Cloud Height Product Briefing to the Proving Ground

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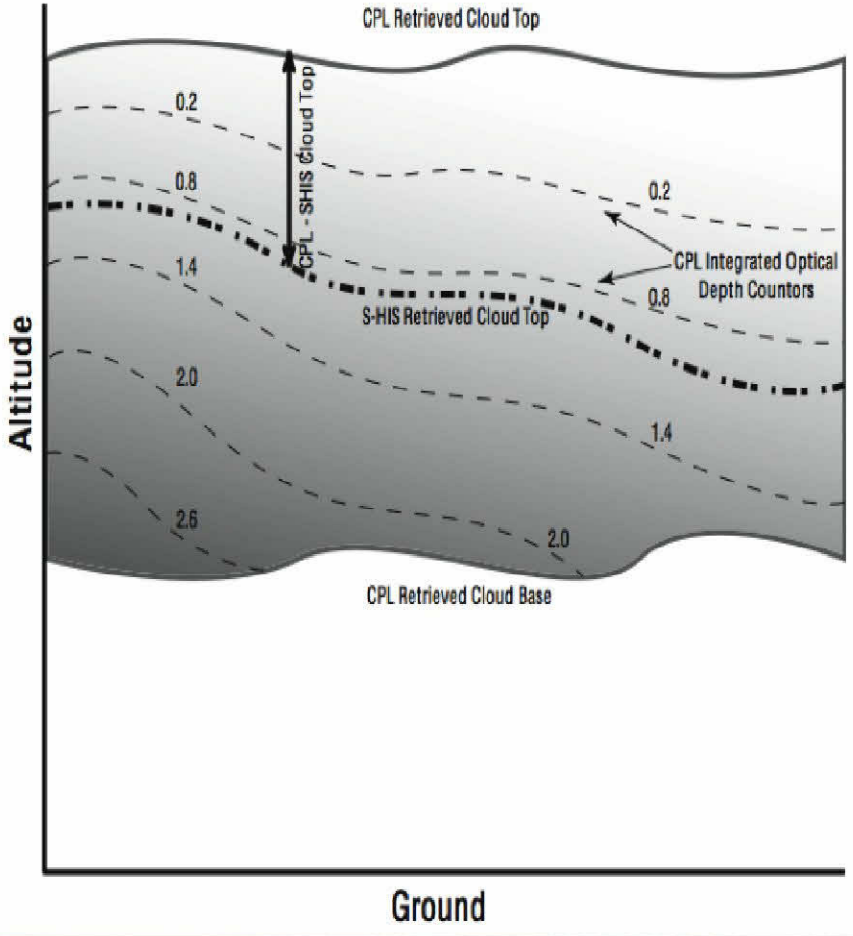
Outline

- Definition of Cloud Height Product
- Algorithm Description
- Current sources of cloud height data from NESDIS
- Current real-time applications
- Potential real-time applications
- Examples over Alaska and Hawaii
- PG plans

What is Cloud Height?

- Cloud height is defined as the height of the highest detected cloud layer.
- We express height in terms of altitude (km), temperature (K) or pressure (hPa)
- Our height is the effective radiative level where a single layer isothermal cloud would reproduce the observations.
- In the schematic to the right, the IR-height would be the thick dashed line.
- Multi-layer clouds complicate this retrieval but we do account for them.



How Do We Measure Cloud Height?

- We have developed innovative techniques to estimate cloud height from **IR-only techniques**.

- The methods have been applied to all sensors: AVHRR + GOES-IL (11,12 μm), GOES-MOP (11,13.3μm), VIIRS (8.5,11,12μm) and GOES-R(11,12,13.3μm).

- While the channels and resulting performances vary, all algorithms share the same physical basis and coding framework.

- IR approaches where found to be superior other methods and provided consistent day-night results.

- These approaches also **provide information on cloud microphysics** which gives more insight into cloud evolution.

Current NESDIS + CIMSS Real-Time Sources of Cloud Height Values

- Goes Surface and Insolation Project (GSIP) provide GOES-imager derived cloud properties for all standard domains.

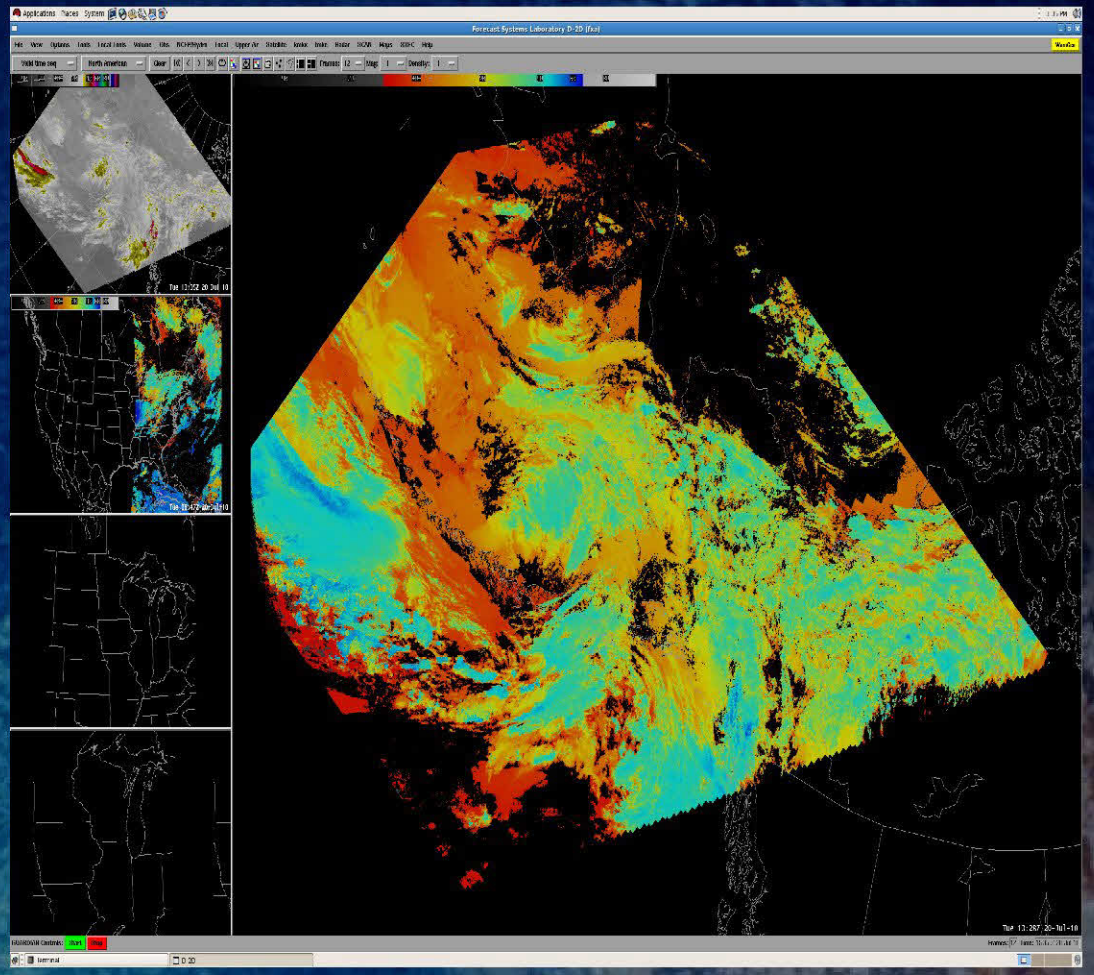
- Clouds from AVHRR Extended (CLAVR-x) provides 1 km cloud height over Alaska and Hawaii from AVHRR HRPT

- CIMSS GEOCAT provides cloud height from GOES imagers in real-time.

- CIMSS and NESDIS provide GOES Sounder values.

- CIMSS serves cloud height information from MODIS and AVHRR into AWIPS (screen shot to the right).

AWIPS Screen-shot of a cloud height product from CIMSS



Current Real-Time Applications

- Cloud heights are assimilated into NWP models by the UK Met Office and other groups.
- The GOES-R Atmospheric Motion Vector (aka winds) algorithm will use our cloud heights for wind vector height assignments. They have found significant benefit in using our cloud heights and we have benefited from this interaction.
- Cloud heights are used extensively in the aviation community.

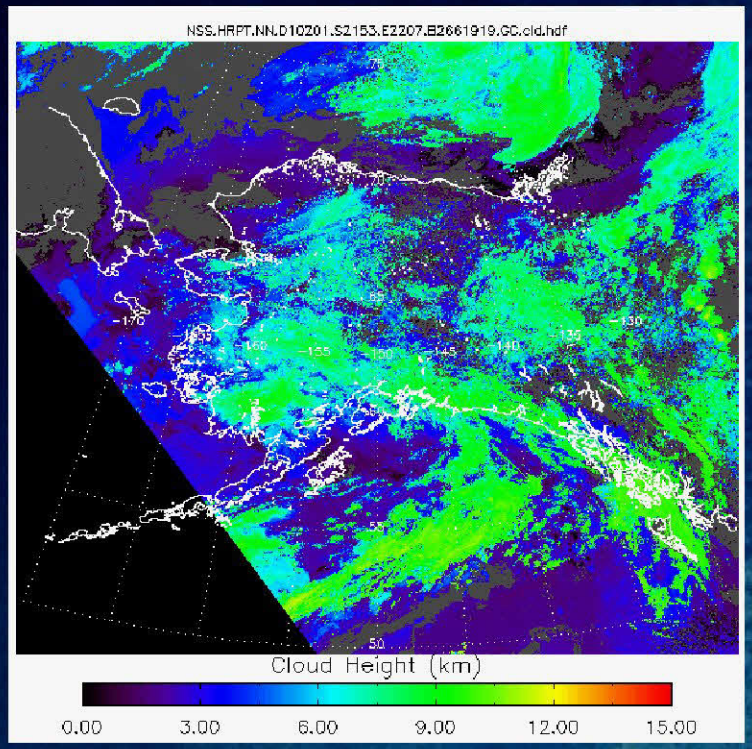
Potential Real-Time Applications

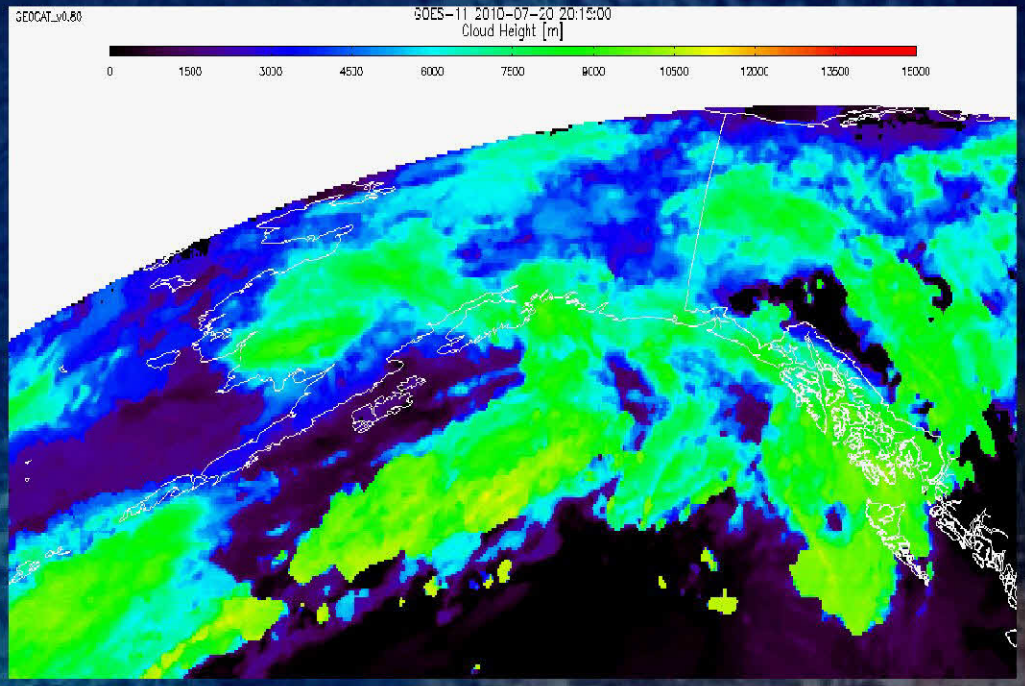
- Temporal evolution of cloud height gives a direct measure of the cloud-top vertical velocity during convective development. This information might find use in future CI work.

- Microphysical information from these IR approaches can be used to detect the presence of small ice crystals near cloud top. This crystals may give forecasters skill in detecting large IWP conditions that pose threats to aviation.

Alaskan Example

Examples below show information provided today by GOES/West (Right) and POES/AVHRR (Left) from July 20, 20 UTC and July 21 1 UTC (4 hours total)

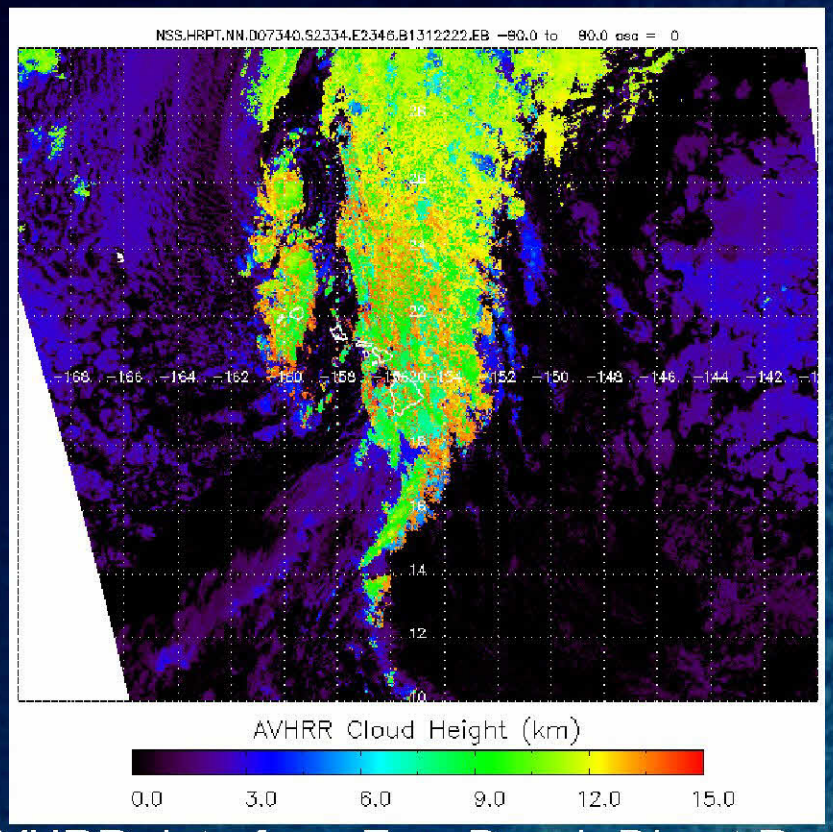


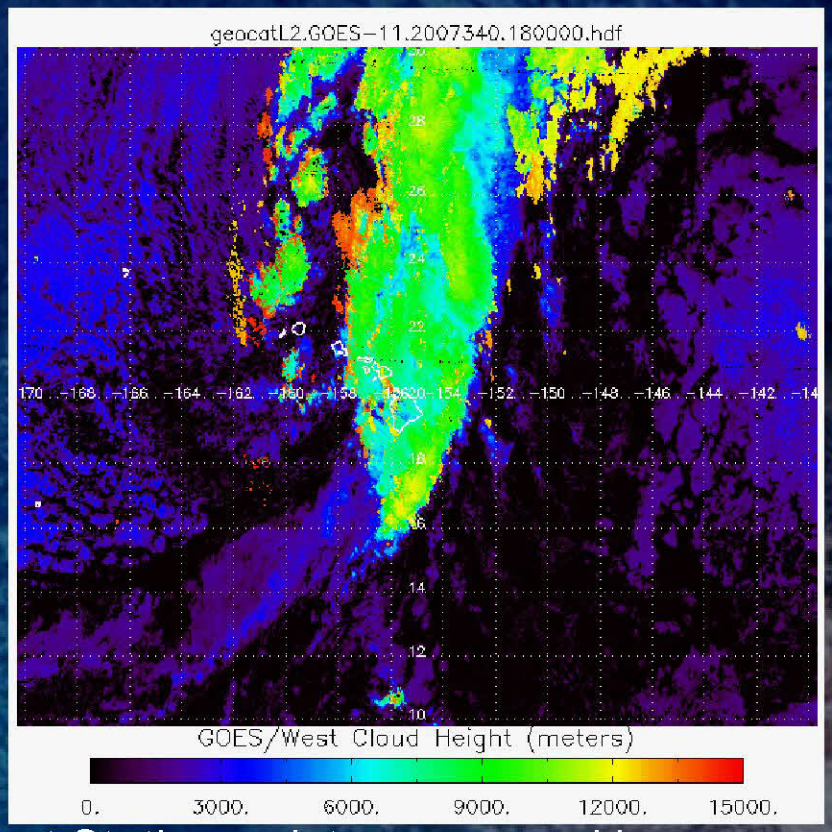


We are developing techniques to merge cloud height information from multiple sources into one coherent product

Hawaiian Example

Examples below show cloud height information provided today by GOES/West (Right) and POES/AVHRR (Left) for December 6, 2007 18 Z (approx)



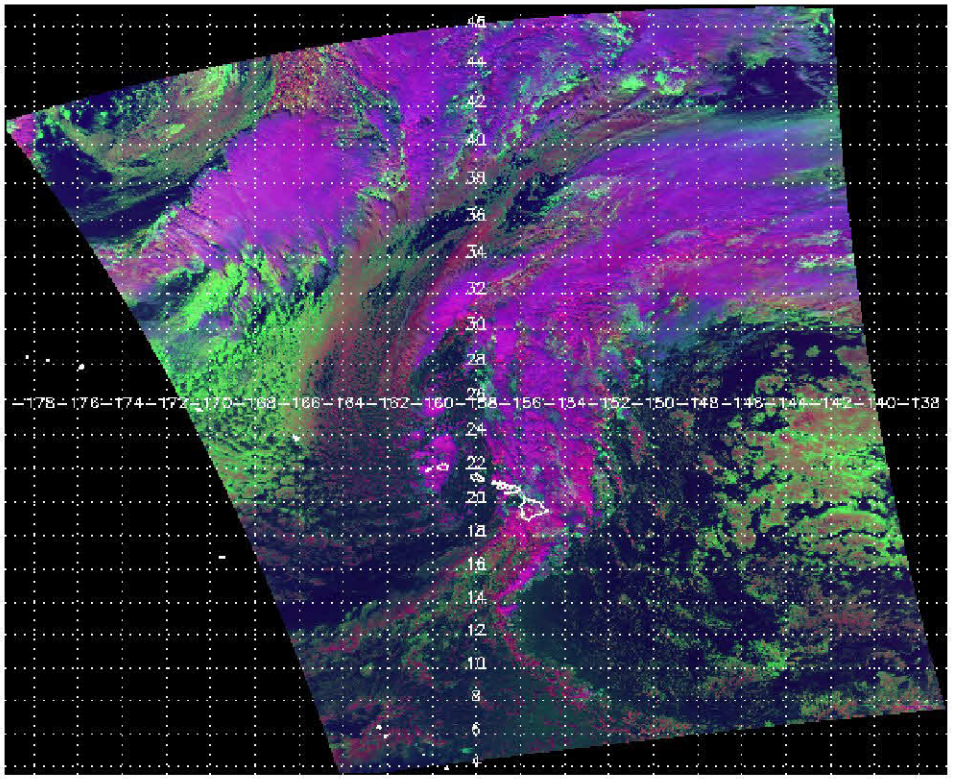


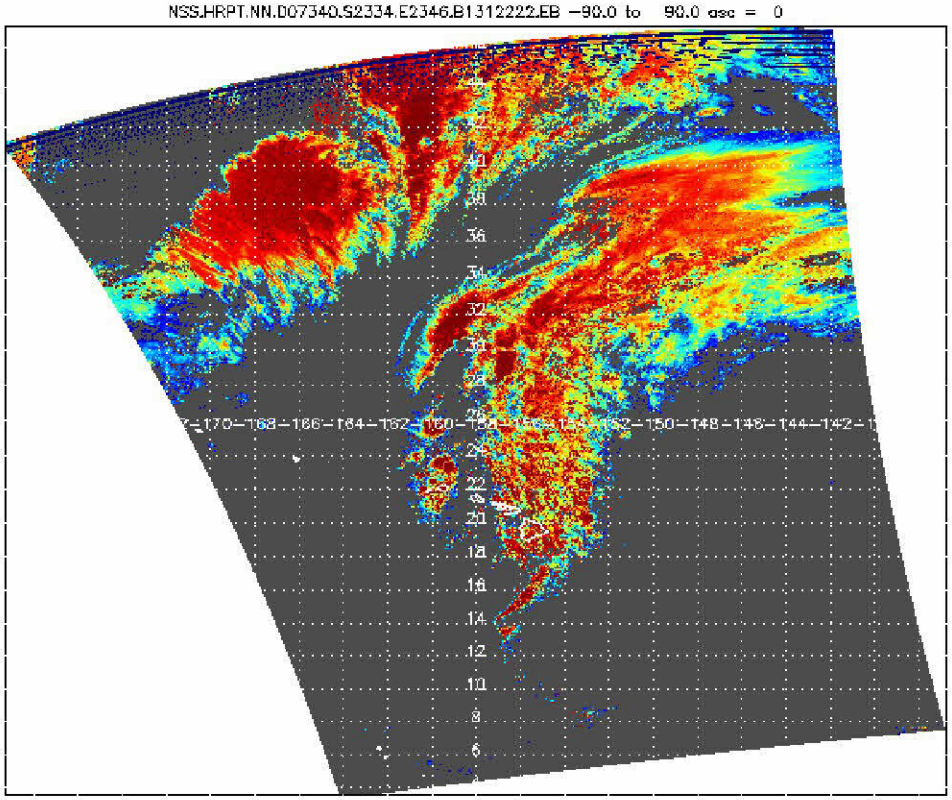
AVHRR data from Ewa Beach Direct Readout Station – data processed in real-time at CIMSS.

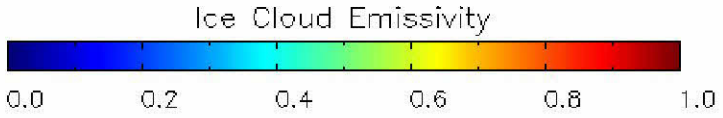
Other IR cloud properties: cloud emissivity

False Color : 0.63 + 3.75 + 11 μm
Ice clouds are purple,

Cloud emissivity: This is a measure of cloud thickness in the IR



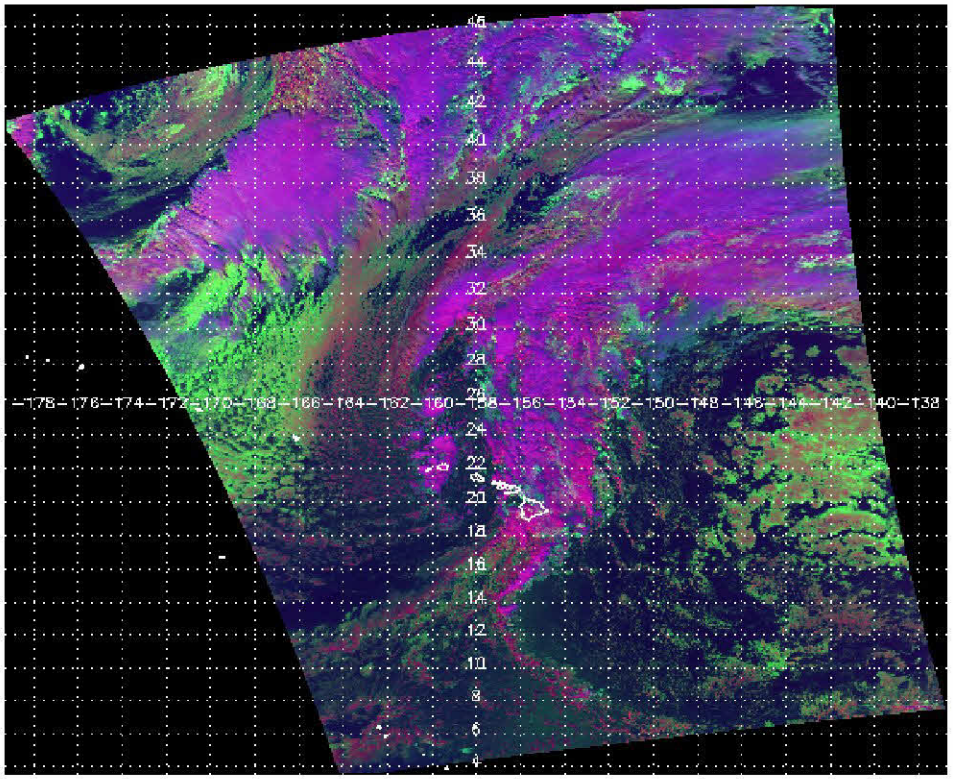


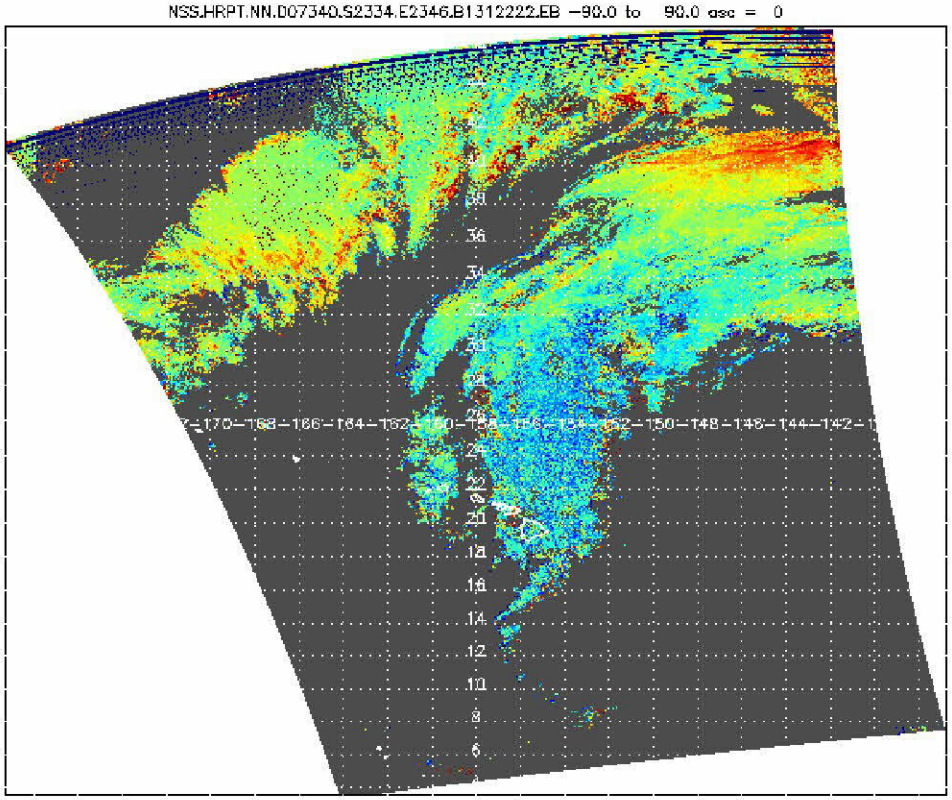


Other IR cloud properties: cloud microphysics (β)

False Color : 0.63 + 3.75 + 11 μm
Ice clouds are purple,

Microphysical Index (β): This is a measure of particle size. Big β = small particles





Ice Cloud Microphysical Index (β)

0.9 1.0 1.0 1.1 1.1 1.2

Limitations

- For very thin cirrus, the IR spectral information available from imagers (even GOES-R) is not sufficient and the uncertainty in the cloud height will be large (2 km). We try to make up for this lack of sensitivity through the use of advanced spatial processing (using thicker part of the cloud to constrain the thinner parts).

- Ability to account for multiple cloud layers is limited by the ability to detect these situations and the ability to prescribe the height of the lower layer(s).

- Inversions provide a challenging situation since our knowledge of their presence is often poor and their impact on inferred height of low clouds is often large.

- These techniques use RTMs coupled with NWP data. Biases in the NWP and/or biases due to uncertainties in channel characteristics may impact the results.

PG Plans

- NESDIS is planning to generate cloud heights operationally using these GOES-R AWG IR-only algorithms on GOES-NOP and JPSS/VIIRS.
- POES and GOES operational products are also available in the short-term using the GOES-R coding framework.
- *The ability of NESDIS operations to meet the latency needs of NWS forecasters is uncertain.*
- CIMSS will continue to provide real-time access to GOES-R AWG cloud products (including via AWIPS).
- Cloud height algorithms can be run locally as well.
- We very much appreciate any feedback on these products and their usage. (*contact: Andrew.Heidinger@noaa.gov*)


NOAA NESDIS STAR
Satellite Oceanography Division
Cooperative Research Program
Satellite Meteorology and Climate Division
Center for Satellite Applications and Research

Questions?

Example IR cloud properties

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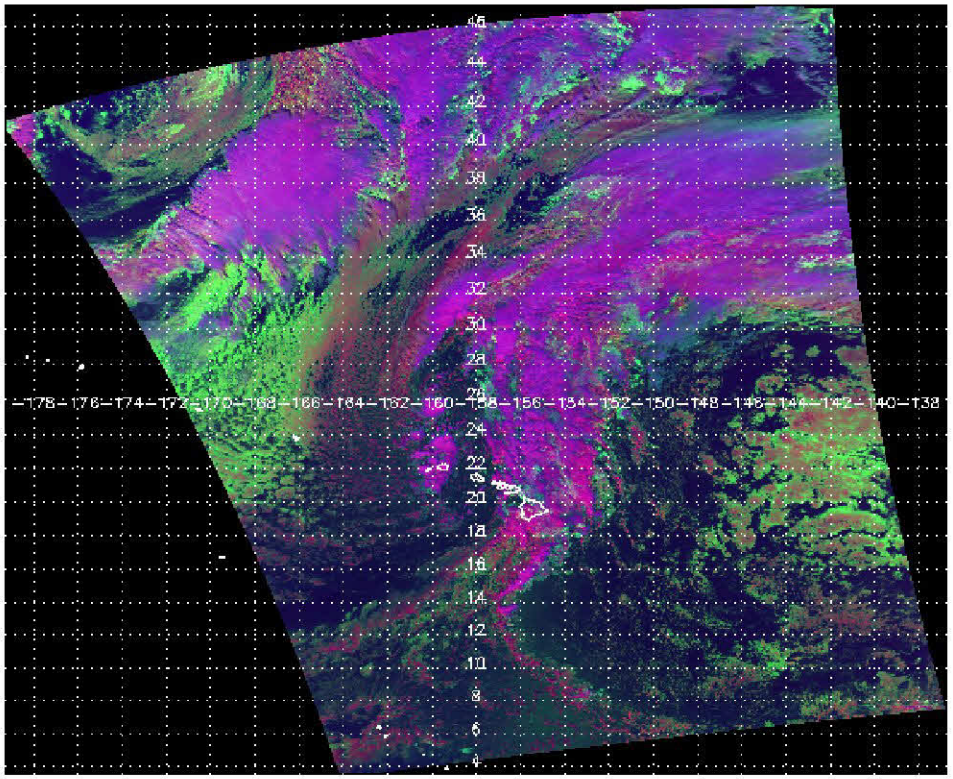
Ice clouds are purple



Cloud Height