

# 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 !

The screenshot shows the HDFView 2.13 interface. The top menu bar includes File, Window, Tools, and Help. Below the menu is a toolbar with icons for file operations. The main window is divided into a file tree on the left and a data table on the right. The file tree lists various datasets, with 'mie\_attenuated\_backscatter' selected. The data table displays a grid of numerical values for the selected dataset. The status bar at the bottom provides metadata for the selected dataset.

	0	1	2	3	
0	1.0831153...	-4.0877303...	-4.4859913...	8.5471875...	-1.739...
1	-5.2982188...	-9.391631E-8	1.7869428...	3.9822194...	1.423...
2	-5.613934E-8	-1.1127859...	-1.5132521...	-2.1410258...	-1.673...
3	-2.062543E-7	-3.6923979...	-1.580478E-8	1.4114934...	2.348...
4	1.777457E-7	-1.8627476...	-8.906252E-8	1.8345636...	-1.082...
5	-4.2178833...	2.7638846...	1.4357241...	-9.8242054...	1.001...
6	-1.3546992...	-1.0390831...	2.8851733...	-3.4556805...	8.449...
7	1.2678214...	7.4088014...	-2.6988374...	-6.0889874...	1.900...
8	-1.1681914...	1.7474315...	-4.890057E-8	-2.749412E-7	5.793...
9	-4.2080554...	6.3003355...	-6.696873E-8	-5.762025E-8	1.383...
10	4.4929402...	8.748464E-8	6.127386E-8	-1.7340129...	2.836...
11	8.474373E-8	9.732423E-8	-2.7503933...	2.0591294...	1.679...
12	1.1881518...	-6.59185E-8	-2.9924003...	3.2795904...	-4.883...
13	1.5489726...	-5.0752984...	2.494301E-7	-1.6175021...	5.302...
14	1.6821828...	6.521482E-8	1.2363184...	-1.0431583...	4.238...
15	-1.3542892...	-7.597779E-8	-2.551226E-8	-2.3753007...	4.108...
16	-2.0841762...	2.0438928...	-1.6171866...	-1.4206735...	-1.192...
17	1.5650285...	-5.96632E-8	-3.463616E-7	-1.981584E-7	4.862...
18	-6.8922986...	1.4225861...	-1.6398438...	-9.467181E-8	-1.204...
19	1.6584973...	-5.338143E-8	2.582969E-7	1.6318378...	-8.259...
20	1.7444992...	-7.024769E-8	7.5135354...	-1.0539899...	-5.607...
21	-6.46438E-8	2.3424332...	4.581508E-8	2.0466209...	-8.131...
22	-1.4321738...	5.9498298...	2.716927E-7	3.1230155...	-3.086...
23	1.9012379...	-1.8153673...	-1.1071547...	2.633491E-7	-8.736...
24	-6.952584E-8	-1.345379E-7	-1.7797977...	-4.2373085...	-1.754...
25	1.5094356...	-1.6315263...	1.6313966...	-1.3738783...	-6.016...
26	-6.6192406...	1.9521545...	-1.586808E-7	4.608751E-8	1.357...

mie\_attenuated\_backscatter (17622, 2)  
32-bit floating-point, 22559 x 254  
Number of attributes = 3  
DIMENSION\_LIST = 1-566,1-1158  
long\_name = Mie co-polar channel attenuated backscatter  
units = m-1 sr-1

# 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) ?

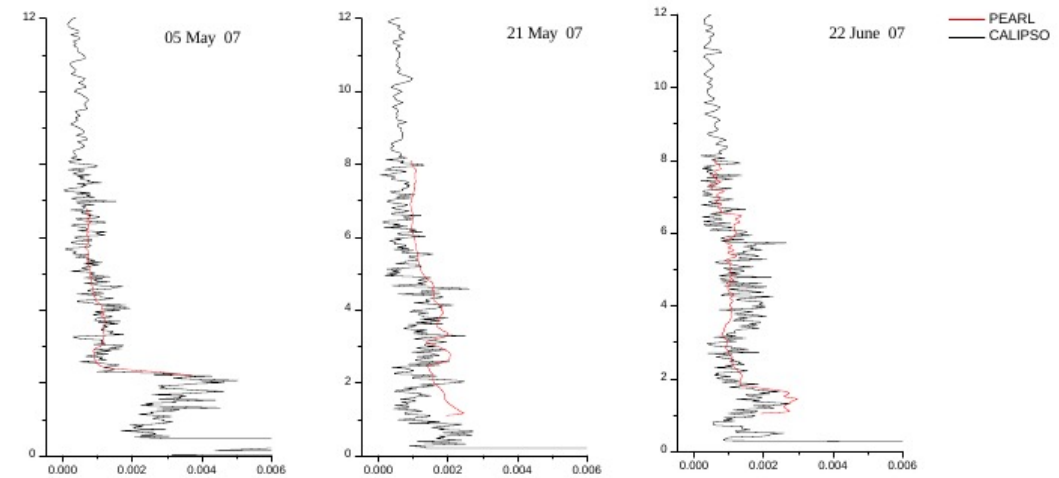
- Validation of Rayleigh Calibration
  - ATLID L1 will come with T and P (via ECMWF) fields. Are these good enough ? Would the use of local Radiosondes (not assimilated by the ECMWF) be useful?
- Common, lidar specific standards for Cal/Val purposes, e.g. well calibrated depolarization measurements including 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 Scalco, 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



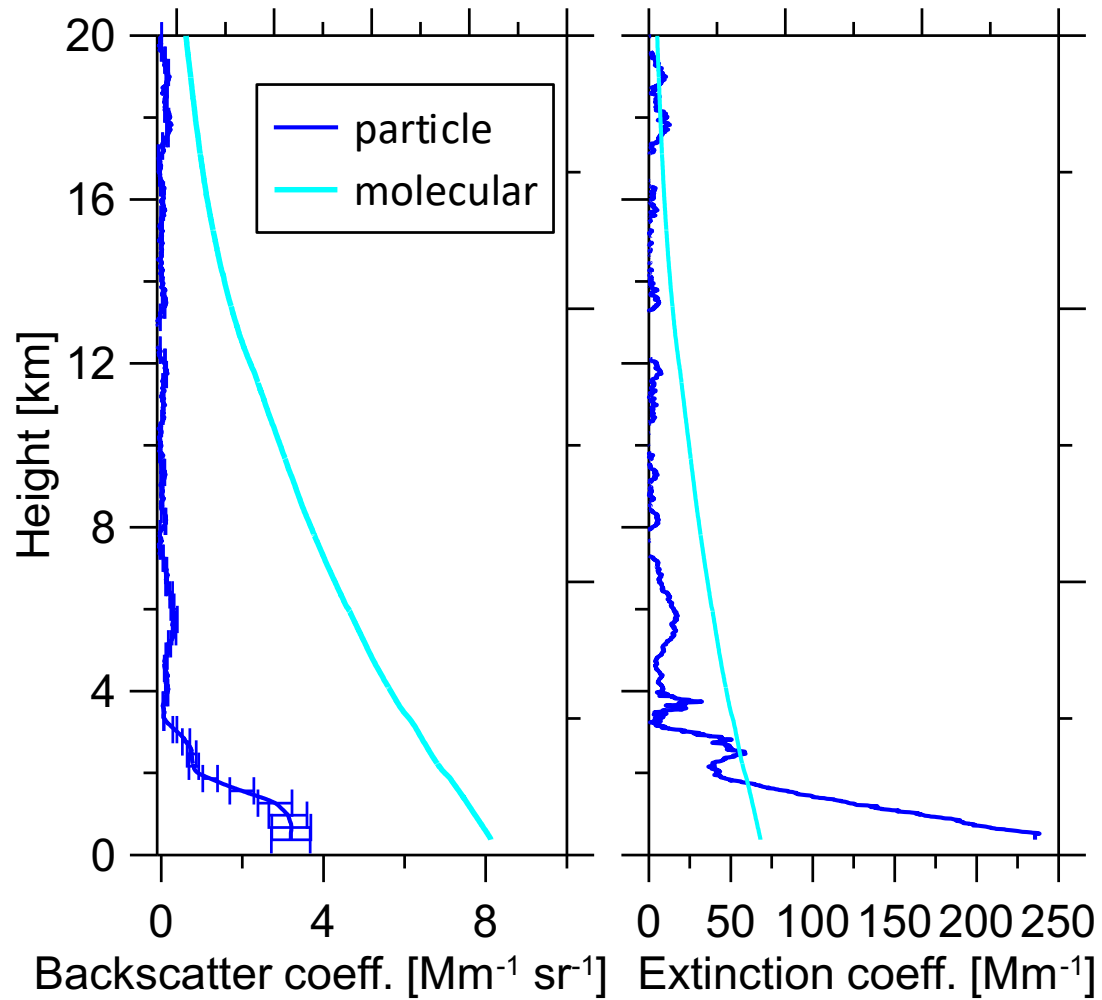
**Attenuated Backscatter @ 532 nm**

**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

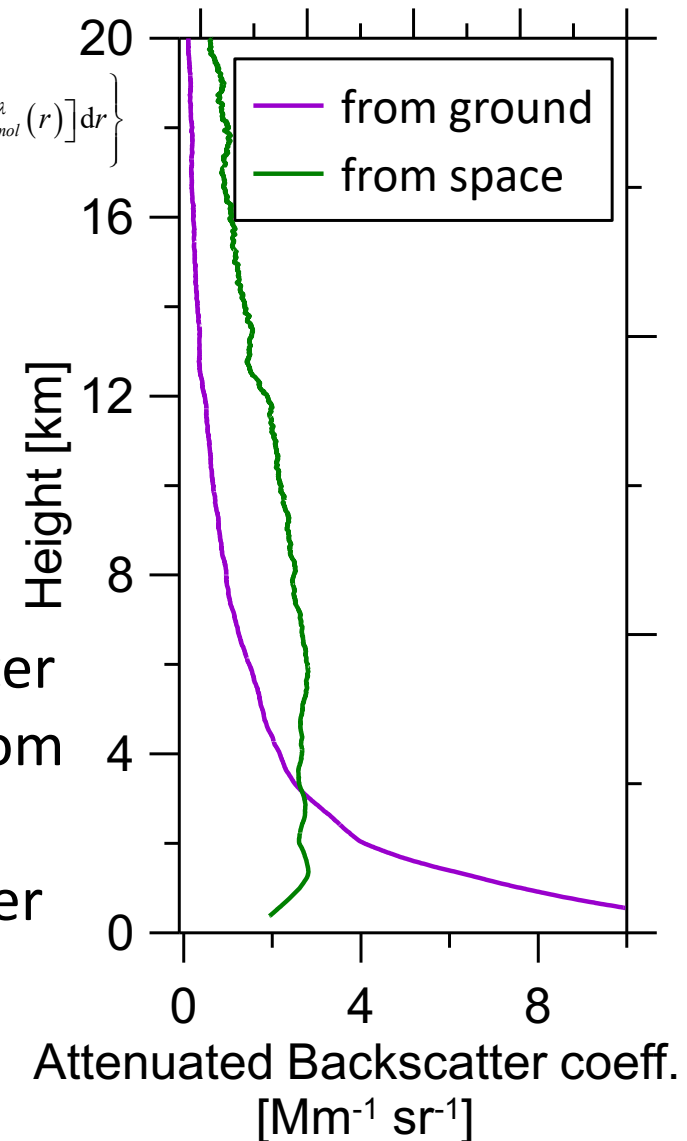
PollyXT\_TROPOS; Leipzig, Germany,  
27 March 2020. 1830-1930 UTC



$$P^\lambda(z) = \frac{C_{\text{sys}}^\lambda O^\lambda(z)}{z^2} [\beta_{\text{par}}^\lambda(z) + \beta_{\text{mol}}^\lambda(z)] \exp \left\{ -2 \int_{z_1}^{z_2} [\alpha_{\text{par}}^\lambda(r) + \alpha_{\text{mol}}^\lambda(r)] dr \right\}$$

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

# The attenuated backscatter coefficient

$$\beta_{\text{attn}}^{\lambda} = (\beta_{\text{mol}}^{\lambda} + \beta_{\text{par}}^{\lambda}) \exp \left[ -2 \int_{z_1}^{z_2} \alpha_{\text{mol}}^{\lambda} + \alpha_{\text{par}}^{\lambda} dz \right]$$

- 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

$$P^{\lambda}(z) = \frac{C_{\text{sys}}^{\lambda} O^{\lambda}(z)}{z^2} \left[ \beta_{\text{par}}^{\lambda}(z) + \beta_{\text{mol}}^{\lambda}(z) \right] \exp \left\{ -2 \int_{z_1}^{z_2} \left[ \alpha_{\text{par}}^{\lambda}(r) + \alpha_{\text{mol}}^{\lambda}(r) \right] dr \right\}$$

$$\begin{array}{c} \text{Blue Arrow} \end{array} P^{\lambda}(z) = \frac{C_{\text{sys}}^{\lambda} O^{\lambda}(z)}{z^2} \beta_{\text{attn}}^{\lambda} \quad \begin{array}{c} \text{Blue Arrow} \\ O=1 \end{array} \quad \beta_{\text{attn}}^{\lambda} = \frac{P^{\lambda}(z) z^2}{C_{\text{sys}}^{\lambda}} \quad (\text{Level 1})$$



# The attenuated backscatter coefficient

$$\beta_{\text{attn}}^{\lambda} = \left( \beta_{\text{mol}}^{\lambda} + \beta_{\text{par}}^{\lambda} \right) \exp \left[ -2 \int_{z_1}^{z_2} \alpha_{\text{mol}}^{\lambda} + \alpha_{\text{par}}^{\lambda} dz \right]$$

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

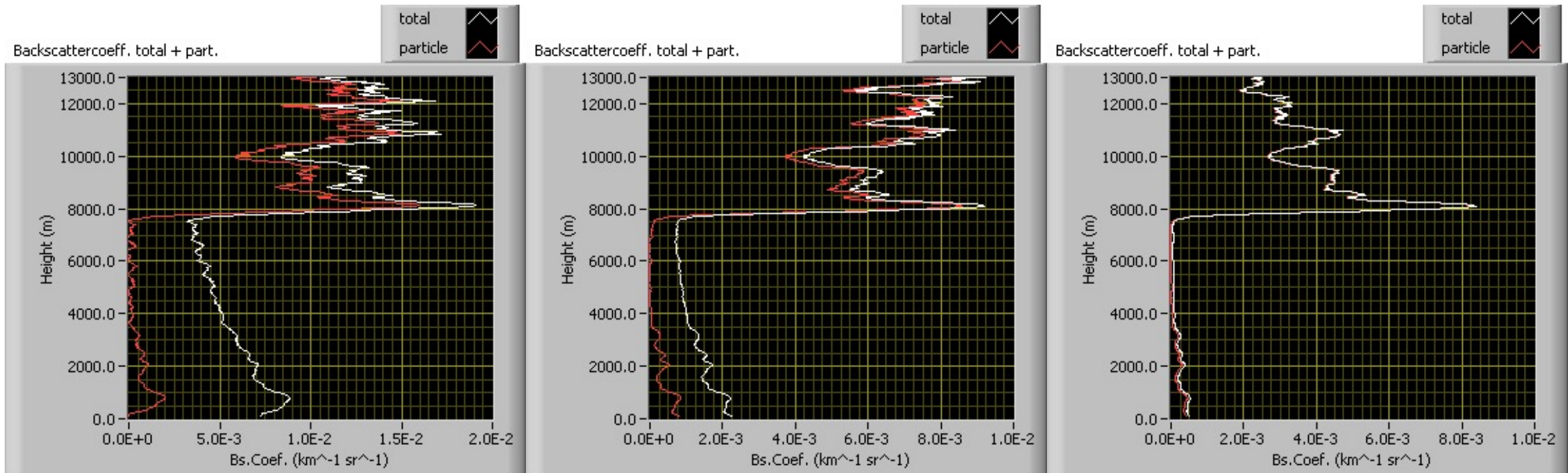
## The lidar equation

$$P^{\lambda}(z) = \frac{C_{\text{sys}}^{\lambda} O^{\lambda}(z)}{z^2} \left[ \beta_{\text{par}}^{\lambda}(z) + \beta_{\text{mol}}^{\lambda}(z) \right] \exp \left\{ -2 \int_{z_1}^{z_2} \left[ \alpha_{\text{par}}^{\lambda}(r) + \alpha_{\text{mol}}^{\lambda}(r) \right] dr \right\}$$

  $P^{\lambda}(z) = \frac{C_{\text{sys}}^{\lambda} O^{\lambda}(z)}{z^2} \beta_{\text{attn}}^{\lambda}$    $\beta_{\text{attn}}^{\lambda} = \frac{P^{\lambda}(z) z^2}{C_{\text{sys}}^{\lambda}}$  (Level 1)

# 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

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

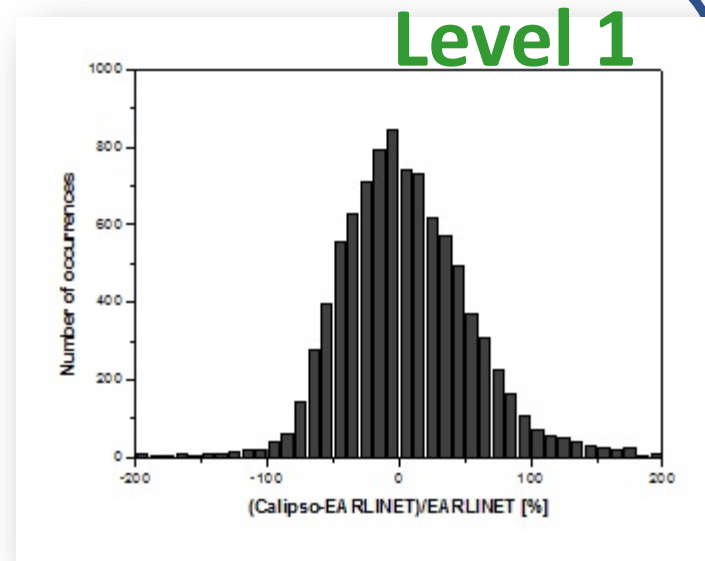
$$\beta_{attn}^{\lambda} \neq \beta_{par}^{\lambda} \text{ @355 nm}$$

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*



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

**Some critical points:**

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

**Level 2**