ATLID L1 Validation

Discussion

What is in the L1 product ?

Calibrated cross-talk corrected ATBS

and

Decomposed error estimates

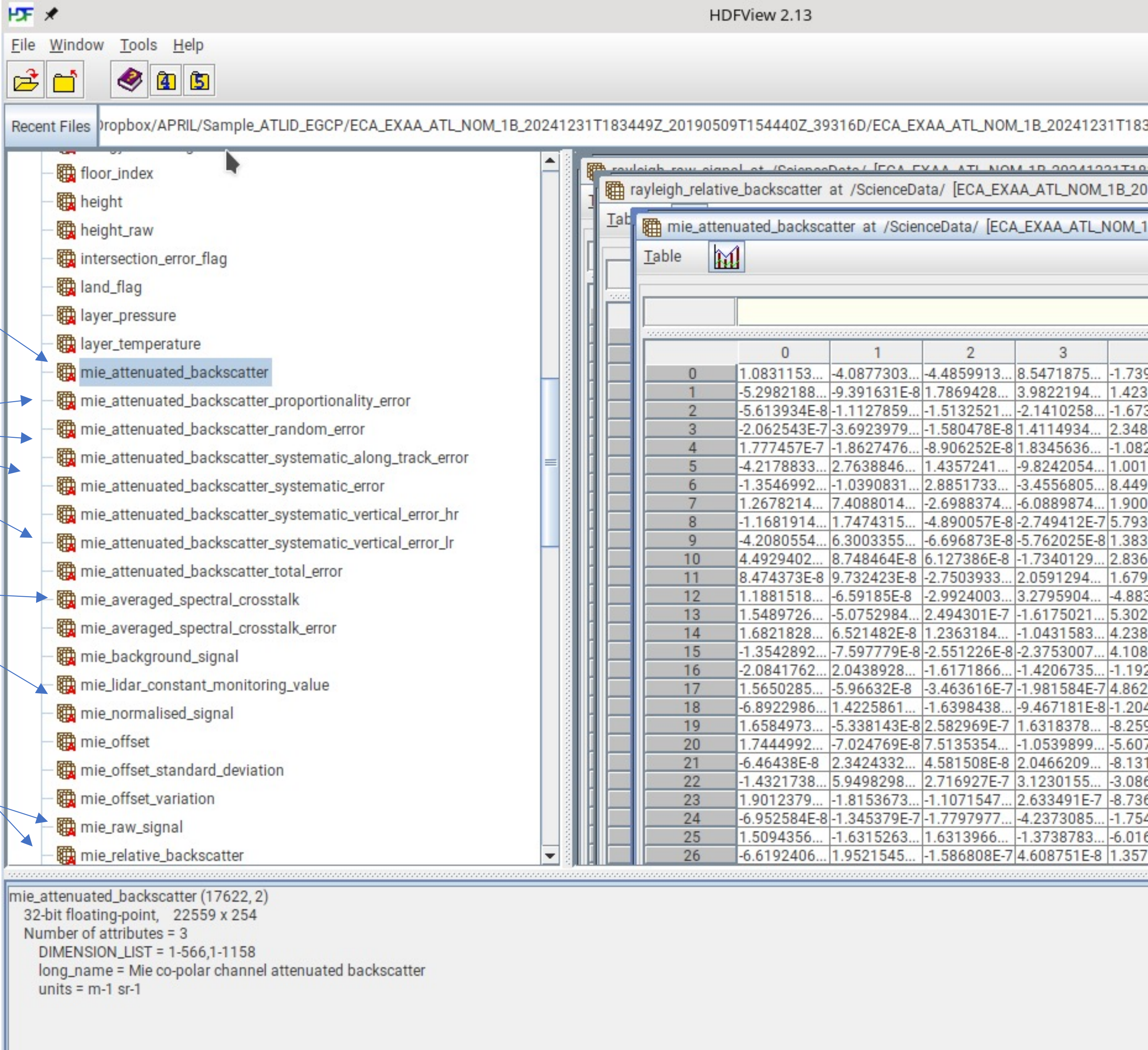
Intermediate products

Cross-talk coefficients used

Raw Signals

Etc..

Data is NetCDF4/HDF5 ! Following similar conventions used in L2 data !



What does ESA expect from the Cal/Val teams ?

- Data submission to Cal/Val data base.
  - Original terrestrial lidar observations ?
  - Final products e.g. filtered terrestrial ATLID(-like) L1 products derived from terrestrial measurements ?
  - Both ?
- Attendance of work-shops.
- Publishing/presentation of results ?

How do we validate L1 (I) ?

- What measurements and conditions to prioritize ?
  - Measurements at 355 nm.
  - Measurements covering the stratospheric aerosol layer ?
  - Coordinated under flights with aircraft based lidars.
    - Homogeneous aerosol fields
  - Ground-based longer-term observations.
    - Statistical approaches.
    - Filtering for homogeneous conditions.
    - Homogeneous Aerosol field.
    - “Homogeneous Cirrus” (esp. depol validation) cases desirable.

How do we validate L1 (II) ?

- Validation of Rayleigh Calibration
  - ATLID L1 will come with T and P (via ECMWF) fields. Are these good enough ? Would the use of local Radiosondes (not assimilated by the ECMWF) be useful?

- Common, lidar specific standards for Cal/Val purposes, e.g. well calibrated depolarization measurements including errors.
  - Who will draft the standards/conventions and how will this process proceed ?

- Can we use data not at 355nm ?

- ATBs can not be directly compared between ground and space-based systems.

  Ground L1 ➔ L2 to Space L1 simulations will be necessary.
  - Simple –vs- complex simulations ?
  - Will enough information on ATLID parameters be available to the validation community for them to conduct advanced simulations ?

For CALIPSO: The approach of using Ground-based L2 products to simulate space-based L1 was successfully implemented. e.g.

One year of CNR-IMAA multi-wavelength Raman lidar measurements in coincidence with CALIPSO overpasses: Level 1 products comparison

L. Mona, G. Pappalardo, A. Amodeo, G. D'Amico, F. Madonna, A. Boselli, A. Giunta, F. Russo, and V. Cuomo

Consiglio Nazionale delle Ricerche – Istituto di Metodologie per l'Analisi Ambientale (CNR-IMAA), C. da S. Loja, 85050 Tito Scalo, Potenza, Italy

Received: 19 January 2009 – Published in Atmos. Chem. Phys. Discuss.: 31 March 2009
Revised: 29 August 2009 – Accepted: 4 September 2009 – Published: 29 September 2009

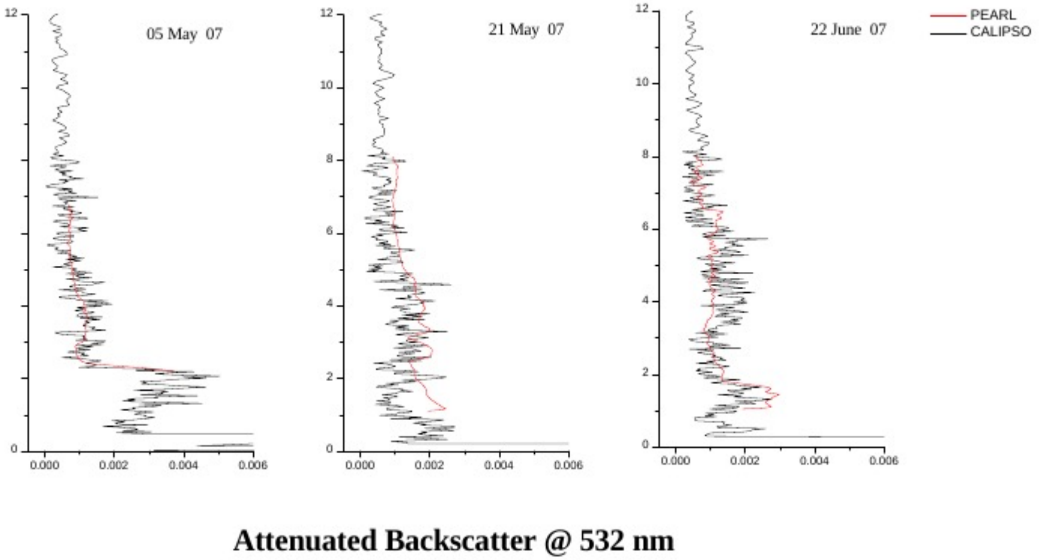
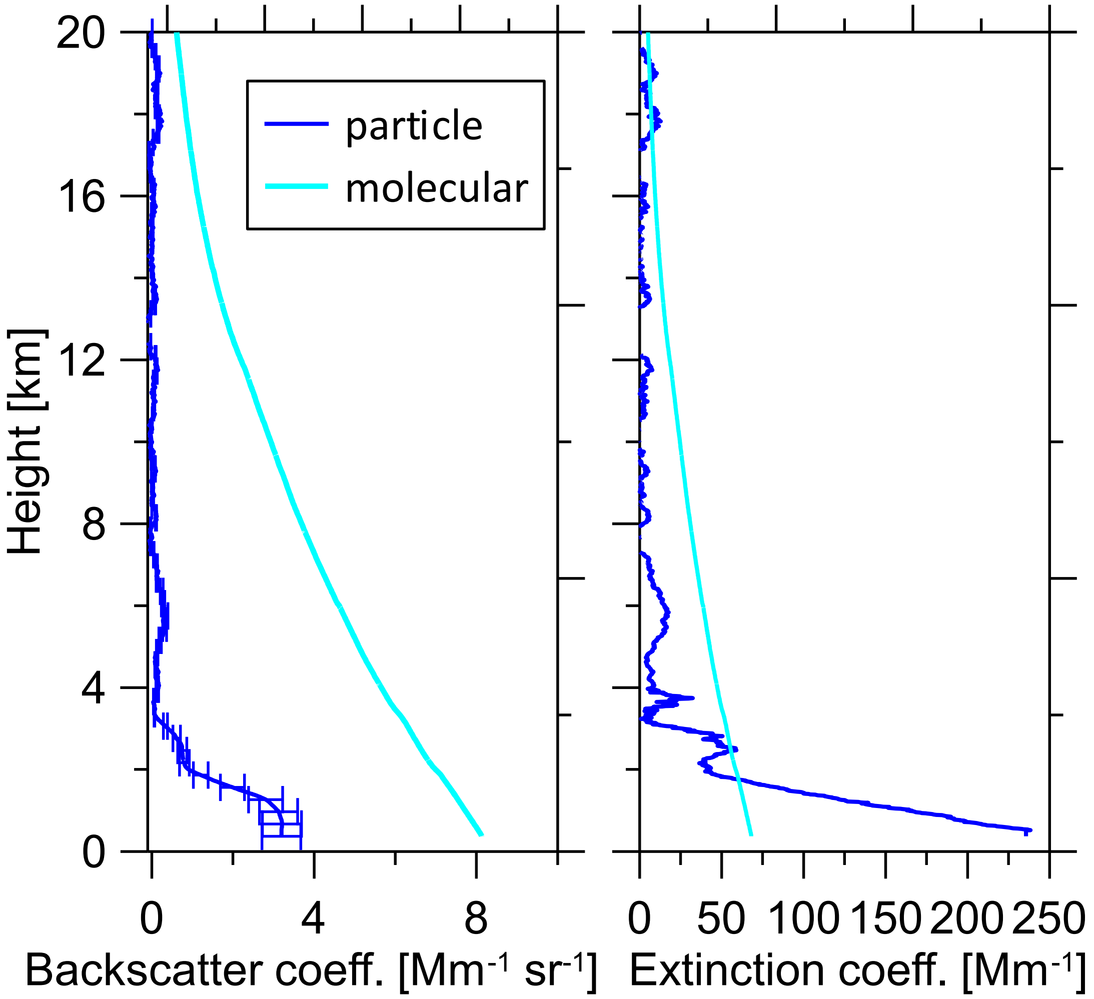


Fig. 9. CALIPSO attenuated backscatter at 532 nm (black lines) for all night-time cases of CALIPSO-PEARL correlative measurements in which no cirrus clouds are detected by CALIPSO. The corresponding PEARL CLAB at 532 nm are reported as red lines. CALIPSO profiles are obtained with 5 km as horizontal resolution. PEARL profiles are averaged over 30 min centered on the CALIPSO overpass of CNR-IMAA.

For UV systems the need is even more obvious !

Example at 355 nm

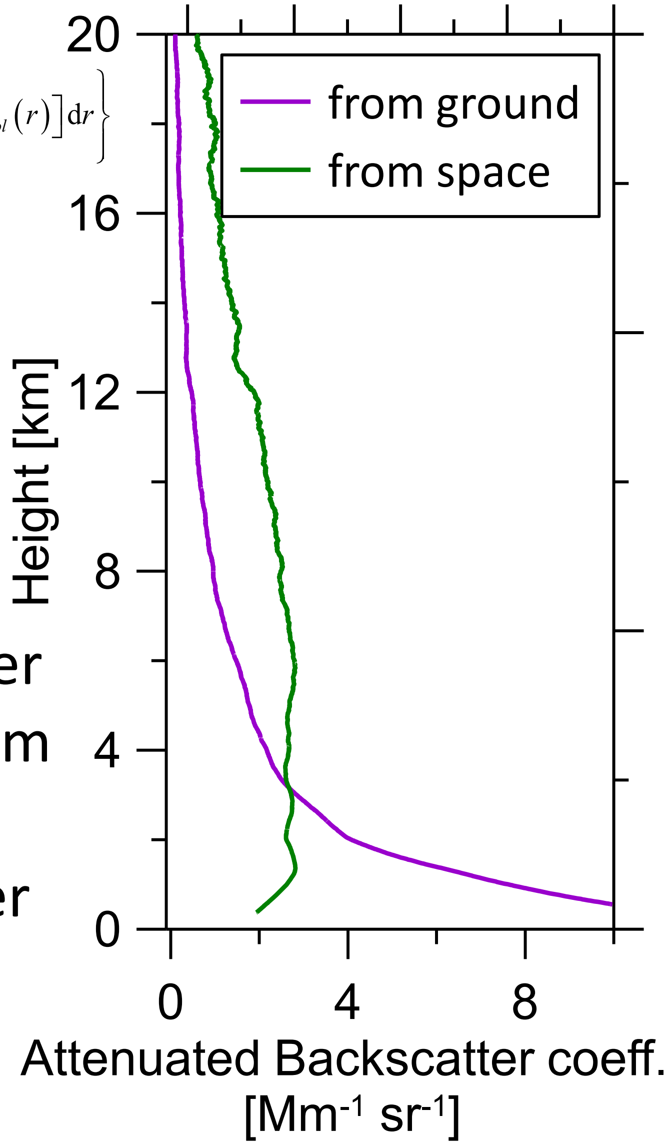
PollyXT_TROPOS; Leipzig, Germany,
27 March 2020. 1830-1930 UTC



$$P^{\lambda}(z)=\frac{C^{\lambda}_{sys}O^{\lambda}(z)}{z^2}\left[\beta^{\lambda}_{par}(z)+\beta^{\lambda}_{mol}(z)\right]\exp\left\{-2\int_{z_1}^{z_2}\left[\alpha^{\lambda}_{par}(r)+\alpha^{\lambda}_{mol}(r)\right]\mathrm{d}r\right\}$$

from ground: z1=0 km
from space: z1= 20 km

With measured backscatter and extinction profiles from ground one can calculate the attenuated backscatter from space!



Validation of the attenuated backscatter

Some thoughts

Leibniz Association

TROPOS
Leibniz Institute for Tropospheric Research

The attenuated backscatter coefficient

$$\beta^{\lambda}_{\mathrm{attn}} = \left(\beta^{\lambda}_{\mathrm{mol}} + \beta^{\lambda}_{\mathrm{par}}\right) \exp\left[-2\int_{z_1}^{z_2} \alpha^{\lambda}_{\mathrm{mol}} + \alpha^{\lambda}_{\mathrm{par}} \, \mathrm{d}z\right]$$

- Is not the same from space and from ground
- attenuation can not be neglected at 355 nm
- Is a EarthCARE L1 product

The lidar equation

$$\mathrm{P}^{\lambda}(z) = \frac{\mathrm{C}^{\lambda}_{\mathrm{sys}} O^{\lambda}(z)}{z^2}\left[\beta^{\lambda}_{par}(z) + \beta^{\lambda}_{mol}(z)\right] \exp\left\{-2\int_{z_1}^{z_2}\left[\alpha^{\lambda}_{par}(r) + \alpha^{\lambda}_{mol}(r)\right]\mathrm{d}r\right\}$$

$$\Rightarrow \quad \mathrm{P}^{\lambda}(z) = \frac{\mathrm{C}^{\lambda}_{\mathrm{sys}} O^{\lambda}(z)}{z^2}\beta^{\lambda}_{attn}$$

O=1

$$\beta^{\lambda}_{attn} = \frac{\mathrm{P}^{\lambda}(z)\, z^2}{\mathrm{C}^{\lambda}_{\mathrm{sys}}}$$

(Level 1)

The attenuated backscatter coefficient

$$\beta^{\lambda}_{\mathrm{attn}} = \left(\beta^{\lambda}_{\mathrm{mol}} + \beta^{\lambda}_{\mathrm{par}}\right)\exp\left[-2\int_{z_1}^{z_2} \alpha^{\lambda}_{\mathrm{mol}} + \alpha^{\lambda}_{\mathrm{par}}\,\mathrm{d}z\right]$$

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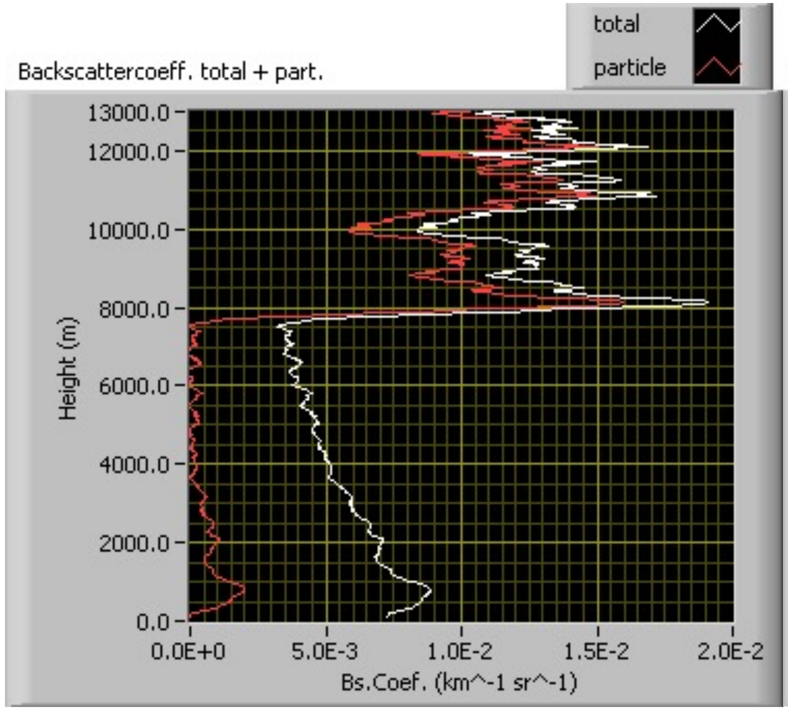
$$\Rightarrow \mathrm{P}^{\lambda}(z) = \frac{\mathrm{C}^{\lambda}_{\mathrm{sys}} O^{\lambda}(z)}{z^2}\beta^{\lambda}_{attn}$$

O=1 ⇒

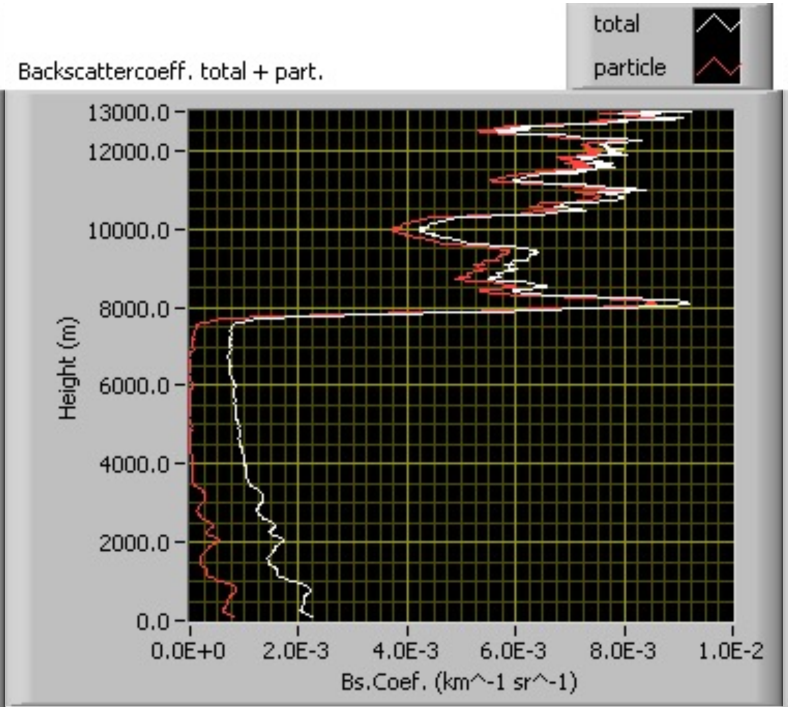
$$\beta^{\lambda}_{attn} = \frac{\mathrm{P}^{\lambda}(z)\,z^2}{\mathrm{C}^{\lambda}_{\mathrm{sys}}}$$ (Level 1)

TROPOS

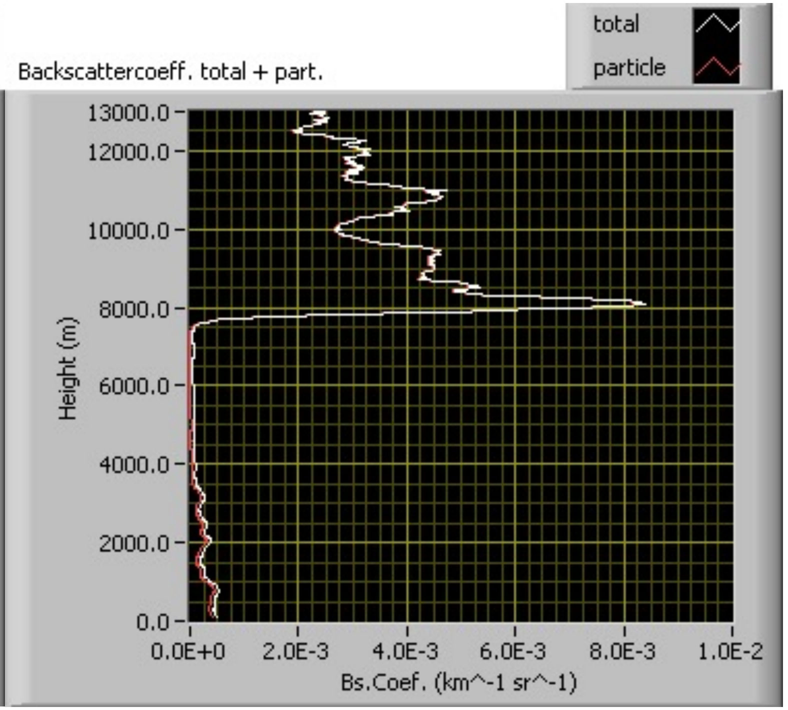
Molecular influence and attenuation
Attenuated backscatter from ground at 3 wavelengths



355nm



532nm



1064nm

$$\beta_{attn}^{\lambda} = \frac{P^{\lambda}(z)\, z^2}{C_{sys}^{\lambda}}$$

1064 nm →

$\beta_{attn}^{\lambda} \approx \beta_{par}^{\lambda}$ @1064 nm

$\beta_{attn}^{\lambda} \neq \beta_{par}^{\lambda}$ @355 nm

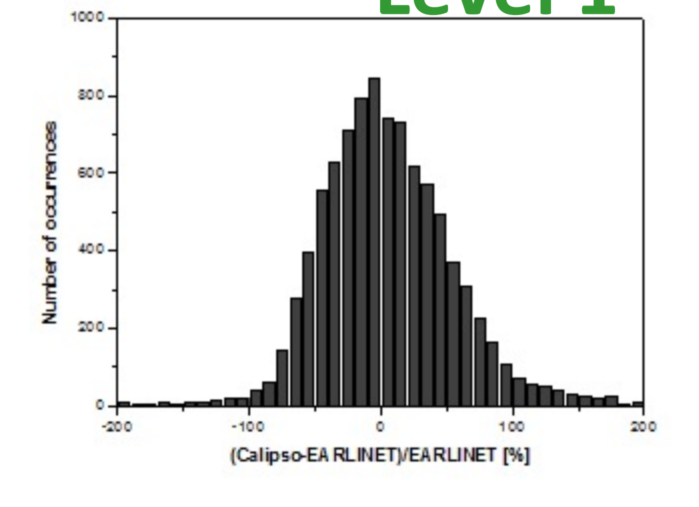
But for shorter wavelengths attenuation need to be taken into account

Level 1 –2 data comparisons

Methodology developed for retrieving CALIPSO-like Level1 data from ground-based elastic/Raman technique ***Mona et al., 2009 ACP***

Systematic comparison: absence of biases and main problems in CALIPSO detected signals ***Pappalardo et al., 2010 JGR***

Level 1



CALIPSO Level 2 data generally perform well both in terms of optical profiles and layer identification.

Level 2

Some critical points:

- **cloud-aerosol discrimination**
- **lidar ratio assumptions**
- **multiple scattering for aerosol below cirrus and large dust particles**

Courtesy Lucia Mona