



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 Properties (CTP)

Maturity Review Date: 10/26/2023
Effective Date: 03/30/2023
Operational System: NCCF, Enterprise Cloud Top Properties Version v2.4.1, Processing Version Tag v3r2

The JPSS Algorithm Maturity Readiness Review Board approved the release of the JPSS Product Enterprise Cloud Top Properties (CTP) with a Provisional Maturity level quality as of 03/30/2023, based on the JPSS [Enterprise Cloud Top Properties Beta/Provisional Validation 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 Properties algorithm - also known as the Algorithm Working Group Cloud Height Algorithm (ACHA) - generates the cloud-top height, cloud-top temperature and cloud-top pressure products from radiometric information from three VIIRS bands M14 (8.55 um), M15 (10.7 um), and M16 (12.0) longwave infrared observations. The retrieval uncertainties of these products are also available. Fundamentally the cloud height algorithm (ACHA) uses a 1-D var optimal estimation approach and employs a combination of infrared channels. The algorithm processes all daytime and nighttime VIIRS pixels globally detected as cloudy from the cloud mask algorithm. The direct output



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is cloud top temperature and the numerical weather prediction (NWP) profiles are used to derive cloud top height and pressure. Specific details on the output are documented below. An extensive description of ACHA may be found in the ACHA ATBD delivered to NOAA Enterprise (<http://www.star.nesdis.noaa.gov/jpss/Docs.php>).

VIIRS Cloud Height 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 ACHA for NOAA-21 is:

JRR-

CloudHeight_v3r2_n21_sYYYYMMDDSSSSSSSS_eYYYYMMDDSSSSSSSS_cYYYYMMDDSSSSSS
S 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:

Cloud Top Height:

| Attribute | DPS | Requirement/Threshold |
|-----------|---------|--|
| Coverage | DPS-481 | The Cloud Height product shall provide geolocated cloud top and base heights per cell, for the highest cloud in the column, globally, day and night, whenever detectable clouds are present, at the refresh rates of the instrument. |
| Precision | DPS-482 | The Cloud Height product shall provide cloud top heights per cell with a measurement precision of 1.0 kilometers for cloud optical thickness greater than or equal to 1; and 2.0 km for cloud optical thickness less than 1. |
| Accuracy | DPS-485 | The Cloud Height product shall provide cloud top heights per cell with a measurement accuracy of 1.0 kilometers for cloud optical thickness greater than or equal to 1; and 2.0 km for cloud optical thickness less than 1. |

Cloud Top Pressure:

| Attribute | DPS | Requirement/Threshold |
|-----------|---------|--|
| Coverage | DPS-489 | The Cloud Top Pressure product shall provide cloud top pressures for one or more atmospheric layers, globally, day and night, whenever detectable clouds are present, at the refresh rates of the instrument. |
| Precision | DPS-490 | The Cloud Top Pressure product shall provide cloud top pressures with a measurement precision of 100 millibars for cloud optical depth greater than or equal to 1; and 200 millibars for cloud optical depth less than 1. |
| Accuracy | DPS-491 | The Cloud Top Pressure product shall provide cloud top pressures with a measurement accuracy of 100 millibars for cloud optical depth greater than or equal to 1; and 200 millibars for cloud optical depth less than one. |

Cloud Top Temperature:

| Attribute | DPS | Requirement/Threshold |
|-----------|---------|---|
| Coverage | DPS-497 | The Cloud Top Temperature product shall provide cloud top temperatures of the highest cloud in the column, globally, day and night, whenever detectable clouds are present, at the refresh rates of the instrument. |
| Precision | DPS-499 | The Cloud Top Temperature product shall provide cloud top temperatures with a measurement precision of 6 kelvin for cloud optical depth greater than or equal to 1; and 12 K for cloud optical depth less than 1. |
| Accuracy | DPS-500 | The Cloud Top Temperature product shall provide cloud top temperatures with a measurement accuracy of 6 K for cloud optical depth greater than or equal to 1; and 12 K for cloud optical depth less than 1. |

The key product outputs in the ACHA are:

- Cloud Top Temperature
- Cloud Top Pressure
- Cloud Top Height
- Cloud 11 um emissivity
- Cloud microphysical index
- Cloud optical depth
- Cloud particle size

Quality flags

The data quality flags are placed in “CloudHgtQF” and shown in Table 1. Optimal Estimation diagnostic flags are in the “CldHgtFlag” variable. These are not shown as they are designed for programmers and not downstream users.

Table 1. Cloud top height retrieval quality flags

| Flag Value | Description |
|------------|---------------------------------|
| 0 | Fully successful retrieval |
| 1 | Marginally successful retrieval |
| 2 | Retrieval attempted and failed |
| 3 | No retrieval attempted |

Product evaluation/validation

- Visual comparisons with the NOAA-21 ACHA products generated outside of NCCF using CLAVR-x.
- Visual comparisons with NOAA-21, NOAA-20 and SNPP generated within the NCCF.
- Quantitative comparisons with S-NPP and NOAA-20 Cloud Height Products.
- Cloud height/pressure 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 cloud height product largely depends on the performance of the VIIRS cloud mask and phase products. The optimal estimation approach in ACHA employs a phase-dependent first guess for its retrieval, so any misclassification of cloud phase would also negatively affect ACHA retrieval. Validation statistics are therefore produced using datasets that are matched by cloud phase.

Known errors/issues/limitations

- Preferred ACHA cloud top pressure values (e.g., 986 hPa) exist in the current dataset. The cause is currently unknown, but will continue to be investigated.
- 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 ACHA products.
- Any NCCF/NDE issues (e.g. missing SDR granules) will negatively impact ACHA.
- It is important to note that this version of ACHA is tuned to maximize the impact of the AMVs within NWP data assimilation. This may negatively impact ACHA results when compared to an objective dataset.

3. Changes Since Last Maturity Stage

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

4. Review Board Recommendations

- None

5. Path Forward/Future Plan

- Continue working with the NOAA Derived Motion Winds team to ensure that the height assignments are in line with their requirements.
- Future updates will ensure that ACHA is standardized between JPSS and GOES sensors and will mitigate Derived Motion Winds issues. An update is planned for early 2024. This change will also slightly improve the AMV product when compared to RAOBs.

6. Additional Items to Note

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

Additional information is available in the ACHA 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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