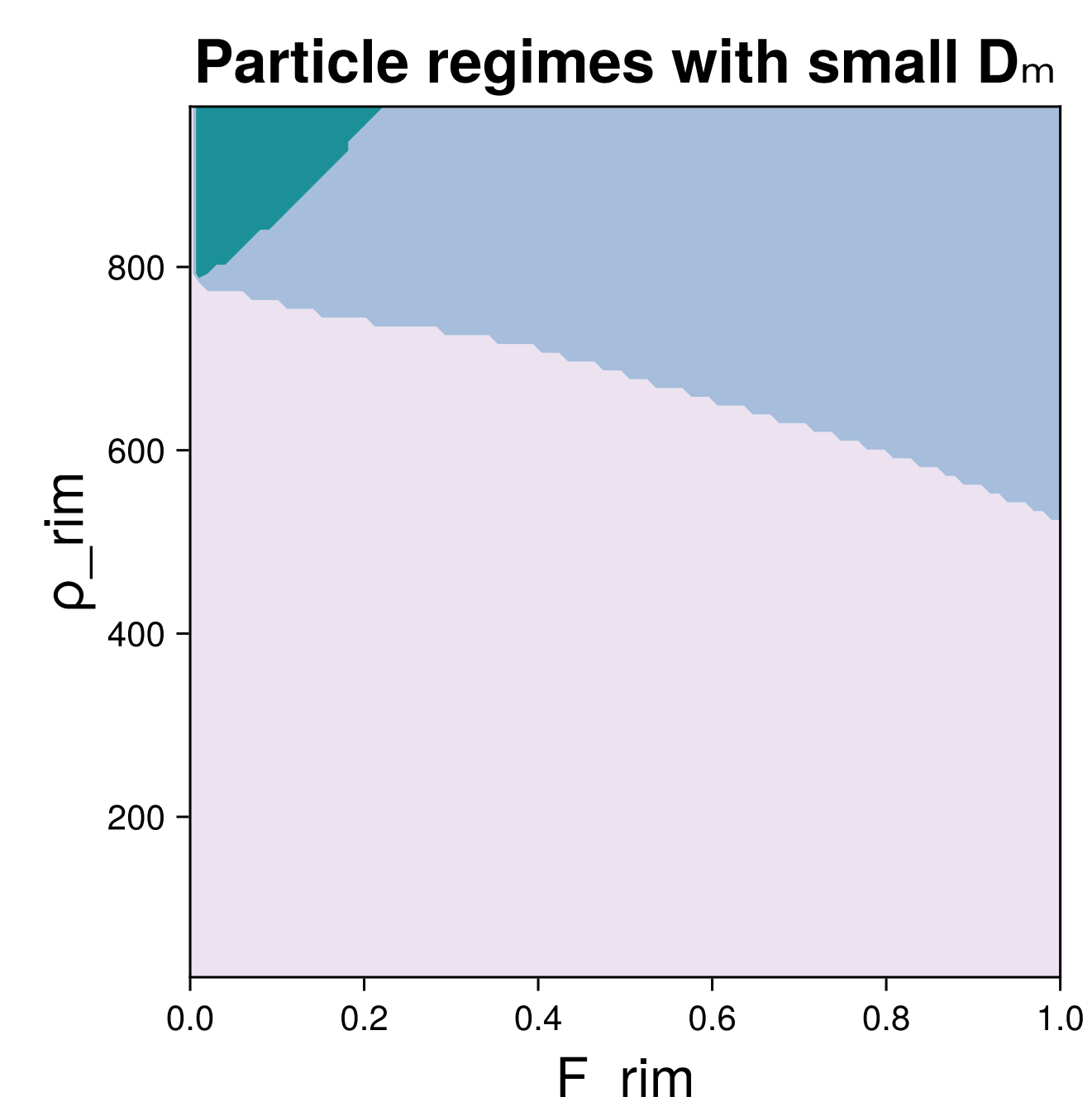
- Open-source software development
 - Extensive documentation, testing
- Goal of GPU-compatibility/efficiency
- Uses RootSolvers.jl and approximation of gamma functions to solve systems and integrate

3) Results

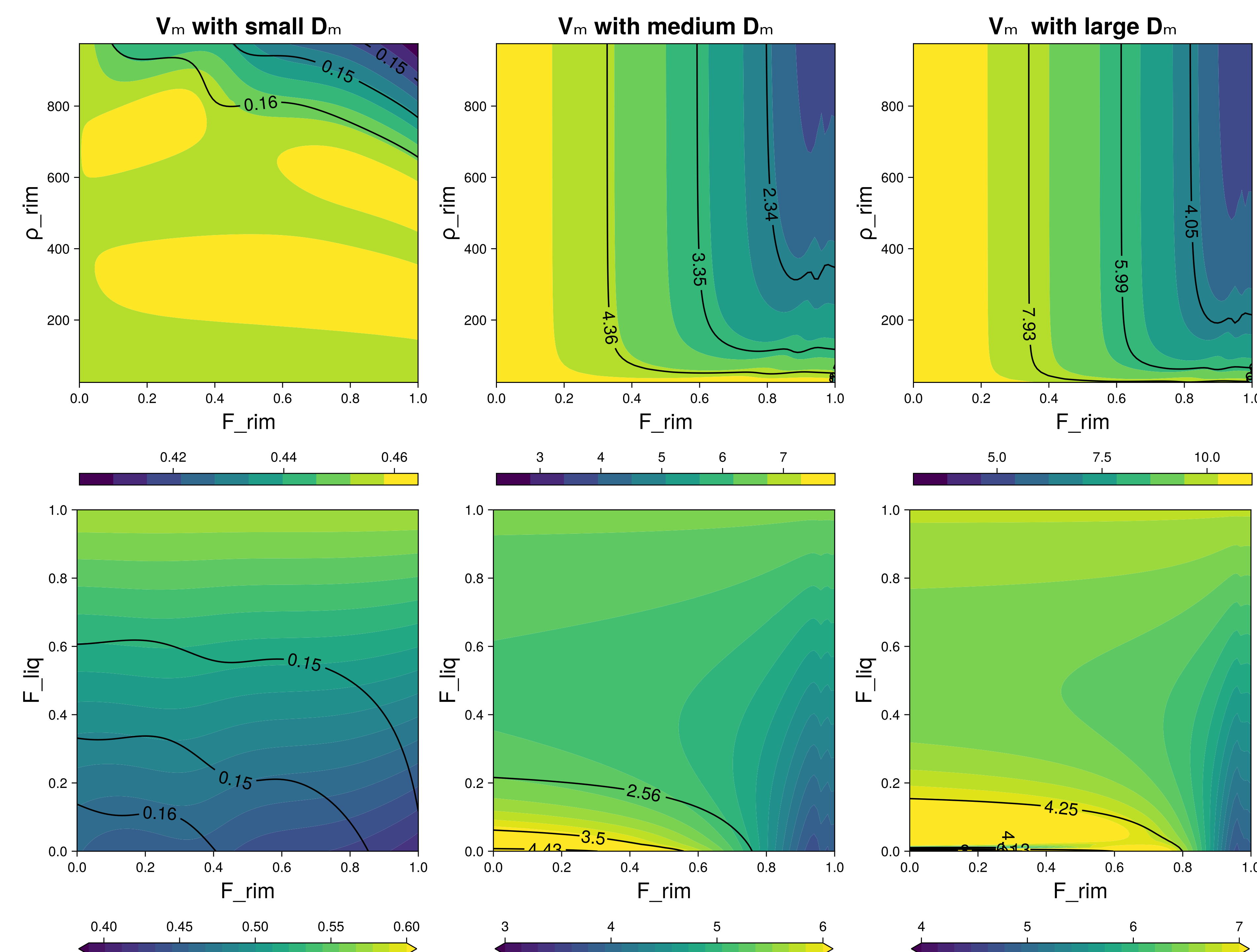
- Threshold solvers and integration are stable for our use cases
- Sedimentation and melting demonstrated in 1D kinematic model
- Scheme reproduces property and velocity regimes from literature

4) Future work

- Implement rest of process rates
- Implement gamma function approximation
- Test in 1D, 2D, large-eddy simulation (LES), and GCM models



dense nonspherical ice (1); graupel (2); partially rimed ice (3)



3) Particle regimes (left); and mass-weighted terminal velocity (m/s) as functions of rime mass fraction and rime density (top) or liquid fraction (bottom). Contours show the mass-weighted mean particle size (mm). Ice mass content and number concentration values used to generate small, medium, and large mean particle sizes are about 0.0008 , 0.5 , 2 kg m^{-3} and 10^6 m^{-3} , respectively. We see relatively smooth modeling of particles across regimes.

Acknowledgements

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 M. G. al, Parameterization of the Bulk Liquid Fraction on Mixed-Phase Particles in the Predicted Particle Properties (P3) Scheme: Description and Idealized Simulations. Journal of the Atmospheric Sciences 76, 561-582 (2019).
 Figure 1 courtesy of Praz et al. 2017 (<https://doi.org/10.5194/amt-10-1335-2017>)
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