GOES-R AWG Cloud Team

Daytime Cloud Optical and Microphysical Properties (DCOMP)
June 8, 2010

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Outline

- Executive Summary
- Algorithm Description
- Requirements
- Validation Strategy
- Validation Results
- Summary

Executive Summary

- The ABI Cloud Daytime Microphysical Parameters generates the products Cloud particle size (CPS), Cloud Optical Depth (COD), Liquid Water Path (LWP) and Ice Water Path (IWP)
- Version 5 was delivered in May 2010. ATBD (100%) is on track for a July delivery
- A classical Nakajima-King two-channels in visible and near-infrared approach has been developed and implemented into an optimal estimation framework.
- Validation strategy includes the comparison of SEVIRI output to MODIS measurements for COD and CPS and comparison to AMSR-E measurements for LWP

Algorithm Overview

- Based on Nakajima& King approach of simultaneous retrieval of COD and REF in one absorption free (visible) and one weakly absorbing NIR channel.
- Radiative transfer calculations with the assumption of fully filled horizontal homogenous cloud pixels.
- Inversion calculations by a 1D-Var Optimal Estimation (OE) technique
- Solution space is a 2D-REF/COD surface
- Under assumption of vertically homogenous behavior of droplet concentration, the water path (LWP/IWP) can be calculated by a simple expression from COD and REF.

Observing system overview

- Instrument Characteristics:

Future GOES imager (ABI) band	Wavelength range (μm)	Central wavelength (μm)	Nominal subsatellite IGFOV (km)	Sample use
1	0.45–0.49	0.47	1	Daytime aerosol over land, coastal water mapping
2	0.59–0.69	0.64	0.5	Daytime clouds fog, inso-lation, winds
3	0.846–0.885	0.865	1	Daytime vegetation/burn scar and aerosol over water, winds
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	1.58–1.64	1.61	1	Daytime cloud-top phase and particle size, snow
6	2.225–2.275	2.25	2	Daytime land/cloud properties, particle size, vegetation, snow

Development (SEVIRI) Channel pair

Baseline GOES-ABI Channel pair

DCOMP Processing Schematic

Ancil Data:
- ABI products: CTP, Cloud Phase
- NWP reanalysis data: H_2O and other gas profiles, O_3
- MODIS surface albedo

Input: RFL2, RFL6

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Atmospheric Correction

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Pixel-based retrieval
(Forward model with LUT search and Optimal estimation)

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Output: COD , CPS

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Calculate LWP and IWP from COD/CPS

DCOMP Example Output

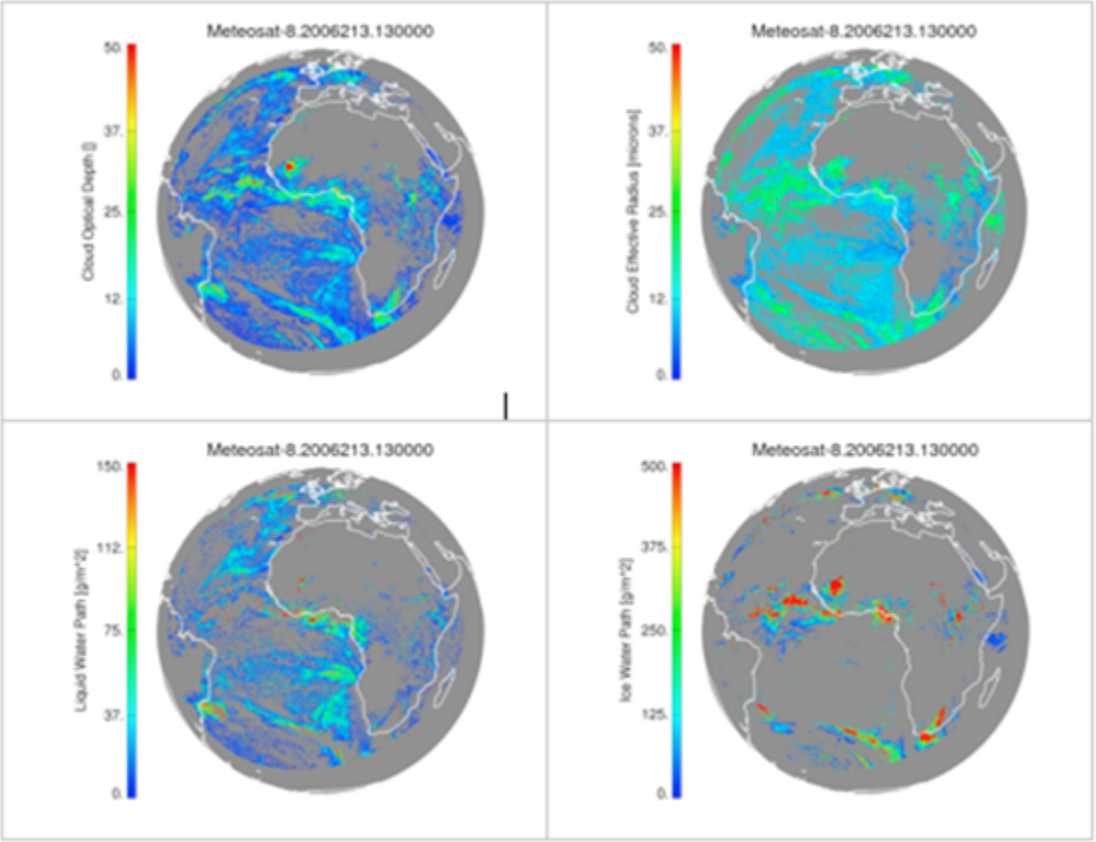


Figure 9 Results of the retrieval for 1st August 2006 13:00UTC for SEVIRI. Upper panel shows optical depth (left) and effective radius (right). Lower panel shows liquid water path (left) and ice water path (right).

Algorithm Changes from 80% to 100%

- Revised large parts of code to comply with AIT's guidance on lookup table handling.

- Include snow and sea-ice capability

ADEB and IV&V Response Summary

- All ATBD errors and clarification requests have been addressed

- No feedback required substantive modifications to the approach

Requirements

Product	Accuracy	Precision	Latency	Horizontal resolution
Cloud Optical Depth	wat: 20% or 2 ice: 30% or 3	wat: 20% ice: 30%	5min	2km
Cloud Particle Size	wat: 4 μm ice: 10 μm	wat: 4 μm ice: 10 μm	5min	2km
Liquid Water Path	50 g/m^2	50 g/m^2 or 30%	5min	2km
Ice Water Path	100 g/m^2	40 %	5min	2km

Qualifiers

These are made with the following qualifiers:

- Sensor zenith angle < 65 degrees

- Sensor zenith angle < 65 degrees and with degraded quality < 82 degrees

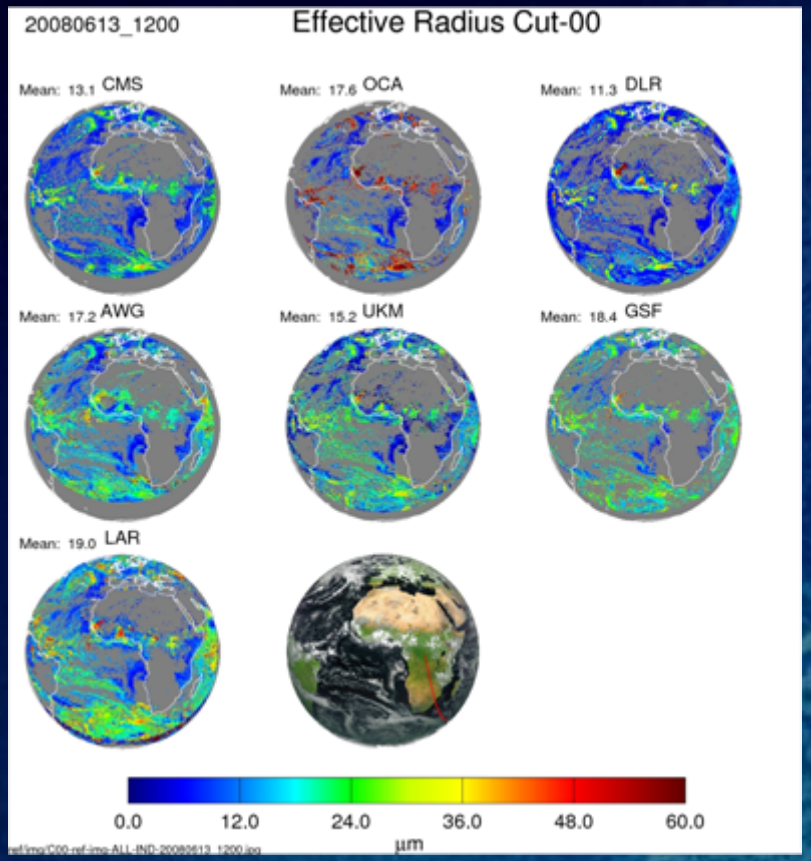
- Cloud mask, cloud height and cloud type are available.

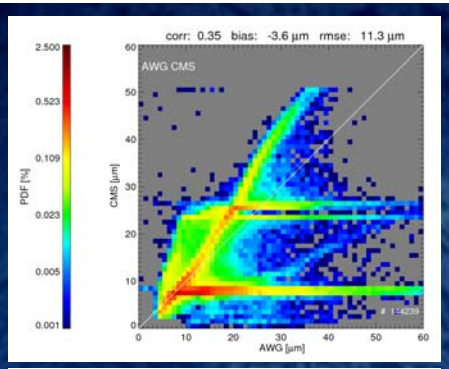
- Cloud optical depth varies from 1 to 60.

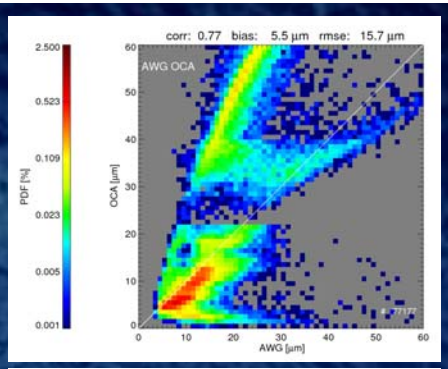
Validation Methodology

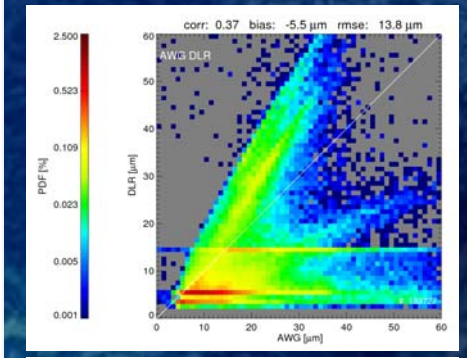
- Microwave Liquid water path measurements by AMSR-E, SSM-I and ARM site ground-based microwave profiler MWR
- There are no really truth data for COD, REF and IWP, but comparable products from other institutes:
  - » SEVIRI products from EUMETSAT and others
  - » NASA MODIS products
  - » NESDIS AVHRR products
- CALIPSO “TAU” product for thin ice clouds.
- CLOUDSAT and CALIPSO may support identification of multi-layer clouds and aerosol layers.

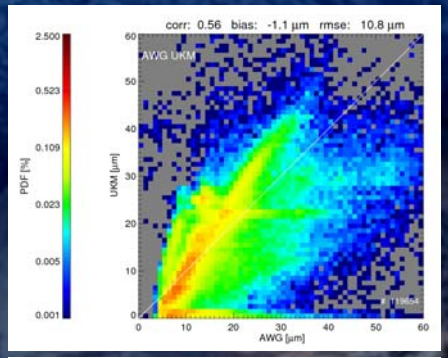
Comparison to other group's products - CPS

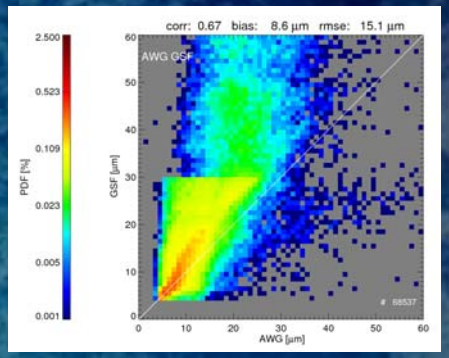


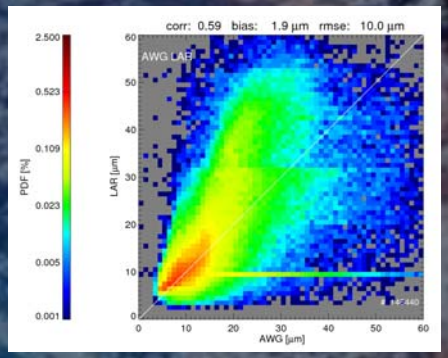








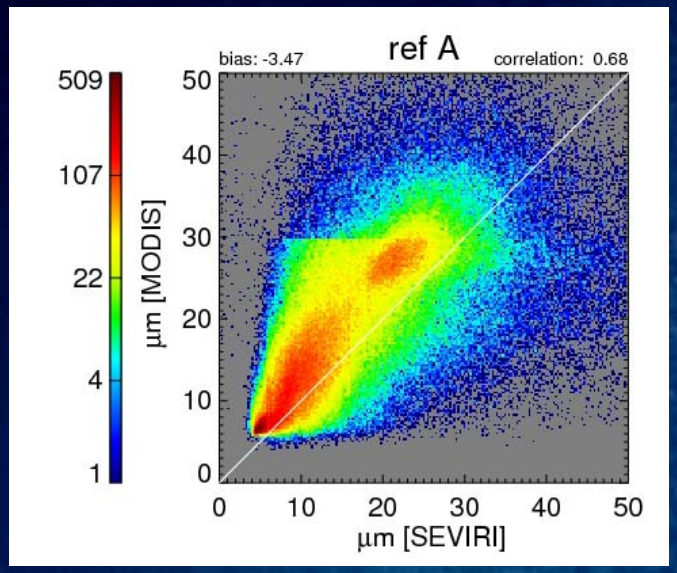




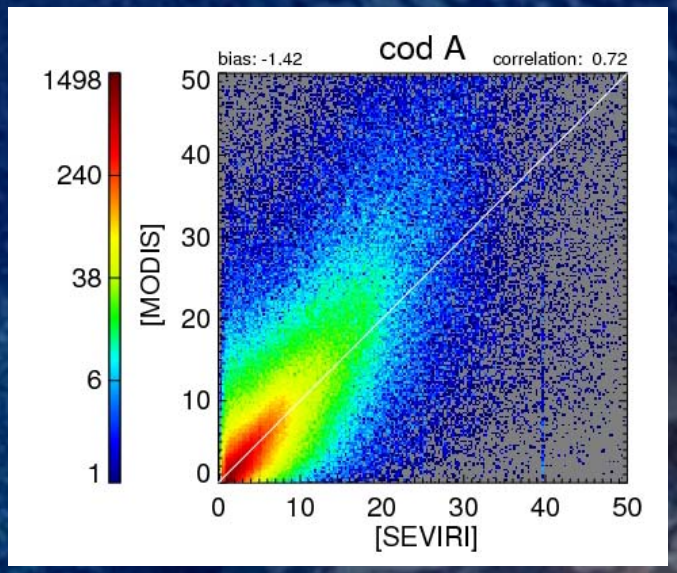
AWG results are on the x-axis of all figures

Validation with MODIS (example 13th June 2008)

Cloud particle size



Cloud optical thickness



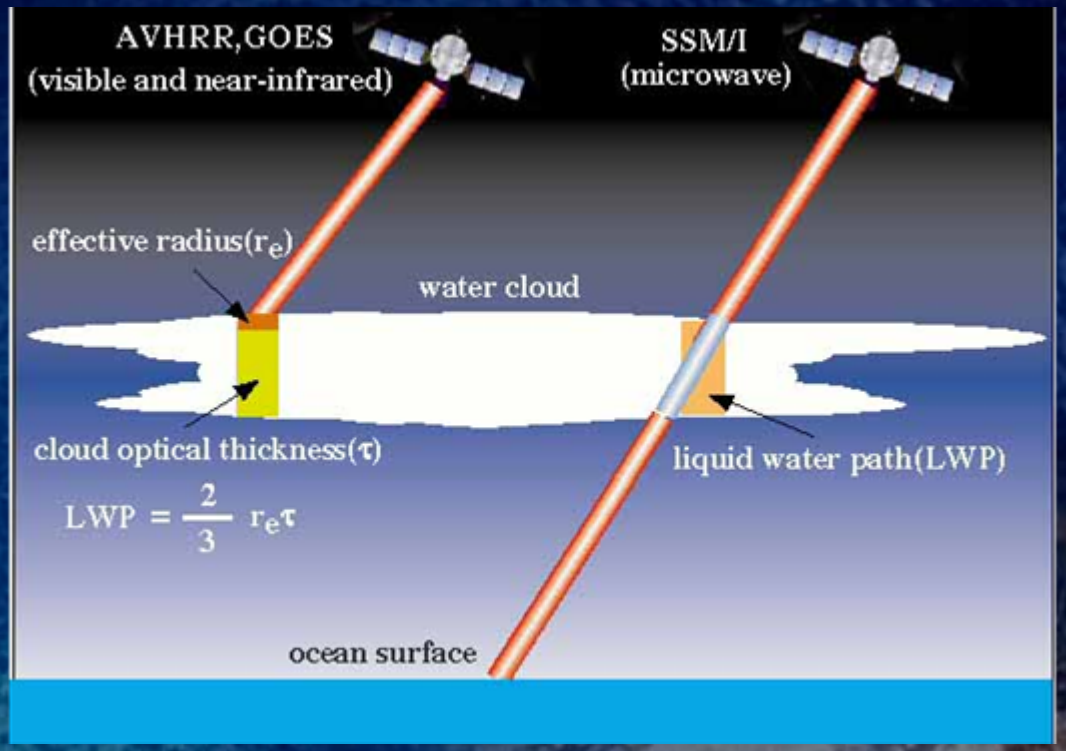
MODIS MYD06 and MOD06 products are a well tested and validated data set.

Note, there is evidence that the SEVIRI 0.65 µm channel is 8% too low.

Much of the scatter is due to spatial/temporal sampling.

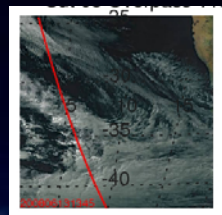
Validation
Liquid water path

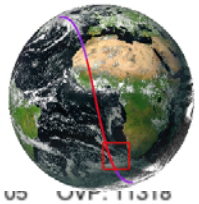
- ABI cloud water path algorithm is based on retrievals of particle size and optical thickness
- Passive microwave observations are directly influenced by liquid water within clouds.
- Microwave algorithms are only possible over ocean due to low and homogonous emissivity values.
- Since LWP is calculated by CPS and COD, LWP validation supports evaluation of these two parameters as well.



AMSRe and SSM/I are our sources of LWP from microwave imagers.

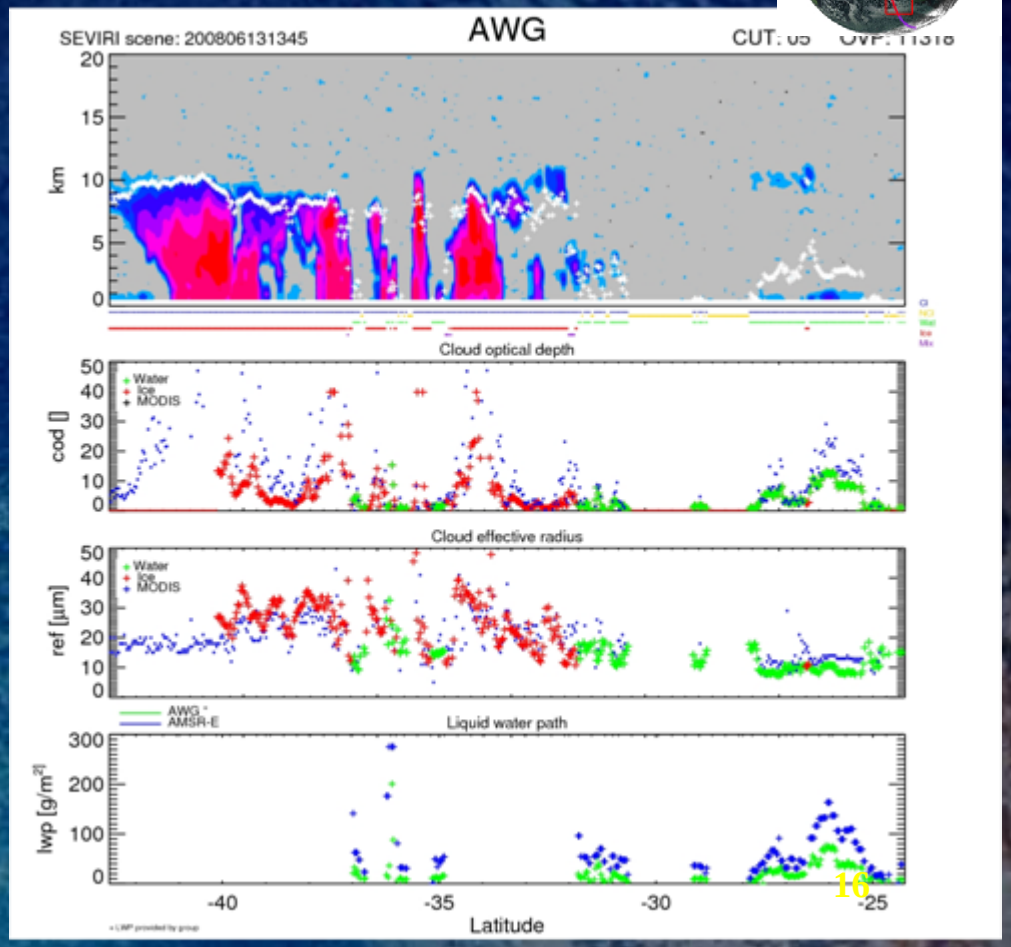
Validation with MODIS and AMSR-E





Comparison along a part of CLOUDSAT Path 11318 from 13th June 2008.

- CLOUDSAT radar profile with ABI cloud height product.
- Comparison of cloud optical thickness and cloud particle size with MODIS MYD06 product
- Comparison of Liquid water path with AMSR-E product



Validation Results Summary

Experiment	Accuracy (Specs)	Precision (Specs)
Liquid Water Path (MODIS)	21.19 (50 g/m2)	41.73 (50 g/m2)
Liquid Water Path (AMSR-E)	30.07 (50 g/m2)	53.75 (50 g/m2)
Cloud Optical Depth (MODIS)	W: 0.23 (2. or 20%) I: 1.58 (3. or 30%)	3.926 (2 or 20 %) 3.704 (3 or 30 %)
Cloud Particle Size (MODIS)	W: 2.51 (4 micron) I: 3.61 (10 micron)	3.87 (4 micron) 5.80 (10 micron)
Ice Water Path (MODIS)	15.62 (100 g/m2)	56.68 g/m2 (100 g/m2)

Summary

•The ABI Daytime Microphysical Parameter Algorithm provides microphysical parameters COD and CPS for daytime observations. Based from these parameters the cloud water content are derived.

•Version 5 is delivered and the 100% ATBD is coming.

•These products meet the specifications.

•These algorithms appear to perform competitively with the other real-time algorithms that exist today.

Backup Material