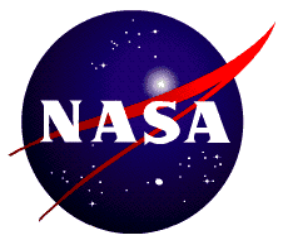


CALIPSO: Version 3 Update and Recent Developments

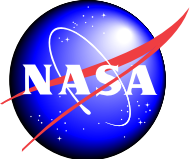


***Dave Winker
and***

***Mark Vaughan, Ali Omar, Zhaoyan Liu,
Yongxiang Hu, Brian Getzewich, Ray Rogers
and Jason Tackett***



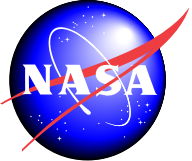
- Summary
- **Version 3 data has many improvements, please use it**



CALIOP Version 3 vs. Version 2: Top 10



- 1. Daytime 532 calibration improved**
 - Better aerosol detection, increases AOD
 - Still issues with 1064 calibration → beware of 1064 retrievals
- 2. Bug in boundary layer cloud-clearing fixed**
 - Reduces fraction of low cloud in 5-km cloud layer product
 - Increases frequency of aerosol within boundary layer
- 3. New CAD algorithm**
 - Improved identification of dense dust
 - Removes artificial identification of high latitude depolarizing layers as cirrus
- 4. Aerosol base identification improved**
 - retrievals now extend to surface more often
- 5. Aerosol and cloud profile products restructured**
- 6. Uncertainty parameters included**
- 7. More realistic lidar ratios for dust (1064) and polluted dust**
- 8. Technical changes with significant impacts:**
 - Fixed logic flaw in CAD_Score
 - Fixed bug in surface identification
 - Improved method of classifying and reporting opaque cloud/aerosol layers
- 9. New cloud ice/water phase algorithm, new cloud Ice Water Content**
- 10. CALIPSO website: new browse images (aerosol, cloud type)**

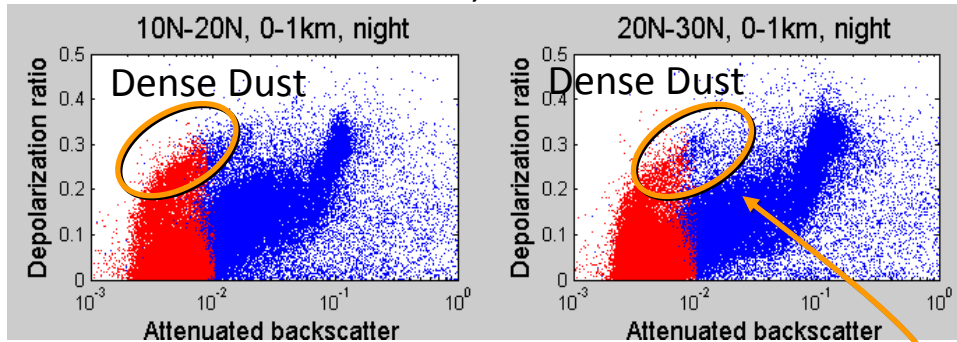


New CAD algorithm adds depolarization, lat-dependence



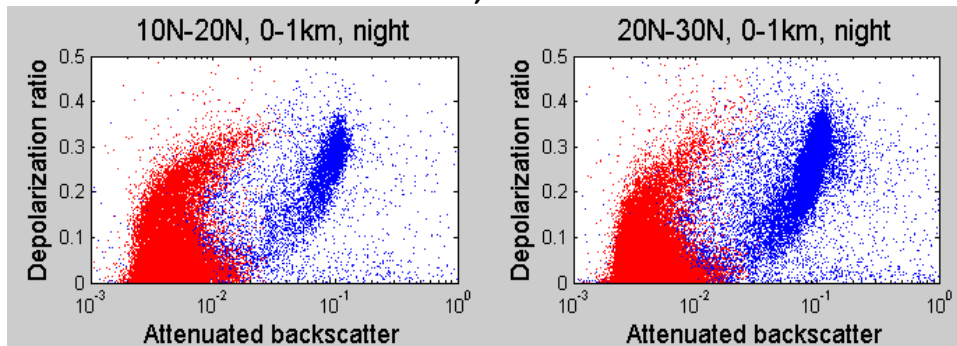
Separation between cloud and aerosol
& dust classification improved in V3

3D, V2.01



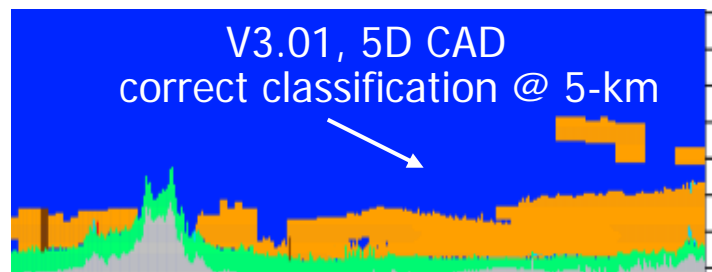
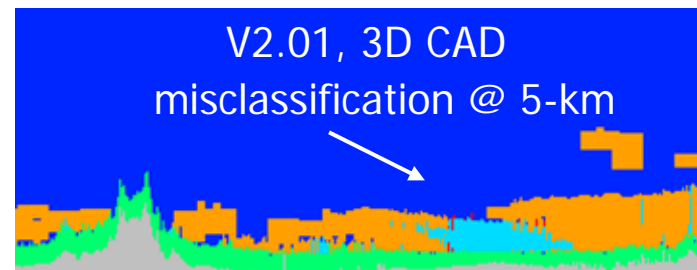
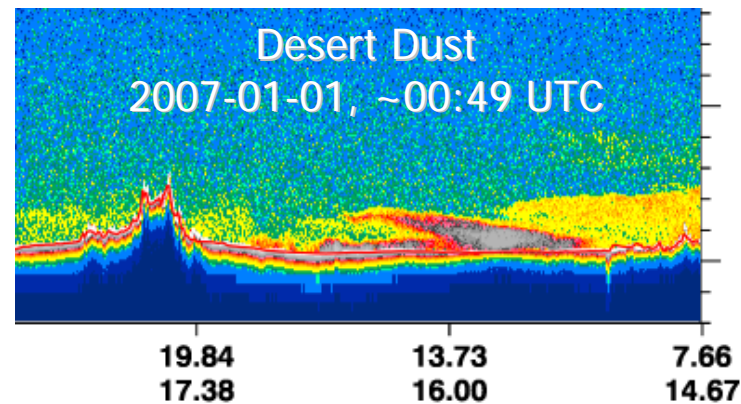
"Continuum" due to cloud-clearing bug

5D, v3

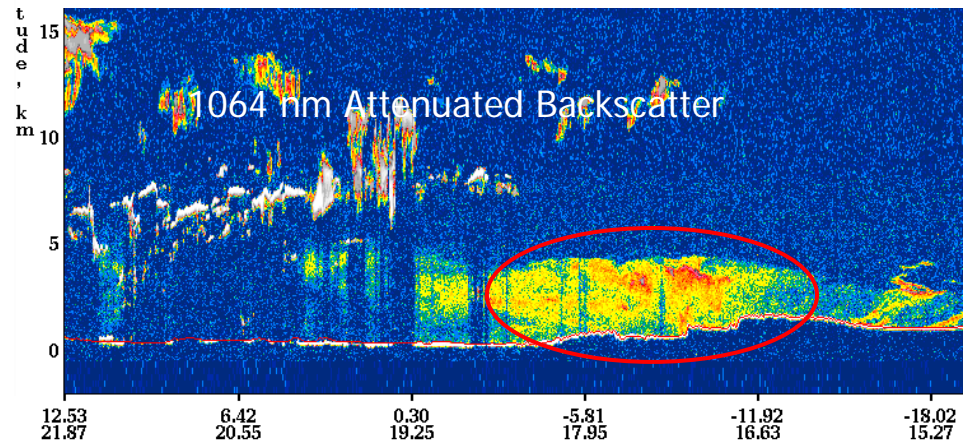
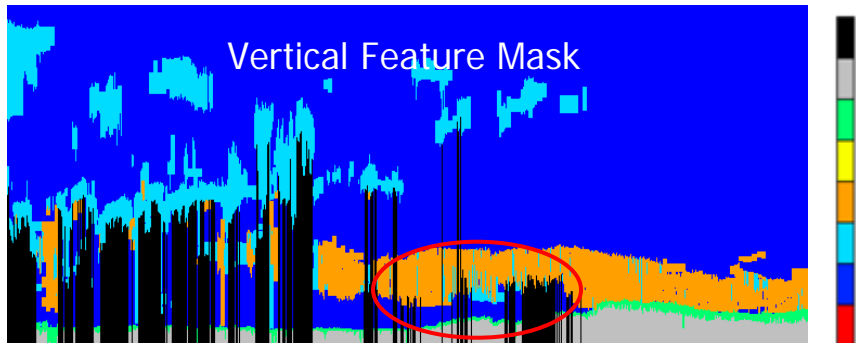
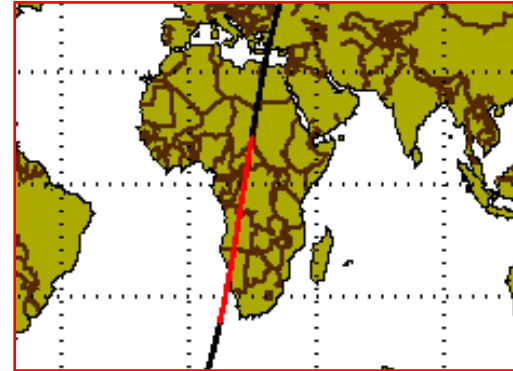
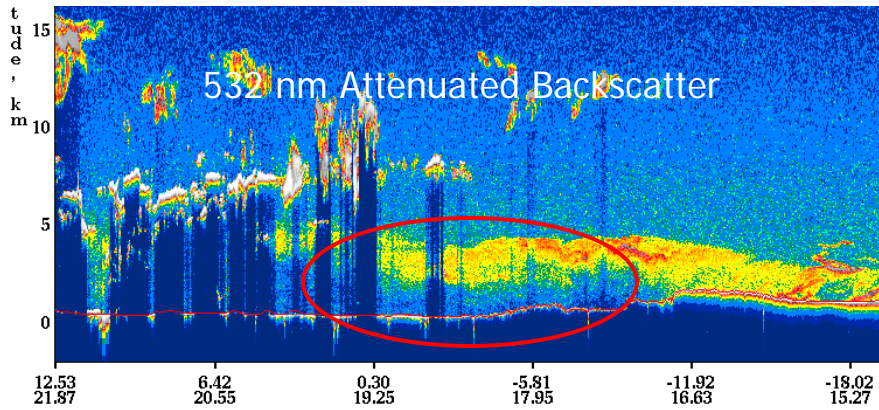


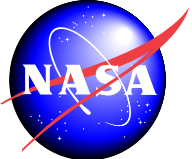
↑
depol

backscatter →



V2 Aerosol base detection sometimes too high



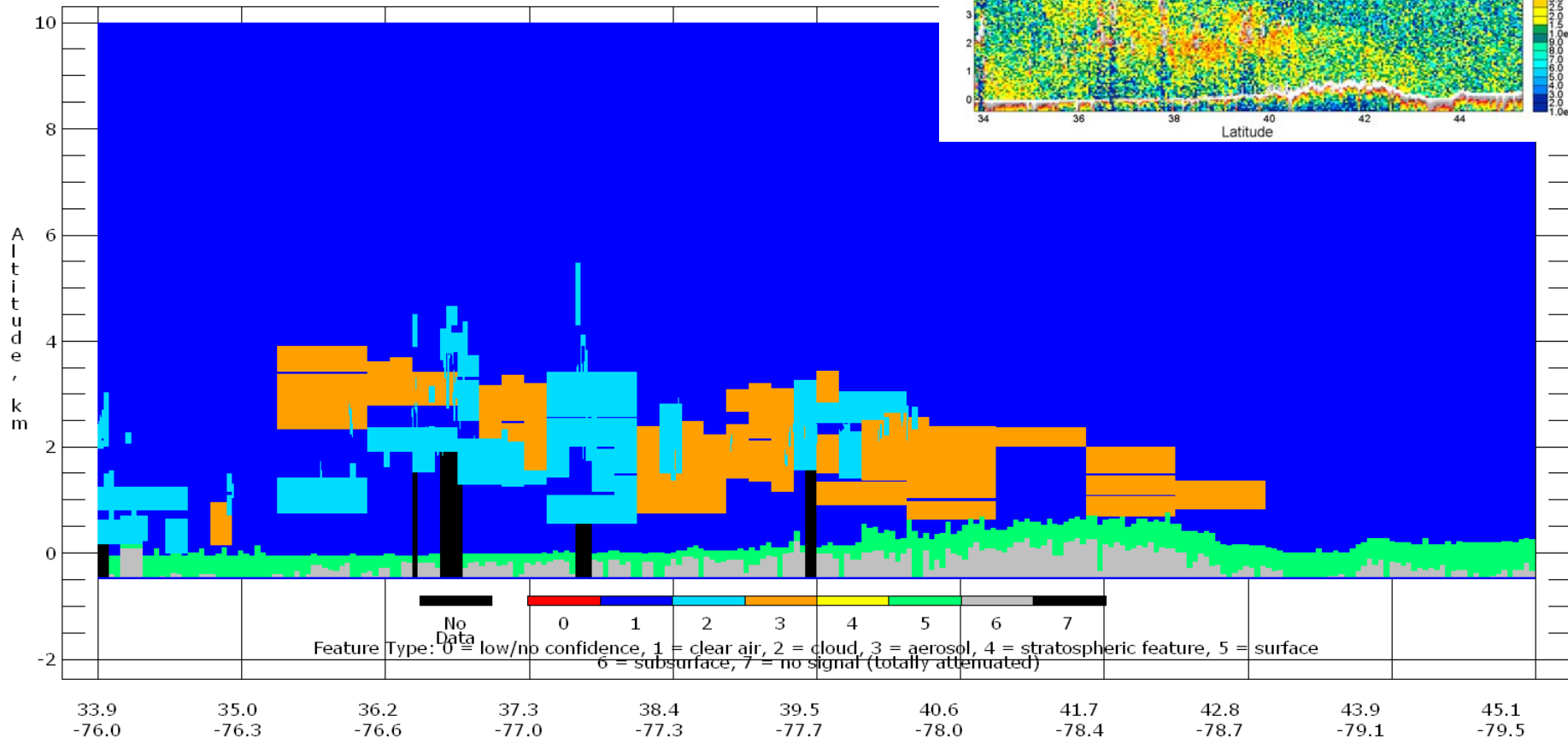
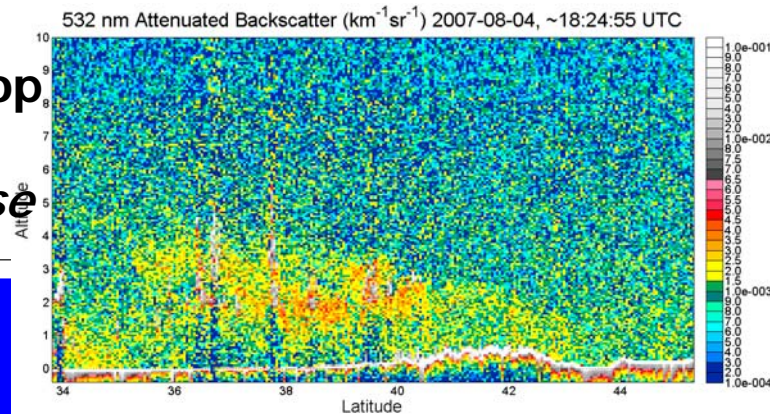


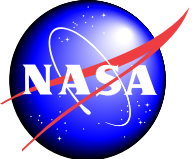
Boundary layer improvements



VERSION 2

software bug in low-altitude cloud-clearing loop
aerosol base detection not always good
extinction only retrieved between top and base





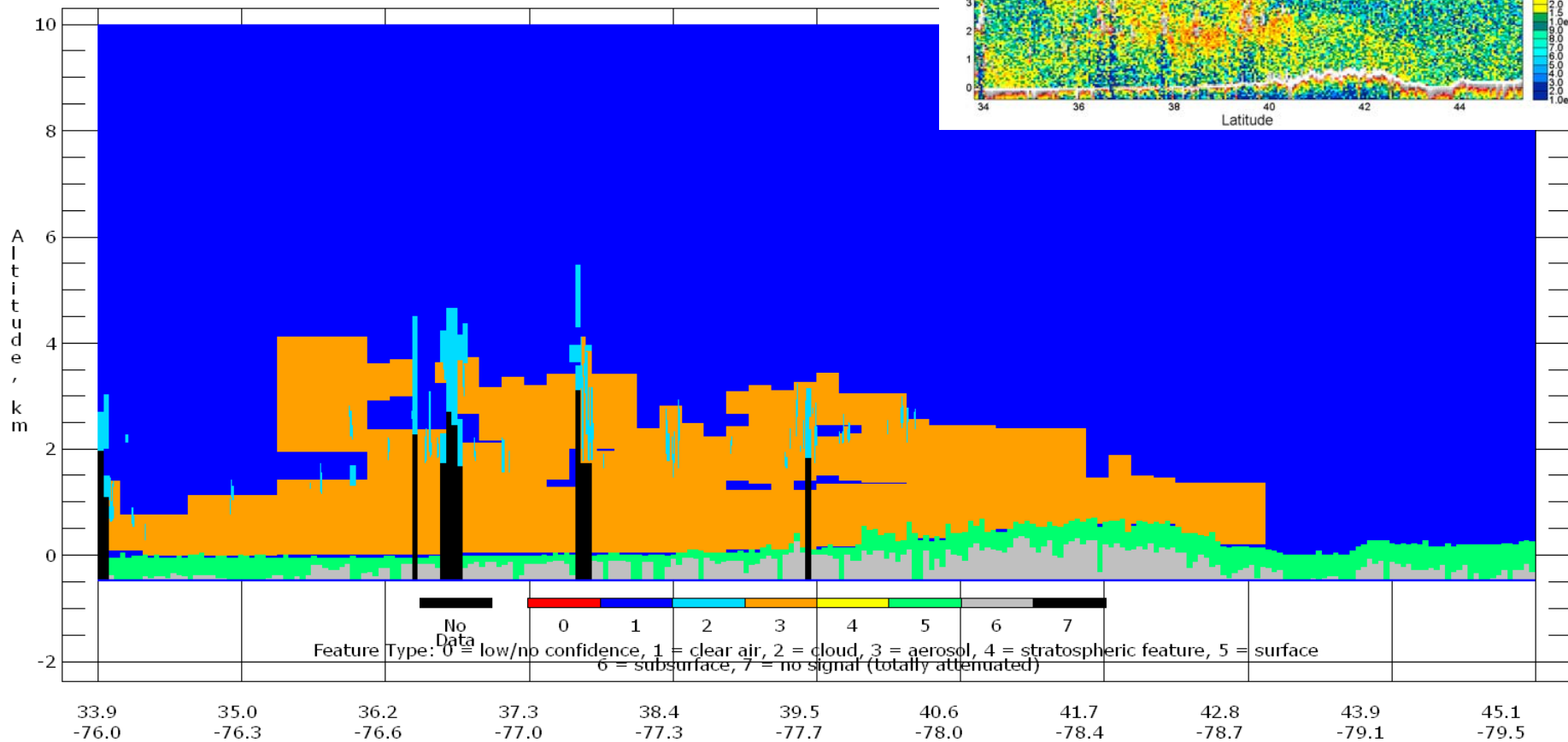
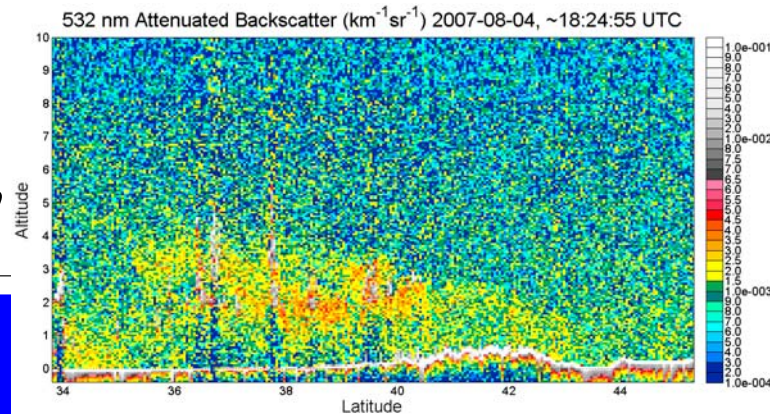
Improved Aerosol Base Detection



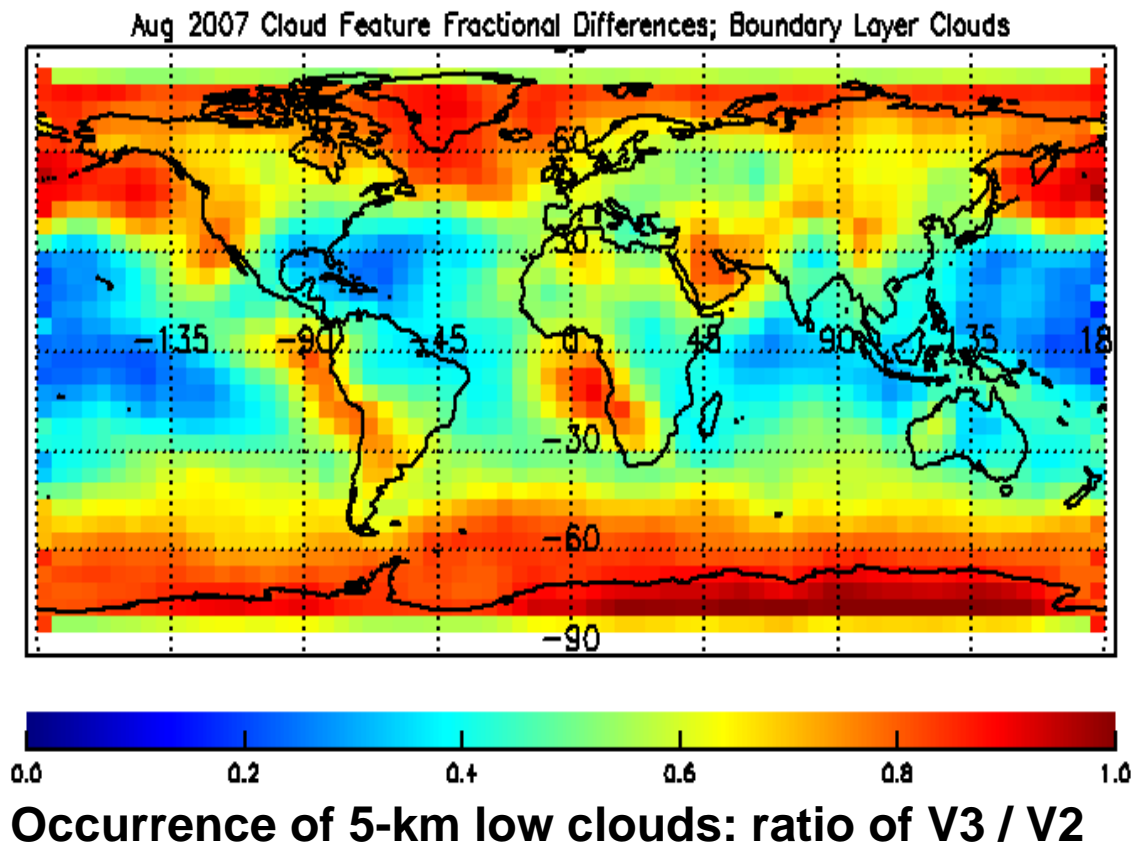
VERSION 3.01

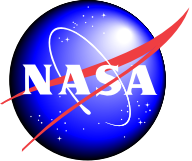
cloud-clearing bug fixed
improved aerosol bases

→ *increases AOD, near-surface extinction*



- Result of fixing the low-altitude cloud-clearing bug is to decrease the cloud fraction of low cloud reported in the 5-km product
- Biggest effects in low latitude oceans
- No effect on 1/3- and 1-km cloud products

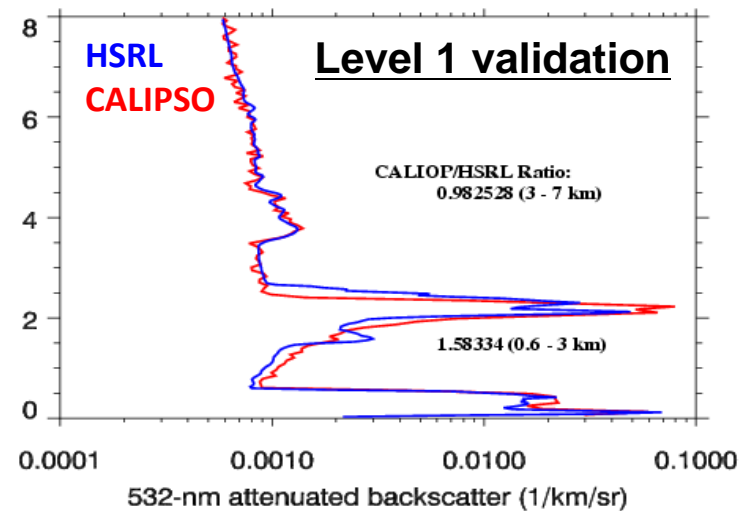
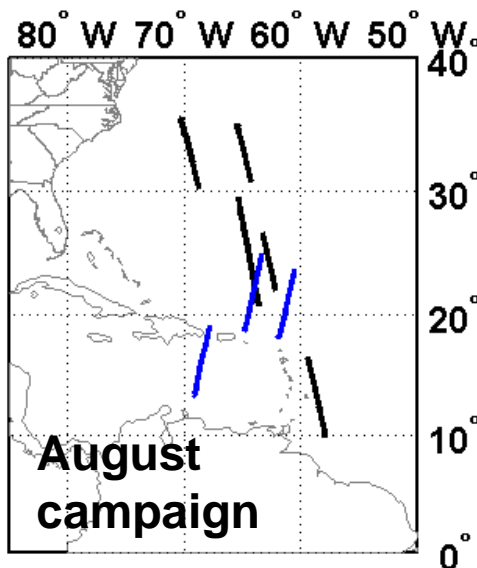
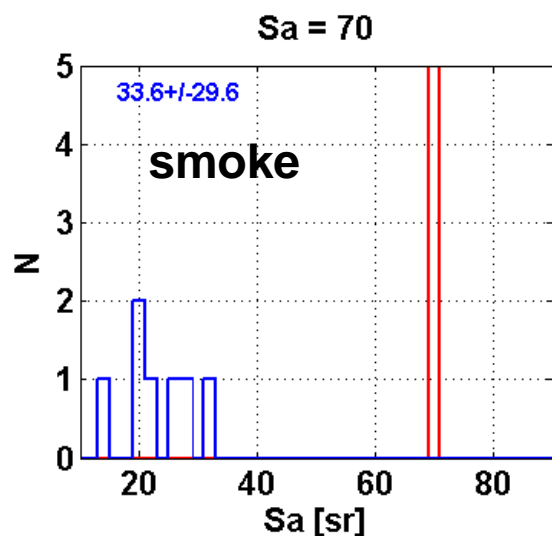
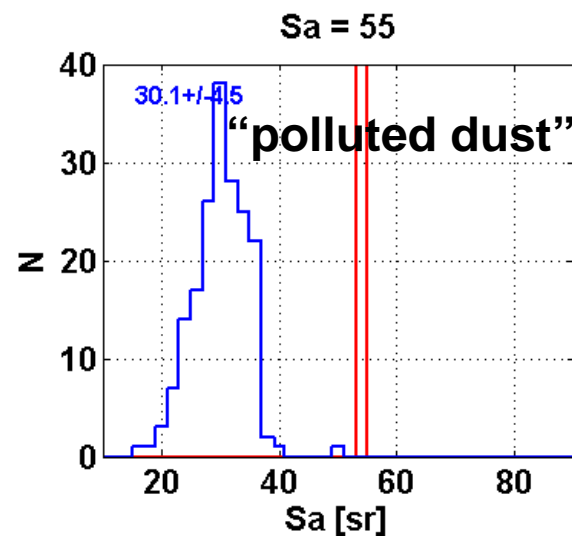
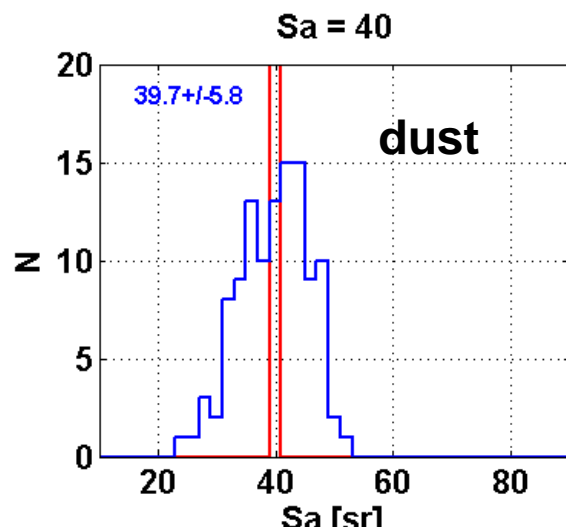
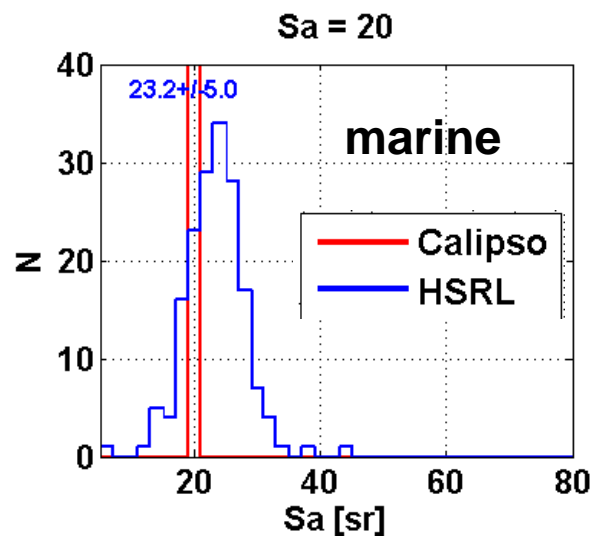


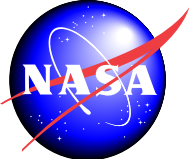


S_a comparisons from August 2010 campaign



From co-located HSRL-CALIOP measurements
(HSRL observations partitioned according to CALIOP aerosol typing)





Restructured Profile Products



Version 2:

Profiles of aerosol and cloud 532 and 1064 extinction and backscatter only

Aerosol profiles reported at 40 km, clouds at 5 km

Version 3:

Both aerosol and cloud profile products now retrieved at 5-20-80 km and reported at 5-km horizontal resolution

Additional profiles:

532 nm perpendicular backscatter and particle depolarization

Atmospheric Volume Description (cloud/aerosol/clear etc.)

Cloud fraction

Uncertainties now included for most parameters

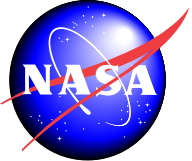
Added column parameters

Column optical depth: cloud, aerosol, stratosphere

Column integrated attenuated backscatter (IAB)

Added data quality information

CAD score, Ext_QC flag, Feature type QA flags



Extinction Uncertainty Estimate



Uncertainty in Particulate Backscatter Coefficients at Altitude n

$$\frac{\sigma^2(\beta_{p,n})}{\beta_{p,n}^2} = A_n^2 \left(\left(\frac{\sigma^2(\chi_n)}{\chi_n^2} \right) + \left(\frac{1}{R_n} \right)^2 \left(\frac{\sigma^2(\beta_{m,n})}{\beta_{m,n}^2} \right) + (2\eta\tau_{p,n})^2 \left(\frac{\sigma^2(S)}{S^2} + \frac{\sigma^2(\eta)}{\eta^2} \right) + \left(\frac{\sigma^2(T_{p,n-1}^2)}{(T_{p,n-1}^2)^2} + B_n^2 \left(\frac{\sigma^2(\beta_{p,n-1})}{\beta_{p,n-1}^2} \right) \right) \right)$$

Measurement Uncertainty

Molecular Number Density Uncertainty

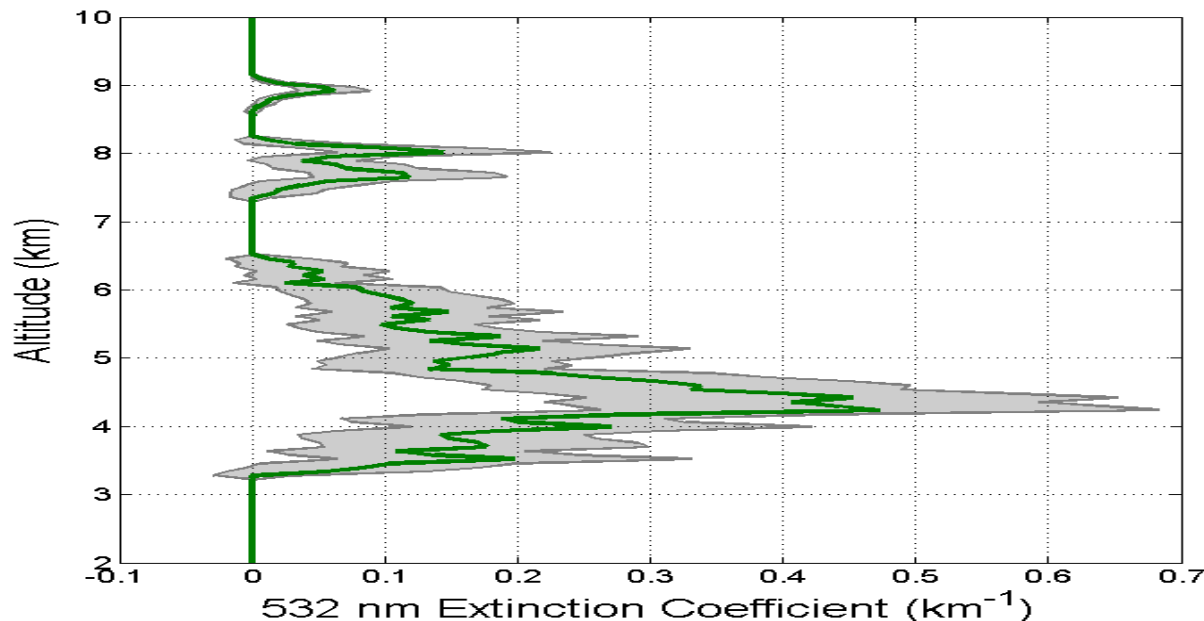
Lidar Ratio Uncertainty

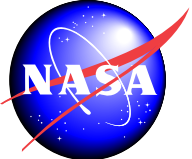
Multiple Scattering Uncertainty

Accumulated Aerosol Attenuation Uncertainty

Includes errors due to

- ⇨ Calibration
- ⇨ SNR
- ⇨ molecular density (again)
- ⇨ offset calculations
- ⇨ polarization gain ratio
- ⇨ polarization cross-talk
- ⇨ ranging



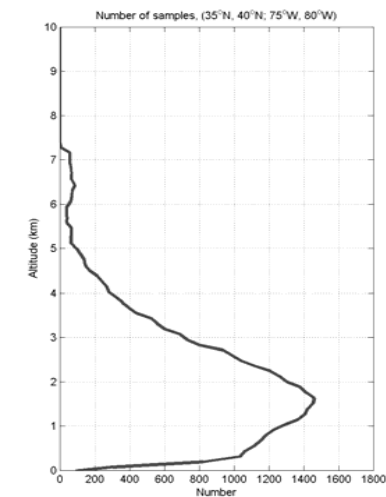
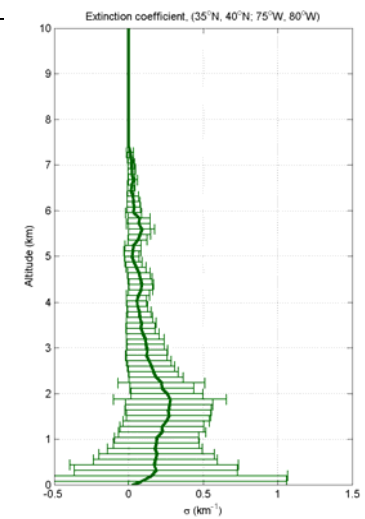
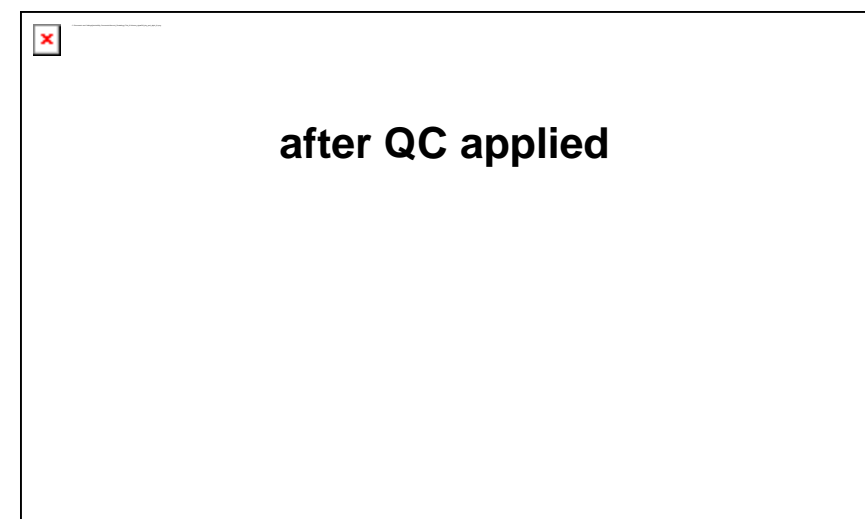
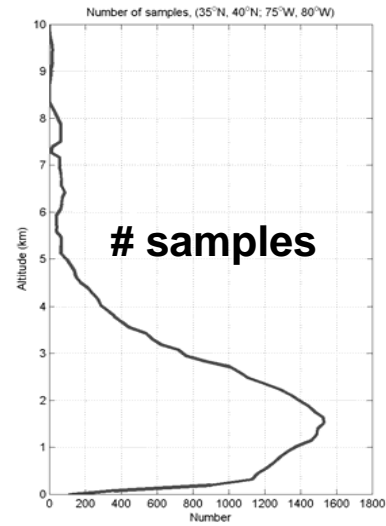
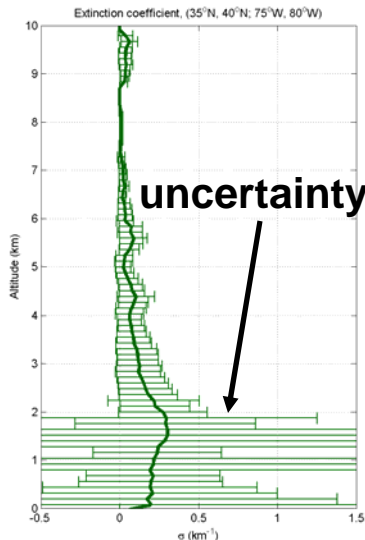
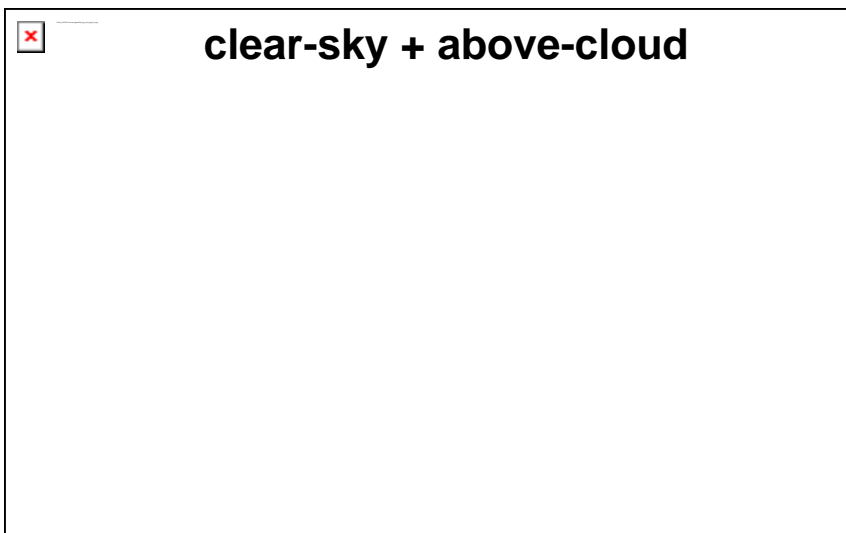


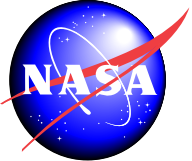
Aerosol Screening Criteria



CENTRE NATIONAL D'ETUDES SPATIALES

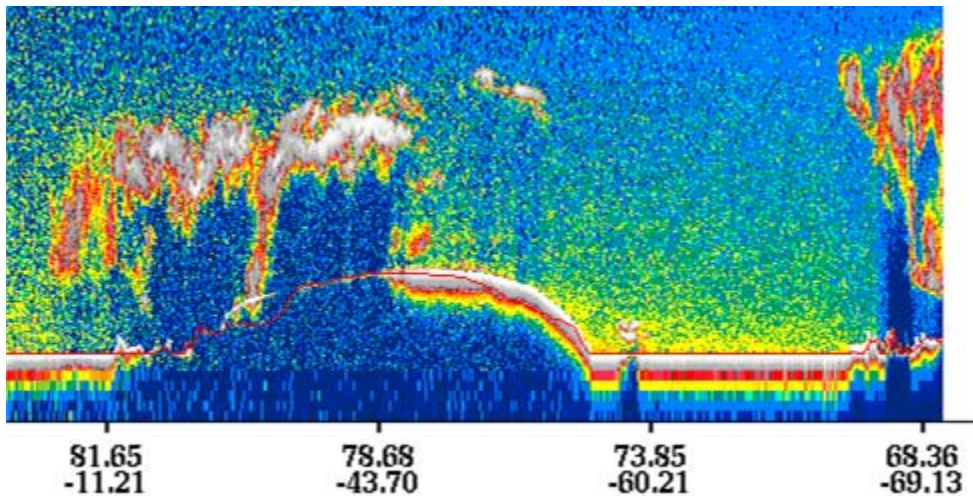
- **CAD_Score: quality flag for layer detection and cloud-aerosol classification**
 - not correlated to quality of extinction retrieval
- **Ext_QC: indicates the type of extinction retrieval and how successful it was**
- **Extinction uncertainty (profile)**
 - For aerosol, primarily driven by uncertainty in lidar ratio
 - Within a profile, uncertainty tends to be systematic, not random
- **Artifacts from thin cirrus**
- **Note: extinction under cloud is more uncertain than above**
 - Uncertainty increases as OD of overlying cloud increases



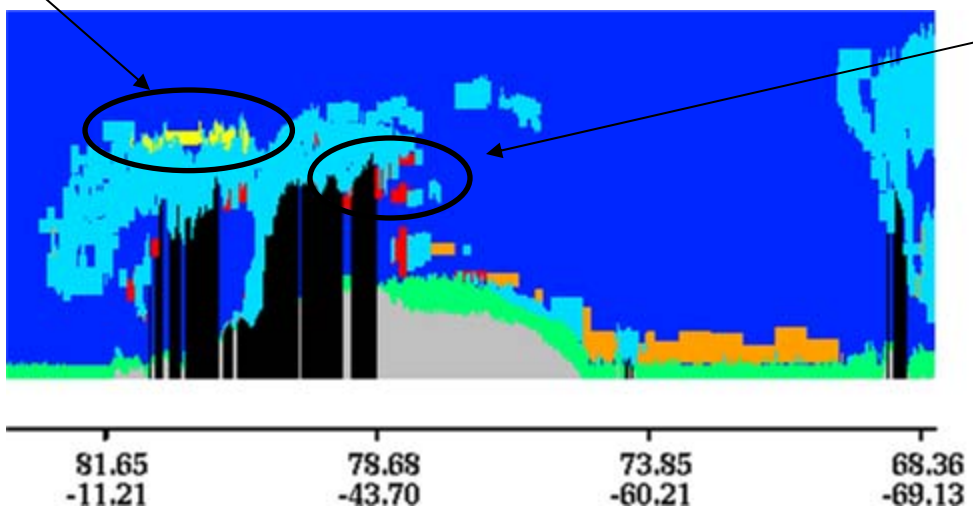


aerosol cloud artifacts (near Greenland)

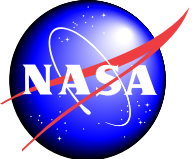
(17 April 2007, 06:53)



cloud artifacts



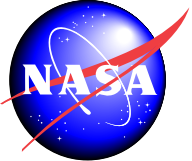
Red - low CAD scores



New: Search and Subset Tool



- **CALIPSO data subsetting feature now available on ASDC website**
- **To request data subset, specify:**
 - data product
 - time period
 - region (bounding box)
- **Currently in Beta – user feedback requested**
 - Firefox, Safari only (at this point)



In development: NRT aerosol product



Special product for model verification/assimilation by operational centers

Nominal delivery within 5-6 hours → “semi-global”

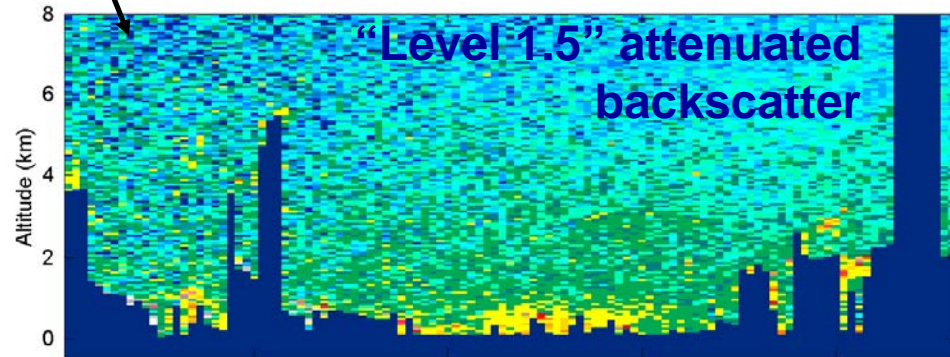
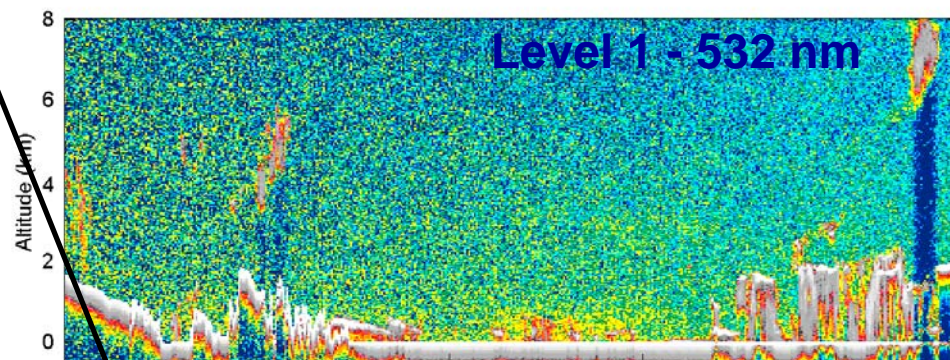
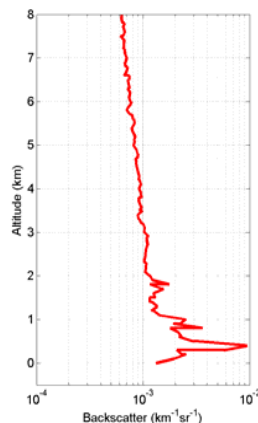
Level 1 profiles (1/3 km x 30-60 m) are cloud-cleared using Level 2 VFM, then averaged to 20 km x 60 m

Status:

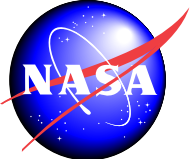
Requirements defined

Draft data product catalog

Expect operational in early 2011



Along track distance (km)



Summary



- **Have now acquired 4+ years of data**
 - Validation continuing
 - Level 3 products in development → quality control!!
- **Version 3 products released in June**
 - Full mission processed and available
 - significant improvements over Version 2
 - New Level 2 IIR product by end of 2010: D_{eff} and IWC from lidar+IR
 - Further improvements to AOD and aerosol extinction underway
- **Payload still healthy**
 - Likely mission life: 2014-16 ??