CRS, the CERES Footprint-scale Surface and Atmosphere Radiation Budget (SARB)

CERES Science Team Meeting (Newport News, 27-29 April 2010)

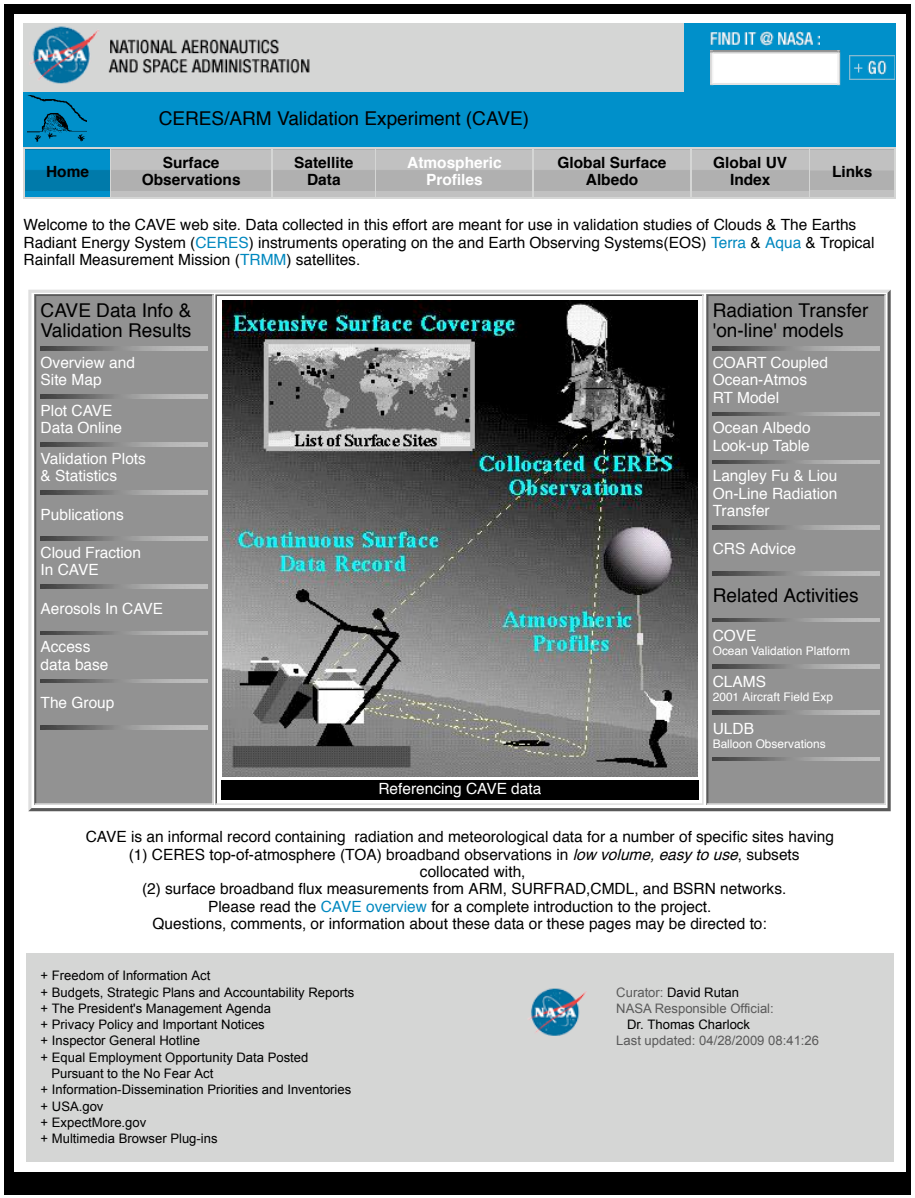
T. P. Charlock (NASA LaRC)
Fred G. Rose (SSAI) - Algorithm development
David A. Rutan (SSAI) - Surface validation with CAVE
David Fillmore (Tech X, Boulder) - MATCH aerosol assimilation
Thomas E. Caldwell (SSAI) - Data Management

Zhonghai Jin (SSAI) – consults on snow grain size retrieval

SARB/SOFA/TISA Working Group Wednesday Morning:

Fillmore - MATCH developments
David Doelling – discussion of new Edition 3 gridded CRS through diurnal cycle
CRS Edition 2G – results with GEOS-5

This presentation: Details on Edition 2 extension and Edition 3 development



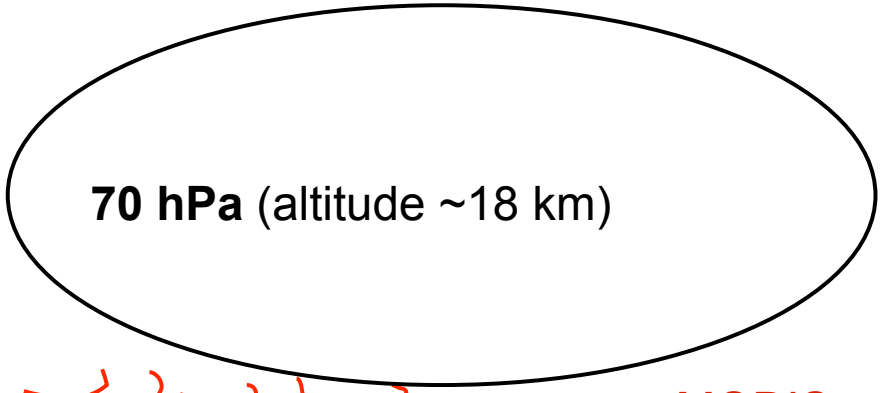
www-cave.larc.nasa.gov/cave/ or google "CERES CAVE"

Easy to use subsets of data, on line radiative transfer, ocean albedo tables…

Ungridded SARB vertical profile at ~2,000,000 CRS footprints/day

Langley Fu-Liou radiative transfer: Kato 2005 SW upgrade, Kratz-Rose LW window

NCEP O3(z)
Mostly from SBUV/2



MINNIS modis

GSFC NWP

GEOS4 T(z), q(z), surface wind
Jin ocean surface albedo = f(wind)

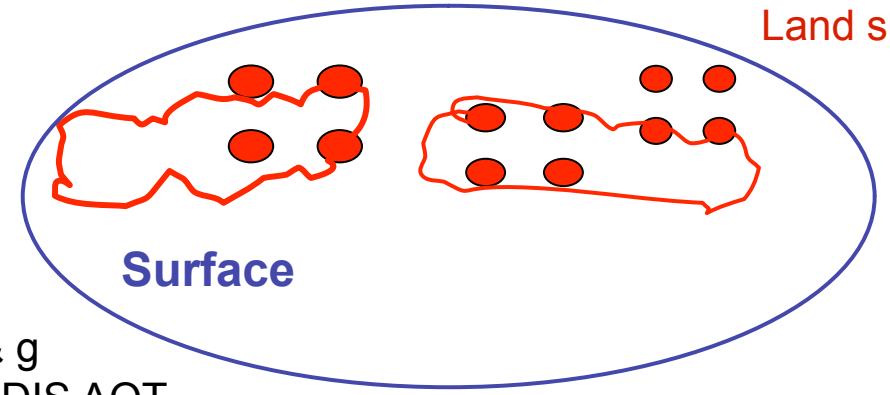
Modis Atmosphere Team

MODIS ~1km pixels provide

Cloud properties (almost always)

Aerosol AOT (sometimes)

Land skin temperature (if clear)



David Fillmore

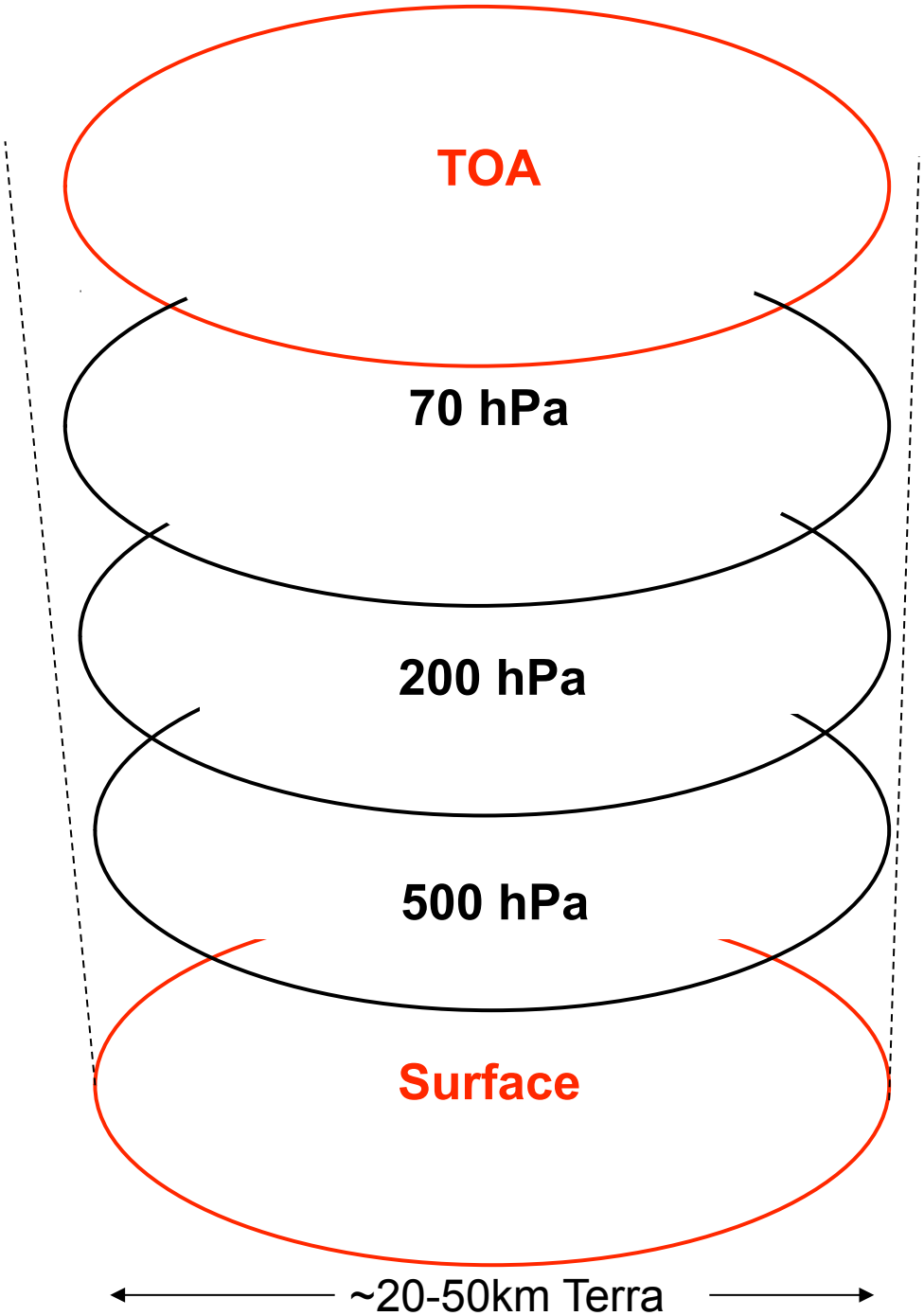
MATCH aerosols
Always used for SSA & g
Used for AOT if no MODIS AOT

Loeb

Priestley

~20-50 km

Large CERES footprint for TOA flux



CERES CRS: Surface and Atmosphere Radiation Budget (SARB) Product

Tuned fluxes at all 5 levels
All-sky & Clear-sky, Up & Down,
SW and LW

Surface & TOA also have Untuned fluxes
Fluxes with aerosols
Pristine fluxes (no aerosols)

Aerosol forcing for all-sky & clear-sky

Tuning does NOT yield a perfect match to TOA observations.

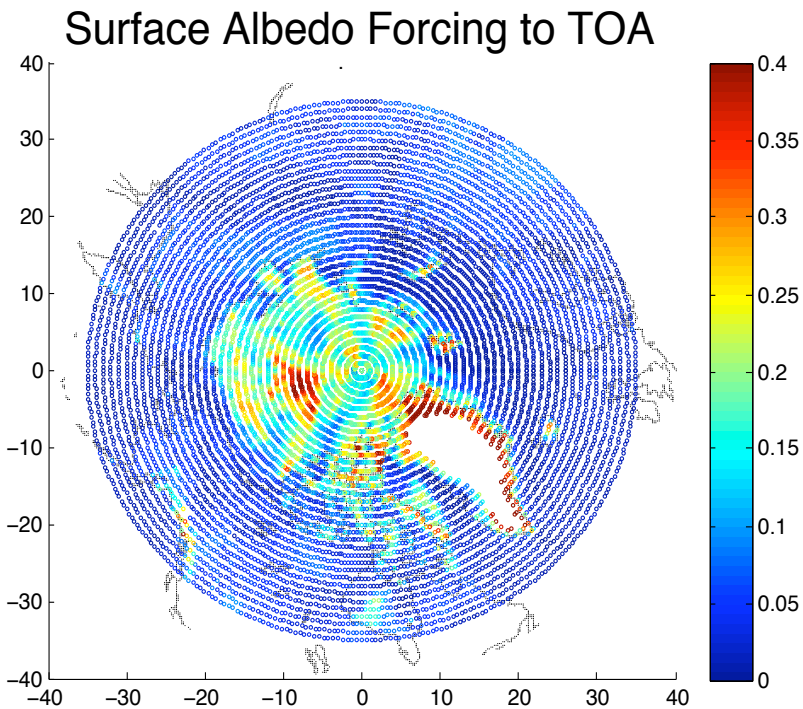
Parameters adjusted when clear:
Skin temperature, aerosol AOT, precipitable water (PW)

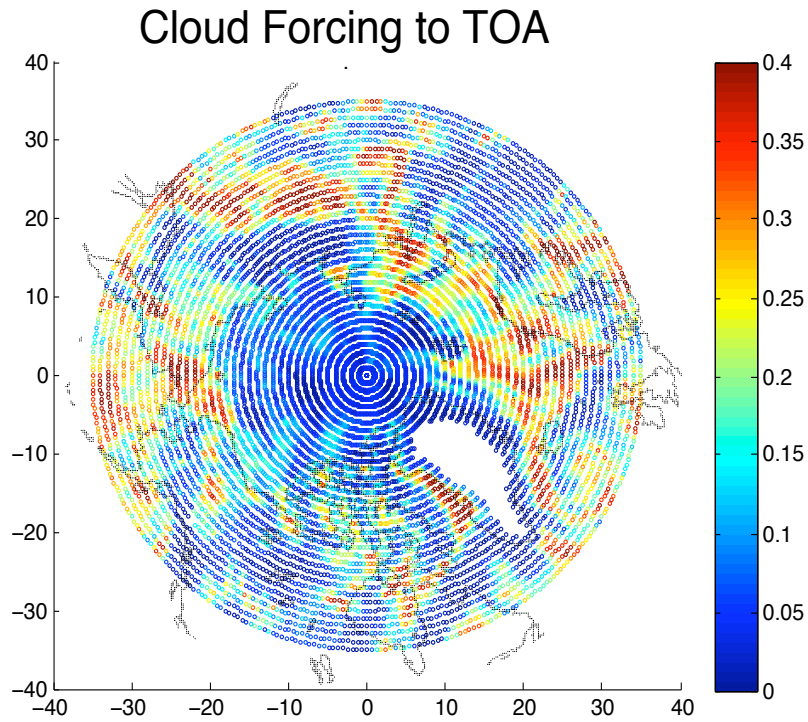
Parameters adjusted when cloudy:
LWP/IWP, cloud top temperature, cloud fractional area within footprint

CRS Edition 3 will have "Surface Albedo Forcing" also spectral TOA fluxes

Surface Albedo Forcing to TOA Albedo
= (All-sky TOA albedo)
- (TOA albedo with no surface albedo)

Cloud Forcing to TOA Albedo
= (All-sky TOA albedo)
- (Clear-sky TOA albedo)

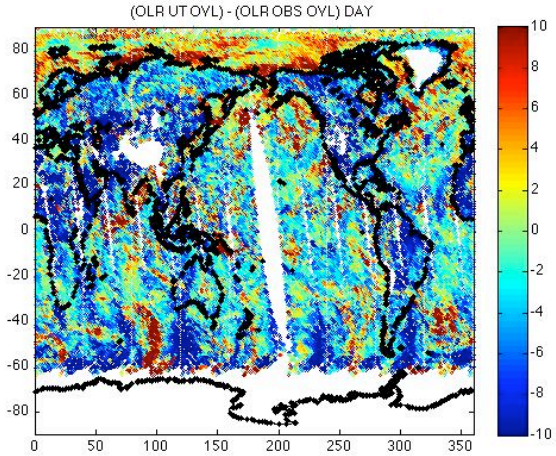




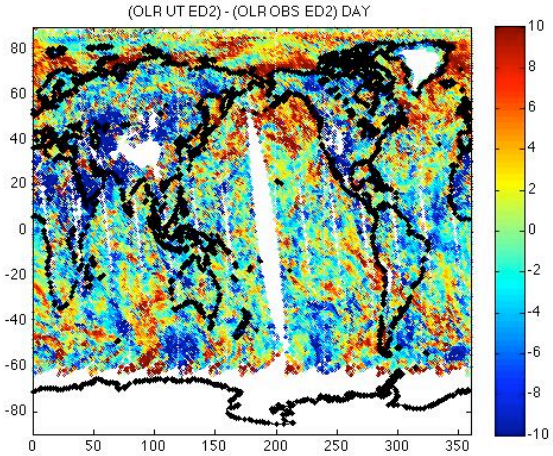
CRS3 using CER_SSF_FM4-MODIS_TestEd3B2 20040715

Prototype CRS Edition 3 using SSF_TestEd3B2
Comparison with Aqua FM4 CRS Ed2B 20040715
OLR Daytime

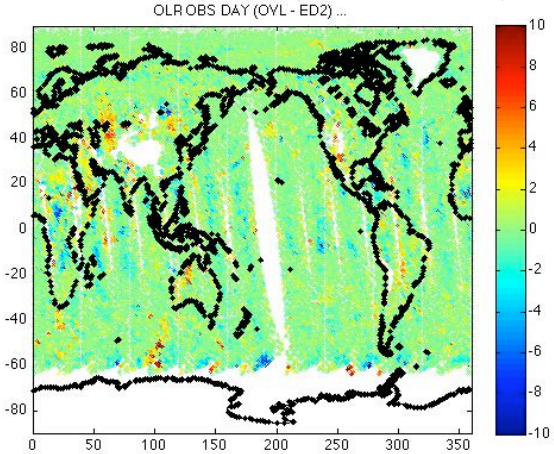
Untuned Bias Ed3



Untuned Bias Ed2



Observation (Ed3 – Ed2)



Prototype CRS Edition 3 using SSF_TestEd3B2

Daytime only Raw FOV averages (N=56694) FM4 20040715

OLR			SW UP at TOA			
Untuned "clear"	Untuned	Observed	Untuned "clear"	Untuned	Observed Rev1	
267.87	245.35	245.38	119.97	231.79	222.88	CRS Ed2B
265.60	243.54	245.36	121.16	232.45	222.91	proto-Ed3

Untuned DLF		Untuned Insolation		
"clear"		"clear"		
316.69	348.70	605.99	469.60	CRS Ed2B
321.12	356.59	603.78	464.36	proto-E3

CER_CRS_Aqua-FM4-MODIS_Edition2B_020029.20040715	GEOS-4
CER_CRS3_Aqua-FM4-MODIS_OVL008.20040715	GEOS-5
CER_SSF_Aqua-FM4-MODIS_TestEd3B2_999999.20040715	GEOS-5

Prototype CRS Edition 3 using SSF_TestEd3B2

ALL-SKY FOV STATISTICS FM4 20040715

Ed2B Observation Rev1	BIAS	RMS	STD	Correlation	N	OCEAN SW UP TOA
193.95	-0.44	12.26	12.25	1.00	56694	SSF TestEd3B2
193.95	11.55	22.29	19.07	0.99	56694	Untuned Ed2B
193.95	10.50	21.74	19.04	0.99	56694	Untuned proto-Ed3

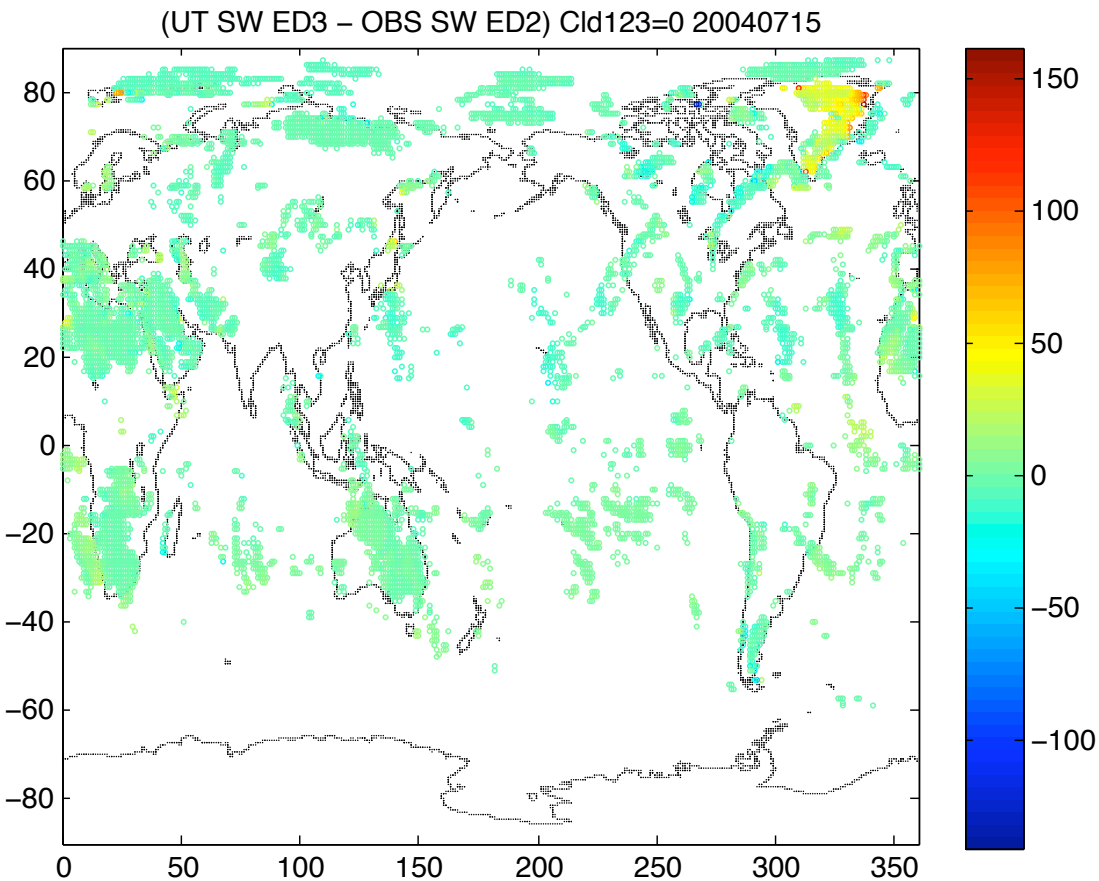
Ed2B Observation	BIAS	RMS	STD	Correlation	N	GLOBE OLR DAY
245.38	-0.02	1.76	1.76	1.00	101889	SSF TestEd3B2
245.38	-0.03	8.03	8.03	0.98	101889	Untuned Ed2B
245.38	-1.84	8.34	8.13	0.98	101889	Untuned proto-Ed3

Ed2B Observation	BIAS	RMS	STD	Correlation	N	GLOBE OLR DAY
226.25	-0.62	2.84	2.77	1.00	87793	SSF TestEd3B2
226.25	-1.14	7.06	6.96	0.99	87793	Untuned Ed2B
226.25	-3.49	9.94	9.30	0.98	87793	Untuned proto-Ed3

CER_CRS_Aqua-FM4-MODIS_Edition2B_020029.20040715 GEOS-4
CER_CRS3_Aqua-FM4-MODIS_OVL008.20040715 GEOS-5
CER_SSF_Aqua-FM4-MODIS_TestEd3B2_999999.20040715 GEOS-5

Prototype CRS Edition 3 using SSF_TestEd3B2 from FOVs with Cld1+Cld2+Cld3 = 0

(Untuned SW TOA) – (Observation)



Prototype CRS Edition 3 using SSF_TestEd3B2 from FOVs with Cld1+Cld2+Cld3 = 0

CRYOSPHERE DAY no Ed2 clouds

Ed2B OBS	Bias	RMS	STD	Correlation	N	
271.67	0.29	2.84	2.82	1.00	9372.00	SW Observation Ed3
271.67	2.92	3.72	2.30	1.00	9372.00	Untuned SW TOA Ed2B
271.67	16.62	30.29	25.33	0.99	9372.00	Untuned SW TOA Ed3 OVL008
235.69	0.04	0.82	0.82	1.00	9372.00	OLR Observation Ed3
235.69	-0.85	2.82	2.69	0.96	9372.00	Untuned OLR Ed2B
235.69	-2.89	5.17	4.28	0.92	9372.00	Untuned OLR Ed3
58.02	0.02	0.30	0.30	1.00	9372.00	WN Observation Ed3
58.02	0.59	0.97	0.76	0.99	9372.00	Untuned WN Ed2B
58.02	-0.57	2.27	2.20	0.91	9372.00	Untuned WN Ed3

CRYOSPHERE NITE no Ed2 clouds

Ed2B OBS	Bias	RMS	STD	Correlation	N	
117.15	-0.82	2.39	2.24	1.00	59921.00	OLR Observation Ed3
117.15	-1.00	4.86	4.75	0.99	59921.00	Untuned OLR Ed2B
117.15	-2.44	6.39	5.91	0.98	59921.00	Untuned OLR Ed3
15.82	-0.23	0.70	0.66	1.00	59921.00	WN Observation Ed3
15.82	-0.17	1.25	1.23	0.99	59921.00	Untuned WN Ed2B
15.82	-0.22	1.69	1.68	0.98	59921.00	Untuned WN Ed3

Prototype CRS Edition 3 using SSF_TestEd3B2 from FOVs with Cld1+Cld2+Cld3 = 0

GLOBE DAY no Ed2 clouds

Ed2B OBS	Bias	RMS	STD	Correlation	N	
173.40	0.31	4.52	4.51	1.00	66105.00	SW Observation Ed3
173.40	1.03	6.20	6.11	1.00	66105.00	Untuned SW TOA Ed2B
173.40	3.93	14.64	14.11	0.99	66105.00	Untuned SW TOA Ed3 OVL008
293.39	-0.06	1.87	1.87	1.00	66105.00	OLR Observation Ed3
293.39	-1.94	6.92	6.64	0.98	66105.00	Untuned OLR Ed2B
293.39	-4.54	8.20	6.83	0.98	66105.00	Untuned OLR Ed3
92.89	0.04	0.99	0.98	1.00	66105.00	WN Observation Ed3
92.89	0.30	3.72	3.71	0.99	66105.00	Untuned WN Ed2B
92.89	-0.52	3.98	3.95	0.98	66105.00	Untuned WN Ed3

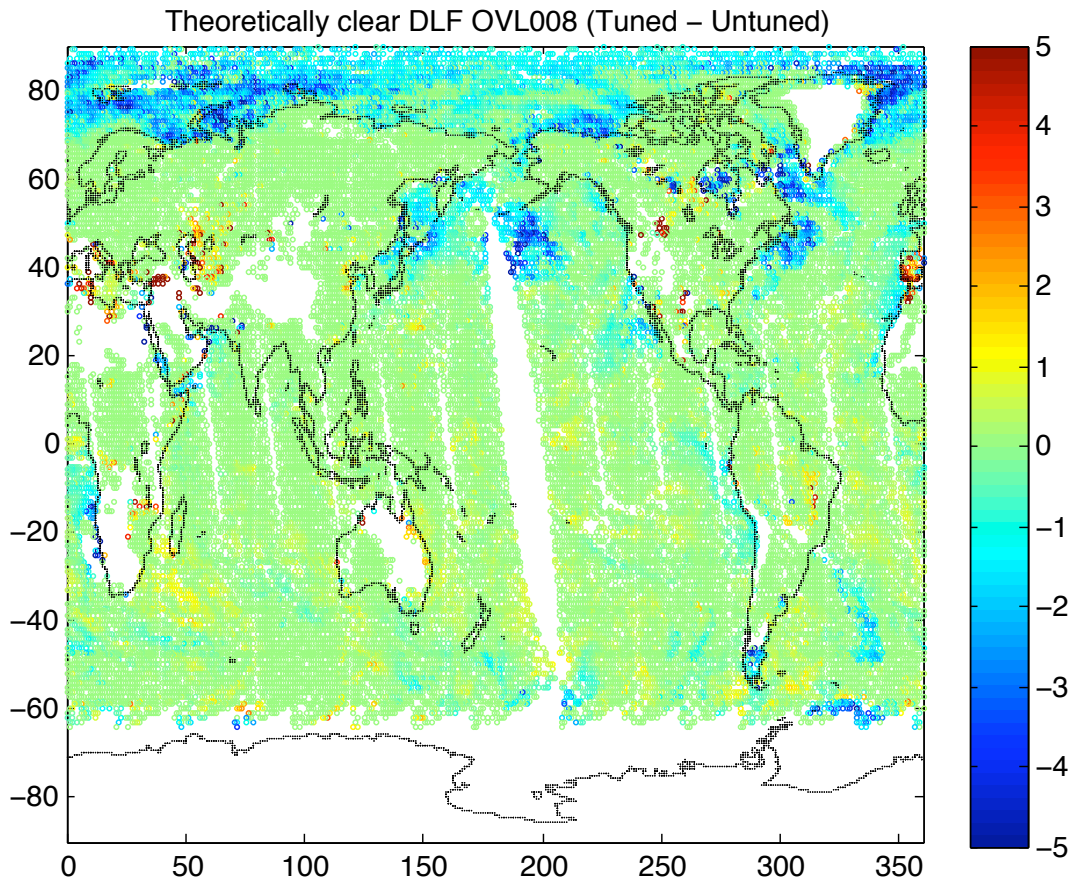
GLOBE NITE no Ed2 clouds

Ed2B OBS	Bias	RMS	STD	Correlation	N	
202.53	-0.58	2.08	2.00	1.00	127667.00	OLR Observation Ed3
202.53	-1.42	4.67	4.45	1.00	127667.00	Untuned OLR Ed2B
202.53	-3.04	5.84	4.99	1.00	127667.00	Untuned OLR Ed3
51.33	-0.12	1.13	1.13	1.00	127667.00	WN Observation Ed3
51.33	0.26	1.75	1.73	1.00	127667.00	Untuned WN Ed2B
51.33	0.15	1.88	1.87	1.00	127667.00	Untuned WN Ed3

Proto-Ed3 Adjustment to Theoretically Clear DLF due to Cloud Placement

Cloudiness > 10%

CER_CRS3_Aqua-FM4-MODIS_OVL008.20040715 GEOS-5
CER_SSF_Aqua-FM4-MODIS_TestEd3B2_999999.20040715 GEOS-5



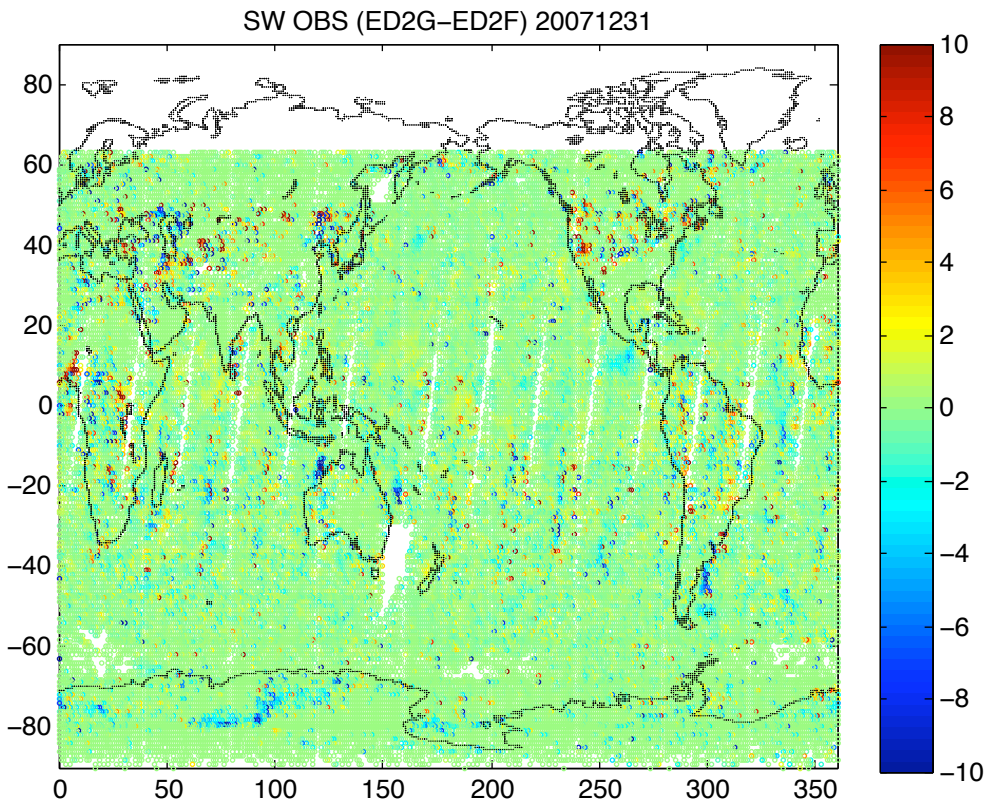
SSF effective Pcloud and Tcloud are used to alter GEOS-5 sounding within 50 hPa of boundaries in tuned prototype Ed3 CRScalculation.

Terra FM1 CRS Ed2F (ends 200712)
GEOS-4

Terra FM1 CRS Ed2G (begins 200801)
GEOS-5

SCF run of Ed2F code with Ed2G SSF and GEOS-5 on 20071231
Every tenth FOV, placed in 1x1 degree grid

Observed SW (Ed2G – Ed2F)



Terra FM1 CRS Ed2F (ends 200712) GEOS-4

Terra FM1 CRS Ed2G (begins 200801) GEOS-5

SCF run of Ed2F code with Ed2G SSF and GEOS-5 on 20071231
Every tenth FOV, placed in 1x1 degree grid

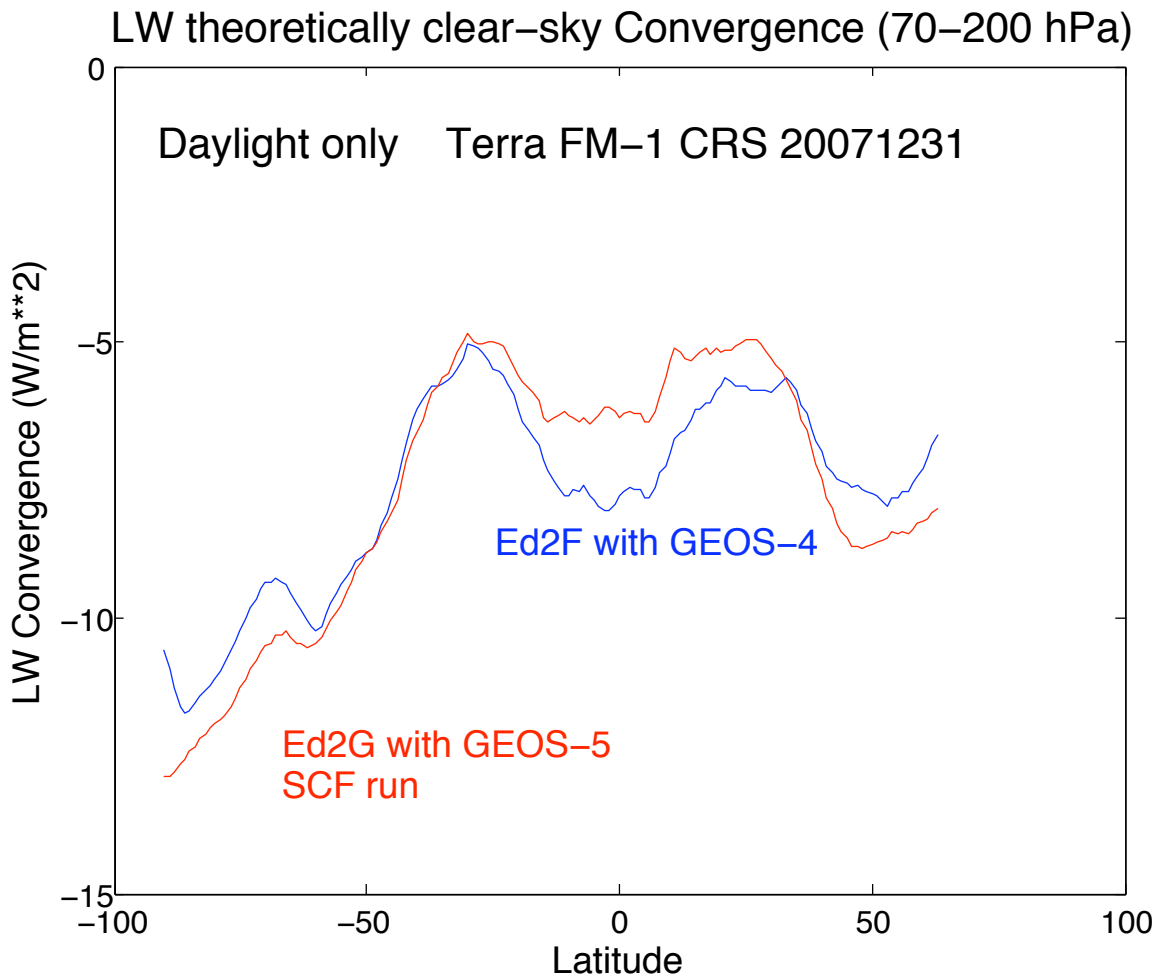
TOA-70 hPa	70-200 hPa	200-500 hPa	500-SFC hPa	SFC NET	THEORETICALLY CLEAR
29.11	7.27	44.84	110.06	650.73	SW conv day Ed2F GOES-4
-0.01	-0.02	-0.76	1.04	-0.35	Ed2G - Ed2F
0	0	0	0	0	tuned and theoretically clear
-10.43	-7.17	-55.22	-105.24	-87.06	LW conv day Ed2F GOES-4
-0.34	0.32	0.31	0.90	-0.53	Ed2G - Ed2F
0	0	0	0	0	tuned and theoretically clear
-10.00	-7.04	-54.42	-110.99	-76.53	LW conv nite Ed2F GOES-4
-0.34	0.14	0.61	0.40	0.00	Ed2G - Ed2F
0	0	0	0	0	tuned and theoretically clear

TOA-70 hPa	70-200 hPa	200-500 hPa	500-SFC hPa	SFC NET	ALL SKY
30.92	9.32	55.27	108.18	503.32	SW conv day Ed2F GOES-4
-0.01	-0.05	-0.95	1.33	-0.33	Ed2G - Ed2F
0	0	0	0	0	ALL sky tuned
-11.16	-8.69	-57.32	-101.48	-60.27	LW conv day Ed2F GOES-4
-0.32	0.29	0.26	0.73	-1.00	Ed2G - Ed2F
0	0	0	0	0	ALL sky tuned
-10.76	-7.78	-51.91	-109.49	-51.19	LW conv nite Ed2F GOES-4
-0.32	0.10	0.57	0.55	-0.97	Ed2G - Ed2F

Terra FM1 CRS Ed2F (ends 200712)
GEOS-4

Terra FM1 CRS Ed2G (begins 200801)
GEOS-5

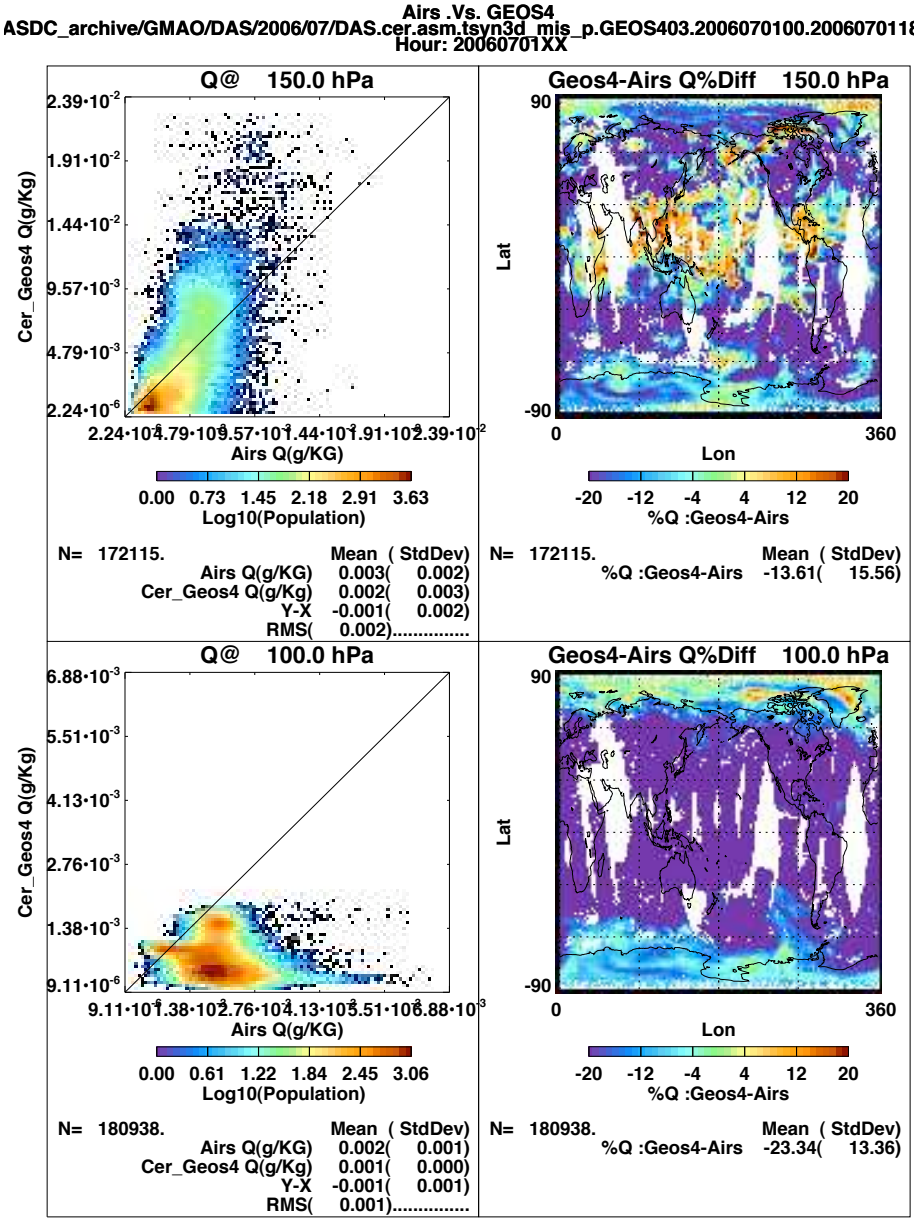
SCF run of Ed2F code with Ed2G SSF and GEOS-5 on 20071231
Every tenth FOV, placed in 1x1 degree grid

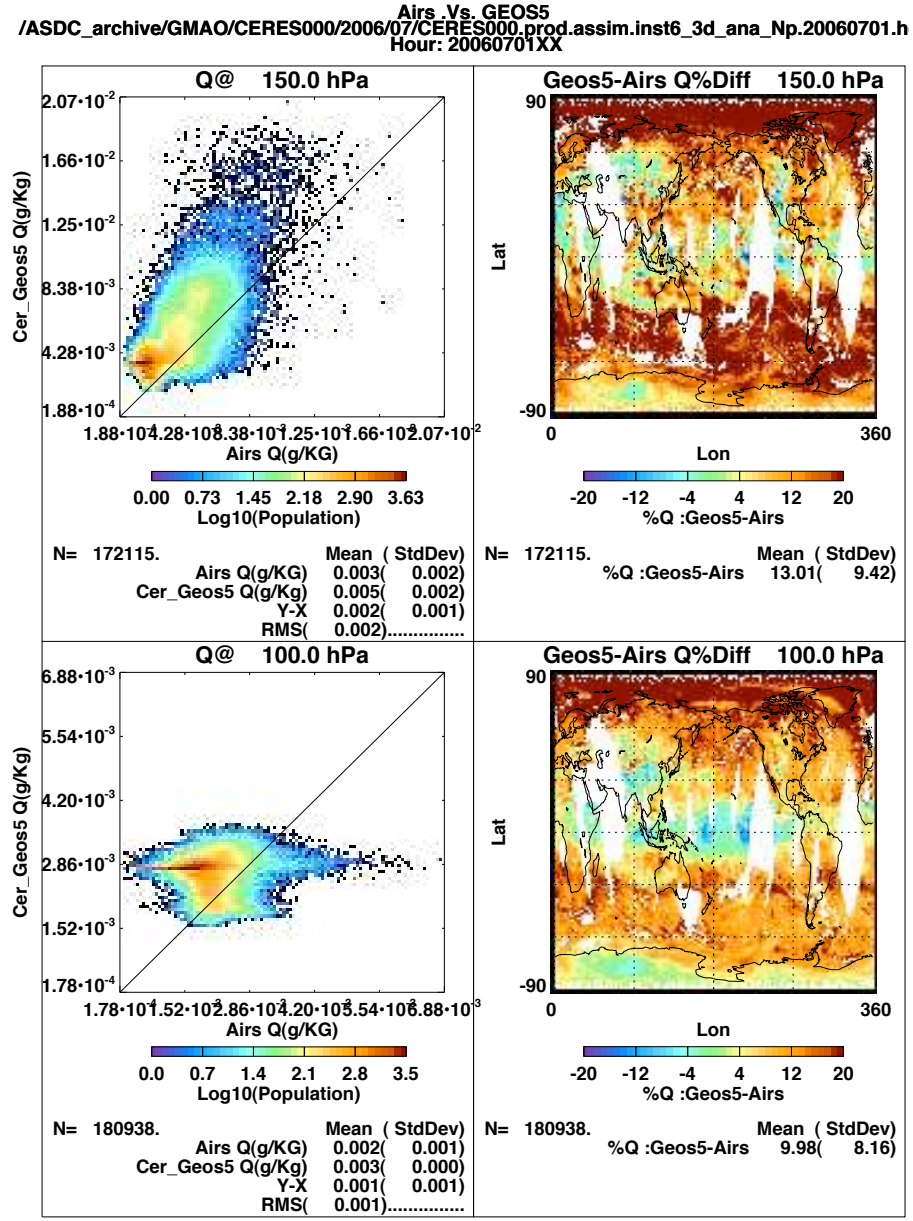


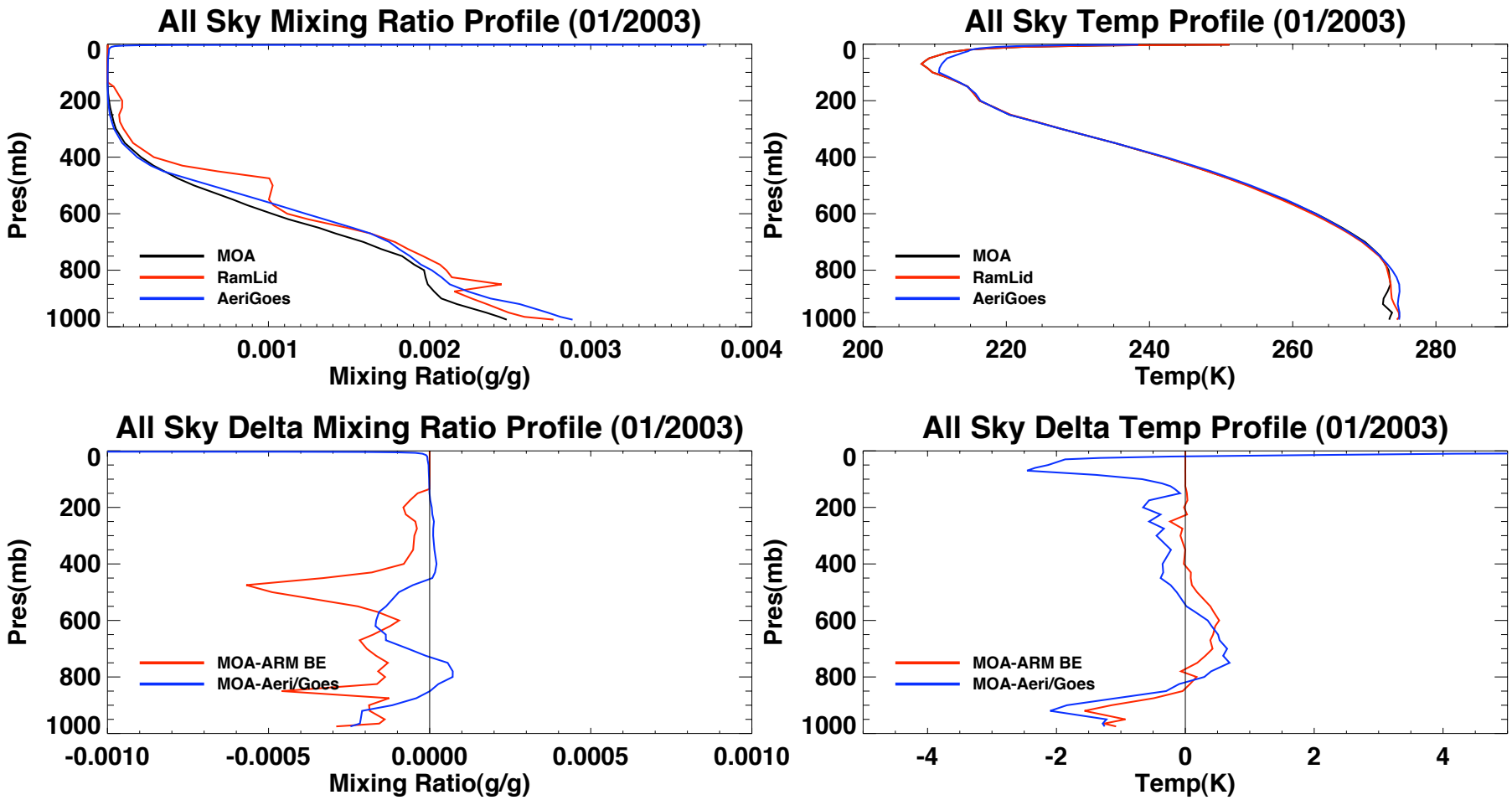
20060701 Humidity (g/kg) Percent Bias & (Stddev)	Geos4- AIRS DAS	G5-Airs CER000
70hpa	-17.9% (16.3%)	+8.4% (8.4%)
100hpa	**-23.3% (13.4%)**	**+10.0% (8.2%)**
150hpa	**-13.6% (15.6%)**	**+13.0% (9.4%)**
200hpa	2.31% (16.2%)	+7.4% (11.8%)
250hpa	4.22% (14.4%)	0.4% (14.4%)
300hpa	1.76% (13.6%)	-0.7% (14.0%)

20060701 Temperature (K) Bias &(Stddev)	Geos4- AIRS DAS	G5-Airs CER000
70hpa	+0.44K (1.6)	-0.15K (1.4)
100hpa	+1.09K (2.0)	+0.86K (1.5)
150hpa	+0.41K (1.5)	+0.64K (1.3)
200hpa	-0.32K (2.0)	+0.09K (1.6)
250hpa	0.09K (1.9)	+0.23K (1.6)
300hpa	0.17K (1.6)	+0.54K (1.3)

GMAO and AIRS UTH





Two ARM SGP quality sounding products are available, but only through 2003.

GOES-5 for 2003 is needed for evaluation with these.
Two directions: Radiation calculations and vertical placement of SSF cloud in CRS.