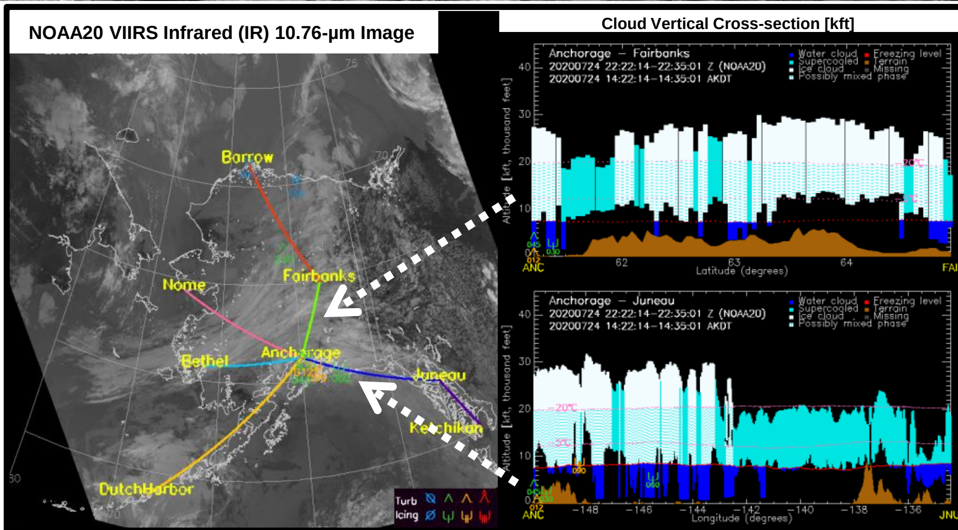
Satellite Cloud Vertical Cross-section (CVC)

Quick Guide

What is the CVC Product?

This experimental product is part of a 3-D satellite cloud height field that displays where clouds are present in a vertical column of the atmosphere. Information on the 3-D cloud structure is important to the aviation community, used for flight planning. Derived from the *Visible Infrared Imaging Radiometer Suite (VIIRS)* instrument on-board operational NOAA satellites, the CVC is computed along flight routes from *Cloud Top Height (CTH) and Cloud Base Height (CBH)* products. Determining the cloud base from satellites is challenging due to inherited limitations of passive sensors (e.g., VIIRS and ABI) which primarily detect cloud top or vertically integrated features.



Thermal IR satellite image over Alaska and CVC varying in altitude from two flight routes. 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 at lower levels (white+cyan). Freezing levels (red) and PIREPs (turb/icing) are also included.
Access data with a user interface for custom flight paths: https://aviation.cira.colostate.edu/

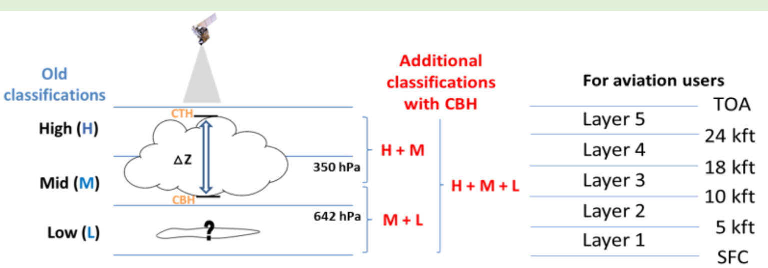
How is CVC Created?

The CVC product is generated by extracting information from several sources, which are combined and displayed along defined routes. The product incorporates CTH data (derived from multiple infrared wavelength 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 temperature data. A statistical approach is used to estimate cloud base with input from cloud top and water products, based on multiple satellite sources including radar and lidar sensors. When satellite input data is not available, a numerical weather model value is used as supplementary data. This processing sequence is currently being applied to VIIRS sensors onboard the S-NPP and NOAA20 satellites, which have a ~50-minute revisit time between the two.

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.



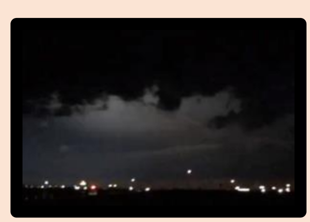
3-D cloud product improvement: CTH and CBH information is used to compute the CVC and other Cloud Cover Layers (CCL) products. CBH introduces additional cloud coverage at lower levels, typically hidden under cloud top.

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: The algorithm is optimal for single layer clouds such as thin cirrus clouds, boundary layer clouds, and deep convection cells. It is not optimal for observations consisting of multiple cloud layers; this may limit the accuracy of the product.

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



Resources: NOAA AWG Cloud Height Algorithm: A. Heidinger, 2015, https://www.star.nesdis.noaa.gov/jpss/documents/ATBD/ATBD_EPS_Cloud_ACHA_v3.0.pdf
Development of a statistical cloud base height retrieval algorithm: Noh et al., 2017, J. Atmos. Ocean. Tech., 34(3), 585-598.

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