



Read-me for Data Users

MEMORANDUM FOR: The JPSS Program Record
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SUBJECT: NOAA-21 Provisional maturity status
DATE: 10/26/2023

Provisional maturity status declaration for Cloud Top Phase/Type

Maturity Review Date: 10/26/2023
Effective Date: 03/30/2023
Operational System: NCCF, Enterprise Cloud Top Phase/Type v2.2.0, Processing
Version Tag v3r2

The JPSS Algorithm Maturity Readiness Review Board approved the release of the JPSS Enterprise Cloud Top Phase/Type Product (hereafter referred to as “Cloud Phase”) with a Provisional Maturity level quality as of 03/30/2023, based on the JPSS Enterprise Cloud Phase Beta/Provisional Maturity Review held on 10/26/2023.

1. Provisional Maturity Stage Definition

- Product performance has been demonstrated through analysis of a large, but still limited (i.e., not necessarily globally or seasonally representative) number of independent measurements obtained from selected locations, time periods, or field campaign efforts.
- Product analyses are sufficient for qualitative, and limited quantitative, determination of product fitness-for-purpose.
- Documentation of product performance, testing involving product fixes, identified product performance anomalies, including recommended remediation strategies, exists.
- Product is recommended for potential operational use (user decision) and in scientific publications after consulting product status documents.

2. Algorithm Description

The Enterprise Cloud Top Phase/Type Algorithm generates cloud top phase classifications based on radiometric information from three VIIRS bands M14 (8.55 um), M15 (10.7 um), and M16 (12.0) longwave infrared observations. The Cloud Phase product assigns each earth-navigated pixel one of the following classifications: clear sky (based on the clear sky mask generated by the Enterprise Cloud Mask algorithm), liquid water, supercooled liquid water, mixed phase, ice phase, or unknown cloud phase. Aside from the clear sky designation, the classification is relative to the highest cloud layer present. Additional Cloud Type definitions are also provided and outlined below. An extensive



description of the Cloud Phase product may be found in the ATBD delivered to NOAA Enterprise (<http://www.star.nesdis.noaa.gov/jpss/Docs.php>).

VIIRS Cloud Phase product requirements are documented in the [JPSS Ground Segment Data Product Specifications \(DPS\)](#) published in December 2019. It is assumed that the DPS requirements supersede the requirements listed in the JPSS Level1 Requirements Supplement (L1RDS).

The Collection Short Name for the NOAA-21 Cloud Phase product is:

JRR-

CloudPhase_v3r2_n21_sYYYYMMDDSSSSSSSS_eYYYYMMDDSSSSSSSS_cYYYYMMDDSSSSSSSS where YYYY is the year in 4 digits, MM the month, DD the day, and SS the seconds down to the sixth or seventh significant digit depending on whether the reference is to the start time of the granule (s), the end time of the granule (e), or the time it was created (c).

Product requirements published in the JPSS Ground Segment DPS (December 2019) are:

Attribute	DPS	Requirement/Threshold
Coverage	DPS-712	The Cloud Phase product shall provide the cloud phase, globally, day and night, whenever detectable clouds are present, at the refresh rates of the instrument.
Probability	DPS-713	The Cloud Phase product shall provide the cloud phase with an 80% probability of correct typing.

There is no longer a Cloud Type requirement.

The key Cloud Phase product outputs are:

- Cloud Top Phase (6 possible categories)
 - 0 – Clear
 - 1 – Liquid water phase
 - 2 – Supercooled water phase
 - 3 – Mixed phase
 - 4 – Ice phase (opaque, semi-transparent, multi-layered)
 - 5 – Unknown
- Cloud Top Type
 - 0 – Clear
 - 1 – Fog type
 - 2 – Liquid water type
 - 3 – Supercooled water type
 - 4 – Mixed type

- 5 – Optically thick ice type
- 6 - Optically thin ice type
- 7 - Multilayered ice type
- 8 - Cloud type undetermined
- 9 - Overshooting cloud type

Quality flags

The data quality flags for phase are placed in the “CloudPhaseFlag” variable and shown in Table 1. It should be noted that this is a packed byte array. Additional diagnostic flags are included in the “CloudTypePacked” variable. Currently 31 tests are spread over a packed byte array. Section 3.4.3.3 in the ATBD describes these in detail. These are not shown here, as they are designed for programmers and not downstream users.

Table 1. Cloud top phase/type quality flags from the “CloudPhaseFlag” variable.

Bit(s)	Quality Flag Description	Bit Interpretation
1	Overall cloud phase/type product quality flag	0 = high quality 1 = low quality
2	L1b quality flag	0 = high quality spectral data 1 = low quality spectral data
3	Beta ratio quality flag	0 = high quality beta calculation 1 = low quality beta calculation
4	Ice cloud quality flag	0 = ice cloud determination based on strong radiative signal 1 = ice cloud determination based on weak radiative signal (low quality)
5	Surface emissivity quality flag	0 = surface emissivity does NOT significantly impact product quality 1 = surface emissivity significantly impacts product quality (low quality)
6	Satellite zenith angle (SZA) quality flag	0 = SZA does NOT significantly impact product quality 1 = SZA significantly impacts product quality (low quality)

Product evaluation/validation

- Visual comparisons with the NOAA-21 Cloud Phase products generated outside of NCCF using CLAVR-x.
- Visual comparisons of NOAA-21,NOAA-20 and SNPP generated within the NCCF.
- Global zonal ice fraction comparisons.
- Quantitative comparisons to GOES-16/18 Cloud Phase products.

- Quantitative comparisons with the Cloud Layer Product from the NASA CALIPSO/CALIOP sensor.
- Quality flags/variable checks.

Product availability/reliability

NOAA-21 Enterprise Cloud Height Algorithm (ACHA) data v3r2 products have been produced since 03/30/2023.

- Inconsistent dataset production from the NDE Integration and Testing (I&T) string created a somewhat limited dataset for the Provisional Maturity review. A continued lack of a consistently generated global datastream over a longer period of time may produce an insufficient dataset needed for the Validated Maturity evaluation.

Algorithm performance dependence

The performance of the VIIRS Phase product largely depends on the performance of the VIIRS cloud mask product.

Known errors/issues/limitations

- Future validation exercises will be negatively affected by the recent end-of-life status for the NASA CALIPSO mission. CALIPSO/CALIOP products were used as an important validation dataset for S-NPP, NOAA-20, and NOAA-21 Cloud Phase products.
- Any NCCF/NDE issues (e.g. missing SDR granules) will negatively impact the Cloud Phase product.
- The NOAA-21 Phase comparisons to GOES-16/18 show an abnormally high amount of mixed phase pixels in NOAA-21 where ABI shows ice. These tend to appear near cloud edges. This may impact downstream algorithms such as ACHA and AMVs.
- The upstream cloud detection algorithm can lead to clear regions being assigned a cloud thermodynamic phase or cloudy regions being classified as clear sky.
- Optically thin cirrus clouds are sometimes misclassified as liquid water, supercooled liquid water or mixed phase.
- The risk of misclassifying liquid water clouds as ice is greatest in regions with broken cumulus clouds.
- The ability to correctly identify clouds that have both liquid water and ice, within the portion of the cloud influencing the measured VIIRS radiances, is limited.
- The baseline cloud phase classification is sometimes inconsistent with near-infrared based assessments of cloud phase, such as false color imagery constructed with phase sensitive near-infrared spectral channels.

3. Changes Since Last Maturity Stage

- This is a combined Beta and Provisional Maturity review, so this is the first formal NOAA-21 Cloud Phase review.



4. Review Board Recommendations

- None

5. Path Forward/Future Plan

- Identify new validation datasets since CALIPSO will no longer be available
- Possible transition to Cloud Phase derived from the current Enterprise Cloud Mask (ECM) algorithm in the future. Comparisons between the current Cloud Phase algorithm and the ECM phase will be undertaken.

6. Additional Items to Note

- The Cloud Team welcomes any feedback on user issues and suggestions to improve Cloud Phase performance.

Additional information is available in the Cloud Phase algorithm theoretical basis document (ATBD) and validation maturity review briefing, which can be accessed at:

<http://www.star.nesdis.noaa.gov/jpss/Docs.php>

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