Center for Satellite Applications and Research
(STAR)

Applicability of GOES-R AWG Cloud Algorithms for JPSS/VIIRS

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Advanced Satellite Products Branch

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Motivation

- GOES-R AWG has developed algorithms for the same cloud properties slated for VIIRS.
- To date, many NPOESS cloud algorithms have not been tested and validated on global data.
- To date, the Government Team(s) have run into technical problems implementing NPOESS code.
- Based the above, the performance of some of the NPOESS algorithms remains unknown – this is a risk.
- It is therefore natural to ask: "Are the GOES-R AWG Cloud Algorithms Applicable to VIIRS?"
- We might need them to:
  - *Serve as an alternative set of algorithms.*
  - *Serve as an additional source of data to help verify NPOESS data when available.*

AWG Algorithm Strategy

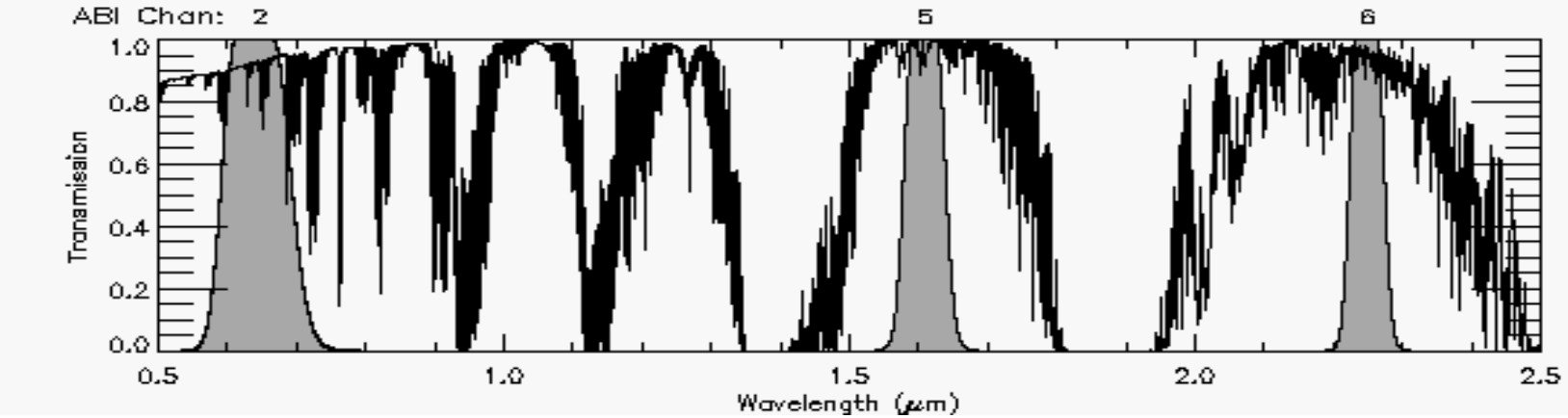
- We propose to
  - use the existing NPOESS VIIRS Cloud Mask (VCM) which also provides cloud phase.
  - ***Implement the AWG Cloud Height Algorithm (ACHA)***
  - ***Implement the Daytime Cloud Optical and Microphysical Properties (DCOMP)***
  - *Explore implementation of AWG cloud typing (M. Pavolonis/NOAA)*
  - *Explore implementation of nighttime cloud optical properties (NCOMP).*

AWG Algorithm Description (1)

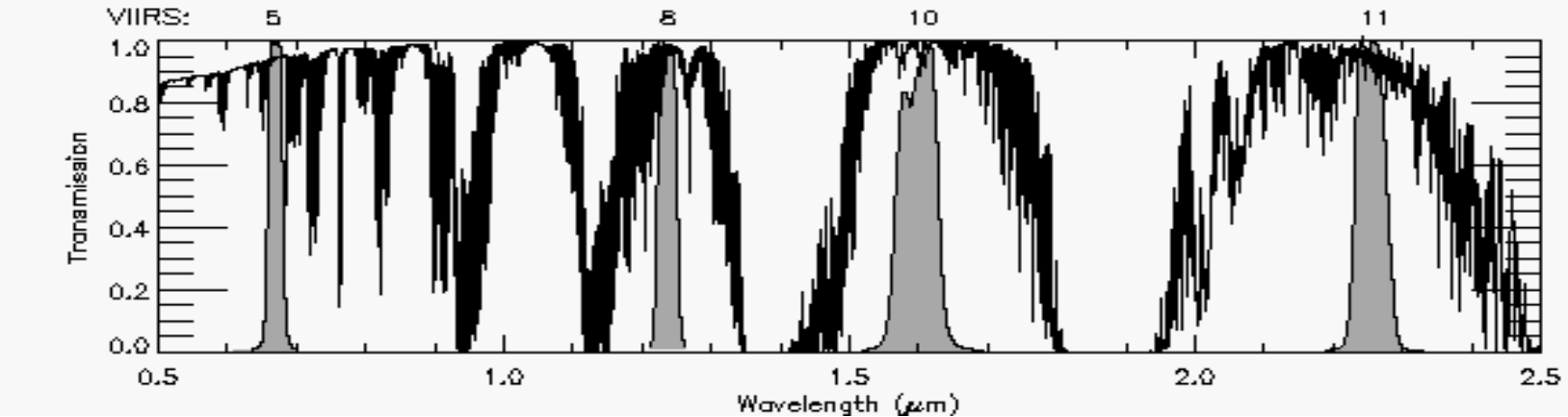
- **DCOMP** – Daytime Cloud Optical and Microphysical Products.
  - ***Products: Cloud Optical Depth, Cloud Particle Size and Cloud Water Path***
  - Based on traditional method of retrieving cloud optical depth and particle size from non-absorbing and absorbing solar reflectance channels.
  - AWG code implemented using Optimal Estimation (OE) and provides pixel-level uncertainties.
  - Algorithm accounts for surface reflectance, molecular scattering and gaseous absorption.
  - Ice scattering tables provided by **Professor Ping Yang**.
  - Lead developer is **Dr. Andi Walther**
  - Currently implemented for AVHRR and GOES processing at NOAA.

DCOMP Spectral Considerations

- Minimal spectral differences in channels available for DCOMP between VIIRS and ABI
- Baseline channel set for GOES-R AWG is 0.63 and 2.2 μm (same as MYD06)
- DCOMP can operate on 1.6, 2.2 and 3.75 μm channels.



ABI



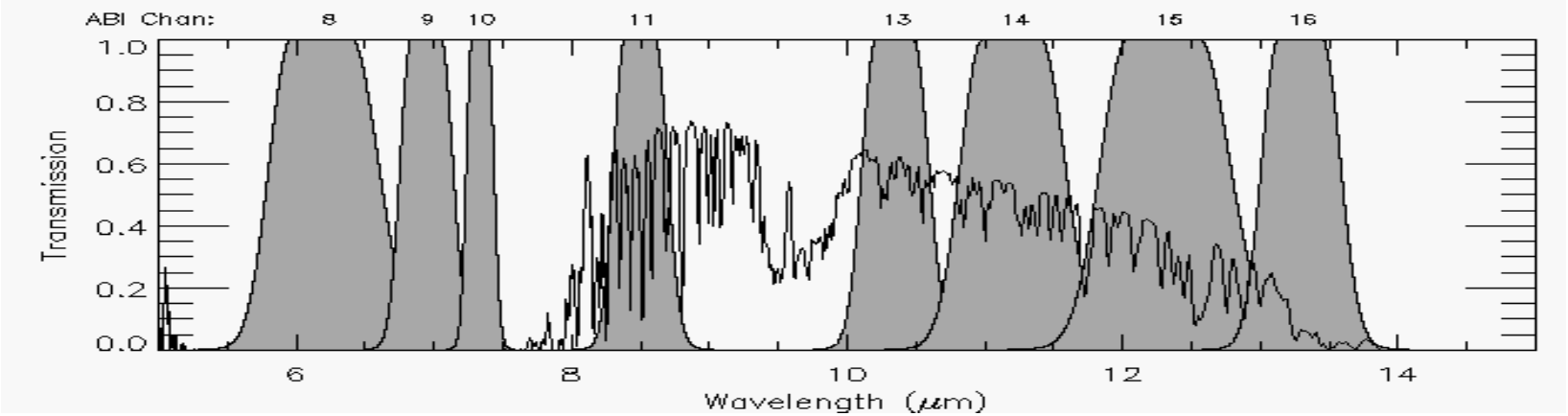
VIIRS

AWG Algorithm Description

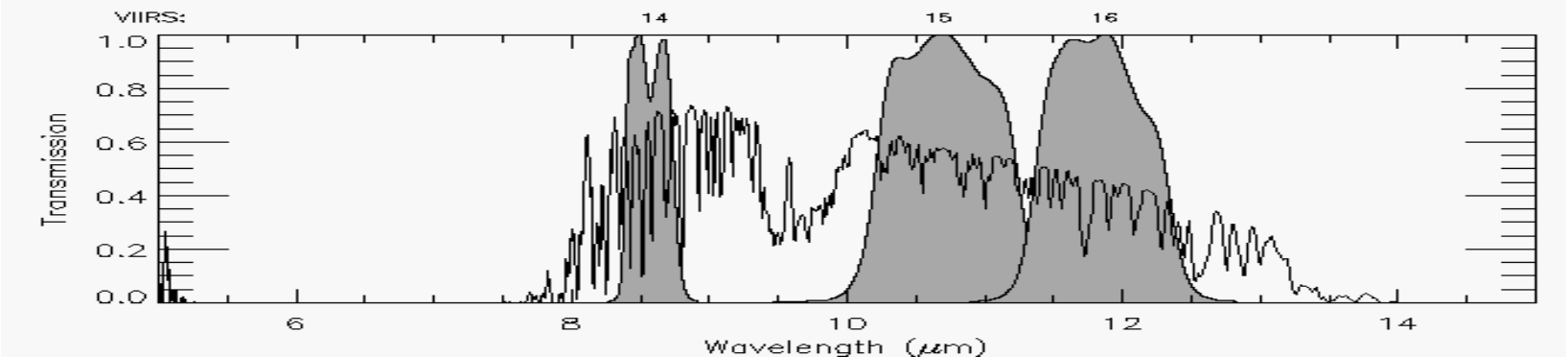
- **ACHA** – AWG Cloud Height Algorithm
  - ***Products: Cloud-top height, temperature and pressure. Cloud emissivity and IR microphysical index.***
  - GOES-R ABI provides multiple IR windows with a H_2O and CO_2 IR absorption bands.
  - The MODIS approach of CO_2 slicing is therefore not possible on VIIRS.
  - The ACHA code was been developed to handle multiple IR channel sets that includes those from AVHRR, GOES, VIIRS, ABI and MODIS.
  - **On GOES-R, ACHA uses 11, 12, and 13 μm channels.**
  - **On VIIRS, ACHA uses 8.5, 11 and 12 μm channels**
  - As with DCOMP, ACHA uses optimal estimation and provides pixel-level uncertainties.
  - Algorithm uses fast IR models (SSEC/PFAAST) and high resolution surface emissivity data bases (SEEBOR).
  - ACHA also provides cloud emissivity and IR microphysical estimates.
  - Currently implemented for AVHRR and GOES processing at NOAA NESDIS

ACHA Spectral Considerations

- VIIRS lacks IR H_20 or CO_2 absorption channels. Notably, the ABI 13.3 μm channel is missing
- ACHA on VIIRS uses all VIIRS longwave IR channels (except the 9.7 μm O_3 channel)
- Heidinger et al (JGR,2010) explores the negative impact on cloud heights.



ABI



VIIRS

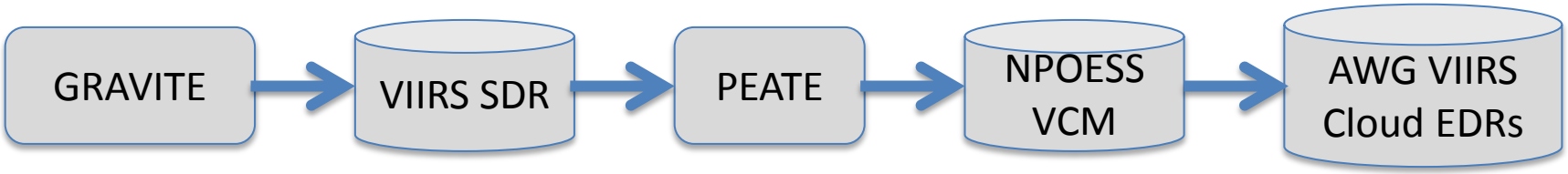
How Do We Test the Viability of GOES-R AWG Algorithms for VIIRS ?

- Test on MODIS as a VIIRS-proxy.
- *Validate against*
  - **NASA MODIS cloud products** provide a set of well-used data from state-of-the-art algorithms that provide a meaningful basis for comparison.
  - **Active sensors (CALIPSO/CloudSat)** provide direct measures of cloud profiles that provide more quantitative performance metrics for cloud-top height.

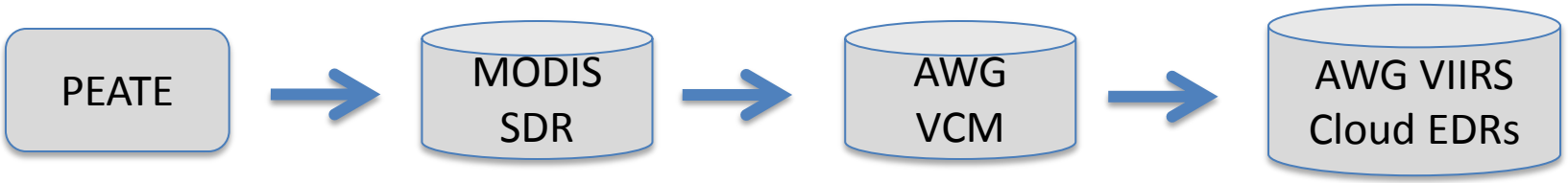
Prelaunch Processing Strategy

PEATE = UW SSEC NPP Processing Infrastructure for NPP funded by NASA
NGAS = Northrop Grumman Aerospace Systems (NPOESS Prime Contractor)

Planned …



Employed for this Work …

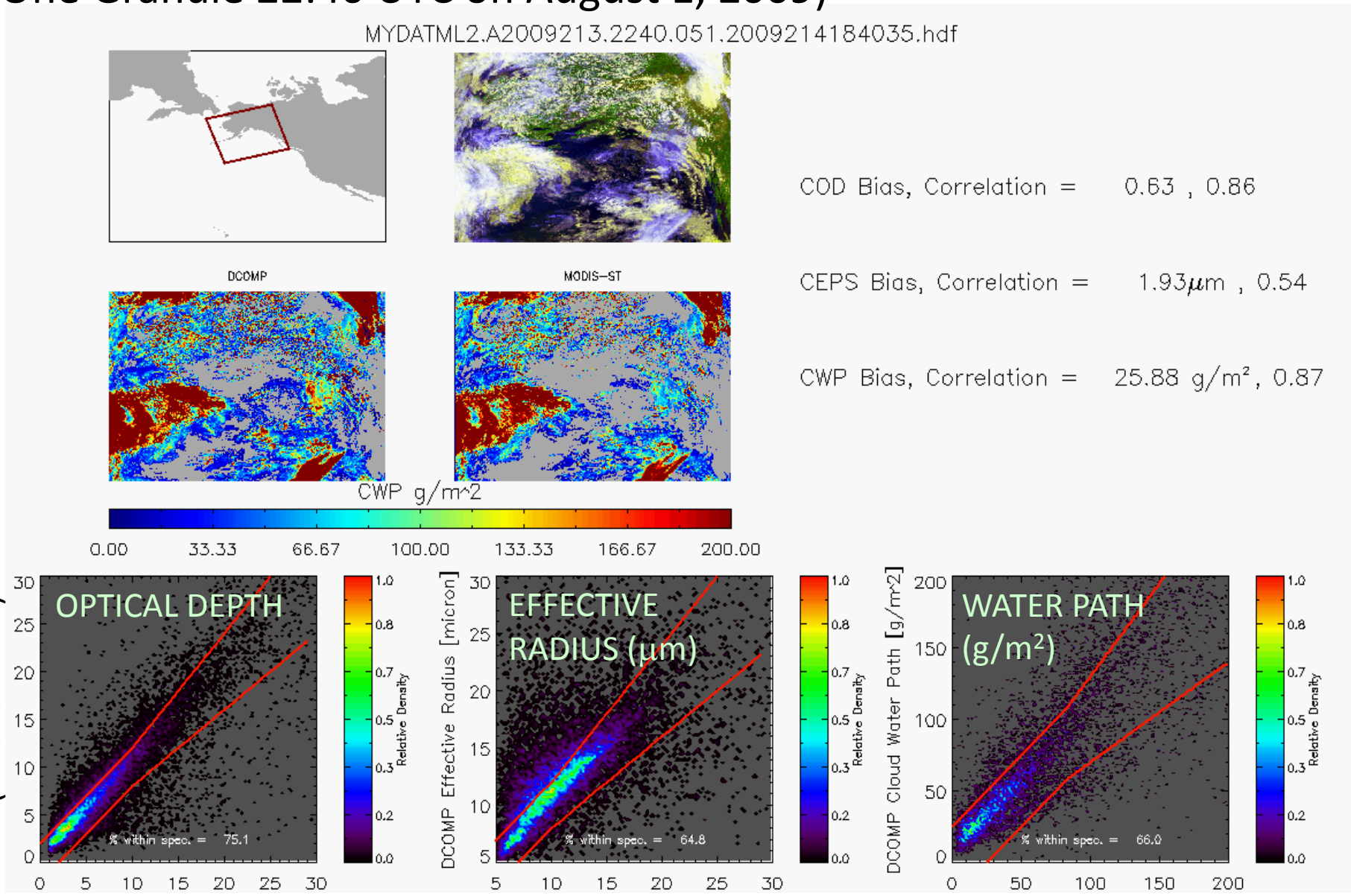


Caveats:

- *AWG VCM is not tuned for the VIIRS applications in contrasts to the NGAS VCM*
- *MODIS observations are used, not simulated VIIRS. AWG uses physical retrievals that account for spectral response of channels. This should not be an issue for this analysis.*

COMPARISON TO NASA MODIS MYD06 CLOUD OPTICAL AND MICROPHYSICAL PROPERTIES

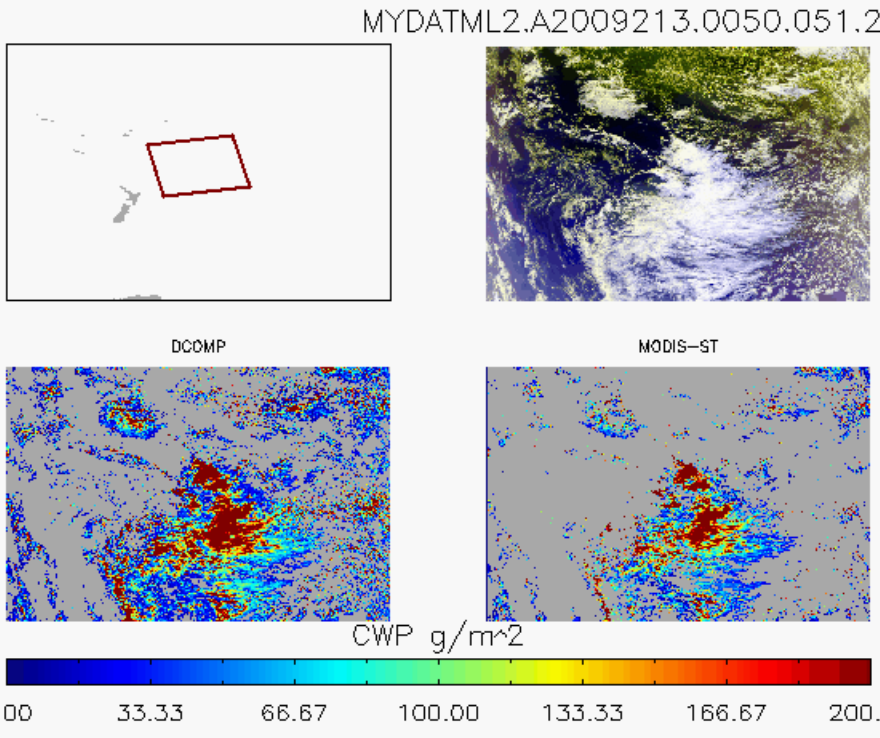
DCOMP Comparison to NASA MODIS MYD06 Products (One Granule 22:40 UTC on August 1, 2009)



AWG PRODUCTS (DCOMP)

NASA MODIS PRODUCTS (MYD06)

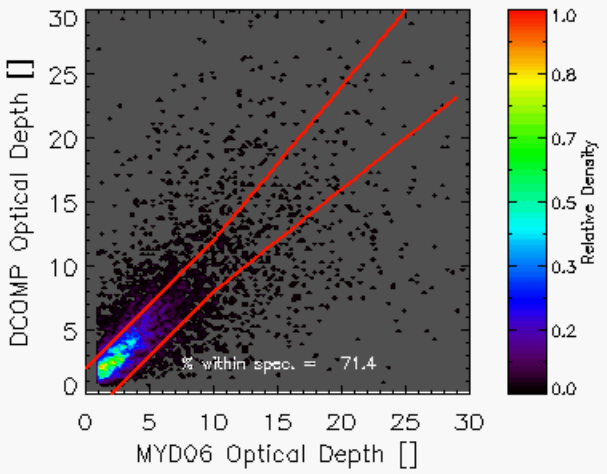
DCOMP Comparison to NASA MODIS MYD06 Products (Full Day – August 1, 2009)

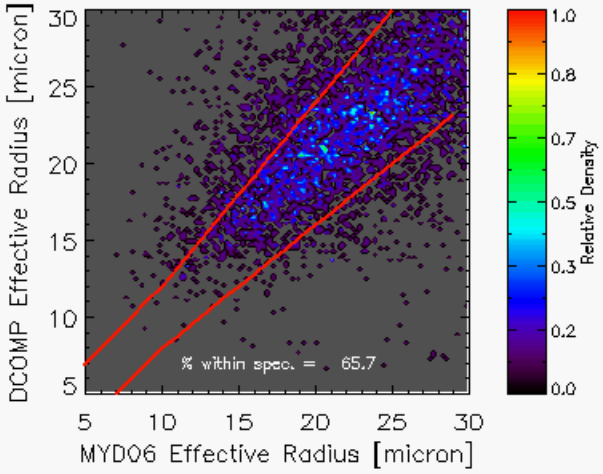


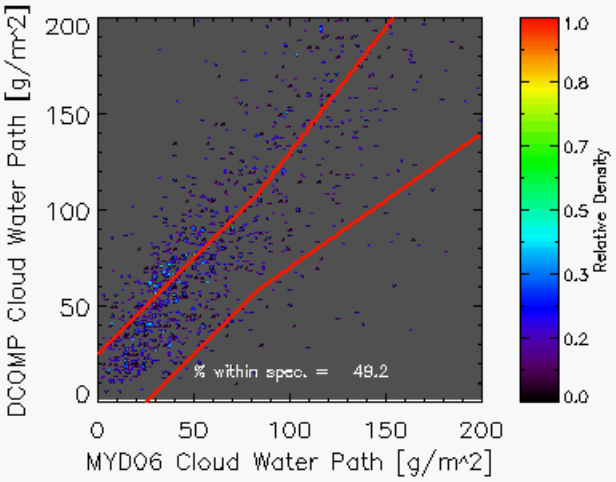
COD Bias, Correlation = 0.59 , 0.61

CEPS Bias, Correlation = 1.69μm , 0.51

CWP Bias, Correlation = 47.21 g/m², 0.81



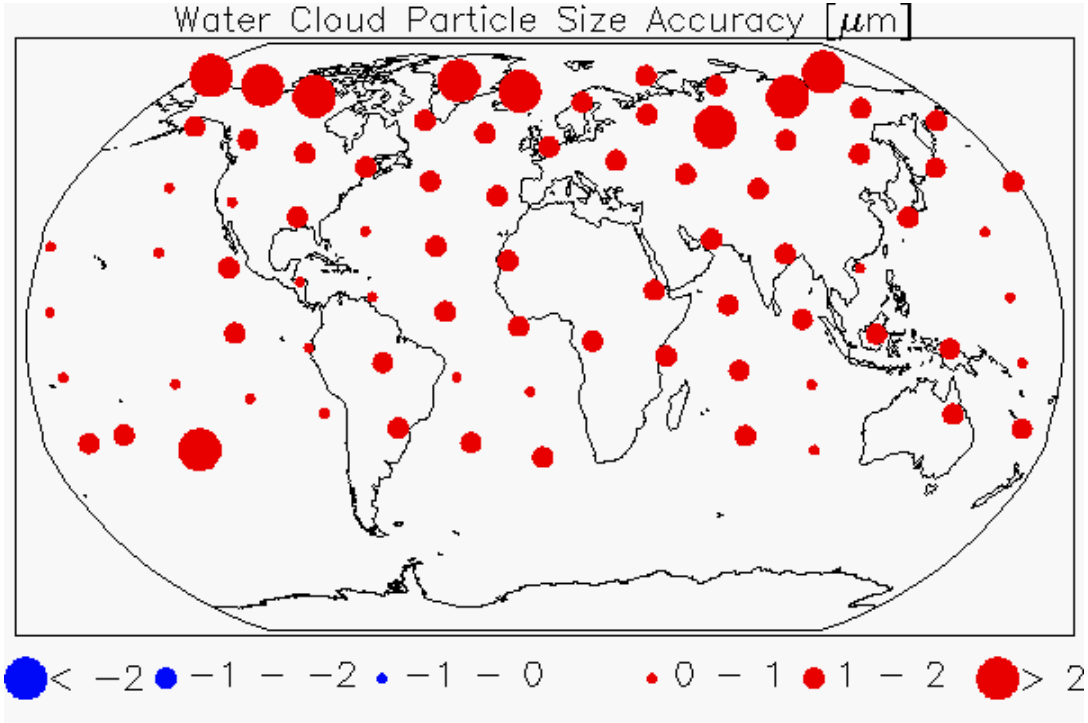




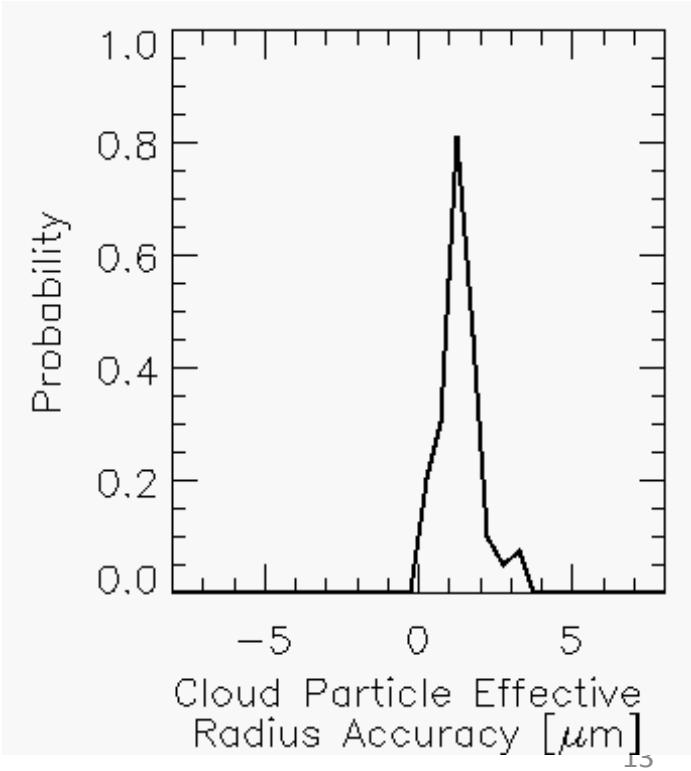
DCOMP Comparison to NASA MODIS MYD06 Products (Full Day – August 1, 2009: Water Phase Clouds)

Each circle provides the accuracy (mean bias) for this granule plotted at the center of the granule.

- Size of the circle indicate magnitude of the bias
- Color indicates sign of the bias

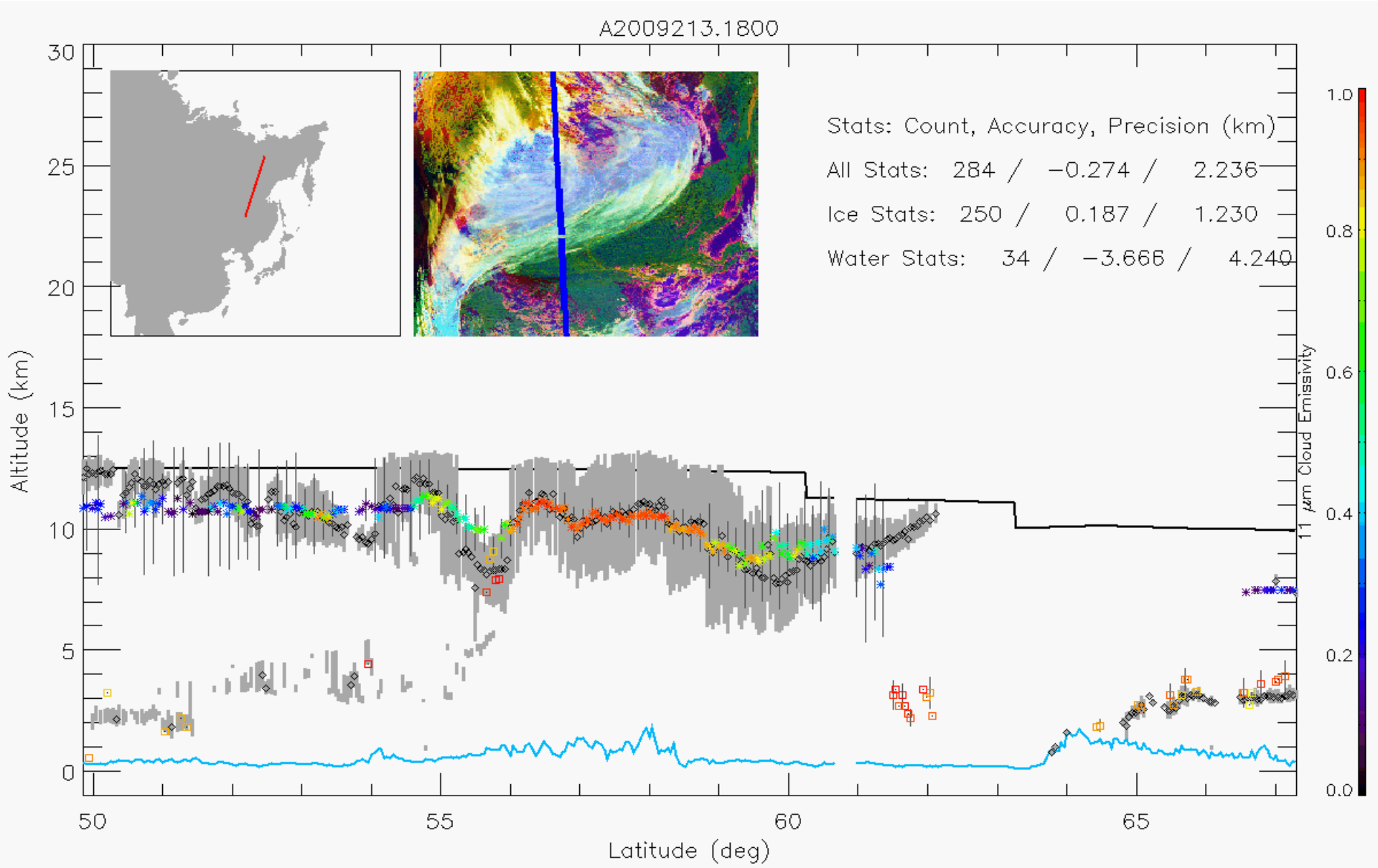


Global distribution of all accuracy values for each granule. Granules with differences exceeding 2 μm are rare.



COMPARISON TO NASA CALIPSO/CALIOP MYD06 CLOUD-TOP HEIGHTS

ACHA Comparison to NASA CALIPSO/CALIOP Products (One Granule 18:00 UTC on August 1, 2009)

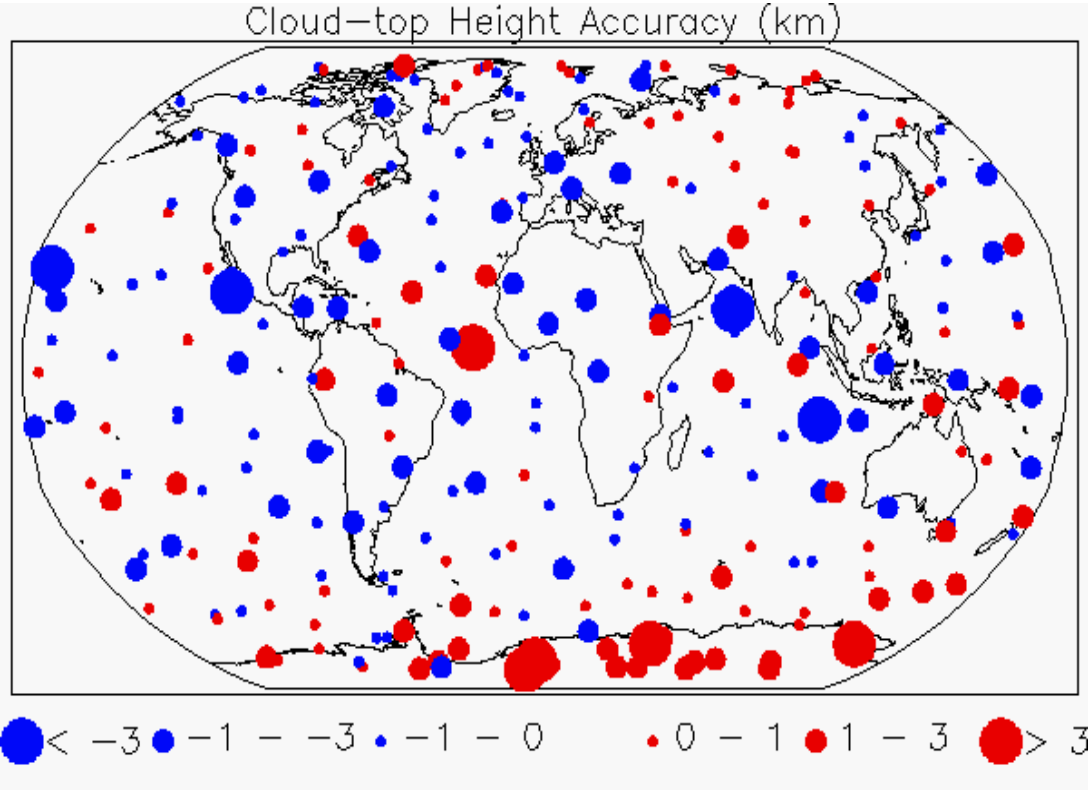


ACHA Comparison to NASA CALIPSO/CALIOP Products (Full Day – August 1, 2009: All Clouds)

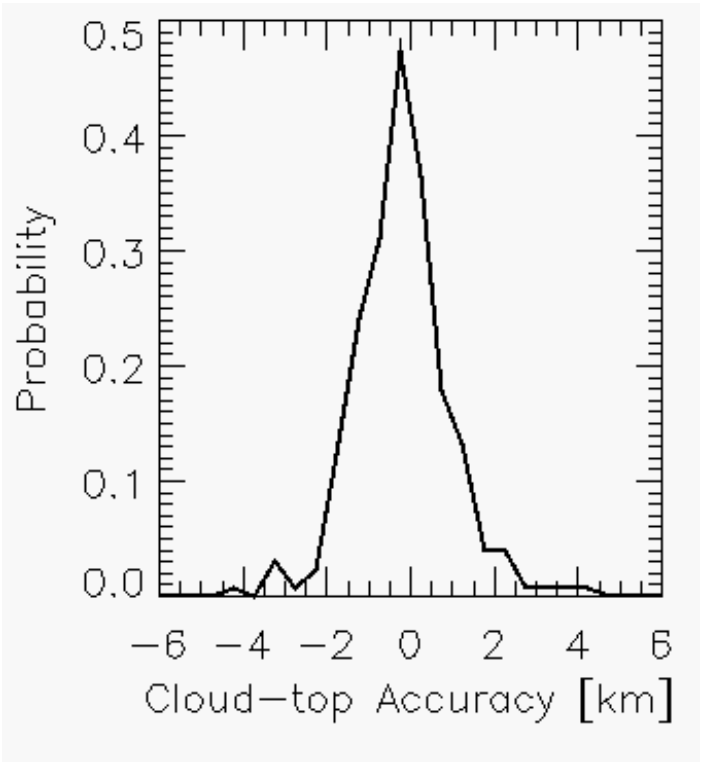
Each circle provides the accuracy (mean bias) for this granule plotted at the center of the granule.

- Size of the circle indicate magnitude of the bias
- Color indicates sign of the bias

Tropical errors due to multi-layer clouds.



Global distribution of all accuracy values for each granule. Granules with errors larger than 2 km are rare.



Conclusions

- The VIIRS products based on GOES-R AWG algorithms are consistent with
  - NASA MODIS MYD06 cloud optical properties
  - NASA CALIPSO/CALIOP Lidar cloud-top heights.
- We will implement these two algorithms (DCOMP and ACHA) on VIIRS proxy data flowing from GRAVITE and on real VIIRS data when available.
- The algorithms will run concurrently during NPP.
- Data shown here is available for the asking.