

Overview of NASA-LaRC TWP-ICE Satellite Products

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TWP-ICE Workshop

November 13-15, 2006

NASA Langley Research Center / Climate Sciences



Introduction

- Daytime: Visible Infrared Solar-infrared Split-Window Technique (VISST)
 - 4 channel iterative model-matching method (0.65, 3.9, 11 and 12 μm)
- Nighttime: Solar-infrared Infrared Split-Window Technique (SIST)
 - 3 channel iterative model-matching method (3.9, 11 and 12 μm)
- Processing MTSAT-1R, FY2-C, *Aqua & Terra* MODIS, NOAA-15/16/17/18
- Retrieves cloud and radiative properties at nominal resolution of 4km
 - clouds: single-layer VISST, multilayer VISST via CO2 slicing, BTD, and MWR
 - radiation: TOA & surface fluxes via NB-BB
- Pixel and Grid-level data available from <http://www-pm.larc.nasa.gov>
- Initial results in TWP-ICE archive, update very soon



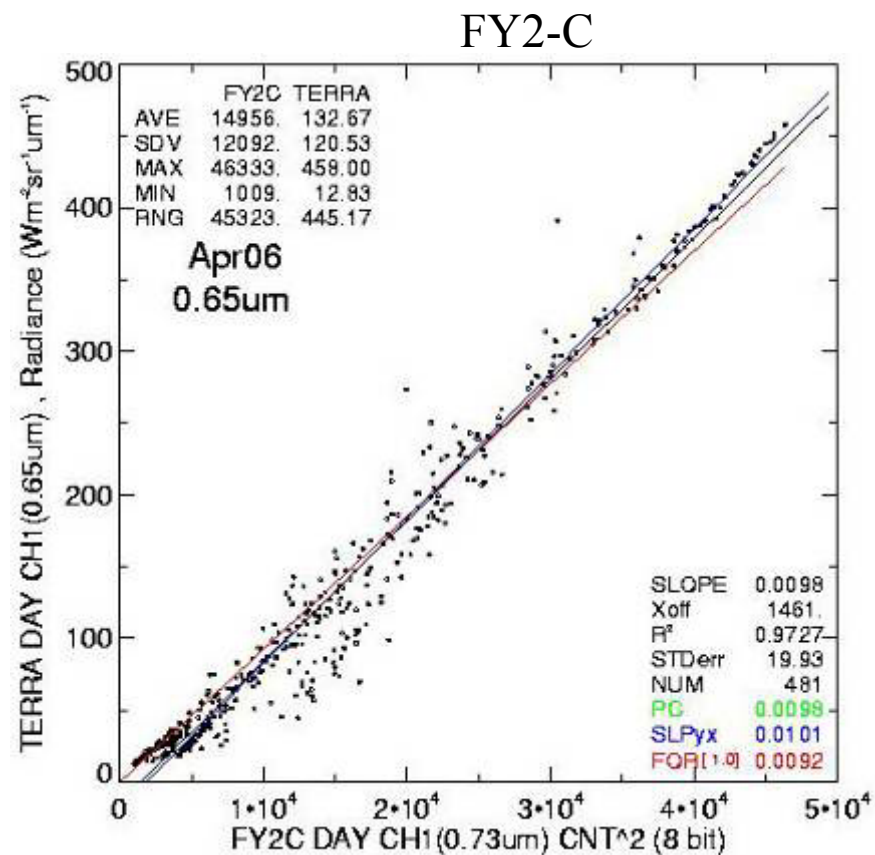
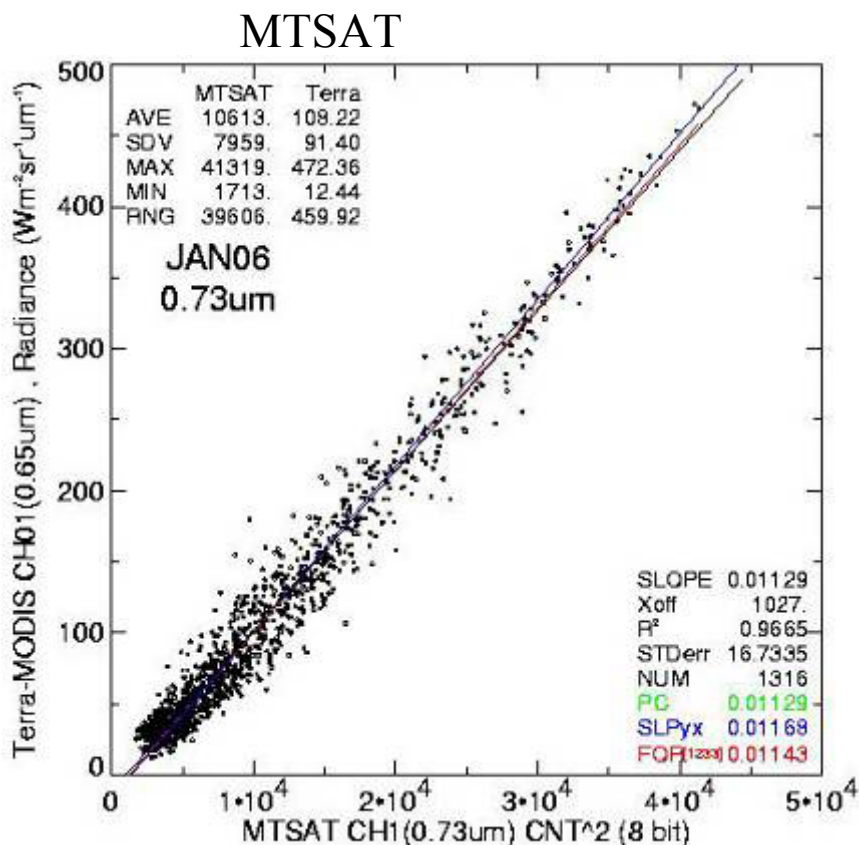
Cloud Products

- Pixel-Level
 - Retrieved at instrument pixel resolution
 - Each pixel is assigned a phase (clear, water, ice, or super-cooled water)
 - Cloud microphysical properties are derived from the pixel radiances
- Gridded
 - Properties are calculated either by phase and/or by cloud height (low, mid, high, or total)
 - Products over the TWP-ICE domain calculated on a $0.5^\circ \times 0.5^\circ$ grid
- Surface-Site and Flight Matched
 - Means of pixel-derived quantities whose center locations fall within a 10 or 20-km radius of Darwin site
 - IOP aircraft flight track matched cloud properties derived from weighted average of 4 closest pixels to aircraft coordinates. Spatial standard deviation is based on weighted distribution of closest pixel & 8 surrounding pixels



GEO Calibrations Using Terra MODIS

Visible



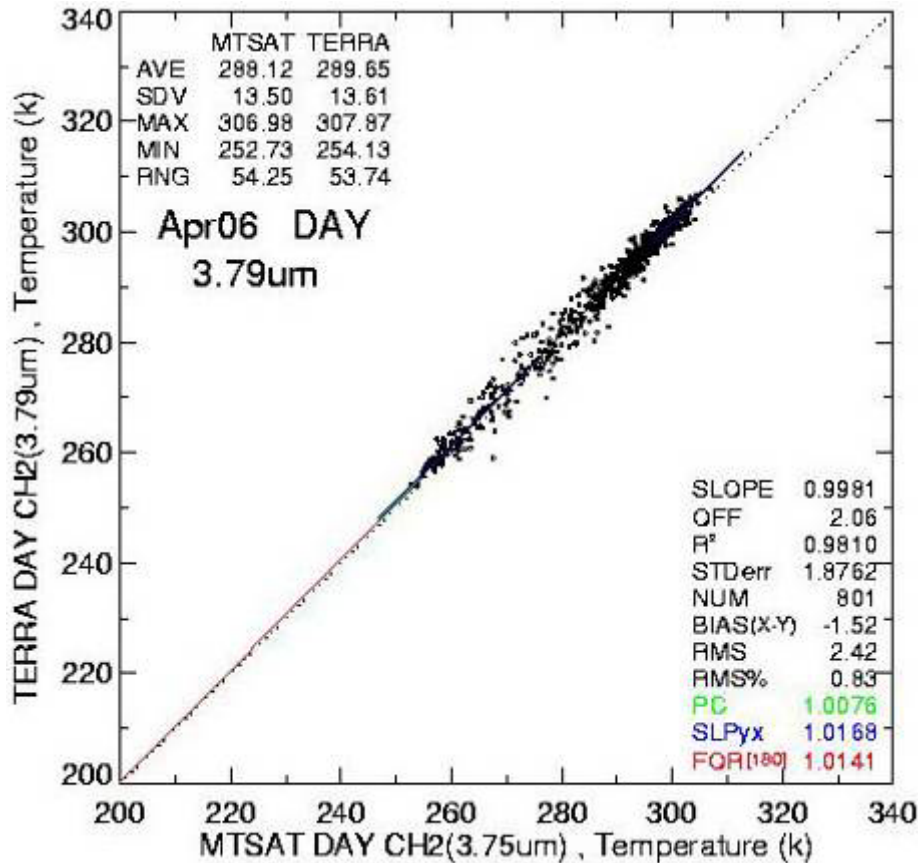
- 0.73- μm channel broader than MODIS 0.64 μm , unresolved spectral differences



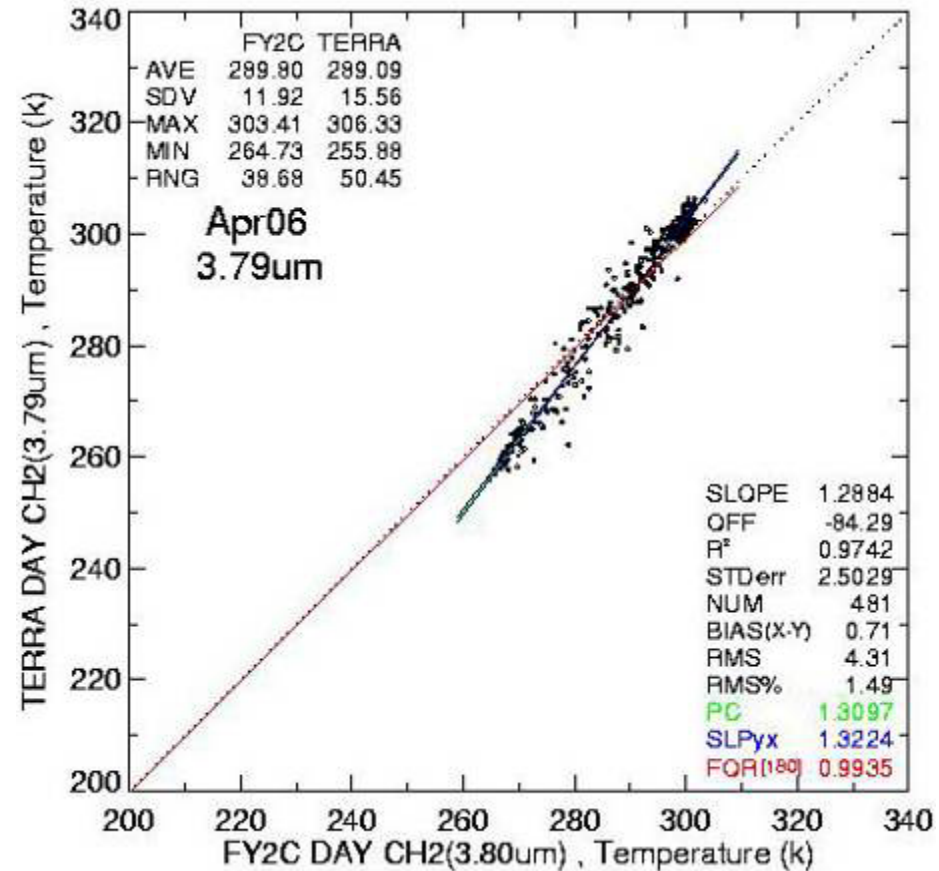
GEO Calibrations Using Terra MODIS

3.75 μm

MTSAT



FY2-C



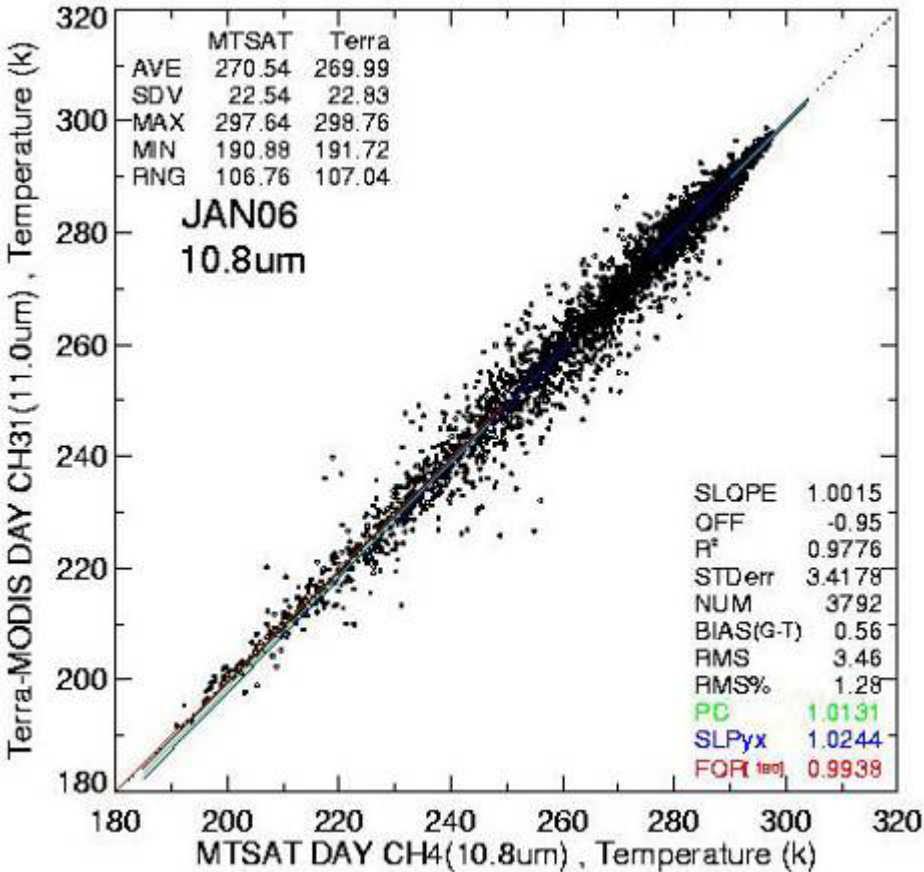
- FY2-C has some dramatic differences that need correction



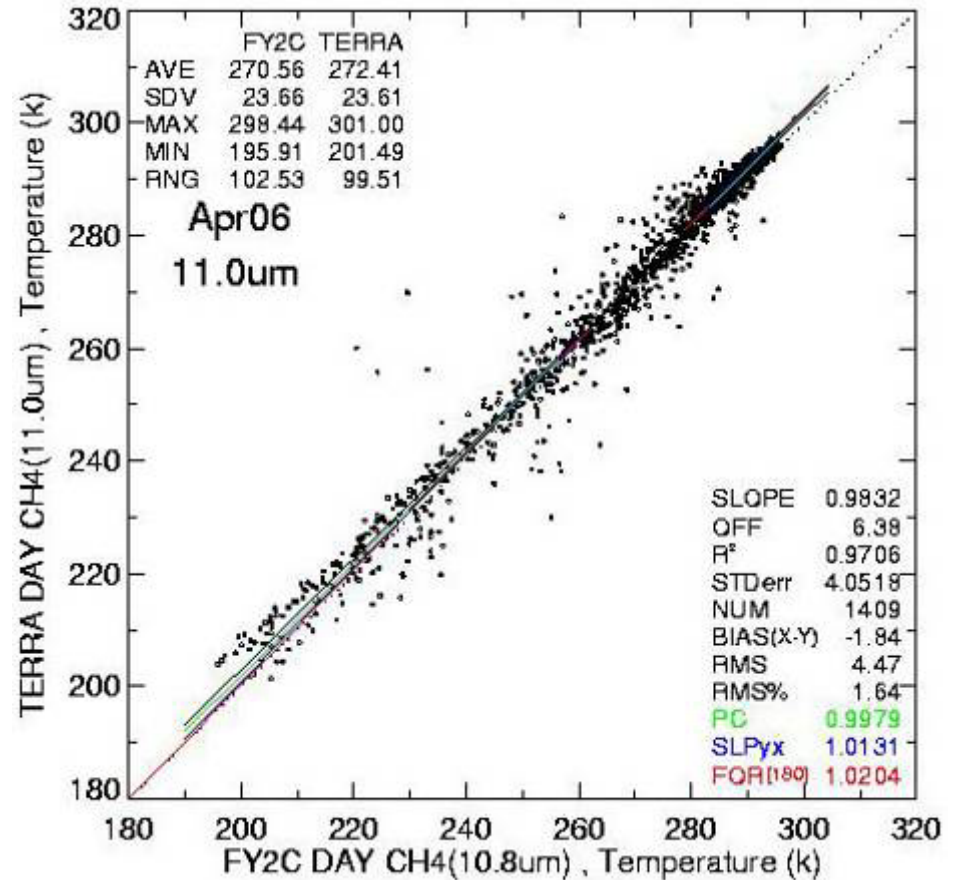
GEO Calibrations Using Terra MODIS

10.8 μm

MTSAT



FY2-C



- MTSAT very close to Terra, FY2-C a little cooler, noisier



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VISST Pixel-Level Cloud Products

0.65 μm Reflectance	Skin Temperature
1.6 μm Reflectance	Cloud Optical Depth
3.7 μm Temperature	Particle Effective Radius/Diameter
6.7 μm Temperature	Liquid/Ice Water Path
10.8 μm Temperature	Cloud Effective Temperature
12 or 13.3 μm Temperature	Cloud Top Pressure
Broadband Albedo	Cloud Effective Pressure
Broadband LW Flux	Cloud Base Pressure
Infrared Emittance	Cloud Top Height
Cloud Mask	Cloud Effective Height
Cloud Phase	Cloud Base Height
Pixel Latitude	Pixel Longitude



VISST Grid-Level Cloud Products

By Cloud Type (liquid, ice, slw, total)	By Cloud Level(low, mid, high, total) *
Cloud Fraction	Cloud Fraction
Cloud Temperature & VIS Reflectance	Cloud Temperature (T, C, B)
Optical Depth (linear and log)	Optical Depth (linear and log)
Cloud Height & Pressure (T, C, B)	Cloud Pressure (T, C, B)
Particle Effective Radius/Diameter	Cloud Height (T, C, B)
Liquid/Ice Water Path	For all Grids
3.7 μm & 10.8 μm Temperatures	Base time, Scan time
Broadband SW Albedo, LW Flux*	VZA, SZA, RAZ
LW & SW Surface Flux	Grid Latitude and Longitude
Infrared Emittance	Clear-Sky 10.8 μm Temperature
* Improved	Clear-Sky Visible Reflectance
* New	

* LBTM Continuity



NASA Langley Satellite Support Website

Tropical Warm Pool International Cloud Experiment (TWP-ICE)

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Real-time Imagery

[-MTSAT -FY2C](#)

[-MTSAT/FY2C](#)

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Real-time Products

[-MTSAT -FY2C](#)

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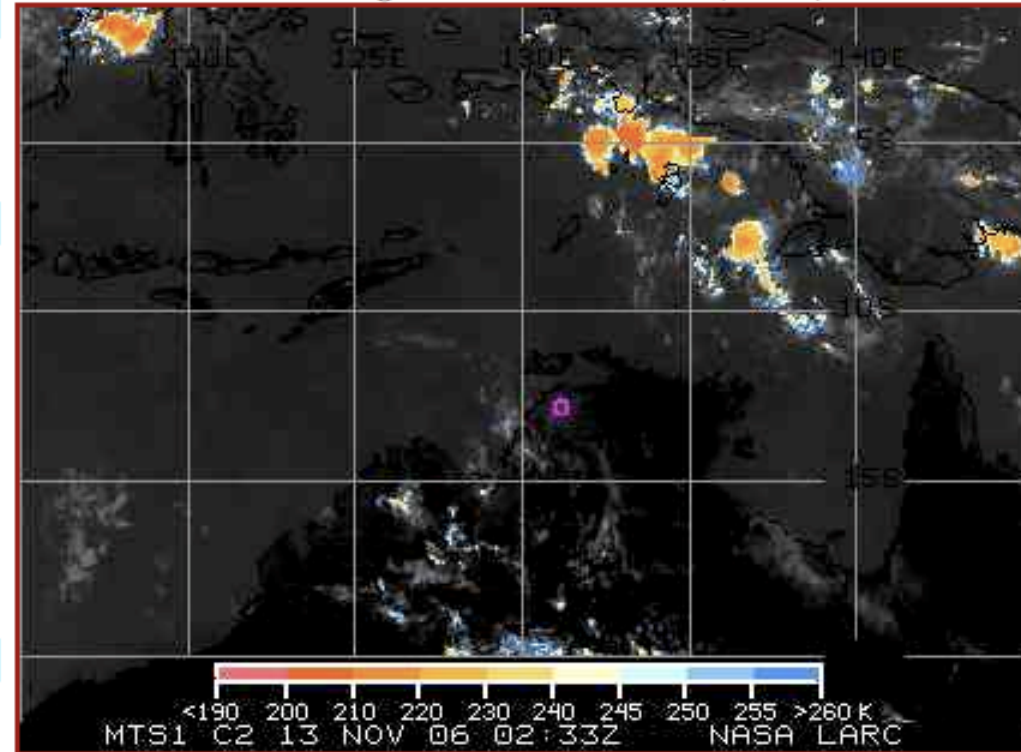
Flight Track Overlay

[-All Aircraft](#)

Flight Track Matched

[-All Aircraft vs
MTSAT-1R](#)

Current MTSAT IR Image Taken on 2006317 (11/13) 0233 UTC



Quick links to latest image: [MTSAT IR](#), [MTSAT VIS](#),
[MTSAT 1km VIS](#), [FY2C IR](#), [FY2C VIS](#), [FY2C 1km VIS](#),



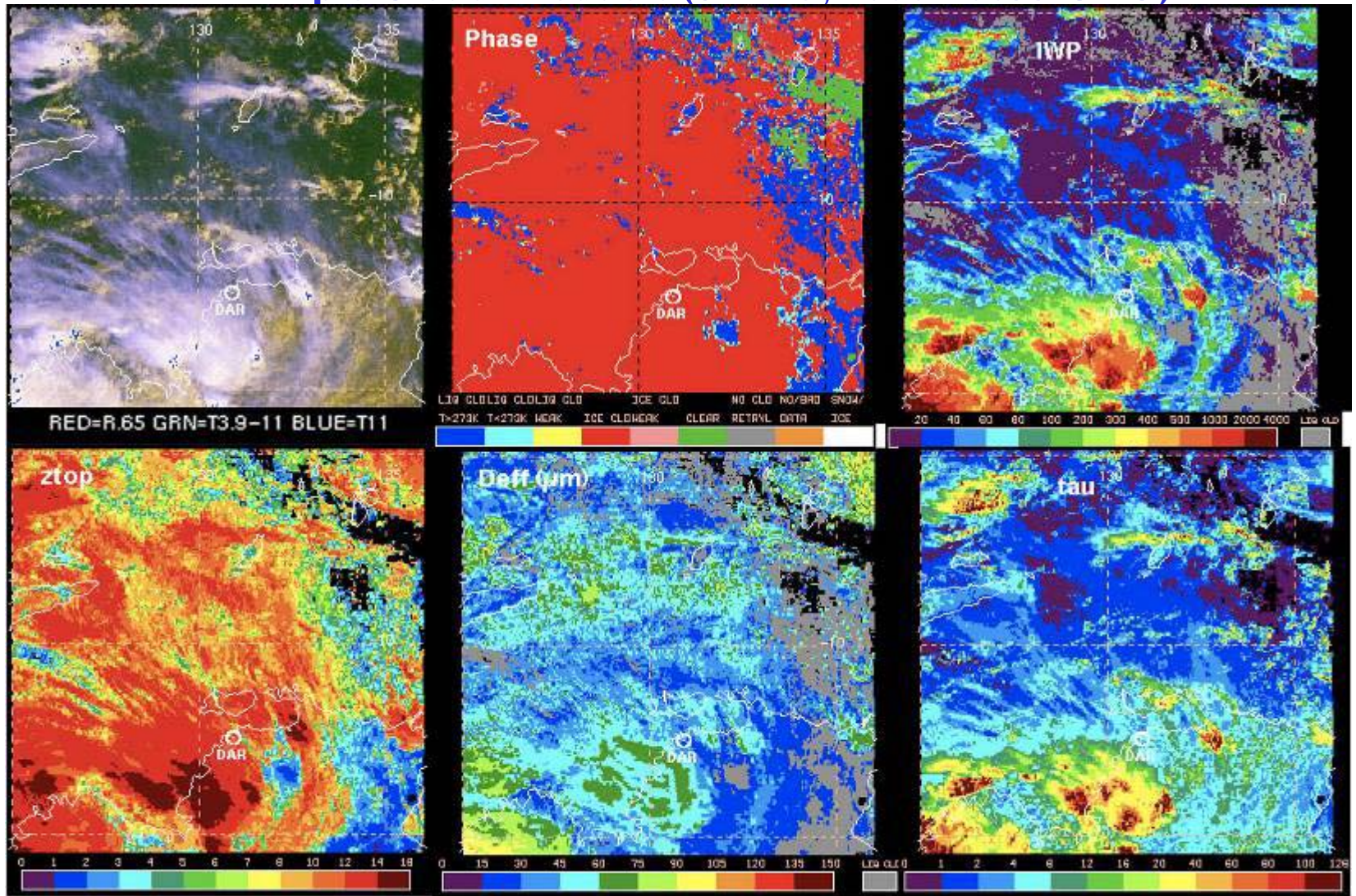
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Example Cloud Products (Jan 25, 2006 - 0033 UTC)



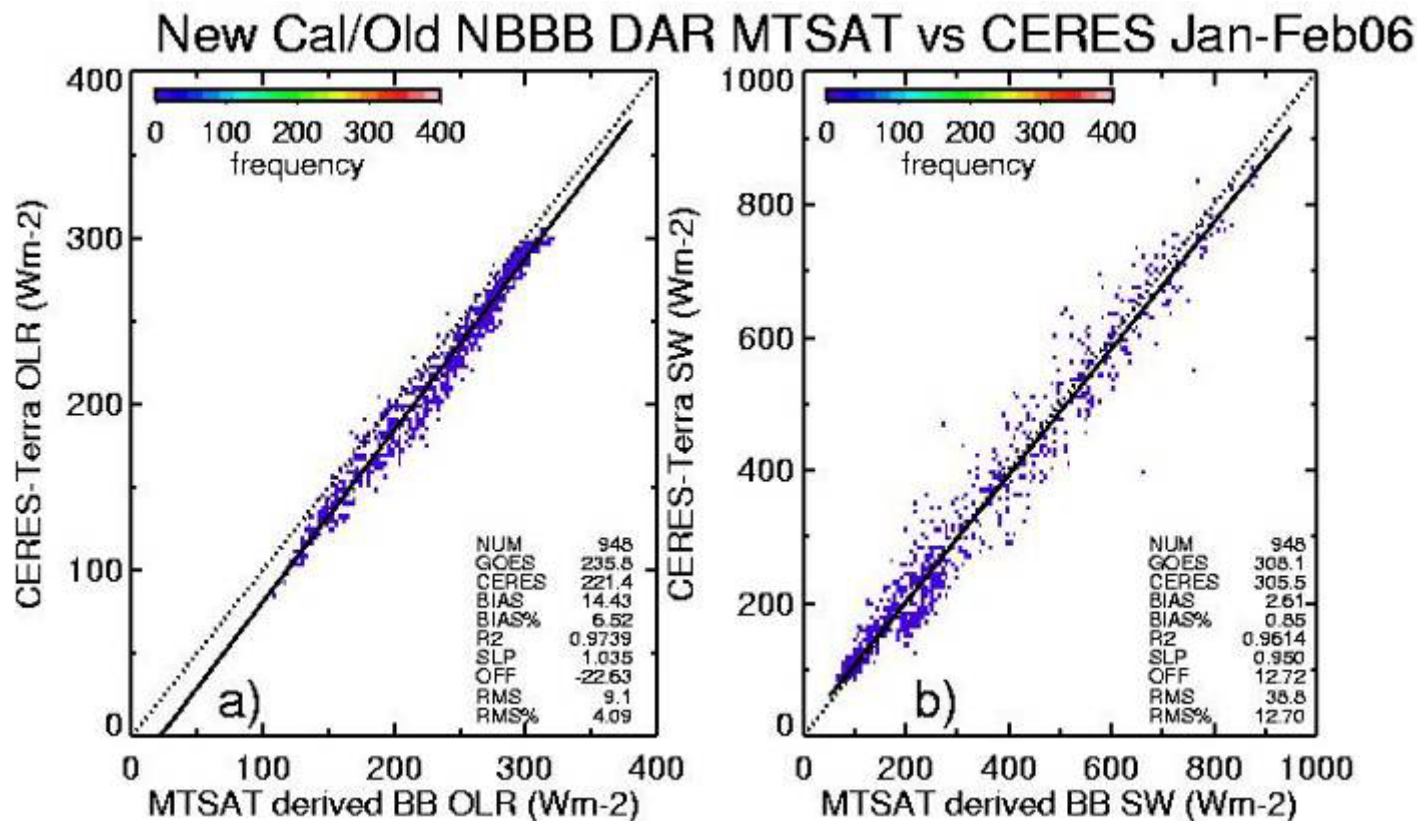
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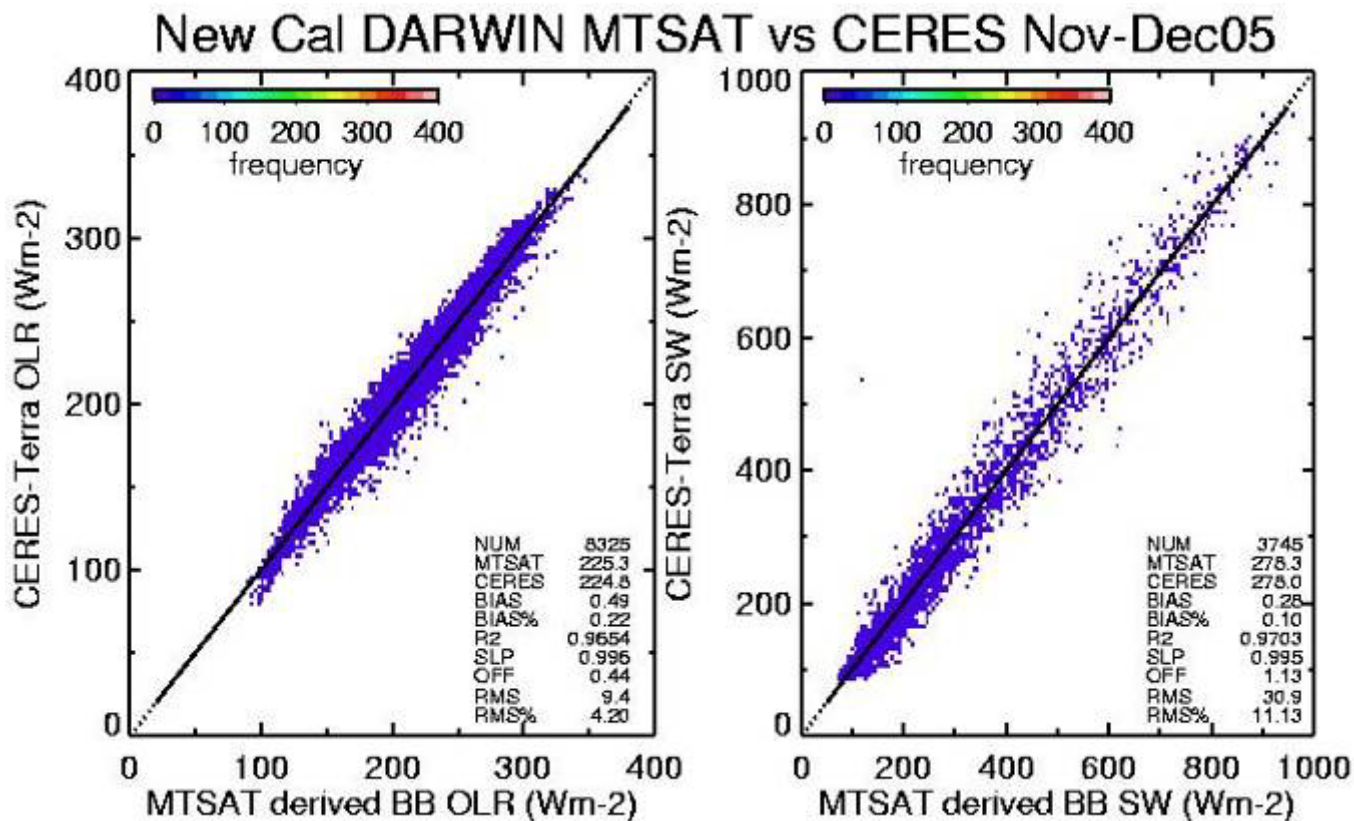
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Initial Archive Data Had Biased OLR



Next Edition: Unbiased TOA Radiation



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Tropical Warm Pool International Cloud Experiment (TWP-ICE)

Aircraft Flight Track Overlay MTSAT Imagery

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Flight Track Overlay

[-All Aircraft](#)

Flight Track Matched

[-All Aircraft vs](#)

[MTSAT-IR](#)

Select a flight day.

Jan 2006						
Su	Mo	Tu	We	Th	Fr	Sa
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Feb 2005						
Su	Mo	Tu	We	Th	Fr	Sa
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18



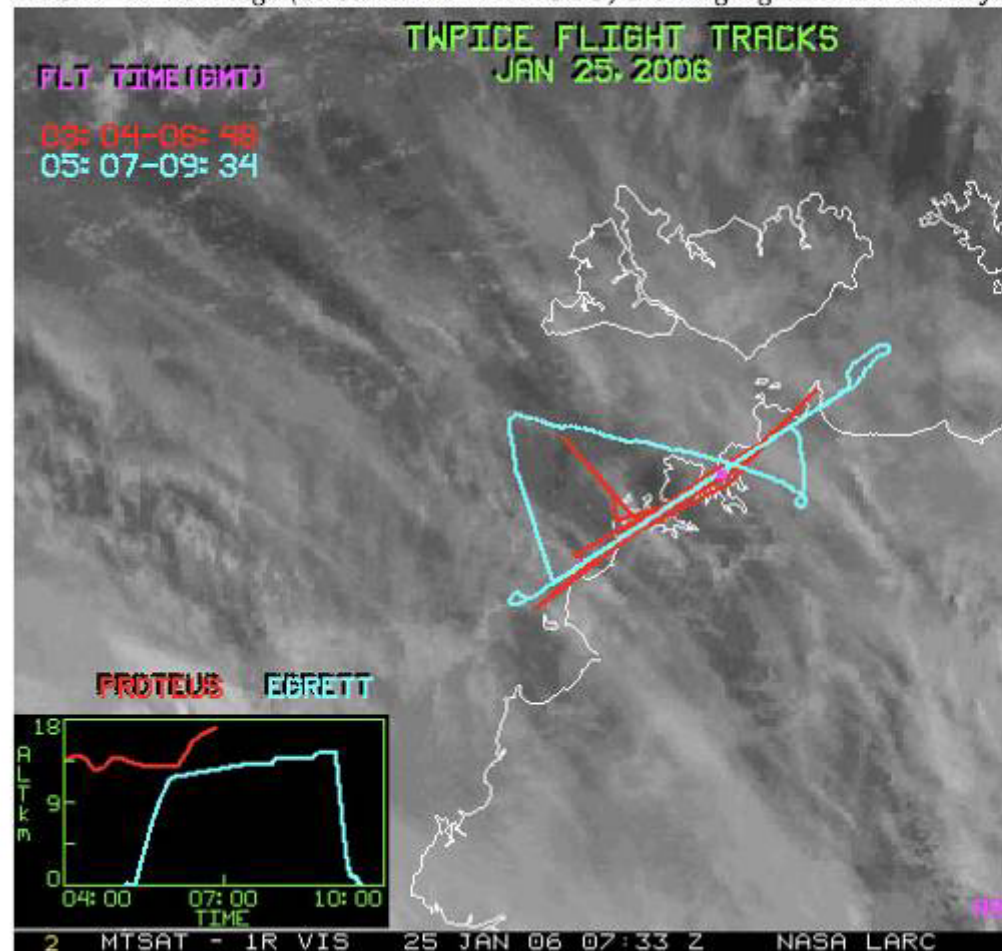
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MTSAT-1R vis image (25 Jan 2006 07:33 UTC) showing Egrett and Proteus flight tracks



Egrett tracks on [visible](#) and [infrared](#) image.

Proteus tracks on [visible](#) and [infrared](#) image.

- **Egrett Flight Track overlaid on MTSAT-1R satellite**
 - JavaScript Loop: [Visible](#), [Infrared](#)
 - Animated GIF Loop: [Visible](#), [Infrared](#)
 - VIS image: [05:33](#), [08:33](#), [09:33](#)
 - IR image: [05:33](#), [08:33](#), [09:33](#)
- **Proteus Flight Track overlaid on MTSAT-1R satellite**
 - JavaScript Loop: [Visible](#), [Infrared](#)
 - Animated GIF Loop: [Visible](#), [Infrared](#)
 - VIS image: [03:33](#), [04:33](#), [05:33](#), [06:33](#)
 - IR image: [03:33](#), [04:33](#), [05:33](#), [06:33](#)
- **Aircraft Navigation Data:**
 - [Proteus](#)
 - [Egret](#)



NASA Langley Satellite Support Website Tropical Warm Pool International Cloud Experiment (TWP-ICE)

MTSAT-1R/FY2C VISST Derived Cloud Products Along The Aircraft Flight Path Over Darwin

MTSAT-1R/FY2C VISST Derived Cloud Products are computed from the individual aircraft navigation files, where the cloud retrieval parameter is based on the weighted average of the 4 closest (4km) pixels of satellite image to the aircraft coordinates. The (spatial) standard deviation is based on a weighted distribution of the closest pixel and the 8 surrounding pixels.

Select 4 Cloud Parameters	Sigma Plot	Aircraft / Satellite	Flight Days	Start Hour	End Hour
Cloud Optical Depth <input type="text"/>	yes <input checked="" type="radio"/> no <input type="radio"/>	Proteus <input type="text"/>	Jan-25-2006 <input type="text"/>	00.0 <input type="text"/>	24.0 <input type="text"/>
Effective Ice Diameter <input type="text"/>	yes <input checked="" type="radio"/> no <input type="radio"/>	MTSAT-1R <input type="text"/>			
Cloud Top Height <input type="text"/>	yes <input checked="" type="radio"/> no <input type="radio"/>	<input type="button" value="PLOT"/>			
Ice Water Path <input type="text"/>	yes <input checked="" type="radio"/> no <input type="radio"/>				

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Real-time Imagery

[-MTSAT -FY2C](#)

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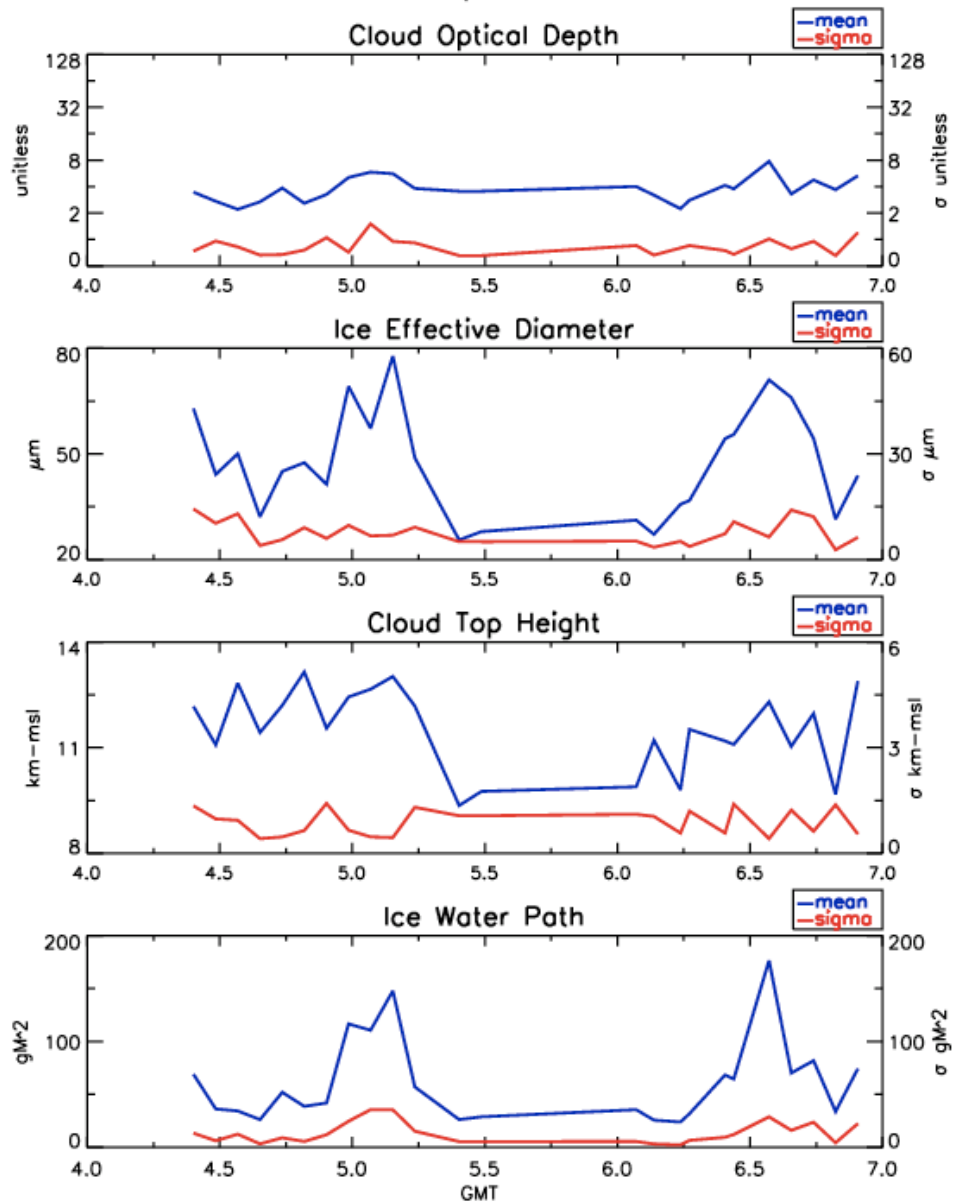
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NASA-Langley MTSAT-1R VISST Derived Cloud Products
PROTEUS Matched, 25 JANUARY 2006



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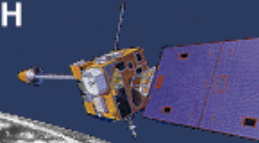
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NASA LANGLEY CLOUD AND RADIATION RESEARCH

(Minnis Group)



Ground Site Data for ARM-TWP Darwin

Site Center Latitude: 12.43° S
Site Center Longitude: 131.35° E

2003	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2004	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2005	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2006	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Oct	Nov	Dec



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MTSAT-1R VISST Derived Cloud Products For ARM-TWP DARWIN Site

MTSAT-1R VISST derived Cloud Products are computed from the individual pixel retrievals from half hourly MTSAT-1R images. The cloud product means and standard deviations are computed from the pixels within both a **10 km (30 pixels)** and **20 km (110 pixels)** radius centered on the ARM-TWP DARWIN site.

Select up to 4 Cloud Products	Line 1 Select Type / Radius	Line 2 (<i>optional</i>) Select Product / Type / Radius	
1- Cloud Product ▾	Type ▾ 20 km ▾	Cloud Product ▾	Type ▾ 20 km ▾
2- Cloud Product ▾	Type ▾ 20 km ▾	Cloud Product ▾	Type ▾ 20 km ▾
3- Cloud Product ▾	Type ▾ 20 km ▾	Cloud Product ▾	Type ▾ 20 km ▾
4- Cloud Product ▾	Type ▾ 20 km ▾	Cloud Product ▾	Type ▾ 20 km ▾
January 2006 Start Day <input type="text" value="01"/> ▾ End Day <input type="text" value="30"/> ▾		<input type="button" value="Plot"/>	

Using the data version of Jan 2006



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In addition to plots...

ASCII Option

YYYYDDD (julday)	IMG-GMT (hhmmss)	SITE-GMT (fra-dy)	TAU-ln cloud mean 10km (--)	TAU-ln cloud mean 20km (--)	D-eff ice mean 20km (um)	R-eff liquid mean 20km (um)	Z-top cloud mean 20km (km-msl)	Z-bot cloud mean 20km (km-msl)	IWP ice mean 20km (gm-2)	LWP liquid mean 20km (gm-2)
2006025	3300	25.0345	5.2900	4.6300	36.5700	-99.0000	11.4600	8.7200	50.8300	-99.0000
2006025	13300	25.0761	5.3500	5.7000	33.3900	-99.0000	11.5600	8.5700	57.1100	-99.0000
2006025	23300	25.1178	4.5300	5.2400	34.1800	-99.0000	11.9300	8.9100	56.3900	-99.0000
2006025	33300	25.1595	4.6000	5.1600	31.0100	-99.0000	11.8600	8.9100	49.0100	-99.0000
2006025	43300	25.2011	5.1500	4.5200	32.2500	-99.0000	11.5700	8.8400	42.7100	-99.0000
2006025	53300	25.2430	4.1700	4.2400	27.8000	-99.0000	10.5700	8.2600	35.1100	-99.0000
2006025	63300	25.2845	8.2100	6.2500	37.1600	-99.0000	12.7900	9.3200	72.0900	-99.0000
2006025	73300	25.3261	3.3500	3.9300	34.5100	-99.0000	12.4000	9.5800	44.9100	-99.0000
2006025	83300	25.3680	3.4000	3.3700	34.1200	9.9400	10.7600	9.2600	27.6200	23.3700
2006025	93300	25.4094	2.0800	2.0900	93.5600	-99.0000	14.9800	12.0300	64.2900	-99.0000
2006025	103300	25.4511	2.9600	2.4700	104.2700	-99.0000	13.9300	11.0700	89.0000	-99.0000
2006025	113300	25.4930	1.9400	2.0700	108.7700	-99.0000	13.8500	11.1900	78.3200	-99.0000
2006025	123300	25.5345	2.5900	1.8900	91.8600	-99.0000	13.8000	11.2800	58.6800	-99.0000
2006025	133300	25.5761	1.0900	1.2300	69.1300	-99.0000	15.3700	12.8200	35.8500	-99.0000
2006025	143300	25.6178	3.6500	2.8900	102.0000	-99.0000	14.7600	11.5200	121.0000	-99.0000
2006025	153300	25.6596	2.5800	2.5200	104.7300	-99.0000	14.3800	11.3700	91.5900	-99.0000
2006025	163300	25.7013	1.9900	1.5700	103.4000	-99.0000	14.9700	12.2700	63.8200	-99.0000
2006025	173300	25.7428	2.2400	2.0600	94.4600	-99.0000	14.4200	11.5700	65.8400	-99.0000
2006025	183300	25.7845	1.3600	1.2700	118.4900	-99.0000	15.6500	12.9900	54.0700	-99.0000
2006025	193300	25.8261	1.5100	1.3400	117.1800	-99.0000	15.7400	13.0300	59.0800	-99.0000
2006025	203300	25.8678	1.5800	1.3900	124.2700	-99.0000	15.5600	12.8500	62.9000	-99.0000
2006025	213300	25.9095	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
2006025	223300	25.9511	4.7500	3.7500	48.7000	10.7300	6.2500	5.6400	11.0900	92.7700
2006025	233300	25.9929	3.4900	3.7700	22.8300	12.0100	6.7100	5.4700	25.7000	29.6900

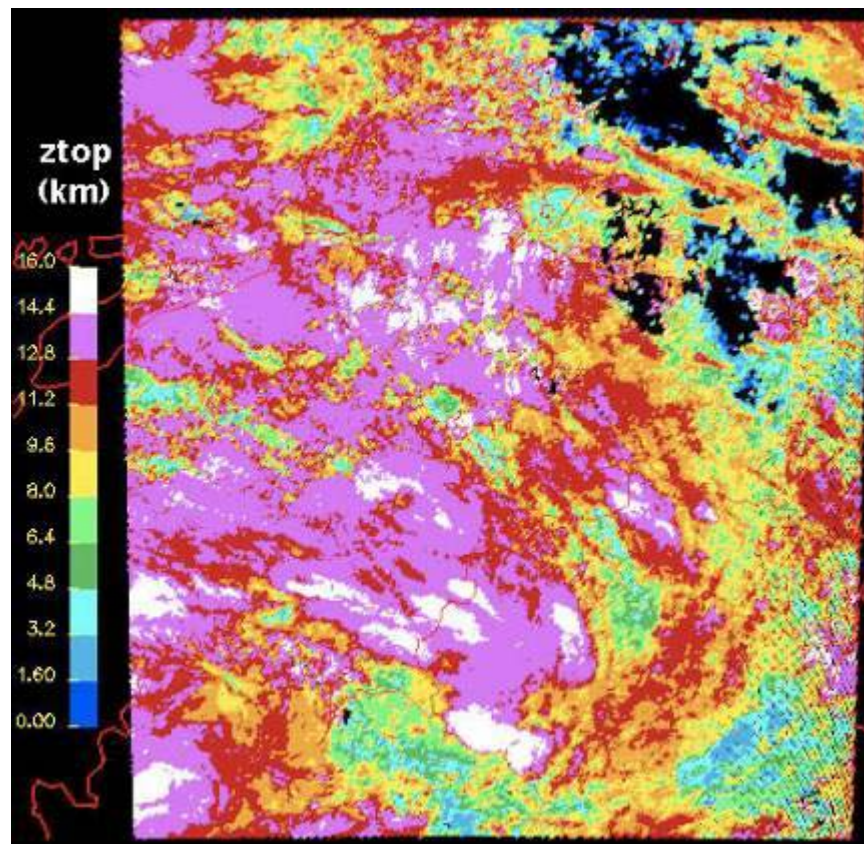
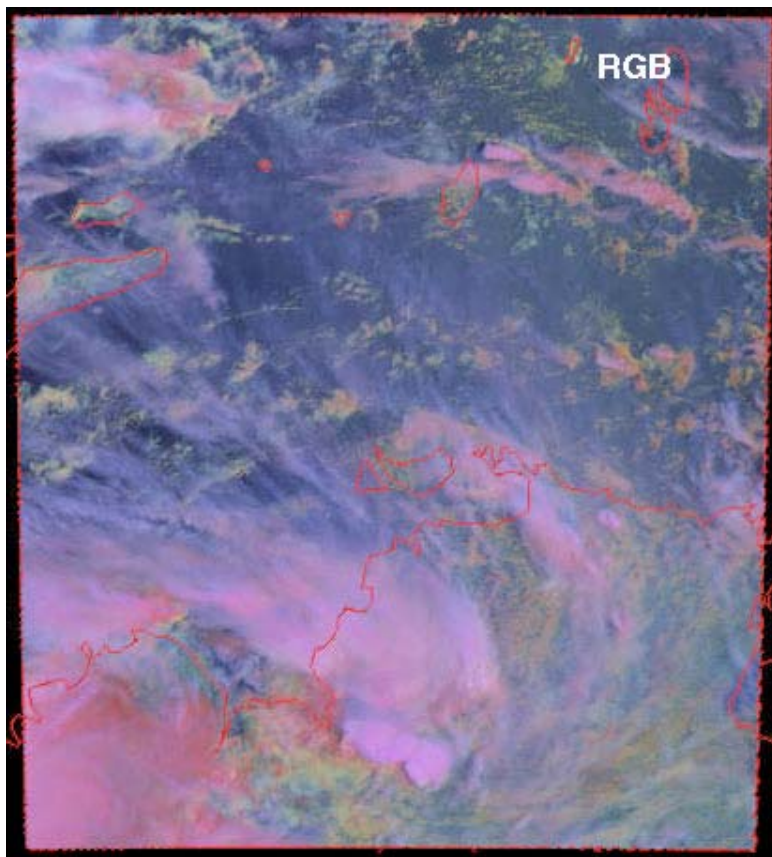


Ongoing Improvements

- **Multilayer Cloud Detection/Retrieval**
 - **CO₂ slicing (*Chang & Li, 2005*), BTD (*Pavlonis & Heidindger, 2004*)**
MCRS (*Minnis et al. 2006*)
- **Improved nighttime retrievals (better masking, surface temp estimates)**
- **Improved twilight cloud mask and retrieved properties**
- **Reprocessing of AVHRR & MODIS retrievals, new TRMM**
- **Updated calibrations**
- **Increased validation with surface, satellite, and aircraft observations**
- **Gridded products including surface & TOA radiation**



Terra MODIS Cloud Properties (Jan 25, 2006 -0130 UTC)



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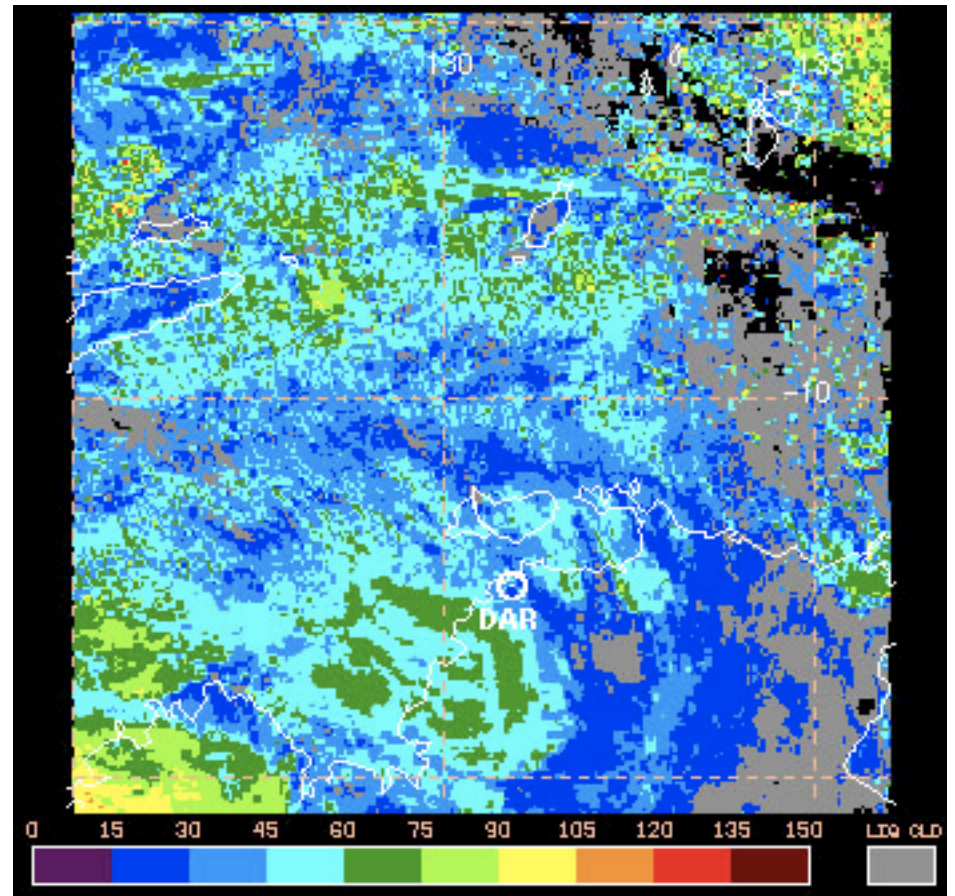
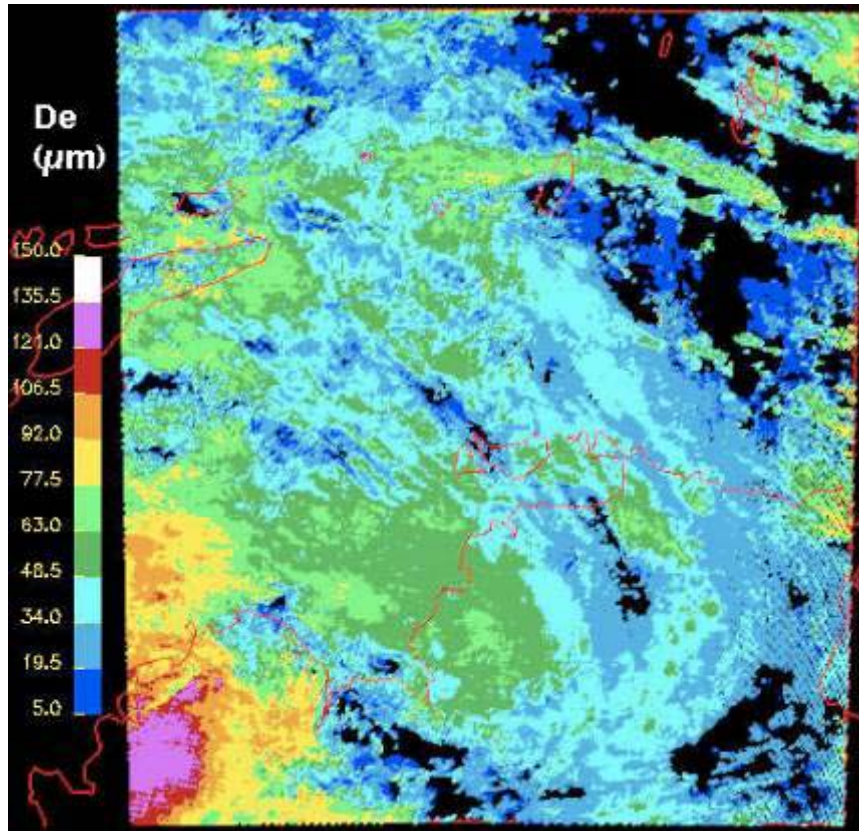


Same Properties from Different Satellites

Example, 25 January 2006, Deff

Terra MODIS 0130 UTC

MTSAT, 0033 UTC



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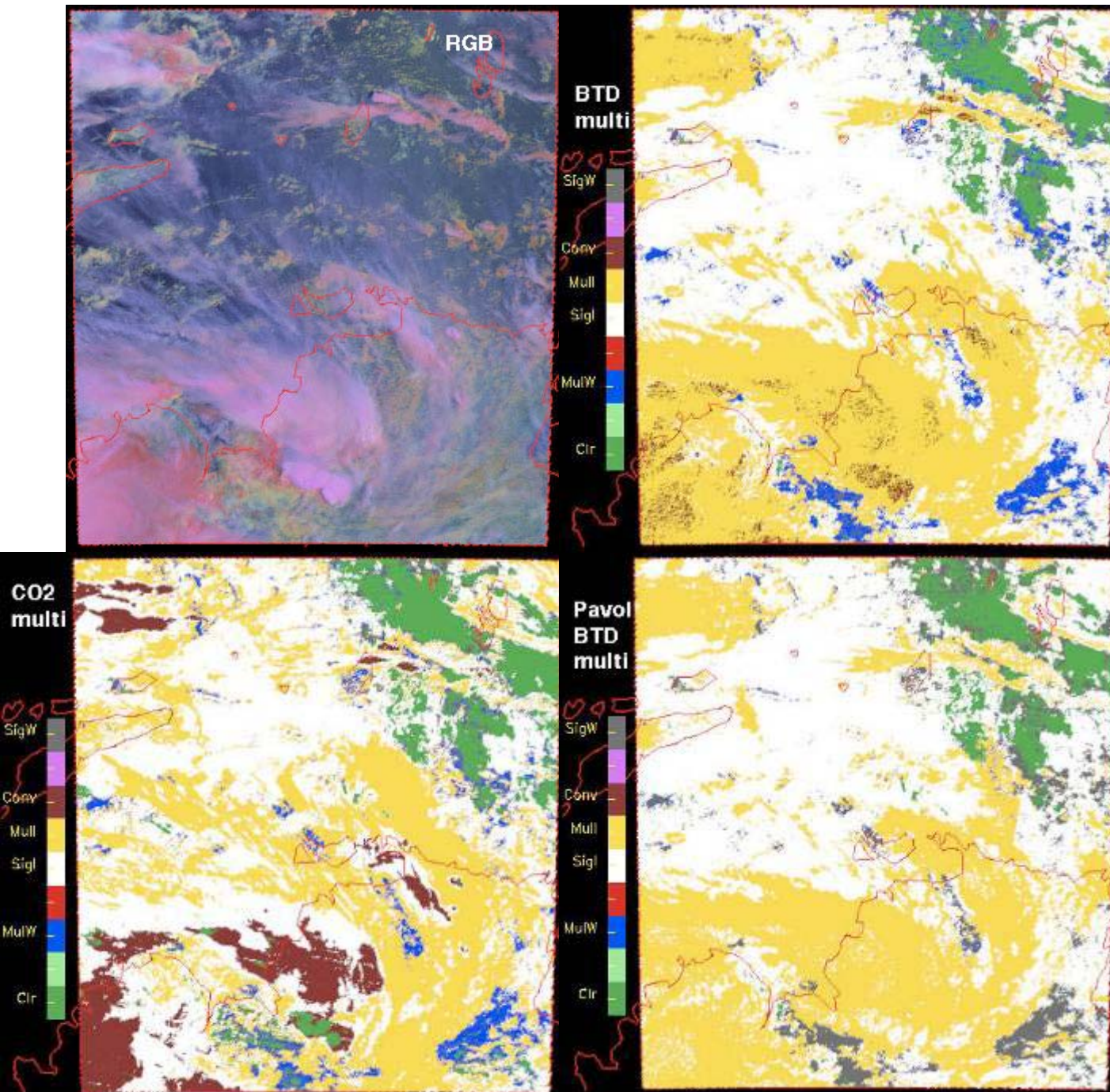
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Multilayer cloud detection

Terra MODIS

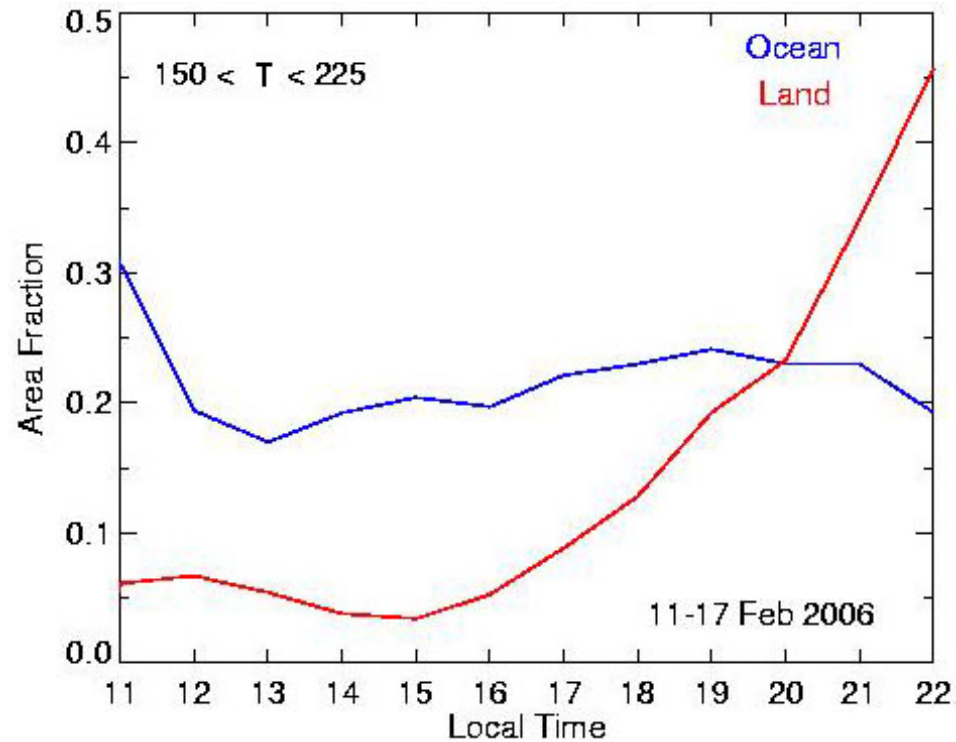
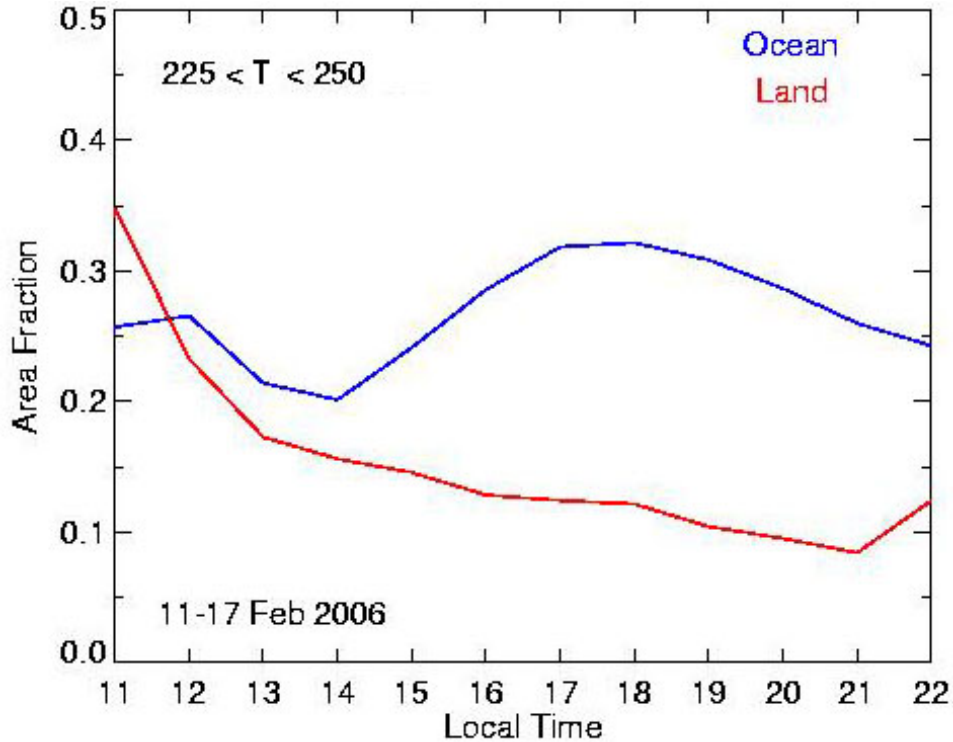
Jan 25, 2006



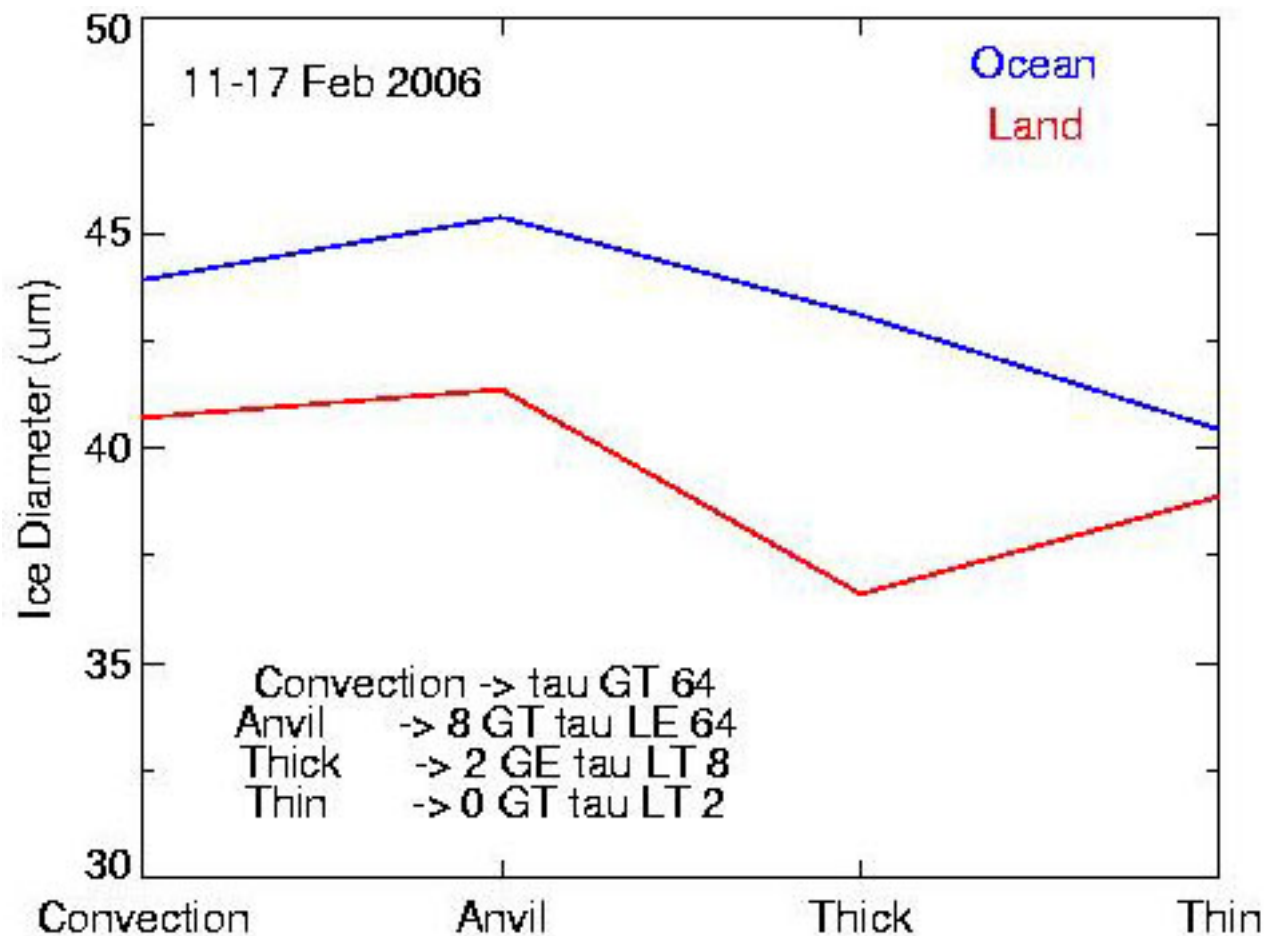
13-15, 2006



Data Uses; e.g., diurnal cycle studies



Data Uses; e.g., cloud characteristics



Summary

- MTSAT & FY2-C hourly data available at pixel & gridded scales (FY2-C???)
 - Reprocessing in next few weeks with latest calibrations and mask
Into the archive before end of Nov
- Initial MODIS & AVHRR products available at website, TRMM VIRS to be processed
- Validation with in situ and remote datasets: need collaboration
- These products will be updated as algorithm improvements (such as multi-layered and mixed phase cloud detection) are implemented
- Several WWW based tools are available to provide easy access to the data and new tools are under development
- Comments, suggestions, and feedback are welcome.
- Please visit www-pm.larc.nasa.gov and click on [Cloud Products and Satellite Imagery](#)

