


**Beta/Provisional Maturity Science Review  
For NOAA-21 Cloud Top Properties  
(Height/Pressure/Temperature)**



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NOAA Cloud Science Team Lead: Mark Kulie  
Algorithm Lead: Andrew Heidinger*

*Presented by Steve Wanzong  
Date: 10/26/2023*

# JPSS/GOES-R Data Product Validation Maturity Stages - COMMON DEFINITIONS (Nominal Mission)

## 1. Beta

- Product is minimally validated, and may still contain significant identified and unidentified errors.
- Information/data from validation efforts can be used to make initial qualitative or very limited quantitative assessments regarding product fitness-for-purpose.
- Documentation of product performance and identified product performance anomalies, including recommended remediation strategies, exists.

## 2. Provisional

- 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.

## 3. Validated

- Product performance has been demonstrated over a large and wide range of representative conditions (i.e., global, seasonal).
- Comprehensive documentation of product performance exists that includes all known product anomalies and their recommended remediation strategies for a full range of retrieval conditions and severity level.
- Product analyses are sufficient for full qualitative and quantitative determination of product fitness-for-purpose.
- Product is ready for operational use based on documented validation findings and user feedback.
- Product validation, quality assurance, and algorithm stewardship continue through the lifetime of the instrument.



# BETA/PROVISIONAL MATURITY REVIEW MATERIAL

- Algorithm Cal/Val Team Members
- Product Overview/Requirements
- Evaluation of algorithm performance to specification requirements
  - Algorithm version, processing environment
  - Evaluation of the effect of required algorithm inputs
  - Quality flag analysis/validation
  - Error Budget
- User Feedback
- Downstream Product Feedback
- Risks, Actions, and Mitigations
- Documentation (Science Maturity Check List)
- Conclusion
- Path Forward

## Algorithm Cal/Val Team Members

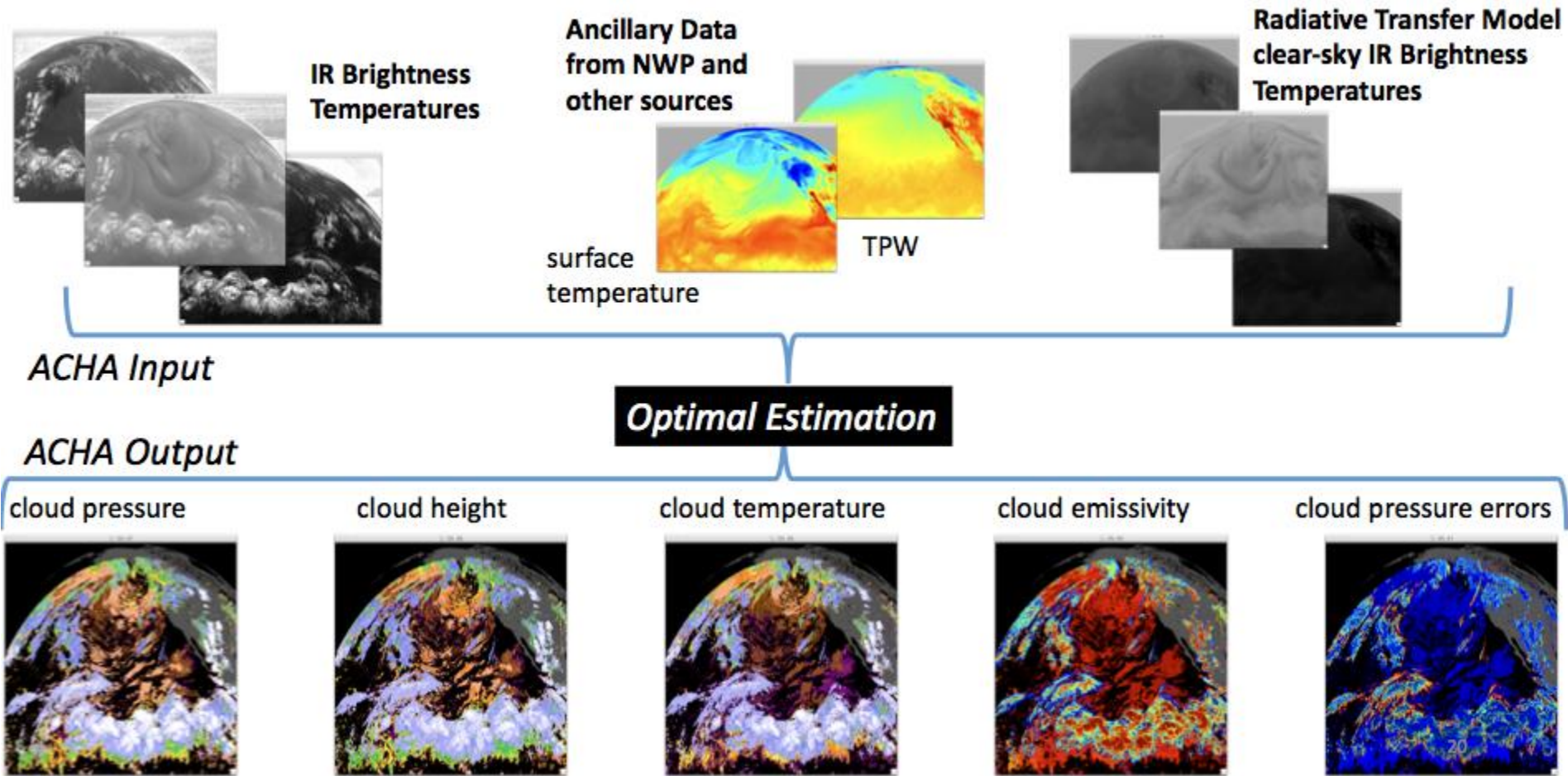
Name	Organization	Major Task
Mike Foster	UW-Madison/SSEC	CIMSS ACHA PI
Andrew Heidinger	NOAA-NESDIS-GEO	Algorithm Development Lead
Jay Hoffman	UW-Madison/CIMSS	Long Term Monitoring
Mark Kulie	NOAA-NESDIS-STAR-SMCD	Team Lead
Yue Li	UW-Madison/CIMSS	Algorithm Development/Maintenance
William Straka	UW-Madison/CIMSS	ASSISTT Integration
Steve Wanzong	UW-Madison/CIMSS	Algorithm Development/Maintenance
David Donahue	OSPO	Cloud Algorithm PAL
Shuang Qiu	OSPO	Product Area Lead

# Product Overview

- Enterprise Cloud Height uses the following channels
  - M14 (8.55  $\mu\text{m}$ )
  - M15 (10.7  $\mu\text{m}$ )
  - M16 (12.0  $\mu\text{m}$ )
- The cloud team assumes that all sensor input is valid given full maturity for the VIIRS SDRs
- Note - The SRF for NPP/N20 and N21 for the 11 $\mu\text{m}$  (M15) and 12 $\mu\text{m}$  (M16) channels are noticeable different. This can lead to some differences when comparing the same algorithm among the three satellites.

	Band No.	Driving EDR(s)	Spectral Range ( $\mu\text{m}$ )	Horiz Sample Interval (km) (track x Scan)	
				Nadir	End of Scan
Reflective Bands	VisNIR				
	M1	Ocean Color Aerosol	0.402 - 0.422	0.742 x 0.259	1.60 x 1.58
	M2	Ocean Color Aerosol	0.436 - 0.454	0.742 x 0.259	1.60 x 1.58
	M3	Ocean Color Aerosol	0.478 - 0.498	0.742 x 0.259	1.60 x 1.58
	M4	Ocean Color Aerosol	0.545 - 0.565	0.742 x 0.259	1.60 x 1.58
	I1	Imagery EDR	0.600 - 0.680	0.371 x 0.387	0.80 x 0.789
	M5	Ocean Color Aerosol	0.662 - 0.682	0.742 x 0.259	1.60 x 1.58
	M6	Atmosph. Correct.	0.739 - 0.754	0.742 x 0.776	1.60 x 1.58
	I2	NDVI	0.846 - 0.885	0.371 x 0.387	0.80 x 0.789
	M7	Ocean Color Aerosol	0.846 - 0.885	0.742 x 0.259	1.60 x 1.58
	S/MWIR				
	M8	Cloud Particle Size	1.230 - 1.250	0.742 x 0.776	1.60 x 1.58
	M9	Cirrus/Cloud Cover	1.371 - 1.386	0.742 x 0.776	1.60 x 1.58
	I3	Binary Snow Map	1.580 - 1.640	0.371 x 0.387	0.80 x 0.789
M10	Snow Fraction	1.580 - 1.640	0.742 x 0.776	1.60 x 1.58	
M11	Clouds	2.225 - 2.275	0.742 x 0.776	1.60 x 1.58	
I4	Imagery Clouds	3.550 - 3.930	0.371 x 0.387	0.80 x 0.789	
M12	SST	3.660 - 3.840	0.742 x 0.776	1.60 x 1.58	
M13	SST Fires	3.973 - 4.128	0.742 x 0.259	1.60 x 1.58	
Emissive Bands	LWIR				
	M14	Cloud Top Properties	8.400 - 8.700	0.742 x 0.776	1.60 x 1.58
	M15	SST	10.263 - 11.263	0.742 x 0.776	1.60 x 1.58
	I5	Cloud Imagery	10.500 - 12.400	0.371 x 0.387	0.80 x 0.789
	M16	SST	11.538 - 12.488	0.742 x 0.776	1.60 x 1.58

## How AWG CLOUD HEIGHT (ACHA) Works



# Product Overview/Requirements

- **Cloud Top Temperature.**
- JPSS Ground Segment Data Product Specification; October 2019.

Attribute	DPS	Requirement/Threshold	Performance
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.	

Note : ACHA is tuned for AMV Performance. Cloud metrics may be degraded.



# Product Overview/Requirements

- **Cloud Top Height.**
- JPSS Ground Segment Data Product Specification; October 2019.

Attribute	DPS	Requirement/Threshold	Performance
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.	

Note : ACHA is tuned for AMV Performance. Cloud metrics may be degraded.

# Product Overview/Requirements

- **Cloud Top Pressure.**
- JPSS Ground Segment Data Product Specification; October 2019.

Attribute	DPS	Requirement/Threshold	Performance
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.	

Note : ACHA is tuned for AMV Performance. Cloud metrics may be degraded.

- Description of processing environment and algorithms used to achieve the maturity stage:
  - v3r2
  - Software is unchanged from the Spring 2022 Super Dap.
  - Upcoming update will bring software inline with Pro and improve AMV performance.
  - Significant changes are described in this document.
    - [Cloud Algorithm Updates](#)

# Executive Summary

- Visual Inspection, CTP Zonal Plots, Histograms of CTP, CALIOP comparisons, MODIS comparisons.
- Missing/Incomplete data sets.
- **Recommendation: Beta/Provisional Maturity (effective March 30, 2023).**
  
- Note: An upgrade to ACHA will happen early 2024.
- Note: CALIOP data ends in June 2023.

# Algorithm Performance Evaluation

We have chosen independent sources of cloud top properties that provide qualitative and quantitative analysis of the performance using more than 15 days from June 2023.

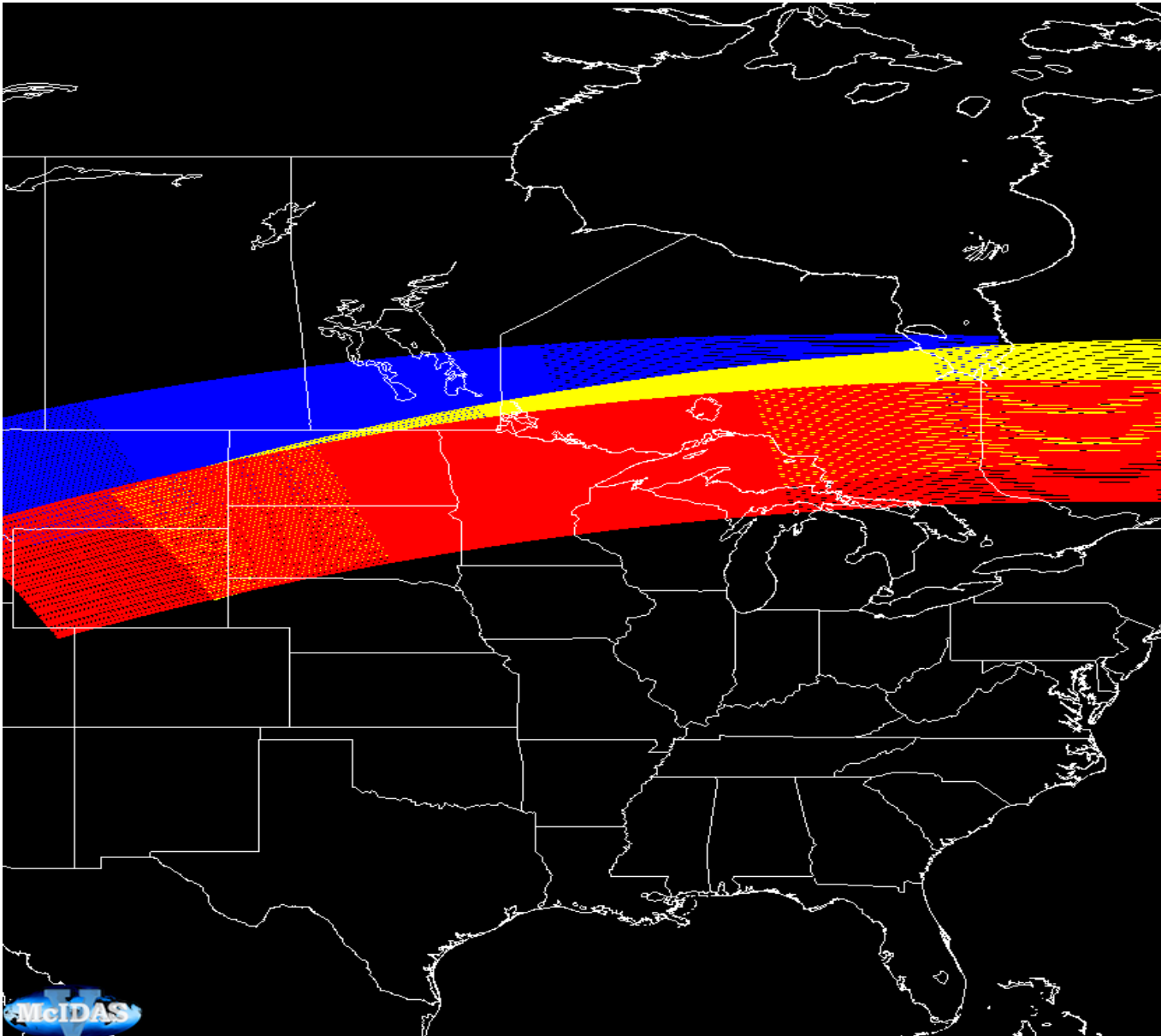
We also compare to non-NDE generated ACHA data to diagnose NDE-specific issues.

Our Specific Validation Strategies are:

1. Visual inspection of NDE ACHA against CLAVR-x ACHA.
2. Intercomparison of NDE ACHA using NOAA-21, NOAA-20 and SNPP.
3. Validation against NASA CALIPSO/CALIOP.

## Visual Comparisons

# Algorithm Performance Evaluation

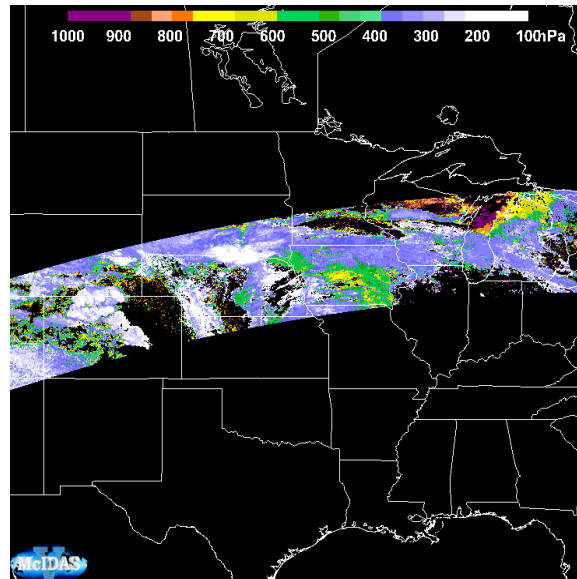
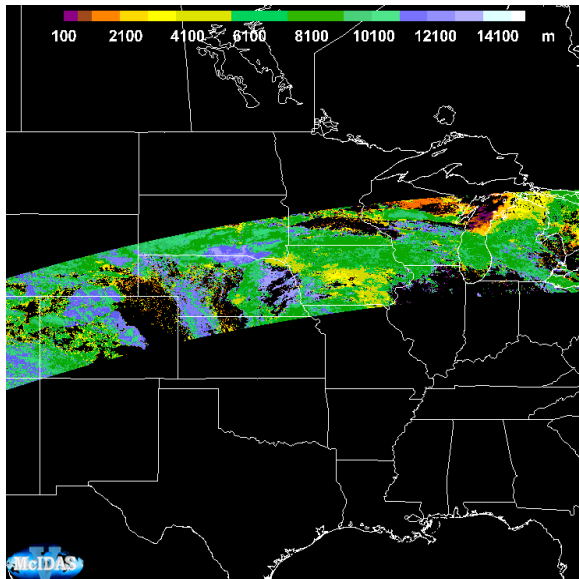
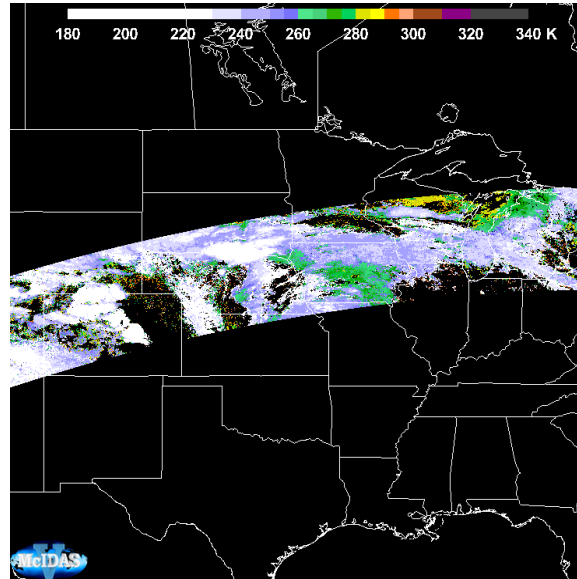
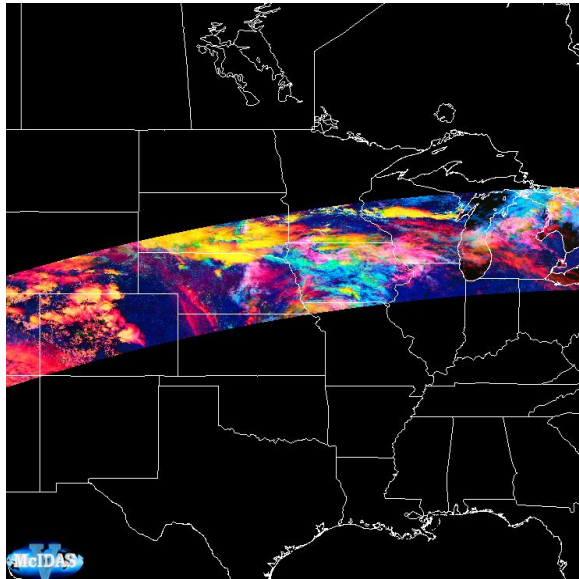


- NOAA-21 : 2023 1017 1857 UTC
- NOAA-20 : 2023 1017 1835 UTC
- SNPP : 2023 1017 1926 UTC

# ACHA Cloud Top Products Under Review

Example level 2 products from NDE NOAA-21 between 1916 and 1917 UTC on 06/10/2023 showing:

- Cloud Type RGB and Cloud Top Temperature (K) (top row);
- Cloud Top Height (m) and Cloud Top Pressure (hPa) (bottom row).
- We will concentrate on CTP going forward as its most important to the AMV team.

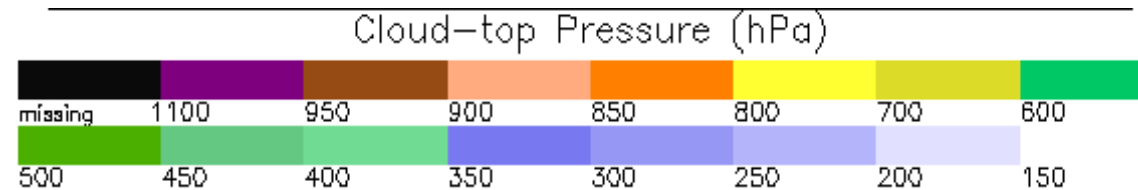
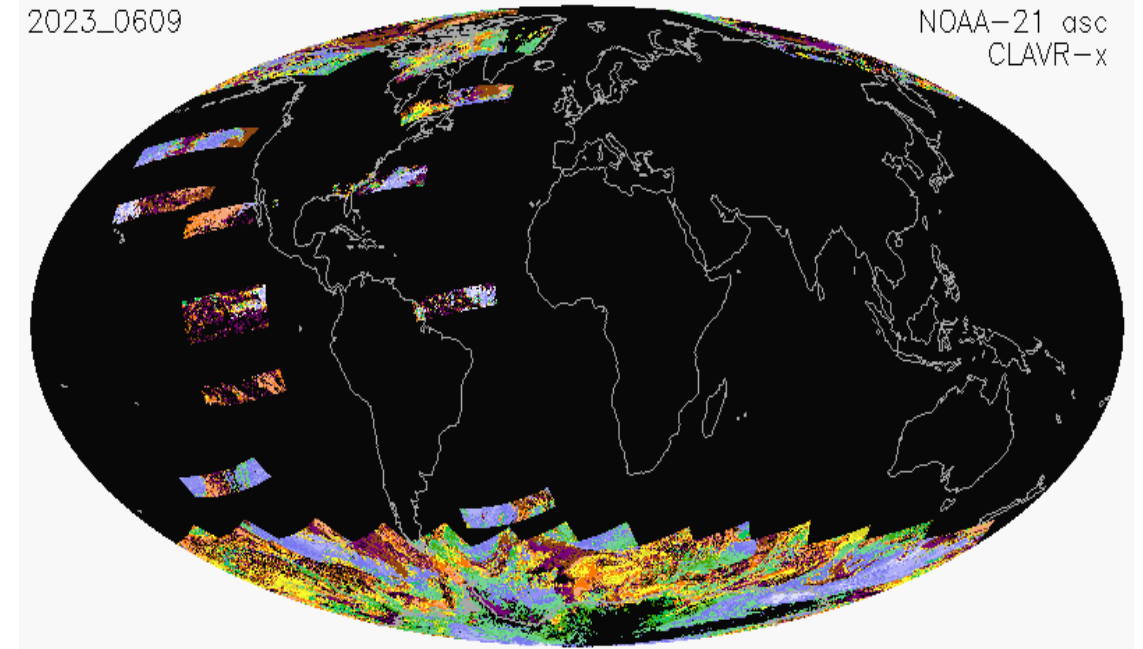
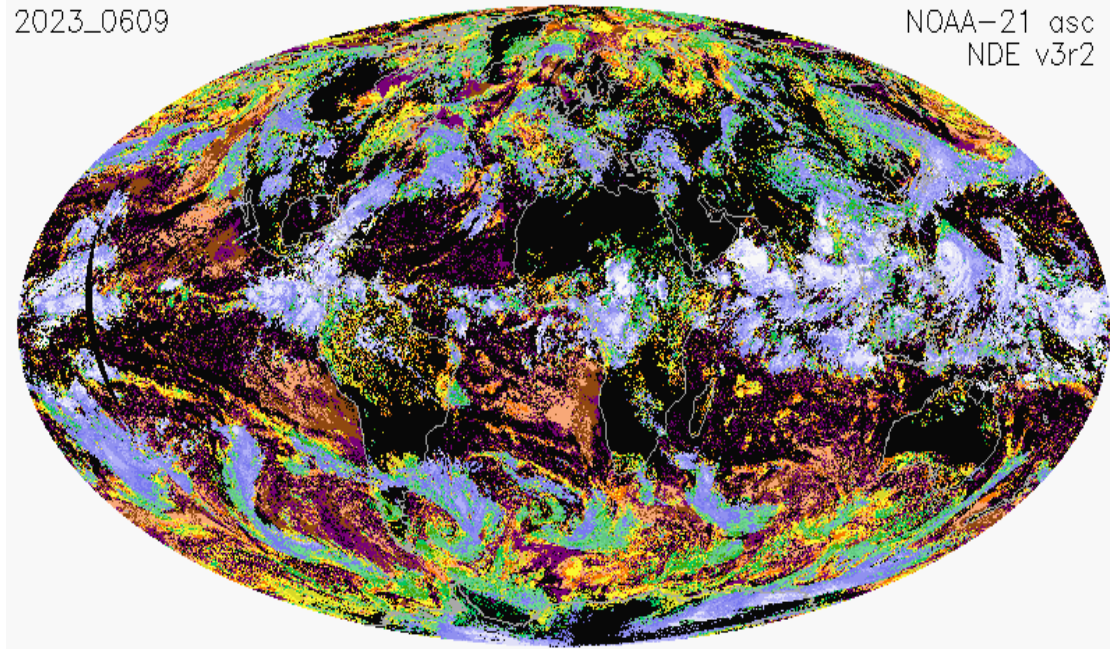




# NOAA-21 Cloud Top Pressure Level2b (Ascending)

NDE

CLAVR-x



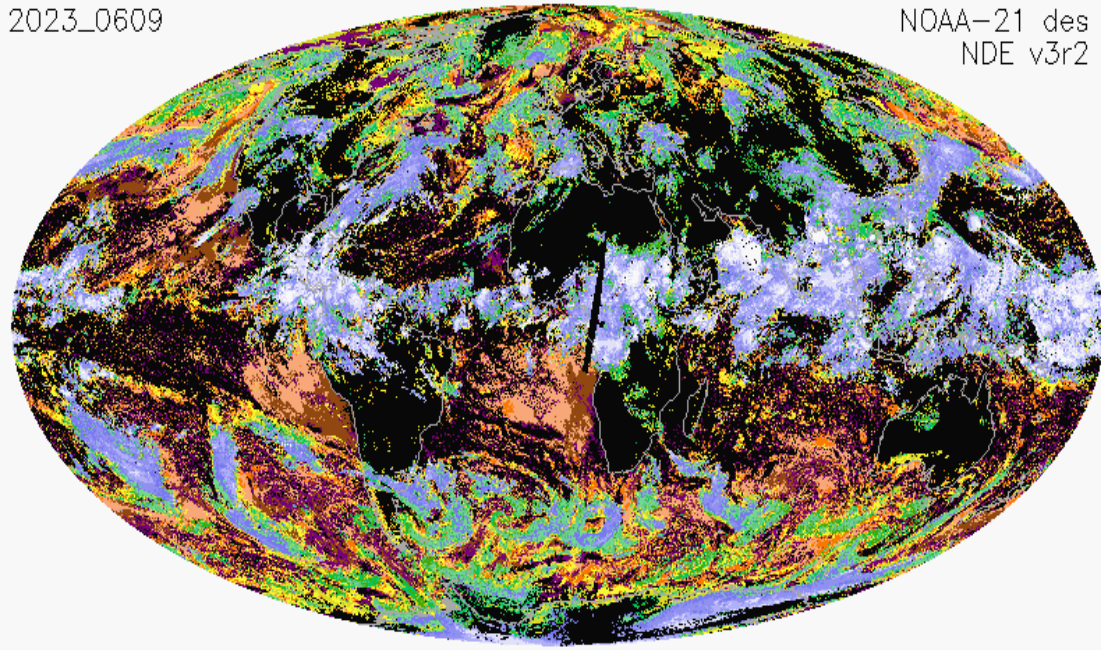
# NOAA-21 Cloud Top Pressure Level2b (Descending)

NDE

CLAVR-x

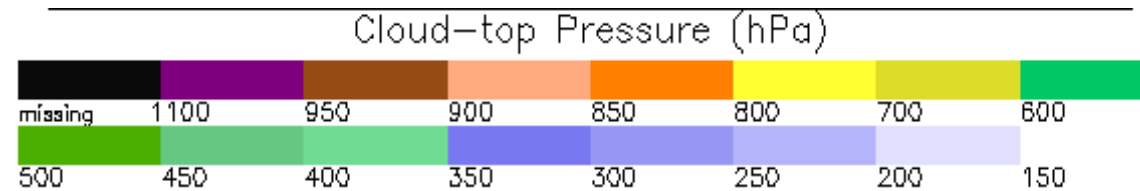
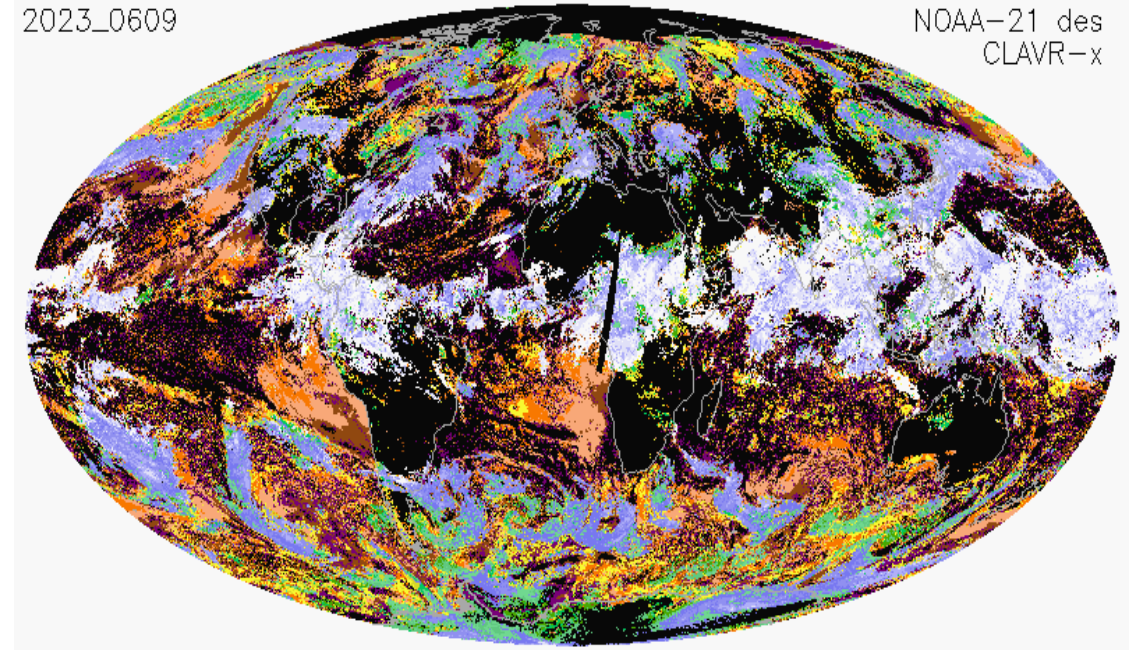
2023\_0609

NOAA-21 des  
NDE v3r2

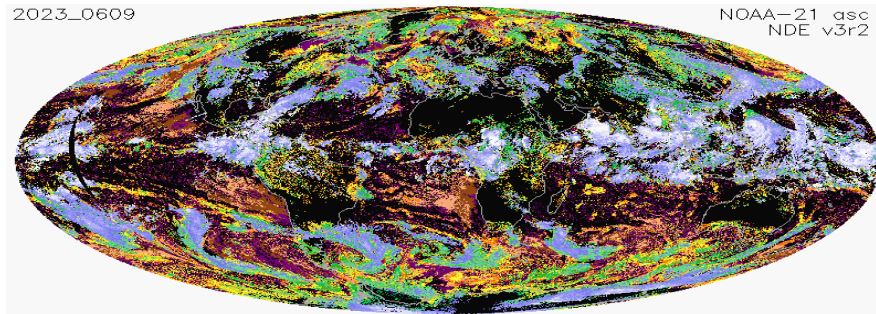
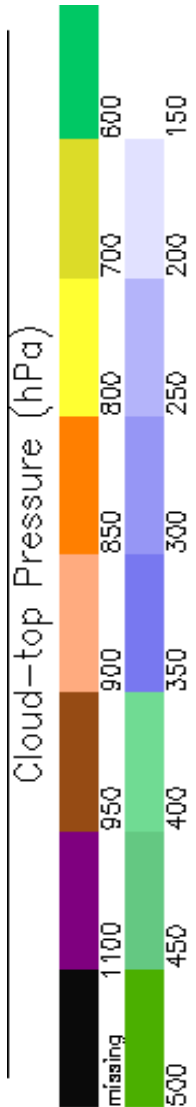


2023\_0609

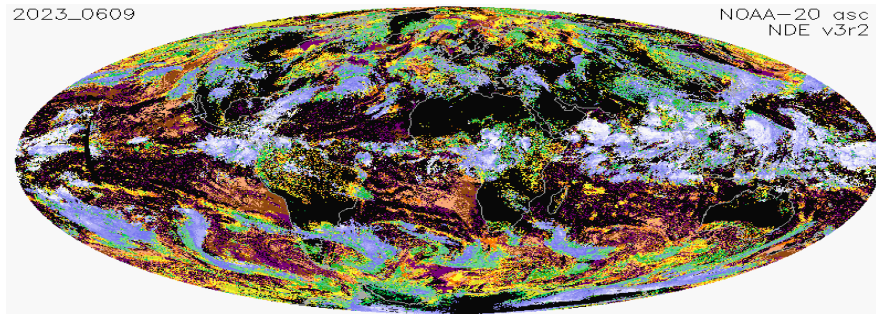
NOAA-21 des  
CLAVR-x



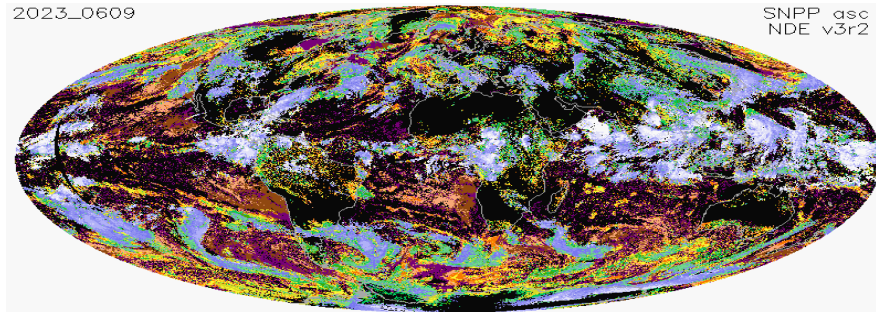
# VIIRS NDE Cloud Top Pressure Level2b (Ascending)



NOAA-21

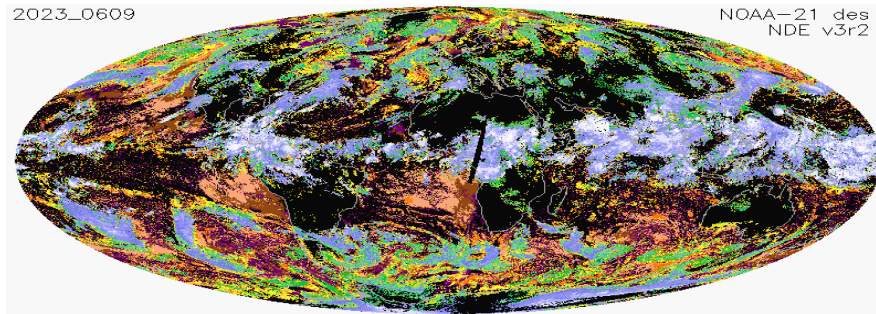
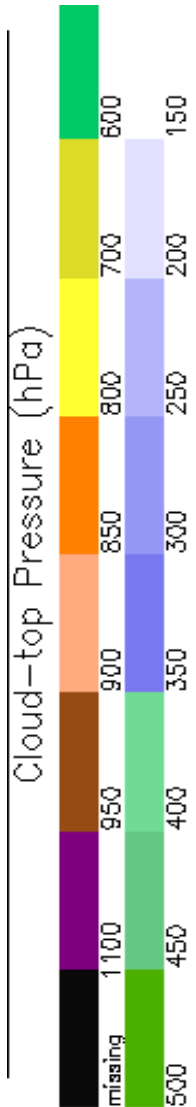


NOAA-20

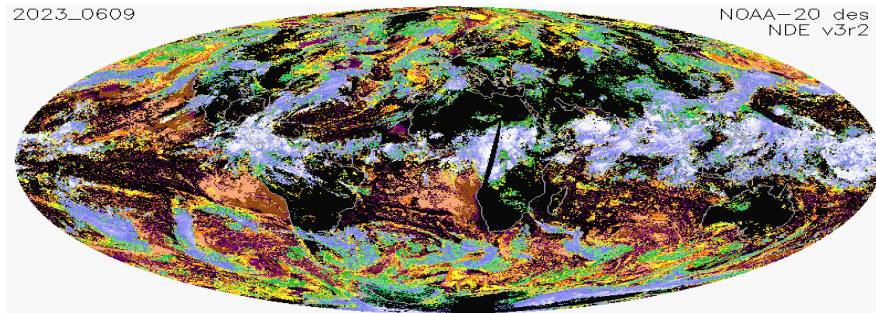


SNPP

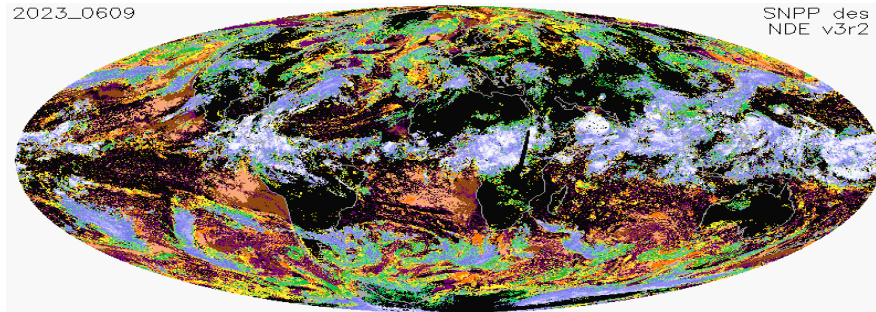
# VIIRS NDE Cloud Top Pressure Level2b (Descending)



NOAA-21

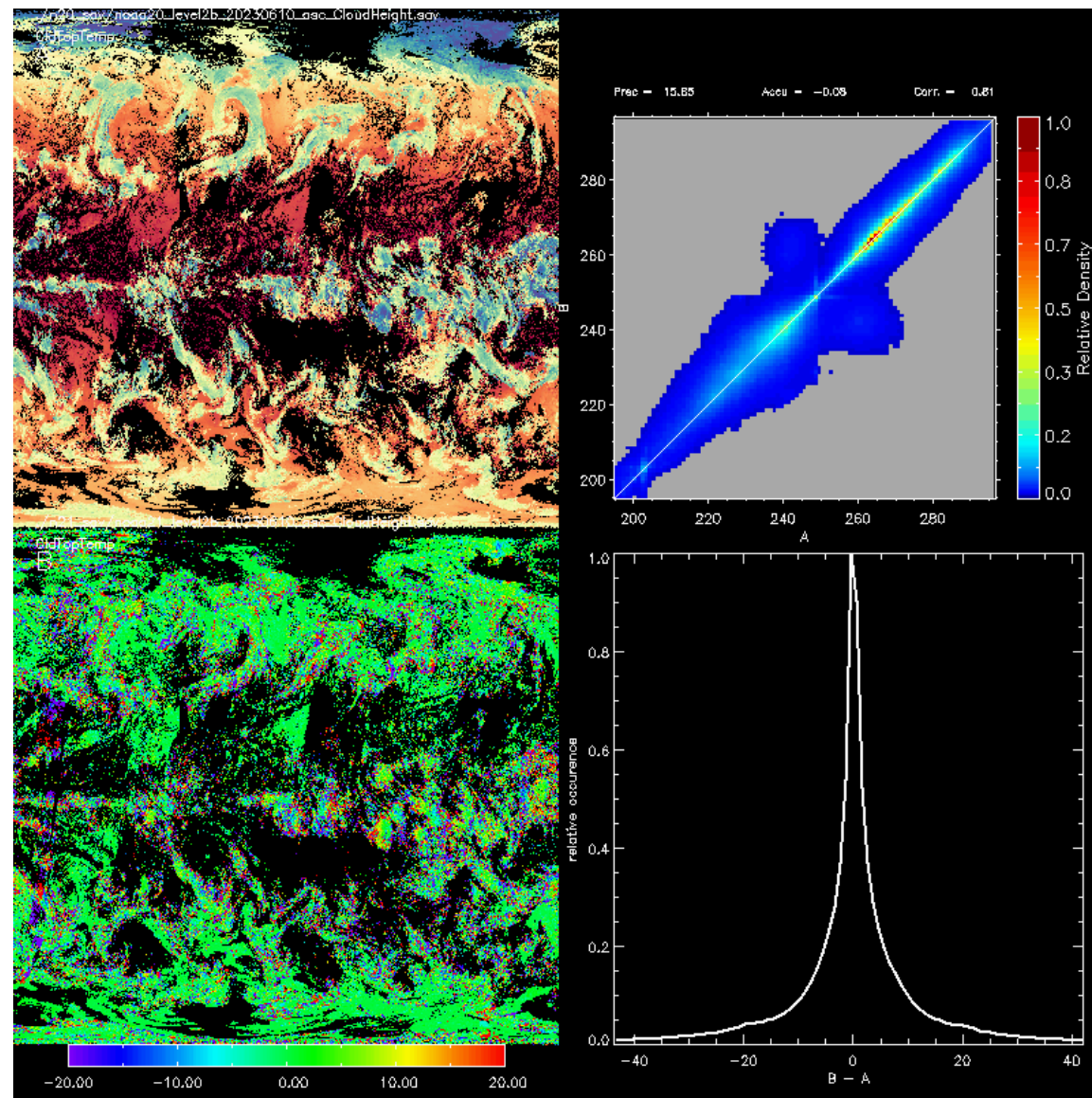
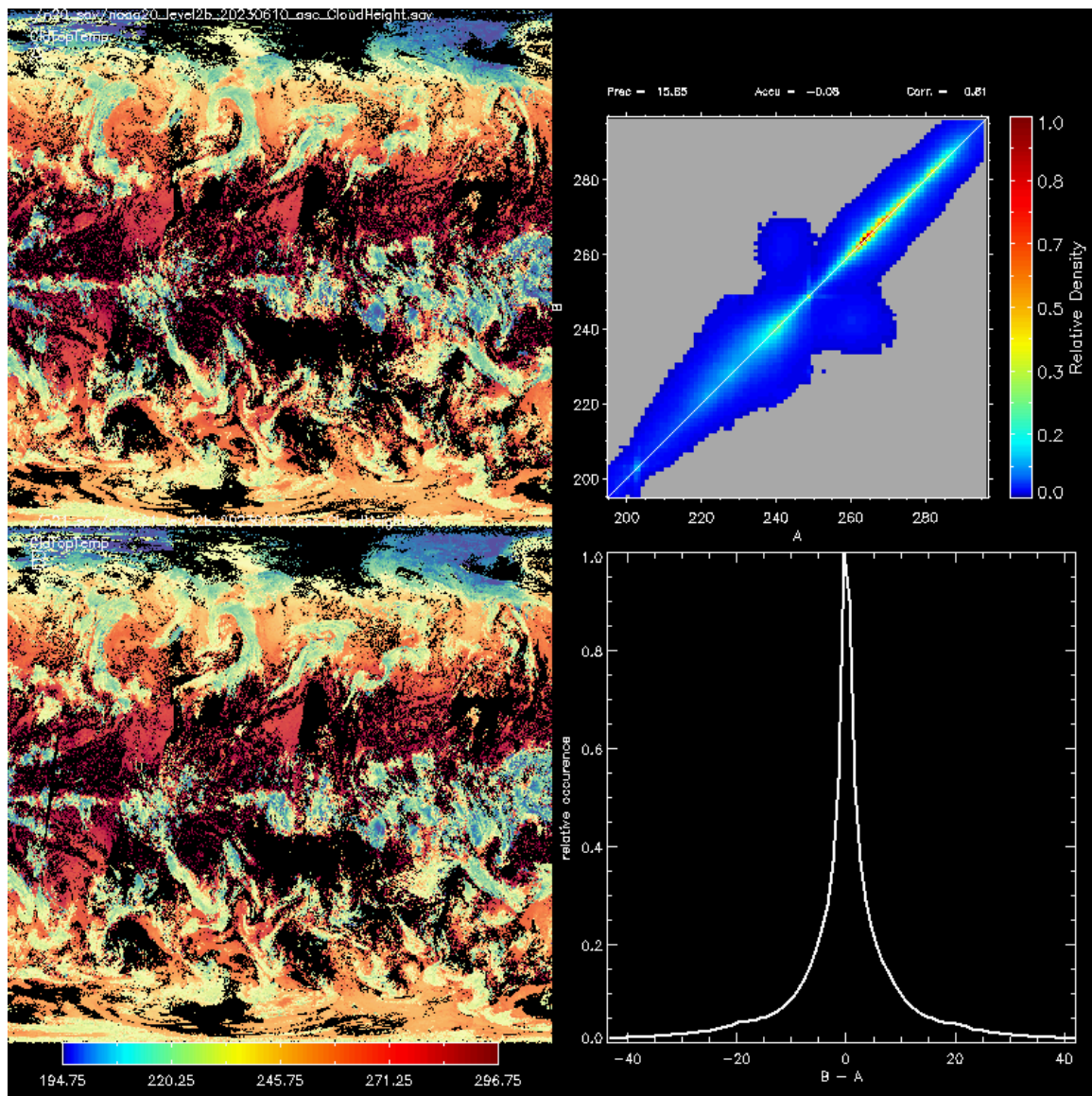


NOAA-20



SNPP

# VIIRS NDE Cloud Top Temperature Level2b (Ascending)

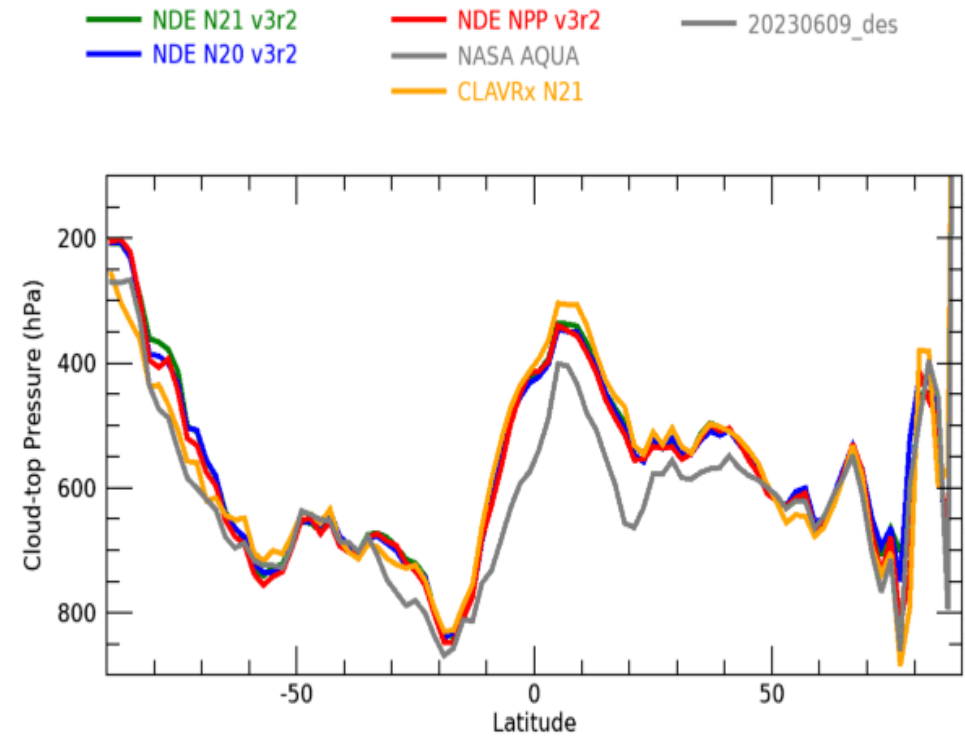
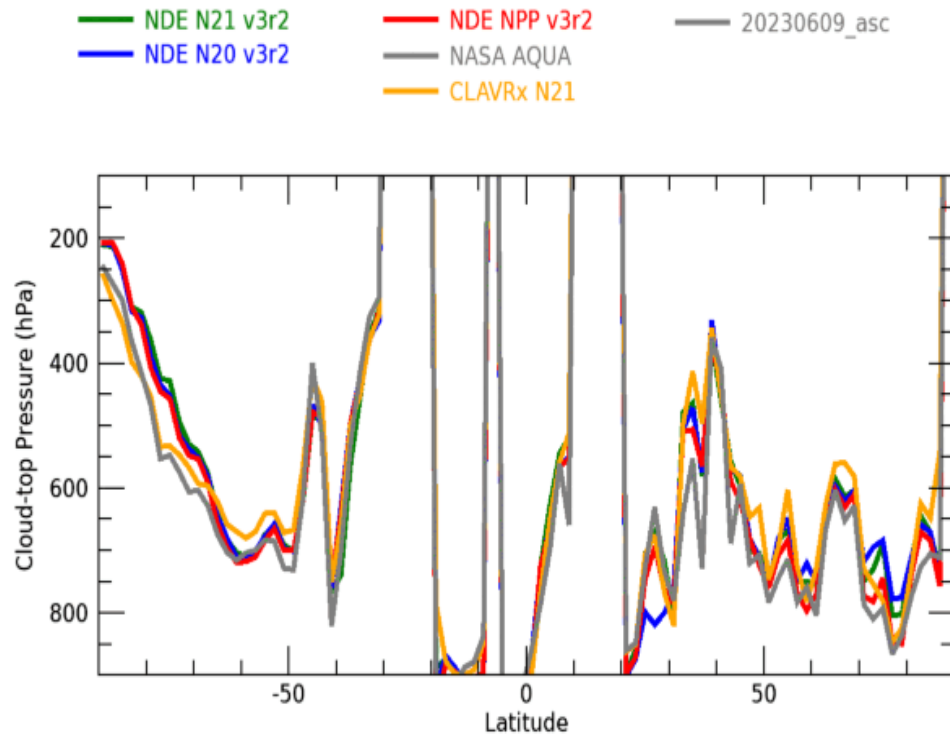


## Zonal Plots

# VIIRS Cloud Top Pressure Zonal Plots

## Ascending

## Descending

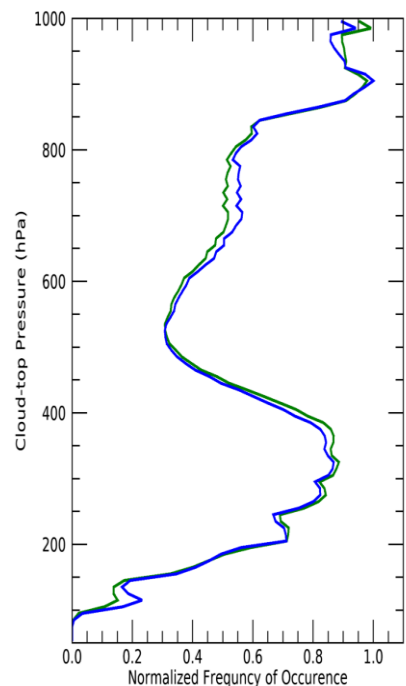


## Distribution Plots



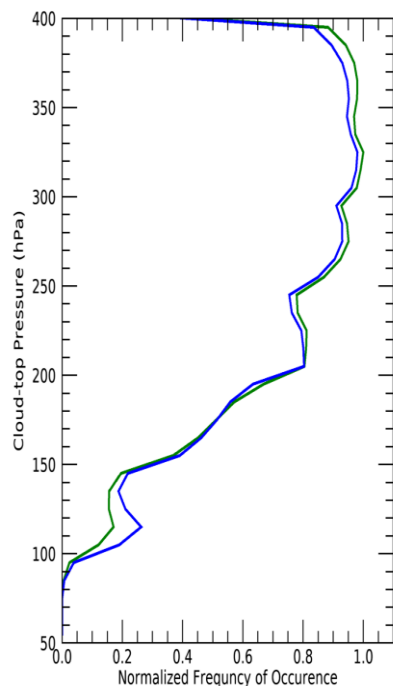
# VIIRS Cloud Top Pressure Distribution (Ascending)

— NDE NOAA-21  
— NDE NOAA-20



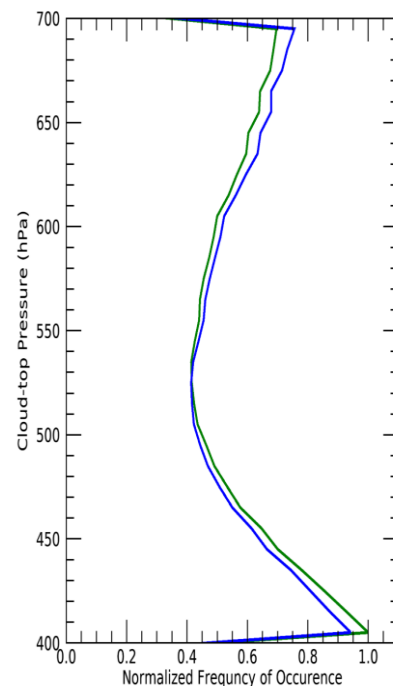
ALL

— NDE NOAA-21  
— NDE NOAA-20



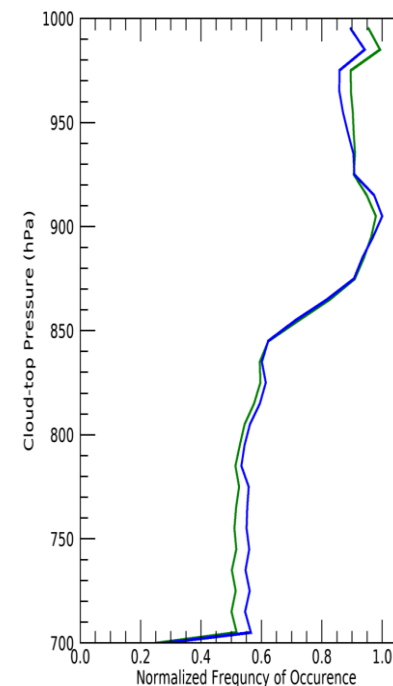
HIGH

— NDE NOAA-21  
— NDE NOAA-20



MID

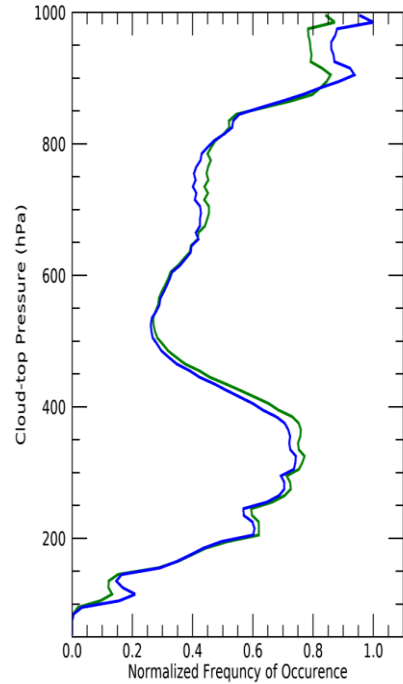
— NDE NOAA-21  
— NDE NOAA-20



LOW

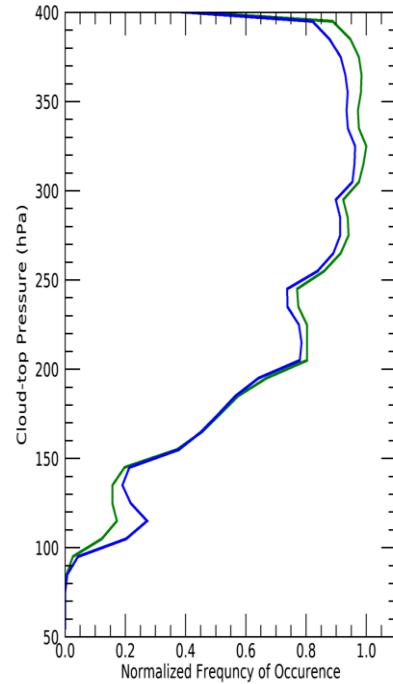
# VIIRS Cloud Top Pressure Distribution (Ascending)

— NDE NOAA-21  
— NDE SNPP



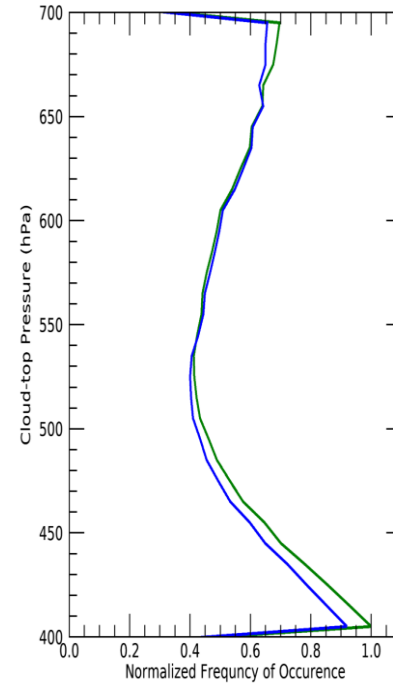
**ALL**

— NDE NOAA-21  
— NDE SNPP



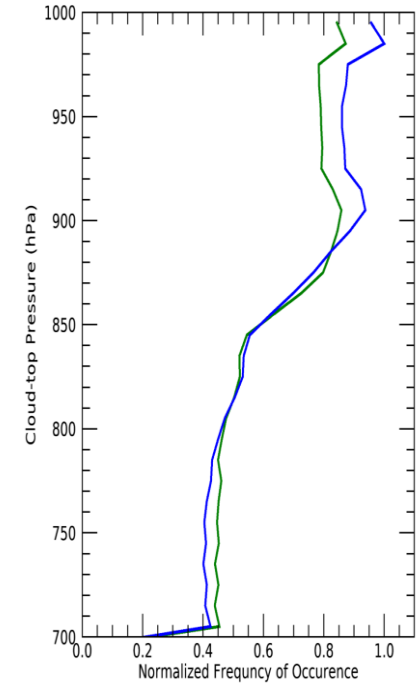
**HIGH**

— NDE NOAA-21  
— NDE SNPP



**MID**

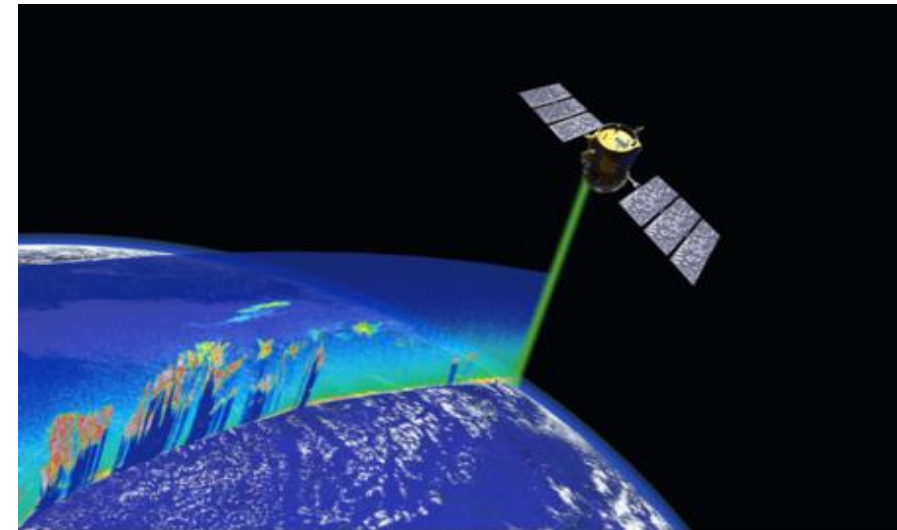
— NDE NOAA-21  
— NDE SNPP



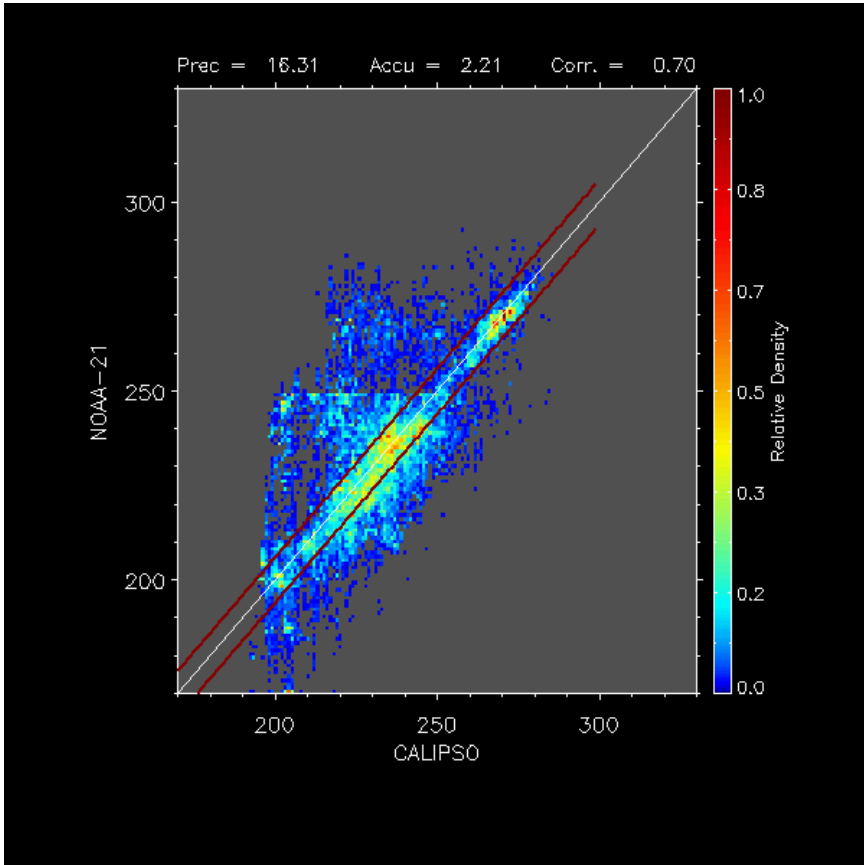
**LOW**

## CALIOP Comparisons

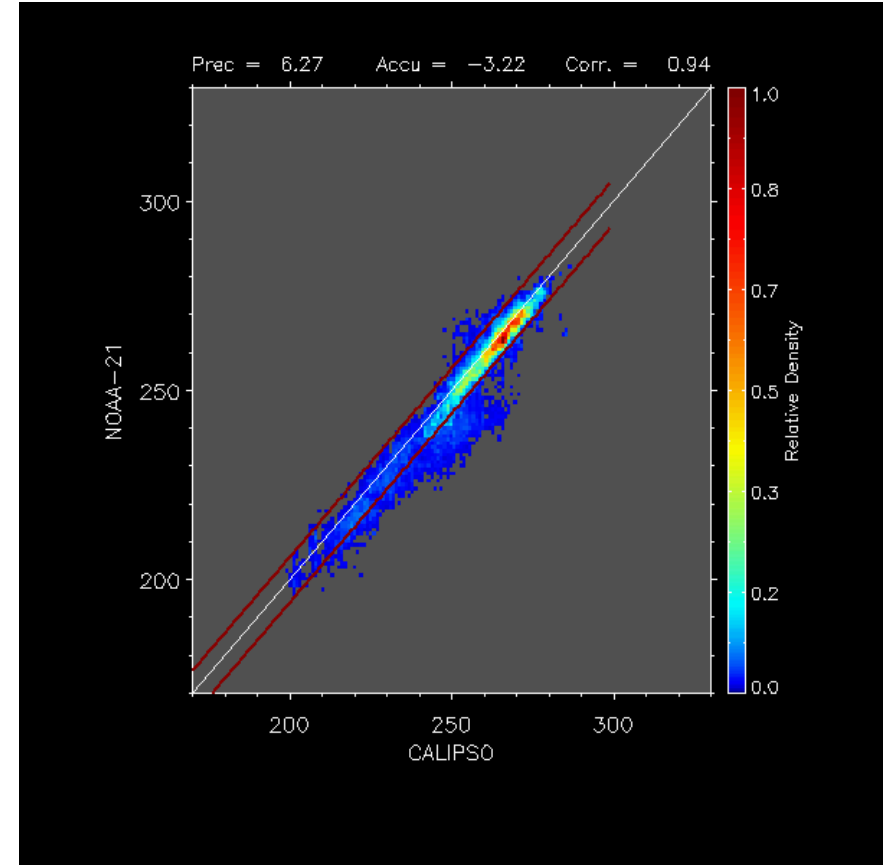
- CALIOP is a lidar onboard of CALIPSO.
- **CALIOP Cloud algorithm results are considered as “Truth”.**
- Nine days of CALIOP and NOAA-21 Matchup data are used from [May and June, 2023](#).
- Filters applied to NOAA-21:
  - Scan time difference  $\pm 15$  minutes,
  - Sensor Zenith Angle  $< 80.0$ .



# CTT - Phase Matching and Single Layer Filtering



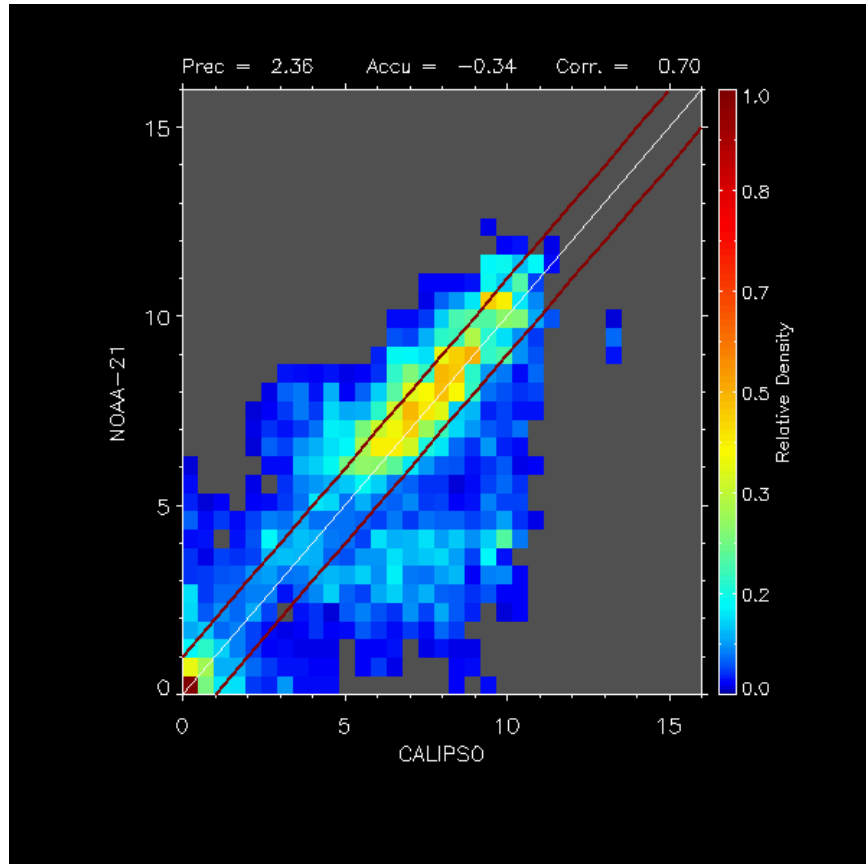
COT < 1



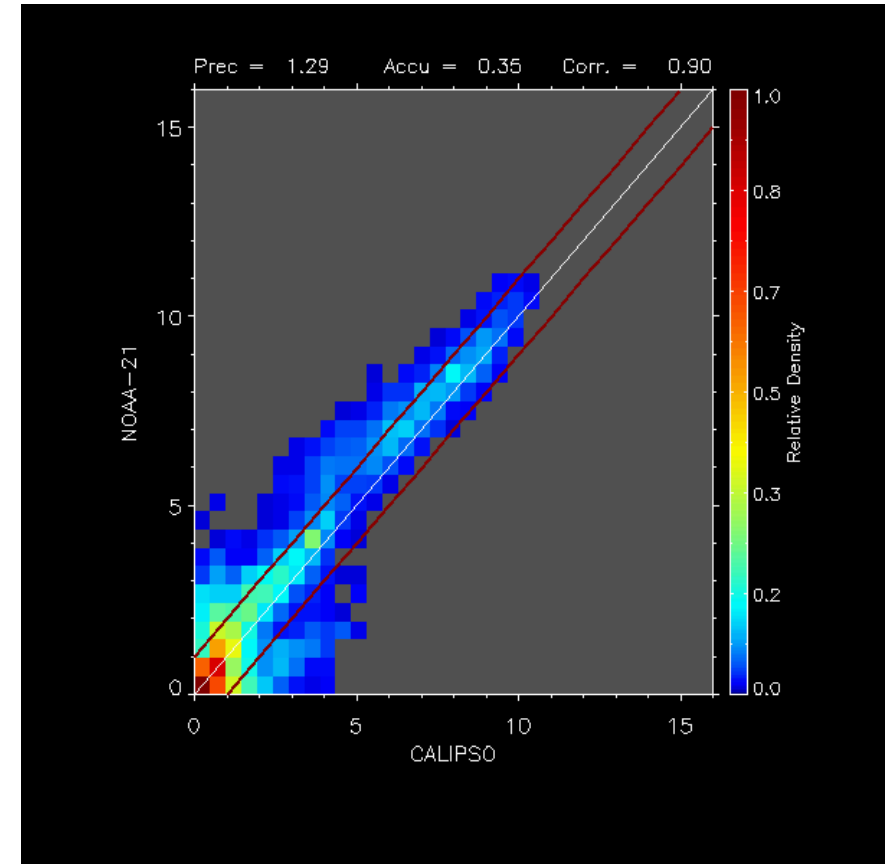
COT  $\geq 1$

6K when  $\tau \geq 1$ , 12K when  $\tau < 1$

# CTH - Phase Matching and Single Layer Filtering



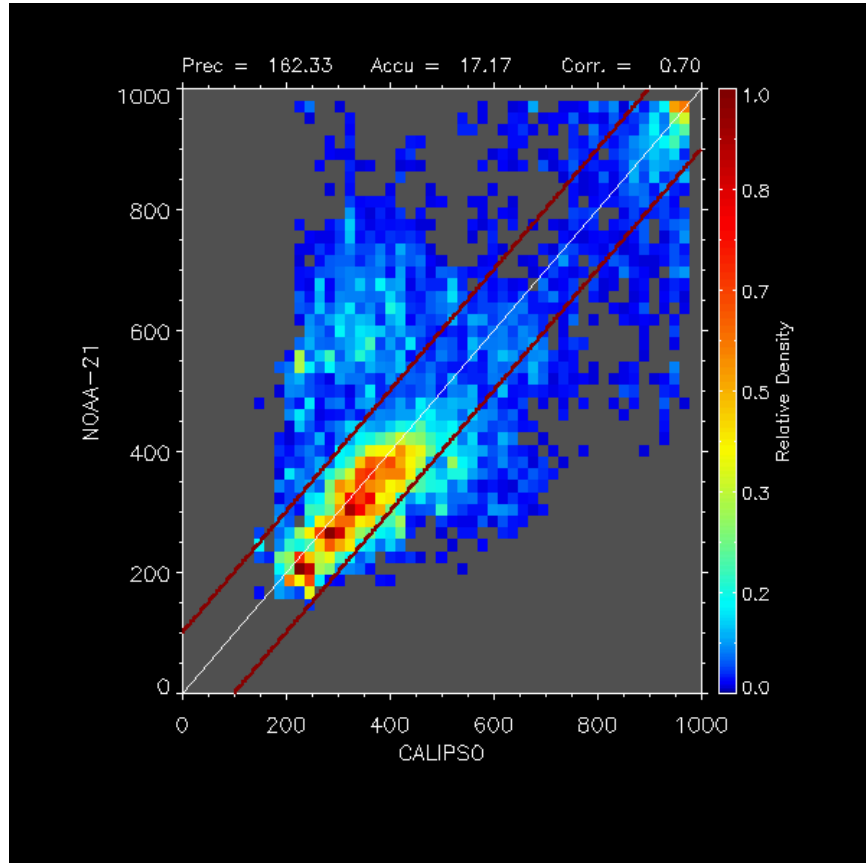
COT < 1



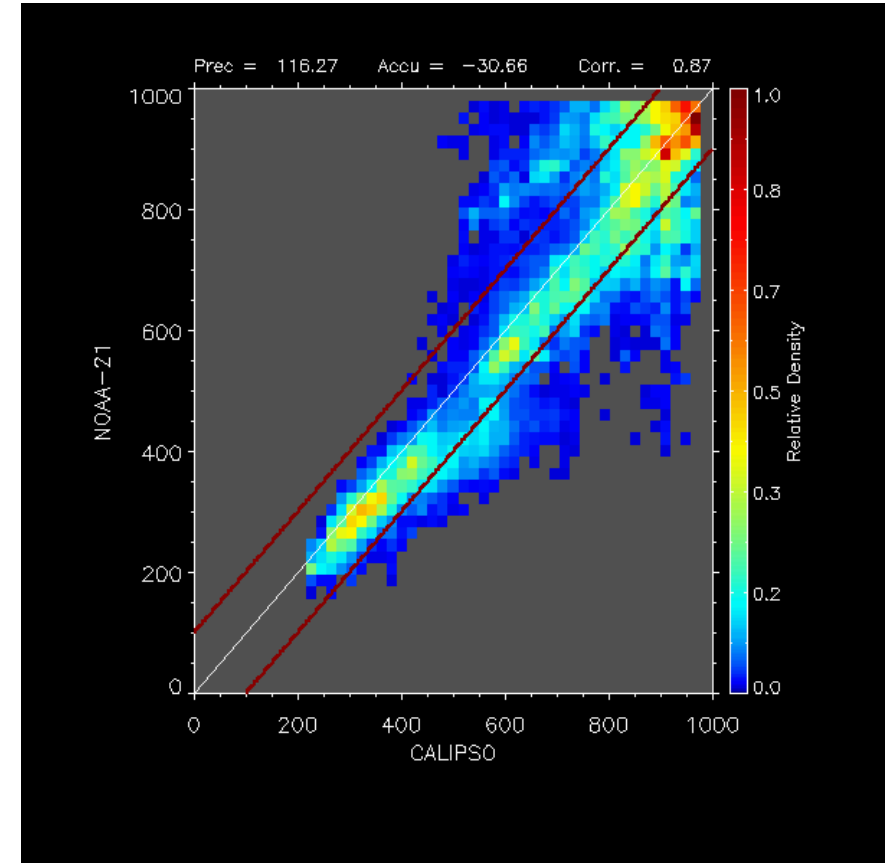
COT >= 1

1km when  $\tau \geq 1$ , 2km when  $\tau < 1$

# CTP - Phase Matching and Single Layer Filtering



COT < 1



COT >= 1

100 hPa when  $\tau \geq 1$ , 200 hPa when  $\tau < 1$

# Error Budget (CTT)

Attribute Analyzed	DPS	Requirement/ Threshold	Pre-Launch Performance	On-orbit Performance			Meet Requirement?	Additional Comments
				NOAA-21	NOAA-20	S-NPP		
Accuracy	500	6K when $\tau \geq 1$ , 12K when $\tau < 1$		-3.2 2.2	N/A	N/A	yes yes	
Precision	499	6K when $\tau \geq 1$ , 12K when $\tau < 1$		6.3 16.3	N/A	N/A	yes no	

Note : ACHA is tuned for AMV Performance. Cloud metrics may be degraded.



# Error Budget (CTH)

Attribute Analyzed	DPS	Requirement/ Threshold	Pre-Launch Performance	On-orbit Performance			Meet Requirement?	Additional Comments
				NOAA-21	NOAA-20	S-NPP		
Accuracy	485	1km when $\tau \geq 1$ , 2km when $\tau < 1$		0.35 -0.34	N/A	N/A	yes yes	
Precision	482	1km when $\tau \geq 1$ , 2km when $\tau < 1$		1.29 2.36	N/A	N/A	no no	

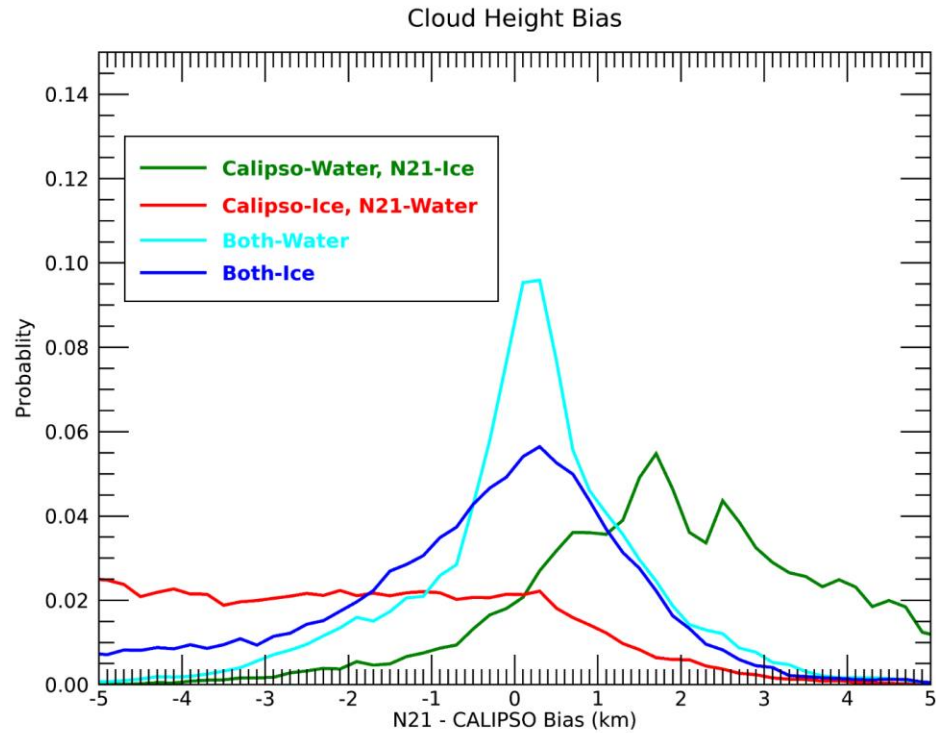
Note : ACHA is tuned for AMV Performance. Cloud metrics may be degraded.

# Error Budget (CTP)

Attribute Analyzed	DPS	Requirement/ Threshold	Pre-Launch Performance	On-orbit Performance			Meet Requirement?	Additional Comments
				NOAA-21	NOAA-20	S-NPP		
Accuracy	491	100 hPa when $\tau \geq 1$ , 200 hPa when $\tau < 1$		-30.7 17.7	N/A	N/A	yes yes	
Precision	490	100 hPa when $\tau \geq 1$ , 200 hPa when $\tau < 1$		116.3 162.3	N/A	N/A	no yes	

Note : ACHA is tuned for AMV Performance. Cloud metrics may be degraded.

# Evaluation of the effect of upstream cloud phase

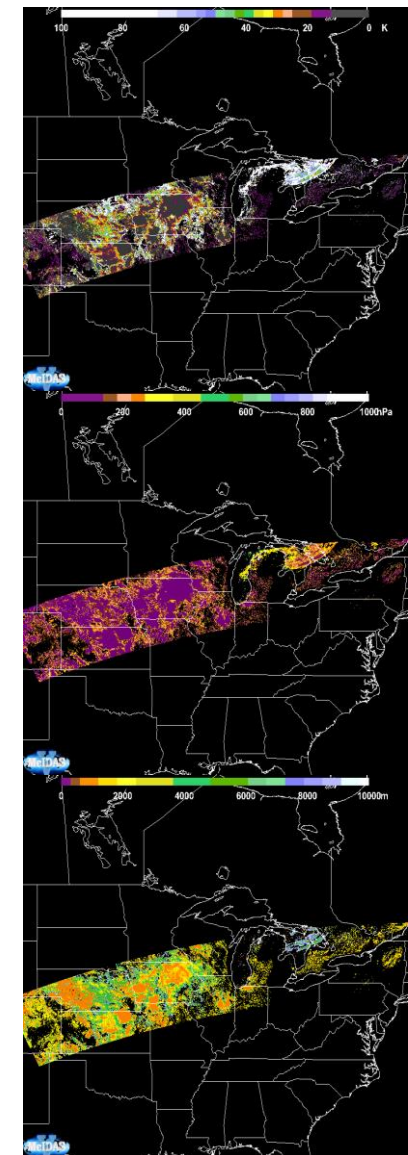
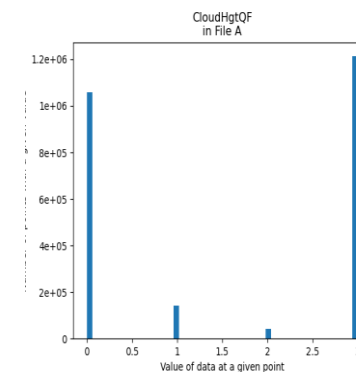


	CALIPSO Water	CALIPSO Ice
NDE N20 Water	30%	18%
NDE N20 Ice	6%	46%

- When cloud phase (water/ice) is correctly identified, ACHA cloud top height performs well compared to CALIPSO
- If phase is incorrectly classified, ACHA tends to underestimate ice phase clouds and overestimate water phase clouds.
- Numbers in the table shows percentages of NDE cloud phase in each category compared to CALIPSO

# Quality Flags/Variable Checks

- ACHA cloud top property outputs quality flags are set as follows:
  - Variable name: CloudHgtQF
  - Values
    - 0 (good)
    - 1 (marginal retrieval) if user selects to process clear/probably pixels
    - 2 (retrieval attempted) if retrieval fails from the optimal estimation algorithm
    - 3 (bad)
- Another flag that explains the ACHA optimal estimation (OE) retrieval quality:
  - Variable name: CldHgtFlag
  - This variable is a 3 dimensional array that sets retrieval quality for each of four direct OE output
  - Values
    - 0: failed
    - 1: low quality
    - 2: good quality
    - 3: high quality
- Missing values in “CldTopPresLow” and “CldTopTempLow”

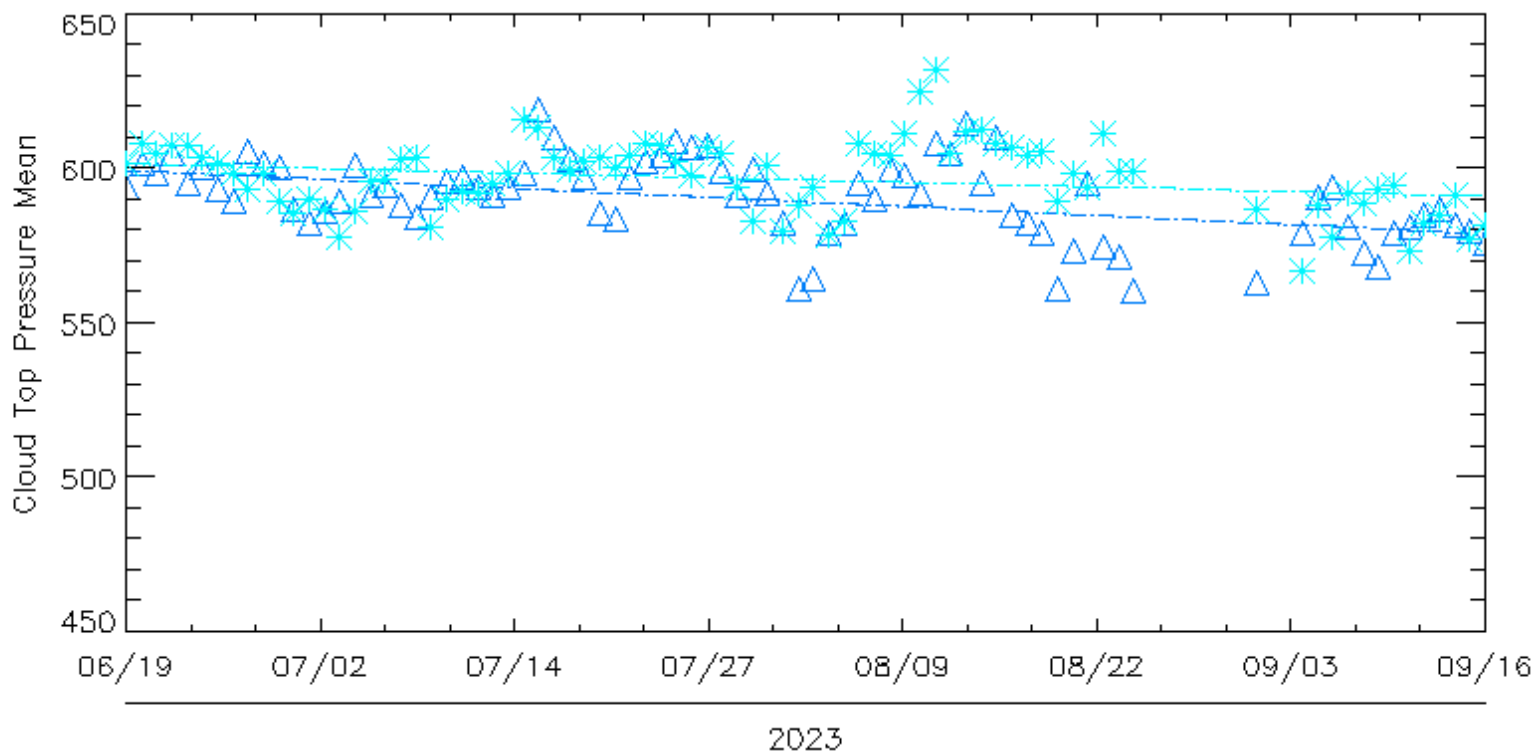


## Long Term Monitoring

# Algorithm Performance Evaluation

Satellite:  Product type:  Statistic:  Trend:

- + SNPP asc  
  ◇ SNPP des  
  □ NOAA-20 asc  
  X NOAA-20 des  
 △ NOAA-21 asc  
 \* NOAA-21 des



# Downstream Product Feedback

Algorithm	Product	Downstream Product Feedback - Reports from downstream product teams on the dependencies and impacts
AMVs	Mask, Phase, Pressure	See next two slides
DCOMP	COD/REFF	TBD
CBH/CCL	Base height/cloud cover layers	Their review will show that they use these products and meet specifications.

# Downstream Product Feedback (AMVs)

"Operational (PDA\_IT)" J02VIIRS\_stats\_NH\_IR\_2023234\_2023262

ASSISST J02VIIRS\_stats\_NH\_IR\_2023234\_2023262

100_1000mb	90S - 90N	25N - 90N	25S - 25N	25S - 90S
Accuracy	5.96	5.96	0.00	0.00
Precision	4.03	4.03	0.00	0.00
Speed Bias	0.98	0.98	0.00	0.00
Speed	18.16	18.16	0.00	0.00
Sample	8373	8373	0	0

100_1000mb	90S - 90N	25N - 90N	25S - 25N	25S - 90S
Accuracy	5.71	5.71	0.00	0.00
Precision	3.82	3.82	0.00	0.00
Speed Bias	0.89	0.89	0.00	0.00
Speed	17.62	17.62	0.00	0.00
Sample	8223	8223	0	0

101_400mb	90S - 90N	25N - 90N	25S - 25N	25S - 90S
Accuracy	6.90	6.90	0.00	0.00
Precision	4.58	4.58	0.00	0.00
Speed Bias	1.17	1.17	0.00	0.00
Speed	24.21	24.21	0.00	0.00
Sample	3827	3827	0	0

101_400mb	90S - 90N	25N - 90N	25S - 25N	25S - 90S
Accuracy	6.72	6.72	0.00	0.00
Precision	4.55	4.55	0.00	0.00
Speed Bias	1.09	1.09	0.00	0.00
Speed	24.12	24.12	0.00	0.00
Sample	3361	3361	0	0

401_700mb	90S - 90N	25N - 90N	25S - 25N	25S - 90S
Accuracy	5.44	5.44	0.00	0.00
Precision	3.17	3.17	0.00	0.00
Speed Bias	0.94	0.94	0.00	0.00
Speed	14.82	14.82	0.00	0.00
Sample	2758	2758	0	0

401_700mb	90S - 90N	25N - 90N	25S - 25N	25S - 90S
Accuracy	5.29	5.29	0.00	0.00
Precision	3.10	3.10	0.00	0.00
Speed Bias	0.78	0.78	0.00	0.00
Speed	14.89	14.89	0.00	0.00
Sample	2942	2942	0	0

701_1000mb	90S - 90N	25N - 90N	25S - 25N	25S - 90S
Accuracy	4.76	4.76	0.00	0.00
Precision	3.41	3.41	0.00	0.00
Speed Bias	0.61	0.61	0.00	0.00
Speed	10.37	10.37	0.00	0.00
Sample	1788	1788	0	0

701_1000mb	90S - 90N	25N - 90N	25S - 25N	25S - 90S
Accuracy	4.59	4.59	0.00	0.00
Precision	2.87	2.87	0.00	0.00
Speed Bias	0.73	0.73	0.00	0.00
Speed	10.44	10.44	0.00	0.00
Sample	1920	1920	0	0

AMV Specifications

-----  
Accuracy : 7.5 m/s  
Precision : 4.2 m/s



# Risks, Actions, and Mitigations

- Provide updates for the status of the risks/actions identified during the previous maturity review(s); add new ones as needed

Identified Risk	Description	Impact	Action/Mitigation and Schedule
NDE/PDA	Missing granules at UW-Madison/CIMSS	Low	We have enough data for analysis
CALIOP end of life	CALIOP reached its end of life in June 2023.	Moderate	Will need to re-run data historical datasets that overlap CALIOP. NOAA-21 will be limited as seasonal analysis will not have all seasons.
AMV Requirements	The AMV requirements are necessary. However, ACHA is not quite optimal for a cloud dataset	Low	Run 2 instances of ACHA?

# Documentations

Science Maturity Check List	Yes ?
ReadMe for Data Product Users	Will be provided after review.
Algorithm Theoretical Basis Document (ATBD)	Yes
Algorithm Calibration/Validation Plan	Yes
(External/Internal) Users Manual	Yes
System Maintenance Manual (for ESPC products)	Yes
Peer Reviewed Publications (Demonstrates algorithm is independently reviewed)	Yes
Regular Validation Reports (at least annually) (Demonstrates long-term performance of the algorithm)	Long term monitoring available on CIMSS web site, on demand.

# Check List - Provisional Maturity

Beta/Provisional Maturity End State	Assessment
<p>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.</p>	<p>In most cases. Some CALIOP comparisons do not meet specifications. However, this version of ACHA is developed to maximize the benefit to the AMV program.</p>
<p>Product analyses are sufficient for qualitative, and limited quantitative, determination of product fitness-for-purpose.</p>	<p>Yes</p>
<p>Documentation of product performance, testing involving product fixes, identified product performance anomalies, including recommended remediation strategies, exists.</p>	<p>Yes, the various review presentations would contain all of this information.</p>
<p>Product is recommended for potential operational use (user decision) and in scientific publications after consulting product status documents.</p>	<p>Yes</p>

- Cal/Val results summary:
  - ACHA meets all accuracy specifications for phase matched and single layer clouds.
  - ACHA precision accuracy does not quite meet all specifications.
  - However, ACHA performs well enough for AMVs to meet specifications. We still have work commitments with the AMV team and this hopefully will continue to improve the product.
  - **ACHA Team recommends ACHA Beta/Provisional maturity as of March 30, 2023.**

- Lessons learned for NOAA-21 Cal/Val
  - CALIOP dataset is small and would benefit from more collocations (this isn't possible with NOAA-21).
  - Qualitative comparisons to SNPP and NOAA-20 are encouraging.
- Planned improvements
  - ACHA needs to investigate a tendency of low-level pressures that are assigned to 986 hPa. Not evident in CLAVR-x.
- Future Cal/Val activities / milestones
  - With no space based lidar available until [EarthCARE](#) in September 2024 we will need to shift to ground based lidar.
  - Investigate ground based lidar systems such as: [NASA Micro-Pulse Lidar Network](#)
  - We continue to be involved with the WMO/CGMS Science Working Groups, including the ICWG (clouds) and IWWG (winds).

## Extra Slides

# Maturity Review - Entry Criteria

- Product Requirements
- Pre-launch Performance Matrix/Waivers
- Provisional Maturity Performance Validation
  - On-orbit instrument performance assessment
    - Identify all of the instrument and product characteristics you have verified/validated as individual bullets
    - Identify pre-launch concerns/waivers, mitigation and evaluation attempts with on-orbit data
- Users/Downstream-Products feedback
- Risks, Actions, Mitigations
  - Potential issues, concerns
- Path forward (to the next maturity stage)
- Summary

## Maturity Review - Exit Criteria

- Provisional Maturity Performance is well characterized and meets/exceeds the requirements:
  - On-orbit instrument performance assessment
    - Provide summary for each identified instrument and product characteristic you have validated/verified as part of the entry criteria
    - Provide summary of pre-launch concerns/waivers mitigations/evaluation and address whether any of them are still a concern that raises any risk.
- Updated Maturity Review Slide Package addressing review committee's comments for:
  - Cal/Val Plan and Schedules
  - Product Requirements
  - Provisional Maturity Performance
  - Risks, Actions, Mitigations
  - Path forward (to the next maturity stage)



- There are known SRF differences between the SRF differences in the 11 $\mu$ m and 12 $\mu$ m channels between NOAA-21 and NOAA-20/SNPP
- This can lead to some differences when comparing the same algorithm among the three satellites.

- Defined Quality Flags
  - Variable
  - Description
  - Value
- Quality flag analysis/validation
  - Test / example / ground truth data sets
  - Analysis / validation results
  - Analysis / validation plan

# User Feedback

Name	Organization	Application	User Feedback - User readiness dates for ingest of data and bringing data to operations

- Findings/Issues from {previous-maturity}/last Review
- Improvements since {previous-maturity}/last Review
  - Algorithm Improvements
  - LUT / PCT updates
- Algorithm performance evaluation
  - Validation data sets (type, periods, coverage)
  - Validation strategies / methods
  - Validation results
  - Long term monitoring readiness
- Inter-sensor comparison
  - Compare with S-NPP and NOAA-20
  - Compare with other satellite product

# JPSS/GOES-R Data Product Validation Maturity Stages - COMMON DEFINITIONS (Nominal Mission)

## 1. Beta

- Product is minimally validated, and may still contain significant identified and unidentified errors.
- Information/data from validation efforts can be used to make initial qualitative or very limited quantitative assessments regarding product fitness-for-purpose.
- Documentation of product performance and identified product performance anomalies, including recommended remediation strategies, exists.

## 2. Provisional

- 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.

## 3. Validated

- Product performance has been demonstrated over a large and wide range of representative conditions (i.e., global, seasonal).
- Comprehensive documentation of product performance exists that includes all known product anomalies and their recommended remediation strategies for a full range of retrieval conditions and severity level.
- Product analyses are sufficient for full qualitative and quantitative determination of product fitness-for-purpose.
- Product is ready for operational use based on documented validation findings and user feedback.
- Product validation, quality assurance, and algorithm stewardship continue through the lifetime of the instrument.

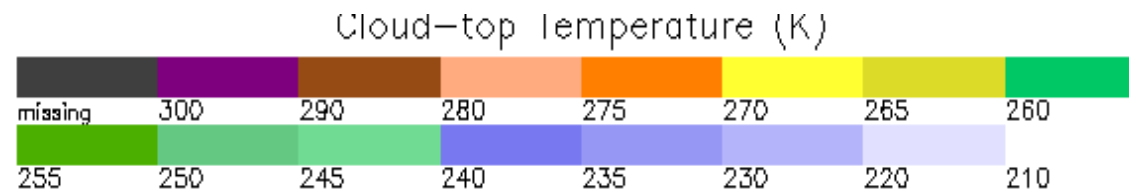
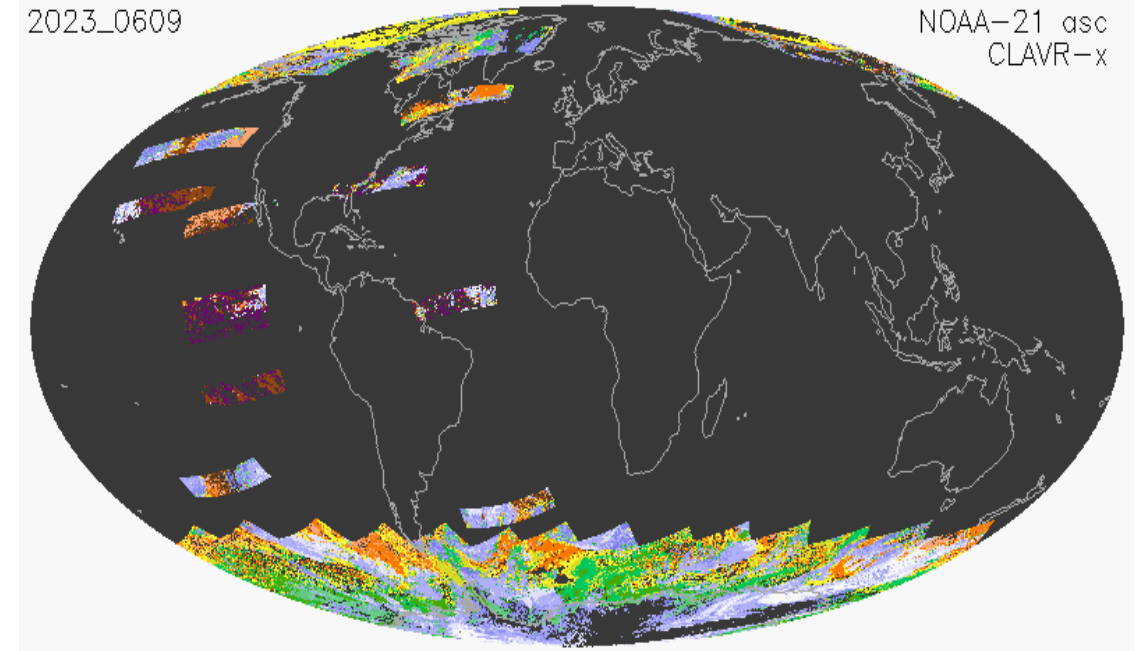
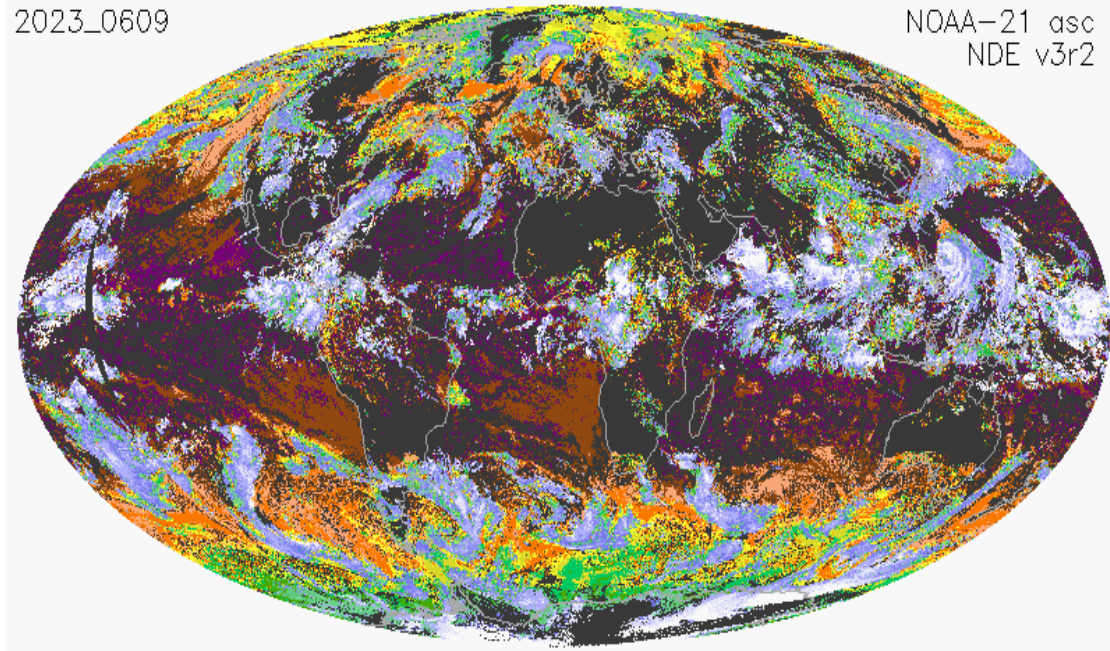
# Check List - Beta Maturity

Beta Maturity End State	Assessment
<p>Product is minimally validated, and may still contain significant identified and unidentified errors</p>	
<p>Information/data from validation efforts can only be used to make initial qualitative or very limited quantitative assessments regarding product fitness-for-purpose</p>	
<p>Documentation of product performance and identified product performance anomalies, including recommended remediation strategies, exists</p>	

# NOAA-21 Cloud Top Temperature Level2b (Ascending)

NDE

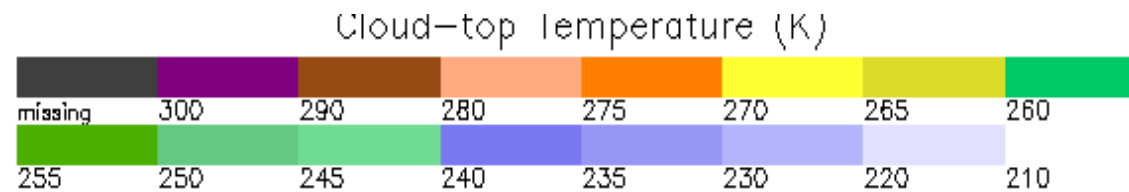
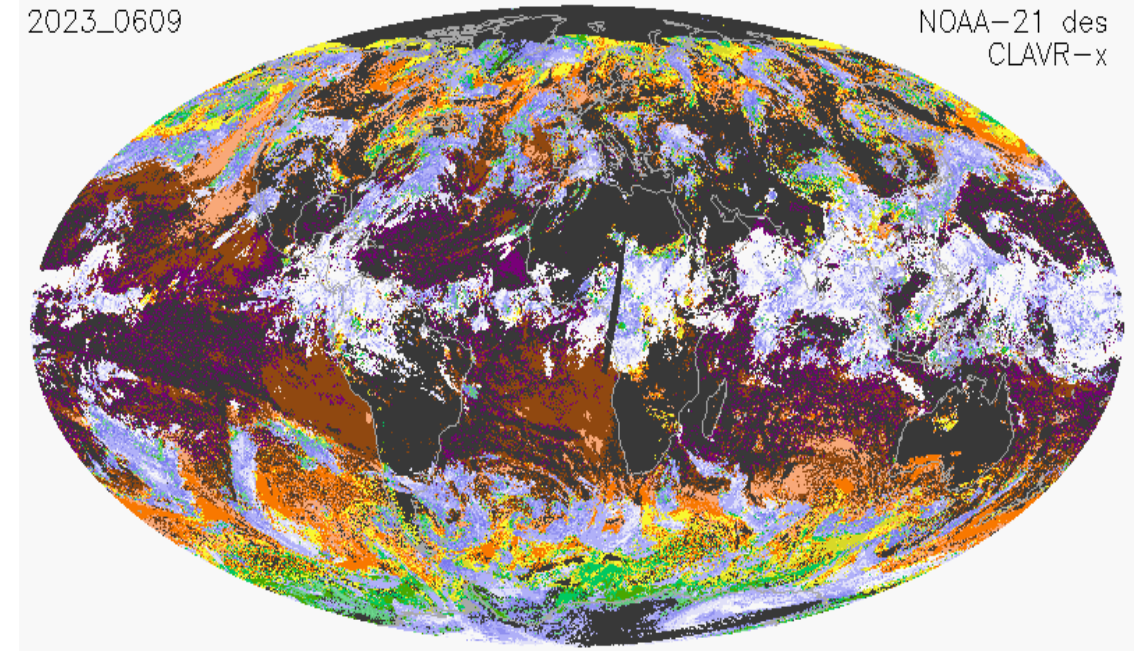
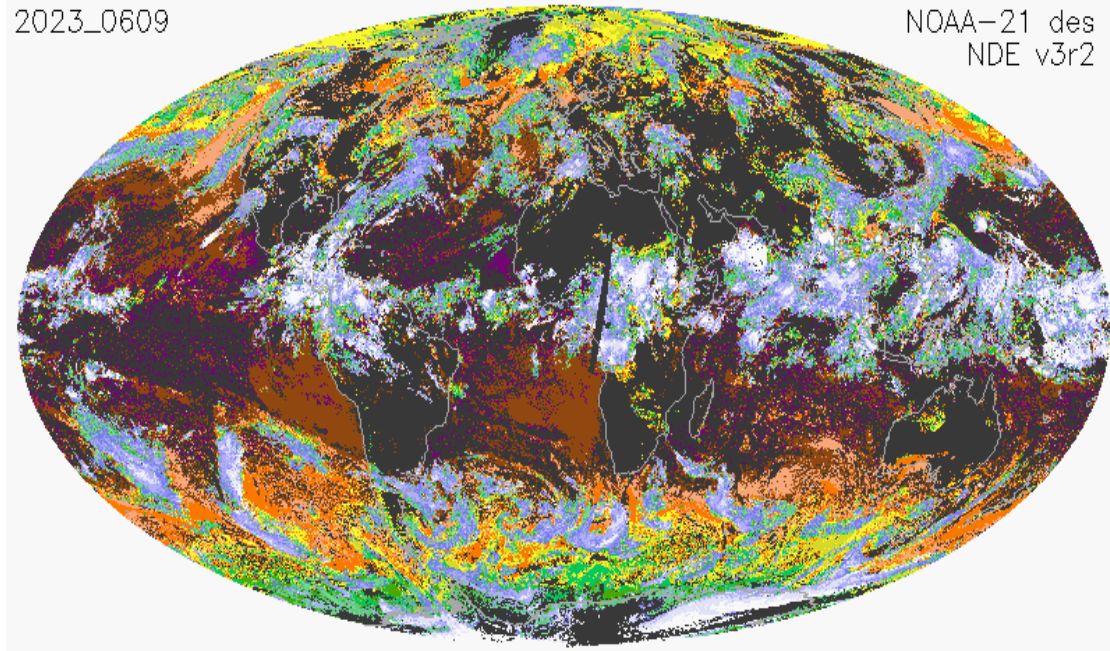
CLAVR-x



# NOAA-21 Cloud Top Temperature Level2b (Descending)

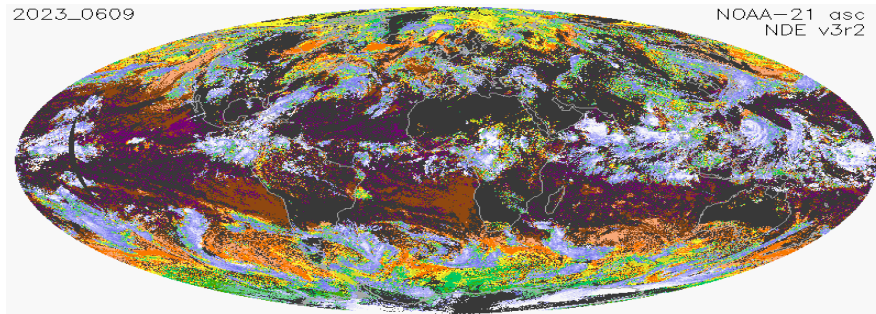
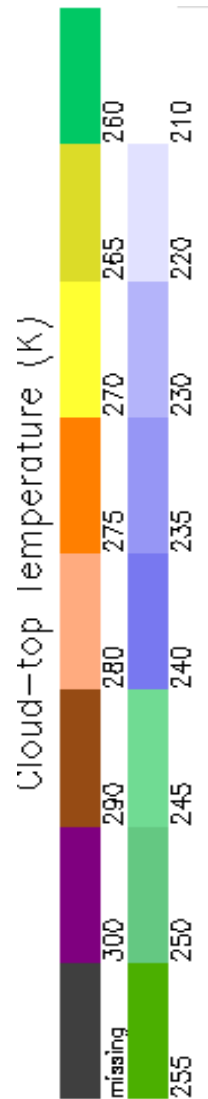
NDE

CLAVR-x

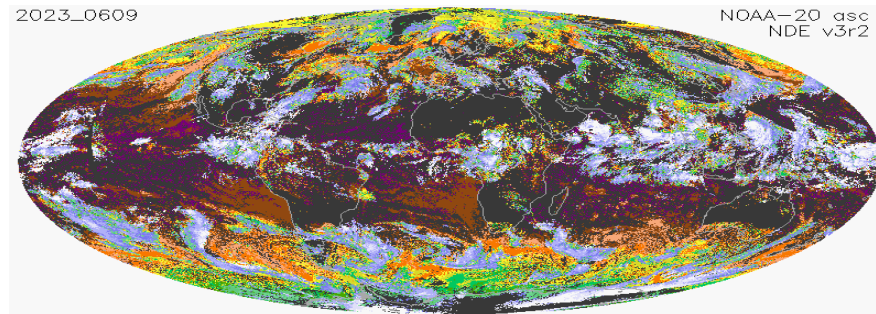




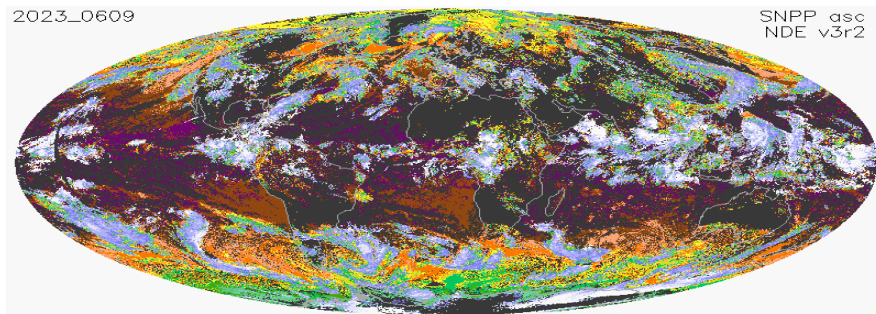
# VIIRS NDE Cloud Top Temperature Level2b (Ascending)



NOAA-21

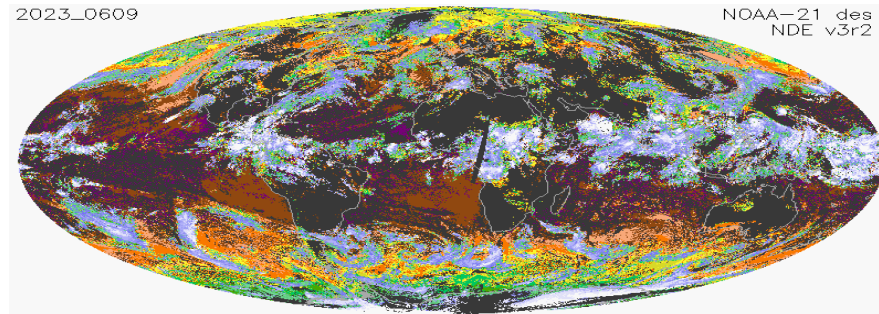
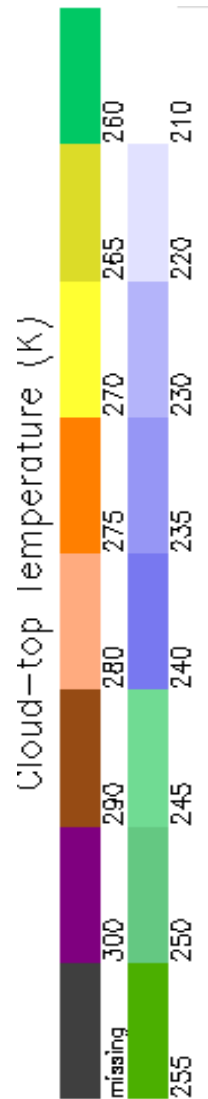


NOAA-20

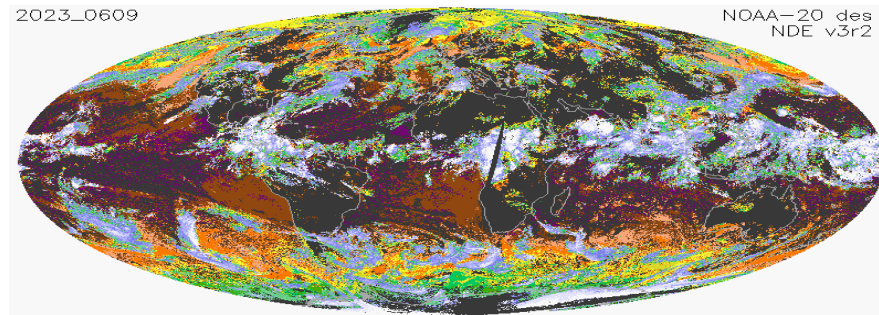


SNPP

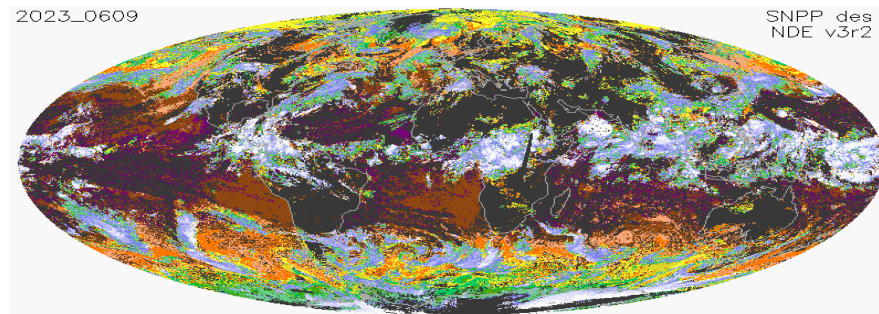
# VIIRS NDE Cloud Top Temperature Level2b (Descending)



NOAA-21



NOAA-20

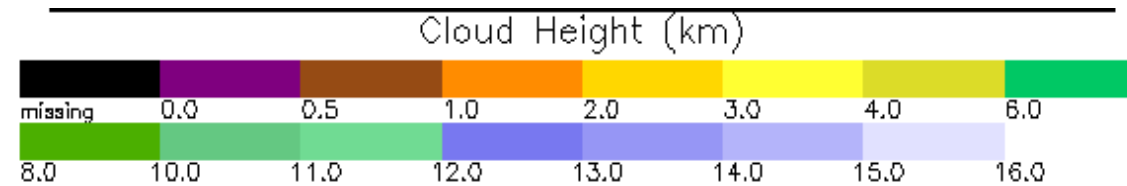
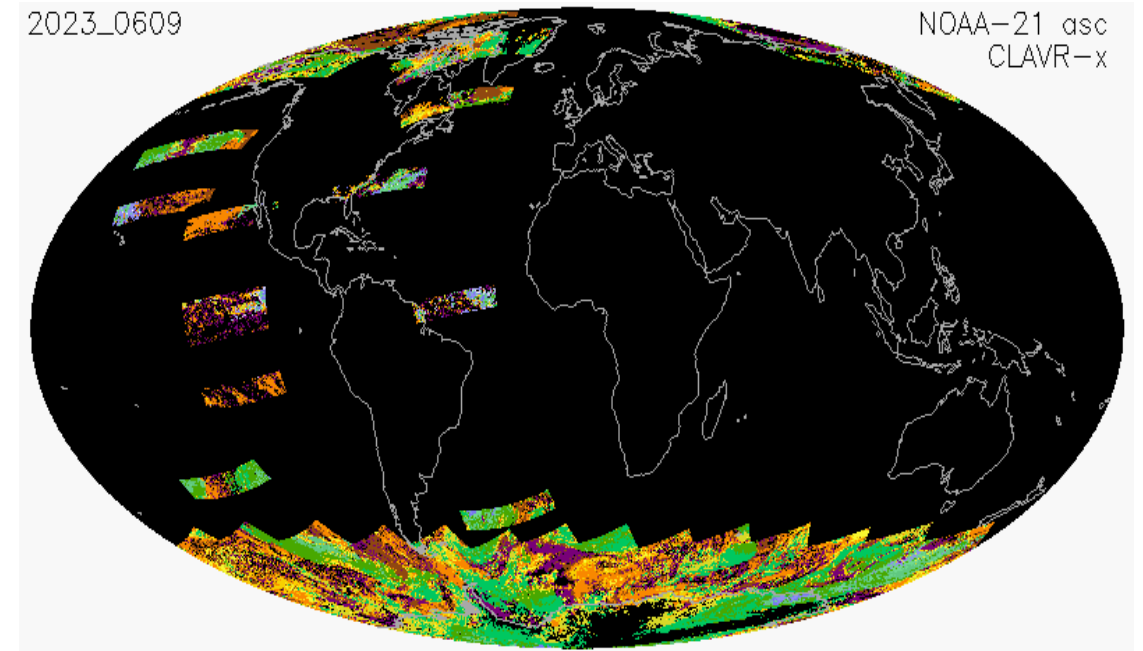
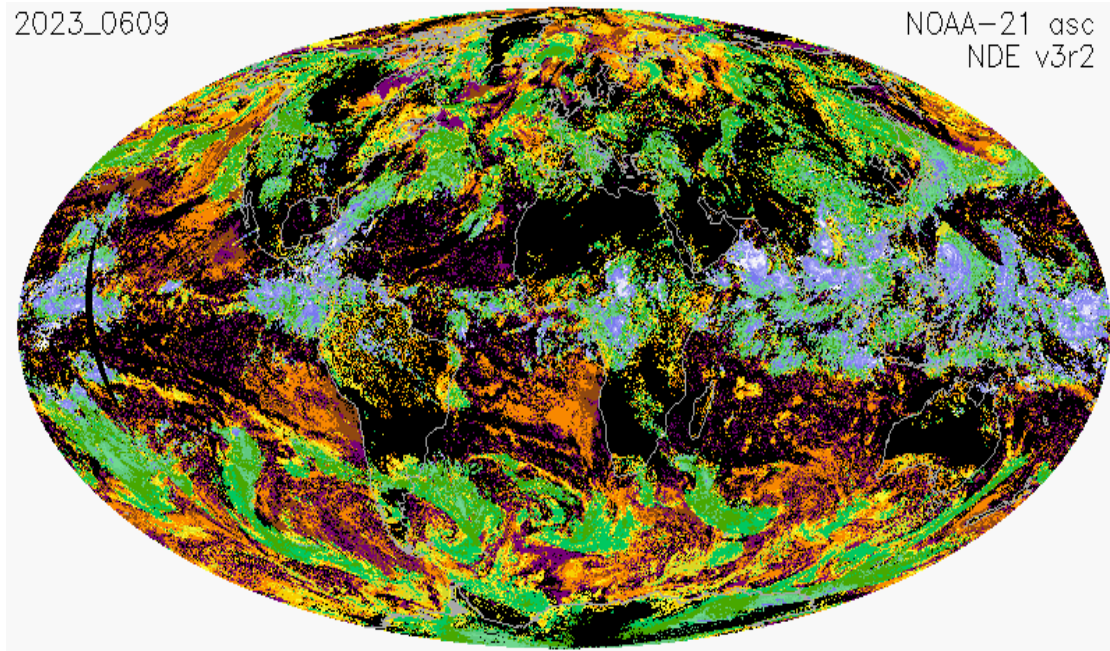


SNPP

# NOAA-21 Cloud Top Height Level2b (Ascending)

NDE

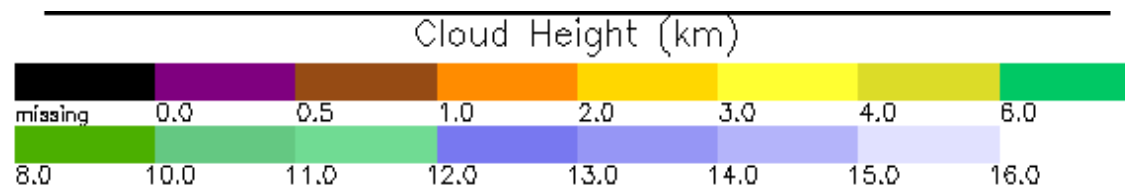
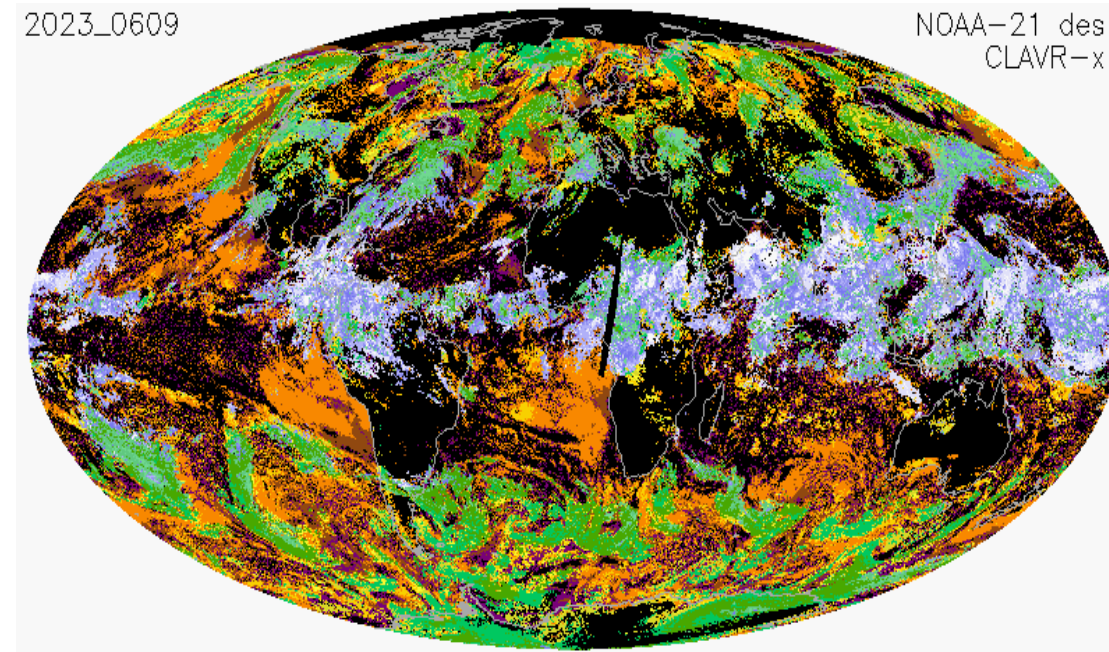
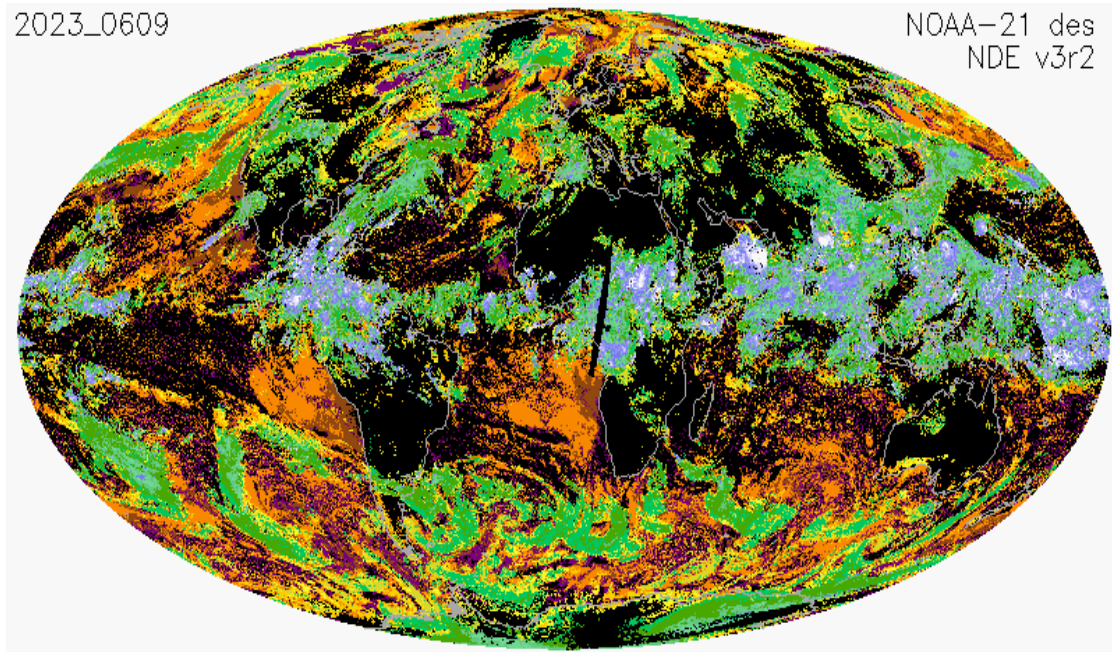
CLAVR-x



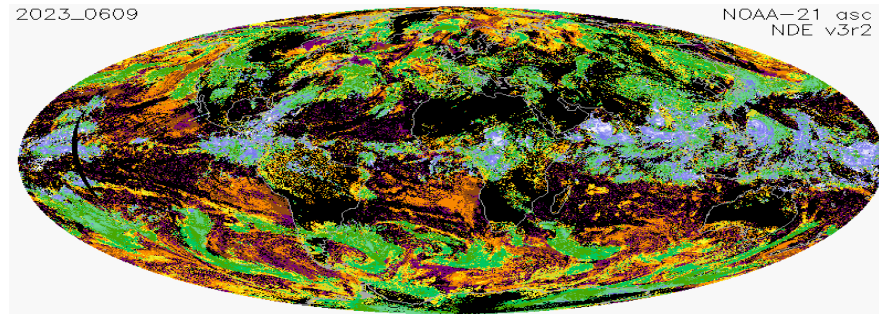
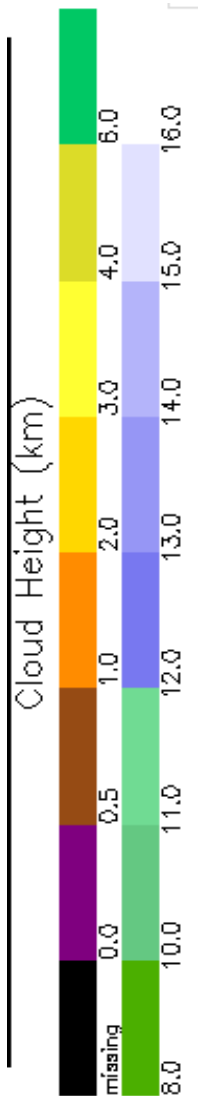
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NDE

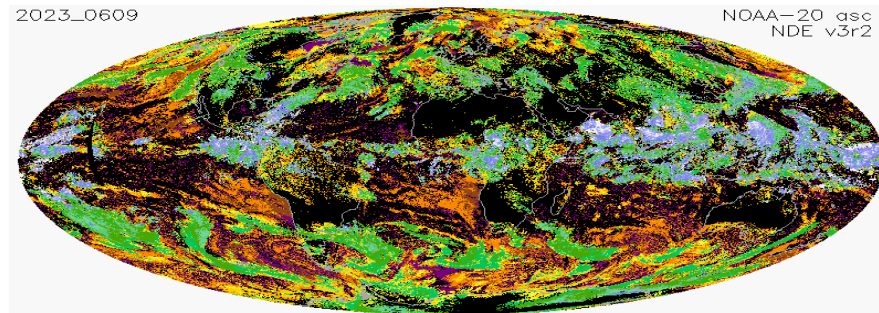
CLAVR-x



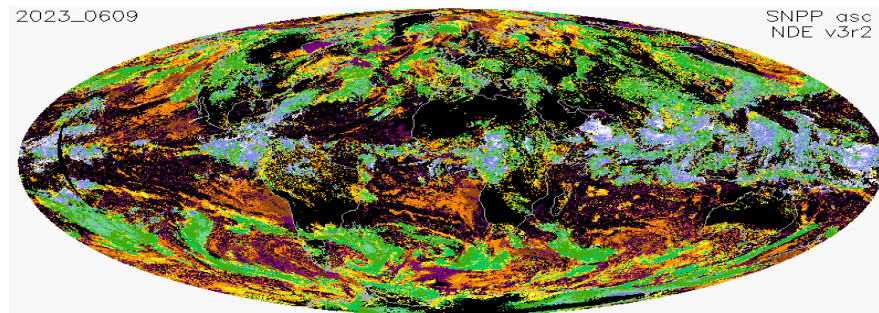
# VIIRS NDE Cloud Top Height Level2b (Ascending)



NOAA-21

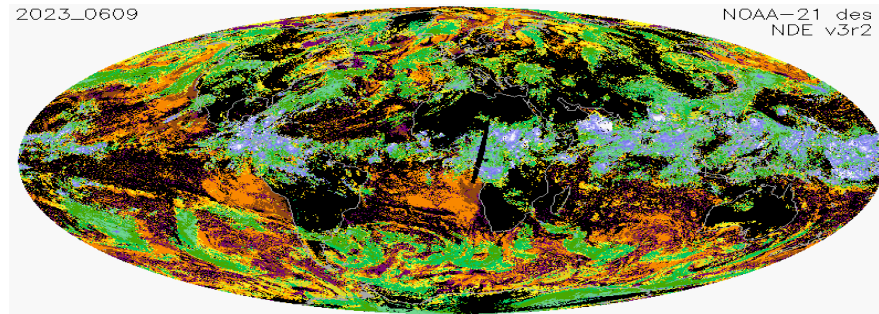
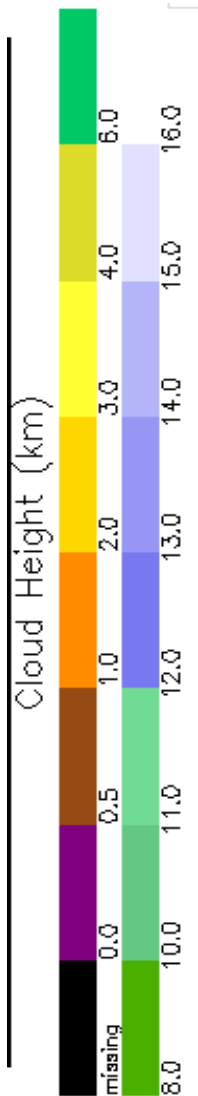


NOAA-20

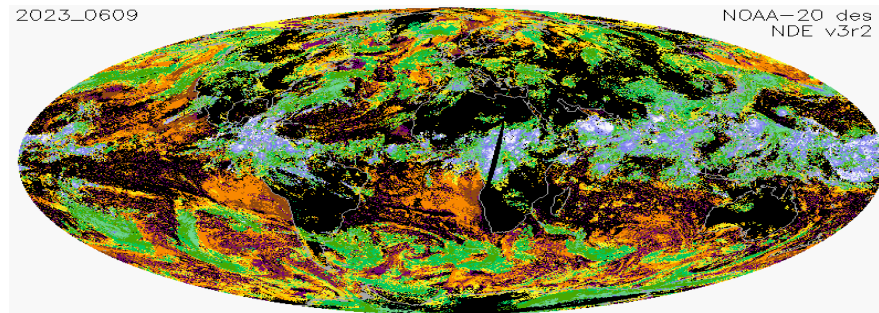


SNPP

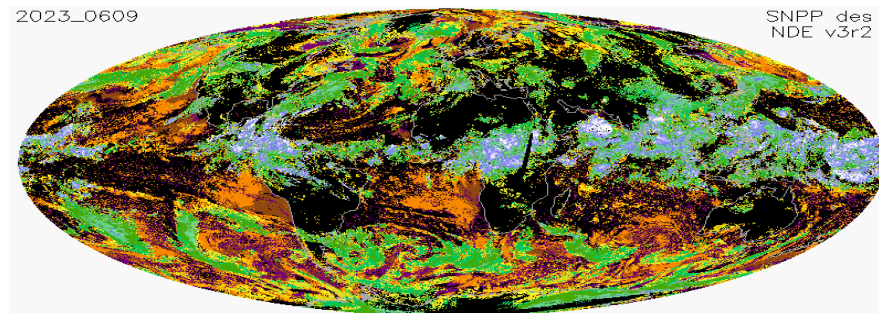
# VIIRS NDE Cloud Top Height Level2b (Descending)



NOAA-21



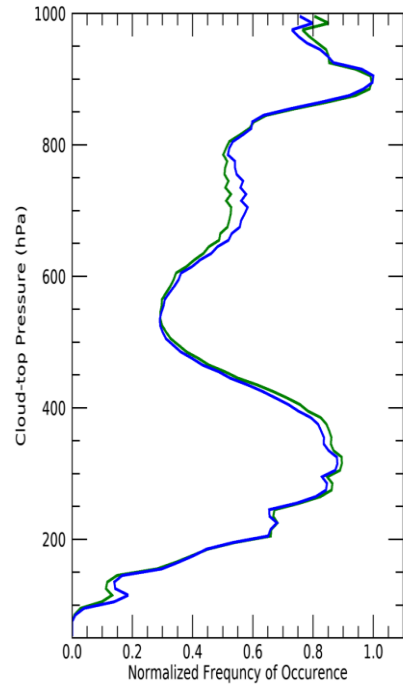
NOAA-20



SNPP

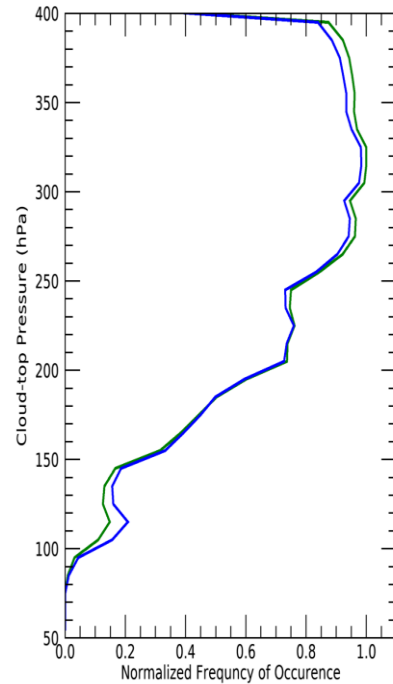
# VIIRS Cloud Top Pressure Distribution (Descending)

— NDE NOAA-21  
— NDE NOAA-20



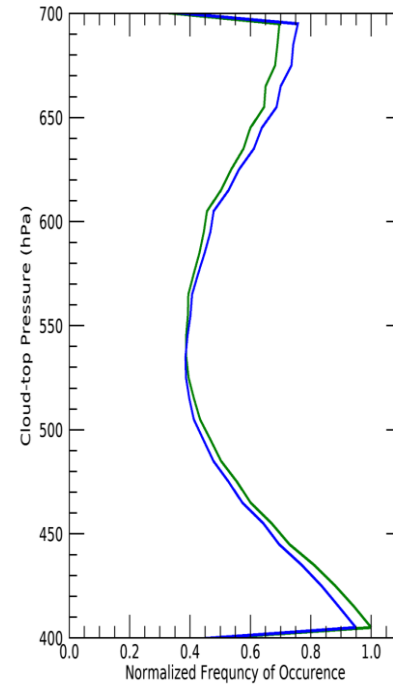
**ALL**

— NDE NOAA-21  
— NDE NOAA-20



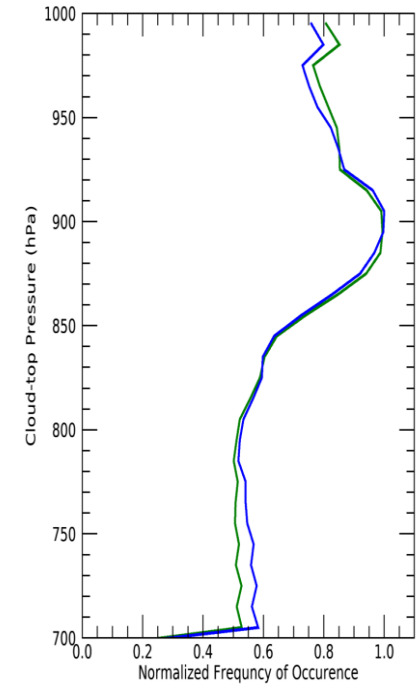
**HIGH**

— NDE NOAA-21  
— NDE NOAA-20



**MID**

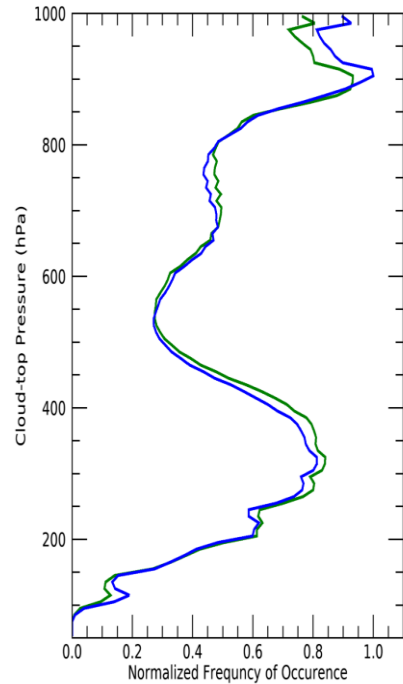
— NDE NOAA-21  
— NDE NOAA-20



**LOW**

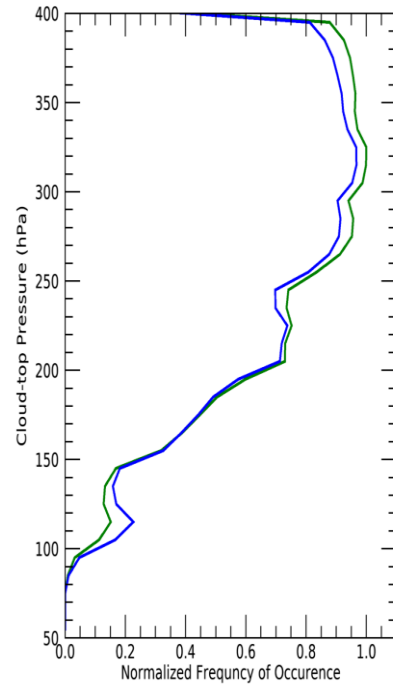
# VIIRS Cloud Top Pressure Distribution (Descending)

— NDE NOAA-21  
— NDE SNPP



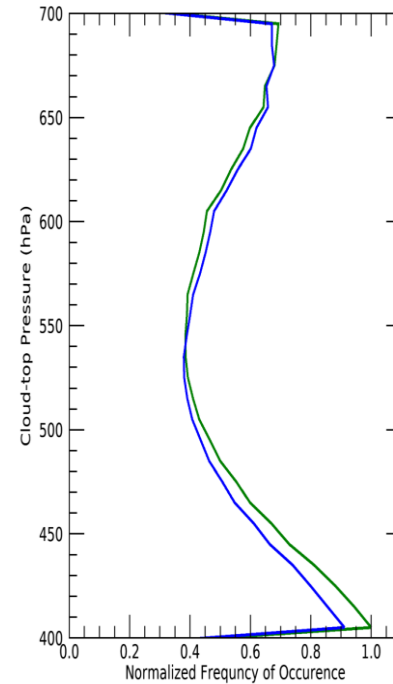
**ALL**

— NDE NOAA-21  
— NDE SNPP



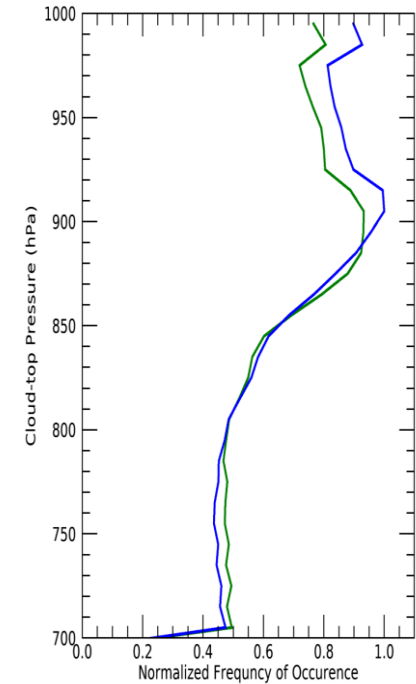
**HIGH**

— NDE NOAA-21  
— NDE SNPP



**MID**

— NDE NOAA-21  
— NDE SNPP

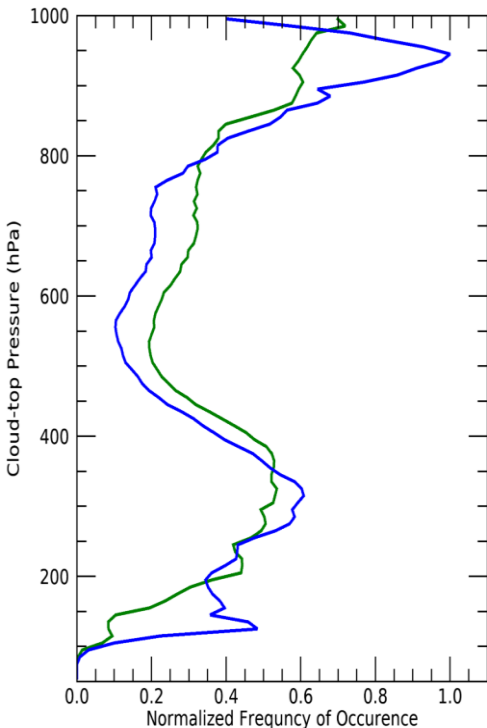


**LOW**

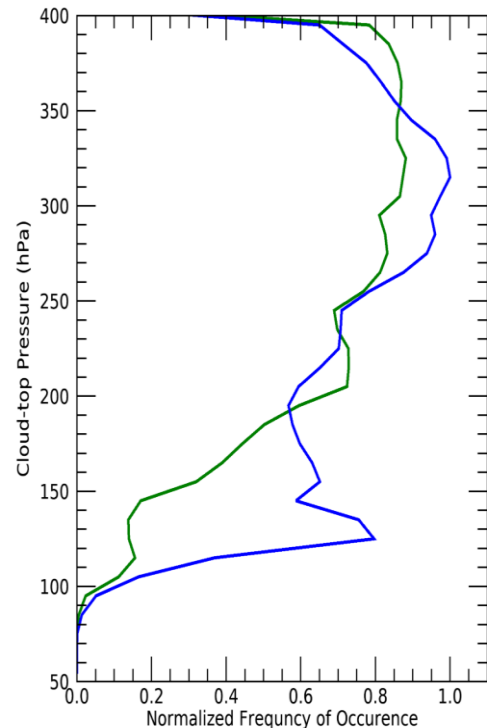


# VIIRS Cloud Pressure Distributions (Ascending)

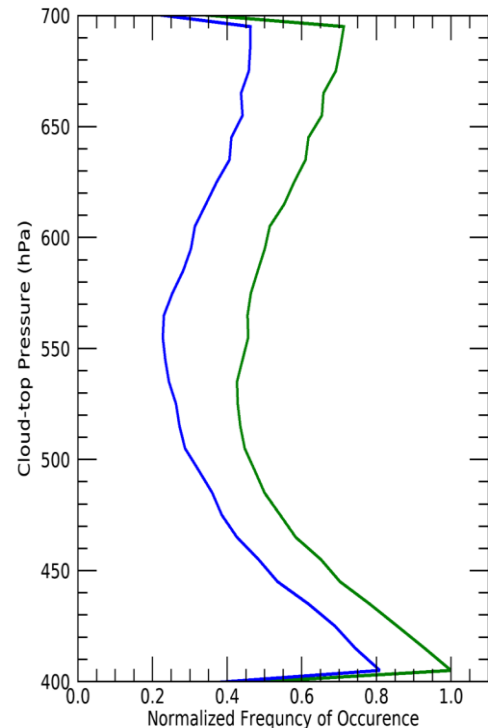
— NDE NOAA-21  
— CLAVR-x NOAA-21



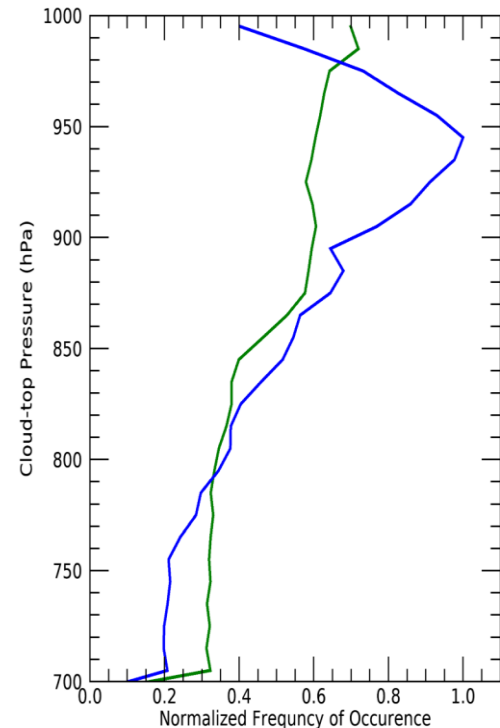
— NDE NOAA-21  
— CLAVR-x NOAA-21



— NDE NOAA-21  
— CLAVR-x NOAA-21



— NDE NOAA-21  
— CLAVR-x NOAA-21



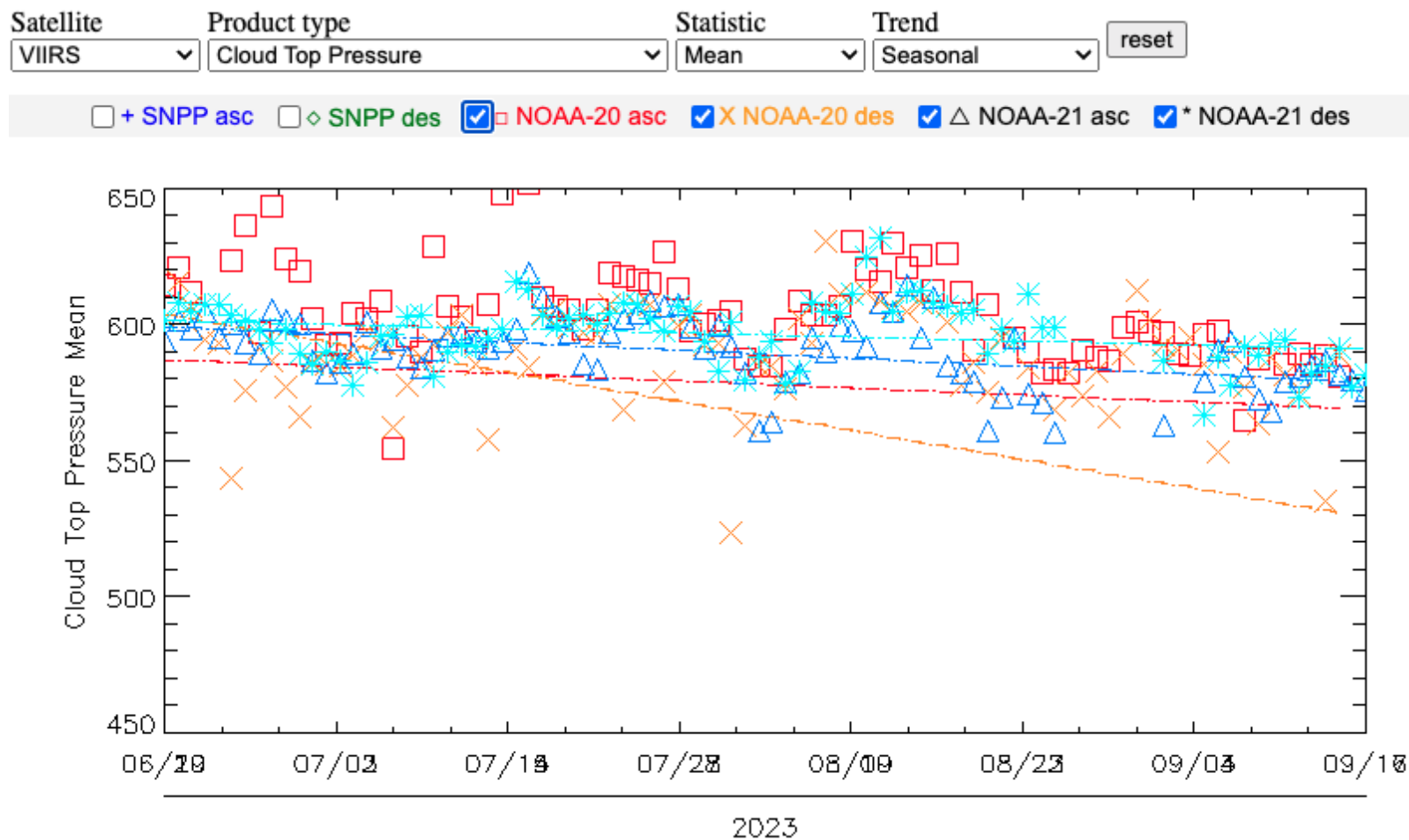


# Comparison to AQUA/MODIS

## Data and Methods

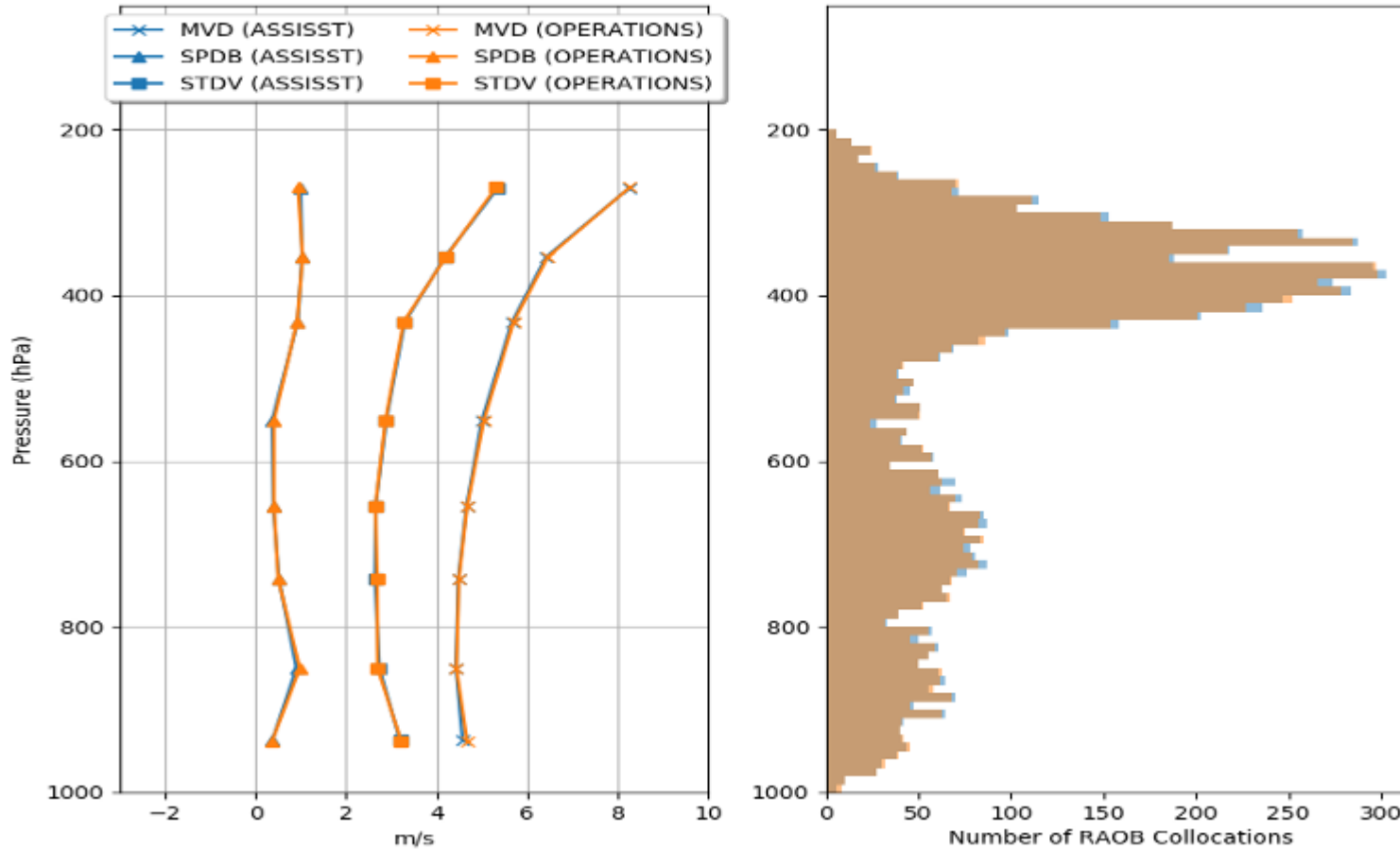
- 3 days of matchup files between NOAA-21 and Aqua MODIS in May and June to, 2023 were used
- ACHA NCCF NOAA-21 were compared to NASA MODIS
- ACHA values from VIIRS pixel closest to a MODIS footprint were used to compare to MODIS

# Algorithm Performance Evaluation



# Downstream Product Feedback (AMVs)

J02 IR Winds  
 Cloud Types: ALL  
 From 2023-08-22 To 2023-09-19

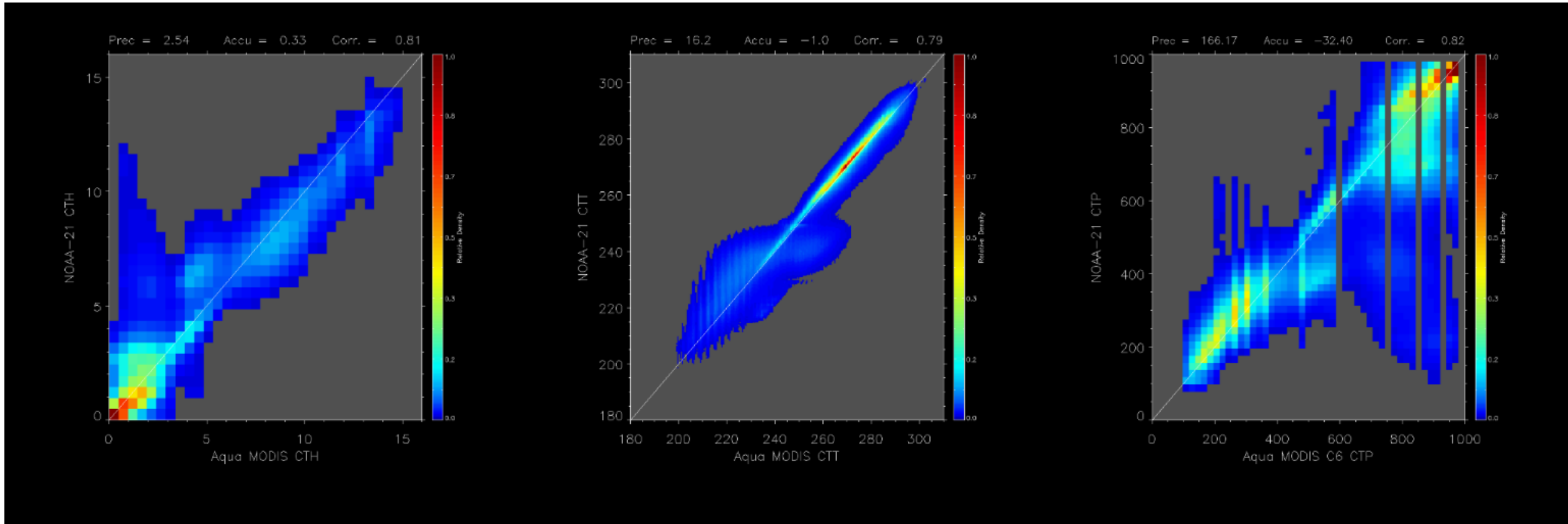


# MODIS Comparison: No Filtering

CTH

CTT

CTP



# MODIS Comparison: Phase-Matched

CTH

CTT

CTP

