Release Notes for TRMM/GPM SLH V08

March 2026

For the GPM SLH V08, the LUTs are built separately for the tropics, midlatitudes, and tropical great mountain ranges, as in GPM SLH V07. The separation among the three regimes should be done referring to the rainTypeSLH values stored in the orbital data, and described in Table 1. TRMM SLH V08 algorithm is the same as the GPM SLH V08 algorithm.

The LUT for mid and higher latitudes was newly developed in the GPM SLH V05. In the TRMM/GPM SLH V06A, the same LUT for mid and higher latitudes is applied and LUT for tropics is the same as TRMM SLH V7A. In the GPM SLH V07, the LUTs for tropical great mountain ranges were newly developed, for which only latent heating is retrieved. In the GPM SLH V08, Q1R and Q2 are newly retrieved, and the LUTs were reconstructed using additional simulation results. The areas of the tropical great mountain ranges are shown in Figure 1. Some recommendations to users of orbital data are listed below, for TRMM/GPM SLH V06A retrieved as tropical precipitation or those as mid latitude precipitation.

The SLH algorithm and Tables are the same as TRMM SLH V7A for the tropics. As for the midlatitudes, the algorithm is the same as GPM SLH V07, while Tables are updated to amend some coding errors. In addition, there are changes in input PR/KuPR Level 2 data (2APR/2AKu) as well as input variables from Near-Surface Rainfall to Estimated Surface Rainfall except for tropical great mountain ranges. As a result, TRMM/GPM SLH V08 products differ from TRMM SLH V7A and GPM SLH V07 products, respectively.

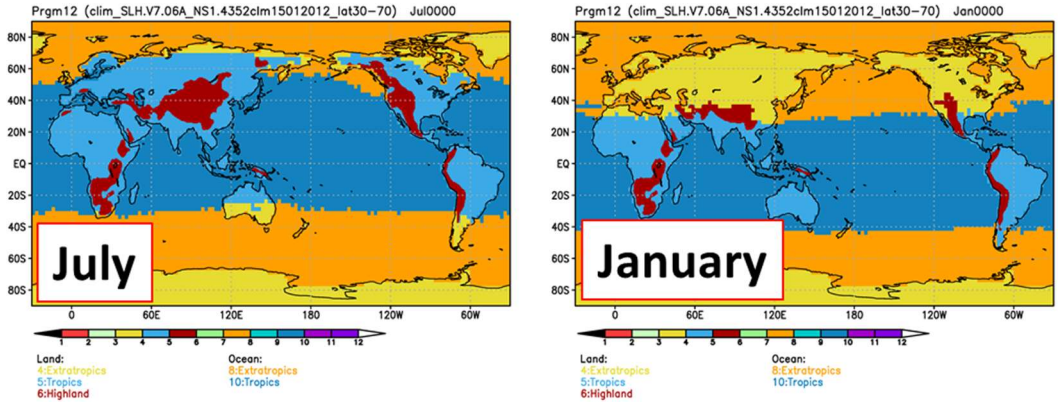

Figure 1 Distribution of the areas (6: Highland) which the LUTs for tropical great mountain ranges are applied with the areas (5: Tropics over Land and 10: Tropics over Ocean)

where the LUTs for tropics are applied and the areas (4: Extratropics over Land and 8: Extratropics over Ocean) where the LUTs for mid and higher latitudes are applied for July (left) and January (right).

Table 1. Description for rainTypeSLH

(a) Tropics and subtropics	(b) Mid and higher latitudes	(c) Tropical great mountain ranges
0: No precipitation	100: No precipitation	200: No precipitation
11: Convective	111: Convective	211: Convective over high-elevation areas 212: Convective over low-elevation areas
21: Shallow stratiform	121: Shallow stratiform	221: Shallow stratiform over high-elevation areas 222: Shallow stratiform over low-elevation areas
31: Deep stratiform 32: Deep stratiform, DI (Intermediary)	131: Deep stratiform, DD, Pmax aloft 132: Deep stratiform, DD, Pmax NS 133: Deep stratiform, DI, Pmax aloft 134: Deep stratiform, DI, Pmax NS 135: Deep stratiform, subzero, Pmax aloft 136: Deep stratiform, subzero, Pmax NS	231: Deep stratiform, DD, Pmax aloft 232: Deep stratiform, DD, Pmax NS 233: Deep stratiform, DI, Pmax aloft 234: Deep stratiform, DI, Pmax NS 235: Deep stratiform, subzero, Pmax aloft 236: Deep stratiform, subzero, Pmax NS
61: Other, Applying table for rainTypeSLH=21	161: Other	261: Other, Applying table for rainTypeSLH=221 262: Other, Applying table for rainTypeSLH=222 263: Other, Applying table for rainTypeSLH=231 264: Other, Applying table for rainTypeSLH=232 265: Other, Applying table for rainTypeSLH=233 266: Other, Applying table for rainTypeSLH=234 267: Other, Applying table for rainTypeSLH=235 268: Other, Applying table for rainTypeSLH=236
Mask		
900: Areas with low melting levels including some mountains except for tropical great mountain ranges 910: Suspicious extreme 920: No precipitation in SLH (precipRate < 0.2 mm/h (0.3 mm/h for tropics) or precipitation depth < 500m) but precipitation exists in 2Aku		

DI: Downward Increasing, DD: Downward Decreasing, NS: Near Surface

(i) Recommendation for horizontal averaging at the utilization of pixel products calculated with the tropical and mid-latitude algorithms for SLP or SLG.

When utilizing pixel-based products for LH estimation using GPM DPR algorithms, horizontal averaging is recommended to reduce the root mean square error (RMSE) between estimated values and model-simulated precipitation. While a general baseline of approximately 50×50 km (equivalent to 100 pixels in GPM DPR sampling) is often cited, the optimal scale depends on the specific algorithm and geographical region.

For the tropics and subtropics, a horizontal averaging scale of approximately 30 km is recommended (Shige et al. 2007). This scale is chosen to stabilize the LH profiles derived from the SLP algorithm by accounting for the spatial representativeness of convective elements. In contrast, for mid and higher latitudes, a broader averaging scale of 100×100 km is recommended to effectively account for the characteristics of mid-latitude weather

systems and the requirements of the SLG algorithm (Hamada et al. 2025).

(ii) No precipitation or Masked out pixels (rainTypeSLH=0, 100, 200, 300, 900, 910, or 920)

SLH values are not estimated (missing) for raintypeSLH=900 or 910.
SLH values are not estimated (0) for raintypeSLH=0, 100, 200, 300, 920.

(iii) Release note for tropical algorithm (0≦rainTypeSLH <100)

Analysis showed consistency among GPM SLH V04, V05, V06 and TRMM SLH V7A, V07 estimates over the coverage of TRMM/PR during a GPM and TRMM overlapping observation period (April-June 2014). Note that:

0. Vertical levels are 80 levels.
1. In the V06B SLH, there was a shallow stratiform type (raintypeSLH=21). In V07 SLH this type is no longer used. Heating in all shallow pixels with their precipitation top heights (threshold 0.3mm/hr) lower than the melting level is estimated as convective type (raintypeSLH=11).
2. Differences of sampling between TRMM/PR and GPM/KuPR affect SLH estimates. The greater global coverage of the GPM Core Observatory (65°N/S) compared to the TRMM coverage (35°N/S) decreases sampling of GPM/DPR over the coverage of TRMM/PR, especially at around the satellite inclination latitudes of 35°N/S, affecting SLH estimates there.
3. Retrieval for tropical cyclones and high mountains/winter mid-latitudes pixels will be developed.
4. For tropical latent heating provided in 80 levels, users are recommended to smooth the profile vertical for a few levels to avoid the spurious peak at around 0degC level.
5. The tropical algorithm is sometimes applied at high latitudes in summer. In such cases, pixels to which the tropical algorithm are applied and those to which the mid-latitude algorithm are applied are distributed disorderly. This problem will be fixed in future version.

(iv) Release Note for Mid-latitude algorithm (100≦rainTypeSLH<200)

A. In look up table ranges where sampling numbers did not satisfy the criteria, values are discarded or extrapolated from nearest neighbor bins, depending on the

precipitation type. Sampling number criterion is basically 30, but 60 is chosen for deep stratiform LUT with precipitation maximum at the near surface level. Corresponding range for the convective LUT is PTH>11km. Note that in case that a latent heating profile at the candidate bin used for extrapolation has cooling around the middle (or 0.35-0.45) of relative altitudes, for deep stratiform LUT with precipitation maximum at the near surface level, values at the bin are not used for extrapolation and those at its next bin are utilized.

B. Eddy flux convergence in Q1R and Q2 are estimated assuming that the size of "large-scale grids" is 100kmx100km. Therefore, it is recommended to average horizontally in this spatial scale to utilize Q1R or Q2.

C. CorrectionFactorMidlatType is introduced in the SLH V06B algorithm to consider LH associated with small hydrometeors condensed outside of the precipitating area, transported some distance into the precipitating area, and precipitate. However, the application of this factor in the L2 product is inconsistent in terms of pixel-by-pixel estimation. In the SLH V07 algorithm, this factor is not applied to SLP and SLG products but applied to SLM products. The specific value of the correctionFactorMidlatType is stored in the AlgorithmRuntimeInfo in the L2 product and correctionFactorMidlatType in the L3 product.

(v) Release Note for tropical great mountain ranges (200≦rainTypeSLH<300)

A. As in the midlatitude regime, the eddy flux convergence in Q1R and Q2 is estimated assuming a "large-scale grid" size of 100 km × 100 km. Therefore, it is recommended that Q1R and Q2 be horizontally averaged over this spatial scale.

B. The convective–stratiform classification of SLH algorithm is based on the PR/KuPR Level-2 precipitation type. Because the classification criteria were originally designed for deep tropics, shallow convection over the Tibetan Plateau is sometimes misidentified as stratiform. Therefore, to address this in Version 08, shallow stratiform cases with precipitation rates greater than 10 mm h^{-1} are tentatively processed using the convective LUTs. This effectively lowers the H-method "Intensity" threshold, while Masaki & Shige (2026) propose using "Peakedness".

(vi) Release Note for L3 (gridded; SLG and Monthly; SLM) product

From the TRMM/GPM SLH V06A product, we added the unconditional variables (UnCnd) for all rain type, and modified their variable names to include conditional variables (Cnd). Please refer to the ATBD.

[Note about the missing value for conditional mean]

Note that there are two reasons for missing values for conditional mean (LHCndMean, Q1RCndMean, Q2CndMean), which can be discriminated by 'allPix' values as follows.

1. conditional mean is not defined because there is no precipitation in the grid (precipPix=0), when allPix≠0.
2. missing value is given because the grid value is masked out related to the topography, when and allPix = 0.

[Note about CorrectionFactorMidlatType in SLM]

After the SLH V06B algorithm, heating (LH, Q1R, Q2) has been corrected by the CorrectionFactorMidlatType=0.88 in the area where the midlatitude algorithm is applied. In V07, because this factor is changed to be applied to only the SLM product, but not to the SLP product, the monthly mean of the L2 heating divided by the factor corresponds to the SLM product in the midlatitude area.

[Note about sampling in SLM]

Due to the orbital characteristics of the GPM Core Observatory, the monthly product SLM contains sampling biases in latitude and local time. These biases can be eliminated by using data accumulated over three consecutive months. For instance, the coverage is about 83% with a single month, whereas it reaches 100% with three months of data.

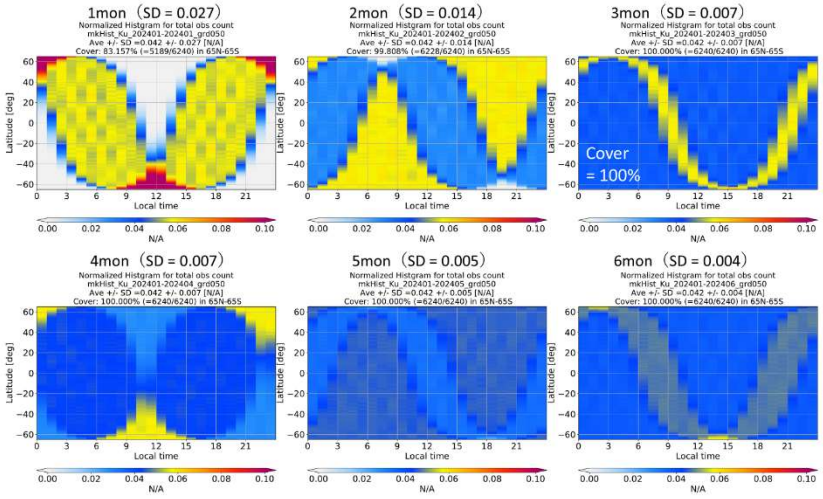

Figure 2 Normalized histogram for the total observation counts during January to June 2024. Panels, arranged from the upper left, show one- to six-month accumulations. The total observation count was calculated using GPM/KuPR Level-2 data and normalized every 0.5-degree of latitude. In each panel, horizontal axis denotes local time (hours), and vertical axis denotes latitude (degrees).