Langley Research Center
Science Directorate

The Broadband World at TOA and Surface According to CERES/SYNI – How Important are Differences Between MODIS, Geostationary and Interpolated Methods?

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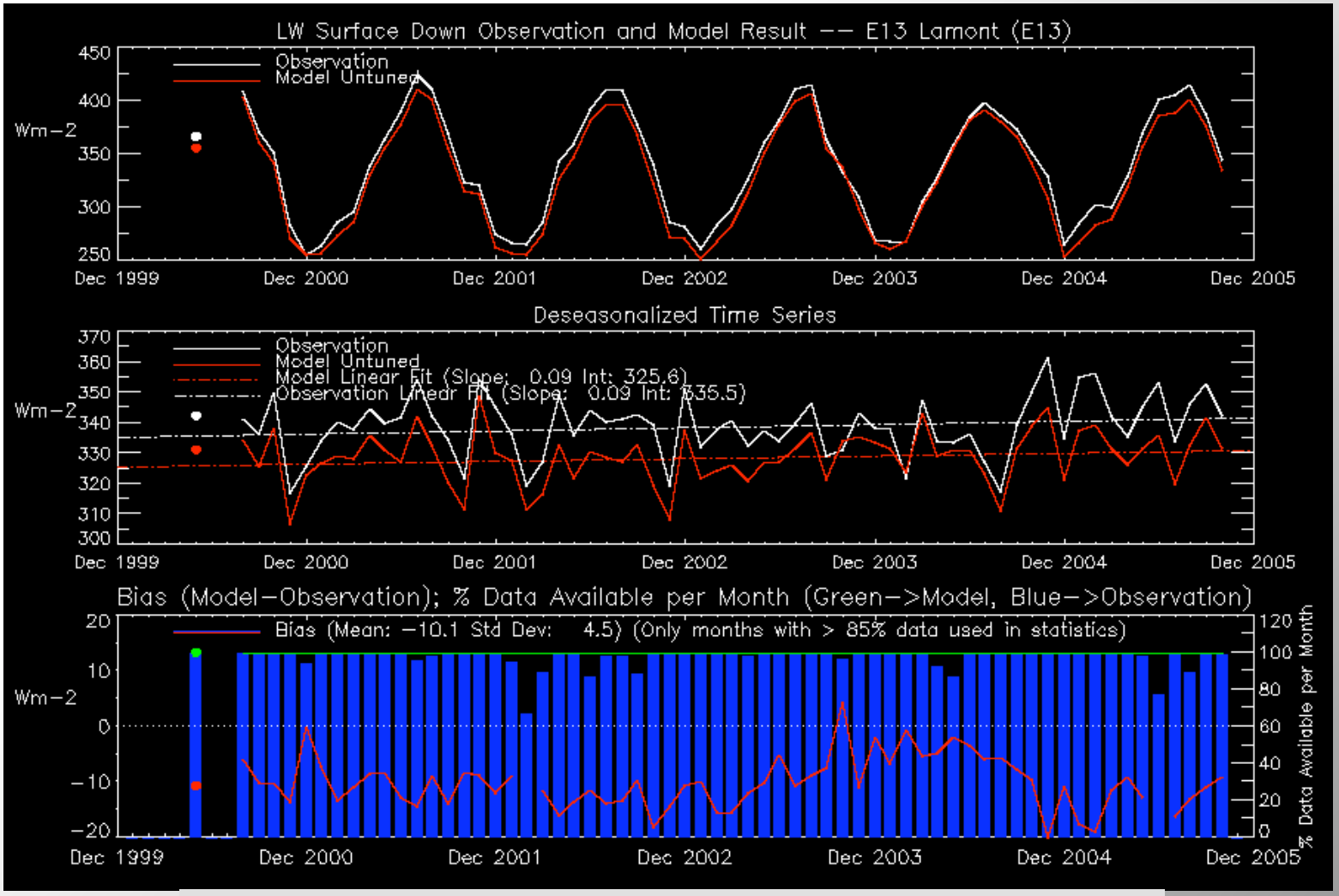
The entire CERES Team!

SYN (Synoptic) Product Edition 2

- Gridded (1°x1°)
- 3-Hourly (Calculations were done hourly)
- Contains
  - TOA Irradiance Observations (From CERES or GOES or interpolated)
  - Cloud & Aerosol Information (From MODIS or GOES)
  - Model Irradiance Calculations, Up/Down @ 5 levels
- Currently:
  - Terra Product May 2000 through Oct 2005
  - Aqua Product Jul 2002 through Oct 2005

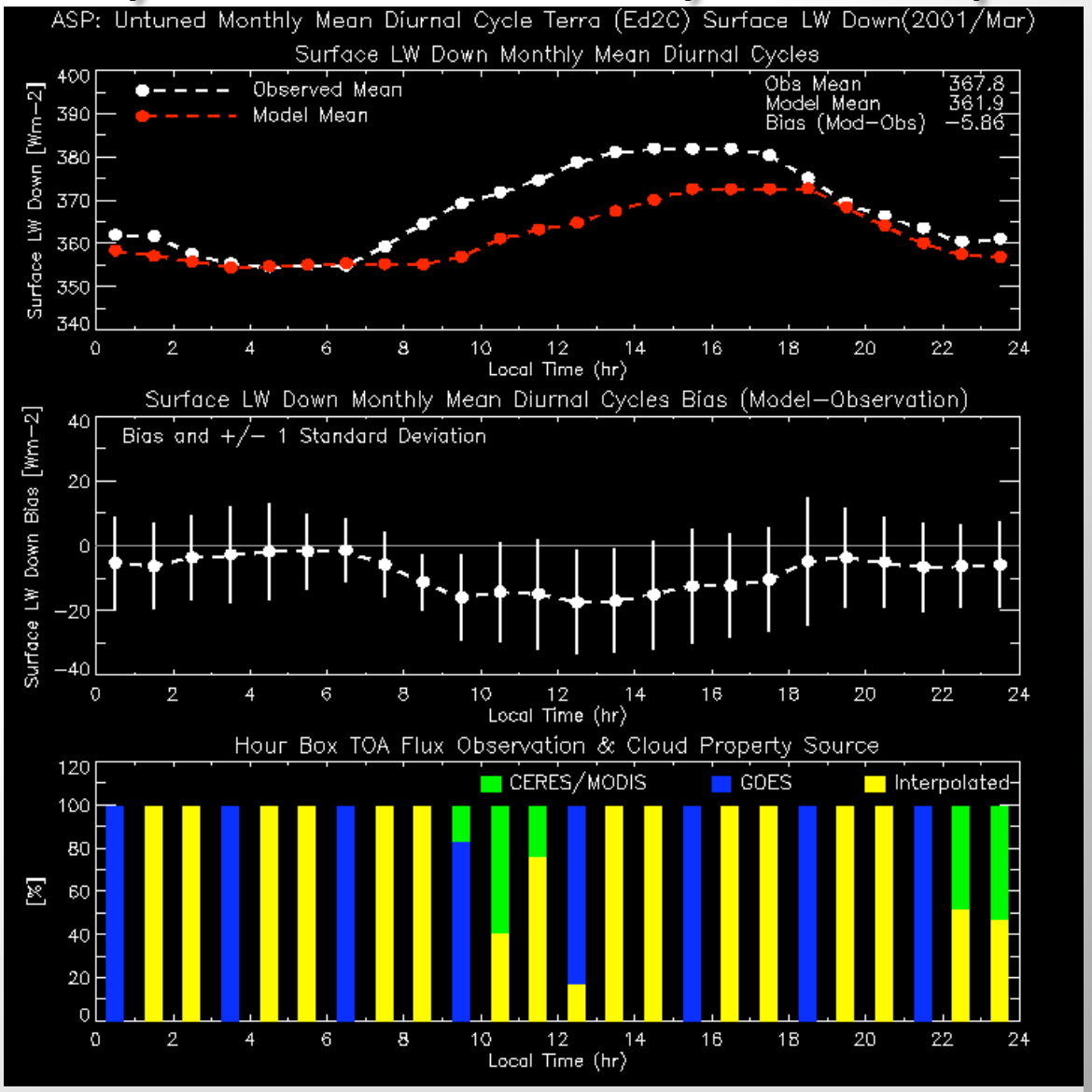
CAVE SYN On-Line Validation Plots

Time series of monthly mean observations & RT calculations.



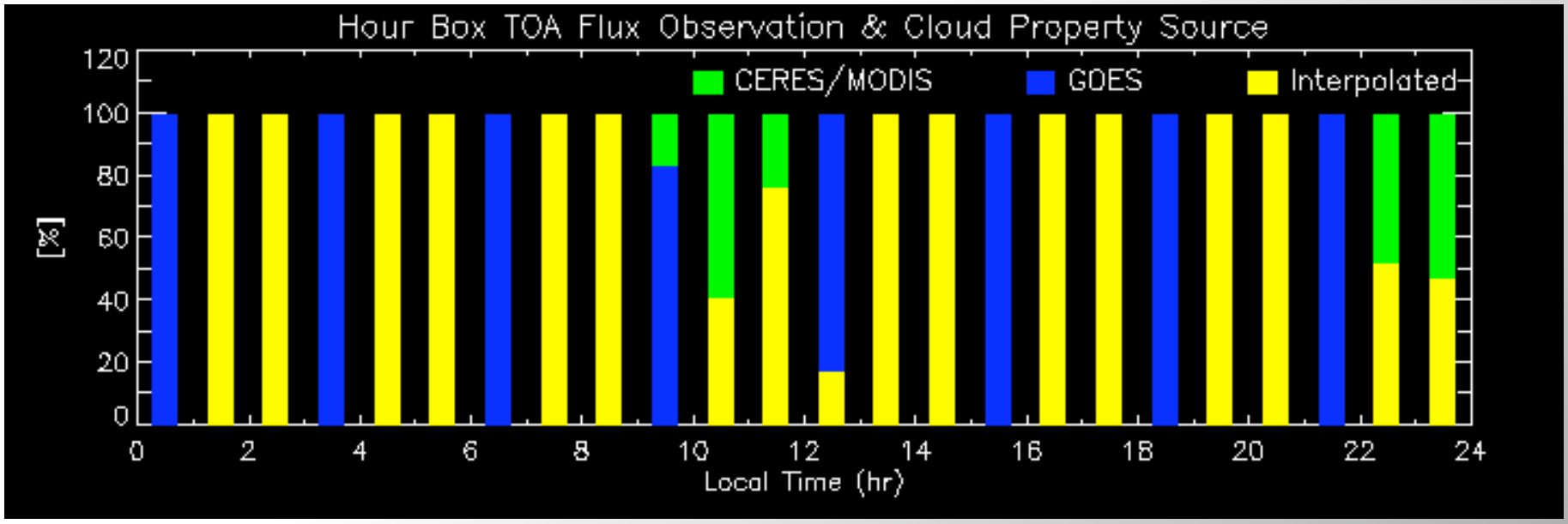
http://www-cave.larc.nasa.gov/cave/pages/synmm.html

Monthly Mean Diurnal Cycle Comparisons



http://www-cave.larc.nasa.gov/cave/pages/syndc.html

Monthly Sampling from different Sources



Color indicates percentage of time in each hour box when:

- CERES irradiance observations, cloud properties from MODIS
- GOES NBB irradiance observations, cloud properties from GOES Imager
- Irradiance observations & cloud properties interpolated in time

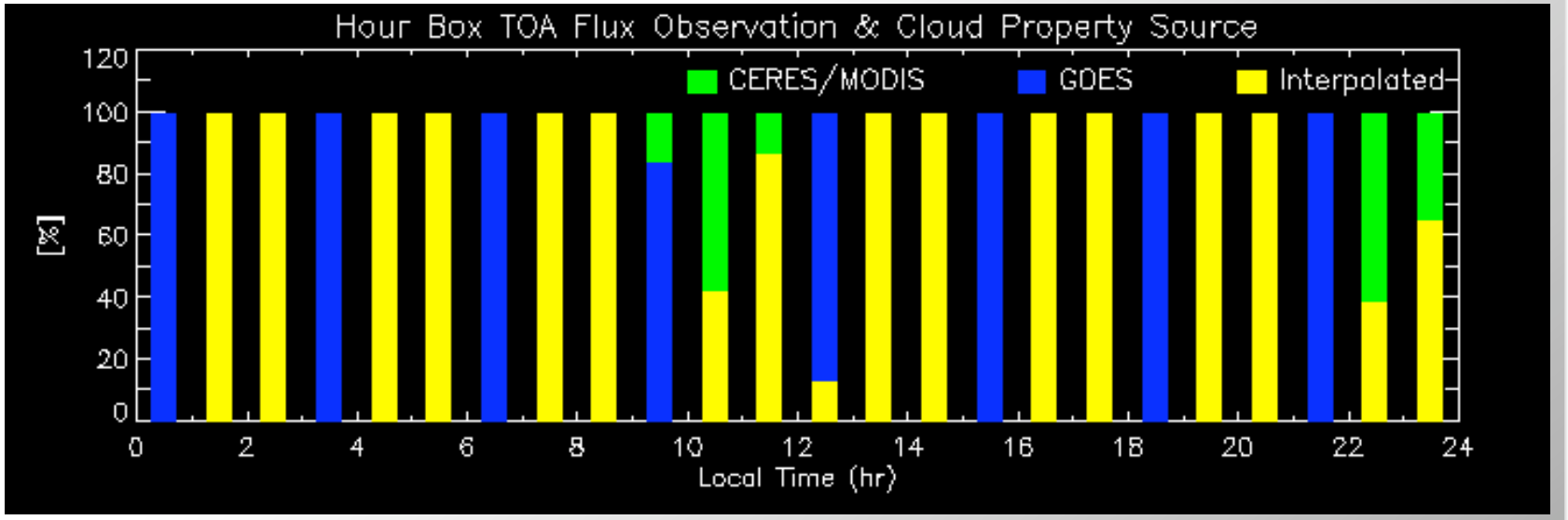
- What if I want to find the effect of the different inputs on the results?
- Can't be done with the SYN product itself.
- Requires hourly SYNI internal product.
  - Extracted during processing at ~180 grid boxes around the glob for validation purposes.

Going to use SYNI and inter-compare:
Morning Terra CERES results to Aqua GOES/ Interpolated values.
Afternoon Aqua CERES results to Terra GOES/ Interpolated values.

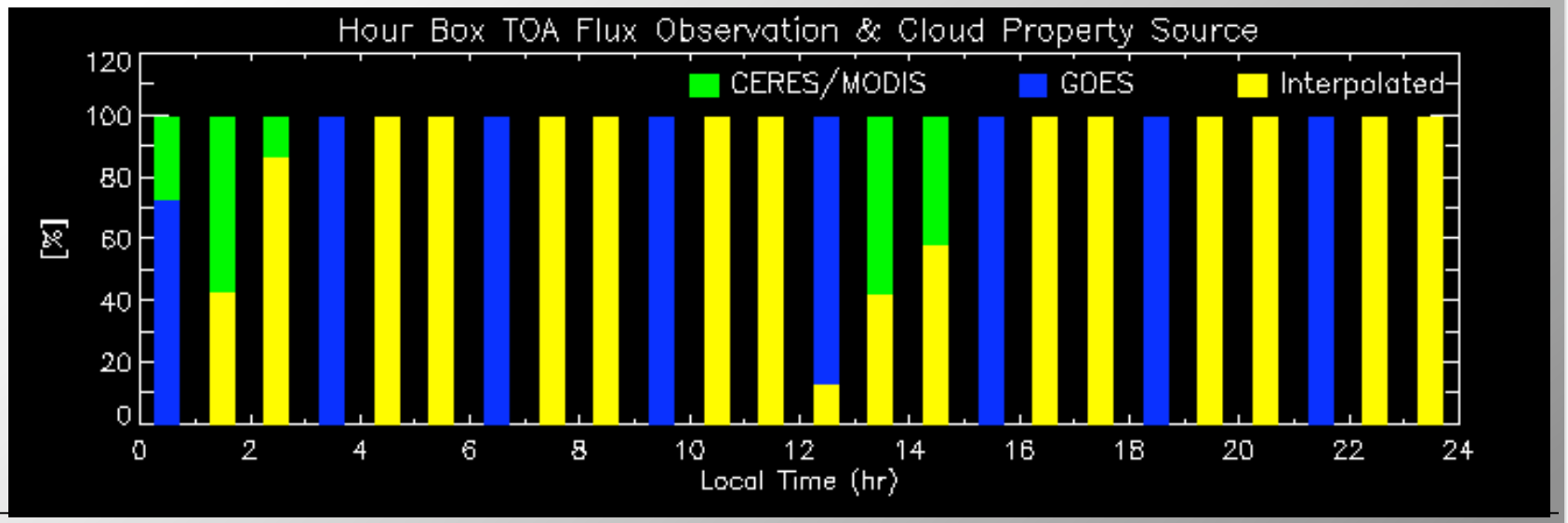
Isolate Data by Grid Box/Local Hour/"Source"

Compare across satellite data streams:

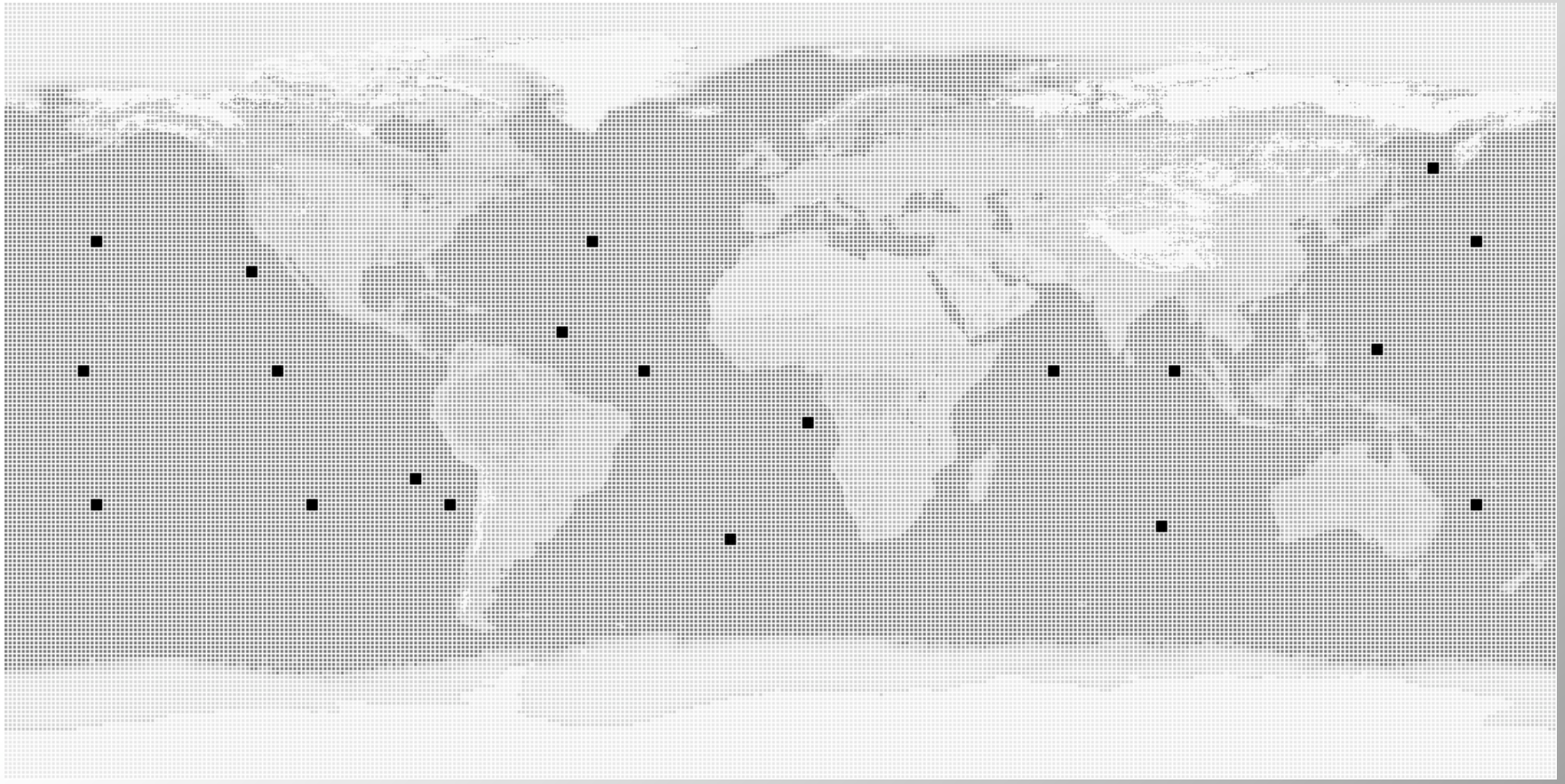
Terra Data Stream



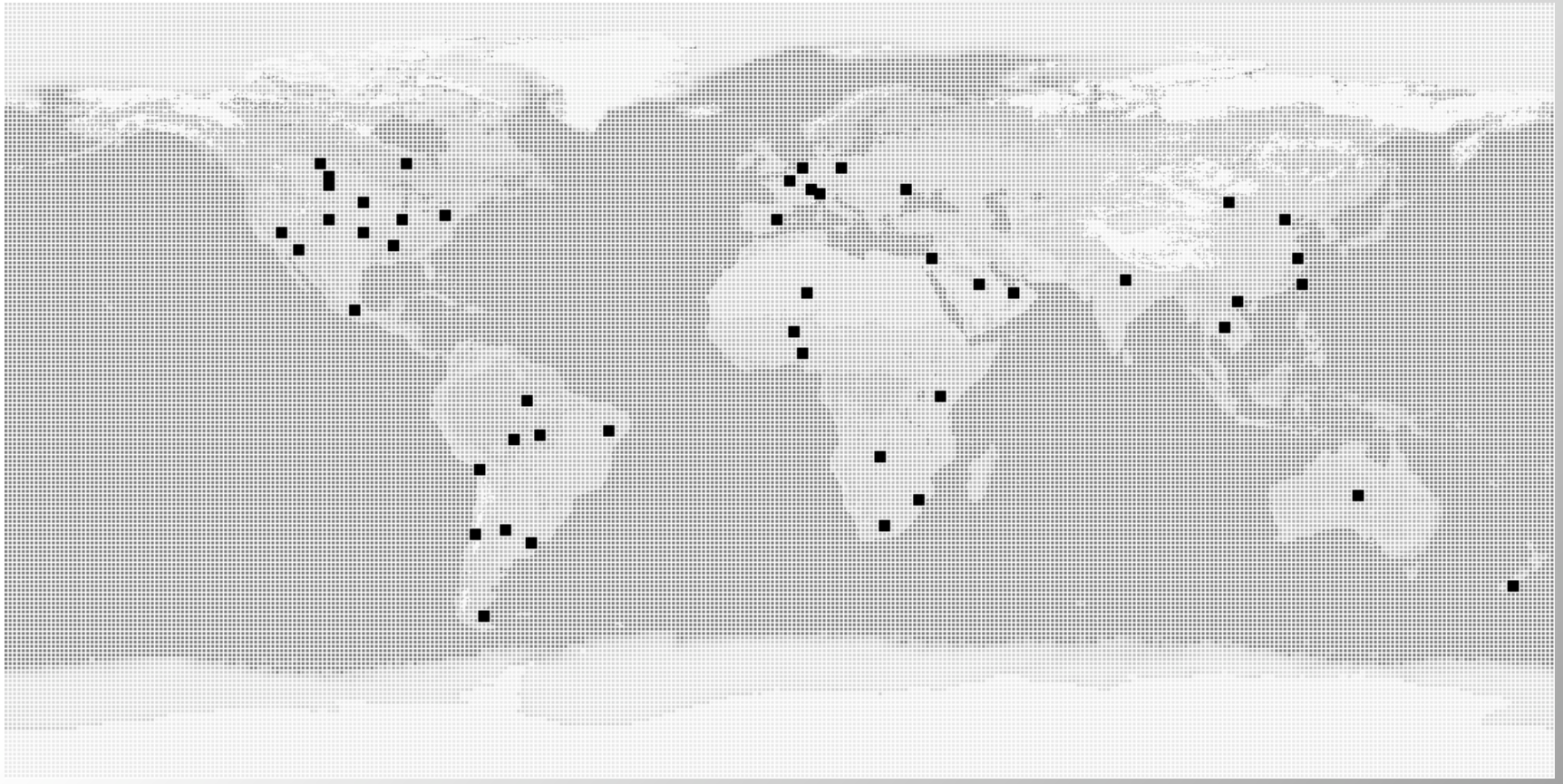
Aqua Data Stream



Ocean grid boxes (20)



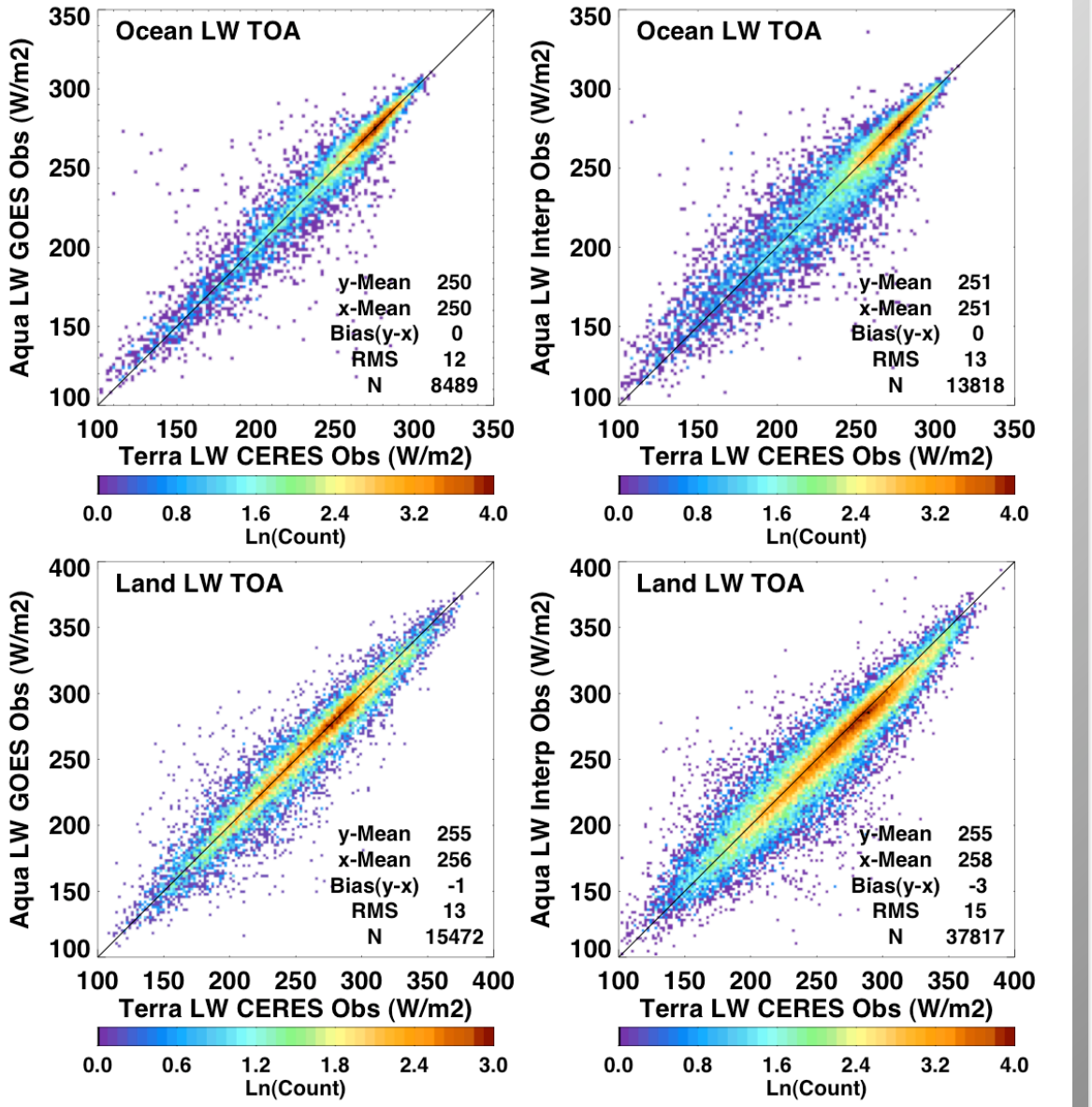
Land Grid Boxes (48)



Terra CERES TOA LW vs. Aqua GOES & Interp. Irradiance

TOA LW Irradiance

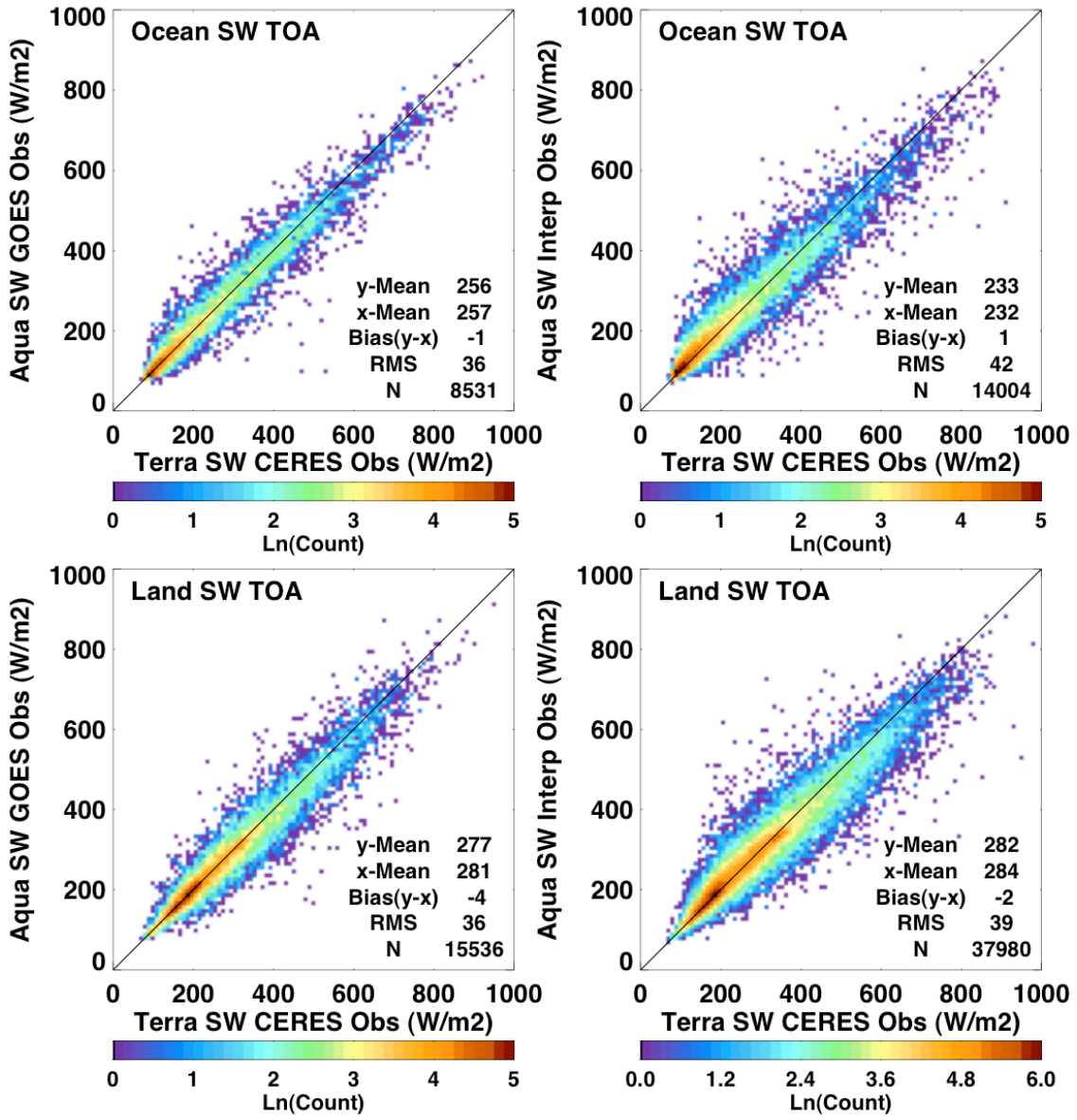
Ocean $CERES_T$ Vs $GOES_A$ Bias 0 RMS 12	Ocean $CERES_T$ Vs $INTP_A$ Bias 0 RMS 13
Land $CERES_T$ Vs $GOES_A$ Bias -1 RMS 13	Land $CERES_T$ Vs $INTP_A$ Bias -3 RMS 12



Terra CERES TOA SW vs. Aqua GOES & Interp. Irradiance

TOA Shortwave Irradiance

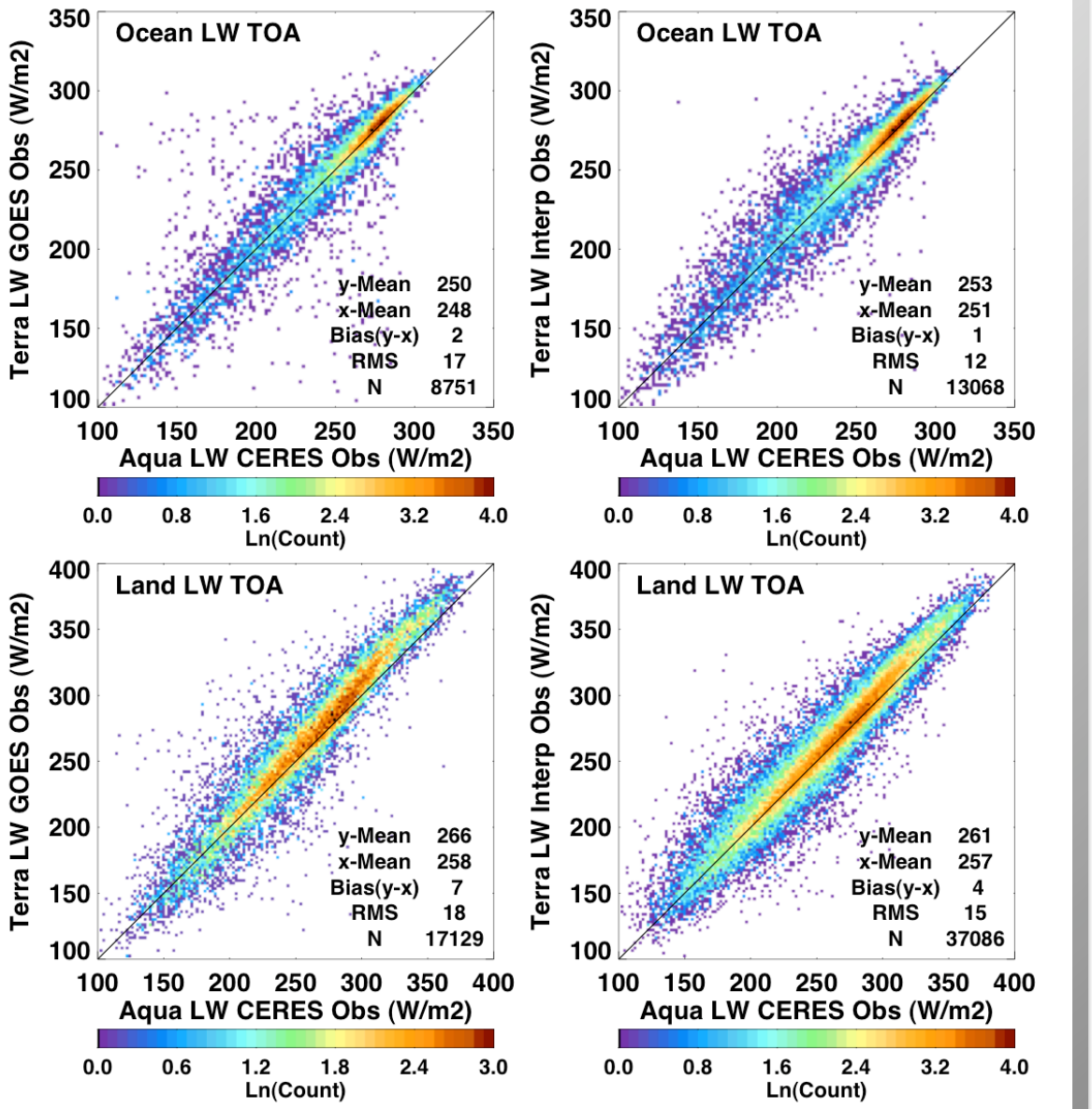
Ocean $CERES_T$ Vs $GOES_A$ Bias 1 RMS 36	Ocean $CERES_T$ Vs $INTP_A$ Bias 1 RMS 42
Land $CERES_T$ Vs $GOES_A$ Bias -4 RMS 36	Land $CERES_T$ Vs $INTP_A$ Bias -2 RMS 39



Aqua CERES TOA LW vs. Terra GOES & Interp. Irradiance

TOA LW Irradiance

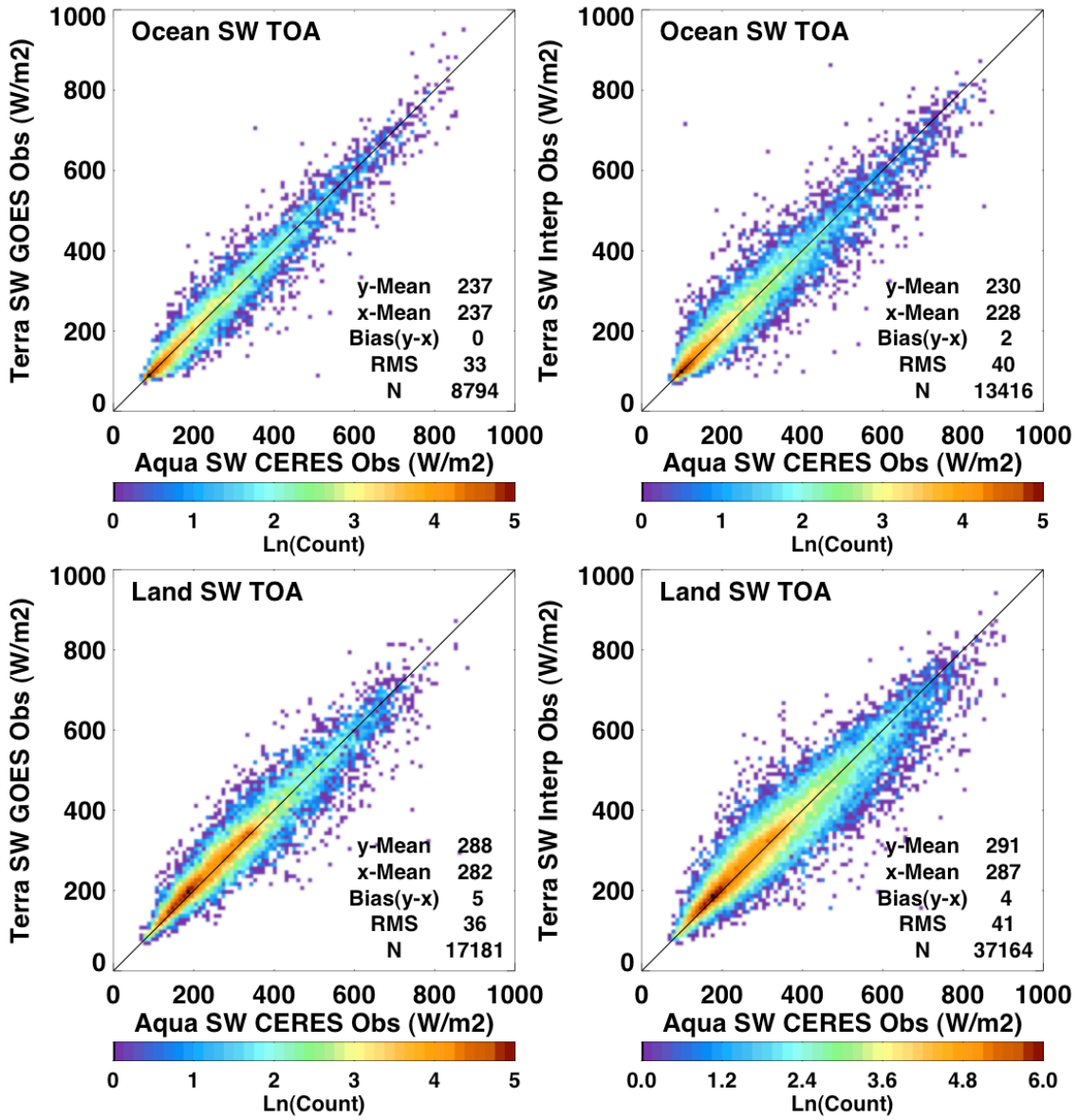
Ocean $CERES_A$ Vs $GOES_T$ Bias 2 RMS 17	Ocean $CERES_A$ Vs $INTP_T$ Bias 1 RMS 12
Land $CERES_A$ Vs $GOES_T$ Bias 7 RMS 18	Land $CERES_A$ Vs $INTP_T$ Bias 4 RMS 15



Terra CERES TOA SW vs. Aqua GOES & Interp. Irradiance

TOA SW Irradiance

Ocean $CERES_A$ Vs $GOES_T$ Bias 0 RMS 33	Ocean $CERES_A$ Vs $INTP_T$ Bias 2 RMS 40
Land $CERES_A$ Vs $GOES_T$ Bias 5 RMS 36	Land $CERES_A$ Vs $INTP_T$ Bias 4 RMS 41



TOA LW Observed Irradiance, Land Grid Boxes

LW Terra (Morning) Data Stream Compared to Aqua (GOES & Interpolated) Wm^{-2}					
Terra CERES Mean		Aqua Imager Mean	Bias	RMS	N
256	GOES	255	-1	13	15472
258	Interpolated	255	-3	15	37817

LW Aqua (Afternoon) Data Stream Compared to Terra (GOES & Interpolated) Wm^{-2}					
Aqua CERES Mean		Terra Imager Mean	Bias	RMS	N
259	GOES	266	7	18	17129
257	Interpolated	261	4	15	37086

TOA SW Observed Irradiance, Land Grid Boxes

SW Terra (Morning) Data Stream Compared to Aqua (GOES & Interpolated) Wm^{-2}					
Terra CERES Mean		Aqua Imager Mean	Bias	RMS	N
281	GOES	277	-4	36	15536
284	Interpolated	282	-2	39	37980

SW Aqua (Afternoon) Data Stream Compared to Terra (GOES & Interpolated) Wm^{-2}					
Aqua CERES Mean		Terra Imager Mean	Bias	RMS	N
282	GOES	288	6	36	17181
287	Interpolated	291	4	41	37164

Surface LW Down Modeled Irradiance (Ocean)

LW Terra (Morning) Data Stream Compared to Aqua (GOES & Interpolated) Wm^{-2}					
Terra Mean (MODIS Clouds)		Aqua Mean	Bias	RMS	N
383	GOES Clouds	383	0	8	8491
382	Interpolated Clouds	382	0	8	13835

LW Aqua (Afternoon) Data Stream Compared to Terra (GOES & Interpolated) Wm^{-2}					
Aqua Mean (MODIS Clouds)		Terra Mean	Bias	RMS	N
381	GOES Clouds	381	0	8	8758
381	Interpolated Clouds	381	0	7	13083

Surface LW Down Modeled Irradiance (Land)

SW Terra (Morning) Data Stream Compared to Aqua (GOES & Interpolated) Wm^{-2}					
Terra Mean (MODIS Clouds)		Aqua Mean	Bias	RMS	N
338	GOES Clouds	340	2	14	15465
339	Interpolated Clouds	341	2	13	37807

SW Aqua (Afternoon) Data Stream Compared to Terra (GOES & Interpolated) Wm^{-2}					
Aqua Mean (MODIS Clouds)		Terra Mean	Bias	RMS	N
351	GOES Clouds	351	0	15	17141
381	Interpolated Clouds	381	0	13	37080

Surface SW Down Modeled Irradiance (Ocean)

SW Terra (Morning) Data Stream Compared to Aqua (GOES & Interpolated) Wm^{-2}					
Terra Mean (MODIS Clouds)		Aqua Mean	Bias	RMS	N
601	GOES Clouds	607	6	48	8526
623	Interpolated Clouds	626	3	53	14002

SW Aqua (Afternoon) Data Stream Compared to Terra (GOES & Interpolated) Wm^{-2}					
Aqua Mean (MODIS Clouds)		Terra Mean	Bias	RMS	N
612	GOES Clouds	622	10	45	8792
629	Interpolated Clouds	633	4	51	13416

Surface SW Down Modeled Irradiance (Land)

SW Terra (Morning) Data Stream Compared to Aqua (GOES & Interpolated) Wm^{-2}					
Terra Mean (MODIS Clouds)		Aqua Mean	Bias	RMS	N
611	GOES Clouds	609	-2	65	15528
620	Interpolated Clouds	619	-1	60	37960

SW Aqua (Afternoon) Data Stream Compared to Terra (GOES & Interpolated) Wm^{-2}					
Aqua Mean (MODIS Clouds)		Terra Mean	Bias	RMS	N
594	GOES Clouds	604	10	63	17168
597	Interpolated Clouds	609	12	66	37140

LW Cloud Forcing (Model Irradiance)

LW Terra (Morning) Data Stream Compared to Aqua (GOES & Interpolated) Wm^{-2}								
	TOA Ocean		TOA Land		Surface Ocean		Surface Land	
	Terra Mean	Bias	Terra Mean	Bias	Terra Mean	Bias	Terra Mean	Bias
Aqua GOES	-26	0	-24	-1	30	0	22	1
Aqua Interpolated	-26	-1	-22	-2	26	0	21	2

LW Aqua (Afternoon) Data Stream Compared to Terra (GOES & Interpolated) Wm^{-2}								
	TOA Ocean		TOA Land		Surface Ocean		Surface Land	
	Aqua Mean	Bias	Aqua Mean	Bias	Aqua Mean	Bias	Aqua Mean	Bias
Terra GOES	-29	1	-29	2	26	-1	25	0
Terra Interpolated	-27	1	-29	1	26	0	26	-2

SW Cloud Forcing (Model Irradiance)

SW Terra (Morning) Data Stream Compared to Aqua (GOES & Interpolated) Wm^{-2}								
	TOA Ocean		TOA Land		Surface Ocean		Surface Land	
	Terra Mean	Delta	Terra Mean	Delta	Terra Mean	Delta	Terra Mean	Delta
Aqua GOES	181	-4	113	-4	-203	6	-140	-1
Aqua Interpolated	157	-1	109	-3	-175	3	-138	0

SW Aqua (Afternoon) Data Stream Compared to Terra (GOES & Interpolated) Wm^{-2}								
	TOA Ocean		TOA Land		Surface Ocean		Surface Land	
	Aqua Mean	Delta	Aqua Mean	Delta	Aqua Mean	Delta	Aqua Mean	Delta
Terra GOES	167	-10	118	-11	-185	11	-149	11
Terra Interpolated	157	-5	126	-11	-174	6	-159	12

Summary

- Overall comparison are good.
- Problem areas include:
  - TOA LW over land comparison of Aqua Observations to Terra GOES/Interpolated values; GOES retrievals are about 2.5% too warm and 2% too bright.
  - Modeled SW Surface down based on GOES imager clouds is generally 1% - 2% larger than modeled SW surface down from CERES/MODIS clouds.
  - Finding some “significant (7%-9%)” differences in SW cloud forcing between modeled fluxes using MODIS clouds versus GOES & Imager clouds.

TOA LW Observed Irradiance, Ocean Grid Boxes

LW Terra (Morning) Data Stream Compared to Aqua (GOES & Interpolated) Wm^{-2}					
Terra CERES Mean		Aqua Imager Mean	Bias	RMS	N
250	GOES	250	0	12	8489
251	Interpolated	251	0	14	13818

LW Aqua (Afternoon) Data Stream Compared to Terra (GOES & Interpolated) Wm^{-2}					
Aqua CERES Mean		Terra Imager Mean	Bias	RMS	N
248	GOES	250	2	17	8751
251	Interpolated	253	2	12	13068

TOA SW Observed Irradiance, Ocean Grid Boxes

SW Terra (Morning) Data Stream Compared to Aqua (GOES & Interpolated) Wm^{-2}					
Terra CERES Mean		Aqua Imager Mean	Bias	RMS	N
257	GOES	256	-1	36	8531
232	Interpolated	233	1	42	14004

SW Aqua (Afternoon) Data Stream Compared to Terra (GOES & Interpolated) Wm^{-2}					
Aqua CERES Mean		Terra Imager Mean	Bias	RMS	N
237	GOES	237	0	33	8947
228	Interpolated	230	2	40	13416