Surface and Top of the Atmosphere Radiative Fluxes at High Latitudes

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Outline

- Information on shortwave (SW) radiative fluxes at global and regional scales is available from satellites
- At global scale, inference schemes are generally driven with the International Satellite Cloud Climatology Project (ISCCP) data
- MODIS (Terra and Aqua) is a more recent observing system, with 36 spectral channels; provides improved information on the state of the atmosphere and the surface (aerosols, cloud optical depth, surface conditions); information needed for inferring radiative fluxes is available both at 5-km and 1^0 resolution
- In this presentation, results and evaluation of radiative fluxes from Terra and Aqua at 1^0 resolution will be presented in the context of other available estimates

MODIS Methodology and Evaluation in mid-latitudes is presented in:

- Wang, H, and R T Pinker, 2009. Shortwave radiative fluxes from MODIS: Model development and implementation. JOURNAL OF GEOPHYSICAL RESEARCH-ATMOSPHERES, 114, D20201.
- Pinker, RT; Wang, HM; Grodsky, SA, 2009. How good are ocean buoy observations of radiative fluxes? GEOPHYSICAL RESEARCH LETTERS, 36, L10811.
- The SW radiative fluxes are computed from MODIS level-2 swath products (MOD04-aerosol, MOD06-cloud, MOD0-profile).
- Inference scheme will be referred to as:

  UMD _MODIS

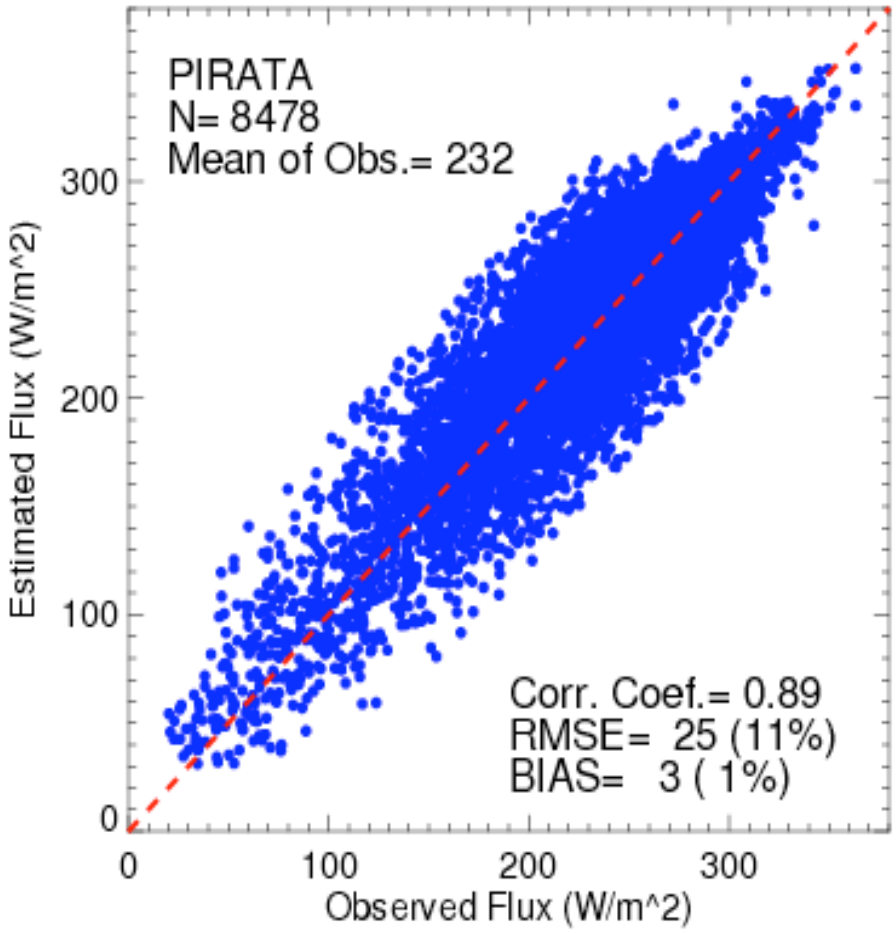
Evaluation of UMD_MODIS SW fluxes against observations from:

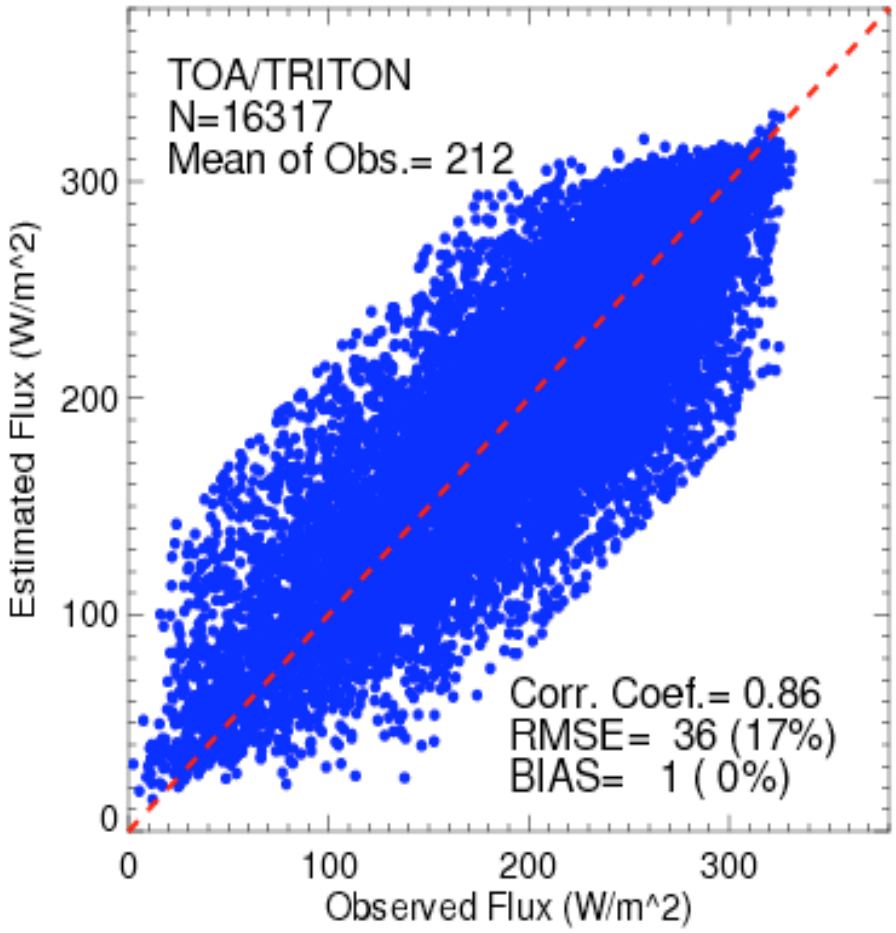
- Tropical Atmosphere Ocean (TAO) Triangle Trans-Ocean Buoy Network (TRITON) Array: 33 buoys
- Pilot Research Moored Array in the Atlantic (PIRATA): 10 buoys
- Baseline Surface Radiation Network (BSRN): 18 sites over land
- Observations of “opportunity”
- Period of observations:

  January 1, 2003-December 31, 2005

Daily mean surface SW flux estimated by UMD_MODIS against PIRATA and TAO/TRITON buoys over the Atlantic and Pacific Oceans

January 2003-December 2005

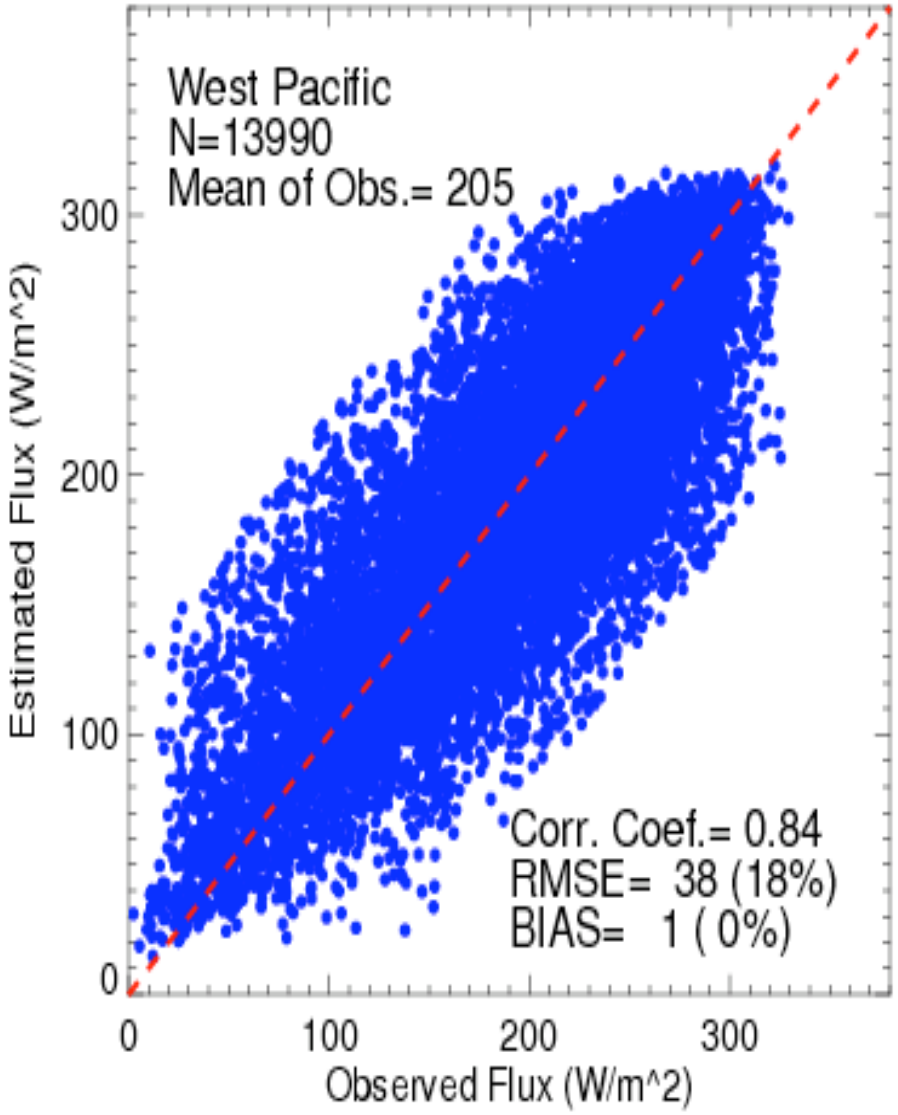


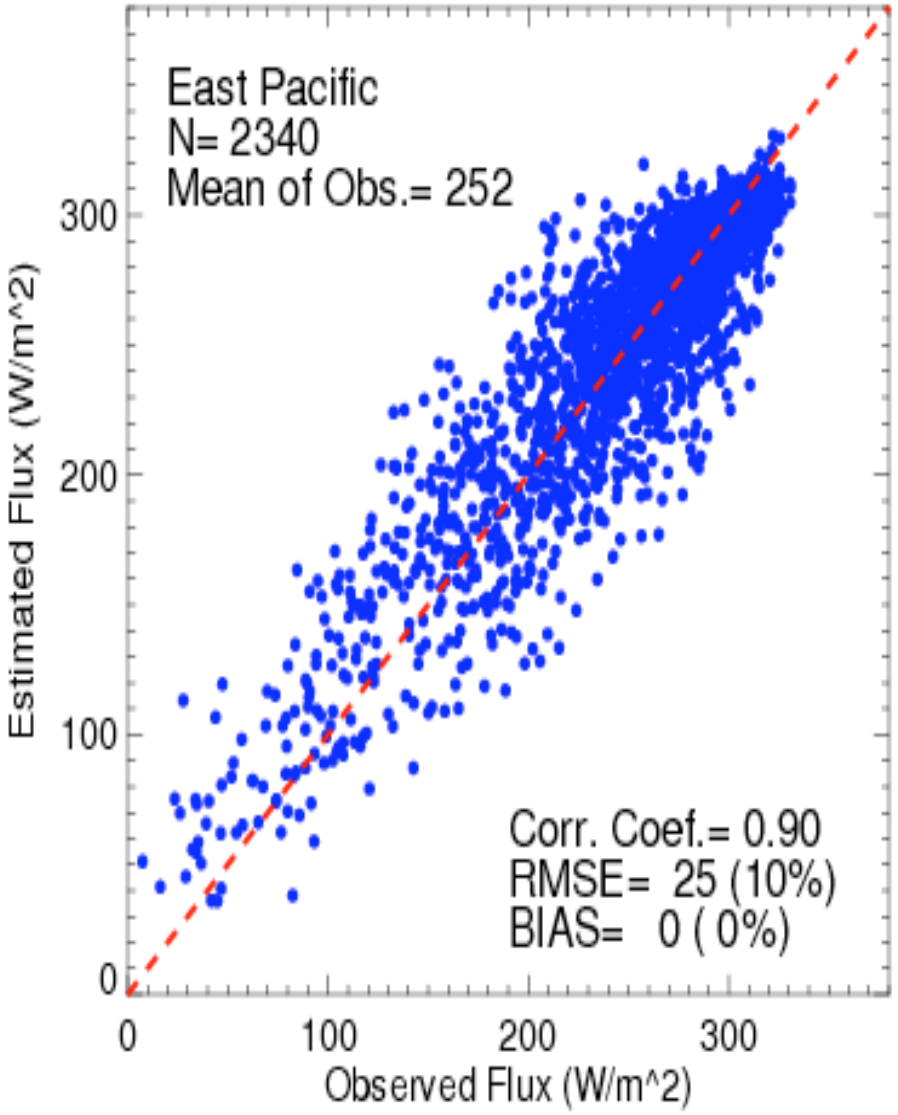


Daily mean surface SW flux estimated by UMD_MODIS against TAO/TRITON buoys over Pacific

January 2003-December 2005

Cases eliminated: 1.2% (West Pacific); 1.6% (East Pacific)

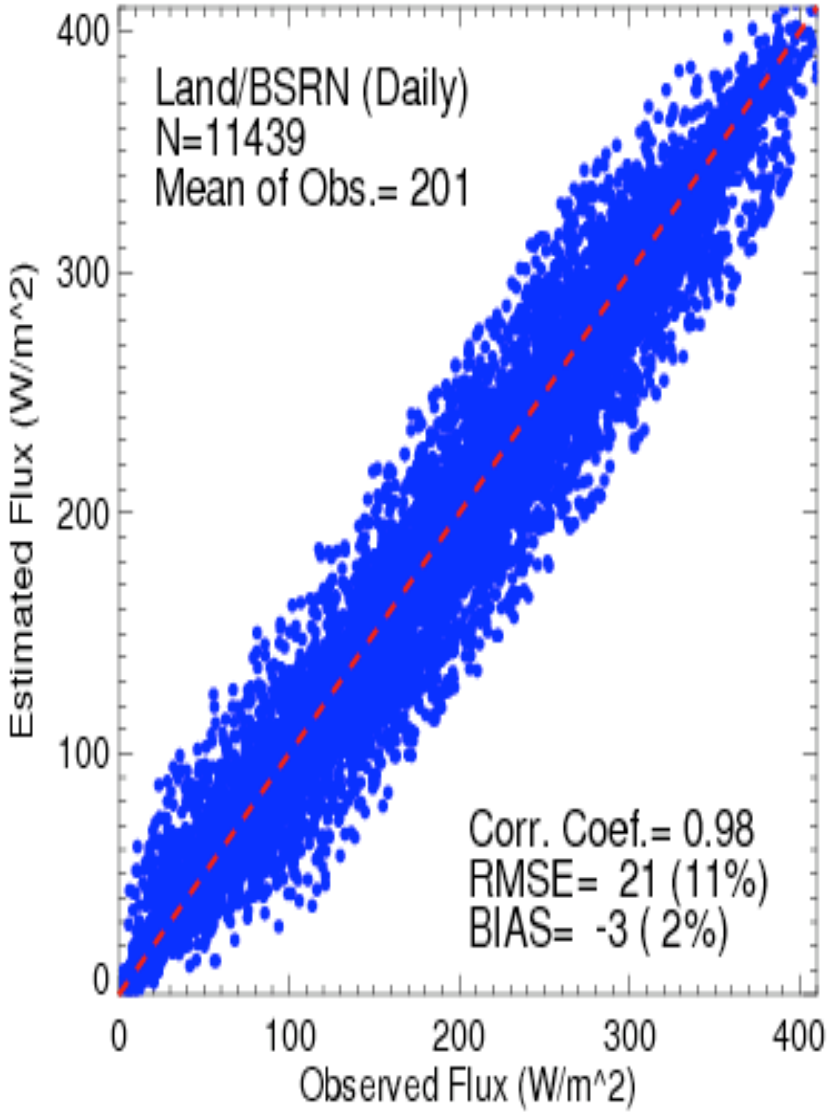


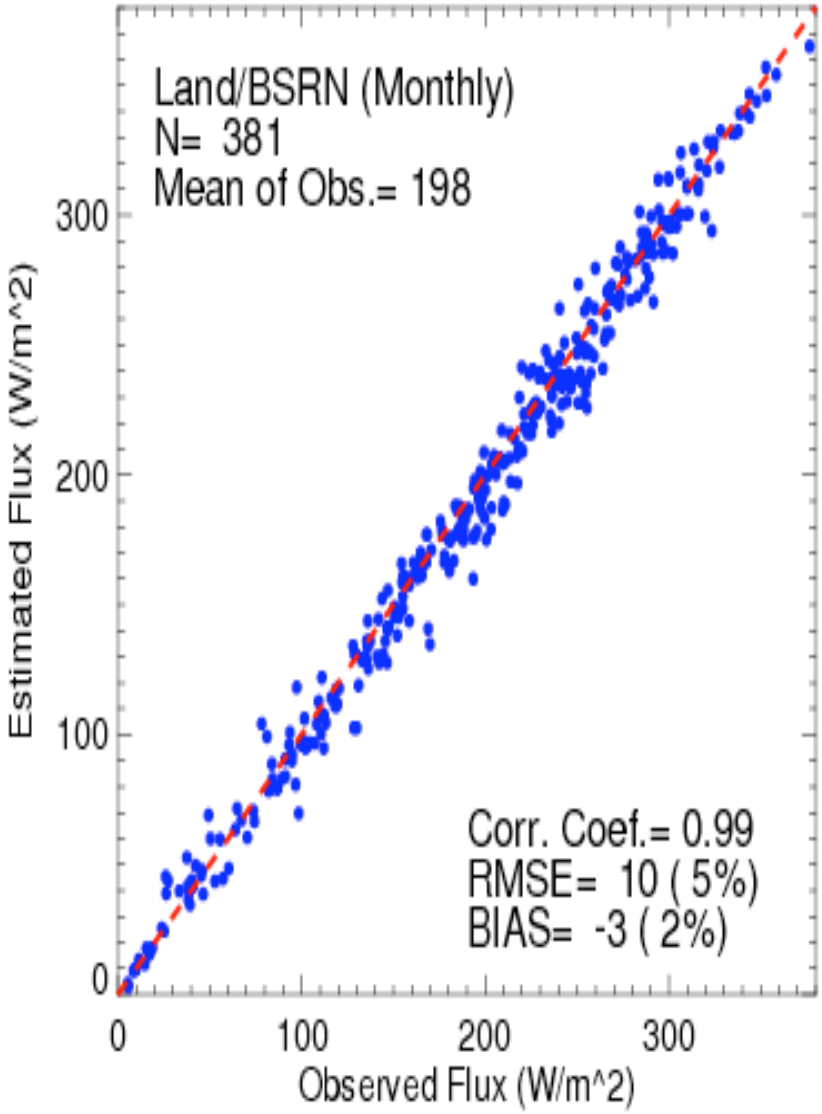


Daily and monthly mean SW flux estimated by UMD_MODIS against BSRN measurements over land

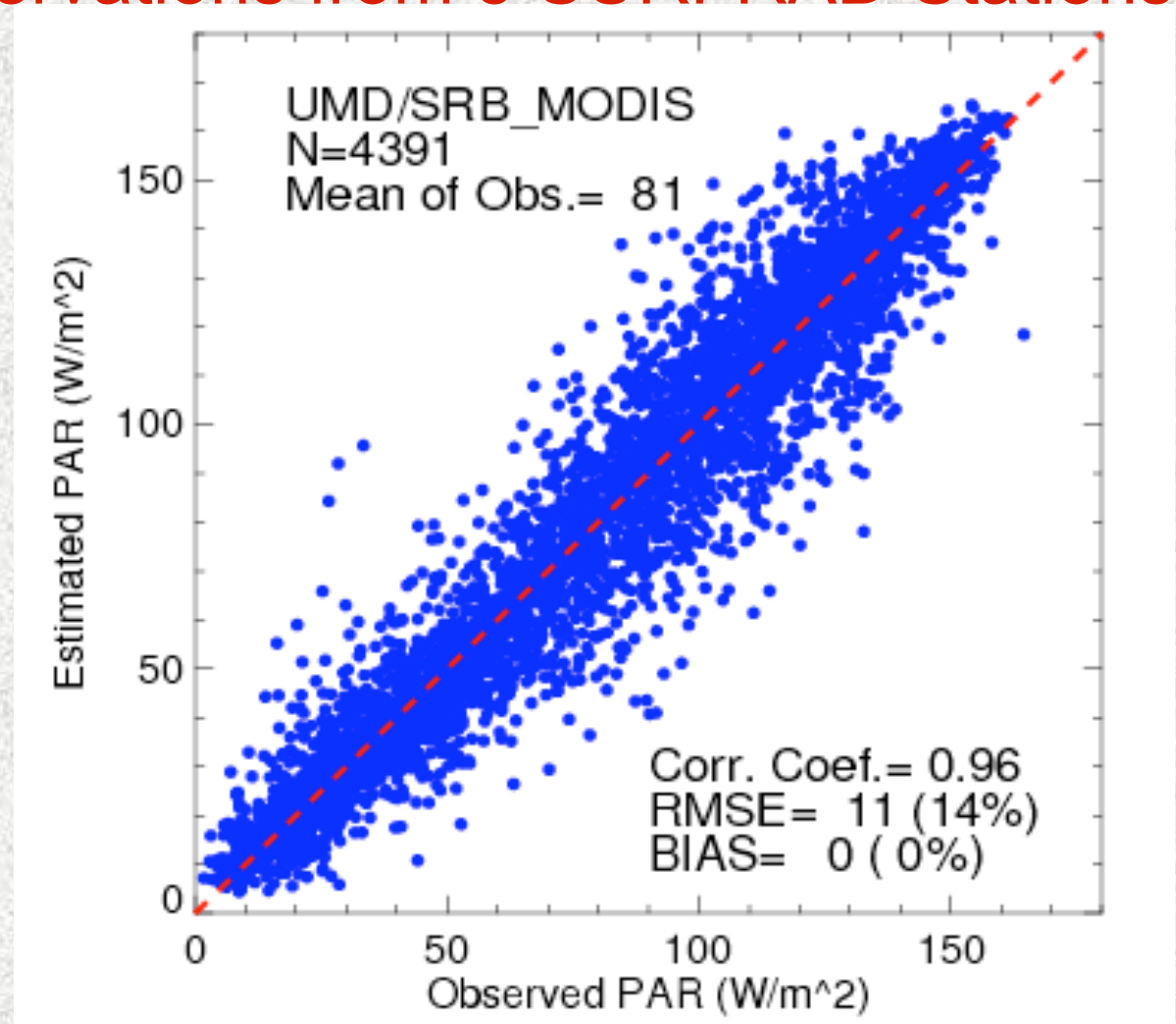
January, 2003-December, 2005)

Cases eliminated: 1.6% (Daily)





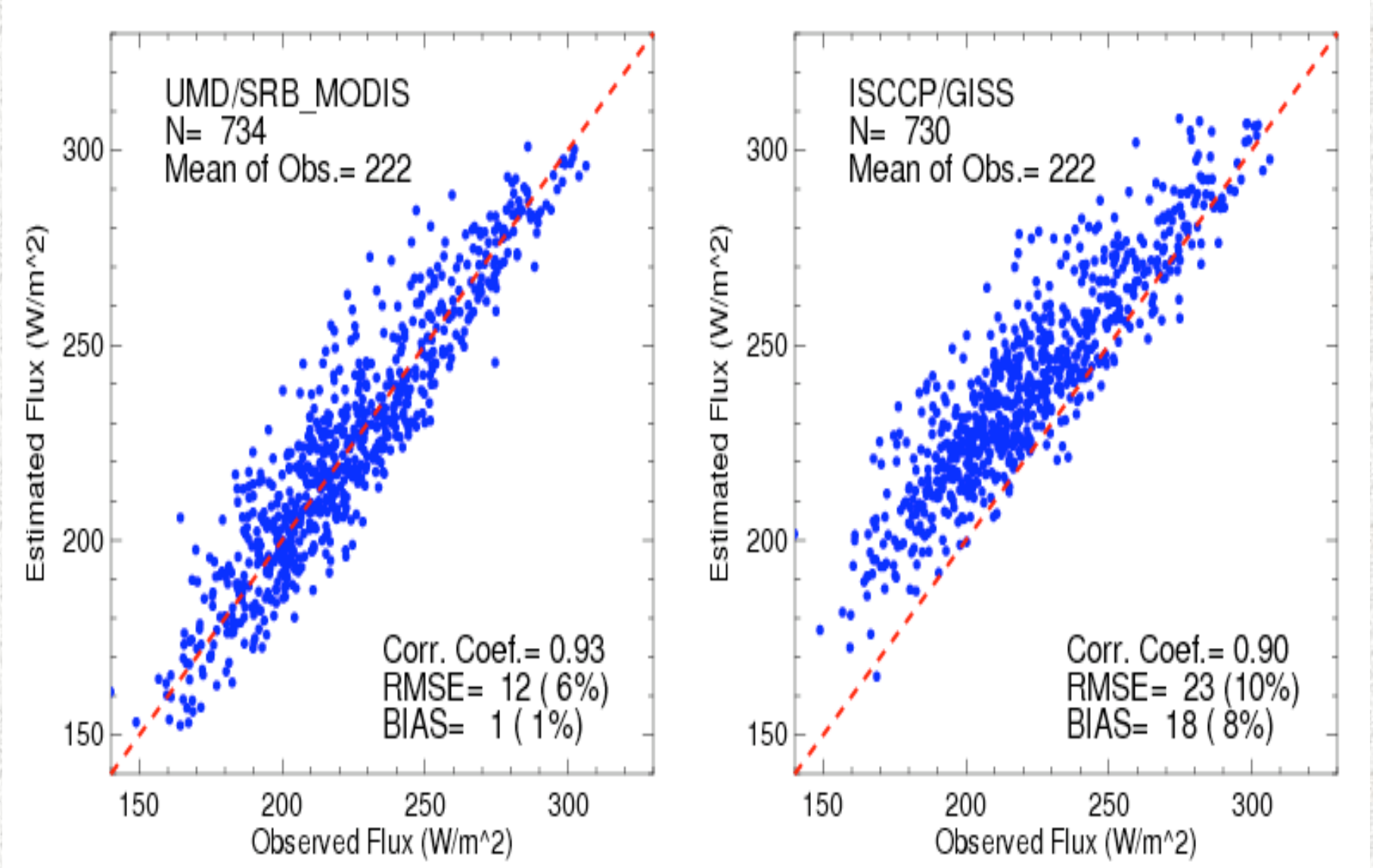
Comparison of Photosynthetically Active Radiation (PAR) from UMD_MODIS against Observations from 5 SURFRAD Stations over US



January 2003-December 2005

Monthly mean surface SW flux estimated by UMD_MODIS and ISCCP-FD against PIRATA and TAO/TRITON buoys

Cases eliminated: 1.3% (UMD/SRB_MODIS; 1.9% (ISCCP-FD)



Information on BSRN sites at High Latitudes used in this study

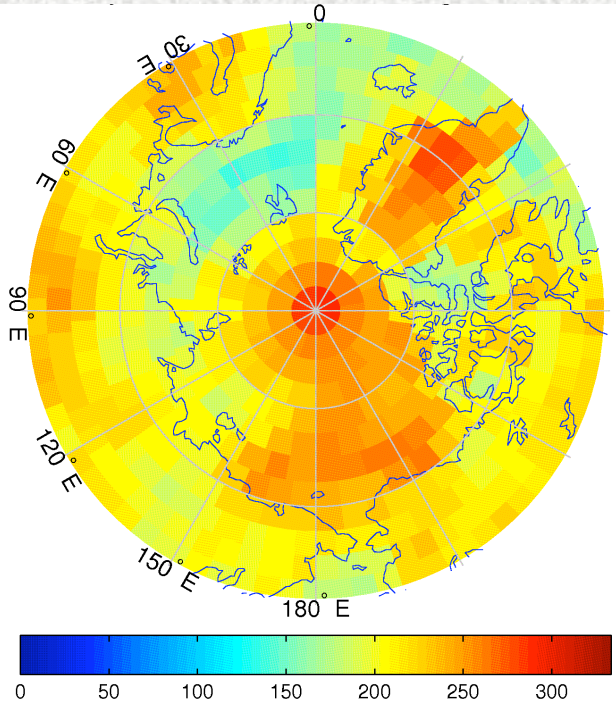
BSRN Site	Abbrev.	Latitude	Longitude
NY-Alesund, Spitsbergen	NYA	78.93^{0}N	11.95^{0}E
Barrow, Alaska	BAR	71.32^{0}N	156.61^{0}W
George von Neumayer, Antarctica	GVN	70.65^{0}S	8.25^{0}W
Syowa, Cosmonaut Sea	SYO	69.01^{0}S	39.59^{0}E
South Pole, Antarctica	SPO	89.98^{0}S	24.80^{0}W

Data Used for Comparison at High Latitudes

Name of Data	Organization	Spatial Res	Temporal Res	Available
UMD_MODIS	UMD	1^0	Twice per day	2003 -2006
CERES/SRBAVG	NASA CERES	1^0	Monthly	2000-2005
GEWEX-LaRC	NASA/Langley	1^0	3 hourly; Daily; Monthly	1983-2007
Extended AVHRR/App	CIMSS/Polar Remote Sensing and Climatology Group	25 km	Twice per day	1982 - 2004
ISCCP-FD	NASA/GISS	2.5^0	3 hourly; Monthly	1983-2007
UMD_ISCCP (D1 and DX)	UMD	2.5^0; 0.5^0	3 hourly; Daily; Monthly	1983-2004

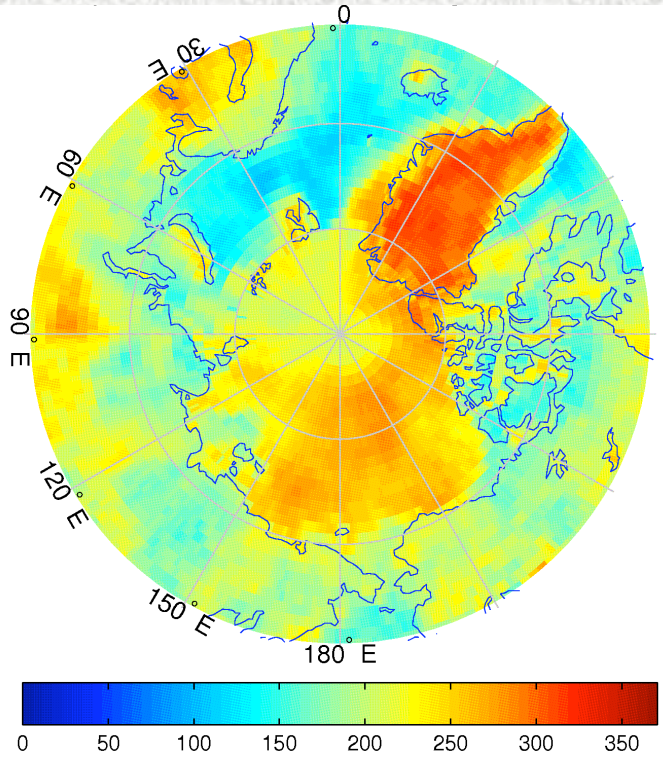
Examples of Global Products at High Latitudes

ISCCP-FD Monthly Mean SW 2005/07



Available globally for 1983-2007 at 2.5^0

UMD_MODIS Monthly Mean SW 2005/07

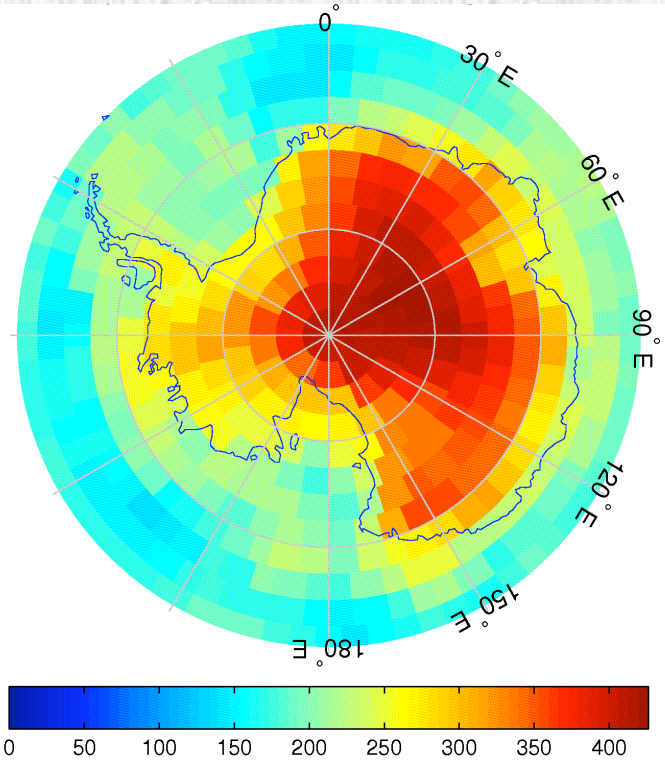


Available globally for 2003--2006 at 1^0

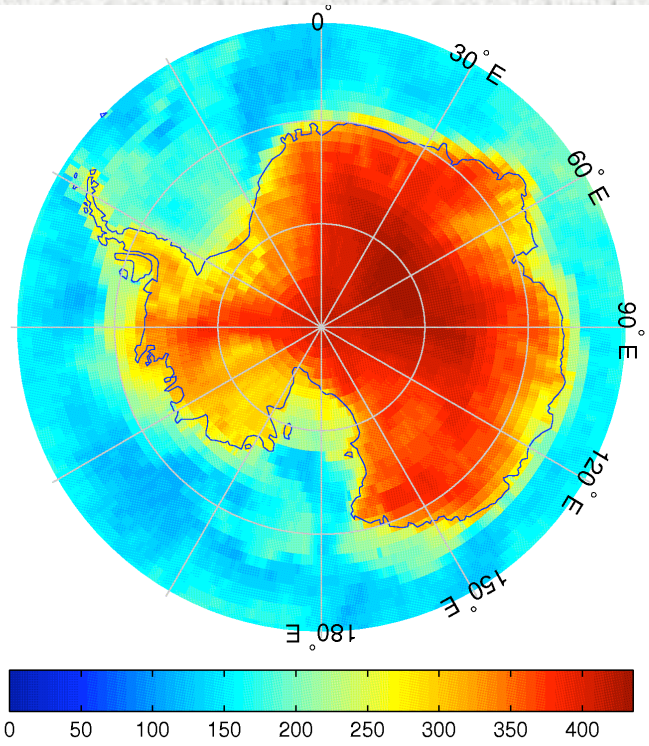
North Pole

Examples of Global Products

ISCCP-FD Monthly Mean SW
2005/01

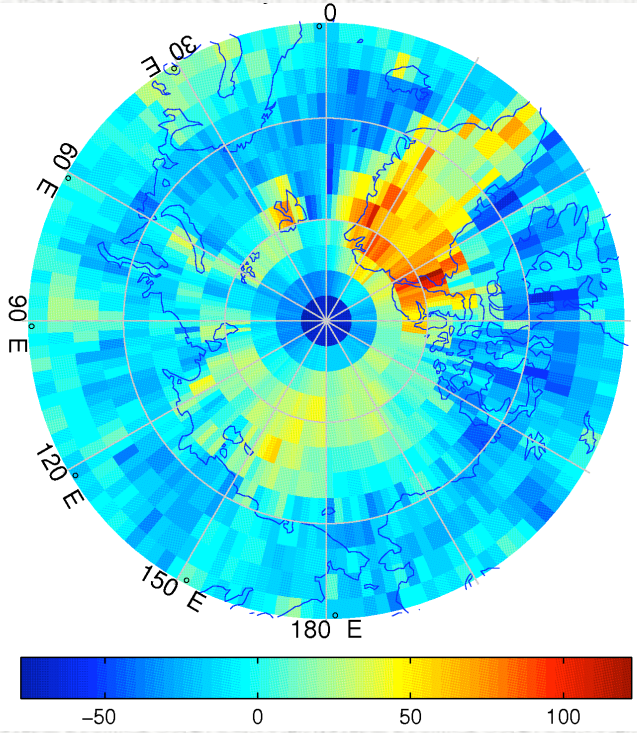


UMD_MODIS Monthly Mean SW
2005/7

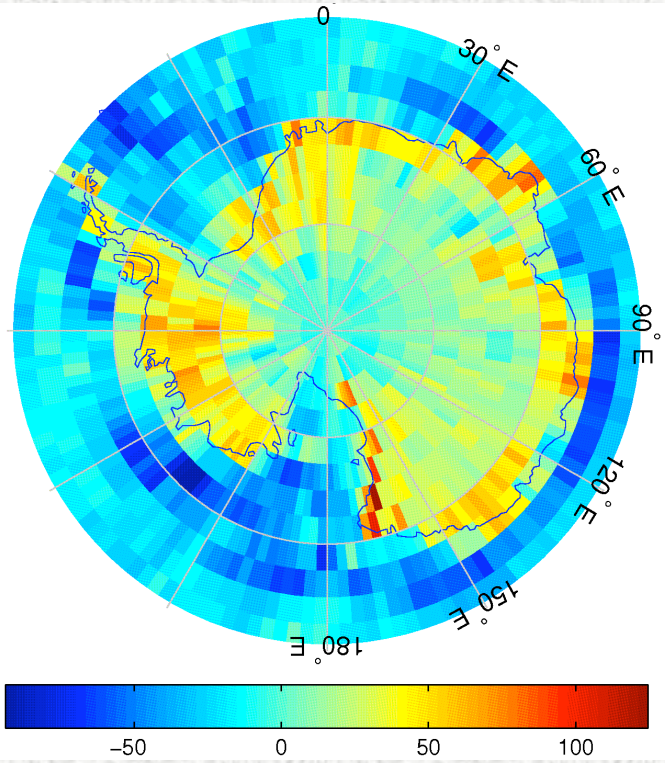


South Pole

2005/07



2005/01

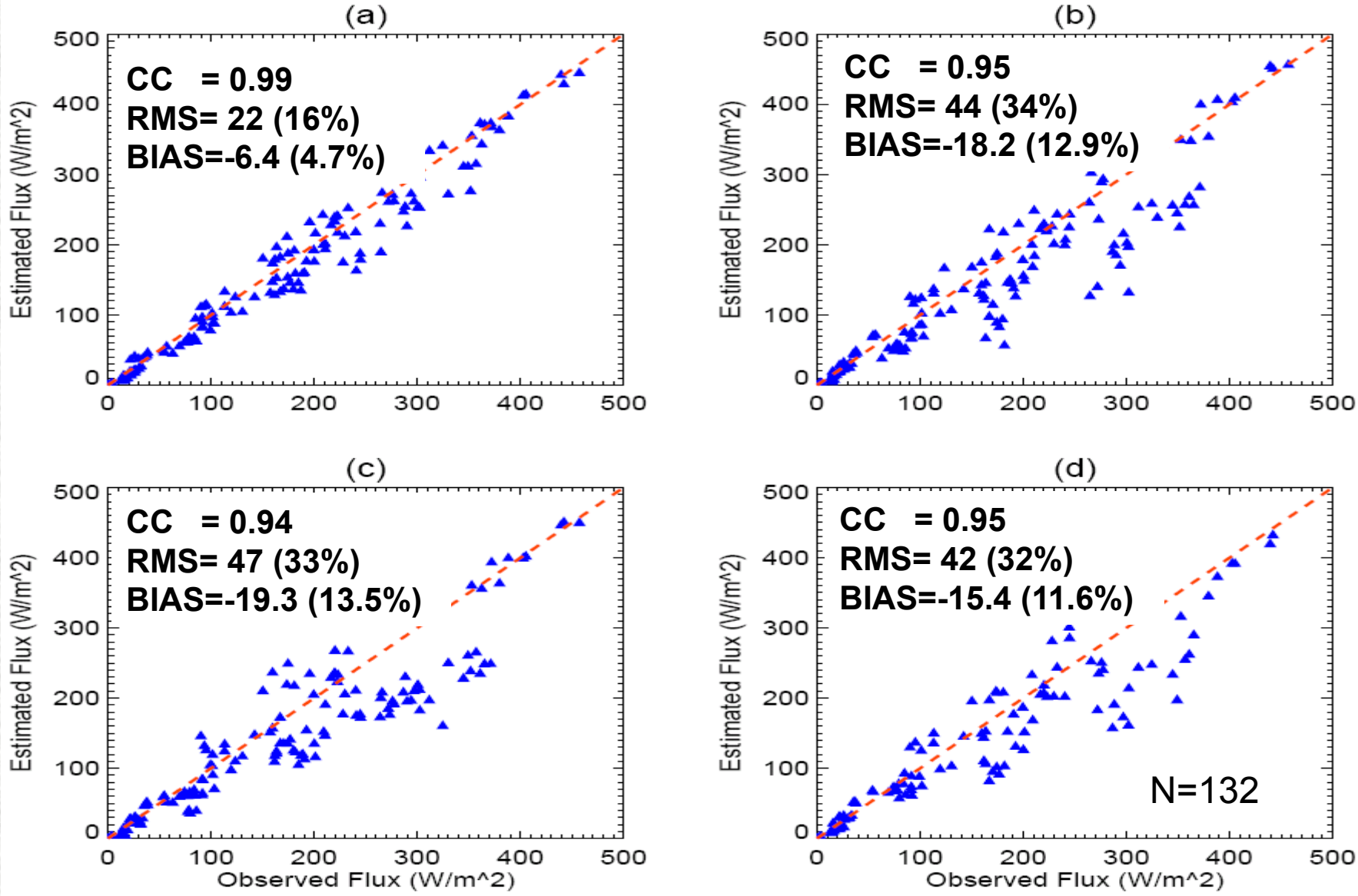


Difference between UMD_MODIS and ISCCP-FD Monthly Means

Notable differences at edges

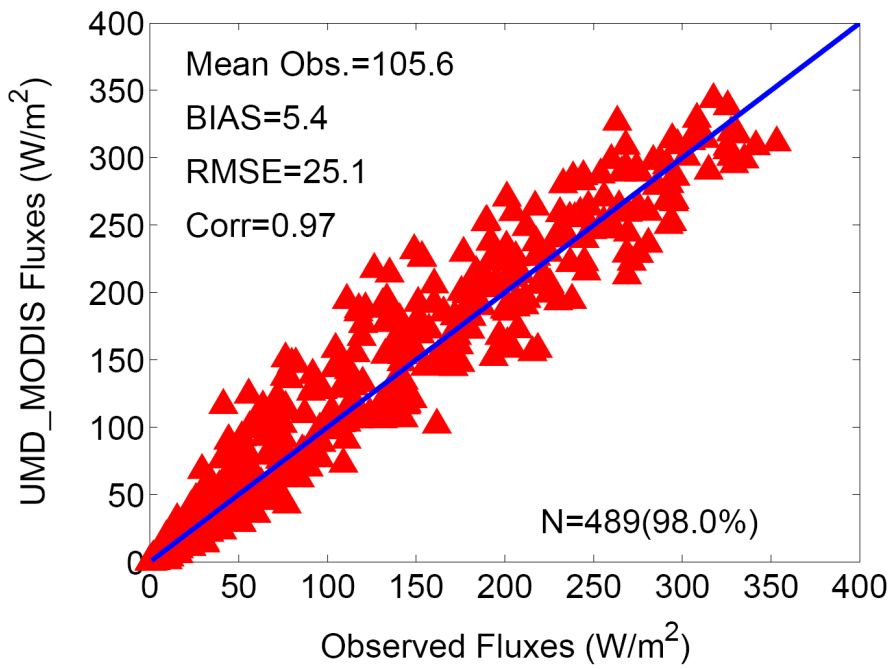
Evaluation of monthly mean SW satellite estimates over Arctic and Antarctica against BSRN stations BAR, NYA, GVN, SPO, SYO during (2003-2005)

Models: a) UMD_MODIS; b) GEWEX-LaRC; c) ISCCP-FD; d) CERES

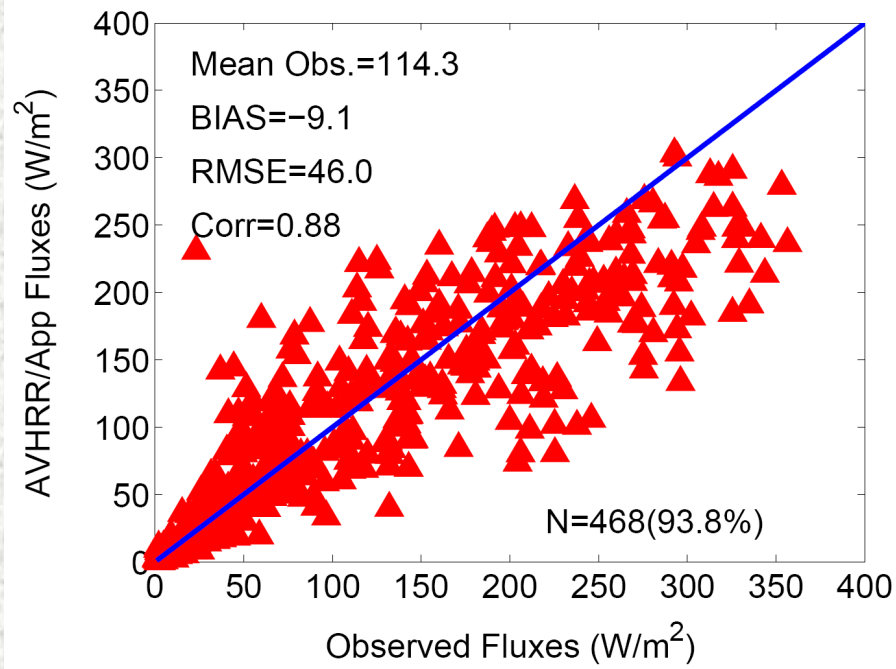


Evaluations of daily SW fluxes from UMD_MODIS, AVHRR/App, and UMD_ISCCP for site NYA (Jan 2003 - Dec 2004)

UMD_MODIS



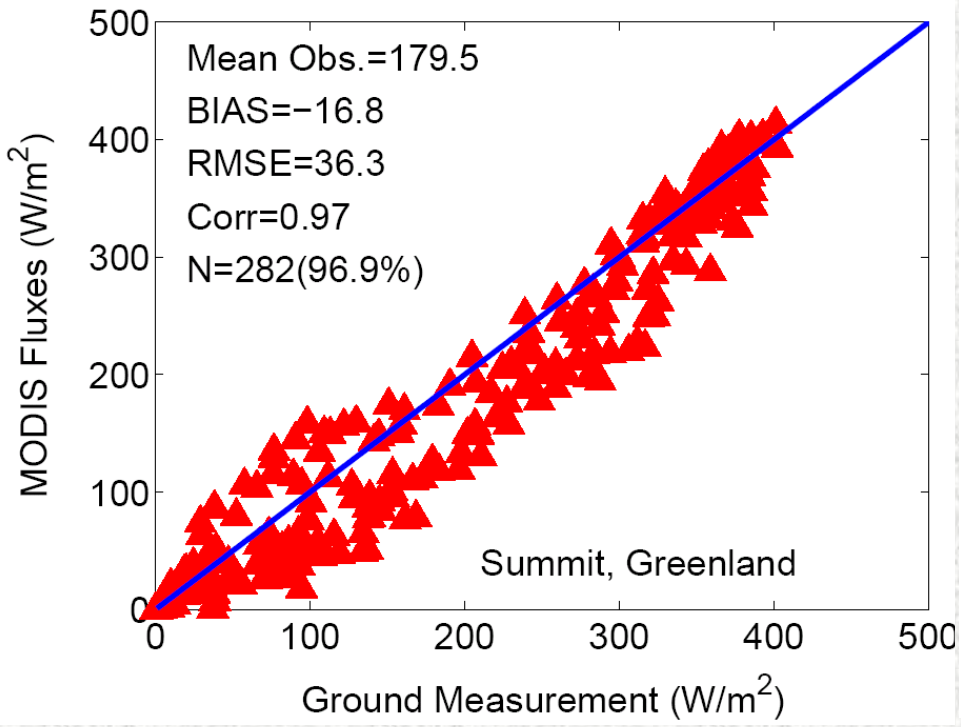
AVHRR/App



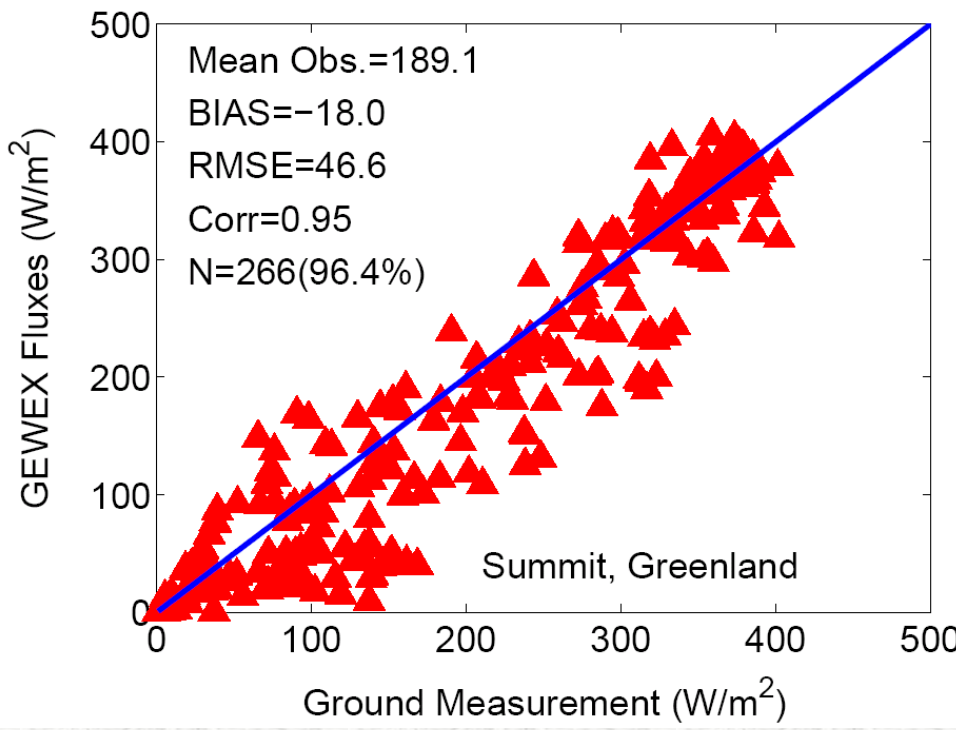
Source (Resolution)	*Correlation*	*Mean Obs.*	*RMSE (%)*	*BIAS (%)*
UMD_ISCCP (2.5^0)	0.84	138	50 (36)	-5 (4)

Evaluations at Summit, Greenland

UMD_MODIS



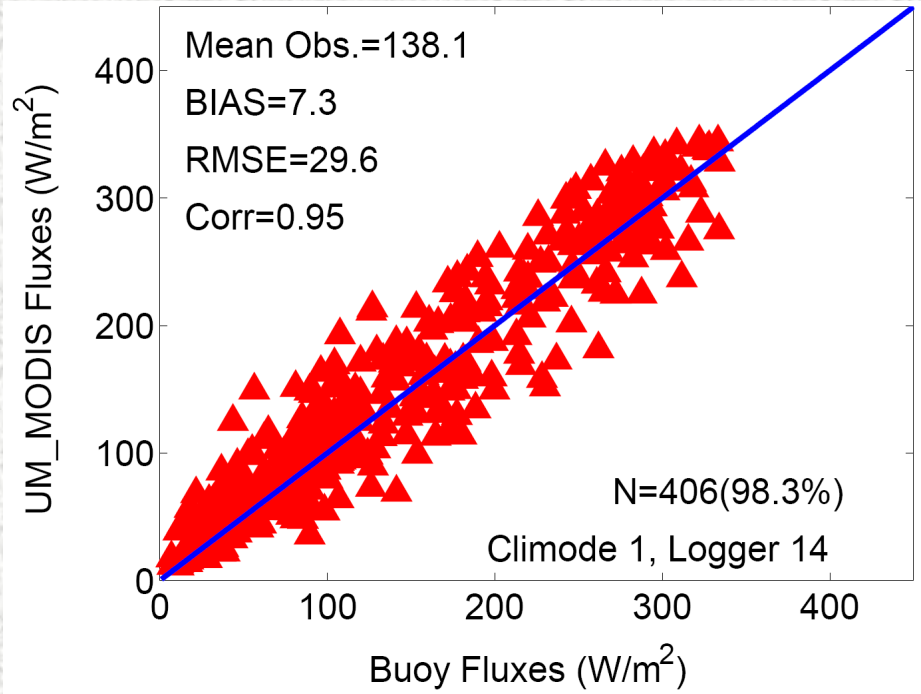
GEWEX-LaRC



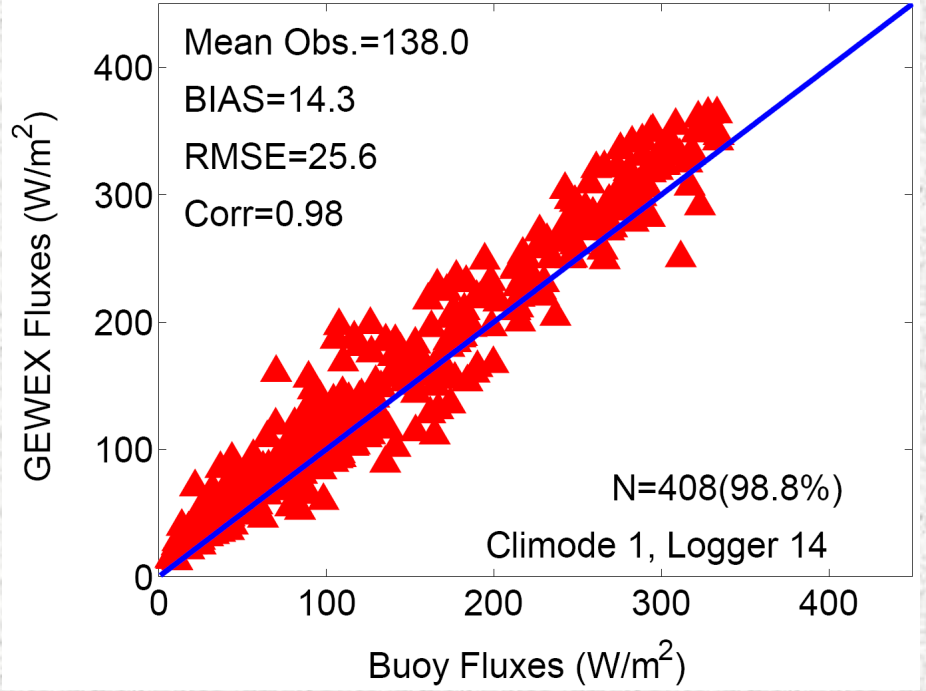
Daily averaged SW fluxes for year 2006

Evaluations at CLIMODE buoy (38^0N, 65^0W) for period (Nov 14, 2005 – Dec 31, 2006) at daily time scale (eliminate 3-SD data)

UMD_MODIS



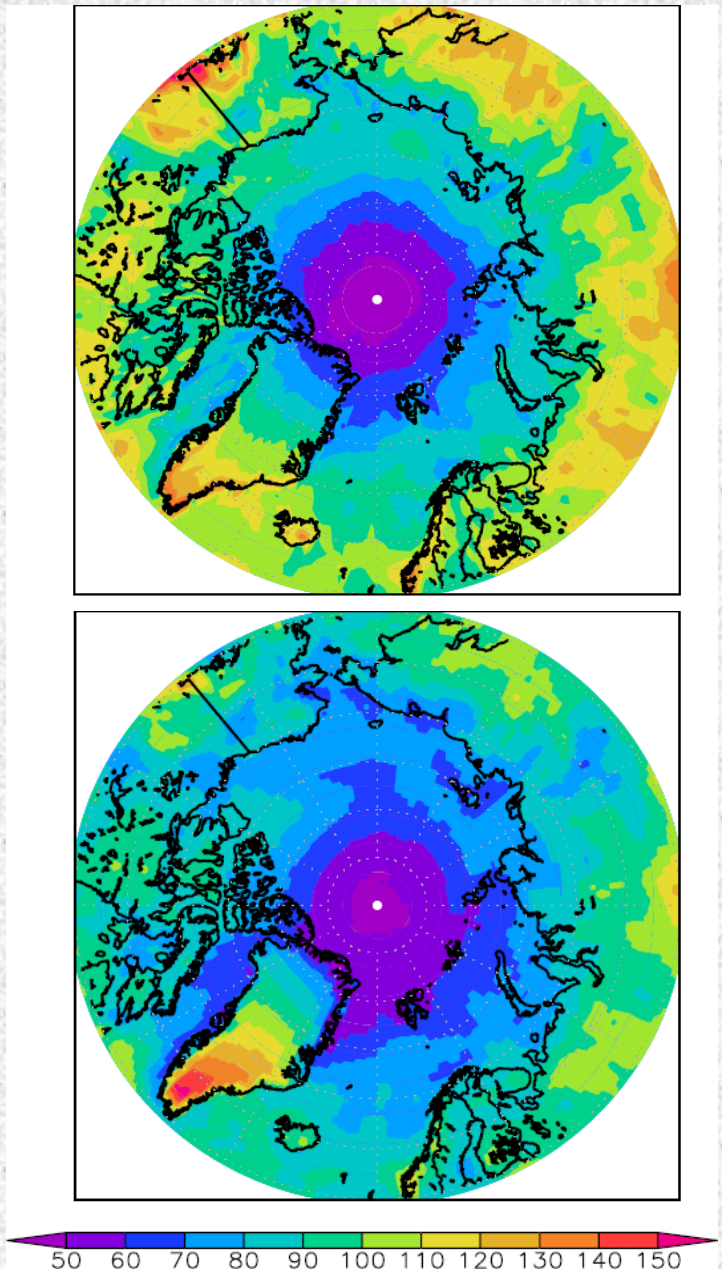
GEWEX



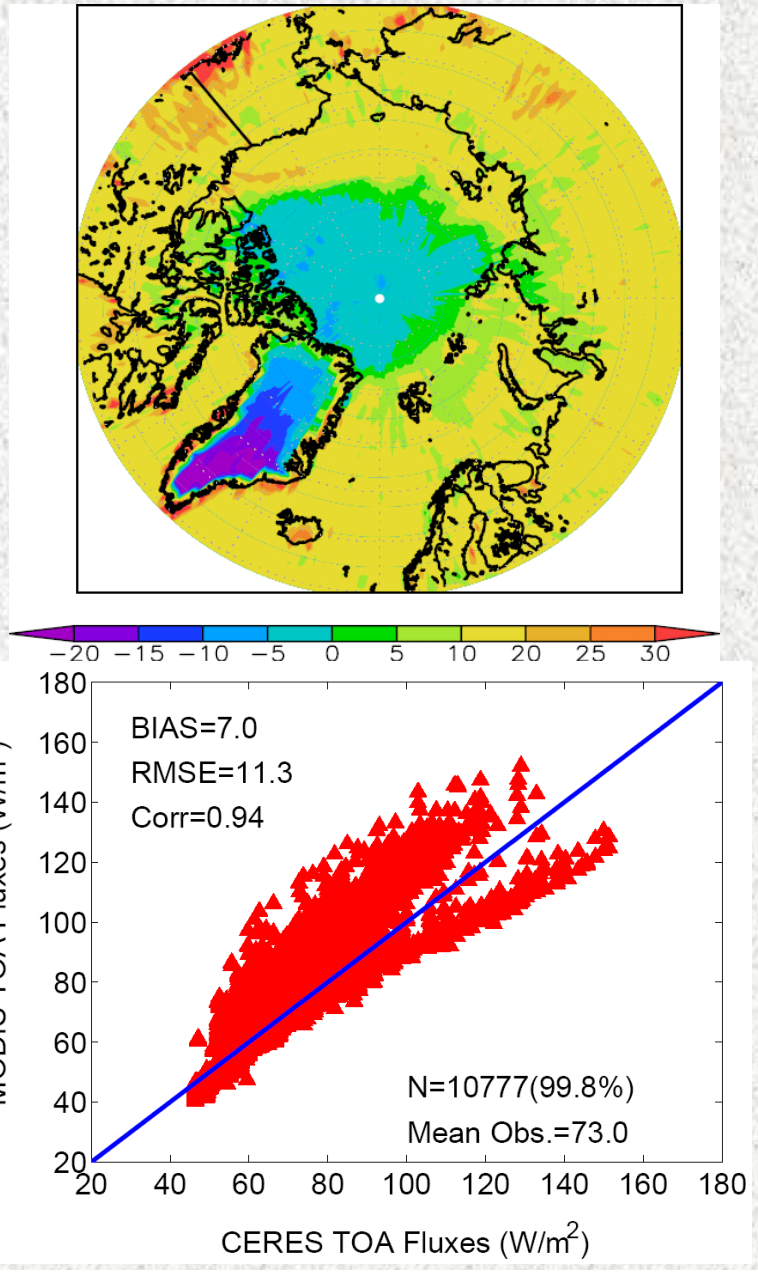
Sep. 2004 Monthly Mean TOA SW Fluxes from UMD_MODIS (1^0) and CERES observations (SRBAVG/Terra product, 1^0)

MODIS

CERES



MODIS - CERES



Summary

- Methodology to derive surface SW radiative fluxes from MODIS observations was developed
- It was implemented at global scale (1^0 resolution) for 2003-2005
- Results of evaluation at daily and monthly time scales against ground measurements over land, water, and at high latitudes indicate good agreement with ground observations
- Additional evaluation at the TOA is needed
- Interested users can obtain this product upon request and feedbacks would be appreciated.