Remote sensing microphysical retrieval and cloud microphysics parameterizations rely on a knowledge of the shape of cloud drop size distributions (DSD). These are often approximated by Gamma, lognormal, or, more specifically by Khrgian-Mazin, Marshall-Palmer type distributions.

We ask the question which functional form approximates best the drop size distributions in drizzling stratocumulus?

Specifically, we evaluate the accuracy of lognormal and Gamma-type distributions in approximating higher moments of the DSDs based on datasets generated in simulations with LES explicit microphysics model.

The study is based on the CIMMS LES model with explicit size-resolving microphysics.

We simulated several cases of stratocumulus clouds observed during the ASTEX field experiment.

The simulations represent cloud layers with different intensities of drizzle in the cloud and provided over 19,200 DSDs for each case.

The three parameter lognormal fit (L-fit) is:

\[ n(r) = \frac{N}{\sqrt{2\pi}\sigma} \exp \left[ -\frac{1}{2} \left( \ln r - \ln r_m \right)^2 \right] \]

where \( r_m \) is the modal radius, \( N \) concentration, and \( \sigma \) logarithmic drop spectrum width.

The three parameter Gamma fit (G-fit) is:

\[ n(r) = \frac{N}{\Gamma(\alpha+1)\beta^\alpha} r^\alpha \exp \left( -\frac{r}{\beta} \right) \]

where parameters are \( N \), \( \alpha \) and \( \beta \). \( \Gamma(\alpha) \) is the gamma function.

The three parameters defining each fit are expressed through the 0th, 1st and 2nd moments of the LES derived DSDs. The 4th and 6th moments of the fit are then compared with corresponding moments of the DSD from the LES dataset. That in Sc these moments represent drizzle flux and reflectivity.

The number of parameters can be reduced from 6 to 4 by assuming a fixed drop spectrum width for cloud and drizzle drops. These 4 parameters can be matched to 4 predictive variables of a two-moment cloud microphysical parameterization.

For the HD case (Fig 3), the unimodal fits fail to capture contribution from the tail of the spectrum; thus, rain rate and radar reflectivity are significantly underestimated by either an L-fit (left), or a G-fit (right panels).

The bimodal fit is a sum of two fits defined by three parameters expressed through partial moments integrated over the cloud and drizzle sizes, and another three through moments integrated over the drizzle size.

The number of parameters can be reduced from 6 to 4 by assuming a fixed drop spectrum width for cloud and drizzle drops. These 4 parameters can be matched to 4 predictive variables of a two-moment cloud microphysical parameterization.