Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Statistical theory on the analytical form of cloud particle size distributions[1] WEI WU, National Center for Atmospheric Research/ University of Wyoming, GREG MCFARQUHAR, University of Oklahoma — Several analytical forms of cloud particle size distributions (PSDs) have been used in numerical modeling and remote sensing retrieval studies of clouds and precipitation, including exponential, gamma, lognormal, and Weibull distributions. However, there is no satisfying physical explanation as to why certain distribution forms preferentially occur instead of others. Theoretically, the analytical form of a PSD can be derived by directly solving the general dynamic equation, but no analytical solutions have been found yet. Instead of using a process level approach, the use of the principle of maximum entropy (MaxEnt) for determining the analytical form of PSDs from the perspective of system is examined here. Here, the issue of variability under coordinate transformations that arises using the Gibbs/Shannon definition of entropy is identified, and the use of the concept of relative entropy to avoid these problems is discussed. Focusing on cloud physics, the four-parameter generalized gamma distribution is proposed as the analytical form of a PSD using the principle of maximum (relative) entropy with assumptions on power law relations between state variables, scale invariance and a further constraint on the expectation of one state variable (e.g. bulk water mass).

[1]DOE ASR

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Date submitted: 28 Jul 2017 Electronic form version 1.4