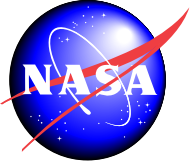


CALIPSO aerosol products and recent applications

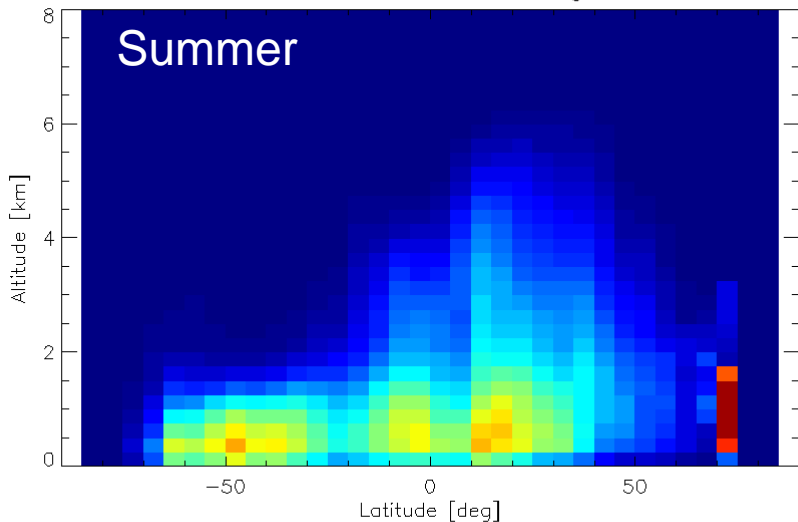
Dave Winker, NASA LaRC



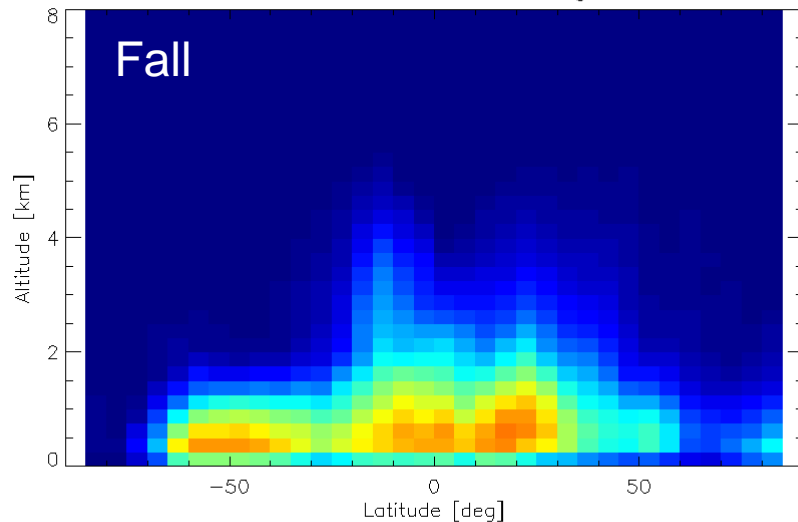
Zonal Mean Aerosol Extinction



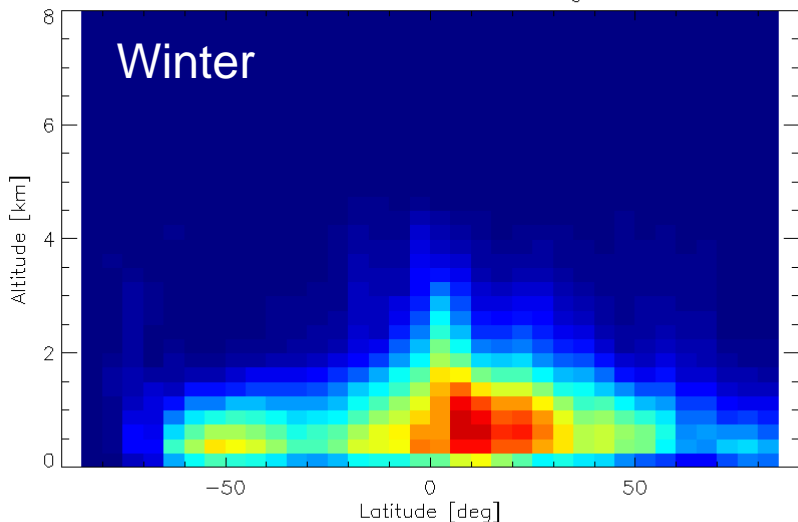
Zonal Mean Extinction (V2.01,AIAB<0.01,SaF=Sal,CloudFree) Global
20060615_20060831 Night



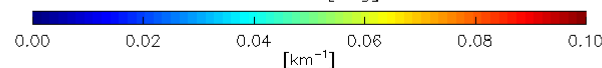
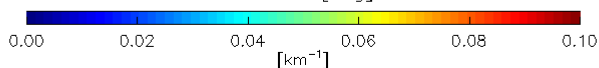
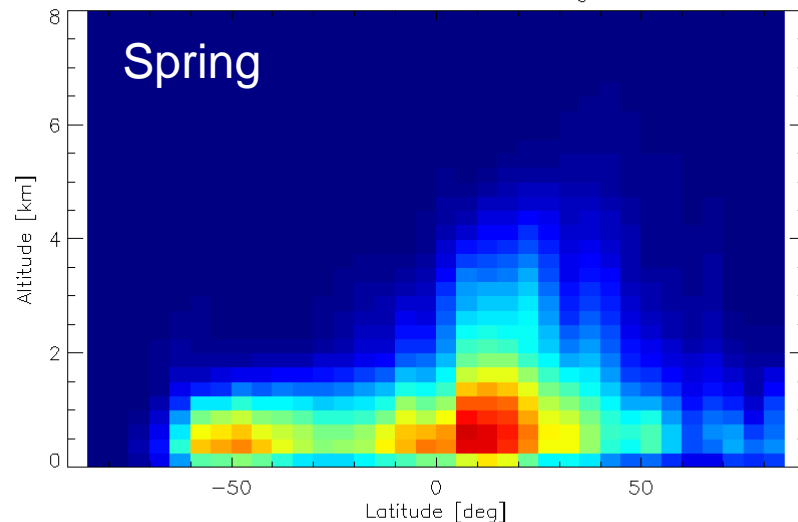
Zonal Mean Extinction (V2.01,AIAB<0.01,SaF=Sal,CloudFree) Global
20060901_20061130 Night



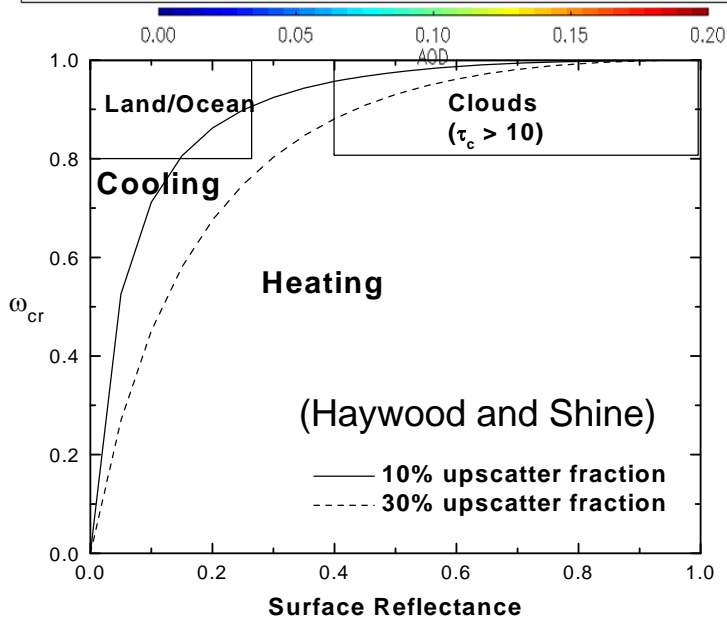
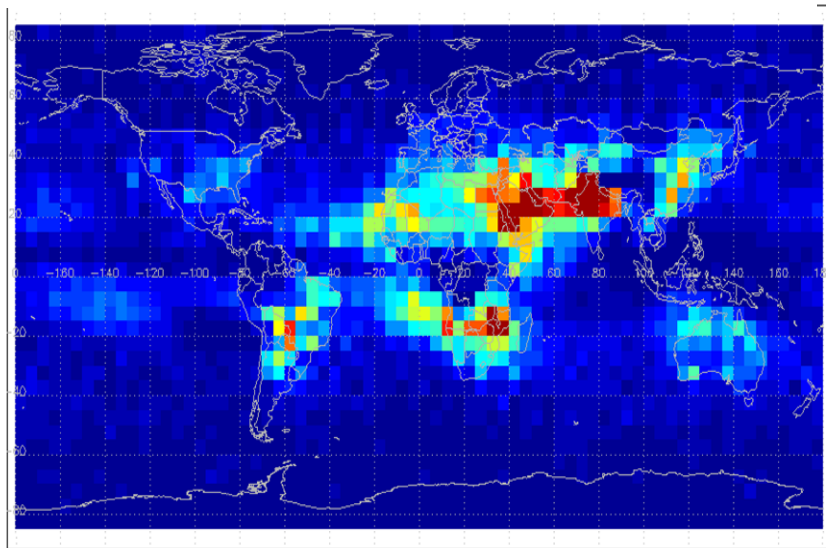
Zonal Mean Extinction (V2.01,AIAB<0.01,SaF=Sal,CloudFree) Global
20061201_20070228 Night



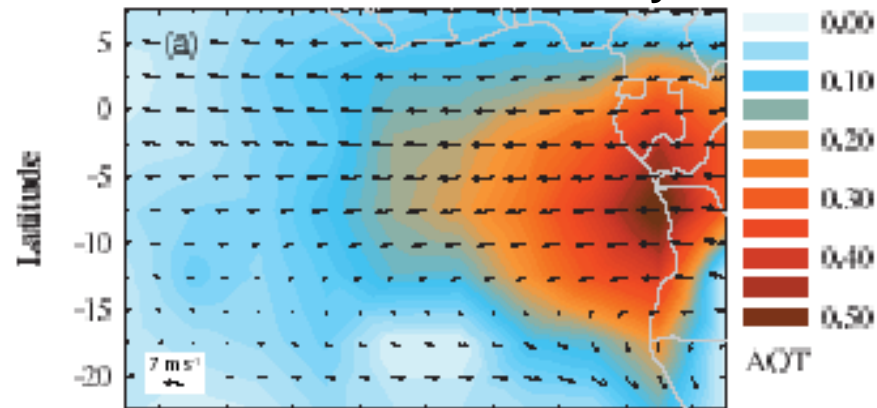
Zonal Mean Extinction (V2.01,AIAB<0.01,SaF=Sal,CloudFree) Global
20070301_20070531 Night



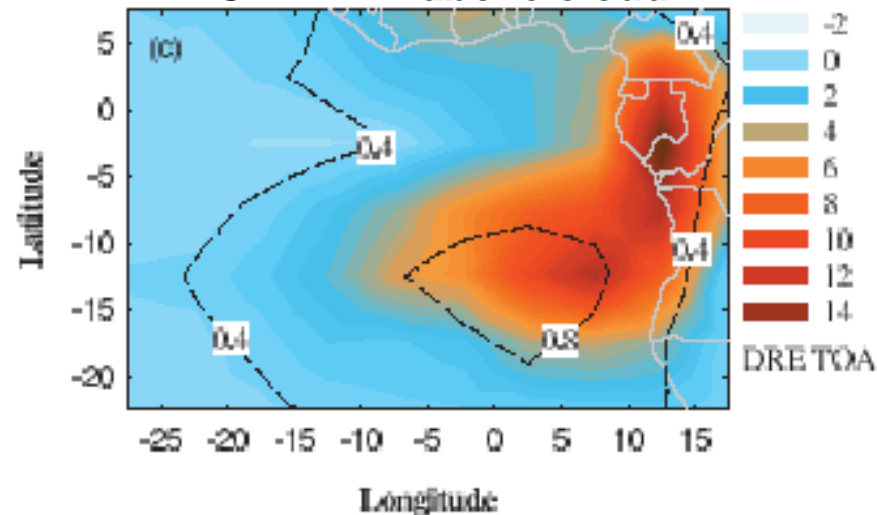
Mean AOD above cloud (SON 2007)



Mean AOD above cloud layers

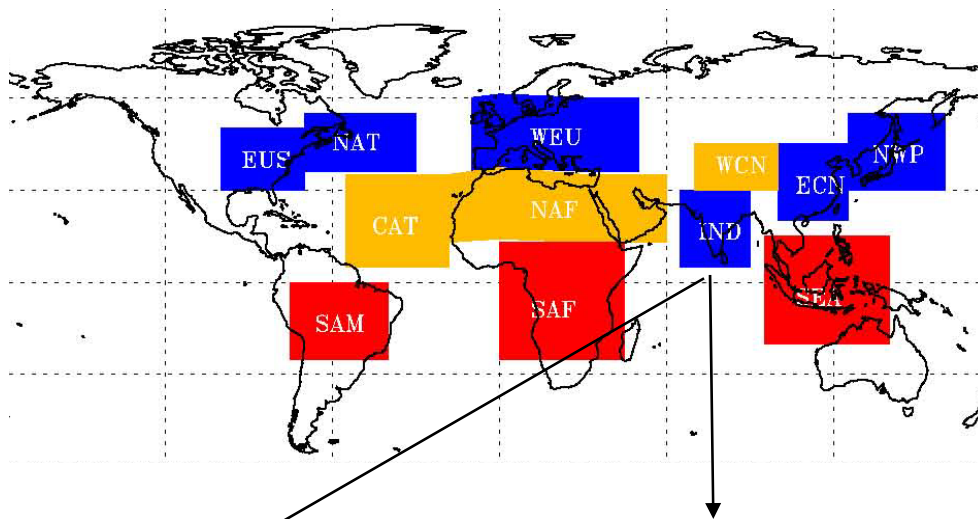


TOA DARE above cloud



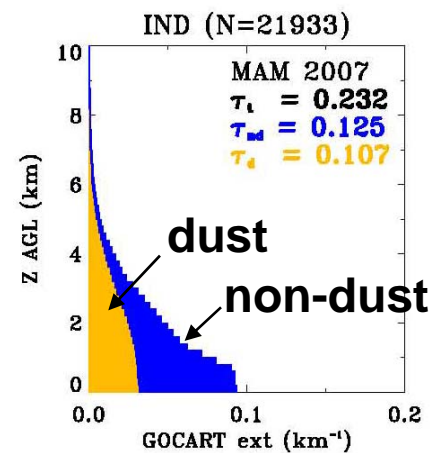
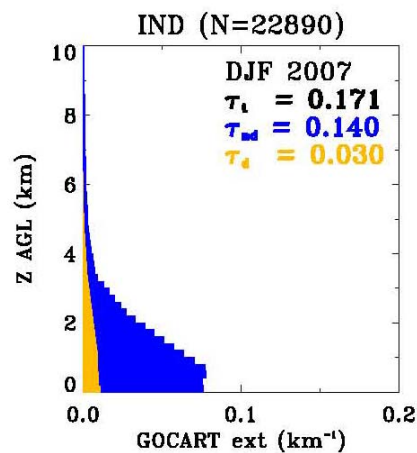
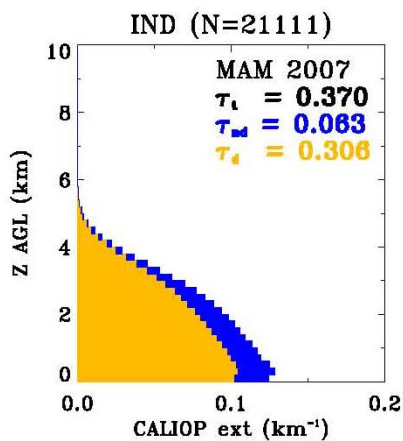
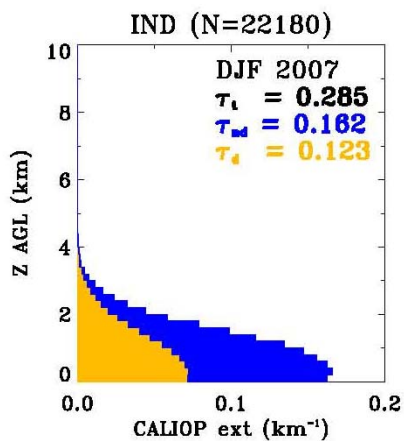
(Chand et al., Nat. Geo., 2009)

Hongbin Yu, et al.
(JGR, submitted)



CALIOP extinction

GOCART extinction

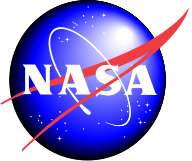


DJF

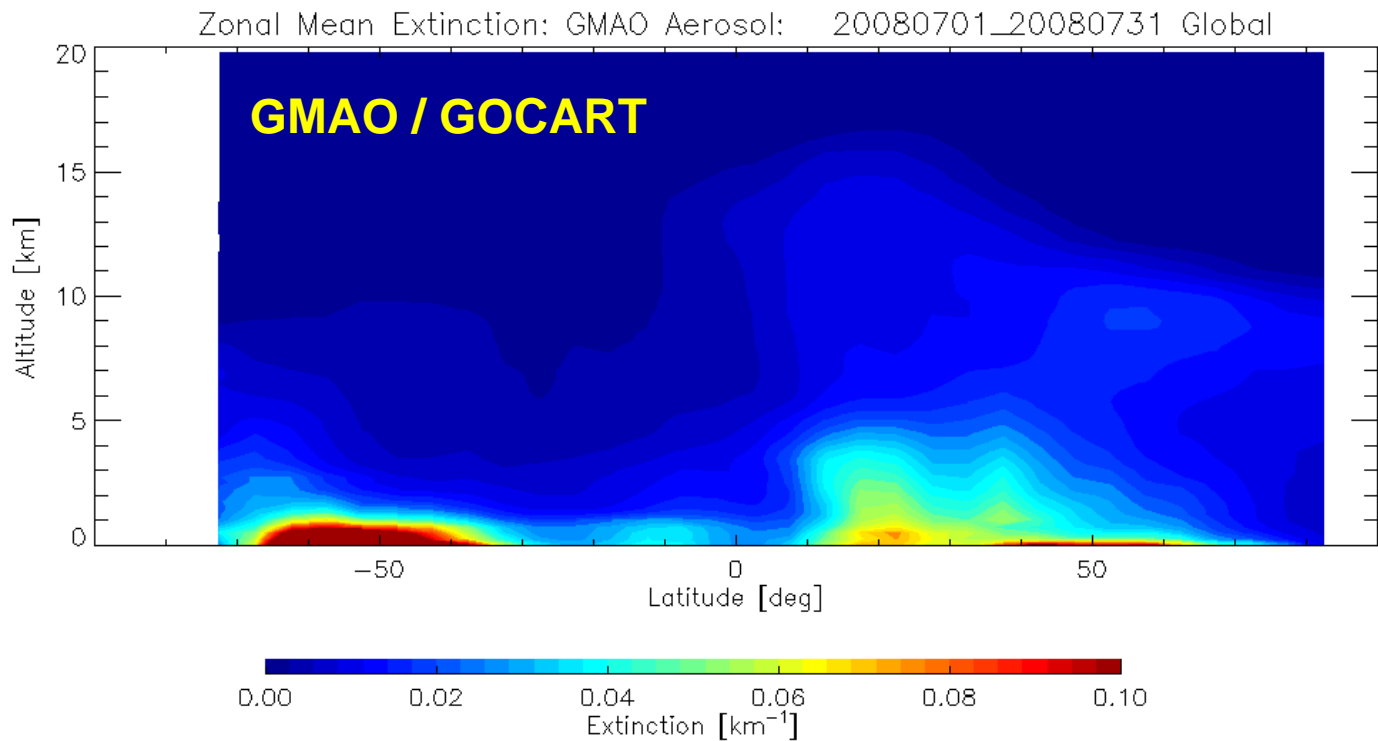
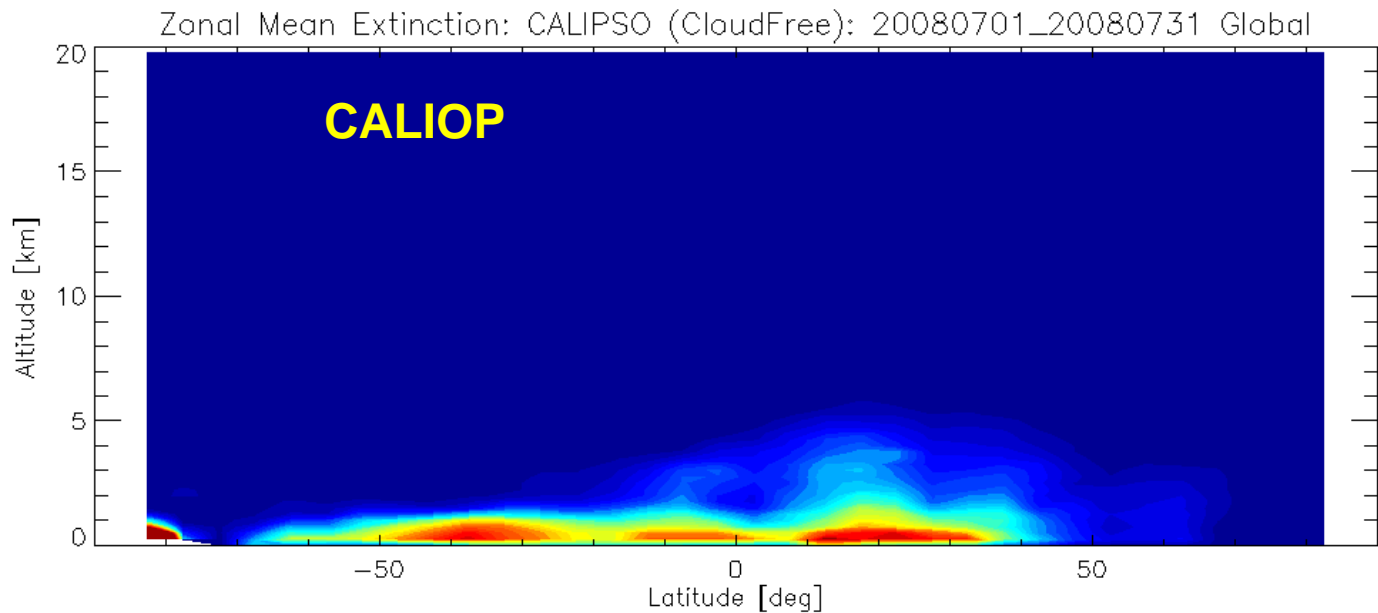
MAM

DJF

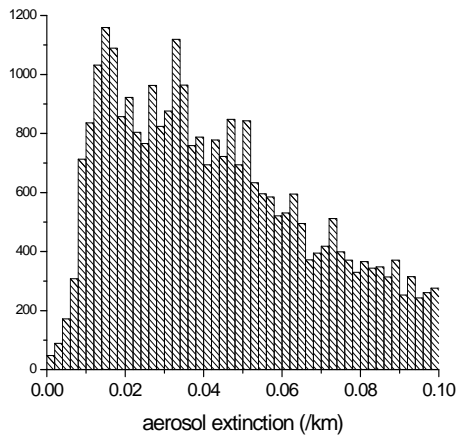
MAM

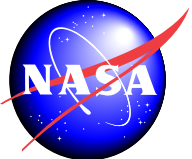


Global zonal mean aerosol extinction (cloud-free columns)



CALIOP extinction PDF

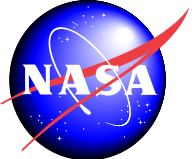




Version 3 Data Products: Level 1



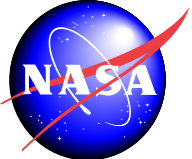
- **Version 3 algorithms now used for Level 1 forward processing**
 - Starting from turn-on of CALIOP backup laser in March 2009
- **Version 3 reprocessing of Level 1 is underway**
 - All mission data to be reprocessed, from 7 June 2006
- **Improved 532 nm daytime calibration**
 - Daytime uncertainties improved from 10% to 5%
 - Stratospheric aerosol biases (mostly tropical) not yet corrected
- **1064 nm calibration: significant biases remain**
 - Initial approach using cirrus targets more variable than expected
 - Investigating new approaches (sea surface, etc.)



Version 3 Data Products: Level 2



- **Uncertainties now provided for most parameters**
- **Aerosol and cloud profile products restructured and improved**
 - Aerosol now reported at 5 km
 - Many added parameters, including data quality flags
- **Algorithm Improvements:**
 - Revised strategy for extinction retrievals boundary layer aerosol, constrained cirrus retrievals
 - New cloud ice/water phase algorithm
- **Several significant bugs fixed**

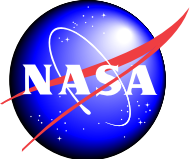


Restructured Profile Products



CENTRE NATIONAL D'ETUDES SPATIALES

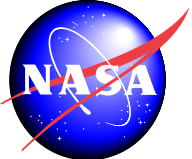
- **Version 2:**
 - Profiles of 532 and 1064 extinction and backscatter only
 - Cloud profiles reported at 5 km horizontal resolution
 - Aerosol profiles averaged to 40 km
- **Both aerosol and cloud profiles now reported at 5-km horizontal resolution**
 - Retrieved at 5-20-80 km, reported at 5 km
- **Added new profiles:**
 - 532 nm perpendicular backscatter, particle depolarization
 - Atmospheric description (cloud/aerosol/clear etc.)
 - Cloud fraction within the 5-km horizontal grid
- **Added column parameters:**
 - Column optical depth: cloud, aerosol, stratosphere
 - Column integrated attenuated backscatter (IAB)
- **Added data quality information**
 - Uncertainties, etc.



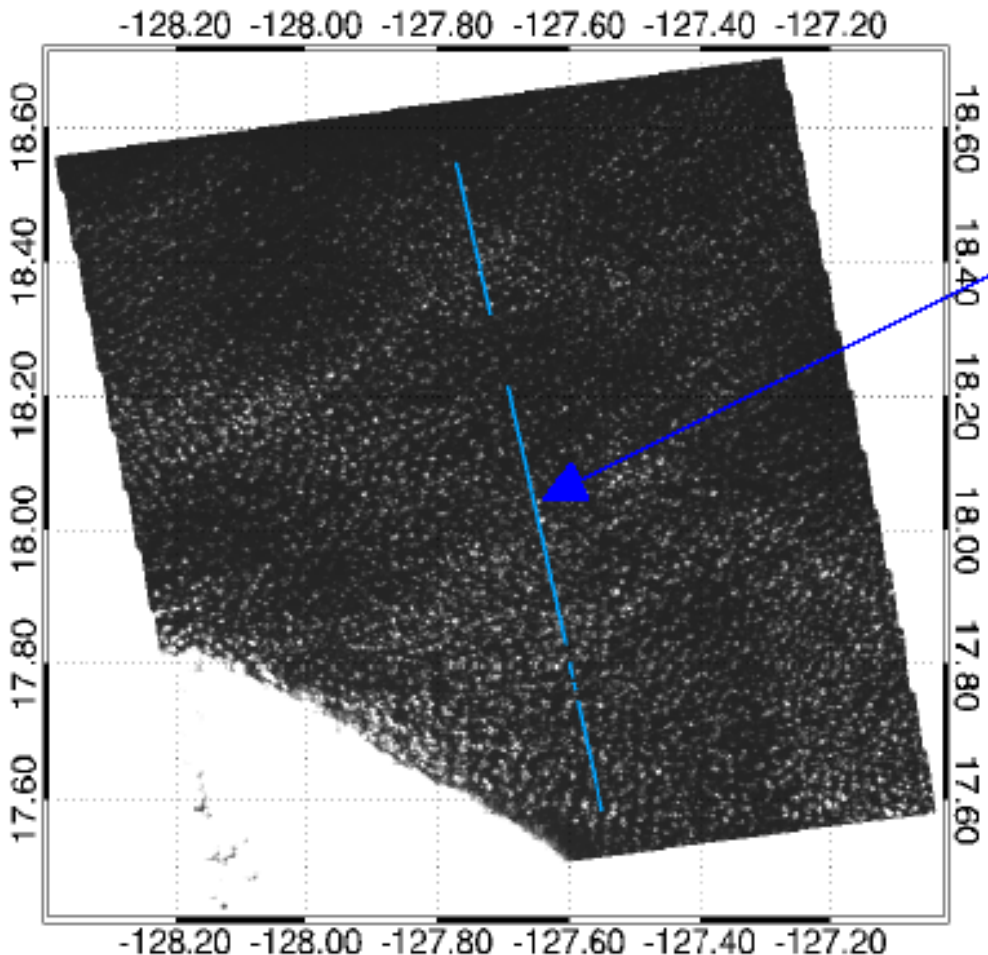
Bug Fixes



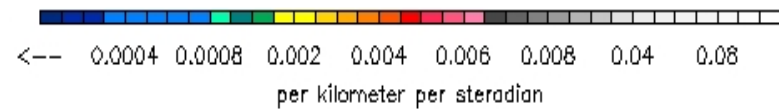
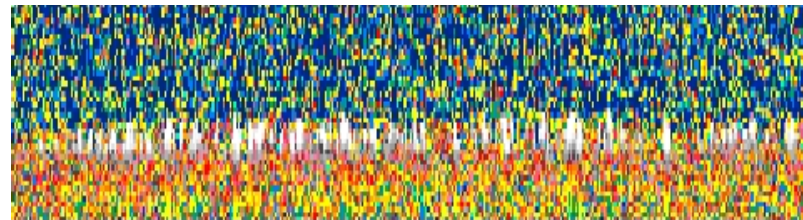
- **Surface detection is now more reliable**
 - Bugs in surface detection algorithms caused low marine clouds to sometimes be classified as ocean surface
- **Handling of multiple scattering corrected**
 - Multiple scattering corrections applied incorrectly to constrained retrievals (4% of cirrus) in Version 2
 - Multiple scattering corrections not propagated to lower layers
- **Boundary layer cloud clearing fixed**
 - Has biggest impacts in marine trade cumulus regions

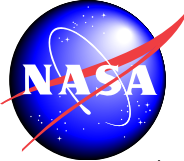


Bug in V2 boundary layer cloud clearing

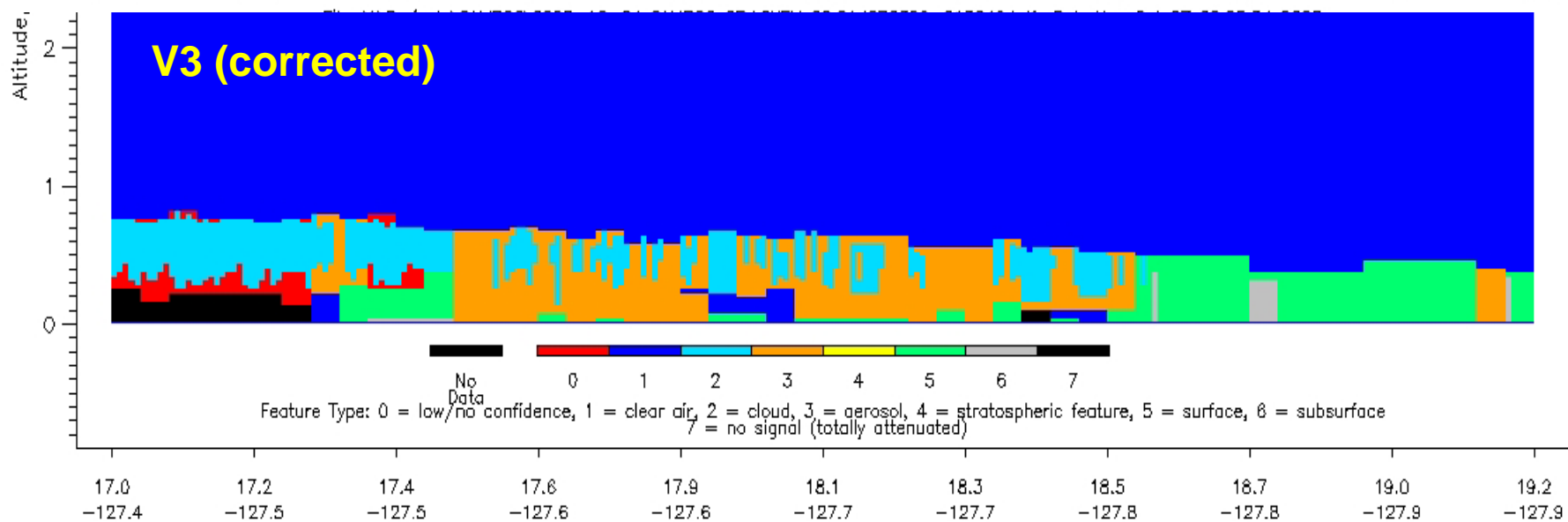
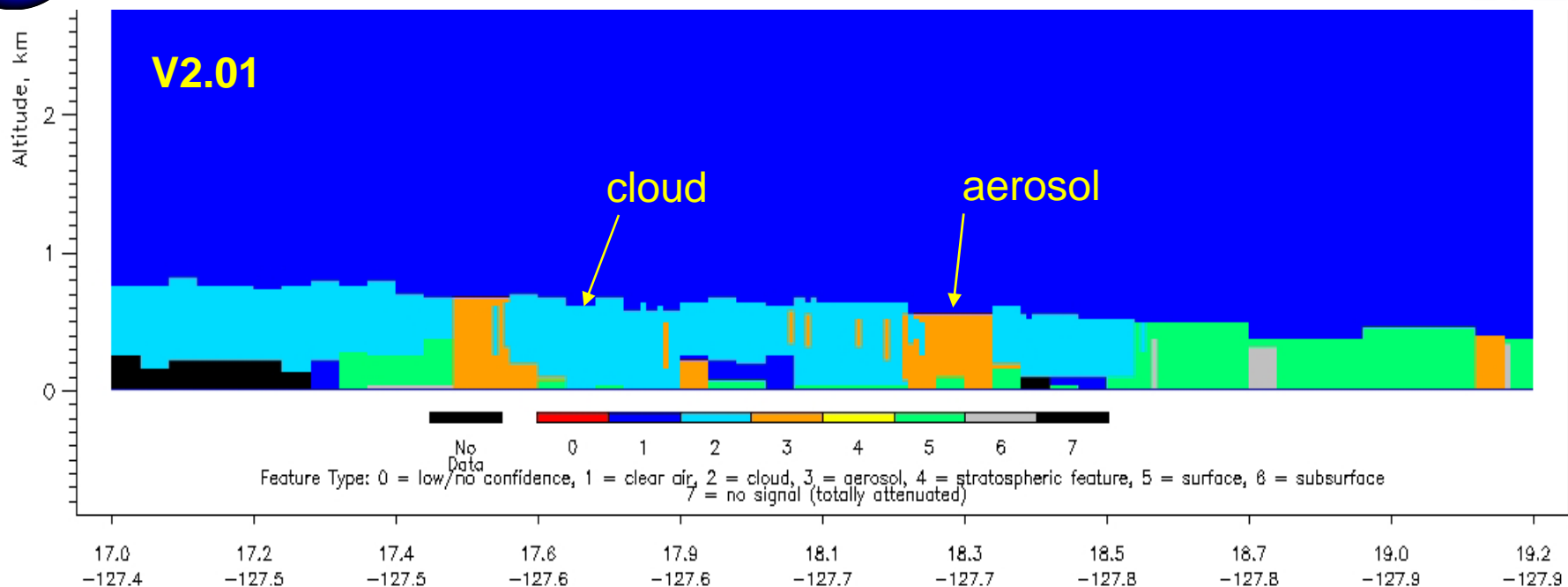


- In Version 2, clouds below 4 km not cleared properly
- Cloud-contaminated aerosol classified as 'cloud'
- Cloud-clearing scheme fixed in Version 3

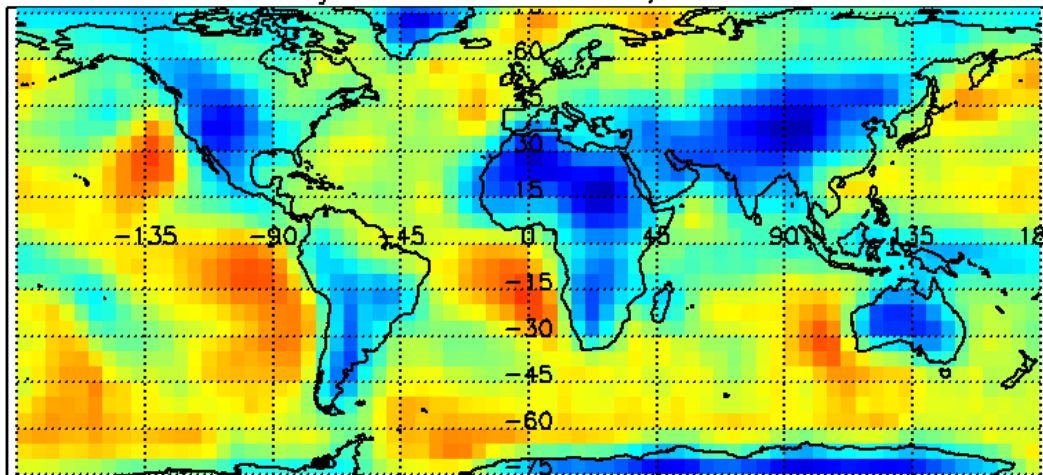




Trade cumulus scene



January 2007 Low Cloud Fraction; Version 2.01



Version 2.01

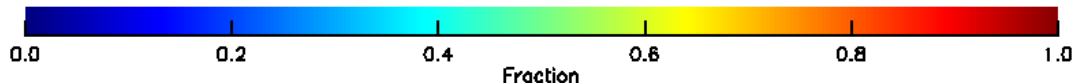
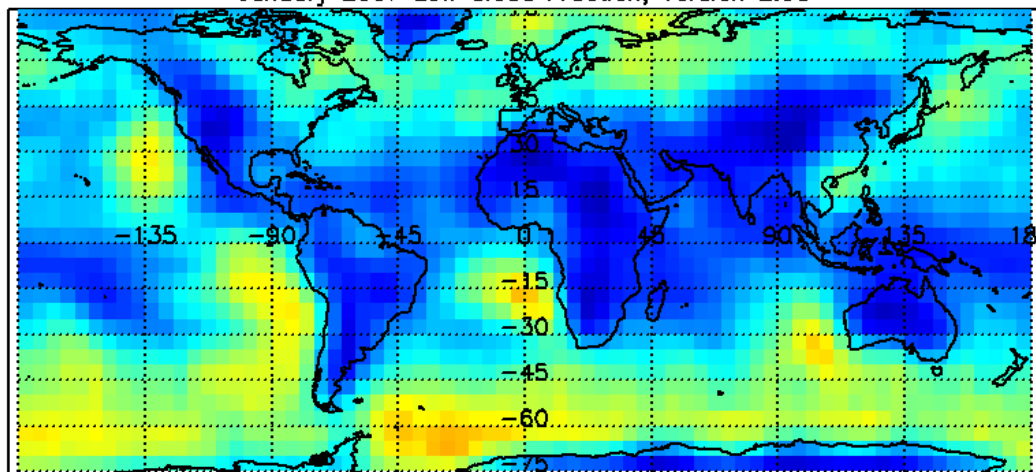
Global mean cover of single-layer low cloud reduced from 26.1% to 21.8%

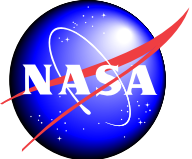
Regional reductions as much as a factor of 5.



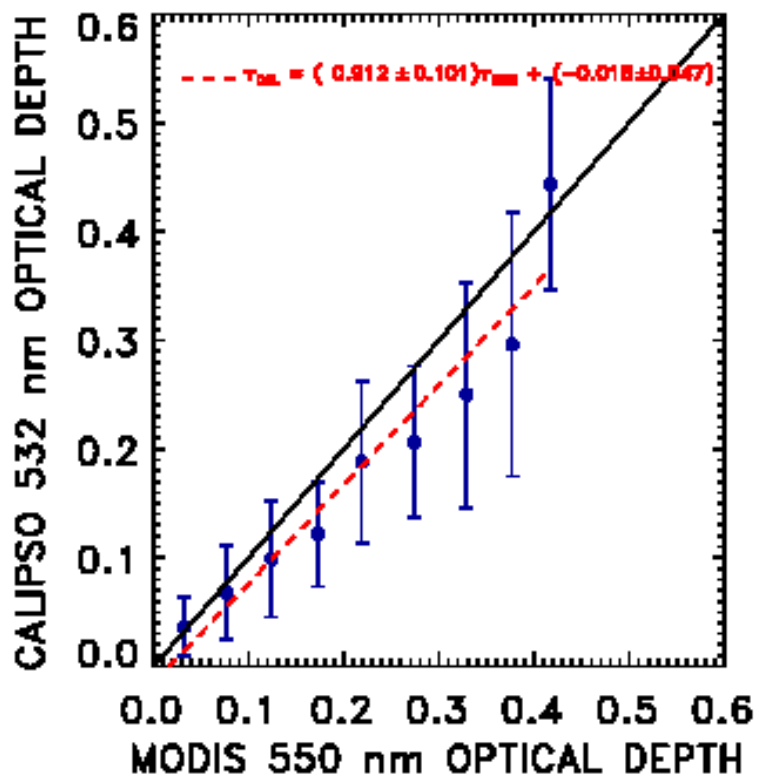
January 2007 Low Cloud Fraction; Version 2.93

Version 3-alpha test

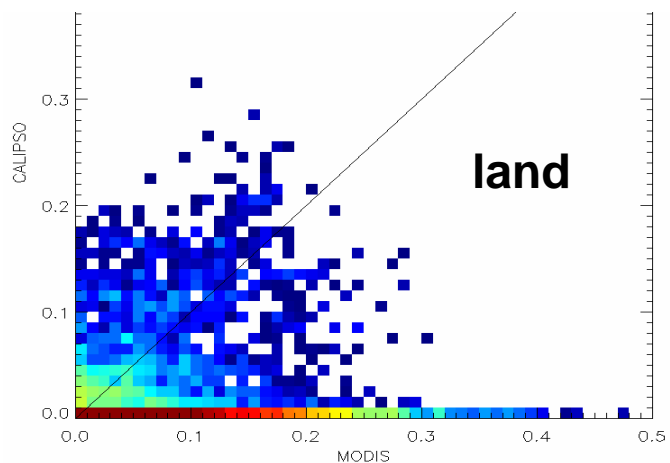
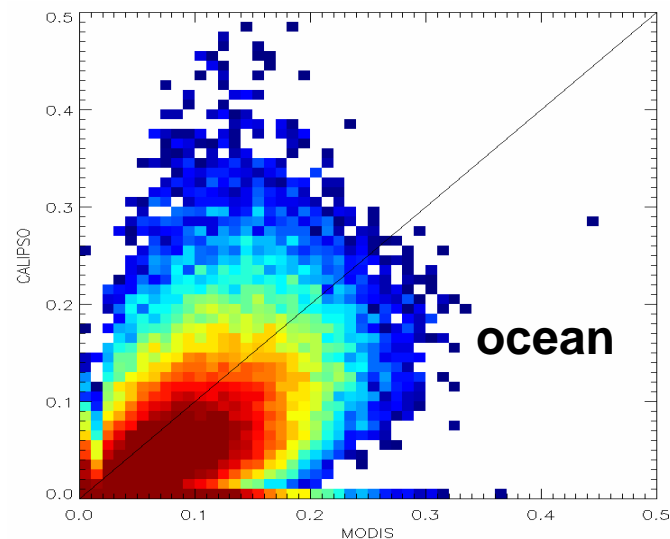




AOD: MODIS vs. CALIOP

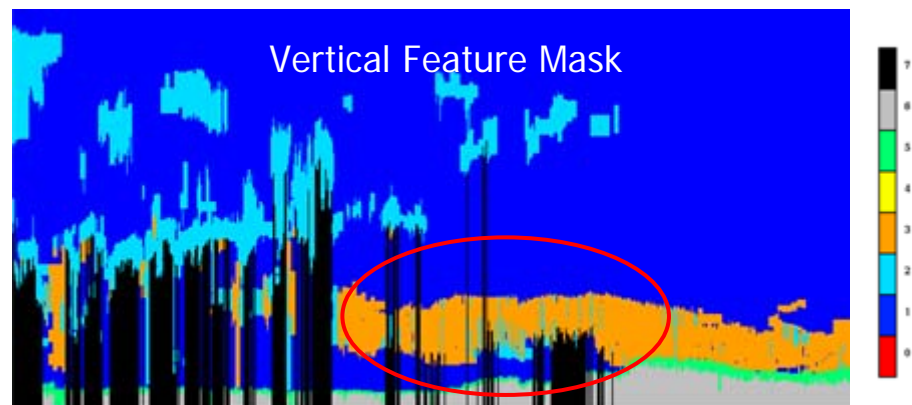
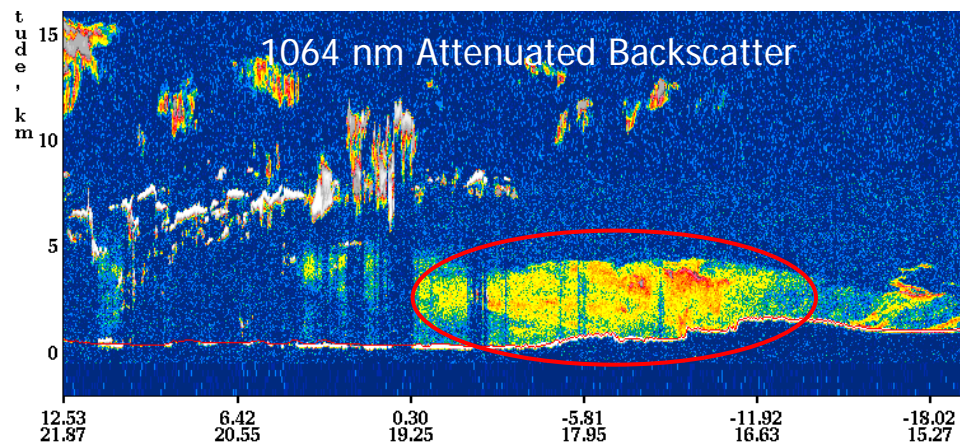
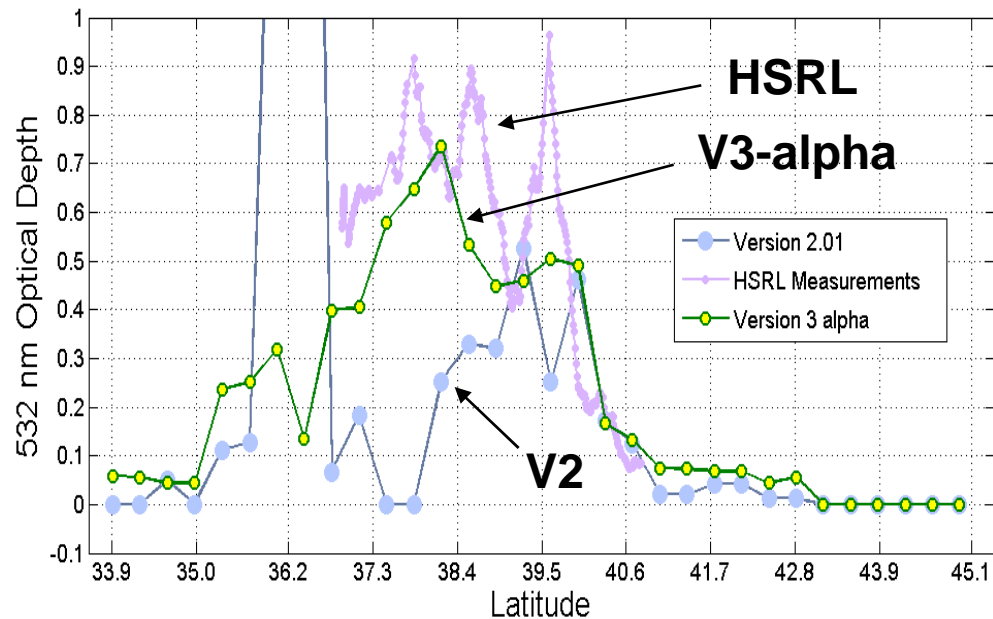
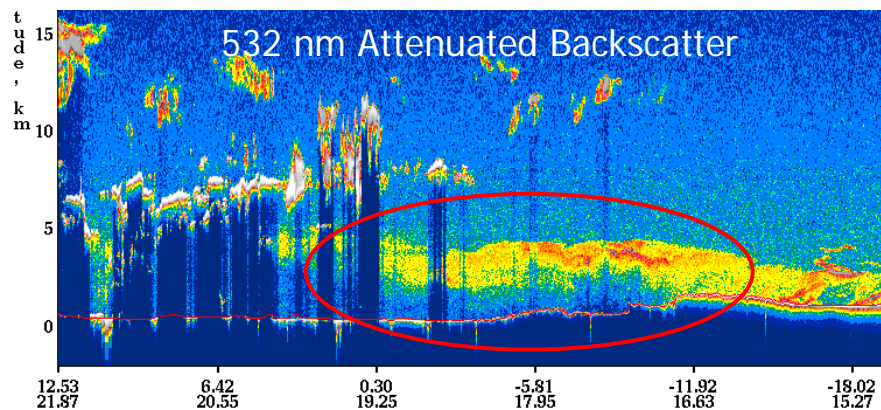


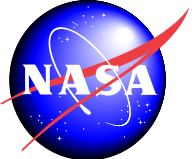
CALIOP AOD vs. MODIS (matched, instantaneous footprints)



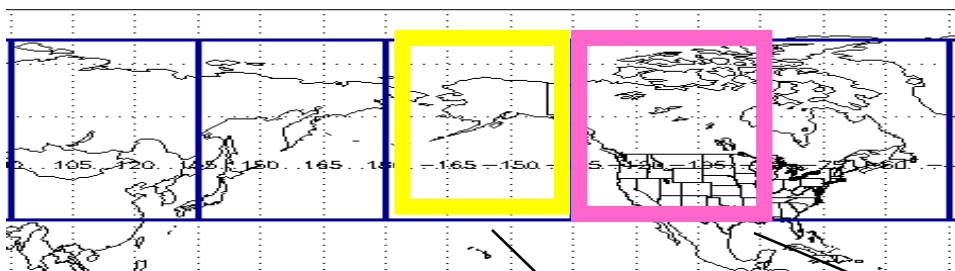
Coakley and Tahnk:

In large, cloud-free ocean regions (to avoid near-cloud effects) find CALIOP AOD agrees well with MODIS, but a small CALIPSO low bias





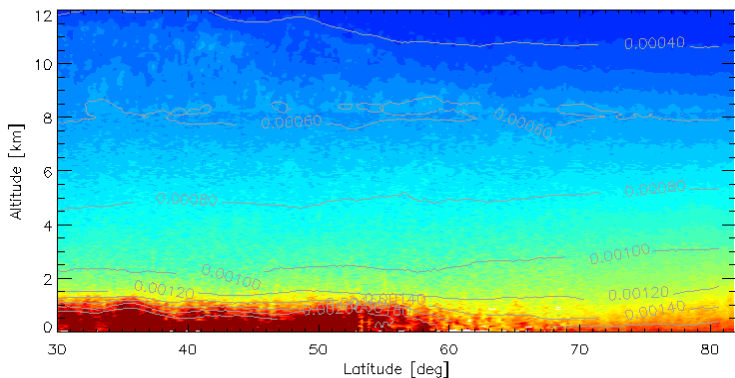
Future Directions (1/2)



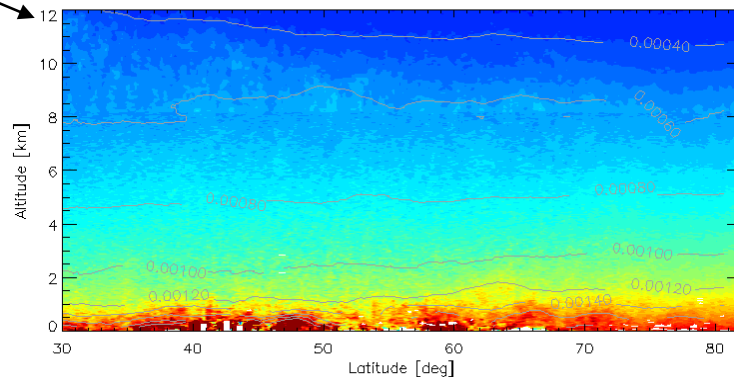
Cloud-cleared, longitudinally averaged attenuated backscatter profiles: aerosol+molecular signal

**2008
Jan**

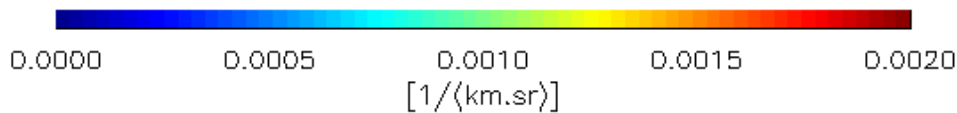
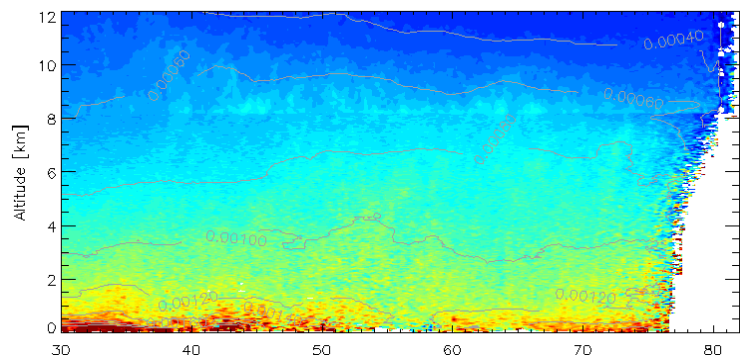
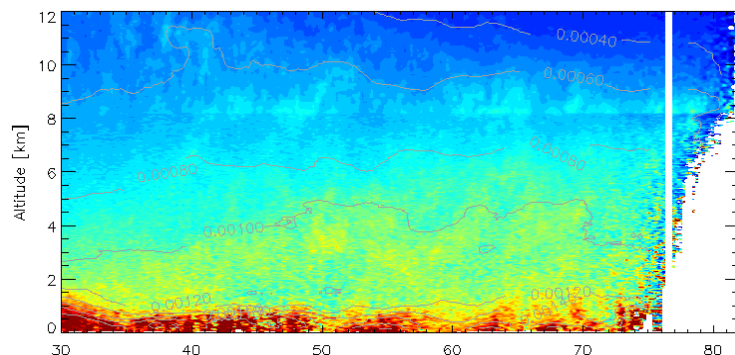
Zonal Mean -180_-135 Attn Bks 532 (ABks_ttl<.01 & ABks_perpen<1e-3)
20080101_20080131 DandN



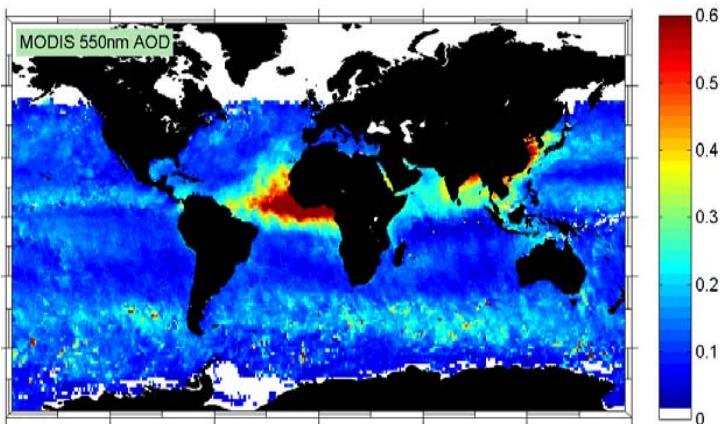
Zonal Mean -135_-90 Attn Bks 532 (ABks_ttl<.01 & ABks_perpen<1e-3)
20080101_20080131 DandN



April

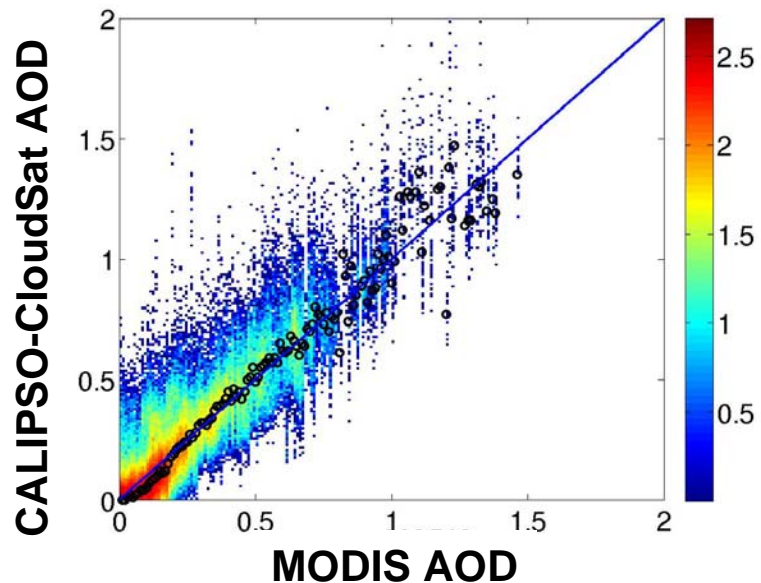
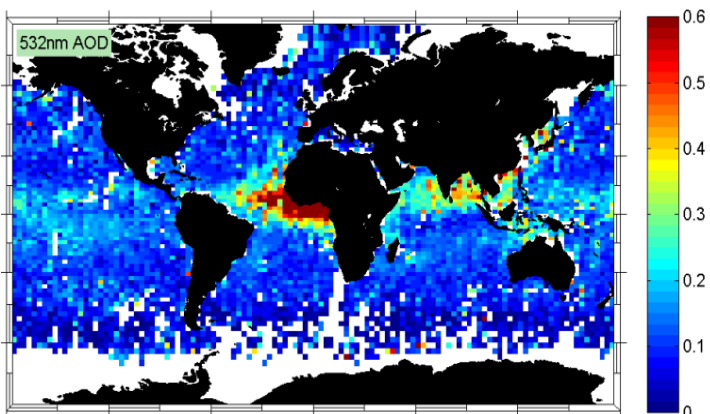


MODIS

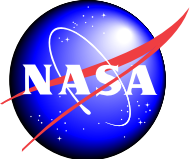


- Ocean surface reflectance depends on wind speed – use **CloudSat** measurements
 - AMSR-E to correct for water vapor
- Column transmission from **CALIOP** surface return
 - gives AOD directly, no microphysical assumptions
 - Current AOD uncertainty ~ 0.05

CALIPSO-SSrefl (preliminary)



(Josset, Pelon, and Hu: IEEE, 2009)

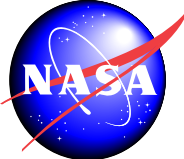


Summary



CENTRE NATIONAL D'ETUDES SPATIALES

- **Three years of data acquired, instrument still healthy**
- **Version 3 data products due soon**
 - All mission data to be reprocessed
- **Further improvements planned after V3**



- Winker, D. M., M. A. Vaughan, A. H. Omar, Y. Hu, K. A. Powell, Z. Liu, W. H. Hunt, and S. A. Young, 2009: “Overview of the CALIPSO Mission and CALIOP Data Processing Algorithms”, *J. Atmos. Oceanic Technol.*, doi:10.1175/2009JTECHA1281.1, in press
- Hunt, W. H, et al., 2009: “CALIPSO Lidar Description and Performance Assessment”
- Powell, K. A., et al., 2009: “CALIPSO Lidar Calibration Algorithms: Part I - Nighttime 532 nm Parallel Channel and 532 nm Perpendicular Channel”
- Liu, Z., et al., 2009: “The CALIPSO Lidar Cloud and Aerosol Discrimination: Version 2 Algorithm and Initial Assessment of Performance”
- Omar, A., et al., 2009: “The CALIPSO Automated Aerosol Classification and Lidar Ratio Selection Algorithm”
- Vaughan, M., et al., 2009: “Fully Automated Detection of Cloud and Aerosol Layers in the CALIPSO Lidar Measurements”
- Hu, Y., et al., 2009: “CALIPSO/CALIOP Cloud Phase Discrimination Algorithm”
- Young, S. A. and M. A. Vaughan, 2009: “The retrieval of profiles of particulate extinction from Cloud Aerosol Lidar Infrared Pathfinder Satellite Observations (CALIPSO) data: Algorithm description”