CATS Data Release Notes
Version Releases: 2.06

26 February 2016

The Cloud-Aerosol Transport System (CATS), launched on 10 January 2015, is a lidar remote sensing instrument that provides vertical profiles of atmospheric aerosols and clouds. The vertical profile information obtained by CATS, particularly at multiple wavelengths and with depolarization information, provides height location of cloud and aerosol layers, as well as information on particle size and shape. The CATS instrument provides measurements of cloud and aerosol profiles similar to CALIPSO, filling in the gap in diurnal coverage of CALIPSO, so this information can continually be used to improve climate models and our understanding of the Earth system and climate feedback processes. Changes in algorithms for our third release corresponding to our Version 2.06 Level 1 data products are described here.

1.0 Algorithm Changes

The following list of algorithm changes were made in Version 2.06:

- Improved the CATS geolocation computation by determining the angle between the ISS point of reference for the position data and CATS instrument.
- Updated the polarization gain ratio (PGR) for 532 nm in Mode 7.1 based on more statistical samples of coincident CPL and CATS data, reducing the PGR term uncertainties.
- Adopted an iterative computation of the molecular folding correction factor (α).
- Adopted the mean of the calibration coefficient data points in each granule as the operational technique for computing the final calibration constant.

- Added the “Alpha_Value” and “Average_Below_Ground_Photon_Count” parameters (for each wavelength and field of view) to the L1B data product for assessment of the α computation by the CATS algorithm team.
- Added the parameter “Calibration_Fit_Flag” (for each wavelength and field of view) to the L1B data product for the derivation of the backscatter uncertainty in the Level 2 products.

2.0 Parameter Specific Comments

CATS Geolocation
For Version 2.05 data over rugged terrain, differences are observed between the Digital Elevation Model (DEM) altitude at the geodetic latitude and longitude of the CATS laser spot and the ground altitude determined from the lidar signal. The angle between the ISS point of reference for the position data and CATS instrument was unknown and assumed to be zero. This assumption is likely a main source of error in the CATS V2.05 geolocation algorithm.

Statistical analysis was performed; comparing the surface altitude detected using the CATS backscatter data to the DEM of the expected ground track (using V2.05 algorithm). From this analysis, the angles between the ISS point of reference for the position data and CATS instrument was determined as 2.00 degrees for yaw, -0.50 degrees for roll, and -0.25 for pitch. These “offset” angles have been incorporated into the V2.06 algorithms. The DEM using the CATS V2.06 algorithm is more accurate, showing the improvement in the CATS footprint geolocation.

Backscatter and Depolarization Ratio at 532 nm
Low depolarization purity at 532 nm (Mode 7.1) caused a high bias in the perpendicular backscatter and depolarization ratio at 532 nm, as well as a low bias in the 1064-532 backscatter color ratio in version 2.04 L1B data. To improve the accuracy of CATS these parameters at 532 nm, this data must be corrected for this poor depolarization purity at 532 nm using a polarization gain ratio (PGR).

The CATS Version 2-04 data release included these PGR terms, which significantly reduced the high biases in CATS 532 nm attenuated total backscatter and depolarization ratio. However, the statistical analysis of these parameters for cirrus clouds still yielded values 10-20% higher than those observed in the CATS 1064 nm data and over 10 years of Cloud Physics Lidar (CPL) data at 1064 nm. This was largely due to uncertainties of as much as 15% in the computed PGR term because of 532 nm data sensitivity to the α parameter and calibration constant.

These PGR values have been updated for V2-06 based on more statistical samples of coincident CPL and CATS data. These additional samples, in combination with the changes made to the derivation of α and the final calibration constant for each granule, reduce the PGR term uncertainties to 4.5% and thus minimize the high biases in the 532 nm attenuated total backscatter and depolarization ratio to 5-10%.

Mode 7.2 532 nm Backscatter

Unlike the Mode 7.1 data, where the 532 and 1064 nm signals are comparable, the Mode 7.2 532 and 1064 nm signals are very different. Mode 7.2 data at 532 nm is noisy due to issues with stabilizing the seeded laser (laser 2). Since the frequency stability is poor on laser 2, it is not aligned properly with the CATS etalon causing very weak signal transmission. Unfortunately we do not have the necessary controls to fix the problem, so we recommend averaging the nighttime data to ***at least*** 5 km (roughly 14 raw 20 Hz profiles) when analyzing the 532 nm data. **We do not recommend using the daytime 532 nm data in Mode 7.2 for any application.**

Due to the signal transmission issues at 532 nm, laser 2 was thermally tuned to increase the laser energy at 1064 nm to 2 mJ per pulse. Thus the 1064 nm signal in mode 7.2 is very robust, with higher signal-to-noise ratio and lower minimum detectable backscatter than the Mode 7.1 data. **We highly recommend using the 1064 nm data for any analysis that is wavelength-independent (i.e. layer detection, relative backscatter intensity).**