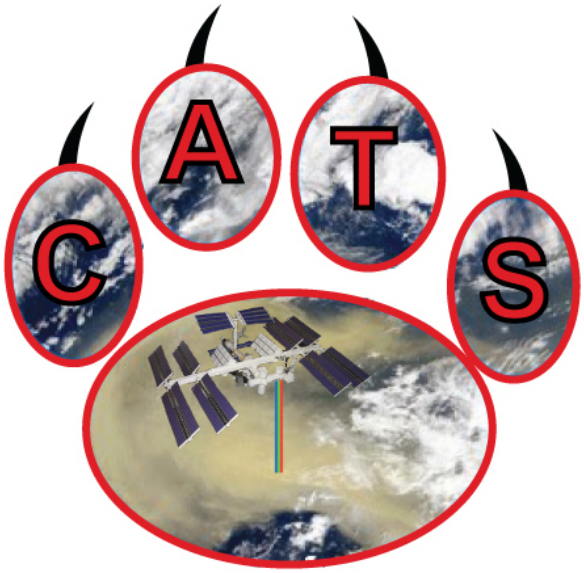

CATS Data Release Notes
L1B Version Releases: 2.07
L2O Version Releases: 1.04

06 June 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 and fourth release corresponding to our Version 2.07 Level 1 data products and Version 1.04 Level 2 data products are described here.

1.0 Algorithm Changes

The following list of algorithm changes were made in L1B Version 2.07:

- The CATS Version 2-06 L1B data release included an error in the algorithm that remaps the raw CATS data to the final CATS data frame (-2.0 to 30.0 km at 60 m vertical resolution). The error caused certain bins in Mode 7.2 to contain the same value of backscatter as the bin above. As a result, layer top and base heights are never detected at these bins in the V1-03 of the L2O data products. For CATS L1B V2-07 and L2O V1-04, this error has been corrected.

The following list of algorithm changes were made in L2O Version 1.04 (V1.03 was the first L2O version released):

- The false positive routine was updated to eliminate falsely detected layers in the upper troposphere and lower stratosphere.
- The layer base bin is decreased by one bin (increase in height) when the base bin is directly above the surface detection. This was done to avoid contamination of the layer-integrated properties of the layer from the surface return signal.
- For L2O V1-04, layers with a base above the tropopause height, or layers with a top above the tropopause height and weak backscatter (IATB < 0.005) are considered aerosols. Previous versions used 18 km as the threshold and not the tropopause height.

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.

Mode 7.1 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).**

The CATS Version 2-06 L1B data release included an error in the algorithm that remaps the raw CATS data to the final CATS data frame (-2.0 to 30.0 km at 60 m vertical resolution). The error caused certain bins in Mode 7.2 to contain the same value of backscatter as the bin above. As a result, layer top and base heights are never detected at these bins in the V1-03 of the L2O data products. For CATS L1B V2-07 and L2O V1-04, this error has been corrected. Users that are analyzing cloud and aerosol top/based height distributions are advised to use the L1B V2-07 and L2O V1-04 data for their analysis. Please note that when using a small amount of data (several granules), layer detection may still favor some bins over others due to interpolation from the raw 78 m vertical bins to the 60 m vertical bins reported in the data products. This affect is very minimal when using large amounts of data (>200 granules). Users that are quantifying statistics of backscatter or depolarization ratio are advised to use the V2-07 data for their analysis. Qualitative studies of approximate vertical distributions and layer boundaries are generally unaffected by the error.