On the use of the log-normal particle size distribution to characterize global rain

Robert Meneghini*, NASA/GSFC, Code 975, Greenbelt, MD 20771
Rafael Rincon, NASA/GSFC, Code 555, Greenbelt, MD 20771
Liang Liao, NASA/GSFC, Caelum Co., Code 975, Greenbelt, MD 20771

Although most parameterizations of the drop size distributions (DSD) use the gamma function, there are several advantages to the log-normal form, particularly if we want to characterize the large scale space-time variability of the DSD and rain rate. The advantages of the distribution are twofold: the logarithm of any moment can be expressed as a linear combination of the individual parameters of the distribution; the parameters of the distribution are approximately normally distributed. Since all radar and rainfall-related parameters can be written approximately as a moment of the DSD, the first property allows us to express the logarithm of any radar/rainfall variable as a linear combination of the individual DSD parameters. Another consequence is that any power law relationship between rain rate, reflectivity factor, specific attenuation or water content can be expressed in terms of the covariance matrix of the DSD parameters.

The joint-normal property of the DSD parameters has applications to the description of the space-time variation of rainfall in the sense that any radar-rainfall quantity can be specified by the covariance matrix associated with the DSD parameters at two arbitrary space-time points. As such, the parameterization provides a means by which we can use the spaceborne radar-derived DSD parameters to specify in part the covariance matrices globally. However, since satellite observations have coarse temporal sampling, the specification of the temporal covariance must be derived from ancillary measurements and models. Work is presently underway to determine whether the use of instantaneous rain rate data from the TRMM Precipitation Radar can provide good estimates of the spatial correlation in rain rate from data collected in 5^0 x 5^0 x 1 month space-time boxes. To characterize the temporal characteristics of the DSD parameters, disdrometer data are being used from the Wallops Flight Facility site where as many as 4 disdrometers have been used to acquire data over a 2 km path. These data should help quantify the temporal form of the covariance matrix at this site.

The various forms and parameterizations of the size distribution raise issues related to the dual-wavelength radar equations. In particular, how do the forms of the equations change as we change the DSD parameterization and how do these modifications affect the characteristics of the solutions?

* Telephone: 301-614-5652
FAX: 301-614-5558
Email: Robert.Meneghini-1@nasa.gov