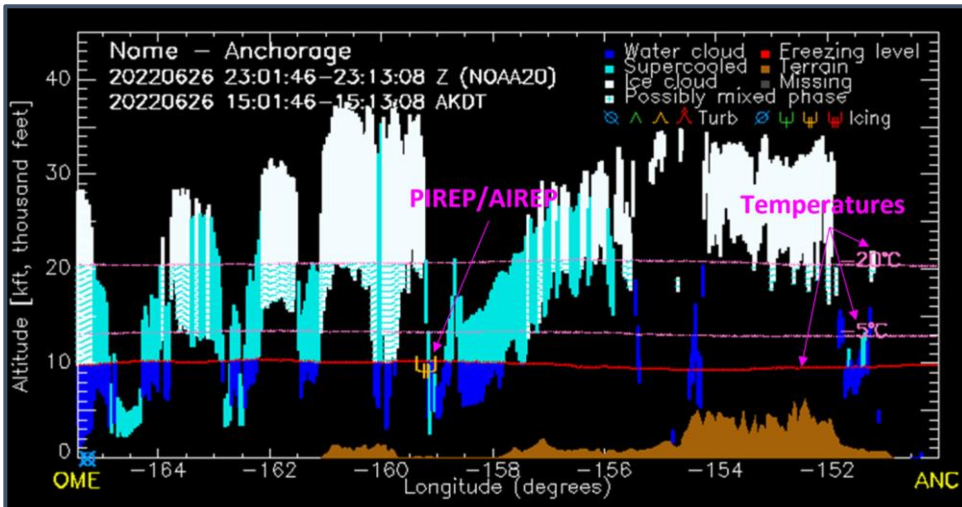
Satellite Cloud Vertical Cross-section (CVC)

Quick Guide

What is the CVC Product?

This ***experimental*** product is part of a 3D satellite cloud height field that displays where clouds are present in a vertical column of the atmosphere. Information on the 3D cloud structure is important to the aviation community, used for flight planning. Derived from sensors on-board operational NOAA satellites, the CVC is computed along flight routes from satellite cloud products such as *Cloud Top Height (CTH)* and *Cloud Base Height (CBH)* with additional data useful for aviation (e.g., temperature and PIREPs). Those multiple data sets are combined through interpolations to provide cloud vertical structure information along flight paths.



Sample CVC between Nome (OME: PAOM) and Anchorage (ANC: PANC) airports over Alaska. CVC displayed in thousand feet [kft] for aviation purposes and colored by cloud top phase; water (blue), supercooled water (cyan), ice (white), missing data (gray), and possibly mixed phase at lower levels (white+cyan). Temperatures (freezing level: red, -20°C and -5°C isotherms: pink), PIREPs (turb/icing: negligible/light/moderate/severe) & terrain included.

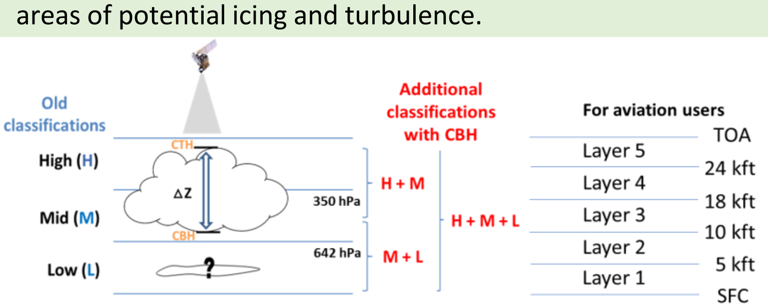
How is CVC Created?

The CVC product is generated by extracting information from several data sources, which are combined and displayed along flight routes with a 1000 ft vertical resolution. The product incorporates CTH data (derived from infrared observations) along with an estimate of CBH, and is categorized by cloud top phase (also from infrared observations). Possibly mixed or water phase at lower levels are indicated using temperatures (satellite-based NUCAPS or numerical weather model data). CBH is estimated with input from CTH and cloud water data from a statistical approach based on satellite radar and lidar sensors. When satellite input data is not available, numerical weather model data (currently GFS model) is used as supplementary input. This process is currently applied to VIIRS sensors onboard the S-NPP and NOAA20 satellites for Alaska, which have a ~50-minute revisit time between the two. Preliminary GOES ABI CVC data is added over CONUS.

Impact on Operations

Applications:

Aviation: Vertical cloud structures from satellite data (applicable to both polar and geostationary sensors) provide information for aviation weather applications globally in combination with numerical weather models. Users can infer areas of potential icing and turbulence.



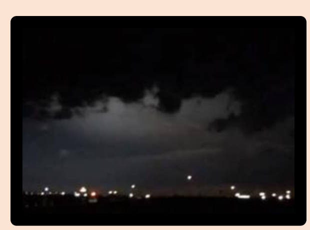
3D cloud product improvement: CTH and CBH information is used to compute the CVC and other Cloud Cover Layers (CCL) products. CBH introduces additional cloud coverage at lower levels, typically hidden under cloud top.

Limitations

Dependency on cloud optical properties: The cross-section product relies on inputs from both cloud top and base products. CBH performance is highly dependent on the accuracy of cloud top and water path data. Missing values are displayed on the product if suitable data is not available.

Multi-layer clouds: Determining the cloud base from satellites is still challenging due to inherited limitations of passive sensors. The algorithm is optimal for single layer clouds such as boundary layer clouds, thin cirrus clouds, and deep convection cells. This may limit the accuracy of the product for satellite observations consisting of multiple cloud layers.

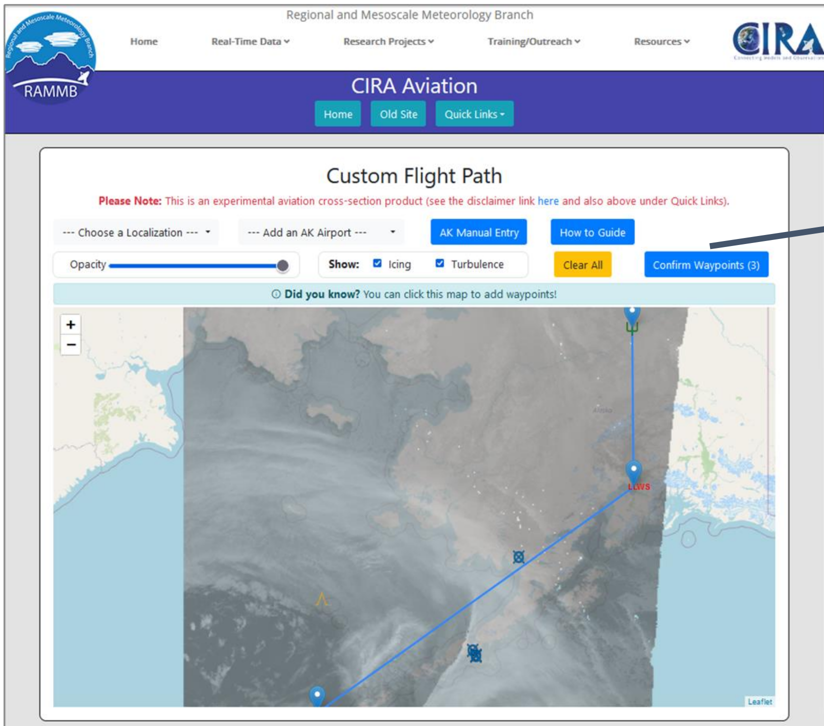
Nighttime observations: The nighttime performance would be degraded due to missing low cloud layers and the difficulty of computing cloud water path from satellites. CVC should be used with caution at night.

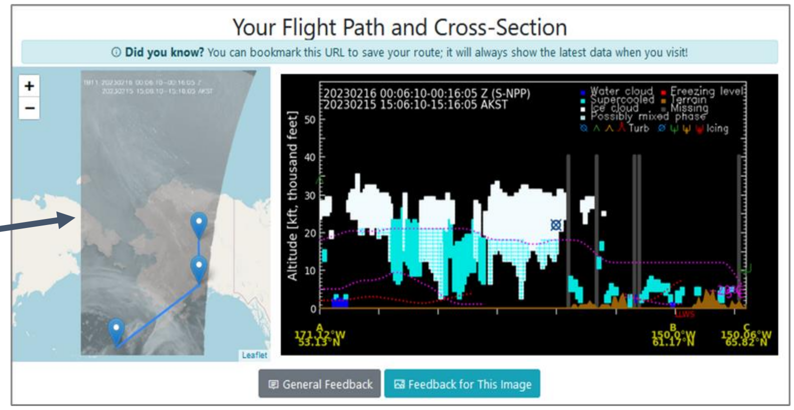


Contributors: Y. J. Noh, J. Torres, B. Daub, J. Haynes, S. Miller (CIRA/Colorado State University, cira_aviation@colostate.edu)

Satellite Cloud Vertical Cross-section (CVC)

Quick Guide





Sample custom CVC that users can create along selectable flight paths at CIRA's experimental aviation website, https://aviation.cira.colostate.edu. Users can find 4-week image archive links on the "Old Site" menu for pre-selected flight paths between major airports over Alaska and CONUS.

(The data latency: currently about 55min-1.5hr for JPSS VIIRS and ~20-25min for GOES-16 ABI)

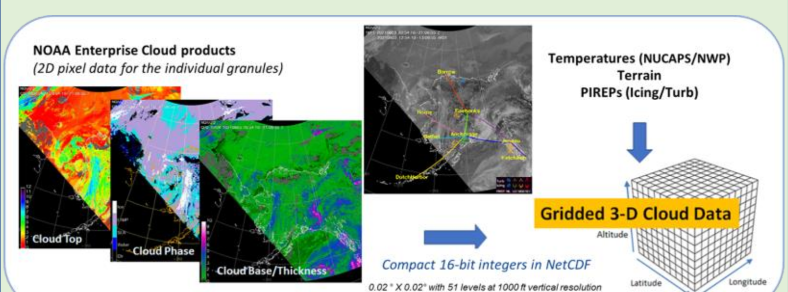
How To Create Your Own CVC?

A user interface that enables custom CVCs along random flight paths is now available at CIRA's aviation website, currently available over Alaska. For flight paths, click on each point along your flight path, or select an airport from the drop-down list, then click "Confirm Waypoints" and then "Generate Cross-Section" to produce a cross-section for your flight path. If you need to start over, click "Clear All". Users can provide feedback and find user documents (quick guide and user survey) on the website. The experimental CONUS domain is available with geostationary satellite data (GOES-16 ABI; updated hourly).

Custom CVCs: Data Processing and Level-2 Cloud Properties

Data Processing and Latency:

For custom CVCs, there is an additional data processing step for fully gridded 3D data sets. Multiple satellite cloud data are combined with supplementary data (temperature and terrain information with PIREPs) into one 3D data field using various interpolation methods. Due to the latency (55min-1.5hr) of JPSS satellite data delivery and additional 3D data processing time, the products may not directly fit to real-time decision making but can provide additional information for a broad observational cloud view.



Dependency on Level-2 cloud properties:

The 3D gridded satellite-based cloud data for CVCs relies on inputs from Level-2 Cloud products such as cloud top, base, and phase. If there is no satellite overpass or no valid Level-2 cloud data value due to upstream satellite data, missing values (gray) will be displayed. Interpolations used to combine multiple data sources may result in smoothed data fields than actual satellite data resolutions.

Resources

CIRA

[Aviation Website](https://aviation.cira.colostate.edu)

NOAA NESDIS STAR

Algorithm Theoretical Basis Document (ATBD): AWG Cloud Height Algorithm

Journal of Atmospheric and Oceanic Technology

Development of a statistical cloud base height retrieval algorithm

Contributors: Y. J. Noh, J. Torres, B. Daub, J. Haynes, S. Miller (CIRA/Colorado State University, cira_aviation@colostate.edu)