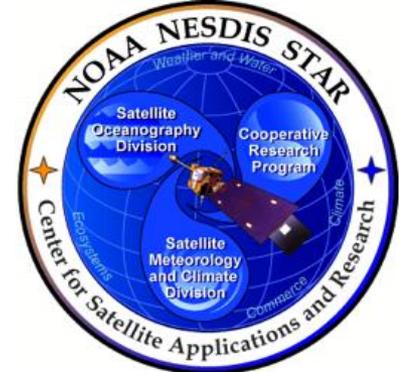




University of Wisconsin-Madison Space Science and Engineering Center
Cooperative Institute for
Meteorological Satellite Studies



Cloud Height and Cloud Temperature for OCONUS GOES-R Proving Ground

Andrew Heidinger
NOAA/NESDIS/ STAR

GOES-R AWG Cloud Team: Michael Pavolonis / NOAA
Pat Minnis / NASA
Andi Walther, Pat Heck and William Straka / CIMSS

Some Product Details

Product Definition: The physical height (temperature) of the highest layer of cloud. In reality, we measure the height of the effective level of emission. *We always fall below the actual cloud-top height. How much depends on how thick the clouds are at the top.*

Height Product Requirements: 0.5 km bias and 1.5 km standard deviation relative to truth.

Temperature Product Requirements: 3 K bias and 5 K standard deviation relative to truth.

Official Requirement Qualifiers: cloud emissivity greater than 0.8 and zenith angle < 62 degrees

Official Horizontal Resolution: Height (10 km), Temperature (2 km)

Actual Horizontal Resolution: The native pixel size of the IR channels.(4 km for current GOES, 2 km for ABI)

Time to process on a full-disk GOES-11 image: 20 seconds out of 130 seconds total.

AWG Cloud Height Algorithm (ACHA)

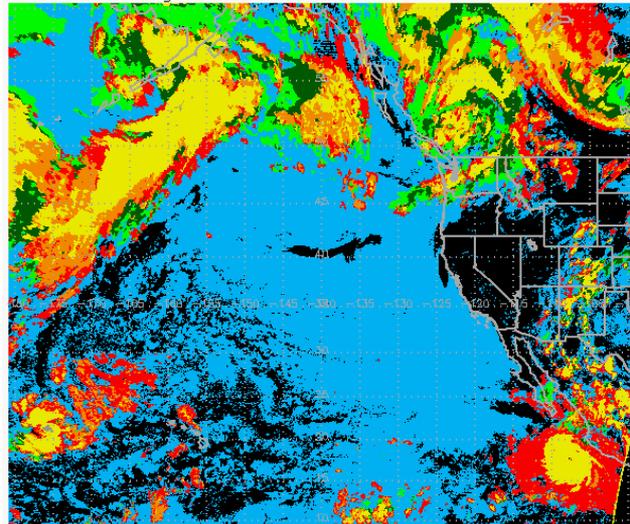
- AWG developed an IR-only solution that uses the *multiple IR channels* on ABI to estimate cloud temperature, emissivity and particle size of highest layer. (*IR only = day/night consistent*). Commonality with the AWG Ash height algorithm.
- Height and Pressure are derived from the temperature and the NWP profiles (GFS). *Simultaneous estimation of cloud microphysics generates a better cloud height.*
- AWG approach has been extended to many current imagers (AVHRR, GOES-11,12,13, MODIS and VIIRS).
- On ABI and MODIS, we use 11, 12 and 13.3 μm .
- On GOES, we use 6.7, 11 and 12 μm or 6.7, 11 and 13.3 μm .
- Much better than a single 11 μm approach.

Example Cloud Height Products.

- Images below are from GOES-11 (6.7, 11 and 12 μm version of ACHA).
- Cloud height products should be used in conjunction with Cloud Type (on left). Cloud phase is used in the first guess in the cloud height algorithm. Phase errors are hard to recover from. Thin ice cloud type is useful in showing regions where the height errors might be larger.
- Cloud height products can be useful in adding vertical extent to other products: i.e. cloud-top turbulence, aircraft icing, etc.

Cloud Type

goes11_2011_202_2030.level2.hdf

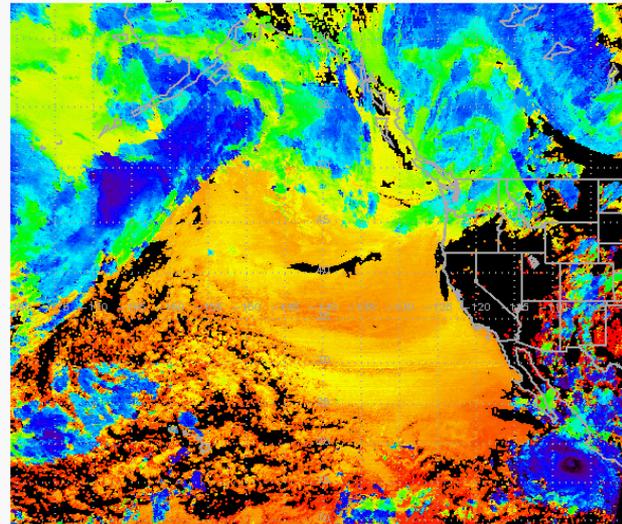


Cloud Type

Clear Sparse Water SC Mixed Thick ice Thin ice Multilay Spare Uncertain

Cloud Temperature

goes11_2011_202_2030.level2.hdf

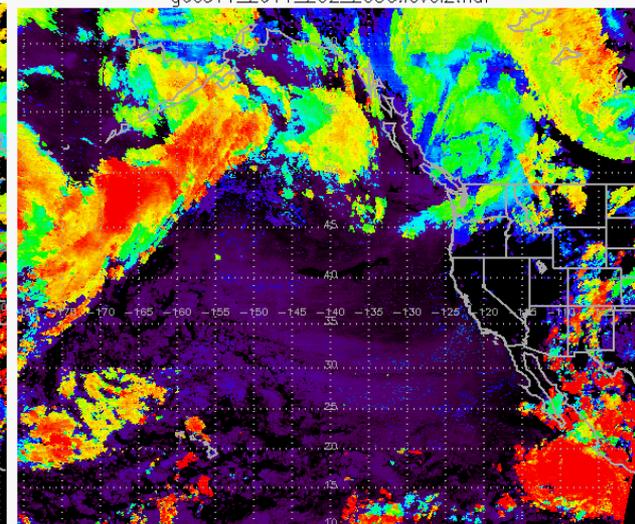


Cloud Temperature (K)

200.0 220.0 240.0 260.0 280.0 300.0

Cloud Height

goes11_2011_202_2030.level2.hdf

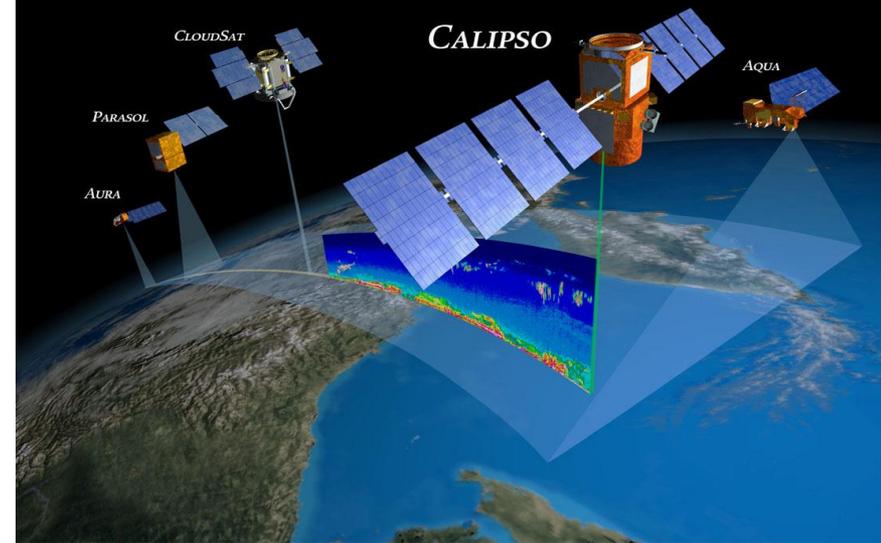


Cloud Height (km)

0.0 2.4 4.8 7.2 9.6 12.0

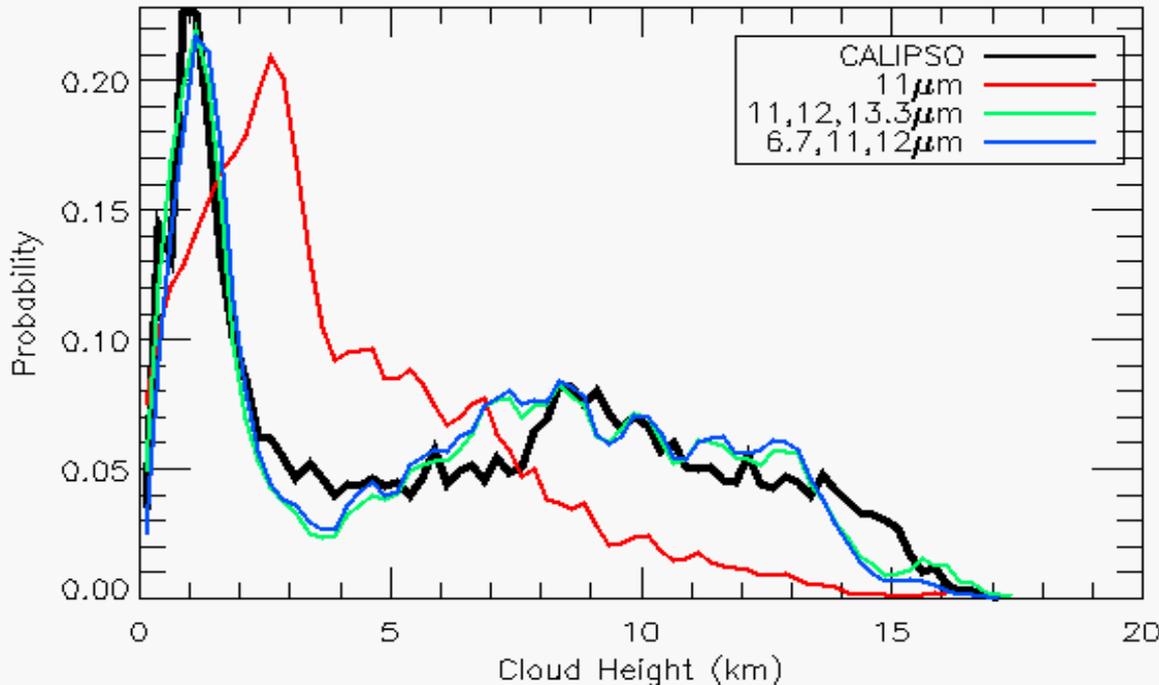
Validation (CALIPSO compared to AQUA/MODIS)

- MODIS provides the spectral channels to test the approaches including GOES-R.
- CALIPSO/CALIOP provides a very sensitive and direct measure of the cloud-top structure.



www.nasa.gov

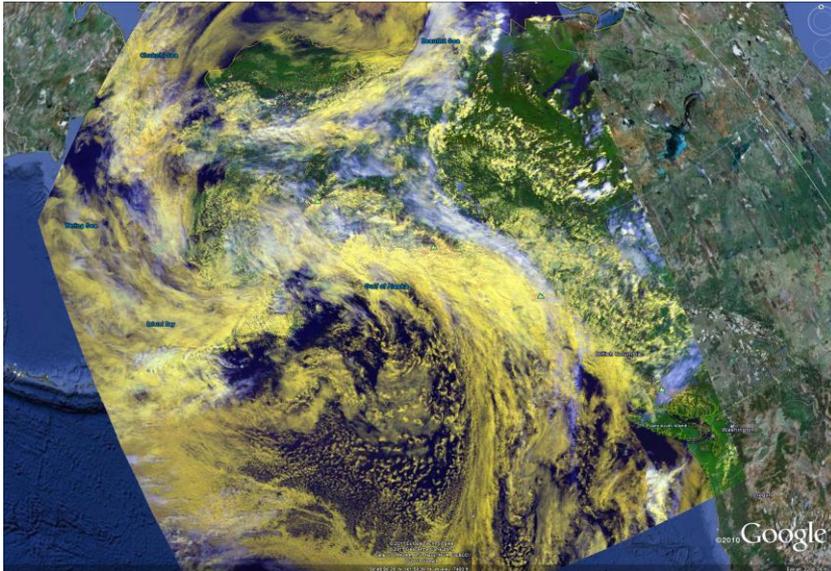
Comparison of Cloud-top Height from CALIPSO to that from ACHA using various channel combinations. (*global for one day – no filtering*)



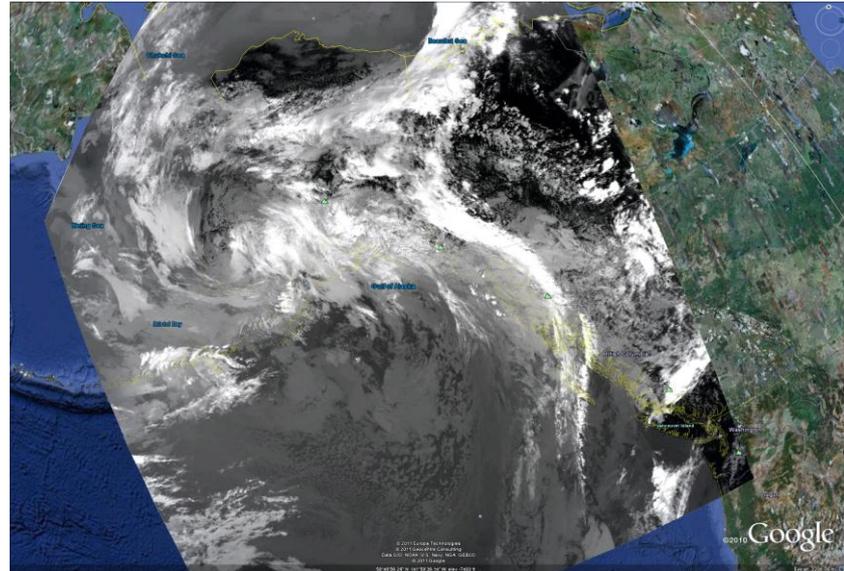
- single channel 11 μm approach performs much worse than GOES-R approaches.
- Current GOES-Imager performance is generally similar with GOES-R (with the water vapor channel).
- GOES-R channel set (available from MODIS) is the best performer.

Polar Orbiting Examples Including Additional Products for Future PG Activities.

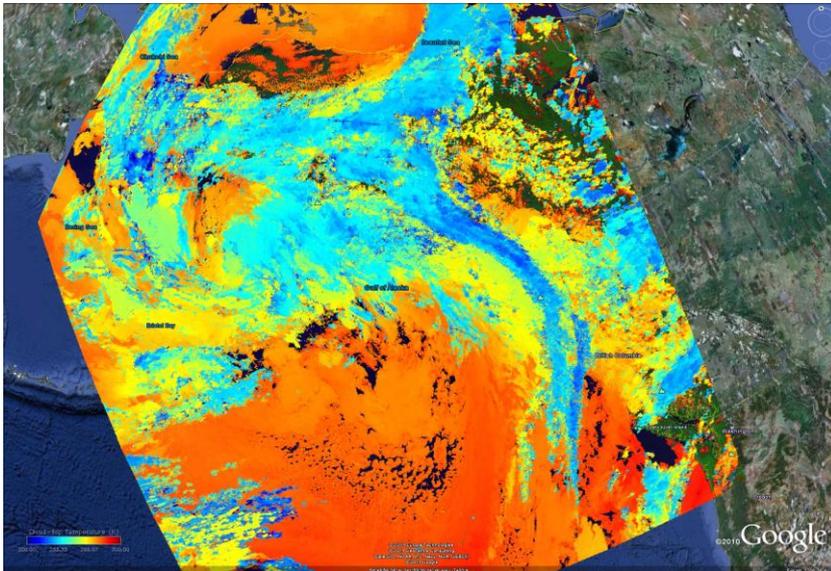
0.63, 0.86 and 11 μm False Color



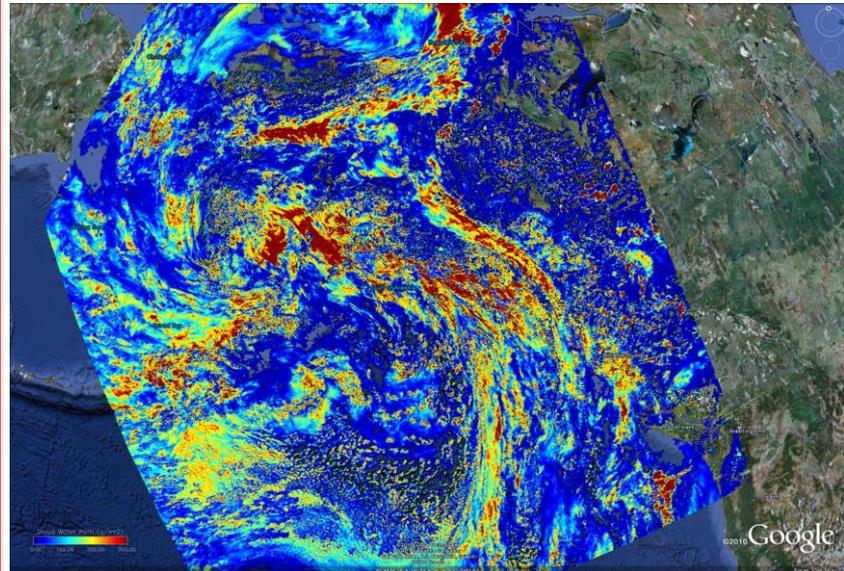
11 μm Brightness Temperature



Cloud-top Temperature

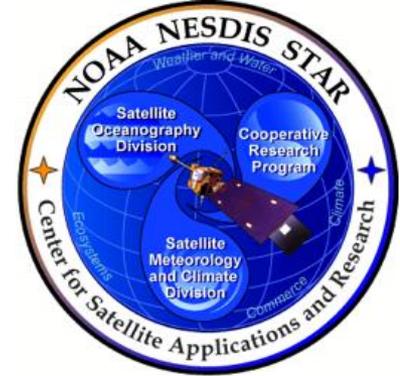


Cloud Water Path – How much water is in the Cloud?





University of Wisconsin-Madison Space Science and Engineering Center
Cooperative Institute for
Meteorological Satellite Studies



Conclusions

- We are excited to have the GOES-R AWG Cloud Height Products in the OCONUS PG.
- Clouds are a very common phenomena and we look forward to the NWS forecaster feedback on the very specific scenarios they deal with.
- We are very interested in ideas for scenarios to include in our training module.