JPSS Cloud Products

Quick Guides

Compliments Slide 7

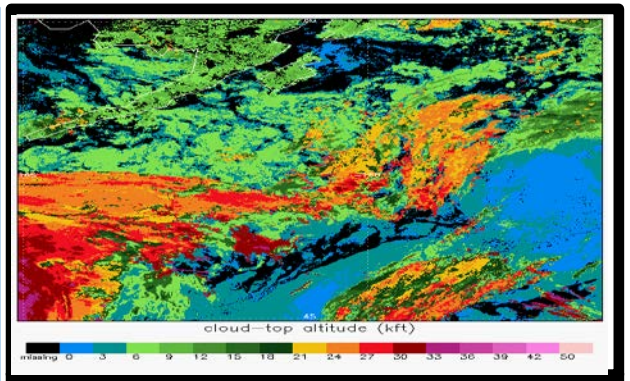
Cloud Top Altitude Quick Guide

Why is Cloud-top Altitude Important?

Cloud-top Altitude (CTA) is the height of the highest cloud in the column expressed in kilo-feet (kft). It is derived from the AWG Cloud Height Algorithm (ACHA).

The Aviation Weather Center (AWC) began to demonstrate ACHA products in 2012. From this initial evaluation, the CTA was requested as feet are the units in aviation forecasting. From this, the request for Cloud Cover Layers (CCL) was born.

The aviation community needs to know where clouds and cloud-specific hazards exist in the atmosphere to optimally plan flight paths.



Cloud-top Altitude Product from SNPP VIIRS at 2248 UTC, 09 July 2018

How is the CTA Defined and What Goes into it?

CTA Products	Function of Input
Cloud-Top Altitude	Sets the fraction in top-most layer
Cloud-Base Altitude	Determine layers below the top that have cloud
Lower Cloud Altitude	if present, determines the contribution for a lower cloud layer

Layer #	Cld Alt (kft)
1	0-5
2	5-10
3	10-18
4	18-24
5	24-100

Impact on Operations

Primary Application

Application: Supporting Aviation's need of cloud information.

Application: Pilots desire information on the vertical distribution of clouds.

Application Name or Short description: Real-time Aviation support

Application: Entities like the NWS Alaska Aviation Weather Unit and the AWC would use this information to give guidance to pilots.

Assumptions/Limitations

Assumptions:

- Hydrostatic Equilibrium.
- Perfect gas.
- Gravity independent of altitude.
- Constant lapse rate.

Limitation : Must have a successful cloud temperature retrieval prior to conversion to CTA.

Reference : Derivation is based on a subset of the International Standard Atmosphere model defined by the International Civil Aviation Organization (1993).

Contributor: Steve Wanzong (CIMSS)

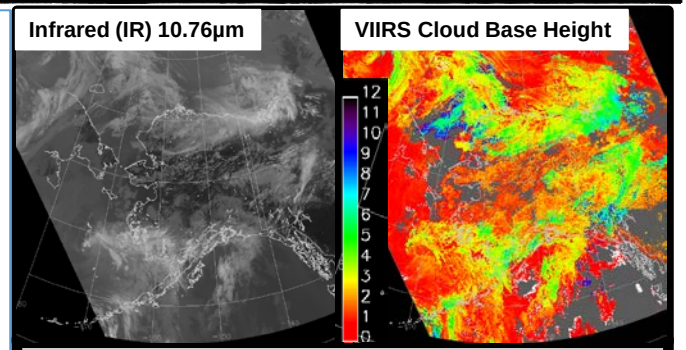
Compliments Slide 8

VIIRS Cloud Base Altitude

Quick Guide

Why is the Cloud Base Altitude (CBA) Important?

The CBA is an estimation of the base altitude of the uppermost cloud layer in each column of the atmosphere as viewed from above by satellite. Information of 3-D cloud structure is significant to the aviation community. It also bears high relevance to model developers for weather and climate applications. CBA is a key component required to construct a full 3-D cloud field, although assigning cloud base from satellite data is still challenging. The current CBA algorithm is operational as part of the NOAA Enterprise Cloud Algorithms.



Sample VIIRS IR (10.76 μm) and VIIRS Cloud Base Height [km] from S-NPP VIIRS over Alaska at 2203 UTC, 28 July 2018. For 'Alaska Cloud Product Demo' users: product will be distributed in AWIPS (displayed in kilofeet, kft) and the Web via Polar2Grid (starting Fall 2018).

How is the VIIRS CBH Created?

The CBA is obtained from a semi-empirical approach, based on a statistical analysis of multiple satellite data (CloudSat/CALIPSO and Aqua MODIS). In the algorithm, Cloud Geometric Thickness (CGT) is derived from statistical relationships between observed CGT, Cloud Water Path (CWP), Cloud Top Height (CTH) and subtracted from CTH to generate CBH. The algorithm includes special accommodations for handling optically thin cirrus (an extinction method) and deep convection (supplementary NWP data). The CBA product is provided for any cloudy pixel with valid cloud top height globally, day and night (750 m resolution, ~50 min revisit between S-NPP and NOAA-20).

$$CBH = CTH - CGT \text{ and } CGT = (a * CWP) + b, \text{ where } a \text{ and } b \text{ are obtained from statistical relationships.}$$

Impact on Operations

Applications:

- CBH information can be used to improve the Cloud Cover Layers (CCL) products by introducing additional cloud coverage at lower levels of the profile, typically hidden under cloud top.
- Vertical cloud structures including CBH provide useful information for aviation weather applications.
- The CBH algorithm is also applicable to geostationary sensors as well as polar satellite sensors. Global observations of 3-D cloud fields are relevant to model developers for integrating improved cloud radiative feedbacks in numerical models.

Limitations

- The performance of the CBH retrieval is highly dependent on the accuracy of CTH and CWP (from cloud optical properties).
- The nighttime CBH retrieval performance would be degraded due to the difficulty of CWP retrievals.
- The algorithm is optimal for single layer clouds or the uppermost layer of multi-layered clouds. The CBH may not be 'ceiling' for multi-layered cloudy scenes. The accuracy of the CBH product for multi-layer clouds may comprise the uncertainties of the upstream retrievals. Most likely CBH = actual ceiling in cases of an optically thin cirrus cloud that is not categorized as a "multi-layer" cloud type, a boundary layer cloud, and a cloud base for deep convection derived using NWP supplementary data.

Resource: Development of a statistical cloud base height retrieval algorithm: Noh et al., 2017, J. Atmos. Ocean. Tech., 34(3), 585-598.

Contributor: Y. J. Noh, Steve Miller (CIRA/Colorado State University) https://www.cira.colostate.edu

Cloud Cover Layers

Quick Guide

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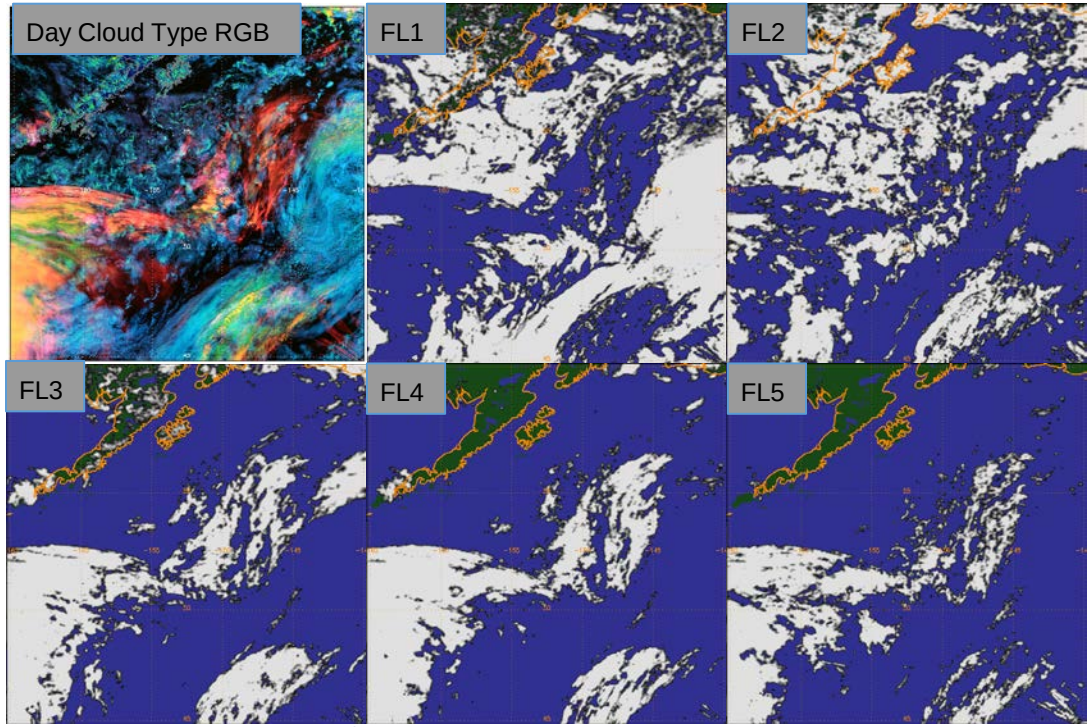
Why is CCL Important?
CCL provides the vertical distribution of clouds in the atmosphere with layers defined by flight levels that are relevant to the Aviation Community.

Layer #	Cld Alt (kft)
1	0-5
2	5-10
3	10-18

Layer #	Cld Alt (kft)
4	18-24
5	24-100



FL1 and FL2 are going be the most relevant to General Aviation

Impact on Operations

Primary Application
Application: Supporting Aviation's need of cloud information.

Limitations

Cloud-Top Pressure Dependency: CCL depends on the cloud pressure product. Mistakes in cloud masking and typing can cause cloud pressure errors:
Cloud-Base Pressure Dependency: CCL profiles is based on cloud-base pressure. Issues with cloud-base will impact CCL.

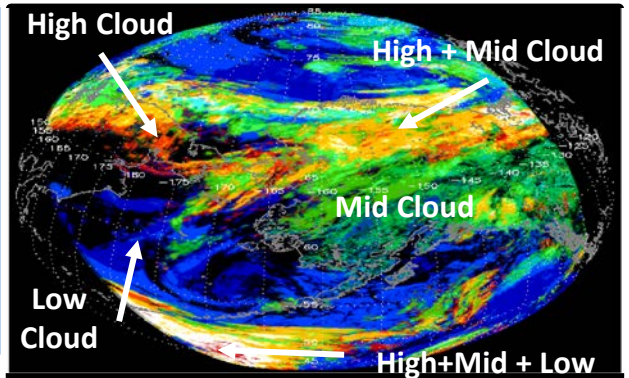
Contributor: Andrew Heidinger (NOAA/STAR)

Compliments Slide 10

Cloud Cover Layer RGB
Quick Guide

Why is the CCL RGB Important?

The Cloud Cover Layers (CCL) product provides 5 layers of cloud fraction. The layers are defined by common flight levels. It is difficult to display all of the 5 layers of CCL at once. This RGB was construct to provide a quick view of the CCL product. ***It is intended to complement the actual CCL quantitative values.*** This RGB also pairs well with the Day Cirrus RGB which can provide visual confirmation of the cloud features.



Product Name from SNPP VIIRS at HHMM UTC, DD Month YYYY

What is the CCL RGB Recipe

Color	CCL Layers	Physically Relates to…
Red	0.75*L5 + 0.25*L4	high clouds
Green	0.25*L4 + 0.5*L3 + 0.25*L2	mid-level clouds
Blue	0.25*L2 + 0.75*L1	low clouds

Flight Levels

FL	Alt. (kft)
5	toa-24
4	18-24
3	10-18
2	5-10
1	0-5

What do the colors mean?

Color	Interpretation
white	high + mid + low
Red	high
Yellow	high + mid
Green	mid
Cyan	mid + low
Blue	low

Impact on Operations

Primary Application: This RGB description provides a way to distill 5 layers of information into one simple-to-interpret RGB. Use this product to monitor cloud levels as diagnosed by the VIIRS Cloud Cover Layer product

Application: This RGB should be used in concert with other RGBs and Products to understand fully the distribution of clouds in Polar Regions.

Limitations

Limitation: This RGB is derived from a product, and the limitations of that product – Cloud Cover Layer – are present in the RGB as well.

Contributor: Andrew Heidinger, NOAA/STAR

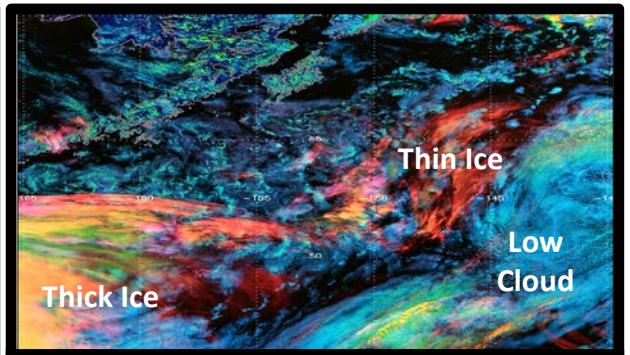
Compliments Slide 11

Day Cloud Type RGB Quick Guide

Why is the Cirrus Day RGB Important?

The Cirrus Day RGB exploits the excellent performance of the 1.38 micron channel (M9). The RGB distinguishes between thin cirrus, thick ice and low cloud. The product is therefore complementary to the cloud height and layer products.

In this RGB, red colors indicate cirrus cloud, yellow colors indicate thick ice, blue colors indicate low clouds and green colors indicate snow/ice on the surface.



Day Cloud Type RGB from SNPP VIIRS at 2248UTC, 28 August 2018

How is the [Product Name] Created? Or [Product] RGB Recipe

Color	Band / Band Diff. (μm)	Physically Relates to…	**Small** contribution to pixel indicates…	Large Contribution to pixel indicates…
Red	**1.38**	Cloud height	Low clouds	**High clouds**
Green	**0.65**	cloud optical thickness	thin clouds	**thick clouds or snow/ice**
Blue	**1.6**	Cloud phase	Ice clouds	**Water clouds**

Impact on Operations

Primary Application: Use this product to identify regions of high and low clouds, and easily distinguish between clouds and surface ice.

Application: This RGB is a reflectance-based qualitative product that is complementary to more quantitative products like Cloud-Top Altitude and Cloud Phase/Type.

Limitations

Daytime only application: This product uses reflectance bands from ABI, and is therefore daytime-only.

Limitation:

1. The product identifies 'High' and 'Low' clouds, but no definition of the level is possible
2. Under dry lower tropospheric conditions, false detections of cirrus clouds can be triggered

Contributor: Andrew Heidinger (NOAA/STAR)

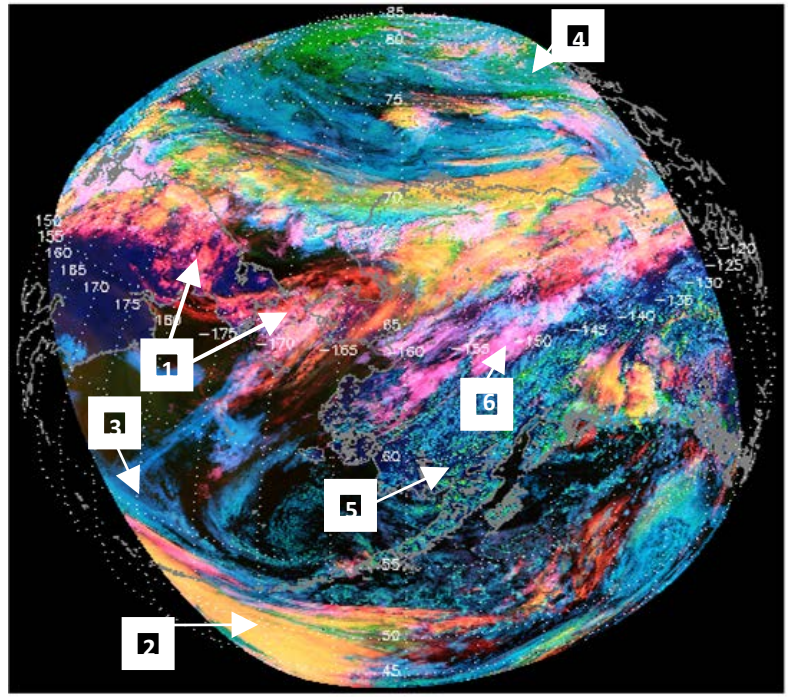
Compliments Slide 11

Day Cloud Type RGB Quick Guide

RGB Image Interpretation

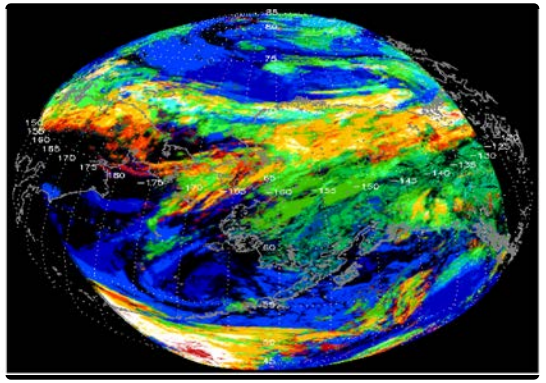
- 1 cirrus *(red)*
- 2 thick ice *(yellow)*
- 3 low water clouds *(blue)*
- 4 snow/ice *(green)*
- 5 glaciating water clouds *(turquoise)*
- 6 elevated water clouds/ supercooled *(white)*

Note:, colors may vary diurnally, seasonally, and latitudinally



Day Cloud Type RGB from VIIRS Data on Suomi/NPPfat 2248 UTC, 28 August 2018.

RGB Color Guide



The Cloud Cover Layer RGB at left from VIIRS Data on Suomi/NPP at the same time as the Cirrus Day RGB above. These two RGBs are complementary and together give information about clouds in the Polar regions.

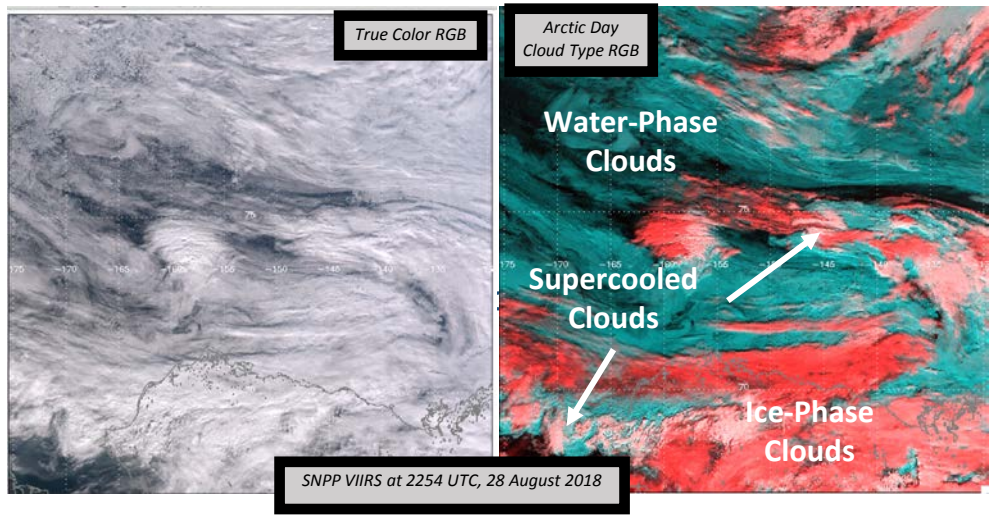
Compliments Slide 12

Arctic Day Cloud Type RGB

Quick Guide

Why is the Arctic Day Cloud Type RGB Important?

The Arctic Day Cloud Type RGB exploits the ability of the 1.38 micrometer channels (M9) to isolate high clouds from the surface below. The 1.6 micrometer channel separates ice and water clouds. Coupled together, these channels make a powerful RGB that can detect clouds and give information in cloud type over snow/ice surfaces during the day. Ice clouds appear red, water clouds appear blue and frozen surfaces are black.



Color	Band / Band Diff. (µm)	Physically Relates to…	Small contribution to pixel indicates…	Large Contribution to pixel indicates…
Red	1.38	cloud height	Low clouds or surface	High clouds
Green & Blue	1.6	cloud phase	ice clouds or snow/ice	water phase clouds

Impact on Operations

Primary Application: Aids pilots and aviation forecasters in the detection of clouds over the Arctic and other snow/ice covered surfaces.

Application: This image complements the quantitative cloud products and other RGBs such as the Cirrus Day RGB.

Limitations

Daytime only application: This RGB only uses solar reflectance channels. Image quality degrades for solar angles higher than 80 degrees.

Contributor: Andrew Heidinger (NOAA/STAR)

Links

JPSS Cloud Products

http://rammb-slider.cira.colostate.edu

http://hippy.gina.alaska.edu/distro/aviation/

Alaska Aviation Weather Unit

https://www.weather.gov/aawu/

FAA Aviation Cameras

AvCamsPlus.faa.gov

Cold Air Aloft

http://rammb.cira.colostate.edu/ramsdis/online/images/latest/cold_air_aloft/nucaps_arctic.gif

CLASS

https://www.class.noaa.gov/

https://www.avl.class.noaa.gov/