

Update on NASA-Langley Satellite Cloud and Radiation Products for the ARM Community

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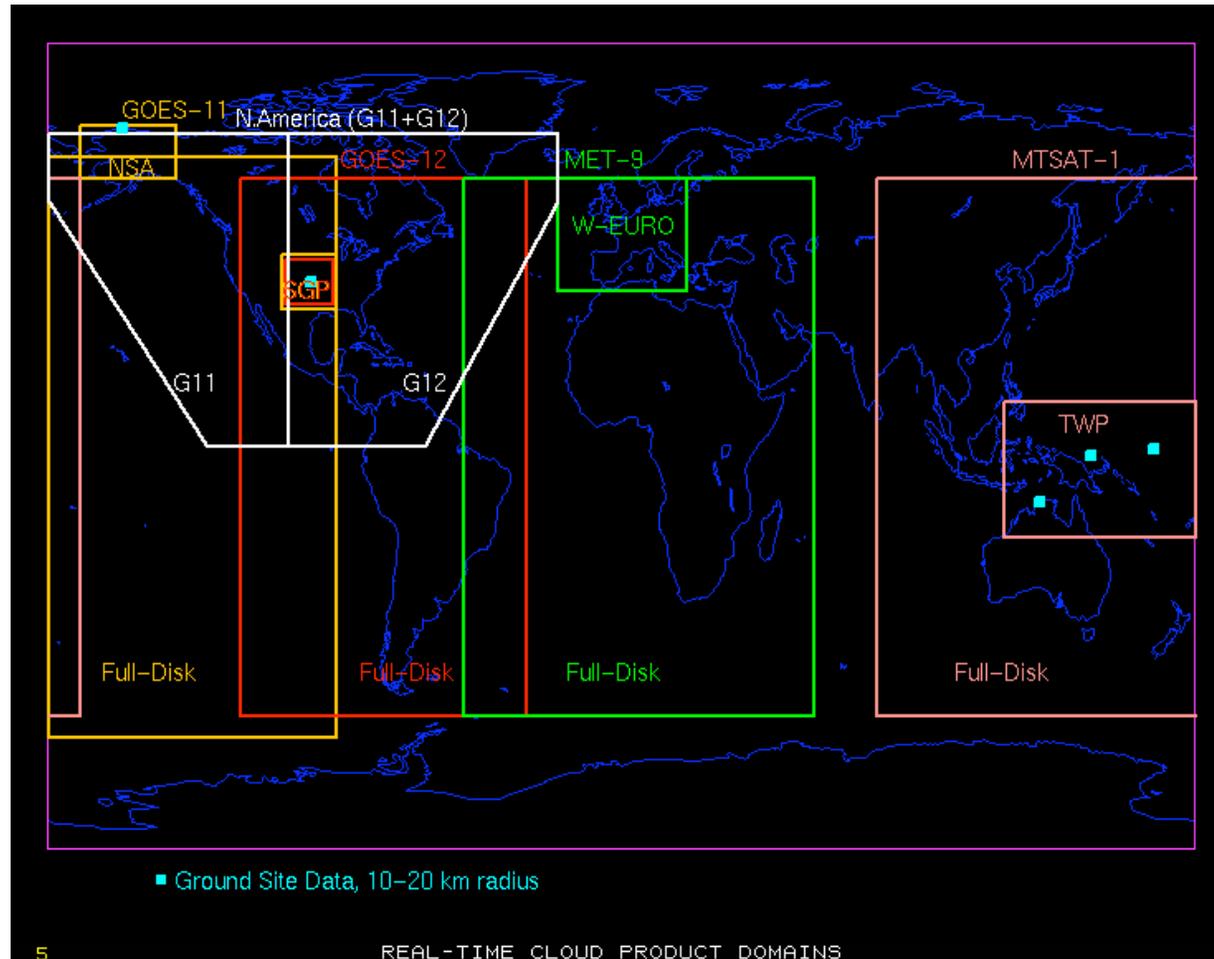


Outline

- Cloud & Radiation Products from VISST algorithm
 - Types
 - Domains
 - Data formats
- Current work & improvements in cloud product retrievals
- Validation

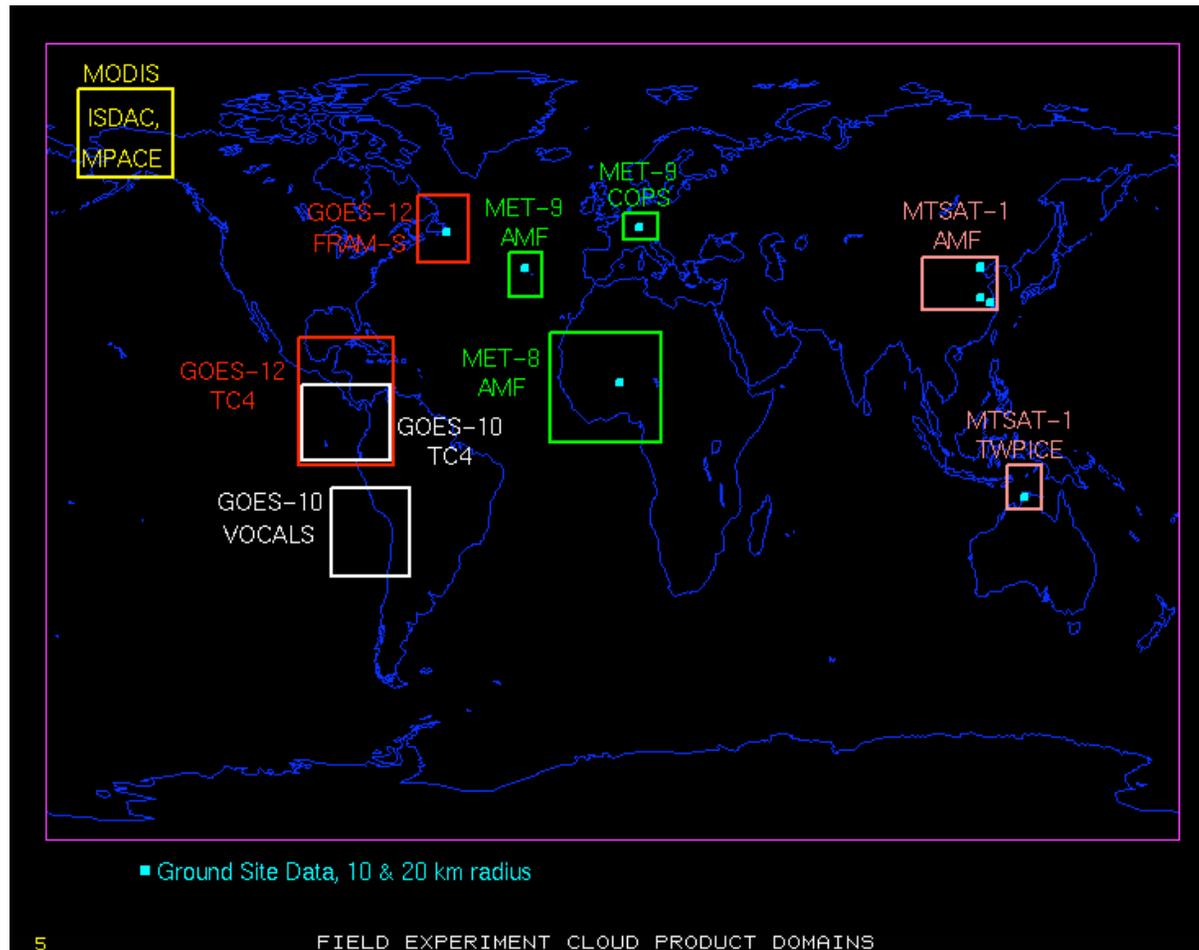


Real-Time Domains



- **Full Disk: 3 hourly, 8 – 12 km resolution**
- **Other domains: 15 min to 1 hour, 3 – 8 km resolution**

Field Experiment Domains



- **Field experiment domains: 15 min to 1 hour, 1 – 4 km resolution**



VISST Cloud Retrieval Parameters & Data Formats

- Parameters: Z, P, T, Phase, τ , ϵ , Reff, Deff, LWP/IWP, ALB, OLR
 - Narrowband (NB) to broadband (BB) fits used to convert NB 0.65 μ m, 11 μ m channel data into BB ALB, OLR.
 - Data accuracy highest for low SZA, no snow/ice, uniform/single-layer, optically thick clouds
- Data Formats
 - Pixel-level binary files
 - pixel-level NetCDF (planned)
 - Monthly ground-site ascii files
 - NetCDF gridded data files
 - McIDAS format AREA files
 - GIF imagery & loops



Improvements in Cloud Product Retrievals

- Currently testing a new cloud thickness parameterization
 - $Z_{thk_{ice}}(lat, land\%, teff, \tau, IWP)$
 - $Z_{thk_{liq}}(lat, land\%, teff, \tau, reff, LWP)$
 - $Z_{bot} = Z_{top} - Z_{thk}$
- Beginning to use new atmospheric profile datasets (ECMWF, MOA), GFS
 - Use more accurate ozone absorption in radiative transfer calculations
=> reduced τ , higher Z_{top}
- Investigating the use of new ice crystal models, rough xtals
 - New $\tau, \epsilon, Deff$ => reduced τ , higher Z_{top}
- ARM-TWP: update to MTSAT calibration & NB-BB fits for 2007 data
 - Revised cloud products, more accurate ALB & OLR
- VOCALS: will be updating GOES-10 products using ozone & new ice models
- TC4: uses updated VISST & multilayer techniques with GOES-10/12



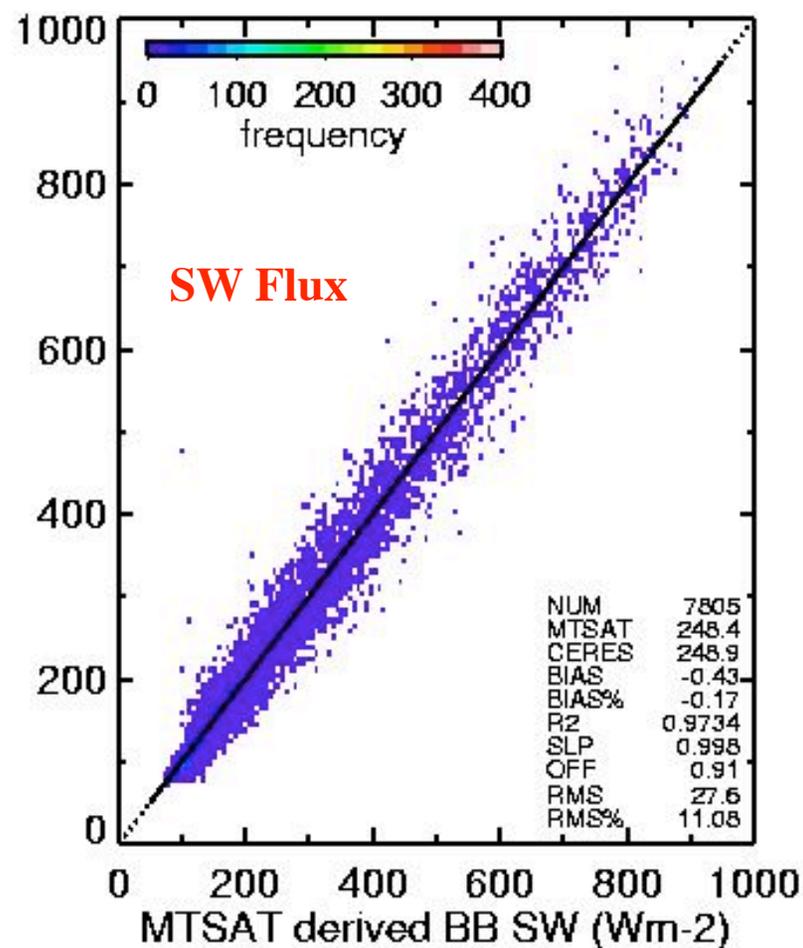
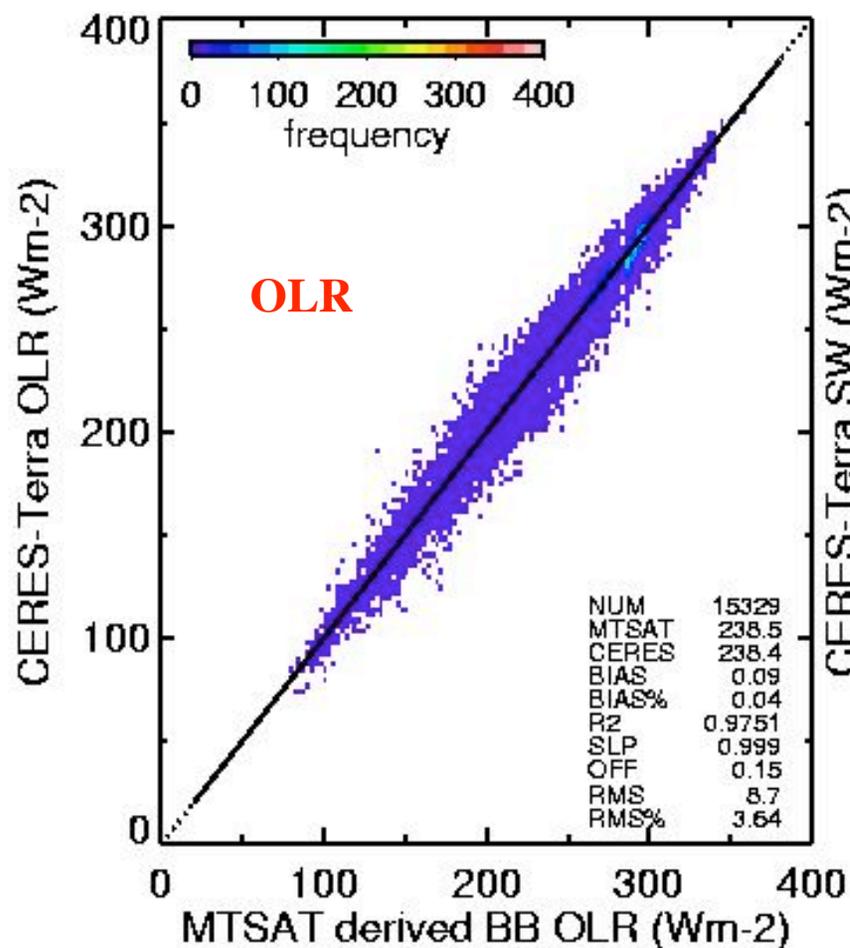
Improvements in Cloud Product Retrievals

- Multilayer Clouds – Modified CO₂ absorbing technique (MCO2AT)
 - Cirrus over liquid clouds
 - 13.3- μ m channel must be present (G12, MET9, MODIS)
 - Latest algorithm has improved cloud classification (Aug 2009)
 - Upper layer: Ztop, Ptop, Ttop, τ , ϵ , Deff, IWP
 - Lower layer: Zeff, Peff, Teff, τ , ϵ , Reff, LWP
 - Current data formats: gif, binary, McIDAS
- Multilayer data used to augment standard retrieval algorithm for Ztop.
 - Data provided in separate stream
- Goal is to come up with 3-D cloud characterization from satellite data
 - with GEOSats => 4-D representation

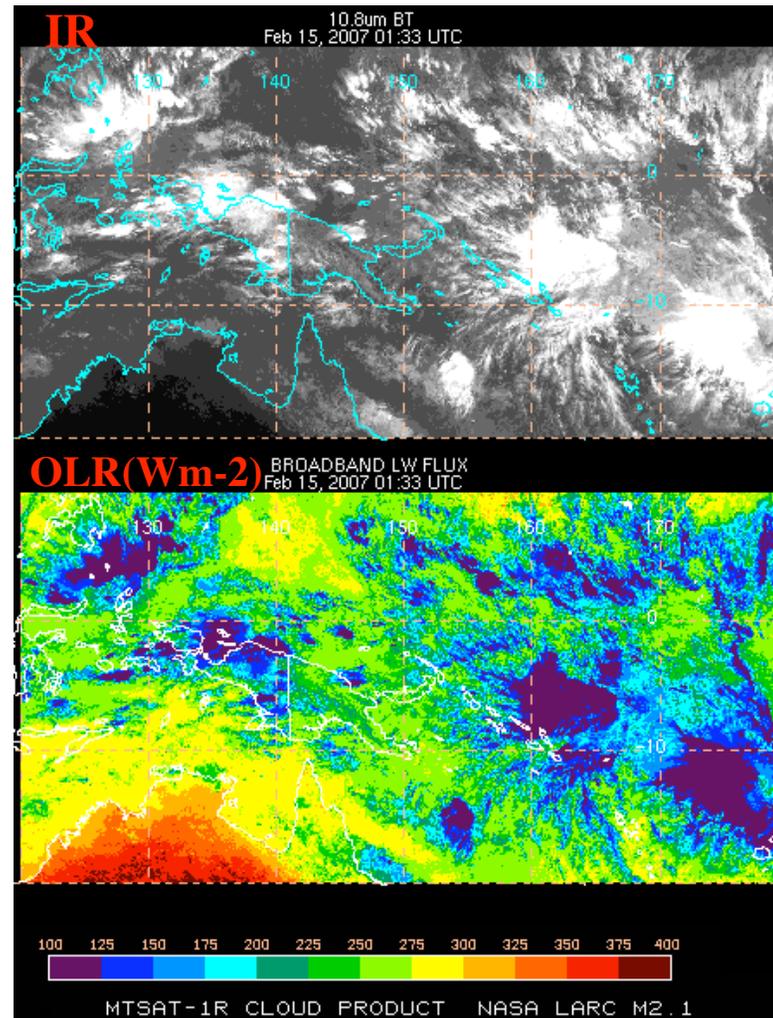
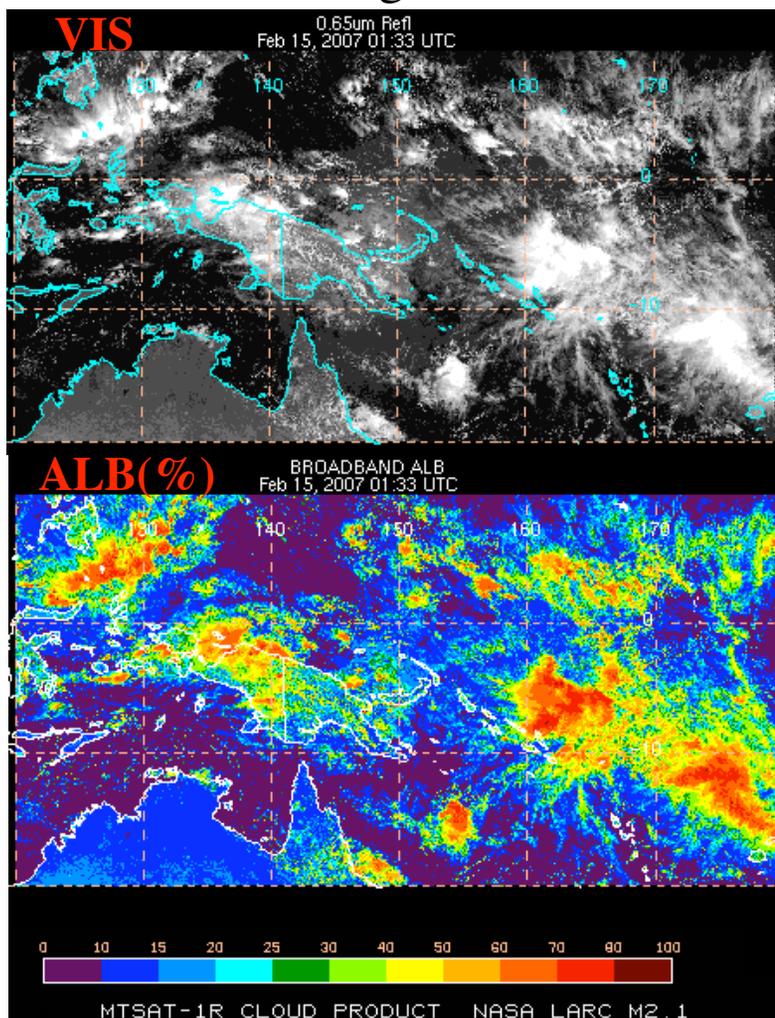


NASA-Langley MTSAT TOA Flux Comparisons

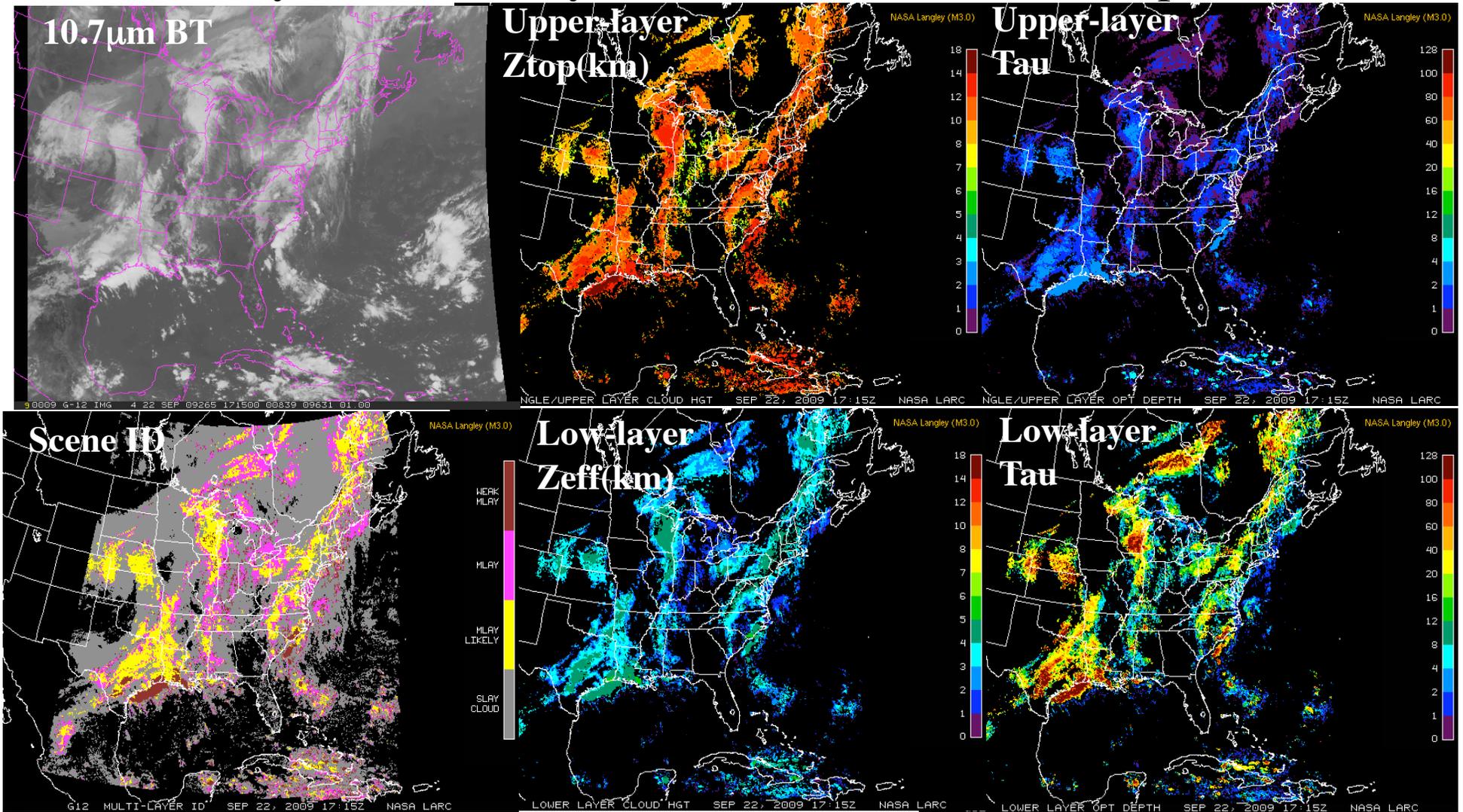
• Jan-Apr 2007: New Vis Calibration & NB -BB Fits



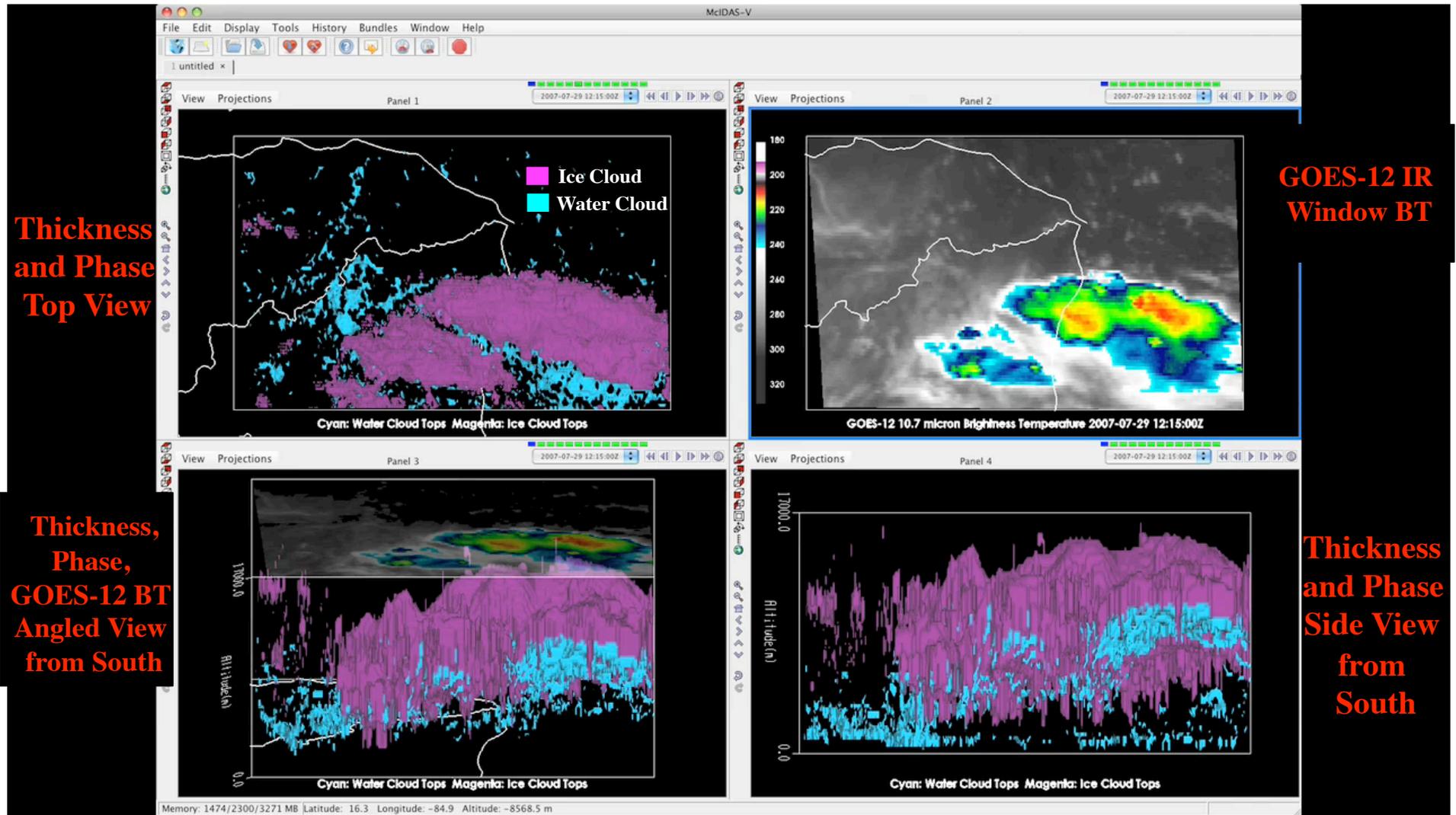
MTSAT Images over ARM-TWP, 0133 UTC 15 Feb 2007 showing broadband ALB, OLR from new NB-BB fits



Multilayer Cloud Analysis: GOES-12, 17:15 UTC Sep 22, 2009



3-D Cloud View over Nicaragua During TC4



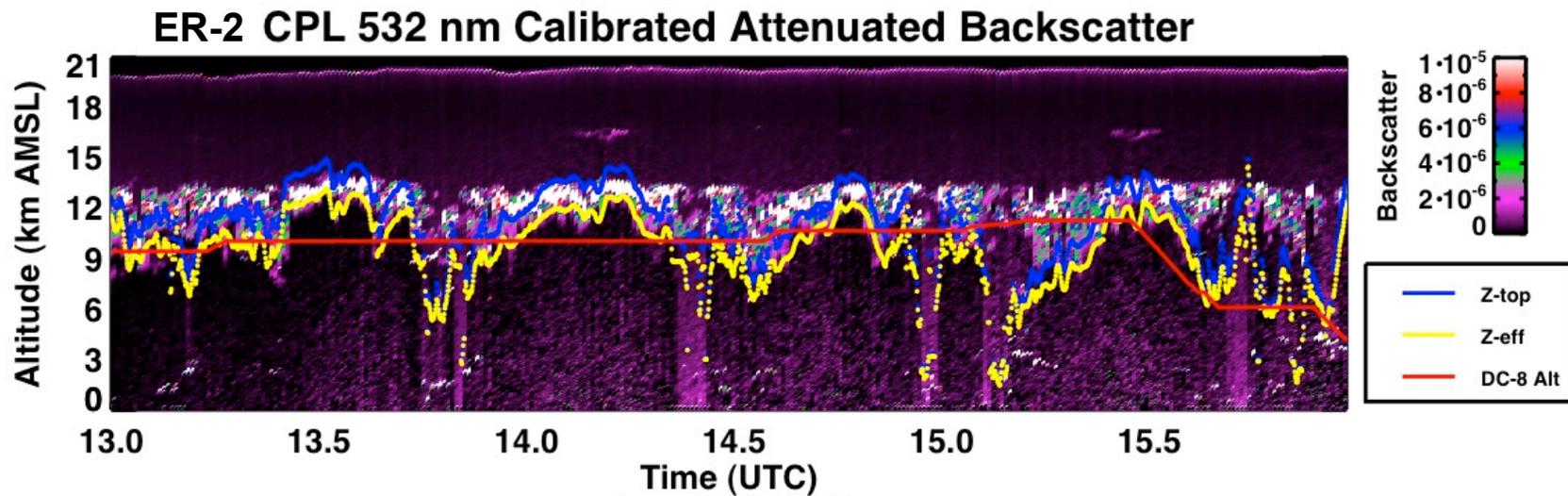
Validation

- Validate and improve cloud products using:
 - Aircraft data (CPL)
 - Surface data (ARM sites, ASOS)
 - CloudSat radar & CALIPSO lidar data
 - ICESAT GLAS lidar data



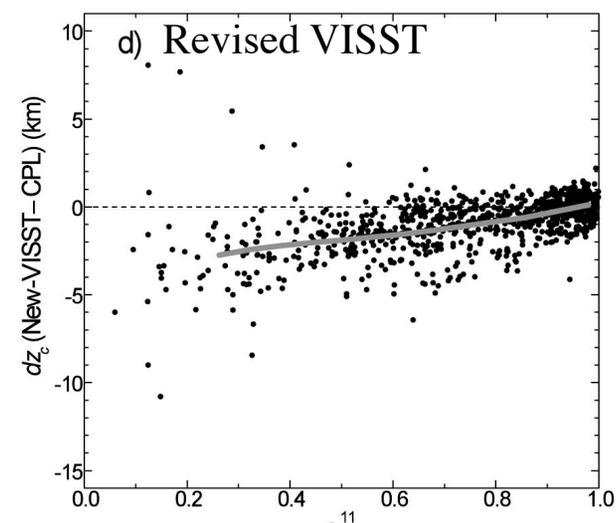
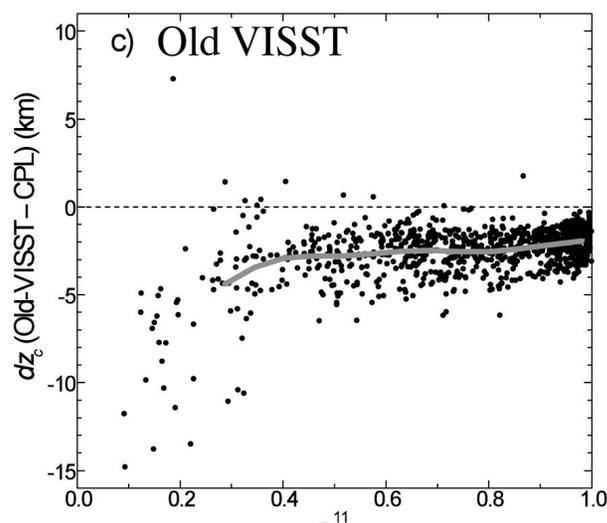
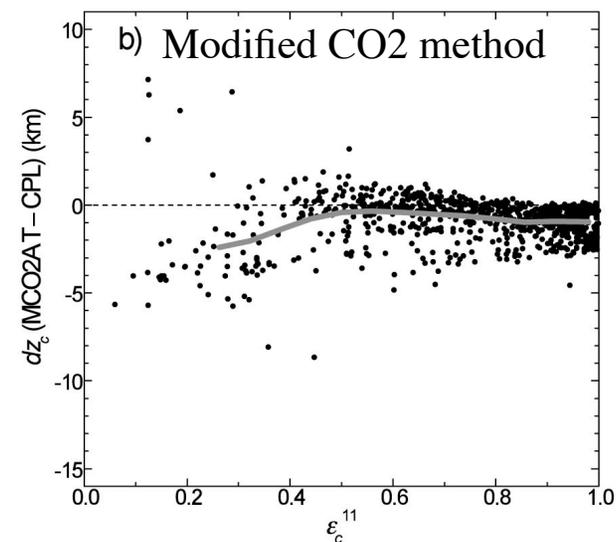
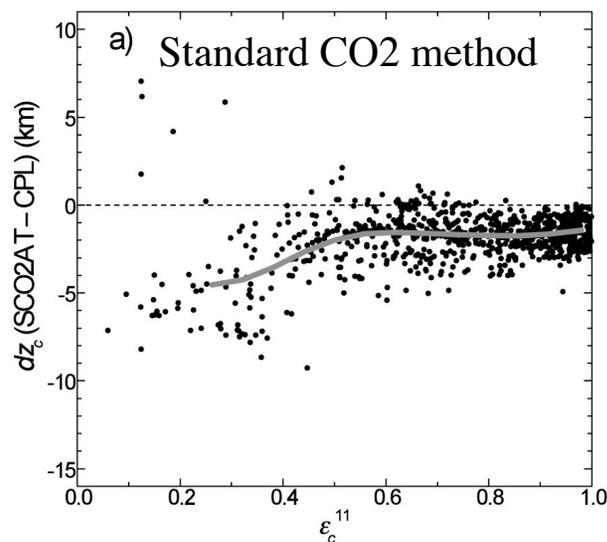
Cloud Height Validation

- VISST GOES-10, TC4 Field Experiment, Aug 8, 2007



GOES-12 vs. ER-2 CPL **Single-layer** Ice-Cloud Top Heights, (TC4 Jul-Aug 07)

- New CO2 method yields more accurate cloud top heights for all cloud optical depths compared to old technique
- Errors grow for $\epsilon < 0.4$
- Revised VISST yields much smaller errors than older version, especially for optically thick clouds



Cloud emissivity from CO2 method

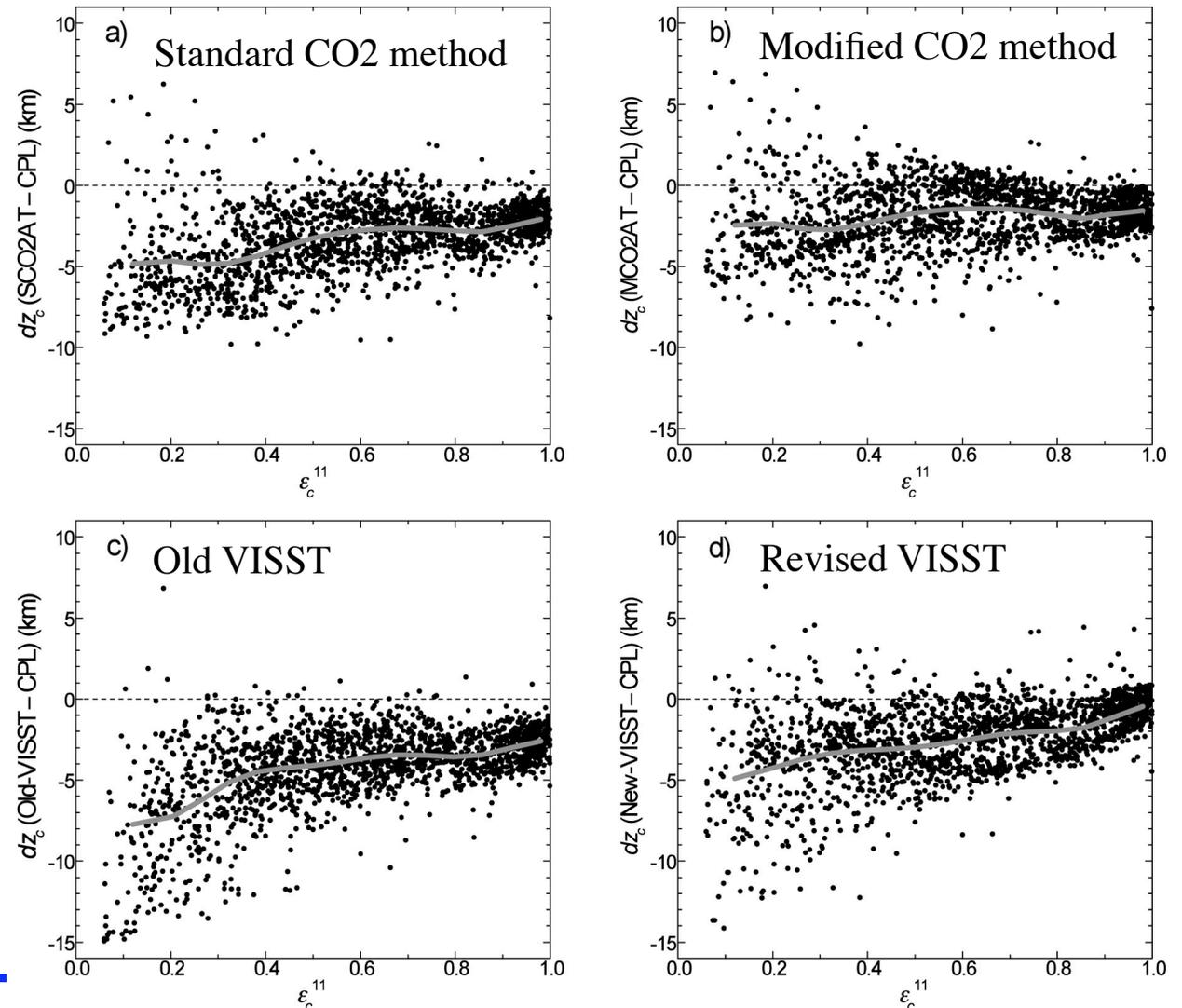


GOES-12 vs. ER-2 CPL **Two-layer** Ice-Cloud Top Heights, (TC4 Jul-Aug 07)

- New CO2 method (MCO2AT) yields more accurate cloud top heights for all cloud optical depths compared to old technique, not as good as single-layer

- Revised VISST yields smaller errors than older version, especially for optically thick clouds

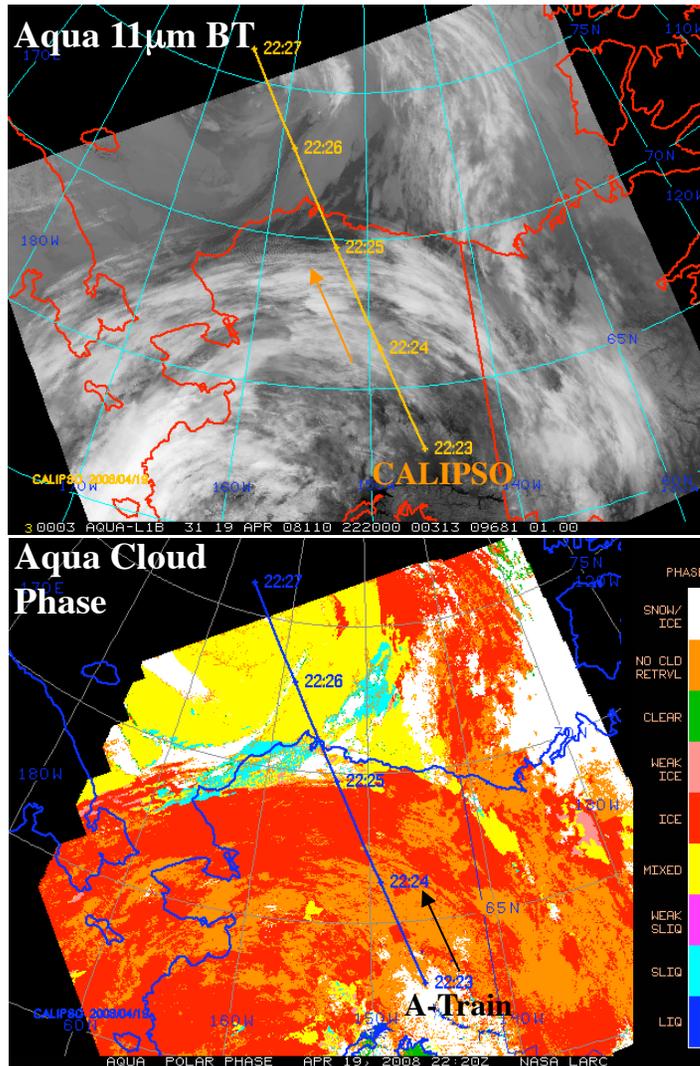
MCO2AT & revised VISST will be used in ARM retrievals



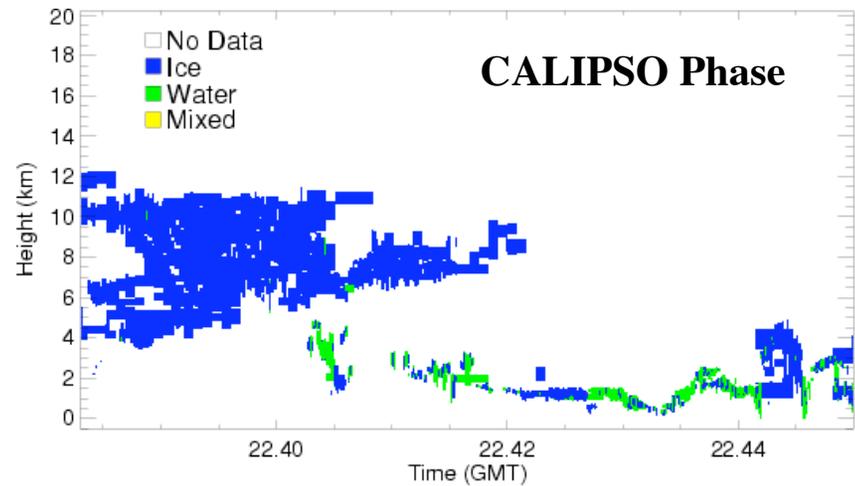
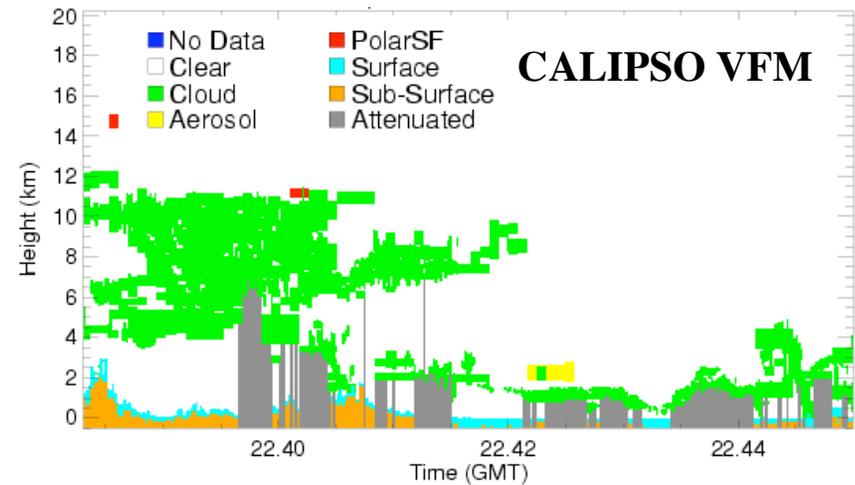
Cloud emissivity from CO2 method



Polar Validation



ISDAC Cloud Analysis, 22:25 UTC Apr 19, 2008

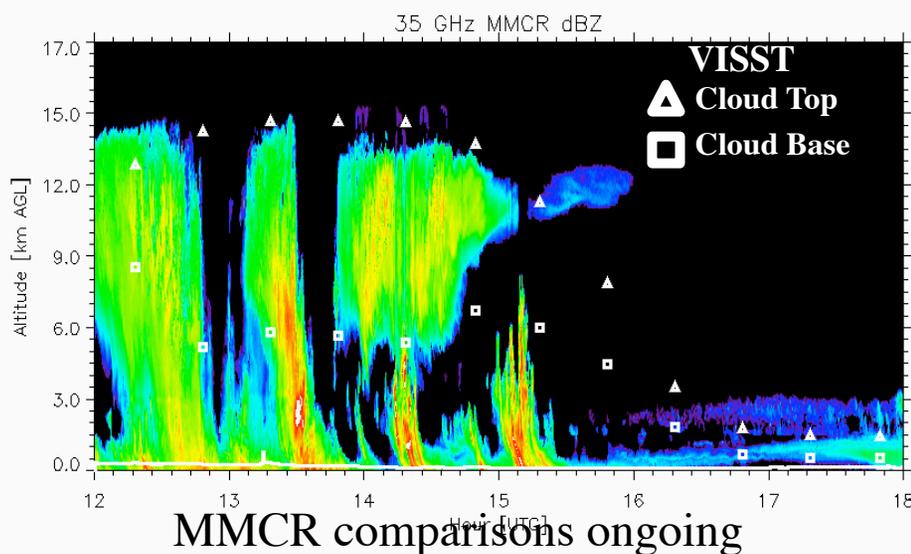


- Comparisons have just begun
- Will compare with flight data also

Cloud Base Validation, ARM & ASOS

VISST Cloud Base vs. National Weather Service Automated Surface Observing System (ASOS) Over the Central USA: June-July 2009

VISST Cloud Thickness & SGP Millimeter Cloud Radar



	RMS Error (km)	Bias (km) Positive Values Indicate VISST Base Higher Than ASOS	Number of Matches
Original Water Cloud Base	1.10	.06	13024
New Water Cloud Base	0.99	-.14	13024
Original Ice Cloud Base	4.81	4.45	8947
New Ice Cloud Base	3.13	2.43	8947

- ASOS RMS errors reduced with new technique, as accurate as Ztop
- Precipitating ice clouds not removed in ASOS dataset
 - precip clouds not included in parameterization



- **Web Page for information & data access:**

<http://www-pm.larc.nasa.gov>

- **Email address for information or questions:**

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NASA Fact

The acronym "NASA" stands for National Aeronautics and Space Administration.

NASA LANGLEY CLOUD AND RADIATION GROUP

Welcome to the NASA Langley Cloud and Radiation Group Home Page
(Principal Investigator: Patrick Minnis)

Recent Field Experiments: [AMF-Azores](#) [FRAM-S](#) [VOCALS](#) [AMF-China](#) [TC4](#)

Swiss Cheese Clouds Produced by Aircraft Over Texas



NASA Langley

Future Work

- **TWP-ICE: Reprocess cloud product data once new calibration & narrowband to broadband fits available**
 - **revise all ARM domain products over time**
- **Improve cloud thickness parameterizations**
- **Improve Multilayer low-layer cloud retrievals**
- **Develop parameterizations to distribute cloud water, particle size with altitude in the cloud**
 - IWP to IWC(z) LWP \rightarrow LWC(z)
 - Deff \rightarrow Deff(z) Reff \rightarrow Reff(z)
- **Examine use of BT6.7-11 μ m data to detect thin cirrus over convection/ anvils & estimate cloud optical depth at night**
- **Work with modelers to provide the products you need**



NASA/Langley Satellite-derived TWP Cloud & Radiative Properties

- ❑ Improved MTSAT vis cal now available for 2007-on (Doelling, Minnis et al)
- ❑ New NB-BB fits are being derived for 2007 dry/wet seasons over Darwin area; wet season LW bias 0.5 W/m^2 (9.1 W/m^2 RMS); SW bias -2.7 W/m^2 (RMS 30.6 W/m^2)
- ❑ VISST processing of MTSAT data over TWP domain for 2007 will be commenced, using updated vis cal and NB-BB fits, as soon as possible
 - ❑ Still more work on MTSAT visible calibration needed for earlier periods, including TWPICE
- ❑ Visit website (<http://www-pm.larc.nasa.gov>) for more information on TWP VISST

