

# **GOES-R AWG Product Validation Tool Development**

## ***Nighttime Cloud Optical and Microphysical Properties (NCOMP)***

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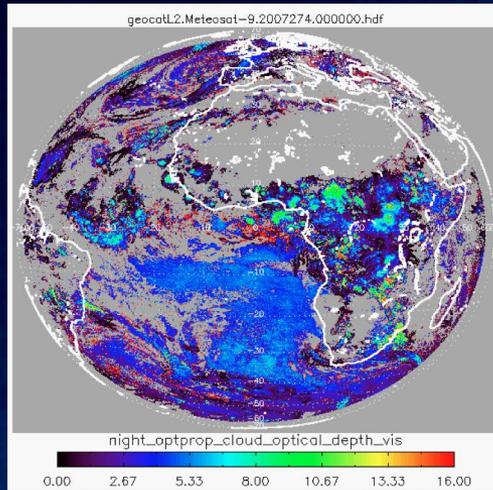


# Products

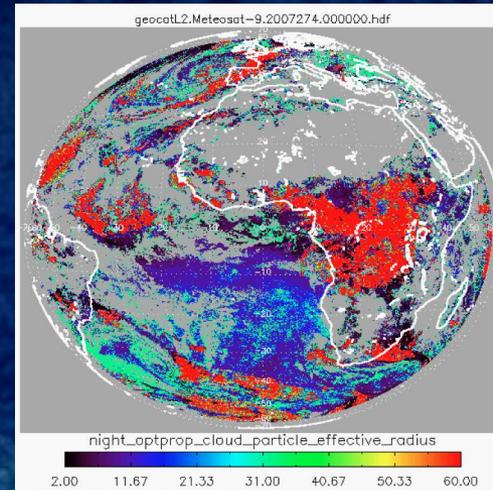


October 1, 2006 00:00 UTC

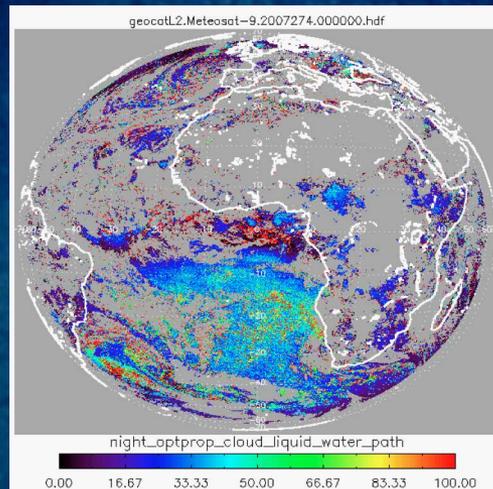
Cloud Optical  
Depth  
(dimensionless)



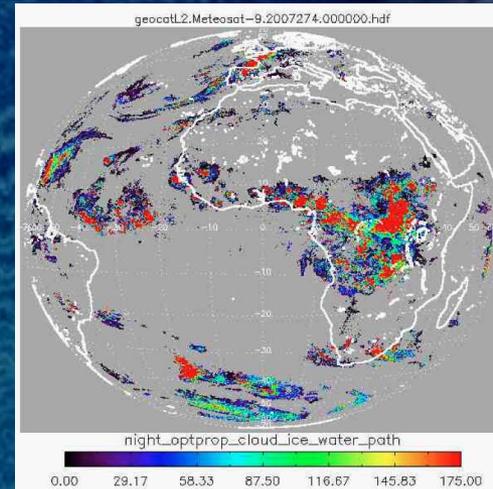
Cloud Particle  
Size ( $\mu\text{m}$ )



LWP ( $\text{g}/\text{m}^2$ )



IWP ( $\text{g}/\text{m}^2$ )





# Validation Strategies



- **Liquid Water Path** – best validation sources of all NCOMP products
  - » **Routine** (spatial & temporal matching, consistency checks):
    - Microwave LWP measurements from AMSR-E<sup>1</sup> and SSMIS<sup>2</sup>
    - NASA LaRC SEVIRI/ABI next gen SIST<sup>2</sup> products
    - ground-based microwave profilers (MWR) with radar/lidar<sup>2</sup>
      - (as available) ARM and CloudNet sites, field campaigns
  - » **Deep-dive** (detailed spatial and temporal matching, case studies):
    - ground-based MWR with radar/lidar<sup>1</sup>
      - ARM and CloudNet sites, field campaigns
    - NASA LaRC CERES MODIS<sup>2</sup> and SEVIRI/ABI SIST<sup>1</sup> products
    - CloudSat (limited for thin clouds)<sup>1</sup>

<sup>1</sup> completed

<sup>2</sup> in development/future



# Validation Strategies



- **Cloud Optical Depth** – independent routine sources less available than for LWP, but deep-dive will provide ample validation
  - » **Routine** (spatial & temporal matching, consistency checks):
    - NASA LaRC SEVIRI/ABI next gen SIST<sup>2</sup> products
    - CALIPSO (thin ice clouds only)<sup>1</sup>
    - Ground-based interferometers (e.g., AERI) and radar/lidar<sup>2</sup>
      - (as available) ARM and CloudNet sites, field campaigns
  - » **Deep-dive** (detailed spatial & temporal matching, case studies):
    - NASA LaRC CERES MODIS<sup>2</sup> and SEVIRI/ABI SIST<sup>1</sup> products
    - CALIPSO (for other than low COD ice clouds, methods in flux)<sup>1</sup>
    - Ground or ship-based AERI or radar/lidar<sup>1,2</sup>
      - ARM and CloudNet sites, field campaigns
    - CloudSat (limited for thin clouds, water and ice both)<sup>1</sup>

<sup>1</sup> completed

<sup>2</sup> in development/future



# Validation Strategies



- **Cloud Particle Size** and **IWP** – even fewer available independent routine sources, but deep-dive will provide ample validation
  - » **Routine** (spatial & temporal matching, consistency checks):
    - NASA LaRC SEVIRI/ABI<sup>2</sup> next gen SIST products
    - Ground-based AERI, or radar/lidar and/or MWR<sup>2</sup>
      - (as available) ARM and CloudNet sites, field campaigns
  - » **Deep-dive** (spatial & temporal matched, case studies):
    - CALIPSO (thinnest ice clouds only, methods in flux)<sup>2</sup>
    - NASA LaRC CERES MODIS<sup>2</sup> and SEVIRI/ABI<sup>1</sup> SIST products
    - Surface AERI, or radar/lidar and/or MWR<sup>1,2</sup>
      - ARM and CloudNet sites, field campaigns
    - Aircraft *in situ* retrievals (CPS)<sup>2</sup>
    - CloudSat (limited for thin clouds, CPS both water and ice)<sup>1</sup>

<sup>1</sup> completed

<sup>2</sup> in development

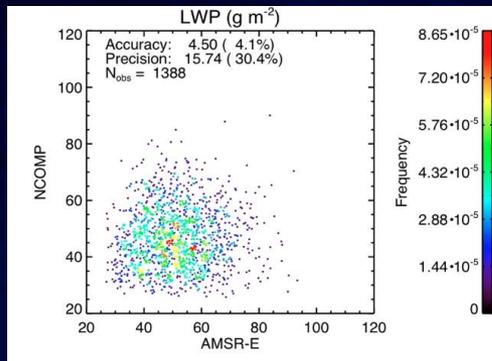


# Routine Validation Tools



## Liquid Water Path

### Retrievals from AMSR-E<sup>1</sup>



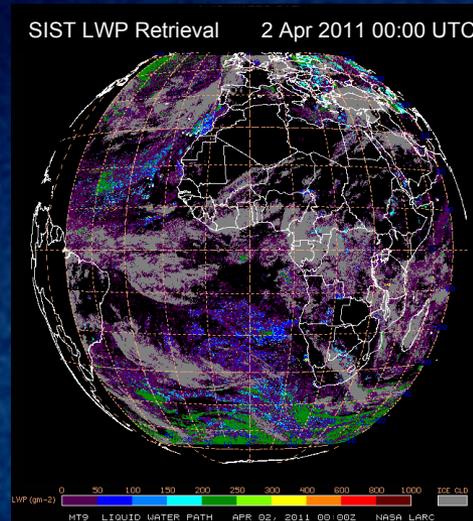
LWP from SEVIRI SIST compared to AMSR-E for thin water clouds

- AMSR-E comparison meets specs for thin water clouds
- IDL-based

→ TBD: is AMSR-E a feasible source for other water cloud types? Is CloudSat LWP appropriate?

<sup>1</sup> completed      <sup>2</sup> in development

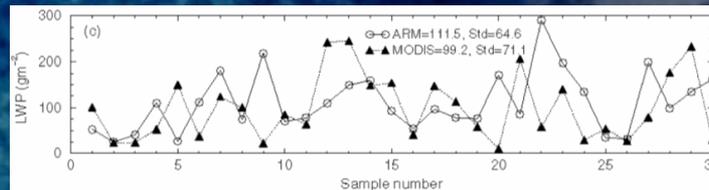
### NASA LaRC SEVIRI/ABI SIST<sup>2</sup> products



LWP from SEVIRI SIST can be compared to NCOMP over entire disk

- SEVIRI/ABI SIST near-realtime
- Validation tool imminent, IDL based, some McIDAS

### Ground-based Retrievals<sup>1</sup>



LWP from ARM MWR and radar/lidar are compared to MODIS SIST at ARM SGP

- Need to transition NCOMP to MODIS
- Subject to ground-based retrievals' availability
- IDL-based

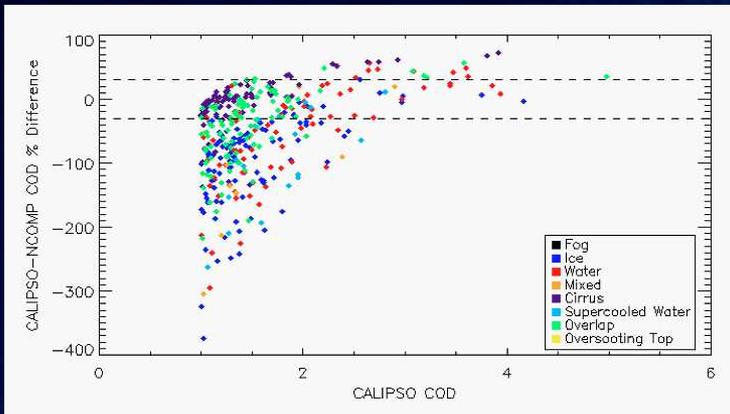


# Routine Validation Tools



## Cloud Optical Depth

### COD retrievals from CALIPSO<sup>1</sup>



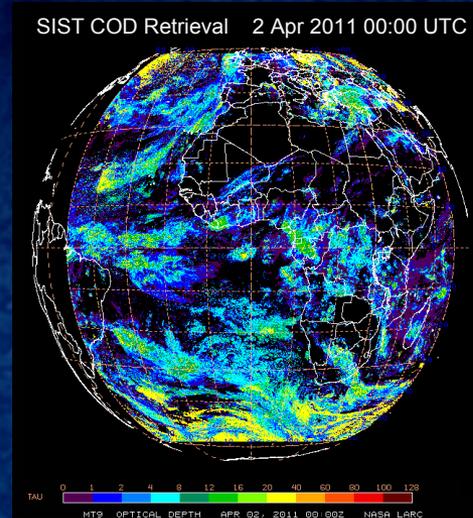
- CALIPSO comparison meets specs
- IDL-based

→ TBD: is CALIPSO a feasible source for other cloud types? Can CloudSat be used for thin clouds?

<sup>1</sup> completed

<sup>2</sup> in development

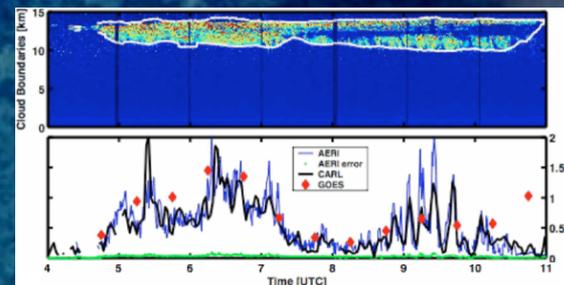
### NASA LaRC SEVIRI/ABI SIST<sup>2</sup> products



COD from SEVIRI SIST can be compared to NCOMP over entire disk

- SEVIRI/ABI SIST near-realtime
- Validation tool imminent, uses IDL, some McIDAS

### Ground-based Retrievals<sup>1</sup>



COD from ARM AERI and lidar (CARL) compared to GOES SIST at ARM SGP

- Subject to ground-based retrievals' availability
- IDL-based



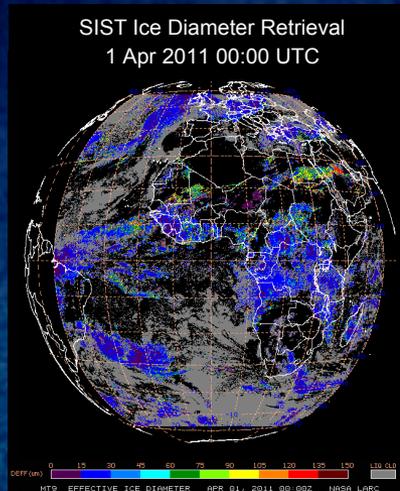
# Routine Validation Tools



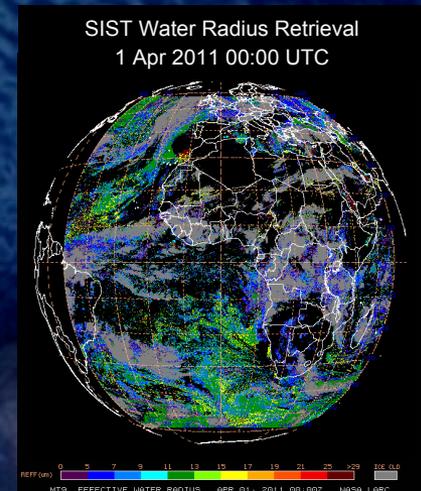
## • Cloud Particle Size

### NASA LaRC SEVIRI/ABI SIST<sup>2</sup> products

- SEVIRI/ABI SIST near-realtime
- Validation tool imminent, uses IDL
- CALIPSO and CloudSat retrievals may mature enough to be used routinely, but that is TBD

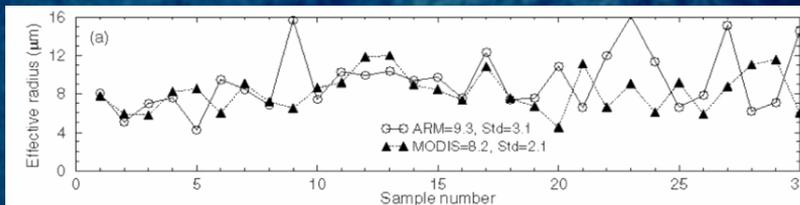


Ice and Water CPS from SEVIRI SIST can be compared to NCOMP over entire disk



## Ground-based Retrievals<sup>1</sup>

CPS from ARM MWR and radar/lidar are compared to MODIS SIST at ARM SGP



- Need to transition NCOMP to MODIS
- Subject to ground-based retrievals' availability
- IDL-based

<sup>1</sup> completed

<sup>2</sup> in development

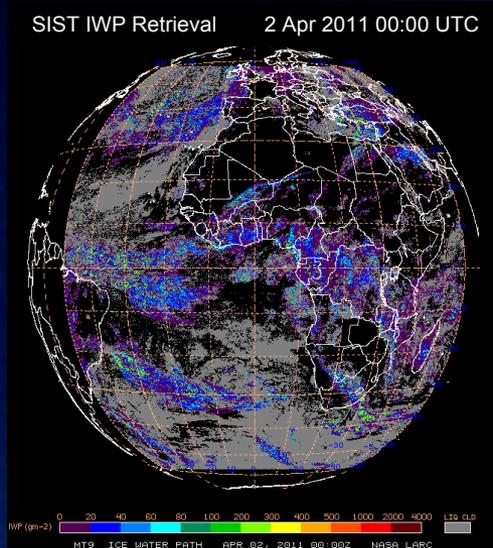


# Routine Validation Tools



## • Ice Water Path

IWP from SEVIRI SIST can be compared to NCOMP over entire disk



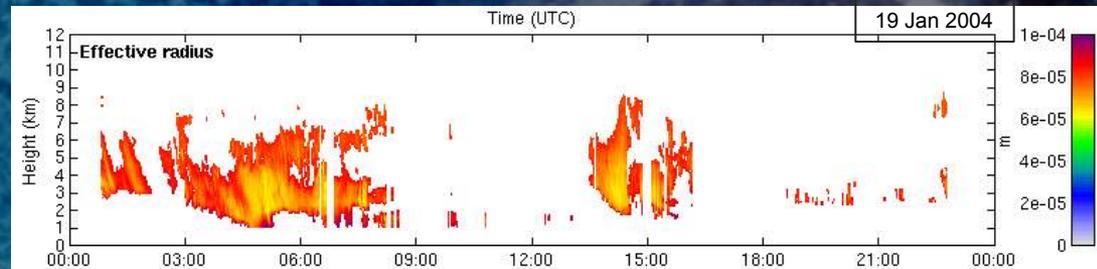
## NASA LaRC SEVIRI/ABI SIST<sup>2</sup> products

- SEVIRI/ABI SIST near- realtime
  - Validation tool imminent, uses IDL
- CALIPSO and/or CloudSat retrievals may mature enough to be used routinely, but that is TBD

## Ground-based Retrievals<sup>2</sup>

IWC from CloudNet site at Paliseau, France

Routine surface site validation opportunities are not likely for IWP, but if ARM or other programs eventually produces quick looks similar to CloudNet, they could be used.



<sup>1</sup> completed

<sup>2</sup> in development



# "Deep-Dive" Validation Tools



## • For all NCOMP Products – an expansion of Routine Tools

### Retrievals from CloudSat and/or CALIPSO<sup>2</sup>

- Given the inherent theoretical errors in CloudSat and CALIPSO, NCOMP validation will necessarily need deep-dive capabilities to assess accuracies of both NCOMP and the validation source.
- Primarily IDL-based
- What else can I say?

### NASA LaRC SEVIRI/ABI SIST<sup>2</sup> products

- Usage of SIST products from both SEVIRI/ABI and MODIS for Deep-dive validation will allow for extensive evaluation of NCOMP products. Evaluating multiple cloud properties from SIST simultaneously will allow for physical consistency checks, e.g., can differences between LWP from NCOMP and SIST be attributed to errors in COD and/or CPS.

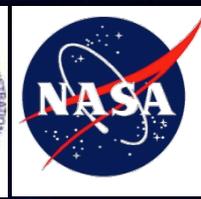
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### Ground-based Retrievals<sup>2</sup>

- Same tools as Routine Validation Tools.
- LWP, COD, CPS and IWP from surface sites, which are accompanied by cloud height and thickness information, allow for a complete vertical depiction of a cloud, as well as its evolution.
- ARM, ARM Mobile Facility and CloudNet sites have these capabilities, so co-location and temporal matching is being adapted from VISST/SIST tools



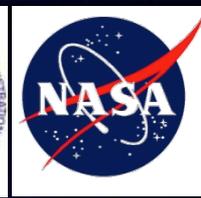
# Ideas for the Further Enhancement and Utility of Validation Tools



- Because NCOMP is based on infrared channels only, it should operate the same both day and night; moreover it should be consistent with DCOMP results for thin clouds
  - DCOMP can be validated with more source data than NCOMP
    - Its uncertainties should be better-defined.
- Can further validate NCOMP by running during daytime using night-like dataset
  - After running DCOMP, remove solar-reflected component of 3.9  $\mu\text{m}$  SEVIRI/ABI data -> nightlike data
  - Apply NCOMP to nightlike data -> nightlike results
  - Compare to DCOMP results for appropriate ranges of parameters
- Apply this approach to SEVIRI & MODIS and to ABI periodically



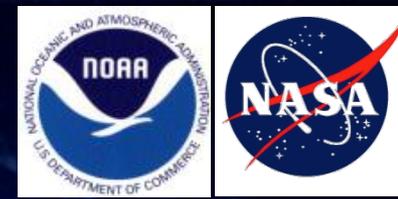
# Ideas for the Further Enhancement and Utility of Validation Tools



- Coordinate with other Cloud Working Group members and other product teams to
  - avoid duplication of effort
  - standardize spatial and temporal matching criteria
  - share validation sources
- Web-based access to routine validation results is a goal, but more difficult for deep-dive.
- Additional visualization tools needed for deep-dive validation is TBD.



# Summary



- Routine Validation
  - Tools using satellite-based sources for LWP and COD have been developed.
  - Tools using satellite-based sources for CPS and IWP have been developed but are not well-understood and are subject to the sources' evolving retrieval algorithms.
  - Tools using surface-based sources for LWP, COD, CPS and IWP have been developed for usage within non-GOES-R systems and are being adapted to GOES-R requirements.
- Deep-dive Validation
  - Tools using satellite-based sources for LWP, COD, CPS and IWP have been developed but some are not well-understood and are subject to the sources' evolving retrieval algorithms.
  - Tools using surface-based sources for LWP, COD, CPS and IWP have been developed for usage within non-GOES-R systems and are being adapted to GOES-R requirements
  - Integrating multiple sources and tools for deep-dive looks is in development. 13