CATS Data Release Notes
L1B Version 2.08
L2O Version 2.00
L2O Version 2.01

01 Sept. 2017

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 sixth release corresponding to our Version 2.08 Level 1 data products, Version 2.00 Level 2, and Version 2.01 Level 2 data products are described here. **Shortly after the CATS Version 2-00 L2O data products for Mode 7.2 were released, three issues were identified in the Version 2-00 L2O data products for Mode 7.2. These issues are described in red in Section 1 and are fixed for CATS Version 2-01 L2O data products.**

1.0 Algorithm Changes

The following lists the algorithm changes made in L1B Version 2.08 (V2-08):

- The backscatter calibrations, and thus accuracy of the attenuated total backscatter profiles, at both 532 and 1064 nm have been improved for CATS V2-08 L1B data. This improved accuracy propagates through many of the L2O data products as well. More details follow in Section 2.0.
- CATS V2-08 L1B data includes a new Depolarization Quality Flag to notify users of granules with depolarization ratio values of poor quality.
- The CATS V2-08 L1B data release includes a new Digital Elevation Model (DEM) from JPL created for CloudSat and CALIPSO. The DEM has a horizontal resolution of ~500 m. For CATS L1B V2-08, the DEM from JPL is interpolated and reported in the data products with a horizontal resolution of 350 m.
- For CATS Version 2-08 L1B and V2-00 L2O, the geolocation is adjusted to correct for granules that have a time offset by comparing the Earth's surface height as determined by the CATS ground signal to the DEM over rugged terrain.
- An algorithm was created to compute the uncertainty in the attenuated total backscatter parameter, which is now reported in the CATS L1B V2-08 data products (1064 nm for Mode 7.2, both wavelengths for Mode 7.1). The CATS V2-07 L1B data release did not include any uncertainty parameters.
- An algorithm to flag and correct erroneous values of 532 nm backscatter and depolarization ratios in Mode 7.1 due to non-linear detection issues was incorporated into the CATS L1B V2-08 data.

The following lists the algorithm changes made in L2O Version 2.00 (V2-00):

- The CATS Version 2-00 L2O data now includes layer detection at both 5 and 60 km horizontal resolutions, as well as a parameter that specifies the horizontal resolution a layer was detected at (called "Horizontal_Resolution_Detection").
- Algorithms were created to compute the uncertainty in all the L2O parameters, which are now reported as absolute uncertainties in the CATS L2O V2-00 data products (1064 nm for Mode 7.2, both wavelengths for Mode 7.1). The CATS V1-05 L2O data release included these uncertainty parameters but they contained fill values (-999.99).
- CATS V2-00 L2O data also includes the new Depolarization Quality Flag from the L1B V2-08 data to notify users of granules with depolarization ratio values of poor quality.
- A new parameter called "Percent Opacity" was added that reports the ratio of the L1B 350 m profiles used for a given L2O 5 km profile in which no surface return was detected TO the total number of L1B 350 m profiles that make up that L2O 5 km profile.
- A second Cloud-Embedded in Aerosol Layer (CEAL) routine of the CATS layer detection algorithm was created to separate a layer into 2 layers if a significant change in the vertical structure of the depolarization ratio is observed.
- Horizontal persistence tests were added to the CATS Cloud-Aerosol Discrimination (CAD) algorithm and aerosol typing algorithm to avoid the superficial "striping" that is visible in the vertical feature mask images for horizontally homogeneous cloud and aerosol layers.

- The CATS aerosol typing routine now employs the GEOS-5 aerosol speciation information along the ISS track to assist the algorithm in differentiating smoke aerosols from polluted continental aerosols over land.
- Threshold values for depolarization-based classification of dust and dust mixture were lowered to 0.25 and 0.15 respectively based on aerosol-type comparisons with CALIPSO.
- The CATS default lidar ratios for marine, marine mixture, dust, and dust mixture were reduced based on results from CALIPSO data, CATS data, and the updates to the CALIPSO V4.10 data products.
- The algorithm to compute extinction and optical depth in cases where the lidar ratio was iteratively reduced in order to process to the bottom of the layer (Extinction QC_Flag = 2 [transparent] or 7 [opaque]) was updated to change the amount that the lidar ratio gets modified from a fixed value of 0.5 to the current lidar ratio adjusted by a scale factor.
- Given the improvements in the quality of the CATS backscatter data, the CATS layer effective multiple scattering factor for ice clouds was updated in V2-00 products to 0.65 (Mode 7.2). The values for Mode 7.1 remained the same (0.423 at 1064 nm and 0.545 at 532 nm).

The following lists the known issues in the L2O Version 2.00 (V2-00) that have been updated in the L2O V2-01:

1. The new variable "Percent Opacity" was not populated with values in the L2O V2-00 data products. The L2O V2-01 data products now contain the correct values.
2. Aerosol layers in direct contact with water clouds were flagged as opaque and the AOD was reported as -1. This was due to an error in the CEAL (Cloud Embedded in Aerosol Layer) routine and is ONLY the case for aerosol layers in direct contact with water clouds.
3. No optical properties are reported for aerosol layers directly above water clouds in the L2O V2-00 data products because the CEAL routine did not properly sequence the layers by altitude when separating them. This is ONLY an issue for above cloud aerosol layers in direct contact with water clouds and does not impact the vertical feature mask in the L2O V2-00 data products.

Please note that if you are using the L2O V2-00 data for applications other than aerosol near clouds and atmospheric opacity, then you will not see any difference between L2O V2-00 and V2-01.

2.0 Parameter Specific Comments

CATS Geolocation

A communications defect in which a time lag (1-2 seconds in some cases) from when the ISS position data is collected to when it is included into the CATS data stream occurs. Statistically this time lag is found to be 1 second in 80% of CATS data profiles, so the CATS Version 2-07 L1B data is corrected for this artifact by adjusting the ISS position data by 1 second. However, the time lag is not constant so instances when the time lag is

not 1 second do occur. For CATS Version 2-08 L1B, an algorithm was created to compare the Earth's surface height as determined by the CATS ground signal to the DEM over rugged terrain. An offset is computed and the geolocation is adjusted to correct for these cases when the time offset is not 1 second. The Earth's surface height as determined by the CATS ground signal now compares very well with the new JPL DEM, showing the improvement in the CATS footprint geolocation.

Attenuated Total Backscatter at 532 nm (Mode 7.1) and 1064 nm (both modes)
The backscatter calibrations at both 532 and 1064 nm have been improved for CATS Version 2-08 L1B data. Detailed comparisons of CATS V2-07 1064 nm attenuated total backscatter data with CALIPSO 1064 nm data and modeled Rayleigh 1064 nm profiles revealed a low bias in CATS V2-07 attenuated total backscatter values due to higher uncertainties in the correction for molecular folding than expected. For V2-08, the molecular folding correction factor, alpha, is computed every 10 seconds (as opposed to once per granule in earlier versions) and more iterations were added. In addition, the altitude range for computing solar background counts was changed to 33-35 km to remove effects of multiple scattering from liquid water clouds near the surface. The molecular folding slope (22-26 km) and calibration (now 22-26 km) altitudes were also adjusted for more accurate estimates and consistency with one-another. These changes result in CATS 1064 nm attenuated total backscatter (Mode 7.2) that compare very favorably with CALIOP and modeled Rayleigh profiles at the same wavelength. Given that the 1064 nm attenuated total backscatter is used to retrieve nearly all L2O data products, the accuracy of these products has also improved.

Mode 7.2 532 nm Attenuated Total 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 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).**

Attenuated Backscatter Uncertainty, 532 nm (Mode 7.1) and 1064 nm (both modes)
The CATS Version 2-07 L1B data release did not include any uncertainty parameters. An algorithm was created to compute the uncertainty in the attenuated total backscatter parameter based on propagation of errors primarily from the calibration constant and signal noise. For L1B V2-08, the uncertainty in the attenuated total backscatter is reported for each 350 m profile and 60 m range bin. The values reported will be absolute

uncertainties, not relative, thus the units will be identical to the units of the attenuated total backscatter (km^{-1} sr^{-1}). The 532nm attenuated total backscatter uncertainty is only reported from Mode 7.1, not for Mode 7.2 due to the poor signal quality discussed above.

1064 nm Attenuated Perpendicular Backscatter and Depolarization Ratio

CATS V2-07 1064 nm depolarization ratios within cirrus clouds for Mode 7.2 yielded more variability than expected compared to CPL 1064 nm and CALIOP 532 nm data. When the CATS laser begins operation after being turned off (for ISS activities, instrument reboots, etc.), the laser polarization is not pure. This results in inaccurate depolarization values for several granules, depending on how long the laser was off, until the laser polarization stabilizes.

CATS Version 2-08 L1B data includes a new Depolarization Quality Flag to notify users of granules with depolarization ratio values of poor quality. Granules with suspect depolarization values are now indicated with values of 1 or 2 in the Depol_Quality_Flag variable and users should only use granules with Depol_Quality_Flag = 0 for studies of particle sphericity. Users should also be cautious when using any L2O data for the suspect granules, as the algorithms for cloud phase and aerosol type use depolarization ratio. The Mode 7.1 laser does appear to suffer from a similar issue, but not to the same extent. That laser stabilizes more quickly.

Table 1. Definitions of the CATS Depolarization Quality Flag

Interpretation of Values
0 = Valid, good quality depolarization data
1 = Depolarization ratio biased low due to recent laser turn on
2 = Depolarization ratio biased high as laser stabilizes

Mode 7.1 Backscatter and Depolarization Ratio at 532 nm

As with earlier versions of CATS L1B data, a unique polarization gain ratio (PGR) is used to improve the accuracy of CATS backscatter and depolarization ratio at 532 nm due to low depolarization purity at 532 nm (Mode 7.1). However, the statistical analysis of these parameters for cirrus clouds still yielded values 5-10% 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 larger uncertainties in the calibration constant and correction for molecular folding than expected, as well as erroneous values due to non-linear detection issues.

For V2-08, the algorithms for backscatter calibration and molecular folding correction were updated for Mode 7.1 at both 532 and 1064 nm just as they were in Mode 7.2. More iterations were added to the molecular folding computation, and the altitude range for computing solar background counts, molecular folding slope, and calibration were all changed to 22-26 km, making all three computations consistent. This results in CATS 532 and 1064 nm attenuated total backscatter (in Mode 7.1) that compare very favorably with CALIOP and modeled Rayleigh profiles at the same wavelength.

The 532 nm backscatter and depolarization ratios in Mode 7.1 CATS Version 2-07 L1B data release included erroneous values due to non-linear detection issues. These values only occurred in 532 nm daytime data in Mode 7.1 when the raw CATS photon counts exceeded a certain value, and was only found in <1% of the CATS Mode 7.1 data. However, it did cause erroneously low 532 nm attenuated total backscatter values. An algorithm to flag and correct these data was incorporated into the CATS L1B V2-08 data. The corresponding flag is found in the first bit of the "Quality_Control_Flag".

Another issue data (only for 532 nm Mode 7.1 data) users should be aware of is unexpected non-linear behavior of the CATS data system at high photon count rates (similar but separate from detector deadtime). This issue is not found in nighttime data, and only present in ~1% of daytime data, but cause erroneous backscatter values for profiles with during local midday with highly scattering clouds present, which cause high solar background and count rates. An algorithm to correct these data was incorporated into the CATS L1B V2-08 data, but users that want to do quantitative statistical analysis of CATS data should filter out these profiles using the First Saturated Bin Index (532 nm) described in CATS L1B Quality Statements document. If the First Saturated Bin Index at 532 nm is set to 1 for a given profile, then that profile is affected by this issue and should not be included in the analysis.

Mode 7.2 532 nm Integrated Attenuated 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. **We do not recommend using the 532 nm integrated attenuated backscatter in Mode 7.2 for any application.** In fact, very few parameters are reported at 532 nm in CATS L2O products due to the increased noise.

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/extinction intensity).**

Number of Layers, Layer Top/Base Altitude

The CATS L2O V1-05 layer detection was only performed at a 5 km horizontal resolution. Strongly scattering layers are more accurately detected than weakly scattering layers, especially during daytime. Because signal-to-noise ratios (SNR) are higher during nighttime compared to daytime, nighttime detection of features is easier than daytime. This is typical for all lidar systems. Comparisons of global aerosol detection frequencies and thin cloud fractions with CALIPSO V4.10, which uses several horizontal resolutions up to 80 km, exhibited a lack of detection of thin cirrus clouds and aerosol layers in CATS L2O V1-05, especially over land during daytime. **The CATS V2-00 L2O data**

now includes layer detection at both 5 and 60 km horizontal resolutions, as well as a parameter that specifies the horizontal resolution a layer was detected at. The reported number of layers, and corresponding layer properties are the merged product of layers detected at both 5 and 60 km. Layers detected at 60 km are reported in the 12 corresponding 5 km profiles, with the same top and base altitudes. The CATS V2-00 L2O data now reports more layers than the V1-05, especially during daytime over land. Initial comparisons of CATS V2-00 and CALIPSO V4.10 cloud and aerosol detection frequencies are much more favorable during daytime.

Also, the base bin/altitude reported may not be the true base. For highly scattering features, the layer base may appear lower than it really is due to multiple scattering effects and opaque layers that completely attenuate the backscatter signal will cause the reported base to be higher than reality.

For L2O V1-05, 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 aerosol layers near the surface from the surface return signal.

The CATS V2-00 L2O data now separates layers that show distinct differences or layering in depolarization ratio. This is common when dust aerosols are directly above and in contact with marine aerosols, or when thick clouds contain both ice particles near the top of the cloud and liquid water particles near cloud base. A second Cloud-Embedded in Aerosol Layer (CEAL) routine of the CATS layer detection algorithm was created to separate such a layer into 2 layers if a significant change in the vertical structure of the depolarization ratio is observed. This results in more layers detected in CATS V2-00 L2O, and more accurate aerosol typing and cloud phase determination.

Horizontal Resolution of Layer Detection

The horizontal resolution an atmospheric layer was detected at is reported for each atmospheric layer within a 5 km profile. The values correspond to the horizontal resolution needed to detect that specific layer. There are only three values that can be reported:

- 0 = a layer was not detected
- 5 = the layer was detected at 5 km
- 60 = the layer was detected at 60 km

Layers detected at 60 km are common in the CATS L2O V2-00 daytime data, but rarely reported in the nighttime data, as these layers are typically detected at 5 km.

Percent Opacity

The quantification of opacity is reported for each 5 km CATS L2O V2-00 profile. The values correspond to the fraction of the total number of L1B 350 m profiles that make up that L2O 5 km profile in which no surface return was detected. For CATS, a profile is considered opaque if no surface return is detected in all L1B 350 m profiles that make up that L2O 5 km profile. The opacity flag has a value of either 1 (opaque profile) or 0 (transparent profile). Thus, the percent opacity will be 1.0 for opaque profiles, and some

value less than 1.0 for transparent profiles. Please note that the opacity flag distinguishes when the backscatter signal becomes completely attenuated due to that feature.

Feature Type
Based on statistical comparisons of CATS L2O V1-05 cloud and aerosol detection frequencies with CALIPSO, and aerosol type with GEOS-5, it was determined that the CATS Cloud-Aerosol Discrimination (CAD) algorithm was incorrectly classifying liquid water clouds as lofted dust mixture or smoke aerosols. This is partly due to enhanced depolarization ratios within water clouds due to multiple scattering, and an inability to utilize the backscatter color ratio in the CAD algorithm due to the noisy 532 nm backscatter data. Since true lofted dust and smoke layers tend to have large horizontal extent, a horizontal persistence test was added to the CATS Cloud-Aerosol Discrimination (CAD) algorithm for L2O V2-00 to identify liquid water clouds with enhanced depolarization ratios of small horizontal extent and correctly classify them as clouds. The result is a reduction of dust mixture and smoke aerosol detection over remote parts of the Earth's oceans in CATS L2O V2-00 data.

Aerosol Type
The CATS L2O V1-05 aerosol typing algorithm was unable to classify polluted continental aerosols over water, as the algorithm required surface type and layer elevation and thickness criteria for discriminating spherical smoke and polluted continental aerosols owing to similarity between backscatter and depolarization properties. Therefore, in the V2-00 aerosol typing algorithm, simulated aerosols from the NASA Goddard Earth Observing System version 5 (GEOS-5) model are incorporated to help discriminate smoke from polluted continental aerosols when CATS observations (surface type, layer elevation, and layer thickness) alone could not identify an aerosol type for spherical aerosols. Aerosols in GEOS-5 are constrained by the utilization of the MODIS derived Quick Fire Emission Database (QFED) for carbonaceous aerosols, the use of advanced emission inventories of nitrates and sulfates, and through the assimilation of MODIS Aerosol Optical Thickness (AOT) for constraining the aerosol loading.

The CATS aerosol typing routine for L2O V2-00 now employs the GEOS-5 aerosol speciation information sampled along the ISS track to assist the algorithm in differentiating smoke aerosols from polluted continental aerosols over land only when GEOS-5 simulates an aerosol layer within the detection limits of CATS at the exact altitude of the CATS observed aerosol layer. The result is an increase of polluted continental aerosol detection, particularly over water, and a decrease in smoke aerosol detection over highly populated regions of the Earth (China, Europe, Eastern U.S.) in CATS L2O V2-00 data.

Comparing the frequency of occurrence of aerosol type between CATS and CALIPSO, it was determined that CATS had a high bias in smoke layers in regions where smoke is known to mix with dust (e.g. south Asia). Therefore, CATS depolarization-based thresholds for classifying dust and dust mixture were reduced from 0.30 and 0.20 to 0.25 and 0.15, respectively.

Superficial "striping" is also visible in the CATS L2O V1-05 aerosol type browse images for horizontally homogeneous dust and smoke aerosol layers. Horizontal persistence tests were added to the CATS aerosol typing algorithm to avoid this "striping" and report aerosol types that are more consistent with the profiles in an 80 km range surrounding a specific 5 km CATS L2O V2-00 profile.

Lidar Ratio

The particulate extinction-to-backscatter ratio, or lidar ratio, is required to retrieve extinction and backscatter coefficient profiles, as well as optical depth from CATS measurements. For aerosols in CATS L2O V1-05, the lidar ratio is assigned from a look-up table based on the aerosol type and the values are very similar to those used in CALIPSO V3, CPL and GLAS algorithms, as shown in Table 2. For transparent layers in which the AOD, and thus extinction coefficient, can be directly retrieved (or "constrained) using the transmission loss through the layer, the lidar ratio can be directly retrieved. Using this technique, CATS V1-05 data yielded mean smoke and dust lidar ratios at 1064 nm of 42 and 38 sr, respectively. Given this value for dust, and the CALIPSO V4.1 default 1064 nm lidar ratios for dust of 44 sr, the CATS L2O V2-00 default lidar ratio values for dust and dust mixture have been changed to 40 sr (Table 2). Also due to recent results from AERONET and CALIPSO V4.1 default 1064 nm lidar ratios for marine of 23 sr, the CATS L2O V2-00 default lidar ratio values for marine and marine mixture have been changed to 25 and 30 sr, respectively (Table 2).

Table 2: CATS 1064 nm Aerosol Default Lidar Ratios

Aerosol Type	V1-05	V2-00
Marine	45.0	25.0
Marine Mixture	40.0	30.0
Dust	55.0	40.0
Dust Mixture	45.0	40.0
Clean/Background	35.0	35.0
Polluted Continental	35.0	35.0
Smoke	40.0	40.0
Volcanic	35.0	35.0

Feature/Column Optical Depth, Extinction Coefficient

The optical depth of all atmospheric particulate layers, clouds, and aerosol throughout the column are reported for each 5 km profile, regardless of the lidar ratio selection method. Histograms of CATS L2O V1-05 cirrus optical depth exhibit a peak in the frequency distribution around a COD of 2.7 as a result of the CATS "modified default" lidar ratio algorithm. This issue is only apparent in CATS L2O V1-05 data when computing extinction and optical depth in cases where the lidar ratio was iteratively reduced in order to process to the bottom of the layer (Extinction QC_Flag = 2 [transparent] or 7 [opaque]). The algorithm was updated for CATS L2O V2-00 to change the amount that the lidar ratio gets modified from a fixed value of 0.5 to the current lidar ratio adjusted by

a scale factor. The value of scale factor is related to the two-way transmittance of the last high quality bin and/or the relative progress through the layer of the last high quality bin, depending on the situation. For cases where the lidar ratio was increased in order to stay within transmittance bounds (Extinction QC Flag= 3), the interval of the iteration remains a fixed value of 0.5.

Given the improvements in the quality of the CATS backscatter data, the CATS layer effective multiple scattering factor for ice clouds was updated in V2-00 products to 0.65 (Mode 7.2). This change will also impact the retrievals of extinction and feature optical depth. The values for Mode 7.1 remained the same (0.423 at 1064 nm and 0.545 at 532 nm).

L2O Uncertainty Parameters

For version 1.05, the uncertainty in all the various L2O parameters in the Layer and Profile products contain fill values (-999.9). For V2-00, algorithms were created to compute the uncertainty in all the L2O parameters, which are now reported as absolute uncertainties in the CATS L2O V2-00 data products (1064 nm for Mode 7.2, both wavelengths for Mode 7.1). The uncertainty parameters provided in the L2O V2-00 Layer product are reported for each layer within a 5 km profile, and include:

- Integrated Attenuated Backscatter Uncertainty (1064 nm Mode 7.2, 532 & 1064 Mode 7.1)
- Integrated Volume Depolarization Ratio Uncertainty (1064 nm Mode 7.2, 532 & 1064 Mode 7.1)
- Integrated Spectral Depolarization Ratio Uncertainty (Mode 7.1)
- Integrated Attenuated Total Color Ratio Uncertainty (Mode 7.1)
- Measured Two-Way Transmittance Uncertainty (1064 nm Mode 7.2, 532 & 1064 Mode 7.1)
- Feature Optical Depth Uncertainty (1064 nm Mode 7.2, 532 & 1064 Mode 7.1)
- Ice Water Path Uncertainty (1064 nm Mode 7.2, 532 & 1064 Mode 7.1)

The uncertainty parameters provided in the L2O V2-00 Profile product are reported for each 5 km profile and 60 m range bin (except the column OD parameters, which are reported once for each profile) in which a layer is detected, and include:

- Particulate Backscatter Coefficient Uncertainty (1064 nm Mode 7.2, 532 & 1064 Mode 7.1)
- Total Depolarization Ratio Uncertainty (1064 nm Mode 7.2, 532 & 1064 Mode 7.1)
- Extinction Coefficient Uncertainty (1064 nm Mode 7.2, 532 & 1064 Mode 7.1)
- Ice Water Content Uncertainty (1064 nm Mode 7.2, 532 & 1064 Mode 7.1)
- Column Optical Depth Uncertainty (1064 nm Mode 7.2, 532 & 1064 Mode 7.1)
- Cloud Optical Depth Uncertainty (1064 nm Mode 7.2, 532 & 1064 Mode 7.1)
- Aerosol Optical Depth Uncertainty (1064 nm Mode 7.2, 532 & 1064 Mode 7.1)

The L2O V2-00 are considered provisional and are still being tested. They may be updated in future data product versions.