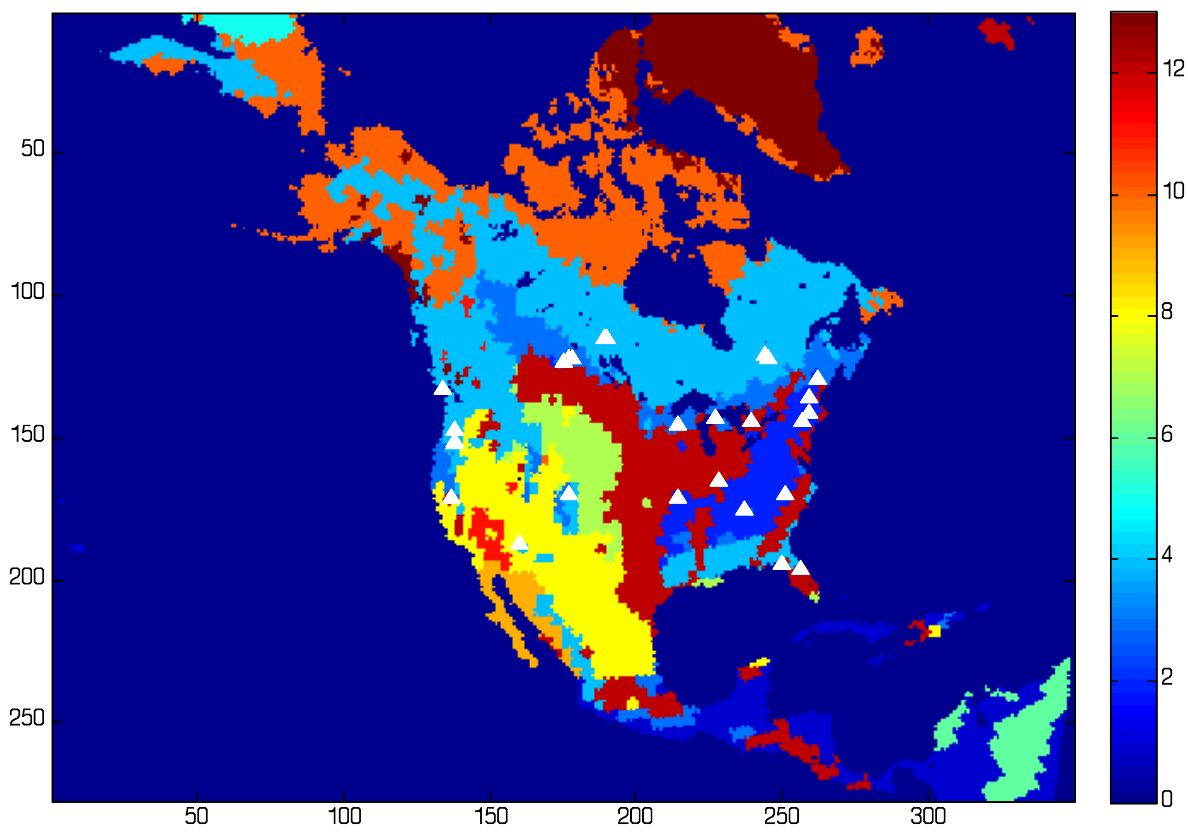
Fluxnet Radiation vs. NARR

Lei Zhao

Locations of Fluxnet Sites Analyzed

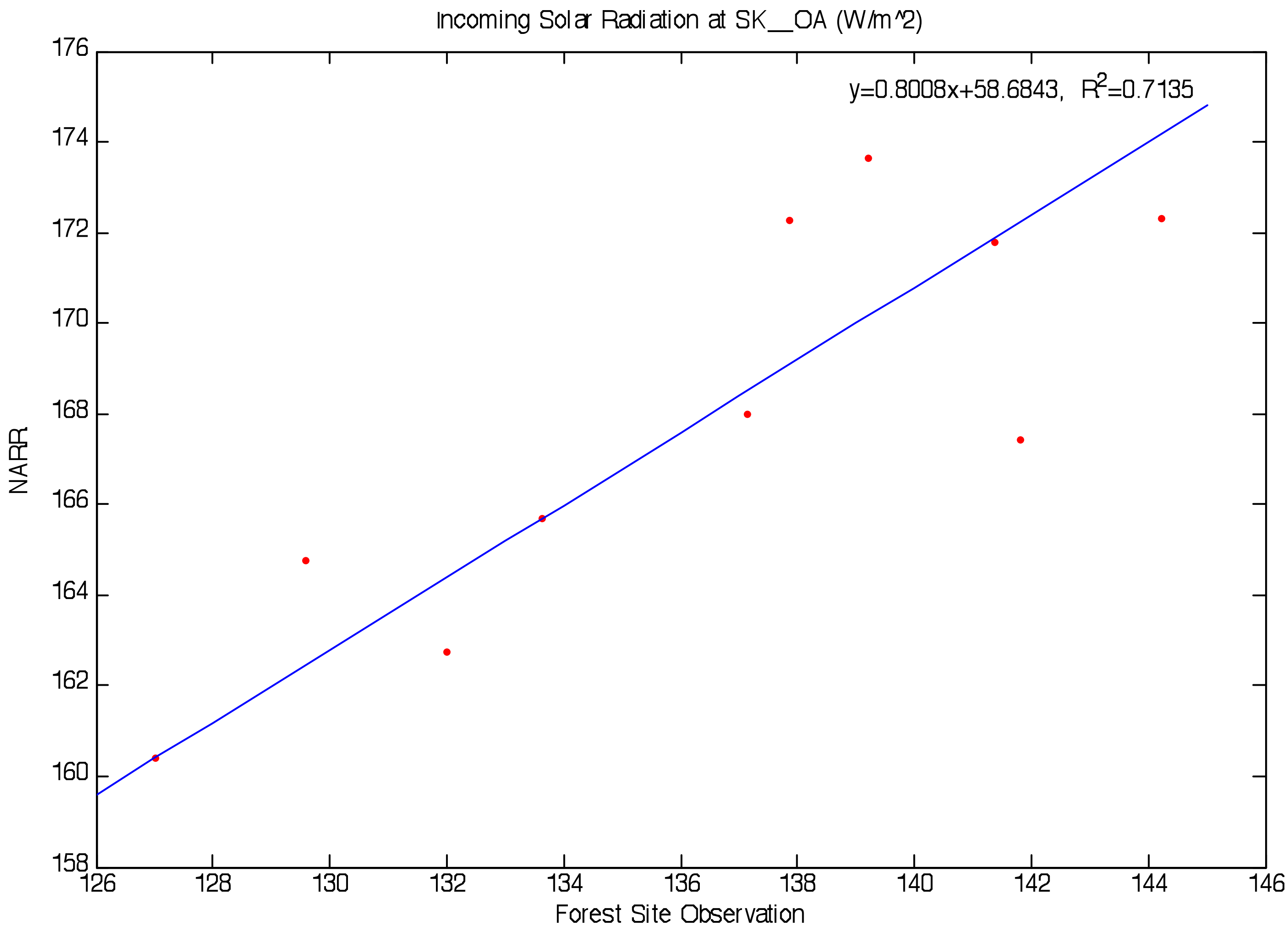


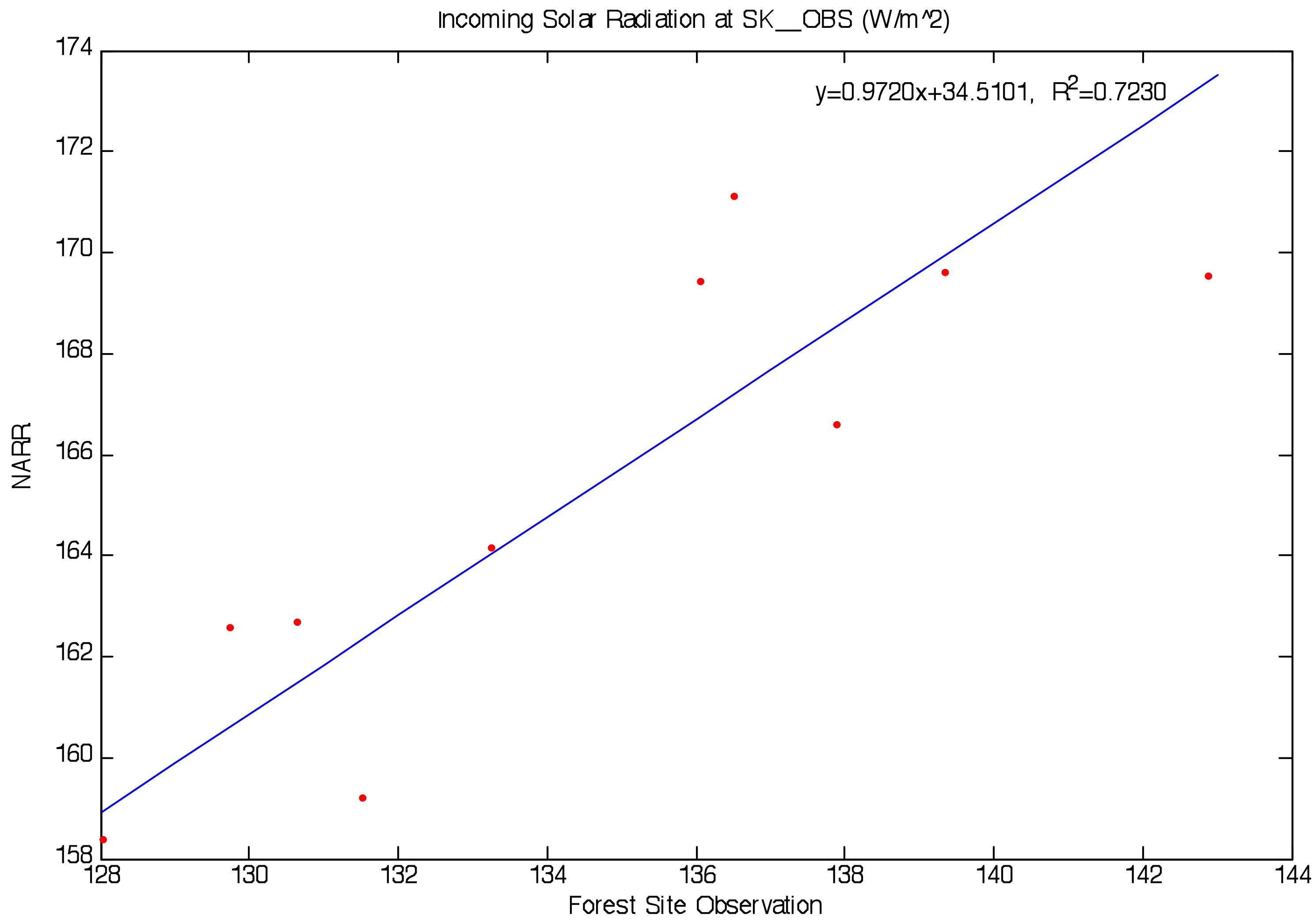
Surface Temperature: NARR vs. Obs.

- NARR surface temperature SYSTEMATICALY higher than sites' observations
- Evoke us to examine the incoming solar radiation

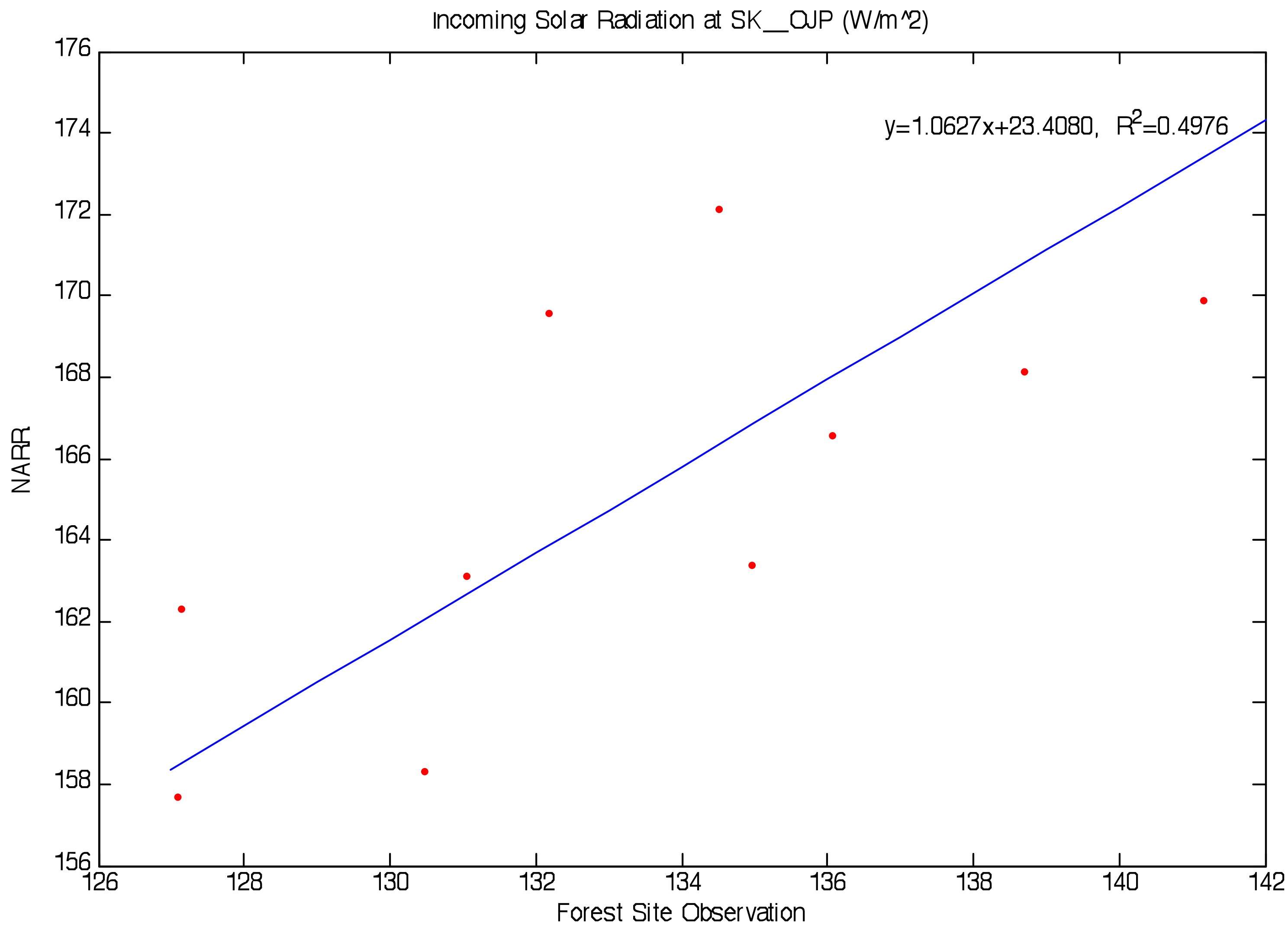
Linear Regression Analysis

- Geometric Mean Regression (GMR)
  - Allow both errors in two vectors (fitted data)
  - Do least square regressions twice
  - Geometric mean of the two

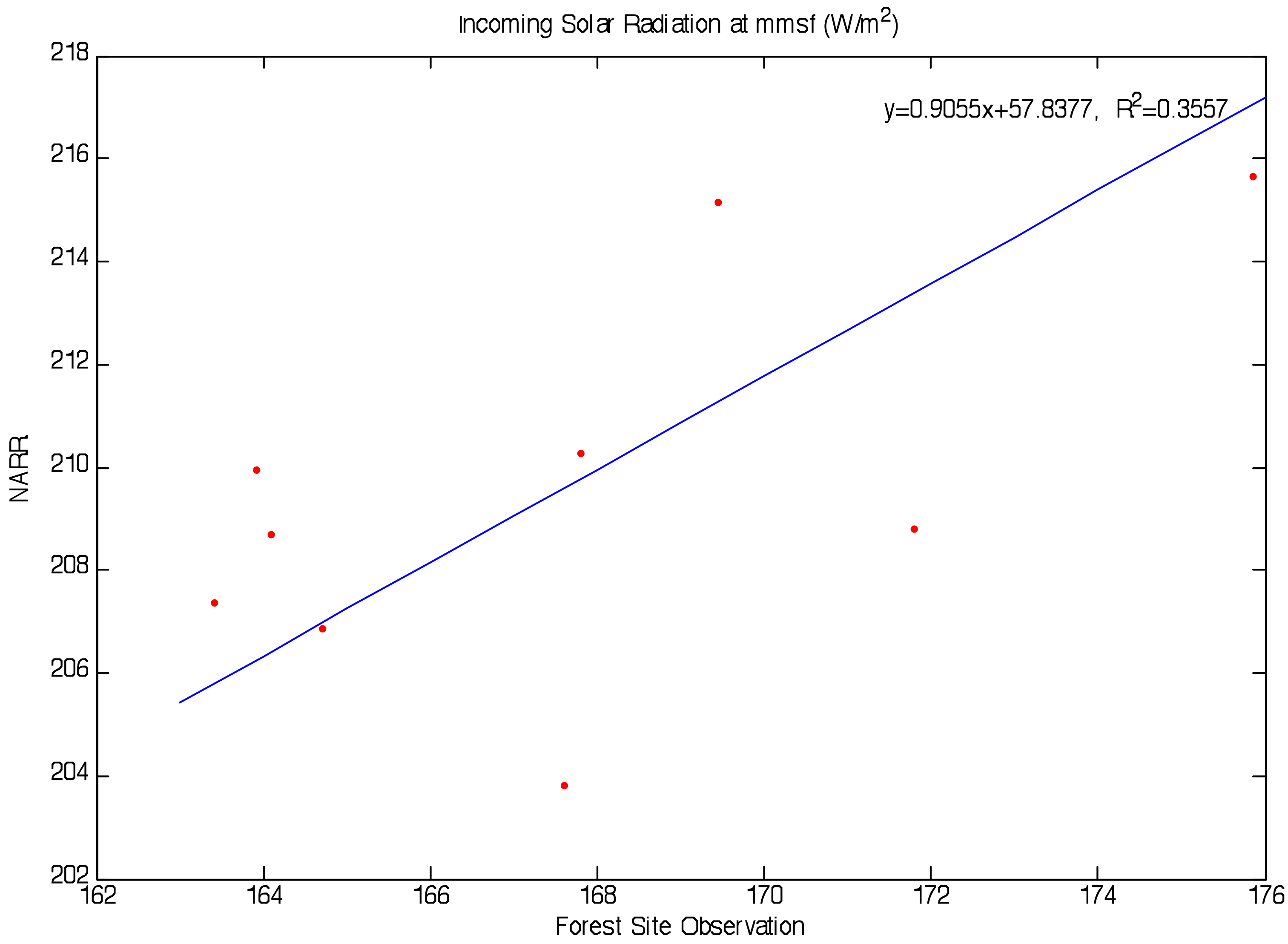

Incoming Solar Radiation at SK__OA (W/m^2)
y=0.8008x+58.6843, R^2=0.7135
NARR
Forest Site Observation
176
174
172
170
168
166
164
162
160
158
126
128
130
132
134
136
138
140
142
144
146

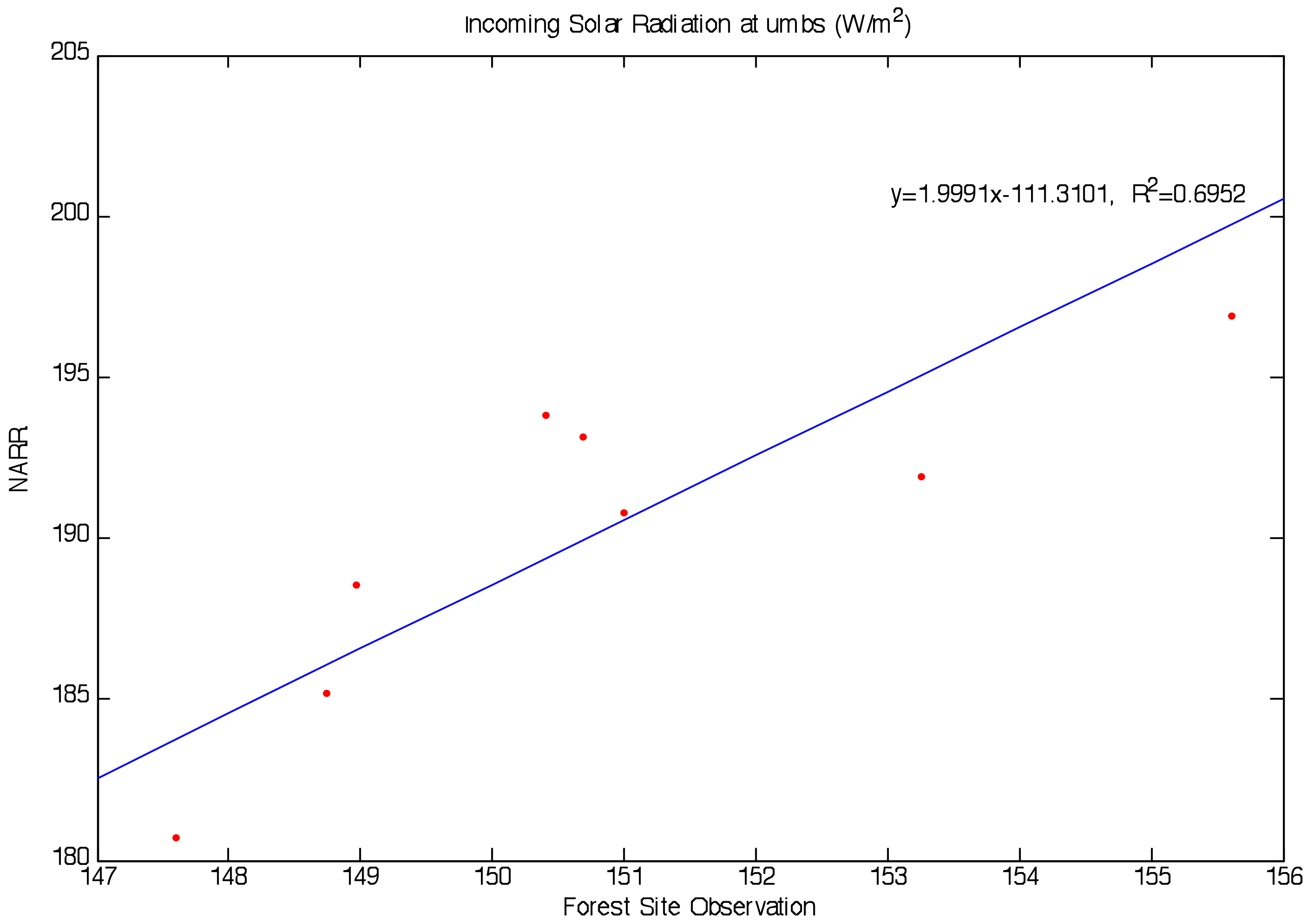


Incoming Solar Radiation at SK__OBS (W/m^2)
y=0.9720x+34.5101, R2=0.7230
174
172
170
168
166
164
162
160
158
NARR
128
130
132
134
136
138
140
142
144
Forest Site Observation

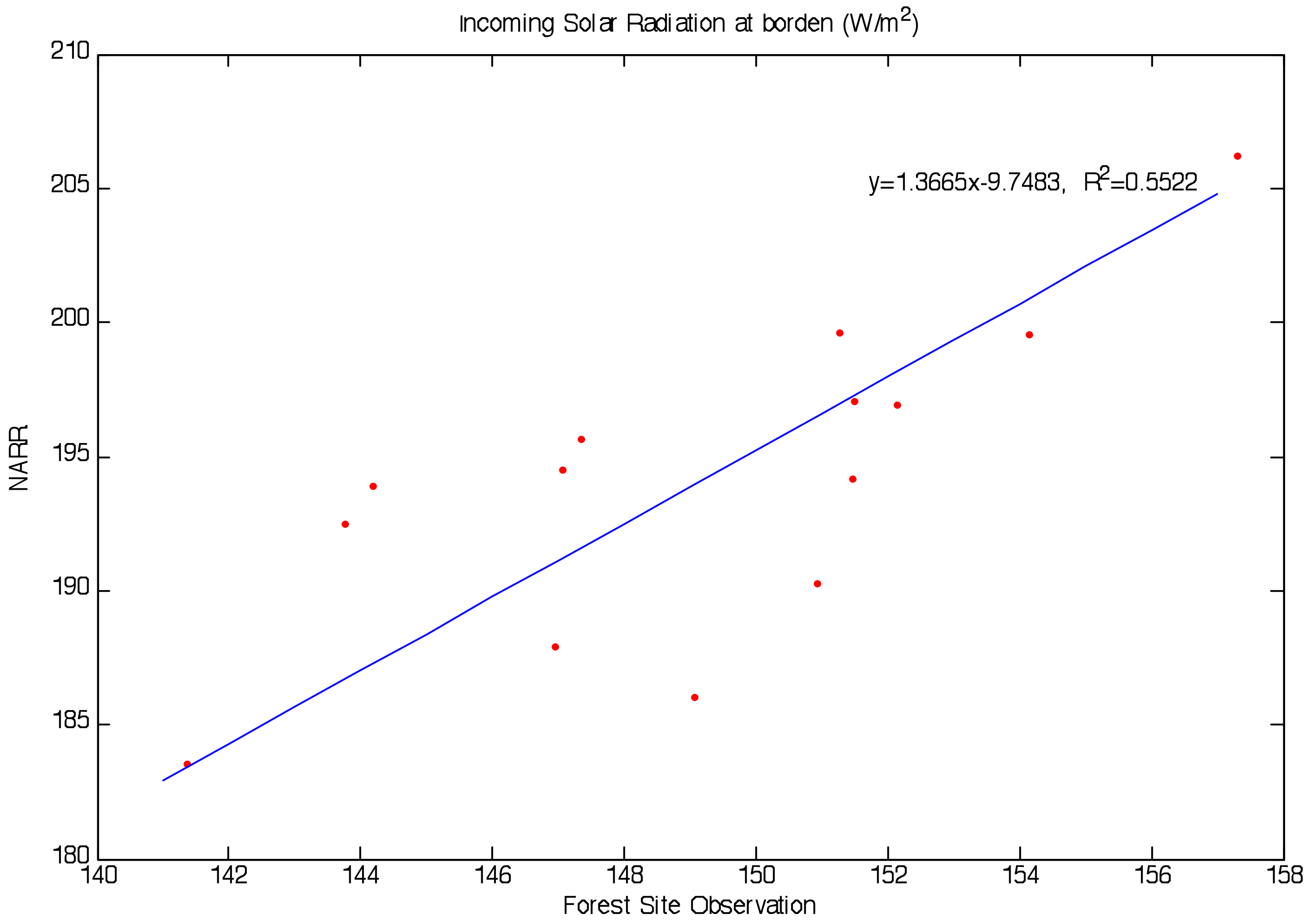


Incoming Solar Radiation at SK__OJP (W/m^2)
y=1.0627x+23.4080, R2=0.4976
NARR
Forest Site Observation
176
174
172
170
168
166
164
162
160
158
156
126
128
130
132
134
136
138
140
142

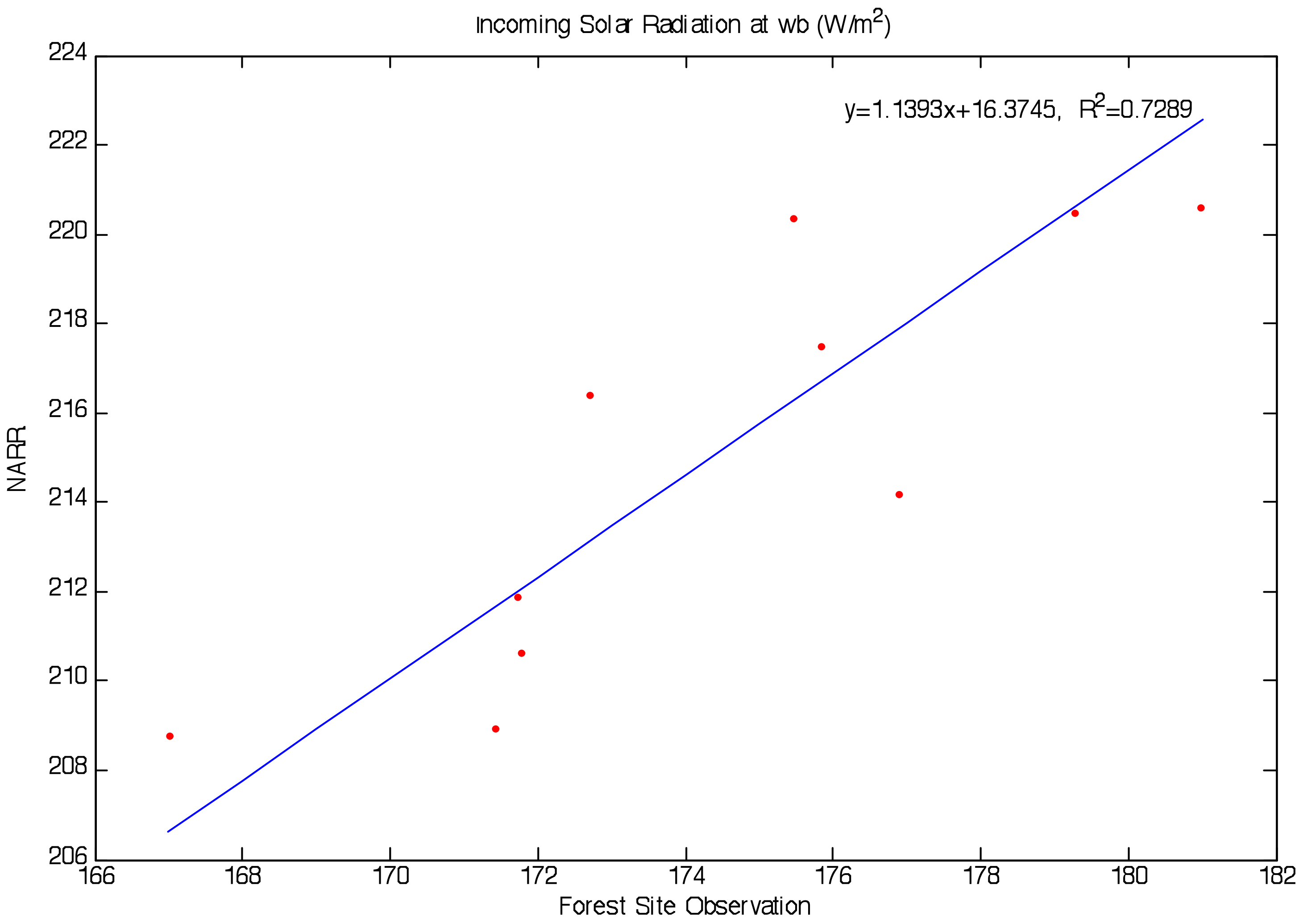

Incoming Solar Radiation at mmsf (W/m2)
y=0.9055x+57.8377, R2=0.3557
NARR
Forest Site Observation
218
216
214
212
210
208
206
204
202
162
164
166
168
170
172
174
176

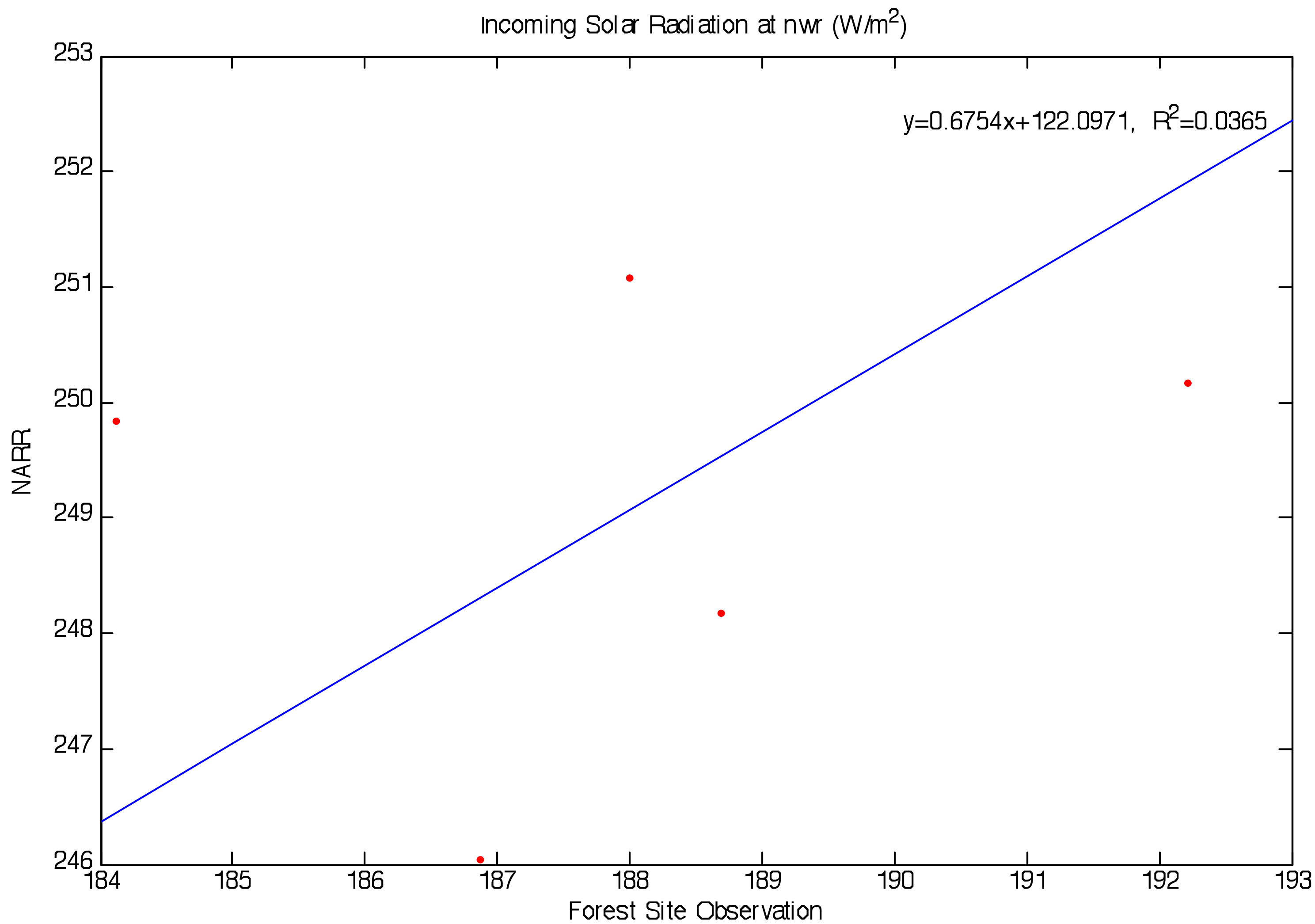


Incoming Solar Radiation at umbs (W/m2)
y=1.9991x-111.3101, R2=0.6952
NARR
Forest Site Observation
205
200
195
190
185
180
147
148
149
150
151
152
153
154
155
156

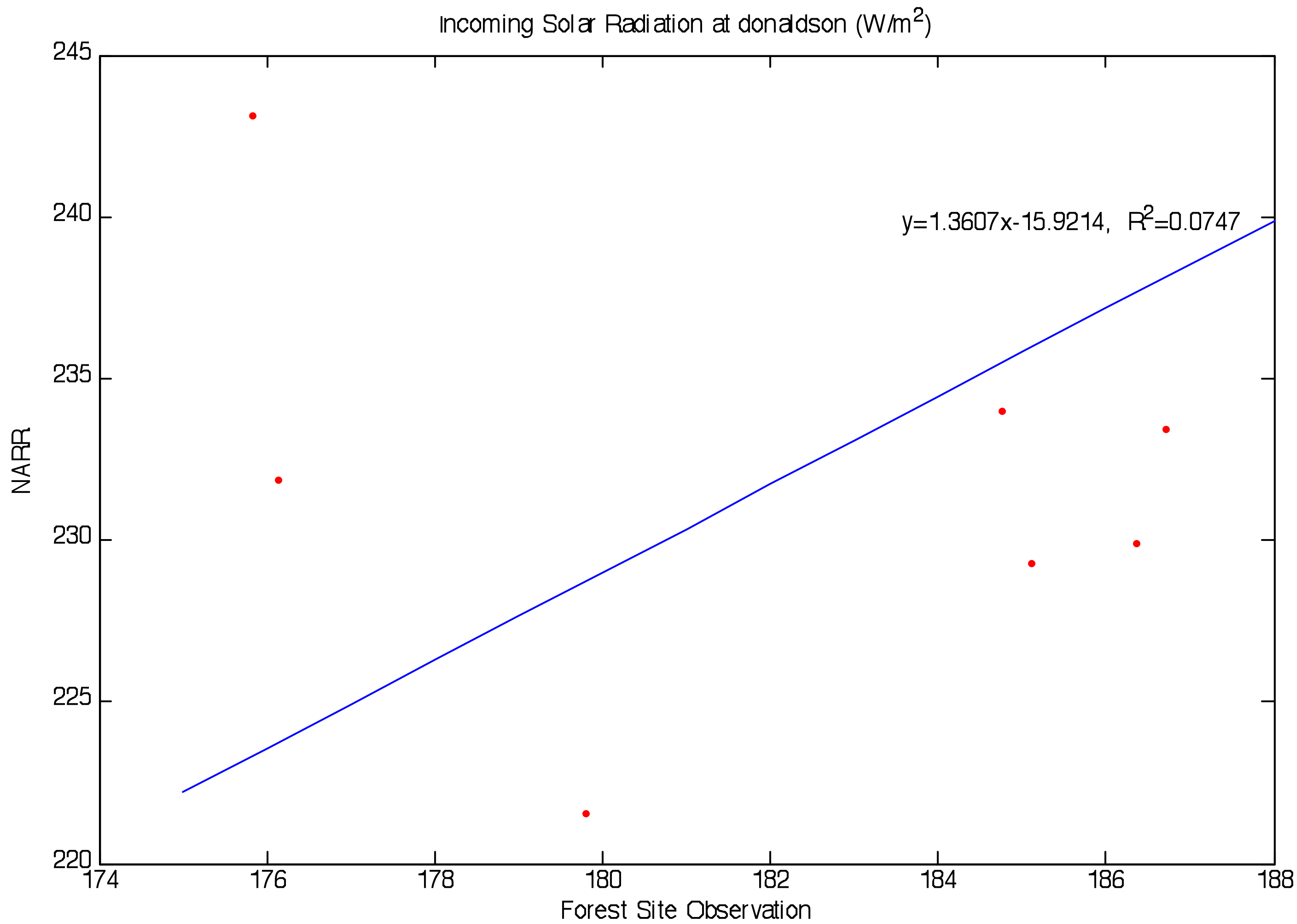


Incoming Solar Radiation at borden (W/m2)
y=1.3665x-9.7483, R2=0.5522
NARR
Forest Site Observation
210
205
200
195
190
185
180
140
142
144
146
148
150
152
154
156
158

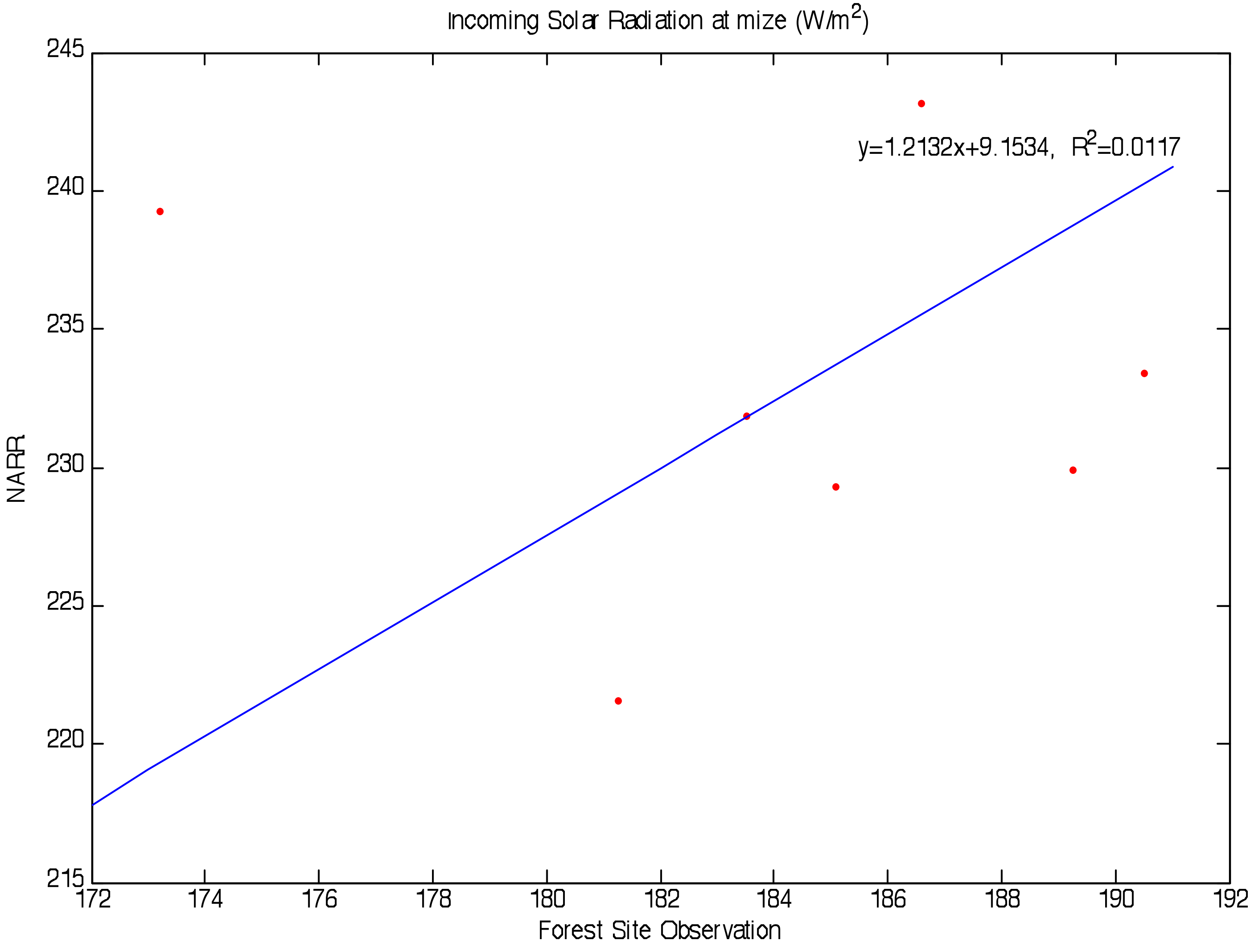

Incoming Solar Radiation at wb (W/m2)
y=1.1393x+16.3745, R2=0.7289
NARR
Forest Site Observation
224
222
220
218
216
214
212
210
208
206
166
168
170
172
174
176
178
180
182



Incoming Solar Radiation at nwr (W/m2)
y=0.6754x+122.0971, R2=0.0365
253
252
251
250
249
248
247
246
NARR
184
185
186
187
188
189
190
191
192
193
Forest Site Observation



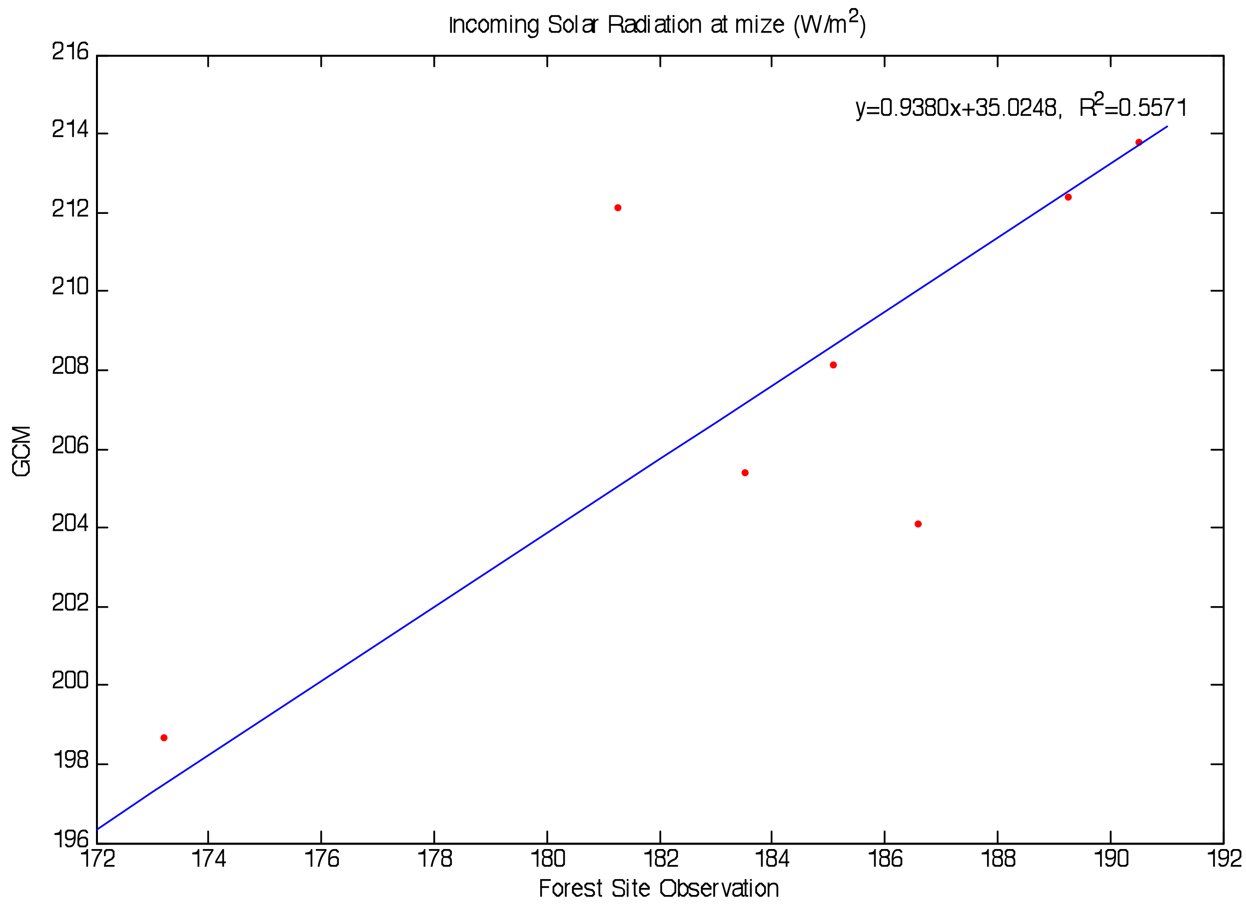
Incoming Solar Radiation at donaldson (W/m2)
245
240
235
230
225
220
174
176
178
180
182
184
186
188
NARR
Forest Site Observation
y=1.3607x-15.9214, R2=0.0747


Incoming Solar Radiation at mize (W/m2)
y=1.2132x+9.1534, R2=0.0117
NARR
Forest Site Observation
245
240
235
230
225
220
215
172
174
176
178
180
182
184
186
188
190
192

A Brief Summary

Site_ID	Yeas_included	R^2	Mean of Site Observation	Mean of NARR values
SK_OA	10	0.7135	136.3887	167.9017
SK_OBS	10	0.723	134.5896	165.3259
SK_OJP	10	0.4976	133.3343	165.0992
mmsf	9	0.3557	167.6258	209.6167
umbs	8	0.6952	150.7828	190.123
borden	14	0.5522	149.1808	194.1131
wb	10	0.7289	174.3128	214.9634
nwr	5	0.0365	187.9796	249.0567
donaldson	7	0.0747	182.1068	231.8715
mize	7	0.0117	184.2007	232.6262

GCM



Incoming Solar Radiation at mize (W/m2)
y=0.9380x+35.0248, R2=0.5571
GCM
Forest Site Observation
216
214
212
210
208
206
204
202
200
198
196
172
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178
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182
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190
192

This evoke us to examine the absorbed solar radiation by the surface that people worked out recently

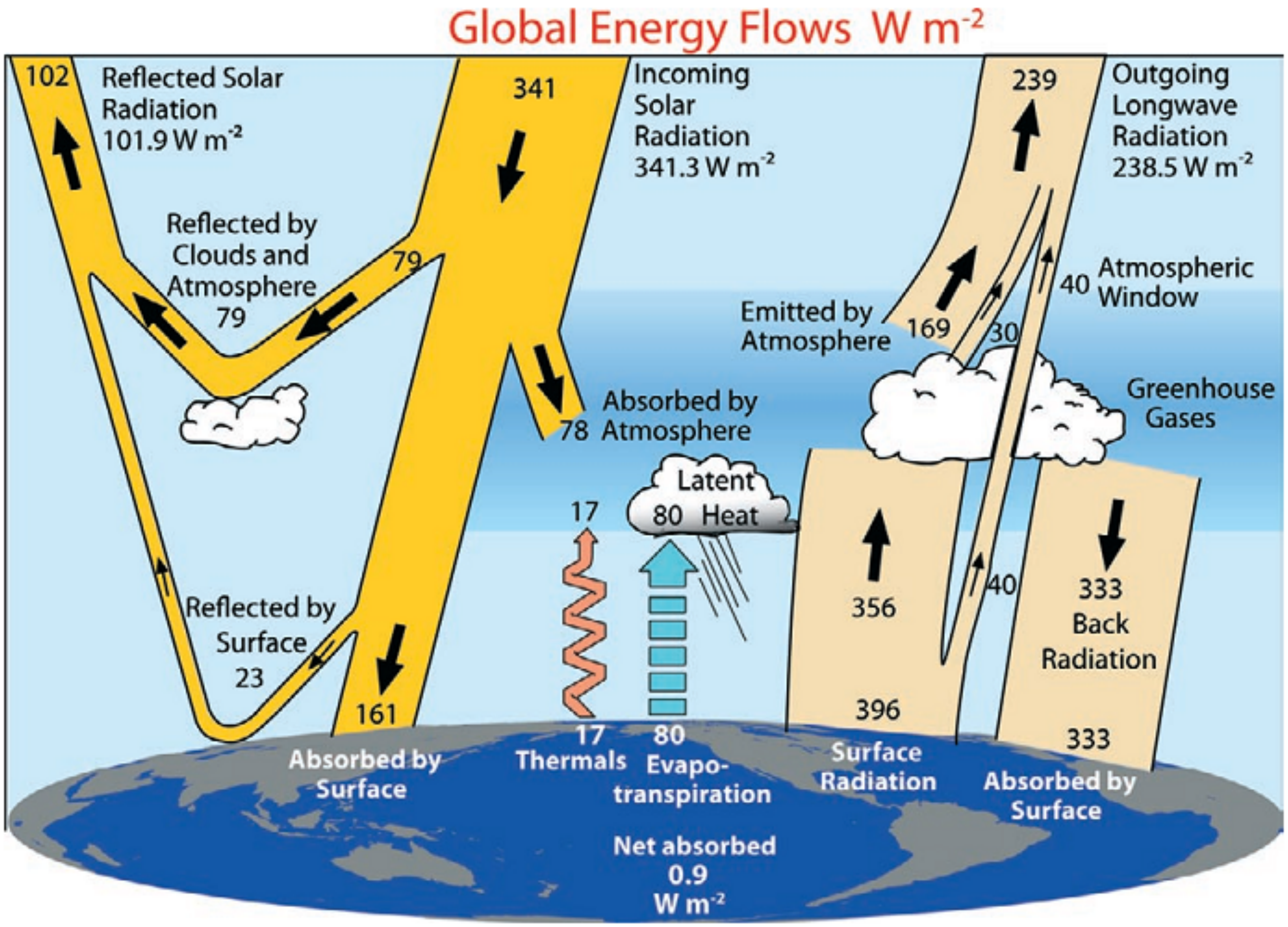


FIG. 1. The global annual mean Earth's energy budget for the Mar 2000 to May 2004 period (W m^{-2}). The broad arrows indicate the schematic flow of energy in proportion to their importance.

Trenberth et al. 2009

EARTH'S GLOBAL ENERGY BUDGET

BY KEVIN E. TRENBERTH, JOHN T. FASULLO, AND JEFFREY KIEHL

An update of the Earth's global annual mean energy budget is given in the light of new observations and analyses. Changes over time and contributions from the land and ocean domains are also detailed.

Weather and climate on Earth are determined by the amount and distribution of incoming radiation from the sun. For an equilibrium climate, OLR[1] necessarily balances the incoming ASR, although there is a great deal of fascinating atmosphere, ocean, and land phenomena that couple the two. Incoming radiant energy may be scattered

in various forms, and converted among the different types, giving rise to a rich variety of weather or turbulent phenomena in the atmosphere and ocean. Moreover, the energy balance can be upset in various ways, changing the climate and associated weather.

Kiehl and Trenberth (1997, hereafter KT97) reviewed past estimates of the global mean flow of

TABLE 1b. Surface components of the annual mean energy budget for the globe, global land, and global ocean, except for atmospheric solar radiation absorbed (Solar absorb, left column), for the ERBE period of Feb 1985 to Apr 1989 (W m^{-2}). Included are the solar absorbed at the surface (Solar down), reflected solar at the surface (Solar reflect), surface latent heat from evaporation (LH evaporation), sensible heat (SH), LW radiation up at the surface (Radiation up), LW downward radiation to the surface (Back radiation), net LW (Net LW), and net energy absorbed at the surface (NET down). HOAPS version 3 covers 80°S–80°N and is for 1988 to 2005. The ISCCP-FD is combined with HOAPS to provide a NET value.

Global	Solar absorb	Solar down	Solar reflect	LH evaporation	SH	Radiation up	Back radiation	Net LW	NET down
KT97	67	168	24	78	24	390	324	66	0
ISCCP-FD	70.9	164.9	24.0	-	-	395.9	344.8	51.1	-
NRA	64.4	161.9	45.2	80.2	15.3	395.5	334.1	61.5	4.9
ERA-40	80.7	155.8	23.1	82.3	15.3	394.8	340.3	54.4	3.8
JRA	75.0	168.9	25.6	85.1	18.8	395.6	324.3	71.3	−6.3

Table 2b. Surface components of the annual mean energy budget for the globe, global land, and global ocean, except for atmospheric solar radiation absorbed (Solar absorb, left column), for the CERES period of Mar 2000 to May 2004 (W m^{-2}). Included are the solar absorbed at the surface (Solar down), reflected solar at the surface (Solar reflected), surface latent heat from evaporation (LH evaporation), sensible heat (SH), LW radiation up at the surface (Radiation up), LW downward radiation to the surface (Back radiation), net LW (Net LW), and net energy absorbed at the surface (NET down). HOAPS version 3 covers 80°S–80°N and is for 1988 to 2005. The values are from ISCCP-FD, NRA, JRA, and this paper. For the ocean, the ISCCP-FD is combined with HOAPS to provide a NET value.

Global	Solar absorbed	Net solar	Solar reflected	LH evaporation	SH	Radiation up	Back radiation	Net LW	NET down
ISCCP-FD	70.8	165.7	22.8	-	-	393.9	345.4	48.5	-
NRA	64.4	160.4	45.2	83.1	15.6	396.9	336.5	60.4	1.3
JRA	74.7	169.8	25.6	90.2	19.4	396.9	324.1	72.8	−12.6
This paper	78.2	161.2	23.1	80.0	17	396	333	63	0.9

“the most realistic published computations to date” (Trenberth)

Calculation of radiative fluxes from the surface to top of atmosphere based on ISCCP and other global data sets: Refinements of the radiative transfer model and the input data

Yuanchong Zhang,[1] William B. Rossow,[2] Andrew A. Lacis,[2]
Valdar Oinas,[3] and Michael I. Mishchenko[2]

Received 16 December 2003; accepted 24 June 2004; published 6 October 2004.

[1] We continue reconstructing Earth's radiation budget from global observations in as much detail as possible to allow diagnosis of the effects of cloud (and surface and other atmospheric constituents) variations on it. This new study was undertaken to reduce the most noticeable systematic errors in our previous results (flux data set calculated mainly using International Satellite Cloud Climatology Project–C1 input data (ISCCP-FC)) by exploiting the availability of a more advanced NASA Goddard Institute for Space Studies (GISS) radiative transfer model and improved ISCCP cloud climatology and ancillary data sets. The most important changes are the introduction of a better treatment of ice clouds, revision of the aerosol climatology, accounting for diurnal variations of surface skin/air temperatures and the cloud-radiative effects on them, revision of the water vapor profiles used, and refinement of the land surface albedos and emissivities. We also extend our previous flux results, limited to the top of atmosphere (TOA) and surface (SRF), to also include three levels within the atmosphere, forming one integrated vertical atmospheric flux profile from SRF to TOA, inclusive, by combining a new climatology of cloud vertical structure with the

Zhang et al. 2004

- Produce the ISCCP-FD version of radiative fluxes based on ISCCP cloud data and radiative transfer model
- Model: the NASA Goddard Institute for Space Studies (GISS) radiative transfer model
- Data: improved ISCCP cloud climatology

Kim and Ramanathan (2008)

- Provided updated estimates of solar radiation
- Making use of many space-based measurements
- The model has new treatment of water vapor absorption and aerosols
- Their results were validated by surface observations

Qian et al (2006)

- Using NCEP-NCAR reanalyses, but the reanalysis cloud cover shows a trend that is not evident in station data.
- Make use of available station data of cloud cover anomaly to adjust the reanalysis monthly surface solar radiation anomaly
- Data used: CRU_TS_2.02 cloud cover data
- $S_{r,adj}=(S_{obs,m}/S_{r,m})S_r$

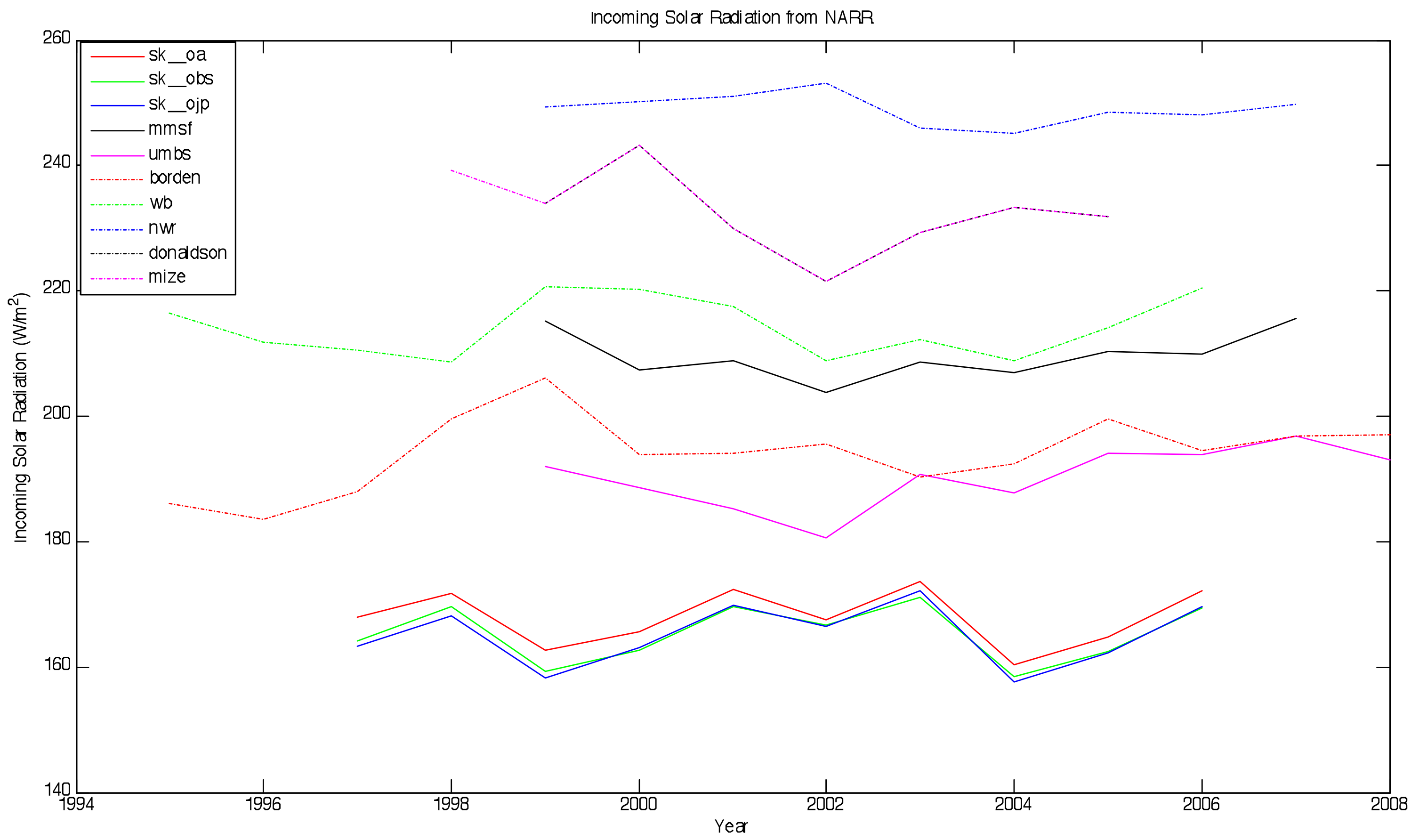
So …

- Estimates of surface radiation fields based on satellite observations have become available recently; however, they are relatively short in length and often affected by errors in satellite observations of clouds and other atmospheric properties, as discussed below

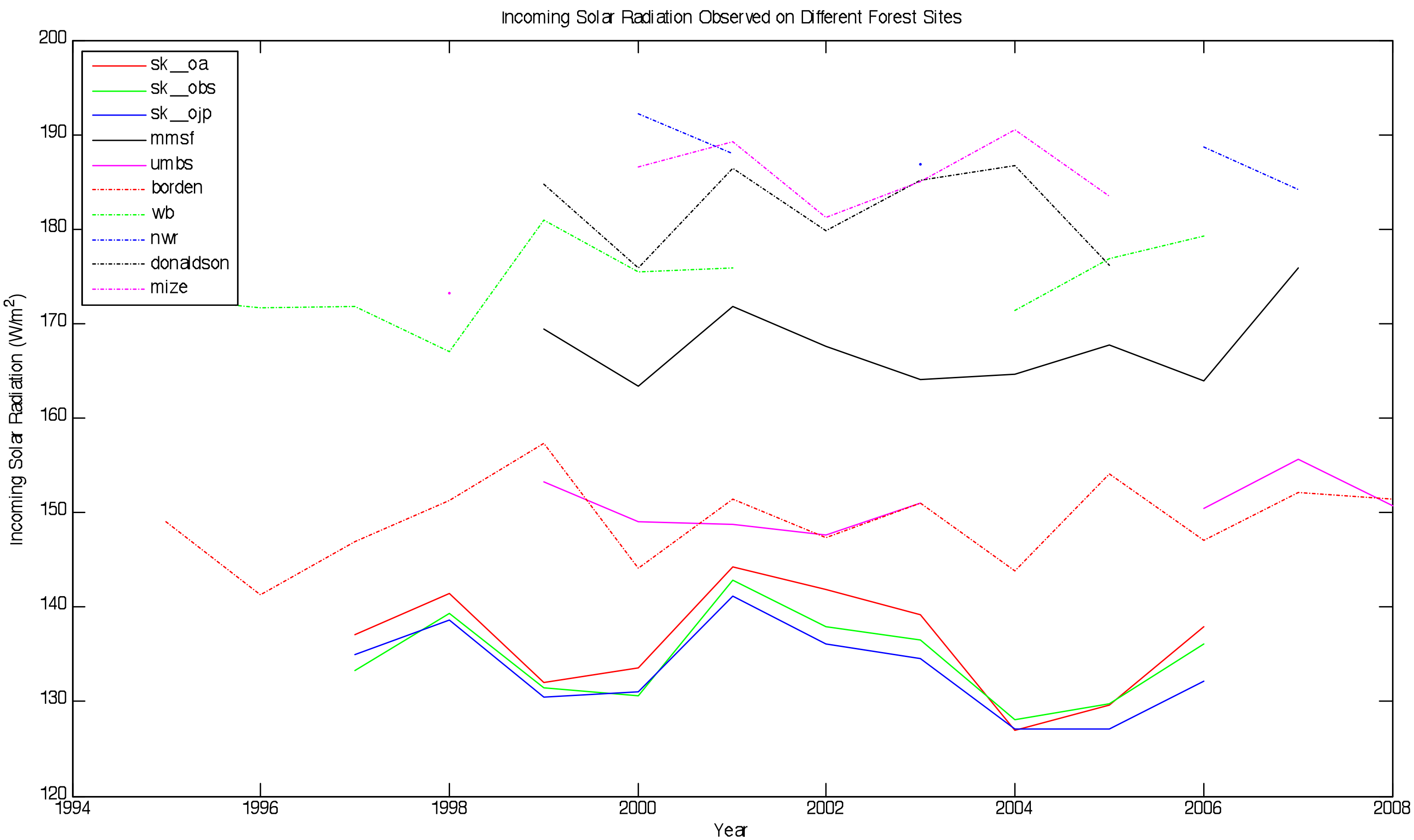
(Qian et al. 2006)

The most uncertainties come from the spurious cloud cover record

- Failure in satellite observation
- Failure in modeling results



Incoming Solar Radiation from NARR
Incoming Solar Radiation (W/m2)
Year
260
240
220
200
180
160
140
1994
1996
1998
2000
2002
2004
2006
2008
sk_oa
sk_obs
sk_ojp
mmsf
umbs
borden
wb
nwr
donaldson
mize


Incoming Solar Radiation Observed on Different Forest Sites
sk__oa
sk__obs
sk__ojp
mmsf
umbs
borden
wb
nwr
donaldson
mize
Incoming Solar Radiation (W/m2)
Year
200
190
180
170
160
150
140
130
120
1994
1996
1998
2000
2002
2004
2006
2008

Thank You for Participation