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Evaluation of the Predicted Particles Properties (P3) microphysical scheme in E3SM

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This Predicted Particle Properties (P3) bulk microphysics scheme (Morrison & Milbrandt 2015) represents a significant advance from traditional bulk schemes where ice-phase particles are artificially partitioned into several different predefined categories with *fixed* properties. The scheme prognoses 4 bulk ice-phase variables (number and mass concentration, rimed-mass, and rimed-volume) which allows ice particle evolution to be simulated through the full range of growth processes - from initial nucleation followed by depositional growth, aggregation, and riming (dry/wet growth). A particular benefit in P3 is the inclusion of rimed particles (graupel/hail) which are important cloud microphysical components in mixed and deep convective clouds that are not included in the Gettelman and Morrison (2015; MG2) scheme.

In this study, we implement a single-category P3 microphysical scheme in the E3SMv2 candidate model version. P3 model results based on 3 years simulations at both 1^{o} and 0.25^{o} are compared against MG2 and observations. The model performance is evaluated by comparing to various observable climatological products like radiation, precipitation, and cloud fraction, but also to cloud-related products such as effective radius, ice and liquid water path, and cloud top height using cloud and satellite simulators. Areas of improved and degraded performances will be discussed, and areas for further improvements will be highlighted.