Scattering Calculations:

Practical considerations

(1) How to characterize clouds?

(2) Specific issues

I. accurate determination of cloud describing parameter

II. determining an optimal particle size grid

How to characterize clouds?

Microphysical and Macrophysical properties

Microphysical		Macrophysical
Mass content [g/m^3] (e.g., IWC) alternatively: volume content [cm^3/m^3], number density [particles/m^3]	Particle size Particle shape	Cloud altitude Geometrical thickness

How to characterize clouds?

Or, more continuously:

Mass content (z)

alternatively:
volume content, number density

Particle size N(r,z)

Particle shape

How to characterize clouds?

Mass content (z)

alternatively:

volume content, number density

"Scaling factor" on optical properties

Particle size (z)

Particle shape (z)

Determine the optical properties

(β_a,β_s,+PhaseFunCTion)

(τ, ω_0)

How to characterize clouds?

Particle size (z)

Particle shape (z)

Mie theory, T-matrix, …

Databases

Single size properties

\+

Size distribution N(r,z)

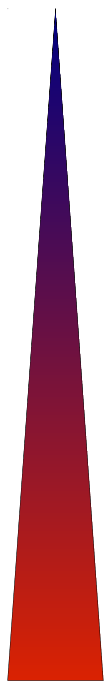
Determine the optical properties

(β_a,β_s,+PhaseFunCTion)

(τ, ω_0)

How to characterize clouds?

Approaches to provide that to RT model



1. IWC(z)
   OpticalProperties(z)

   e.g.,
   AMATERASU/SARTre

2. IWC(z,particlehabit)
   OP(ph)

   e.g.,
   ARTS

3. IWC(z)
   [ph(z)]
   calculate OP inside RTM

   future ARTS?

Specific issues (I)

accurate determination of cloud describing parameter

concerns

Mass Content: $$MC = \int_0^\infty \rho \cdot V(r) \cdot N(r)\,dr$$

Mean Particle size: $$\bar{r} = \frac{\int_0^\infty r^3 \cdot N(r)\,dr}{\int_0^\infty r^2 \cdot N(r)\,dr}$$

by definition over ALL particle sizes

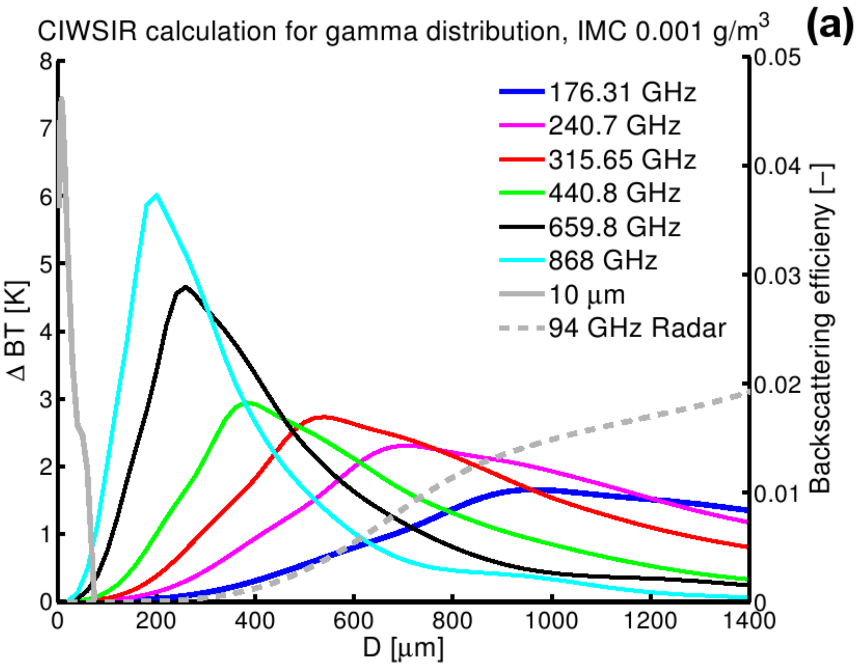
Problem: different quantities are sensitive to different fractions of the size spectrum

Specific issues (I)

accurate determination of cloud describing parameter

Problem: different quantities are sensitive to different fractions of the size spectrum

- Bulk optical properties, i.e. remote sensing observations – depending on spectral region:
  - mm: several tens of µm...few mm
  - IR: several tenths...few tens of µm



Specific issues (I)

accurate determination of cloud describing parameter

Problem: different quantities are sensitive to different fractions of the size spectrum

- Bulk optical properties, i.e. remote sensing observations – depending on spectral region:
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  - IR: several tenths...few tens of µm

effective size	→	small	←	N_{total}
mass mean size	→	large	←	mass content (IWC)

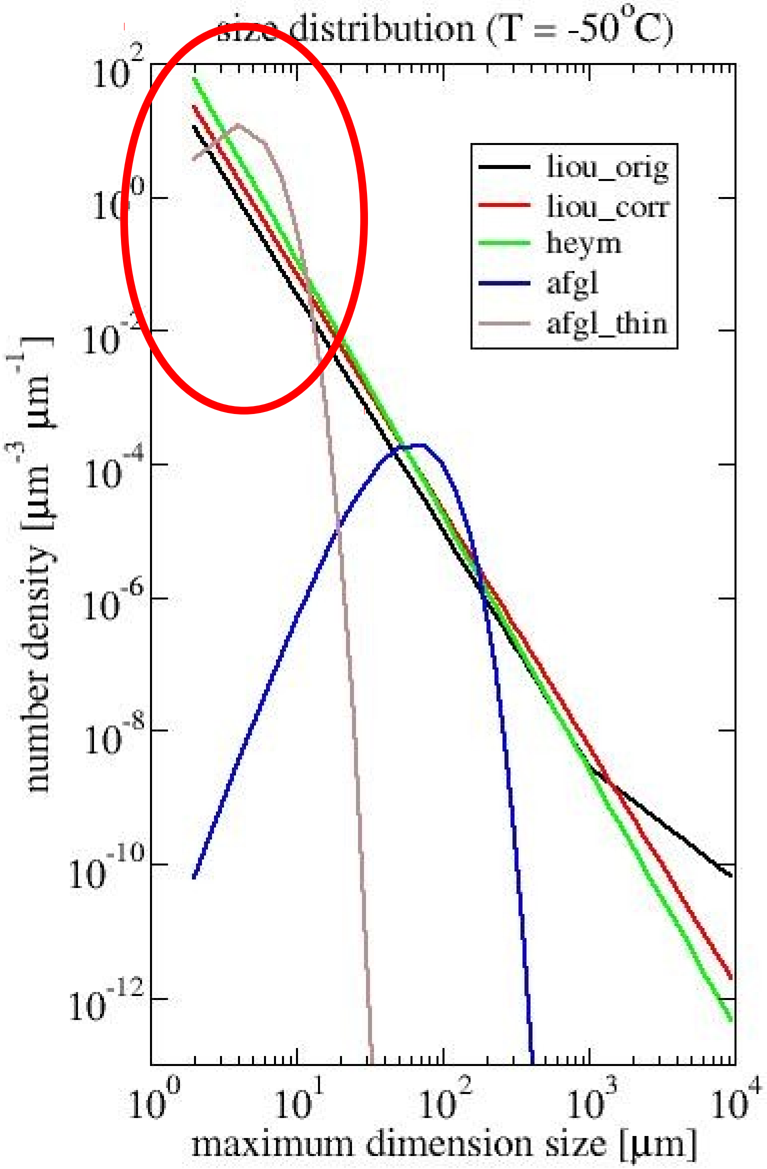
➡ sensible assumptions on no-sensitivity range necessary

Specific issues (I)

accurate determination of cloud describing parameter

Problem: at small and large particle edges, N(r) often not very well known

? What is a good (reliable?) range definition to do the N(r) integrals over?

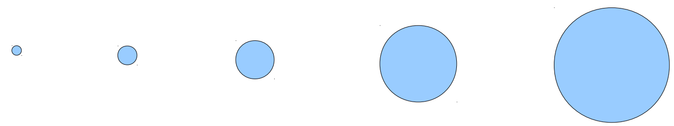


Specific issues (II)

determining an optimal particle size grid

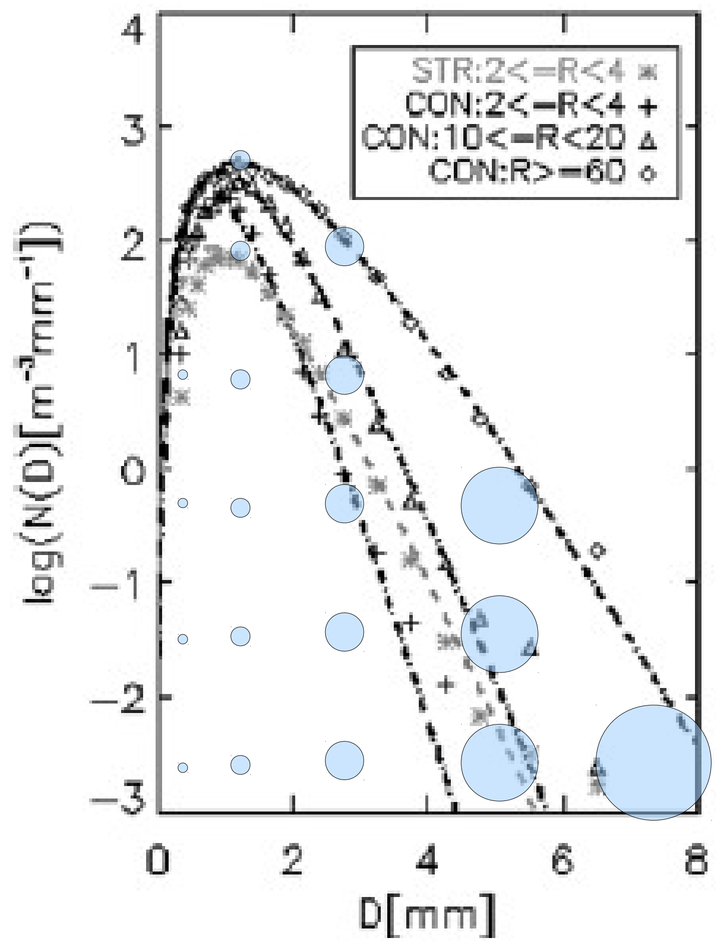
1) Optical properties for single particle (monodisperse):

σ_a, σ_s, PFCT (r)



2) Bulk optical properties: convolve with size distribution N(r)

$$\bar{\sigma} = \int \sigma(r) \cdot N(r)\, dr$$



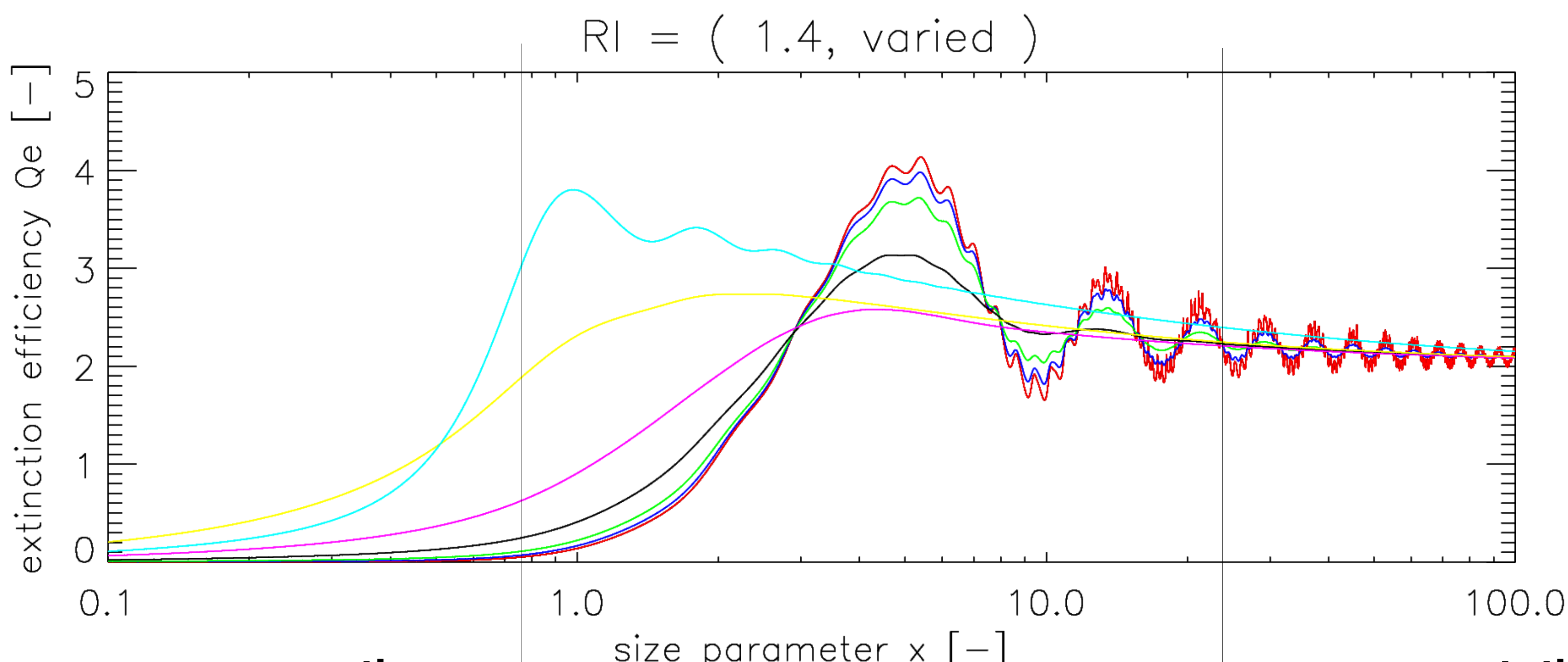
? For step 1), what is an optimal size grid?

- as accurate as necessary
- as efficient as possible

Specific issues (II)

determining an optimal particle size grid

- when σ_a,σ_s,PFCT(r) vary smoothly, grid can be wider
- general idea about σ_a,σ_s,PFCT(r) behaviour from Mie theory



smooth

asymptotic

(but: PFCT strongly varying)