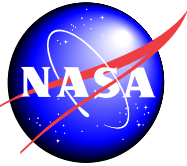


CALIPSO Version 3 Data Products: Additions and Improvements

Dave Winker
and the CALIPSO team

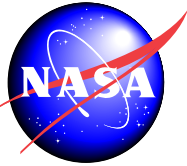




Version 3 Status



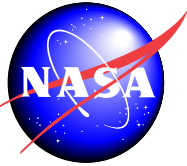
- **Version 3 algorithms now used for Level 1 forward processing**
 - Starting from turn-on of CALIOP backup laser
- **Reprocessing with Version 3 Level 1 to begin soon**
 - All mission data to be reprocessed, from 7 June 2006
- **Version 3 algorithms for Level 2 processing in final testing**
 - Profile products restructured
 - Numerous algorithm improvements
 - Significant bugs fixed
 - All mission data to be reprocessed, probably from 13 June 2006



Version 3 Data Products: Level 1



- **Level 1 data processed using Version 3 algorithms since March 2009**
- **Calibration improvements**
 - **Goal for calibration uncertainty, radiometric stability: 5%**
 - **Improved 532 nm daytime calibration**
 - > 30 km Rayleigh calibration can only be done at night
 - > Daytime uncertainties improved from 10% to 5%
 - > Stratospheric aerosol biases not yet corrected
 - **1064 nm calibration: significant biases remain**
 - > Initial approach using cirrus targets determined to be unreliable
 - > Investigating new approaches (sea surface, etc.)



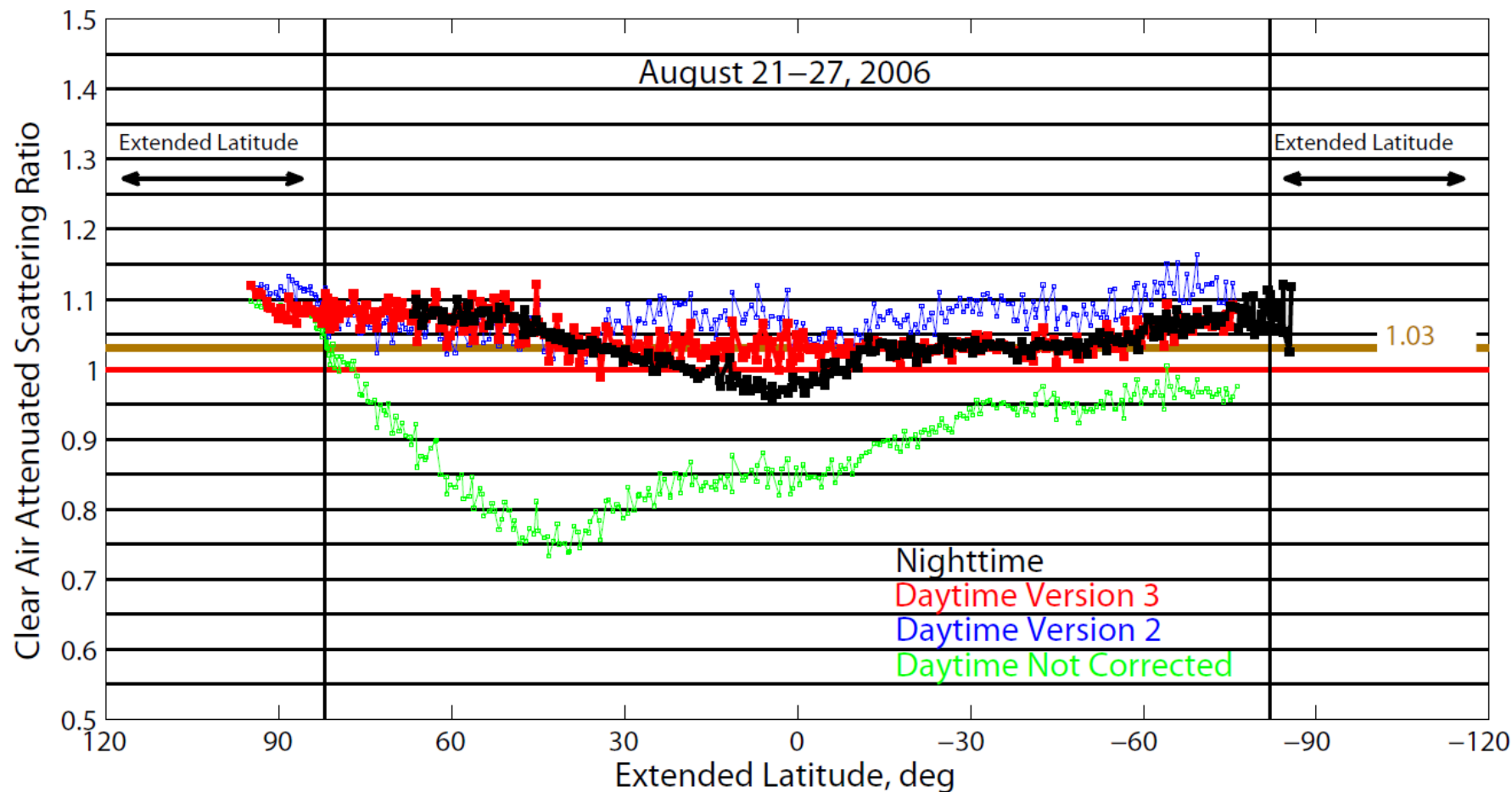
Improved daytime 532 calibration

Version 3 daytime calibration

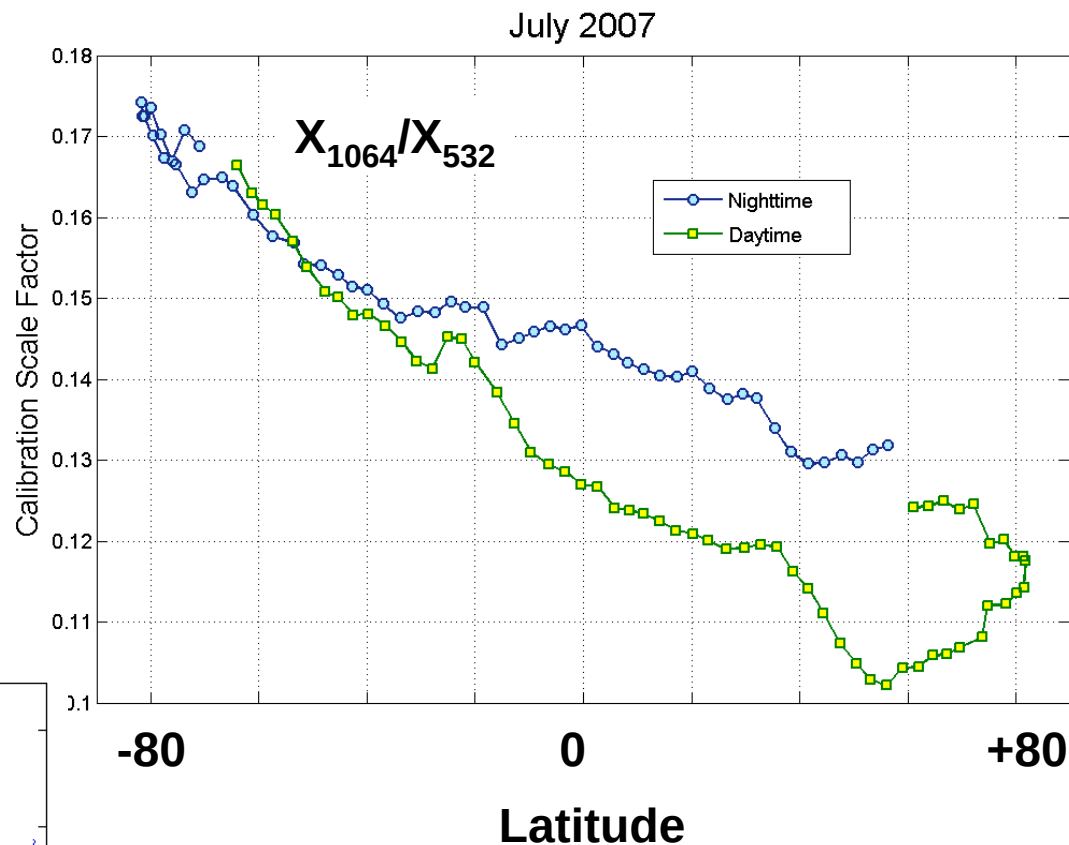
Version 2 daytime calibration

Version 1 daytime calibration (using previous nighttime mean calibration)

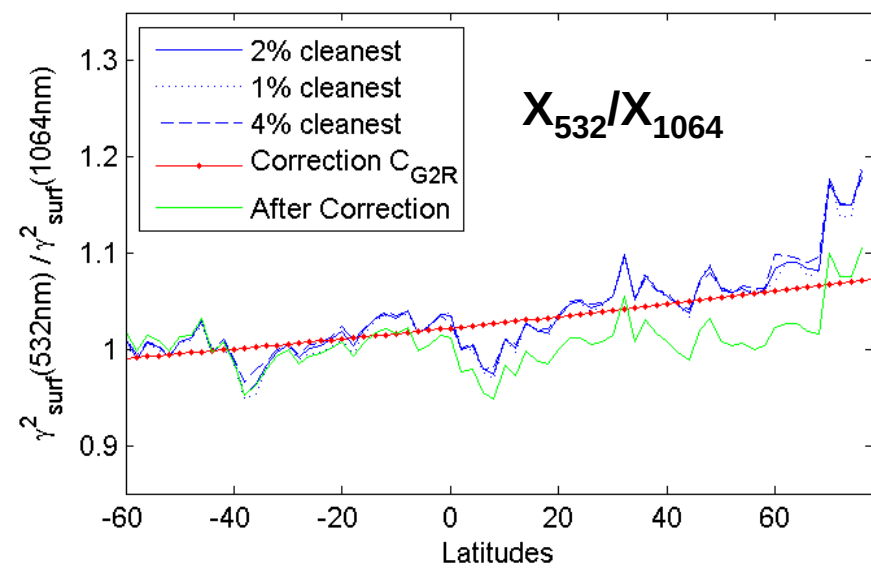
8-12 km, clear-air attenuated scattering ratios:



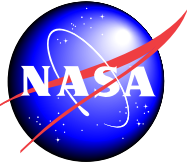
from cirrus backscatter:



from ocean surface backscatter:

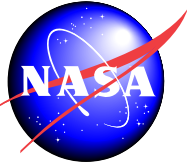


Magnitude and details of biases are seasonally dependent



Version 3 Data Products: Level 2

- **New parameters added**
- **Aerosol and cloud profile products restructured and improved**
 - Aerosol now reported at 5 km
 - Many added parameters
 - Data quality flags now included
- **Algorithm Improvements:**
 - Revised strategy for extinction retrievals boundary layer aerosol, constrained cirrus retrievals
 - 1064 nm lidar ratio for dust changed from 30 to 50
 - New cloud ice/water phase algorithm
- **Several significant bug fixes**



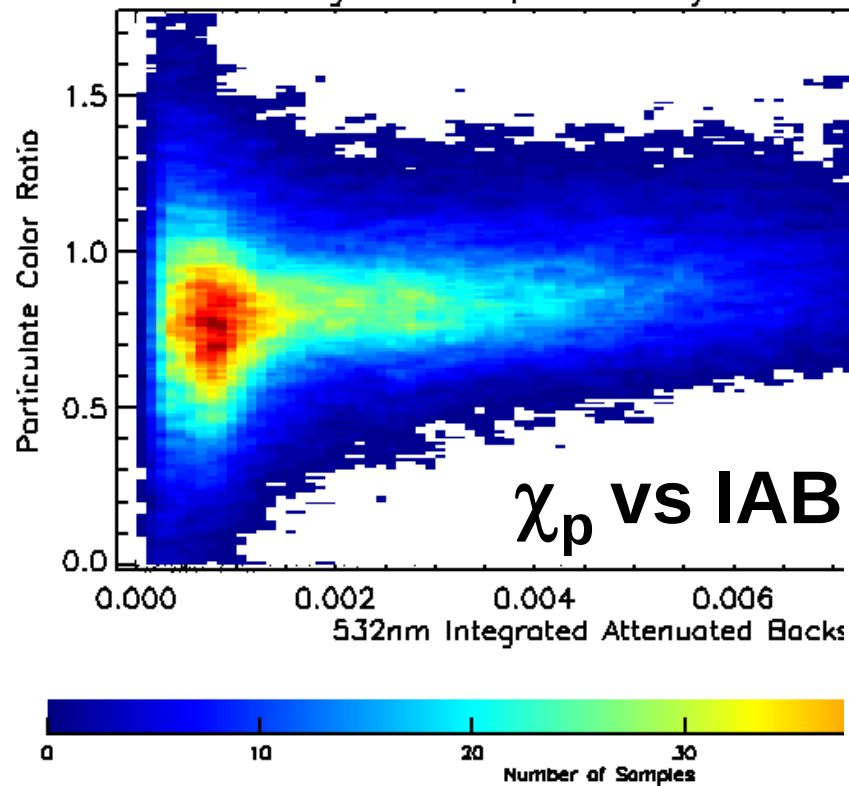
Added Level 2 Parameters



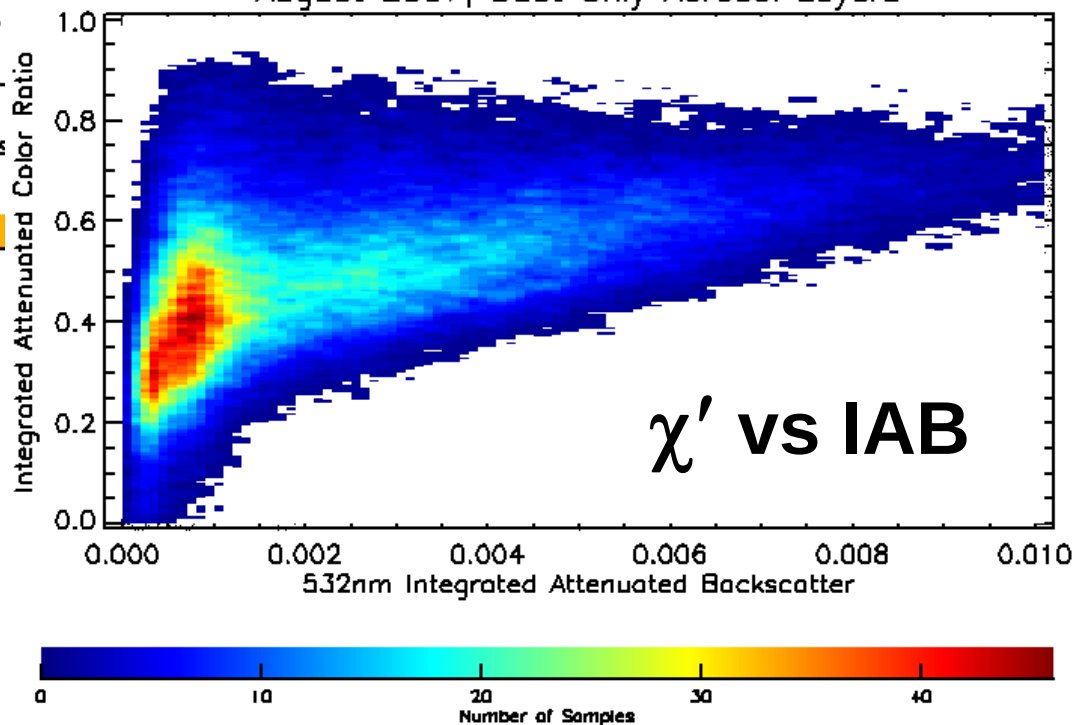
- **Column optical depth**
 - in aerosol and cloud layer and profile products
- **Shape parameter (ice clouds)**
 - Classification of ice habit: plate-like, column-like, irregular, and oriented
 - Based on algorithm of Noel (2002, 2004, 2006)
- **Cloud-fraction parameter added to 5-km layer and profile products**
- **Orbit and path numbers**
- **Cloud base, mid, top pressure**
- **Cloud base and top temperature**
- **Uncertainties now provided for most parameters**

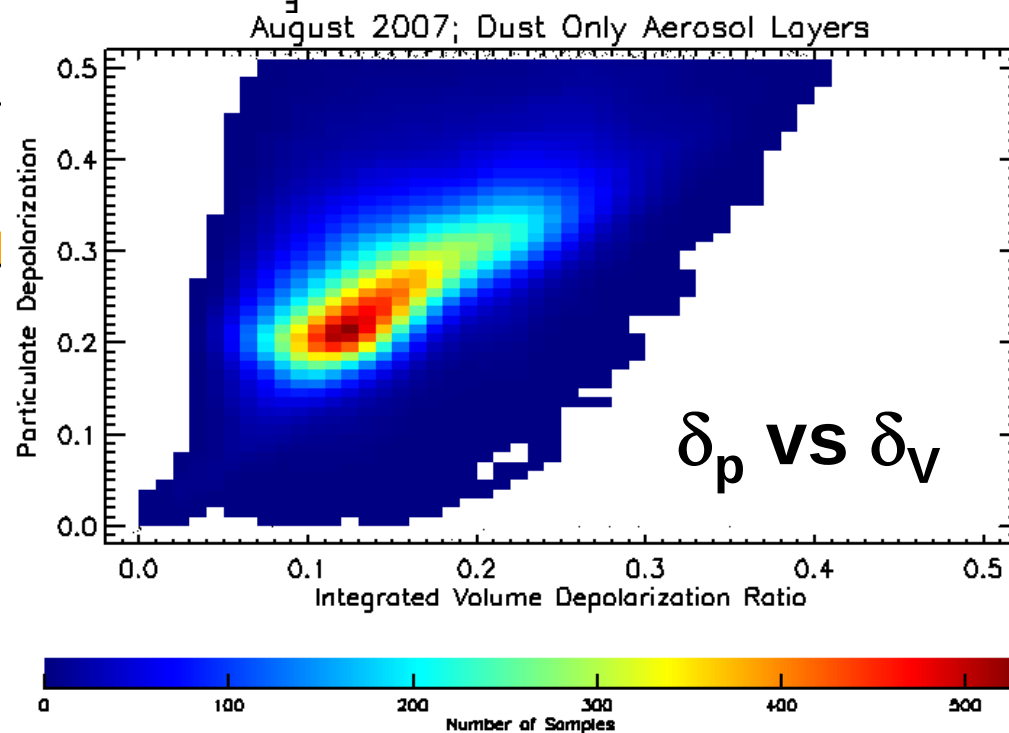
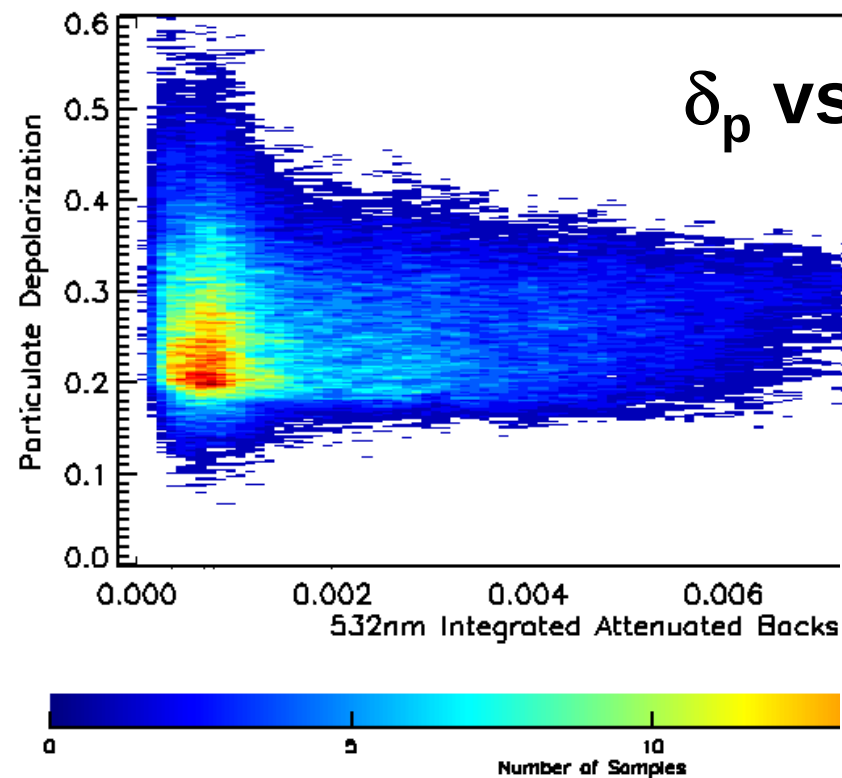
Added Parameters: χ_p

August 2007; Dust Only Aerosol Layers



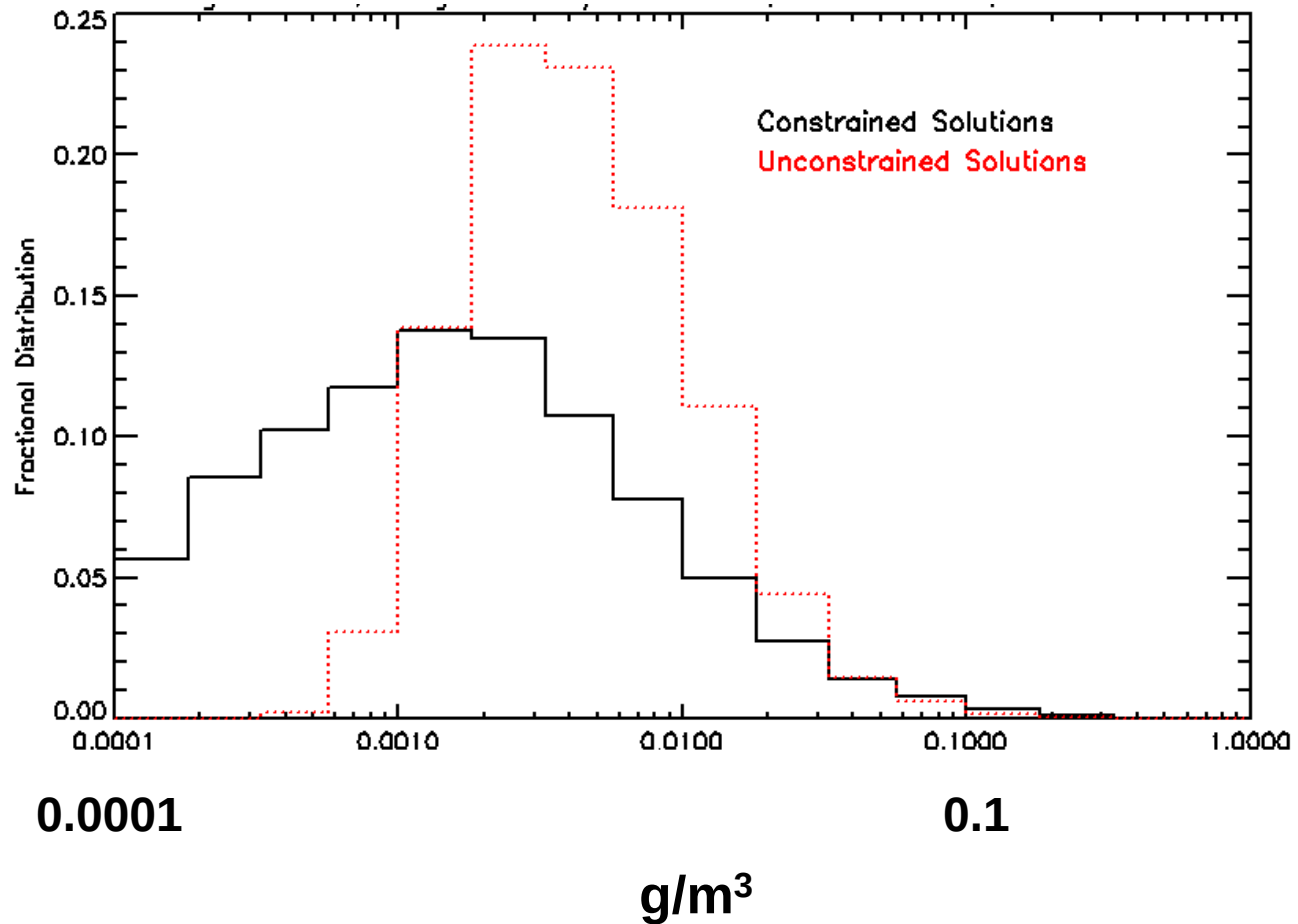
August 2007; Dust Only Aerosol Layers

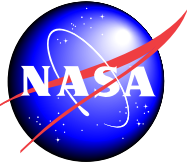




Cloud profile product: Ice Water Content

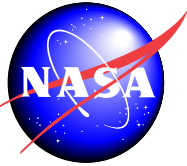
Cloud layer product: Ice Water Path





Restructured Profile Products

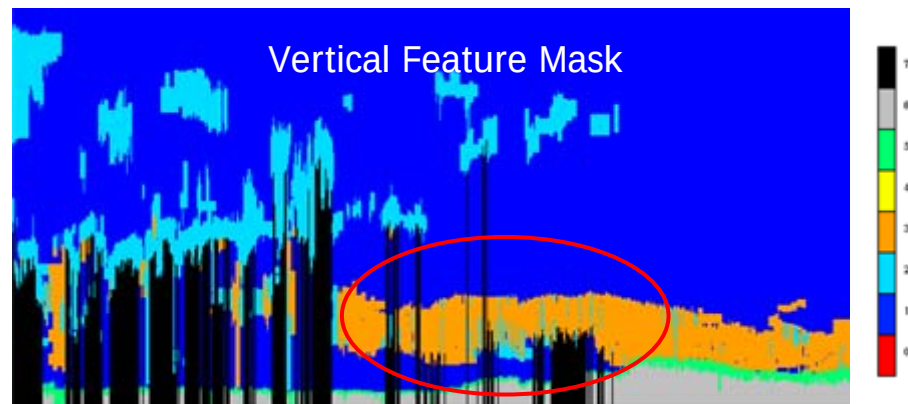
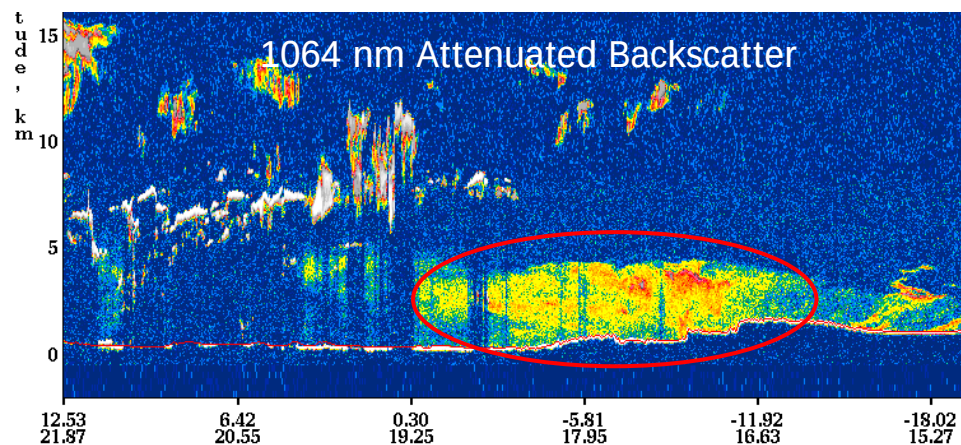
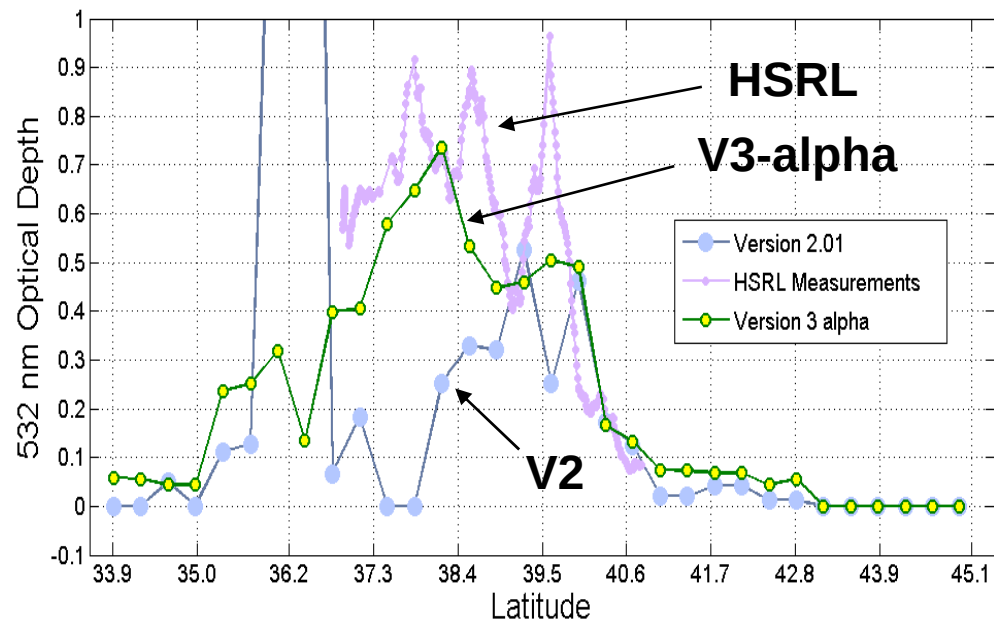
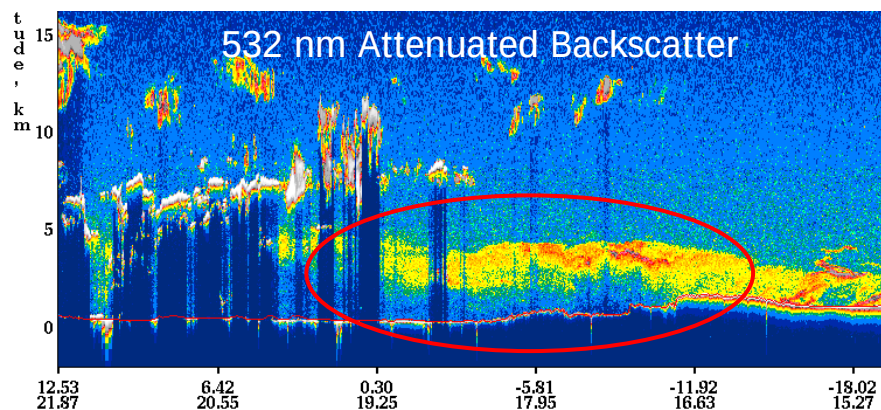
- **Version 2:**
 - Profiles of aerosol and cloud 532 and 1064 extinction and backscatter only
 - Cloud profiles reported at 5 km
 - Aerosol profiles averaged to 40 km
- **Both aerosol and cloud profiles now reported at 5-km horizontal resolution**
 - Still retrieved at 5-20-80 km
- **Added profiles:**
 - 532 nm perpendicular backscatter and particle depolarization
 - Atmospheric Volume Description (cloud/aerosol/clear etc.)
 - Cloud fraction within the 5-km horizontal grid
 - Backscatter and extinction uncertainties
- **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



Algorithm Improvements



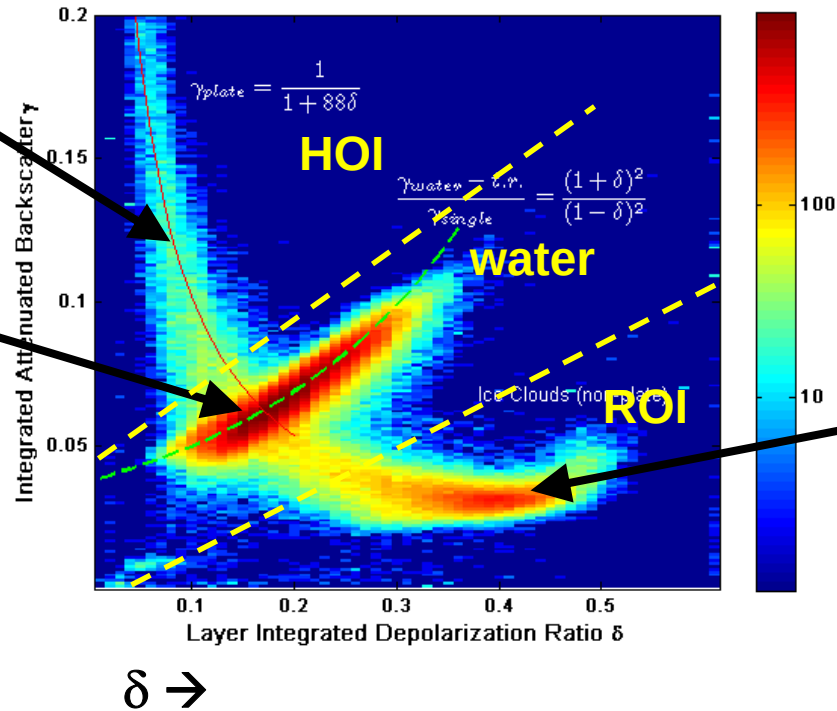
- **Revisions to constrained extinction retrieval strategy**
 - Version 2: constrained retrievals not applied to any cloud or aerosol layer detected on more than one pass through the detection loop
 - This requirement relaxed in Version 3: more constrained retrievals, primarily for nighttime cirrus
- **Revised retrievals of boundary layer aerosol**
 - Version 2: extinction only retrieved within detected layers
 - Version 3: extinction retrieved from top of lowest aerosol layer to the surface
- **1064 nm lidar ratio for dust changed from 30 sr to 50 sr**
 - With the revised boundary layer retrieval strategy, will increase column AOD in dust regions
- **New ice-water phase algorithm**



Oriented crystals

water

IAB →



random ice

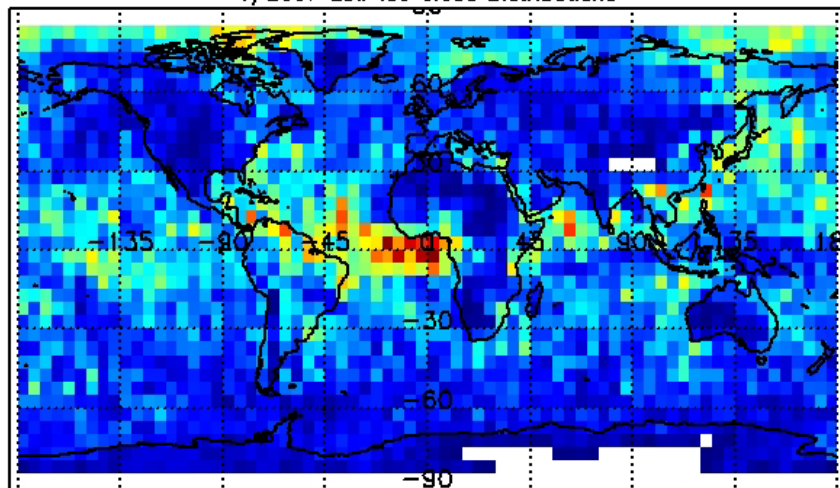
(Yong Hu, et al., Optics Express, 2007)

(Yong Hu, et al., JTech, 2009)

Oriented ice now properly classified (HOI → water in V2)

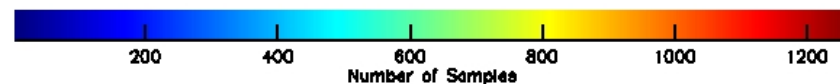
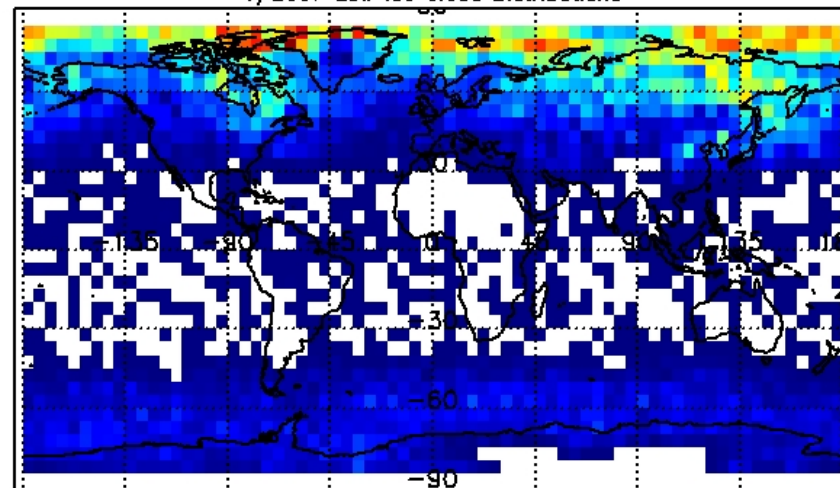
Version 2.01

1/2007 Low Ice Cloud Distributions



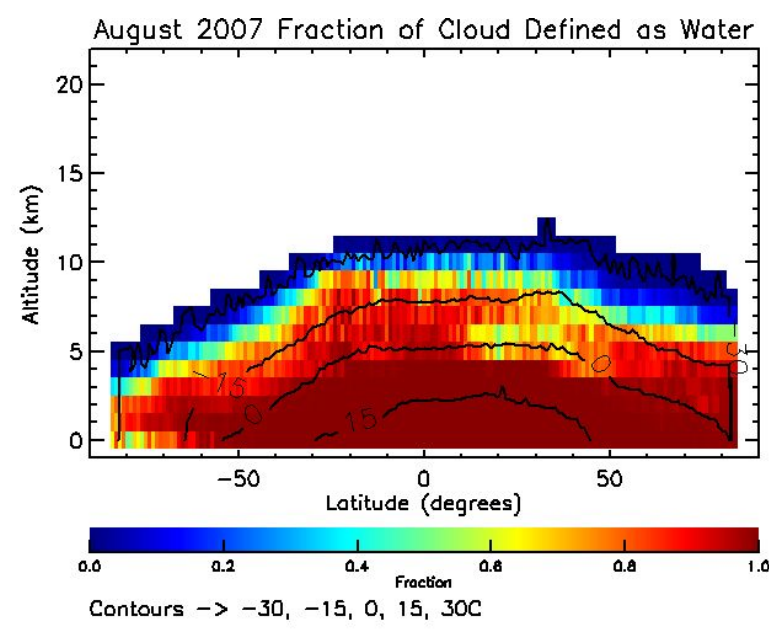
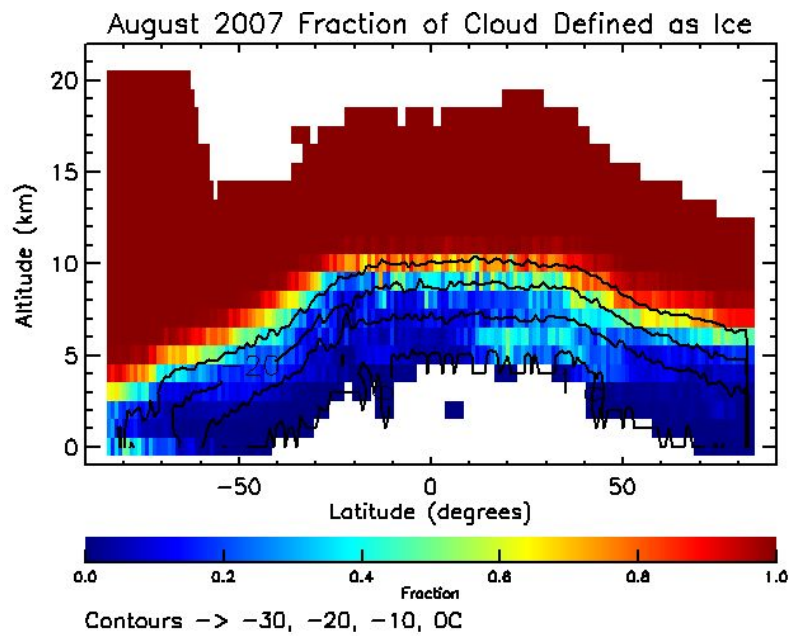
Version 3

1/2007 Low Ice Cloud Distributions

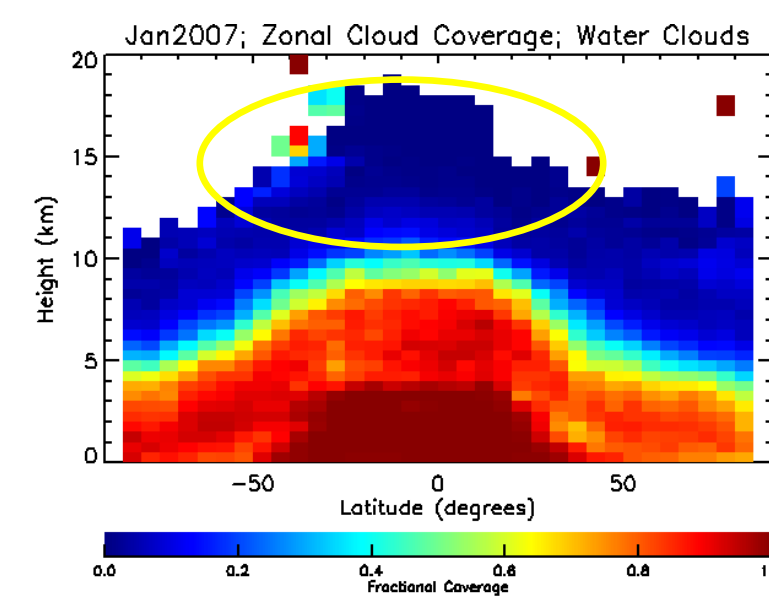
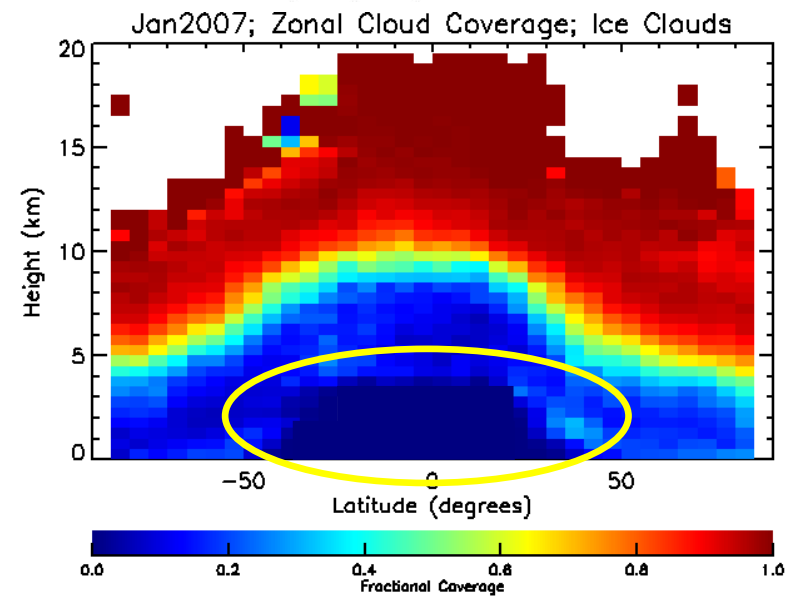


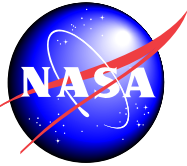
Number of 'ice' clouds with tops below 3.25 km

**V3
(Aug)**



**V2
(Jan)**

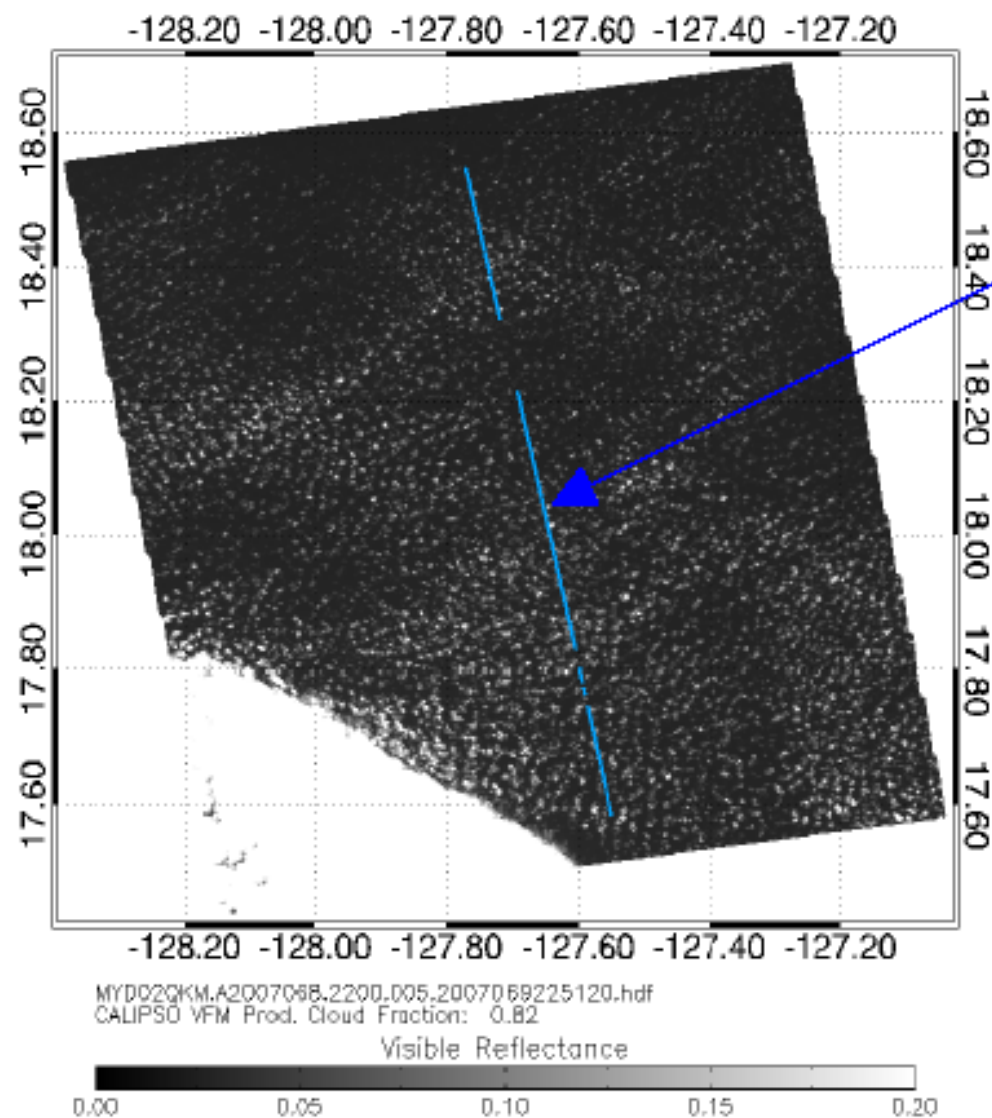




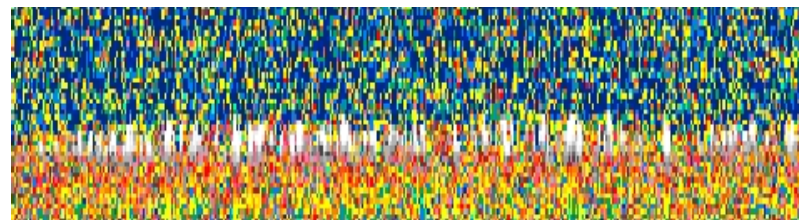
Bug Fixes

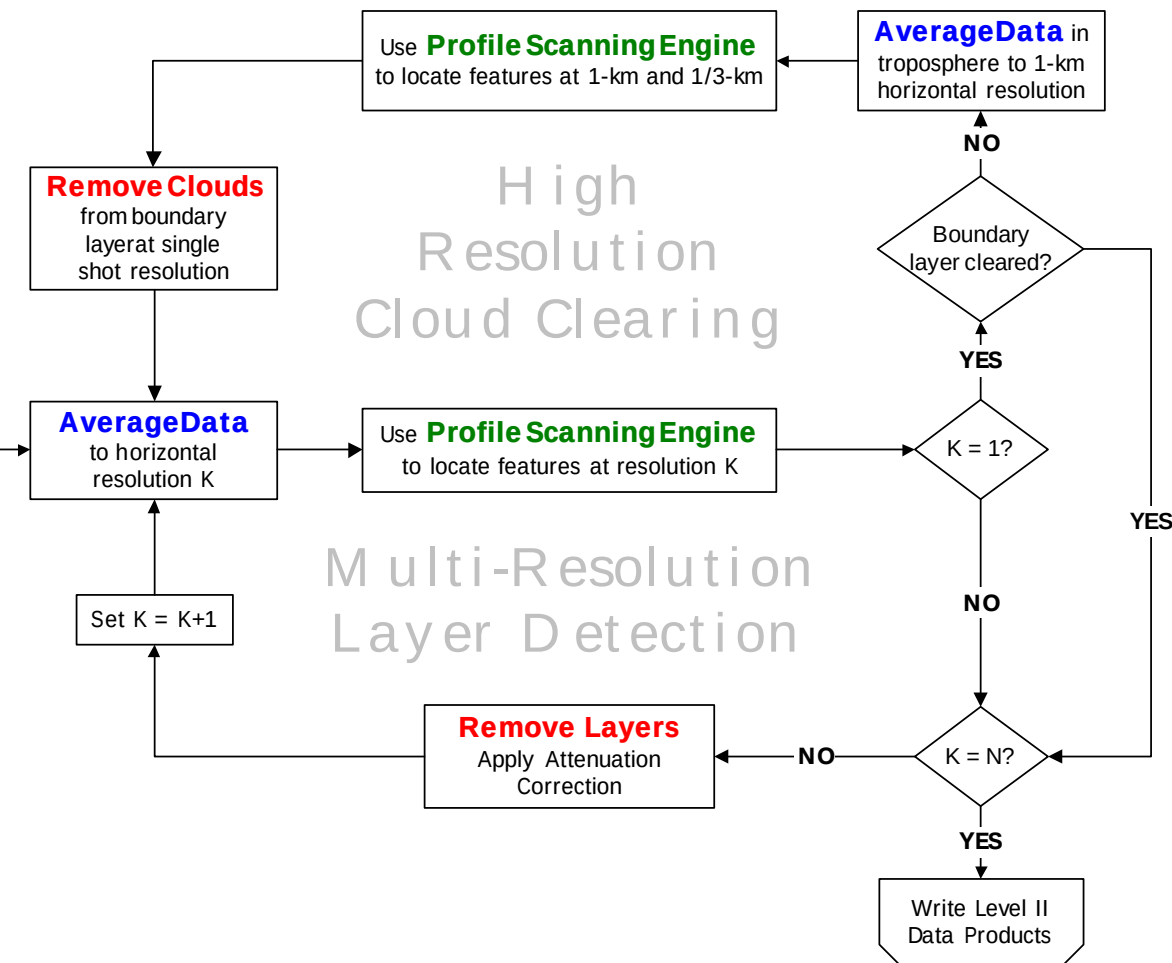


- **Surface detection more reliable, especially in 1/3 km product**
 - Bugs in surface detection algorithms caused low marine clouds to be sometimes classified as ocean surface
 - Other times, surface detections were underreported
- **Handling of multiple scattering corrected**
 - Version 2: multiple scattering corrections applied incorrectly to constrained retrievals (4% of cirrus in Version 2)
 - Multiple scattering corrections not propagated to lower layers
- **Clearing of boundary layer cloud**
 - Fix has biggest impacts in marine trade cumulus regions

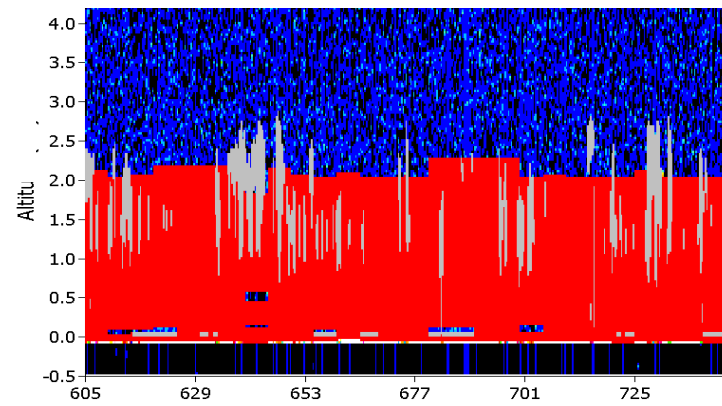
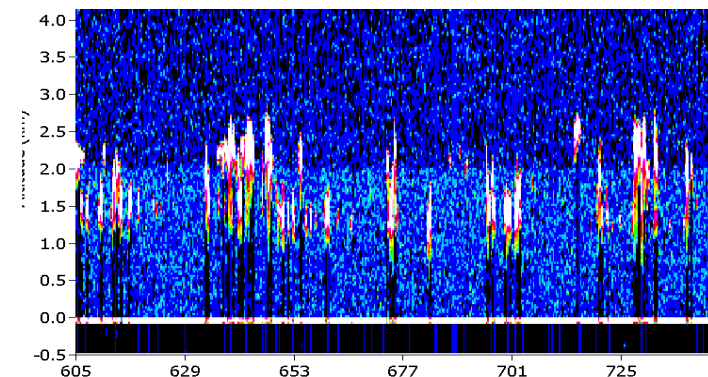


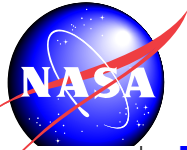
- In Version 2, clouds below 4 km not cleared properly
- Cloud-contaminated aerosol classified as 'cloud'
- Cloud-clearing scheme fixed in Version 3



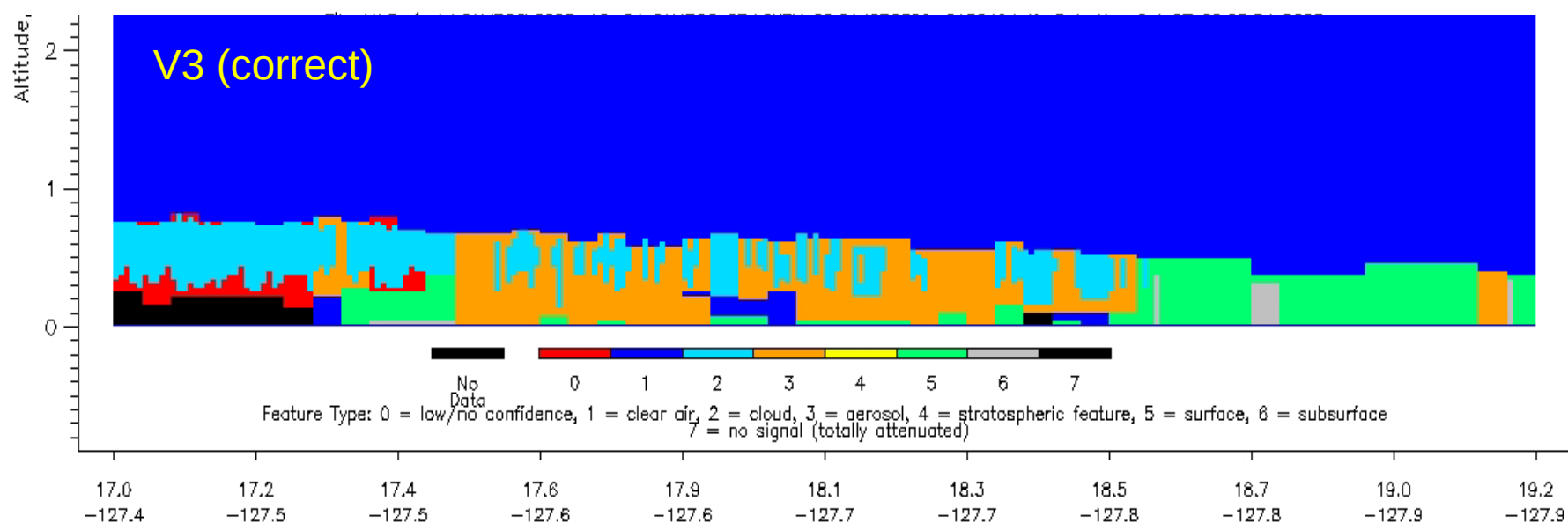
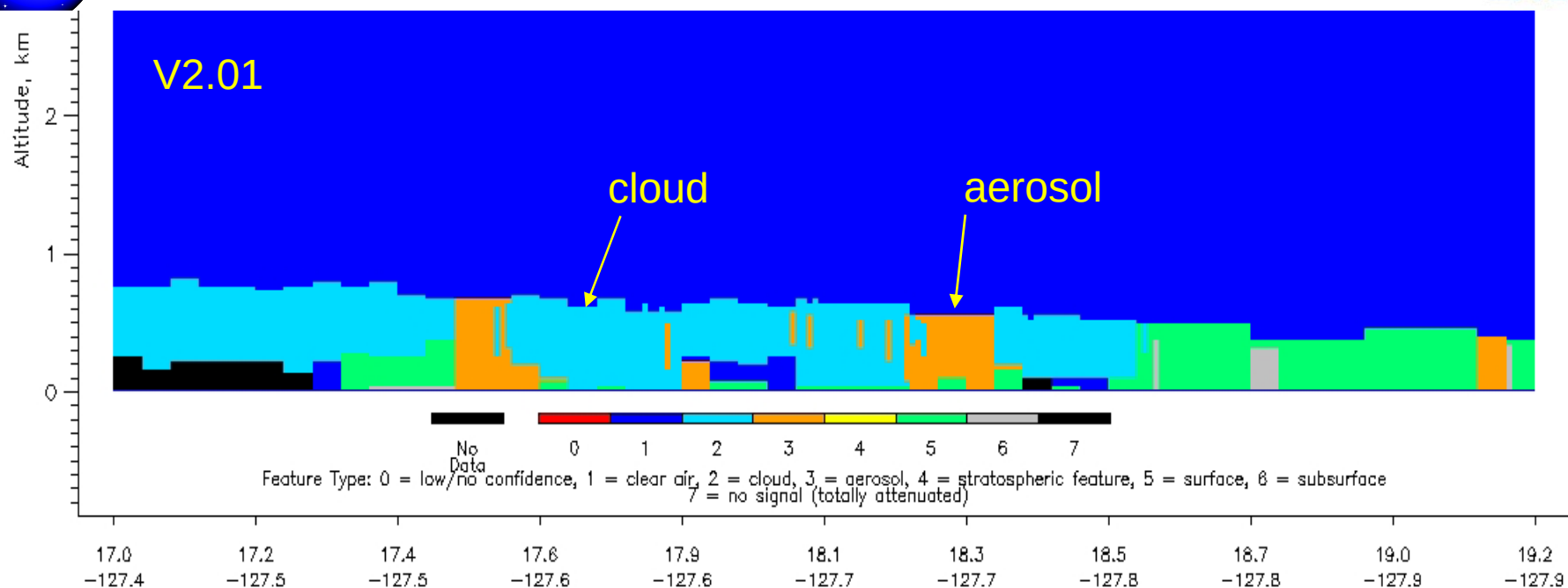


layer detection algorithm applies a special cloud-clearing scheme below 4 km to retrieve boundary layer aerosol

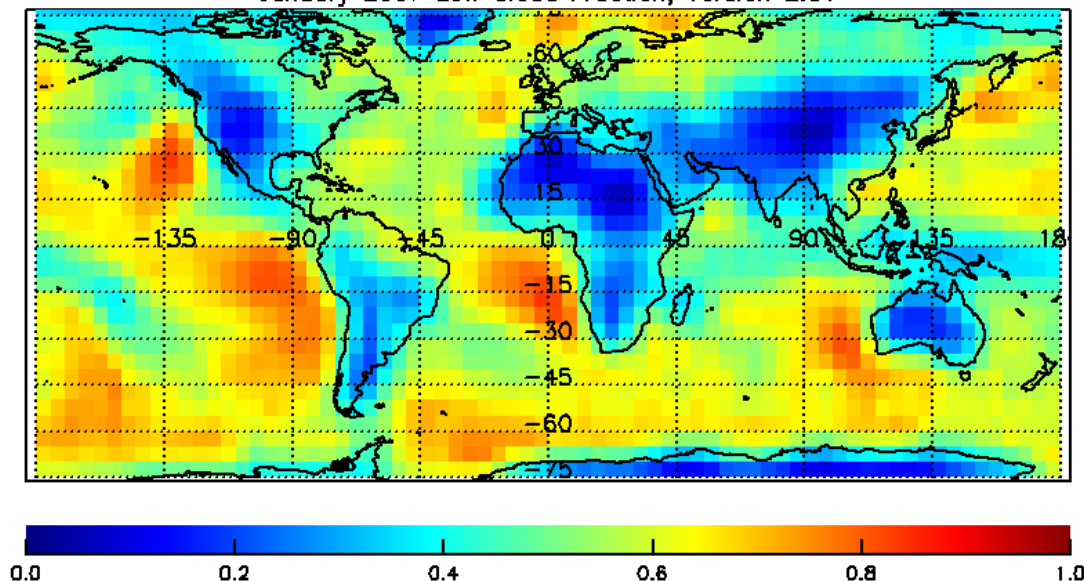




Trade cumulus scene



January 2007 Low Cloud Fraction; Version 2.01

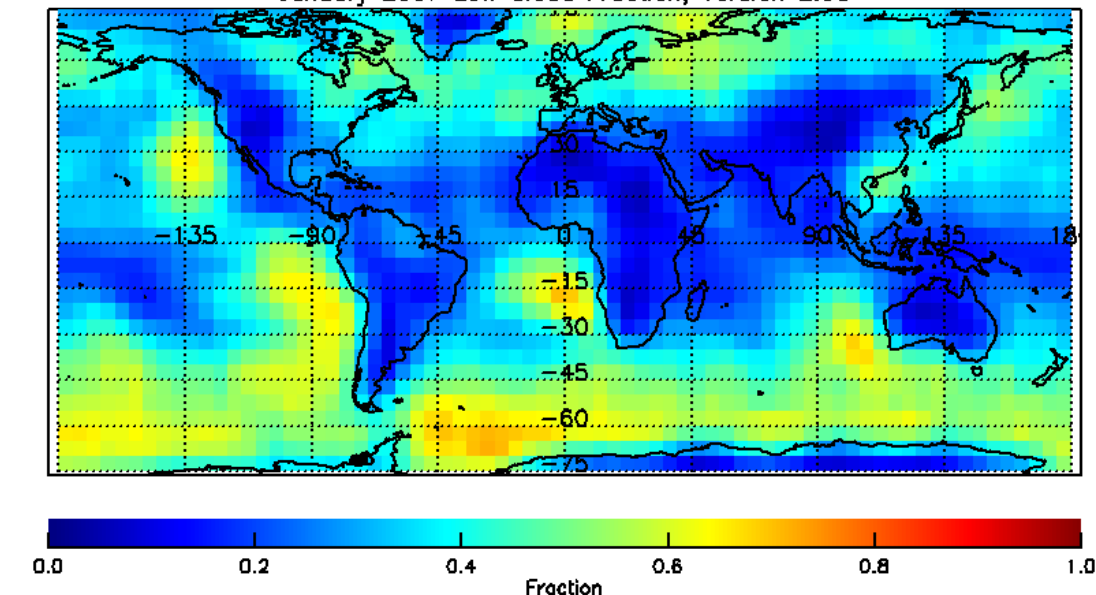


Version 2.01

Global mean cover of single-layer low cloud reduced from 26.1% to 21.8%

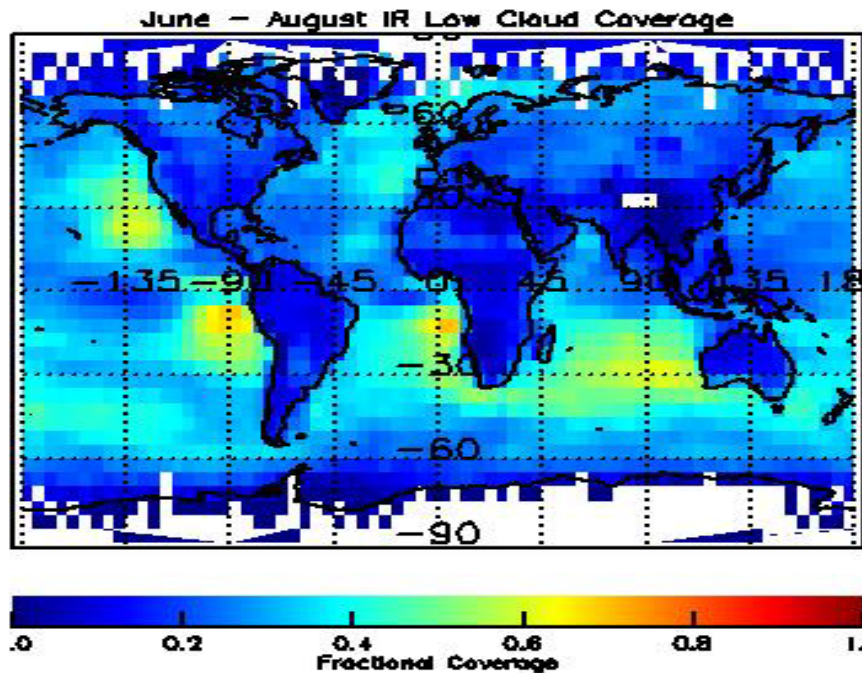
Regional reductions as much as a factor of 5.

January 2007 Low Cloud Fraction; Version 2.93



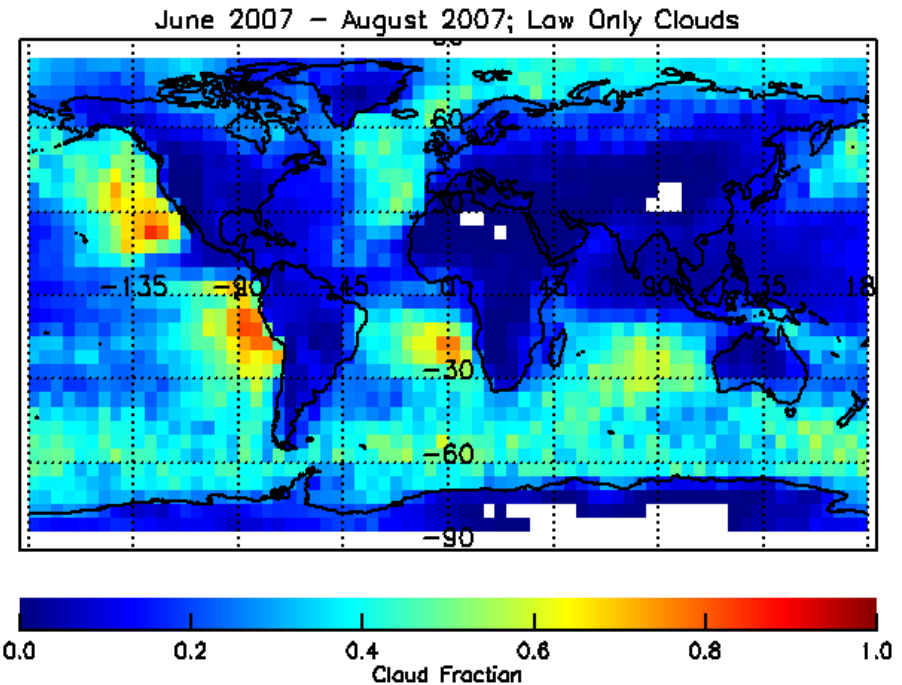
Version 3-alpha test

ISCCP (25.1%)



Low clouds

CALIPSO (24.0%)

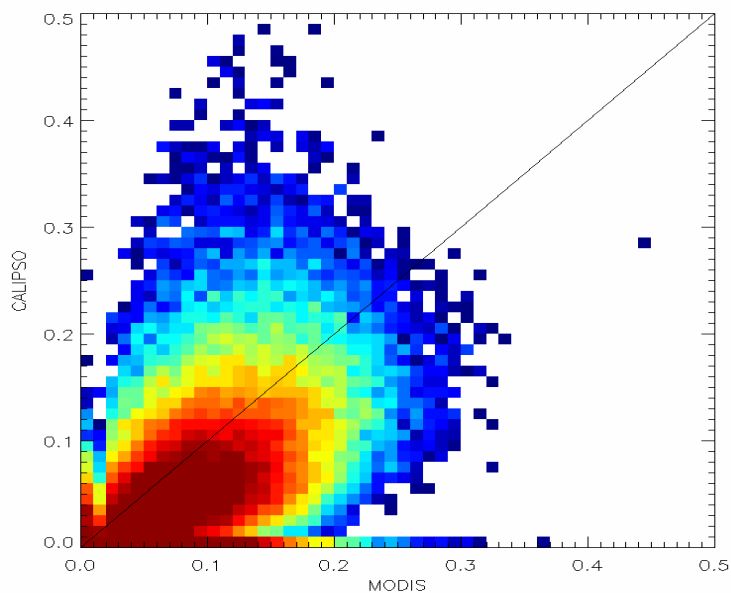


(Single-layer low clouds, except high clouds with OD < 3 ignored)

June-August 2007

- **Further improvements to calibration**
 - Use multiple consistency checks to improve 1064 nm calibration
- **Improve aerosol AOD/extinction retrievals using ocean surface returns**
 - accurate AOD/cloud screening on single shots
 - no microphysical assumptions

Standard CALIPSO AOD vs. MODIS



AOD from ocean sfc returns

