An analysis method to estimate the climatological drop size distribution (DSD) parameter using spaceborne radars (CloudSat’s W-band radar and TRMM’s Ku-band radar) is proposed in this study and a global maps of estimated DSD parameters (e.g. median diameter, D0) are demonstrated. The basic idea of the analysis method is to compare the histogram of radar reflectivity factor (Z) at near-surface range bin in the over-lapping Z range (weak to moderate rain echo). Because of the Mie effect, the Z value of rainfall is different between W- and Ku-band and it reflects the difference in the histograms of W- and Ku-band.

A general characteristic of global maps of D0 is that the local time and year is apparent land-ocean contrast; larger D0 appears over land and smaller D0 appears over ocean except for relatively small D0 over southeastern Asia to China. Also, relatively larger D0 appears in tropical area and mid latitude summer. Diurnal change of D0 can be seen by comparing the day/night time D0; D0 is larger in the night time over ocean while day time D0 is larger over land. Tropical Ocean shows smaller seasonal change, while large change are seen over mid-latitude area.

**Introduction (Motivation of this study: goal)**

- Algorithm validation for GPM/DPR, especially for DSD estimation.
- Utilization of W-band radar data (CloudSat and future EarthCARE).
- Current target is validation of DSD estimation by TRMM/PR.

**Key Idea**

- Difference in histogram of Z between CloudSat and TRMM/PR comes from the Mie scattering effect and attenuation.
- Attenuation correction can be done using surface echo (sigma zero) if we consider only certain area (tracks 125 m sampling).

**Equations**

\[ k = \alpha Z^\beta \]

- \( k \) = k-Z relationship (\( \alpha, \beta \) constant).

\[ k = \int \sigma(D)N(D)dD = \int \sigma(D)D^\beta e^{(\alpha - \beta)D}dD \]

- Start point of DSD model.

\[ Z = \int \sigma(D)N(D)dD = \int \sigma(D)D^\beta e^{(\alpha - \beta)D}dD \]

- Gamma DSD model is used.

\[ N(D) = \frac{d\sigma(D)D^\beta e^{(\alpha - \beta)D}dD}{dD} \]

- Equation to determine \( N_0 \) (Function of \( D_0 \) or mu).

\[ k = \alpha Z^\beta \]

- \( \epsilon \) adjusts the \( k \) in k-Z relationship.

\[ DFR = \frac{ZW}{ZKu} \]

**Result (Example of estimated D0)**

Global dataset: 3-month average, 10 x 10 degree grid (40S to 40N), Land/Ocean, daytime/nighttime
December 2006 to November 2007

(Top) Afternoon 02:00 P.M. ascending mode of CloudSat
(Bottom) Descending – Ascending

**Data**

- Major specification of (CloudSat) and TRMM/PR

**Comparison**

DSD models

- DSD model defined by k-Z (and \( \epsilon \)) relationship gamma DSD with various \( \mu \) factors (single D0 in fixed gamma DSD model)

Fitting result and coverage of DSD model, sing le D0 model is the most appropriate ⇒ simply offset the histogram of CloudSat.

\[ D0 \] database

In order to estimate the path integrated attenuation, no-cloud (no-rain) sigma zero databases are created from CloudSat (TRMM) data.
Evaluation (Comparison of D0 with single frequency precat = TRM/PR only)

- Seasonal change (DJF, MAM, JJA, SON) of climatological D0 and rain rate (December 2006 to November 2007)

- Over land/Daytime

- Over water/Nighttime

- Over water/Daytime

- Over land/Nighttime
• Diurnal change
  – TRMM only
  – Convective vs. Stratiform
  – over land
  – 2007

• Monthly change
  – TRMM only
  – Convective vs. Stratiform
  – over land
  – 2007

• Monthly change
  – TRMM (rain)
  – NOAA (SST)
  – J-OFURO (Sea surface wind)
  – over water
  – 2007