Validated Stage 1 Science Maturity Review for VIIRS Cloud Base, Nighttime Optical Properties and Cloud Cover Layers Products

Andrew Heidinger

September 3, 2014

Outline

- Cloud Base Height
  - Product Requirements
  - Evaluation of algorithm performance to specification requirements
    - Evaluation of the effect of required algorithm inputs
    - Quality flag analysis/validation
    - Error Budget

- Nighttime Optical and Microphysical Properties
  - Product Requirements
  - Issues preventing Val Stage 1 Maturity

- Cloud Cover Layers
  - Product Requirements
  - Issues with definition in NDE
- Conclusion
- Path Forward
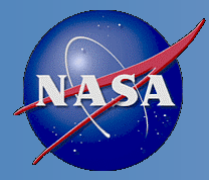
Curtis Seamen, CIRA

CLOUD BASE

Cloud Base Height Requirements

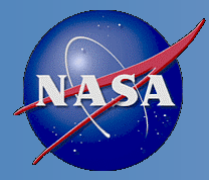| Table 5.3.1 - Cloud Base Height (VIIRS)		
EDR Attribute	**Threshold**	**Objective**
CBH Applicable Conditions: 1. Requirements apply whenever detectable clouds are present.		
a. Horizontal Cell Size	7 km	1 km
b. Vertical Reporting Interval	Base of up to four layers (from surface to 15 km).	Base of all distinct cloud layers (from surface to 30 km).
c. Mapping Uncertainty, 3 Sigma	4 km	1 km
d. Measurement Uncertainty	2 km	0.25 km
e. Refresh	At least 90% coverage of the globe every 12 hours (monthly average)	4 hrs.
		v2.2, 9/22/12
Notes: 1. Reserved		

Cloud Base Height Error Budget

- Based on VIIRS co-locations with CloudSat CPR data.

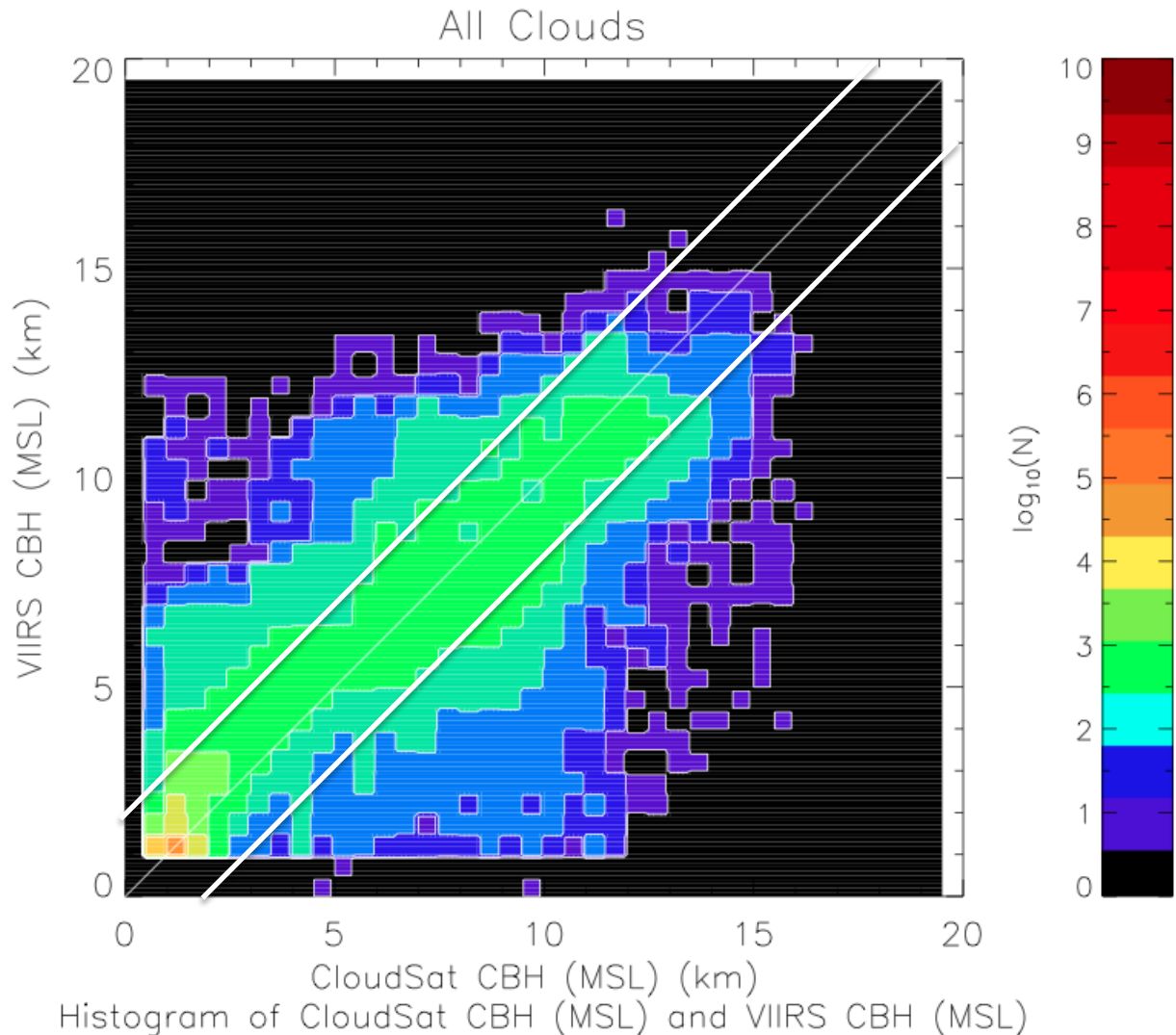- Data for separated for all clouds and those that meet the CTH specification.

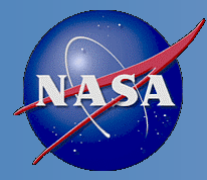| Attribute Analyzed	L1RD Threshold	Analysis/Validation Result	Error Summary
CBH	2 km uncertainty	0.3 km and 40% of time	All clouds
CBH	2 km uncertainty	-0.1 km and 70 % of time	Clouds with CTH within spec

- The Cloud Profiling Radar (CPR) on the NASA CloudSat Mission provides the most complete cloud vertical structure information.

- We define Cloud Base Height as the height of the lowest cloud layer.

- Distribution shows results where CTH was in spec. CBH is based on CTH.

All Clouds

Histogram of CloudSat CBH (MSL) and VIIRS CBH (MSL)

- Same analysis as previous slide but show as a bias histogram.

- Colors denote optical thickness.

- The specification calls for an uncertainty of 2 km.

- NDE is approach is similar to IDPS but new improvements are coming based on CloudSat "tuning".

Continuous Statistics for All Clouds CBH

Average error: −0.2 km	r² value: 0.760
Standard deviation of error: 1.9 km	N: 57772
Median error value: −0.2 km	
RMSE: 1.9 km	

Percentage of pixels with CBH within 250 m of CloudSat: 25.0%

CloudSat − VIIRS All CBH histogram
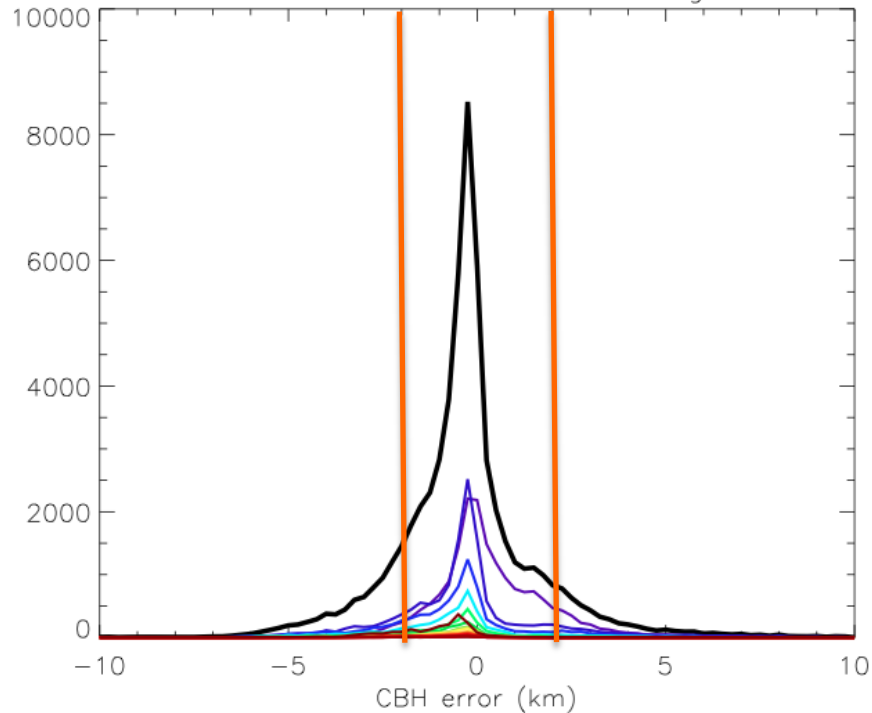
VIIRS Cloud Optical Thickness
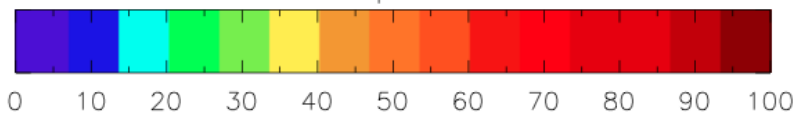
NIGHTTIME CLOUD OPTICAL PROPERTIES

No difference from Day Requirements shown earlier

Table 5.3.6 - Cloud Optical Thickness (VIIRS)		
EDR Attribute	**Threshold**	**Objective**
COT Applicable Conditions: 1. Requirements apply whenever detectable clouds are present.		
a. Horizontal Cell Size	7 km	NS
b. Vertical Reporting Interval	Up to four cloud layers	4 layers
c. Mapping Uncertainty, 3 Sigma	4 km	1 km
d. Measurement Precision	Greater of 33 % or 1 Tau	2 %
e. Measurement Accuracy	Greater of 24% or 1 Tau	5 %
f. Refresh	At least 90% coverage of the globe every 12 hours (monthly average)	3 hrs.
		v2.5, 1/23/13
Notes: 1. Reserved		

No difference from Day Requirements shown earlier

Table 5.3.3 – Cloud Effective Particle Size Parameter (VIIRS)		
EDR Attribute	**Threshold**	**Objective**
CEPS Applicable Conditions: 1. Requirements apply both day and night and whenever detectable clouds are present.		
a. Horizontal Cell Size	7 km	1 km
b. Vertical Reporting Interval	Up to 4 cloud layers	0.3 km
c. Mapping Uncertainty, 3 Sigma	4 km	1 km
d. Measurement Range	0 to 50 μm	NS
e. Measurement Precision	Greater of 22% or 1 μm for water; Greater of 28% or 1 μm for ice	2 %
f. Measurement Accuracy	Greater of 22% or 1 μm for water; Greater of 28% or 1 μm for ice	5%
g. Refresh	At least 90% coverage of the globe every 12 hours (monthly average)	4 hrs.
		v2.2, 9/22/12
Notes: 1. Reserved		

- NDE is implementing the GOES-R version (NCOMP) which comes from Dr. Patrick Minnis of NASA LaRC.

- This algorithm does not run in CLAVR-x and we can't yet run it in the NDE SAPF. Therefore we can't assess its maturity on VIIRS.

- NCOMP will undergo an NDE review later this year and this material should be relevant for the JPSS maturity assessment.

- IDPS products never made it to Provisional.

CLOUD COVER LAYERS

Cloud Cover/Layers Requirements
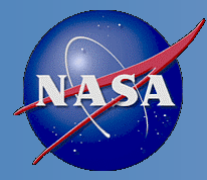
Table 5.3.2 - Cloud Cover/Layers (VIIRS)		
EDR Attribute	**Threshold**	**Objective**
CC/L Applicable Conditions: 1. Requirements apply whenever detectable clouds are present. 2. Cloud Cover shall be computed and reported at each separate, distinct layer, as well as for the total cloud cover.		
a. Horizontal Cell Size	7 km	1 km
b. Vertical Reporting Interval	Up to four cloud layers	0.1 km
c. Mapping Uncertainty, 3 Sigma	4 km	1 km
d. Measurement Range	0 to 1.0 HCS Area	0 to 1.0
e. Measurement Uncertainty (Applies only to total cloud cover; Not applicable to layers)	$0.1 + 0.3(TBR-7) \sin(SZA)$ of HCS Area	Not specified
f. Refresh	At least 90% coverage of the globe every 12 hours (monthly average)	4 hrs.
		v2.5, 1/23/13
Notes: 1. Reserved.		

Cloud Cover Layers Issues

- NDE is implementing the GOES-R version which is simply the cloud fraction for the high, middle and low cloud layers.

- The JPSS Cloud Cover Layers dynamically finds the layers based on binning.

- The performance of both of these is totally dependent on the CTP algorithm.

- Either way is not a technical problem.

- Bill Ward has communicated interest for CCL over Hawaii and we work with him to gauge NWS interest.

Identification of Processing Environment

- All algorithms shown here have been delivered to and implemented in the STAR Algorithm Processing Framework (SAPF).

- Algorithm Version = First Delivery to SAPF (number unknown).

- Version of LUTs : First Delivery to SAPF

- Version of PCTs: Not Applicable

- Description of environment used to achieve validated stage 1
  - All results shown here were generated with CLAVR-x version 5.4
  - CLAVR-x runs within CSPP (VIIRS, MODIS and AVHRR)
  - CLAVR-x runs in OSPO though only on AVHRR and GOES
  - CLAVR-x does not run the Night Cloud Optical Properties
  - CLAVR-x does not run the NDE Cloud Phase/Type Algorithm.
  - The official IDPS VCM including Cloud Phase were used in this analysis. CLAVR-x has the ability to read those in before generated downstream cloud products.

Users & User Feedback

- User Feedback
  - NDE Algorithms Released in CSPP.
  - Most feedback and interaction has been with training users on the product definitions and use of quality flags.
  - Taiwan Weather Service has given most feedback.
  - EUMETSAT has been served CTH since January – no feedback yet.
  - Bill Ward expressed interest Cloud Cover Layers over Hawaii.

- Downstream product list
  - Polar Winds (CTH used in height assignment)

- Reports from downstream product teams on the dependencies and impacts
  - None received for IDPS or NDE algorithms yet.

Conclusion

- Team does not recommend algorithm validated stage 1 maturity yet for
  - Cloud Base
    - While the cloud base performs better than IDPS version, we still think we need development to make a useful product. This development is on-going and should yield a mature product in 6 months.
    - Should we adopt GOES-R L1 Requirements?

- Team can not make a decision on the maturity of the following
  - Nighttime Cloud Optical Properties
    - This algorithm is recently implemented into NDE SAPF. We do not have the ability to run it yet. GOES-R version would meet specs.
  - Cloud Cover Layers
    - NDE Cloud Cover Layers has a different (simpler) definition than JPSS. The algorithm is simple and driven by Cloud Top Parameters. We recommend implemented IDPS-like Cloud Cover Layers into NDE. Alternatively, we adopt simpler GOES-R definition

- ## Planned further improvements
  - cloud base
    - Finalize CloudSat derived parameterizations of geometrical thickness.
    - Finalize use of NWP profiles for thick clouds.
  - Implement IDPS-like cloud cover layers (if directed).

- ## Planned Cal/Val activities / milestones
  - Validate Nighttime COP when available from NDE SAPF
  - Launch our CALIPSO and MODIS near-real time monitoring site.
  - Draft reports on impacts of cloud type and cloud mask errors on cloud product performance.