Validation of the Clouds and the Earth's Radiant Energy System (CERES) Surface Radiation Budget Algorithms

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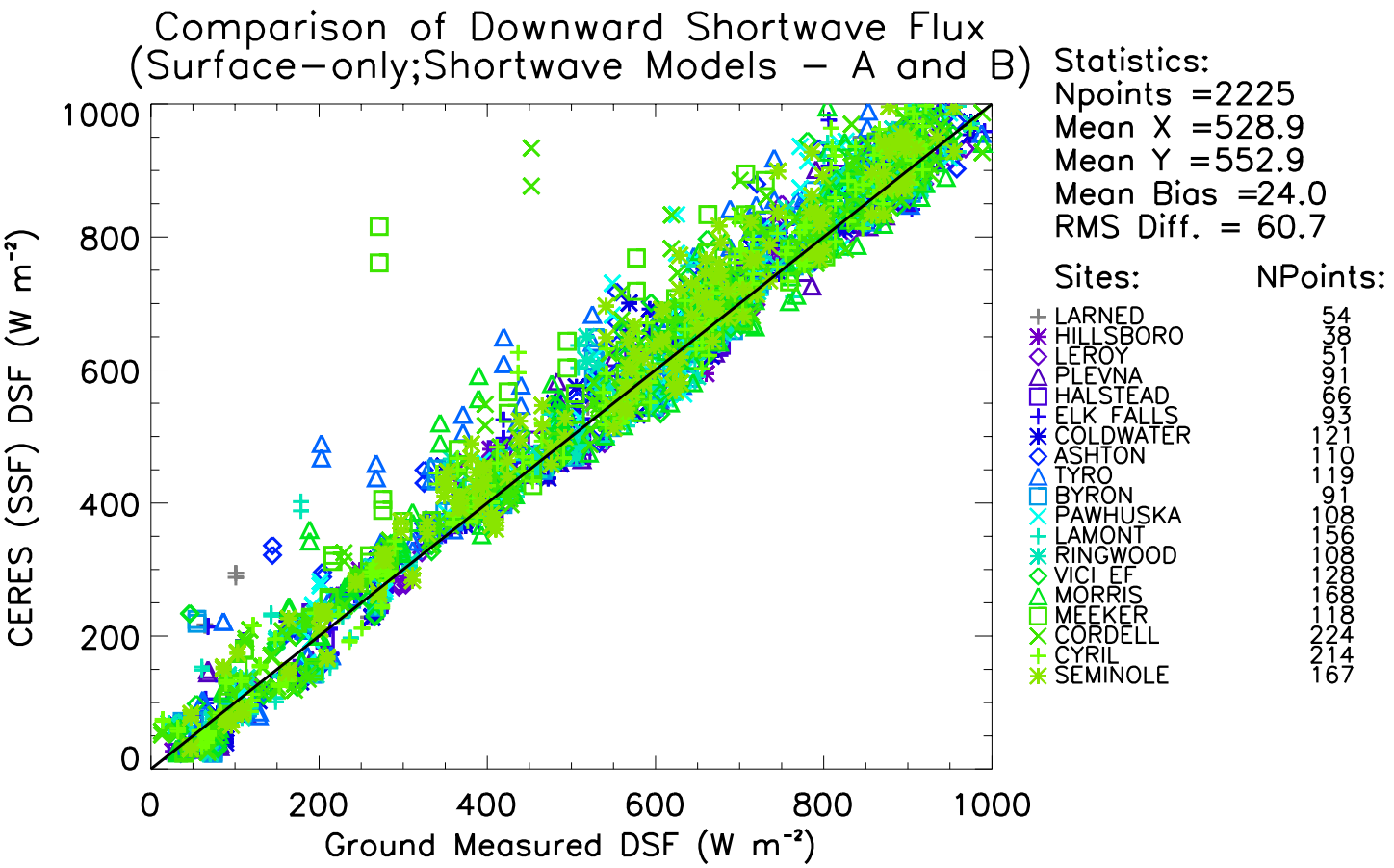
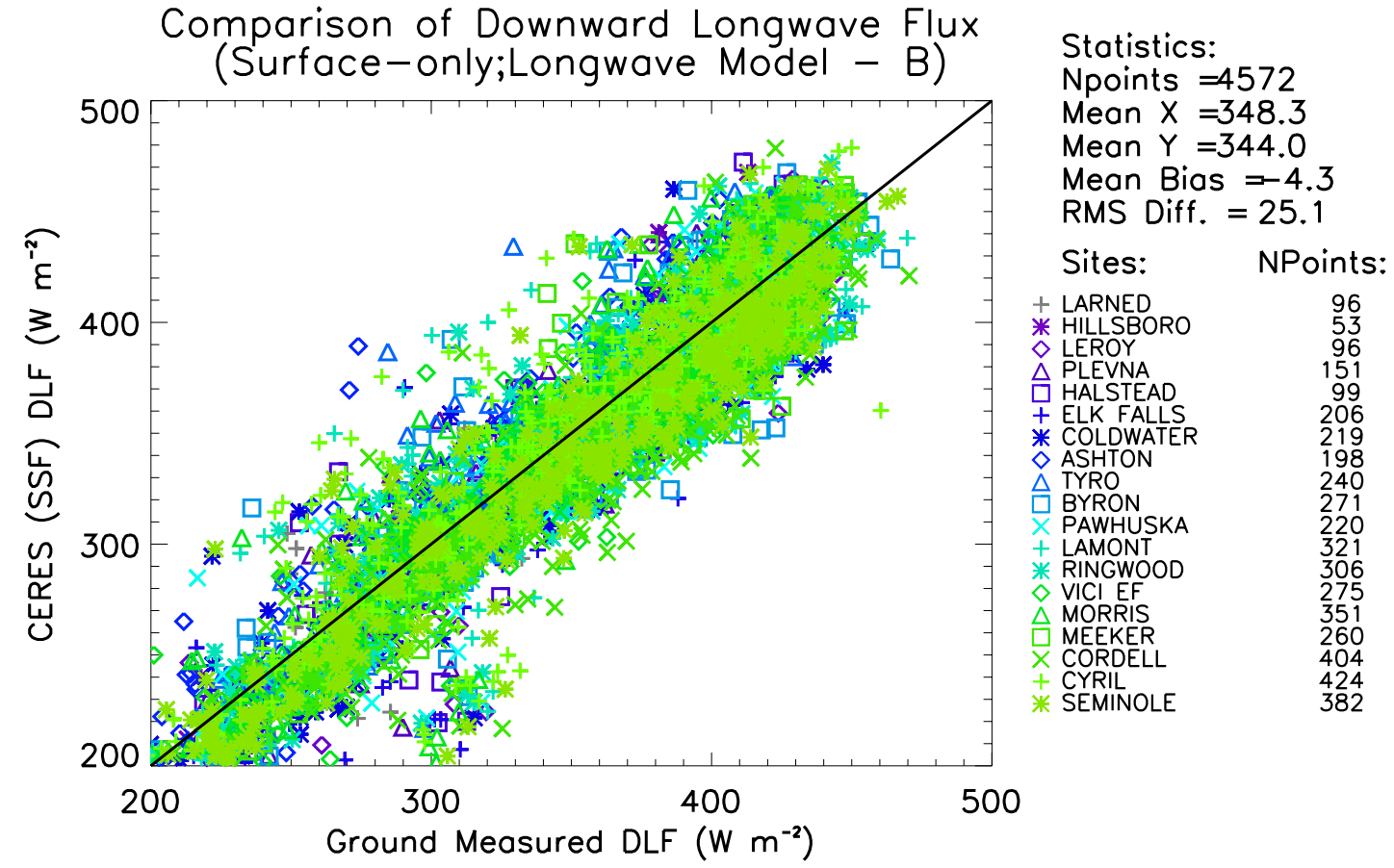
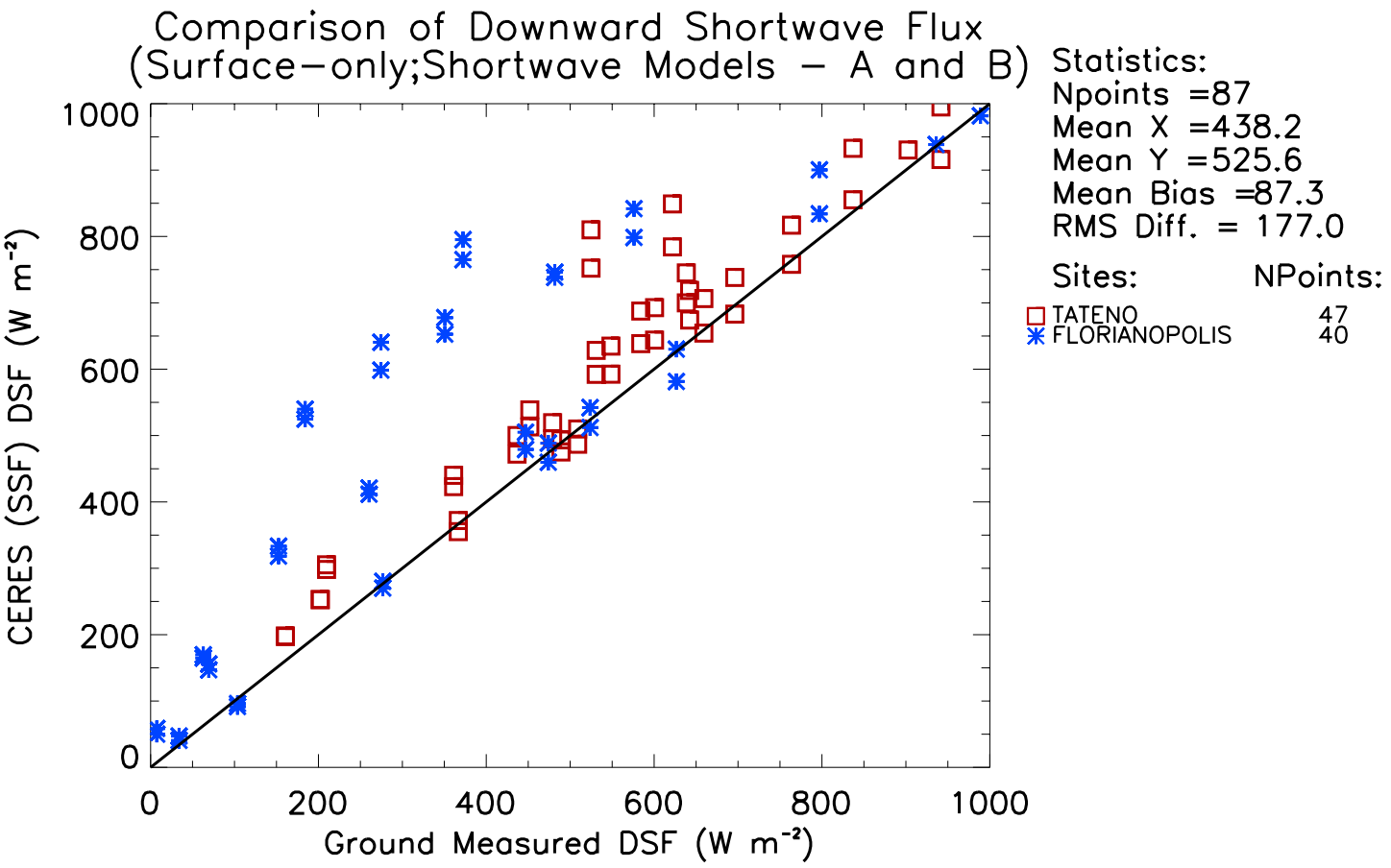
The focus of our study is concentrated upon the establishment of the accuracy of the parameterized surface radiation budget (SRB) algorithms used to produce the CERES single satellite footprint (SSF) instantaneous surface fluxes for both the shortwave (wavelengths less than 5 micrometers) and longwave (wavelengths greater than 5 micrometers) portions of the spectrum. To accomplish the goals of this validation study, we have compared the surface fluxes derived from the CERES TOA measurements to coincident surface fluxes measured directly at the surface. The CERES TOA measurements were obtained from the Tropical Rainfall Measuring Mission (TRMM) satellite for the first eight months of 1998. The coincident surface fluxes were then gathered from 21 Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) sites, 6 Climate Modeling and Diagnostic Laboratory (CMDL) sites and 4 Baseline Surface Radiation Network (BSRN) sites.

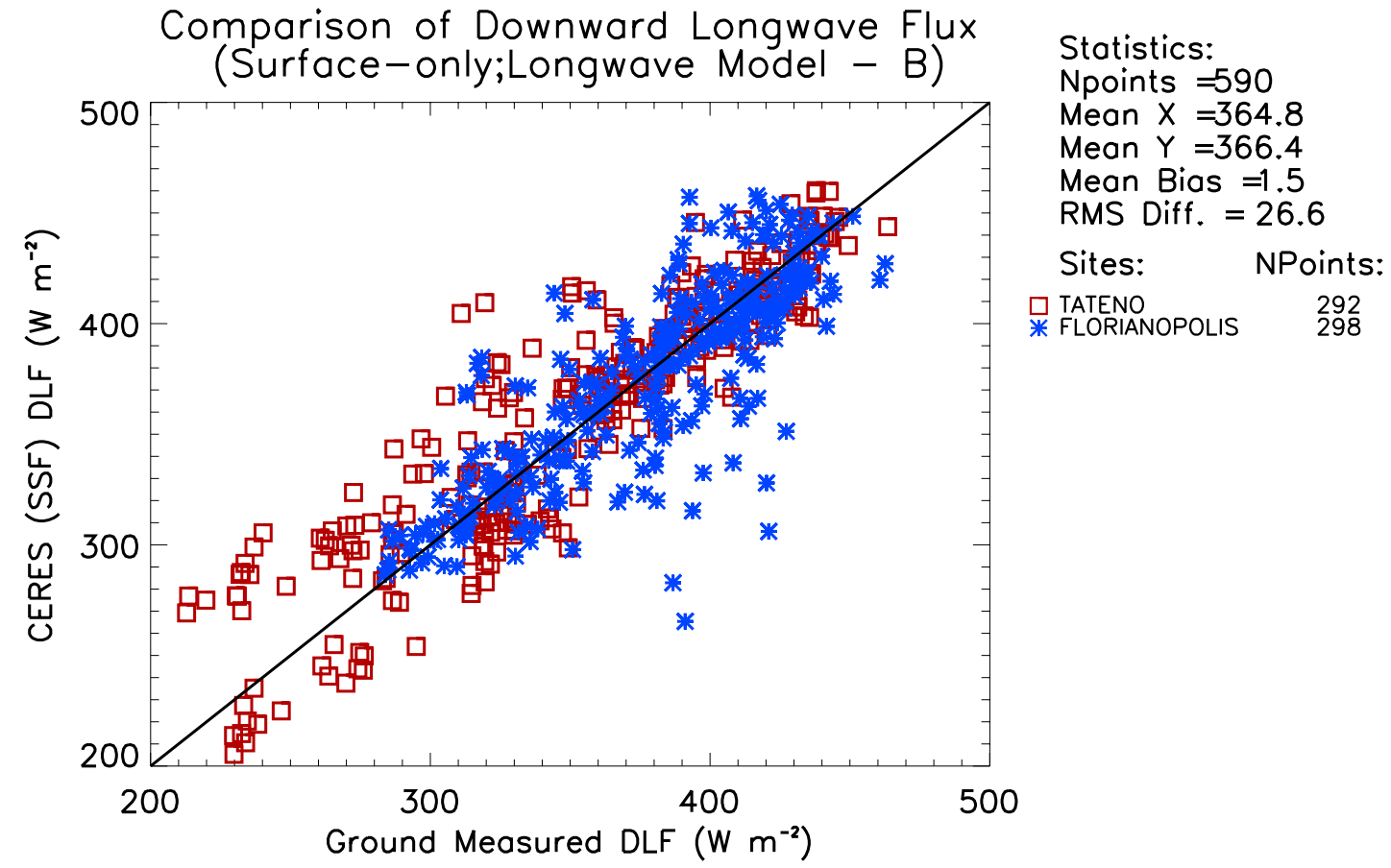
Two SRB models each have been used to obtain the surface fluxes for the shortwave and longwave portions of the spectrum. Early results from our validation efforts clearly demonstrated that the current shortwave models are unsatisfactory for cloudy sky conditions. Thus, we have concentrated on clear-sky conditions until either suitable modifications can be made to the current models or alternative models can be formulated. For clear sky conditions, the shortwave models are found to be in reasonably good agreement with the surface measurements at the ARM/CART SGP sites. At the CMDL and BSRN sites, however, significant discrepancies exist between the surface fluxes derived from satellite data and the measured surface fluxes. These discrepancies are under investigation.

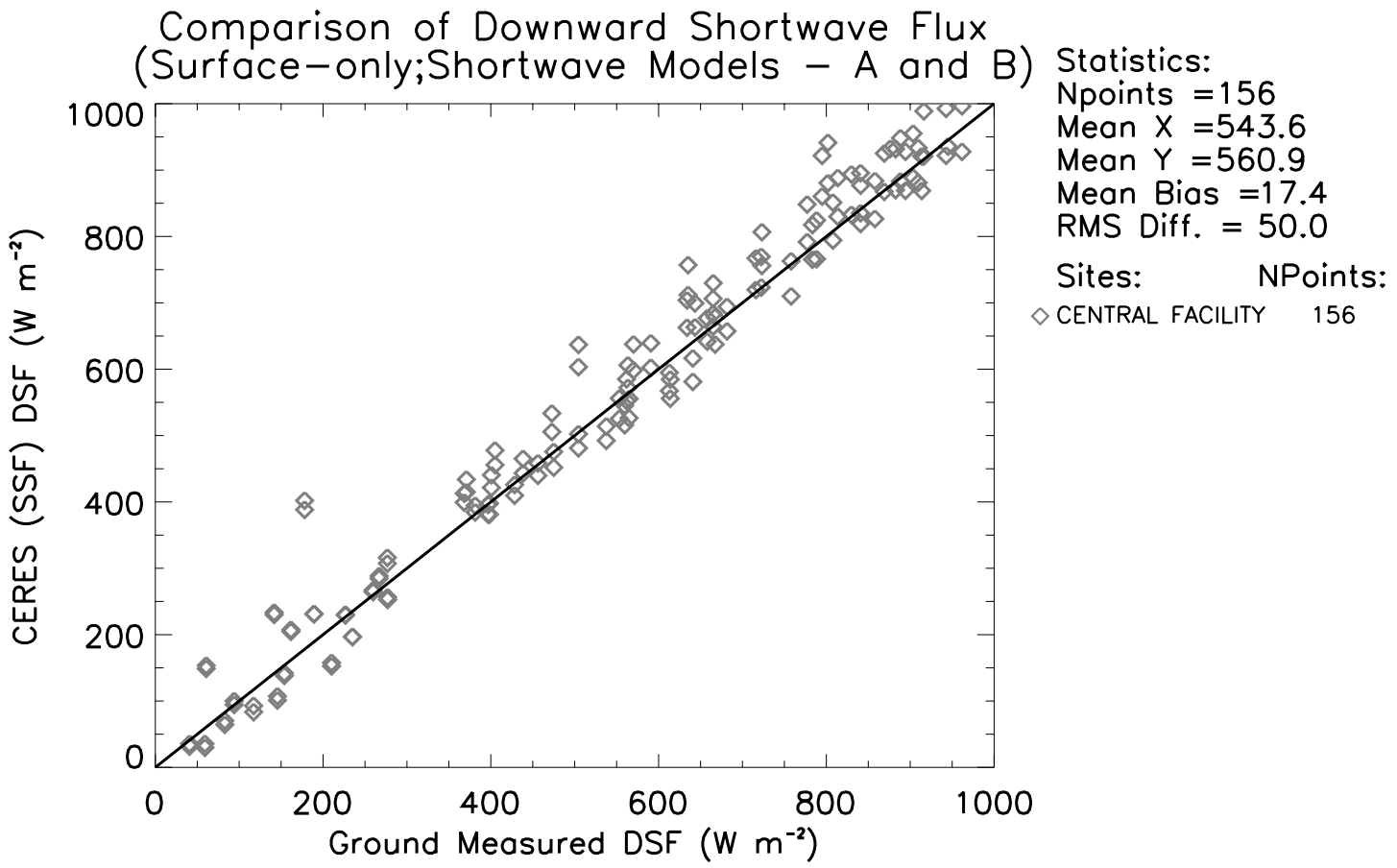
In addition to the shortwave models, there are two longwave models. The Ramanathan and Inamdar model, which derives clear-sky surface fluxes, is bring validated by its authors. The Gupta et al. (1992) longwave model, which relies solely upon the meteorological data to obtain surface fluxes for clear and cloudy sky conditions, is part of this validation effort. The results of the Gupta et al. (1992) longwave model calculations for all-sky conditions are found to be in good agreement with the surface measurements at all the sites.

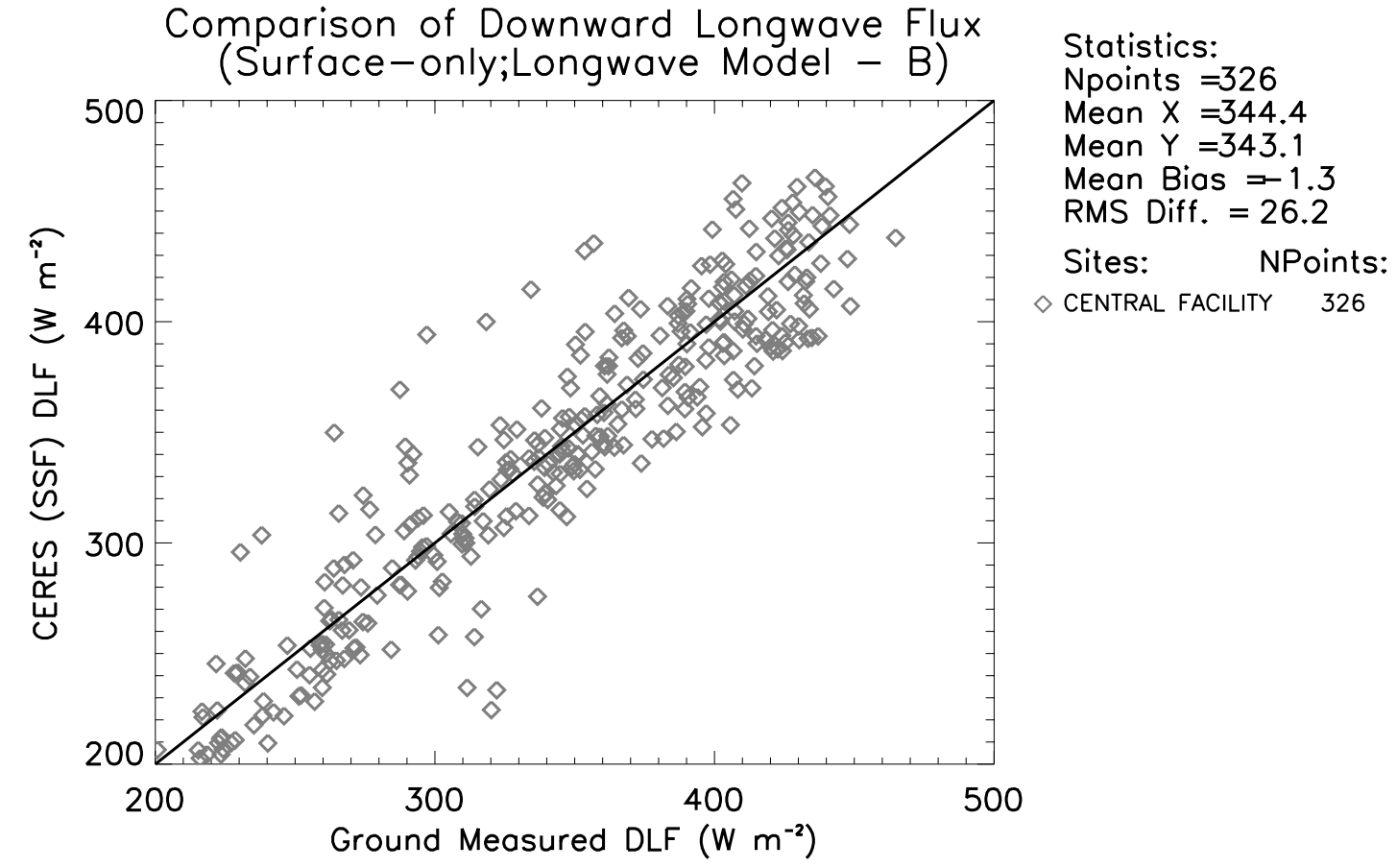

Comparison of Downward Shortwave Flux
(Surface−only;Shortwave Models − A and B)
CERES (SSF) DSF (W m⁻²)
Ground Measured DSF (W m⁻²)
0
200
400
600
800
1000
Statistics:
Npoints =2225
Mean X =528.9
Mean Y =552.9
Mean Bias =24.0
RMS Diff. = 60.7
Sites: NPoints:
LARNED 54
HILLSBORO 38
LEROY 51
PLEVNA 91
HALSTEAD 66
ELK FALLS 93
COLDWATER 121
ASHTON 110
TYRO 119
BYRON 91
PAWHUSKA 108
LAMONT 156
RINGWOOD 108
VICI EF 128
MORRIS 168
MEEKER 118
CORDELL 224
CYRIL 214
SEMINOLE 167

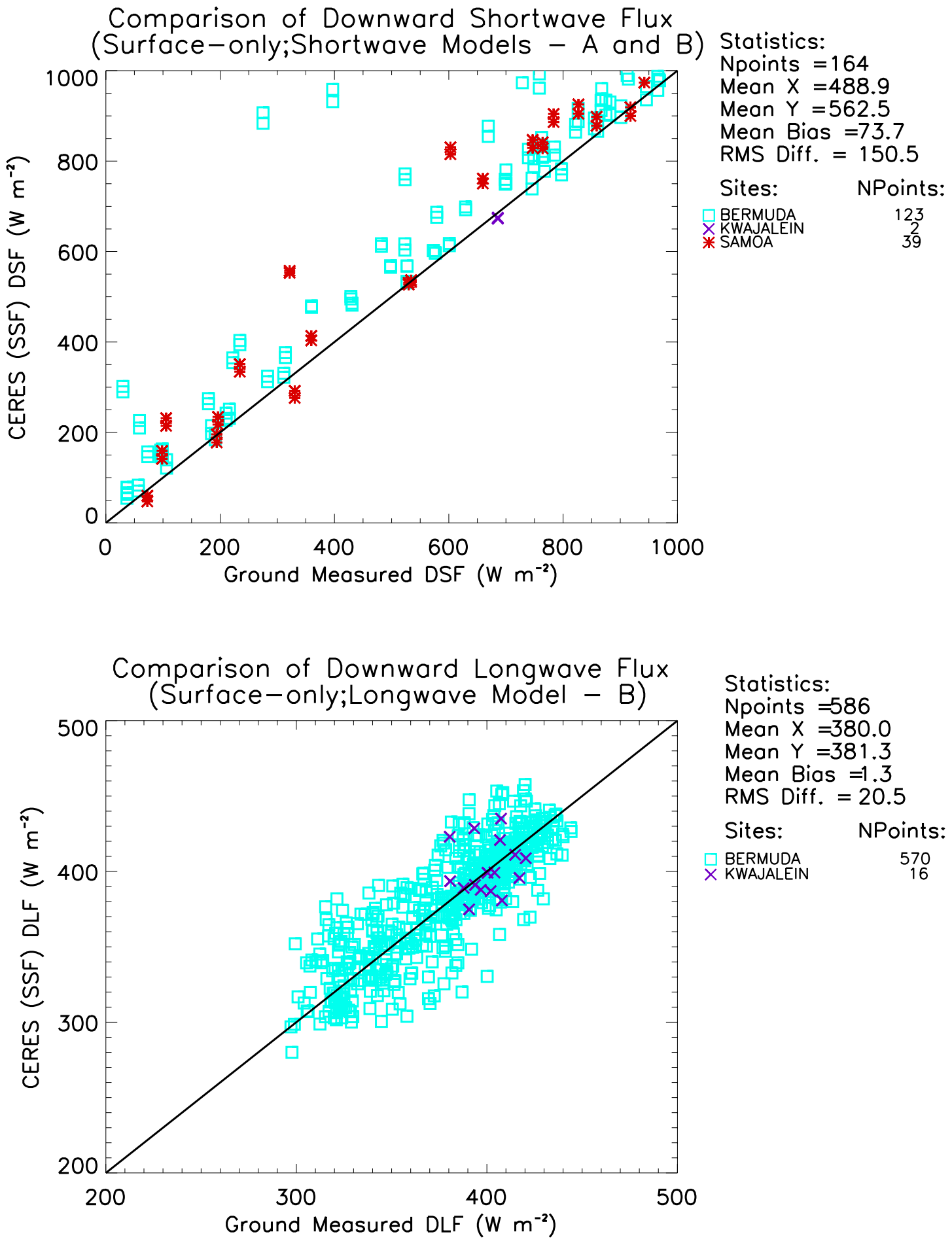

Comparison of Downward Longwave Flux
(Surface−only;Longwave Model − B)
CERES (SSF) DLF (W m⁻²)
Ground Measured DLF (W m⁻²)
200
300
400
500
Statistics:
Npoints =4572
Mean X =348.3
Mean Y =344.0
Mean Bias =−4.3
RMS Diff. = 25.1
Sites: NPoints:
LARNED 96
HILLSBORO 53
LEROY 96
PLEVNA 151
HALSTEAD 99
ELK FALLS 206
COLDWATER 219
ASHTON 198
TYRO 240
BYRON 271
PAWHUSKA 220
LAMONT 321
RINGWOOD 306
VICI EF 275
MORRIS 351
MEEKER 260
CORDELL 404
CYRIL 424
SEMINOLE 382

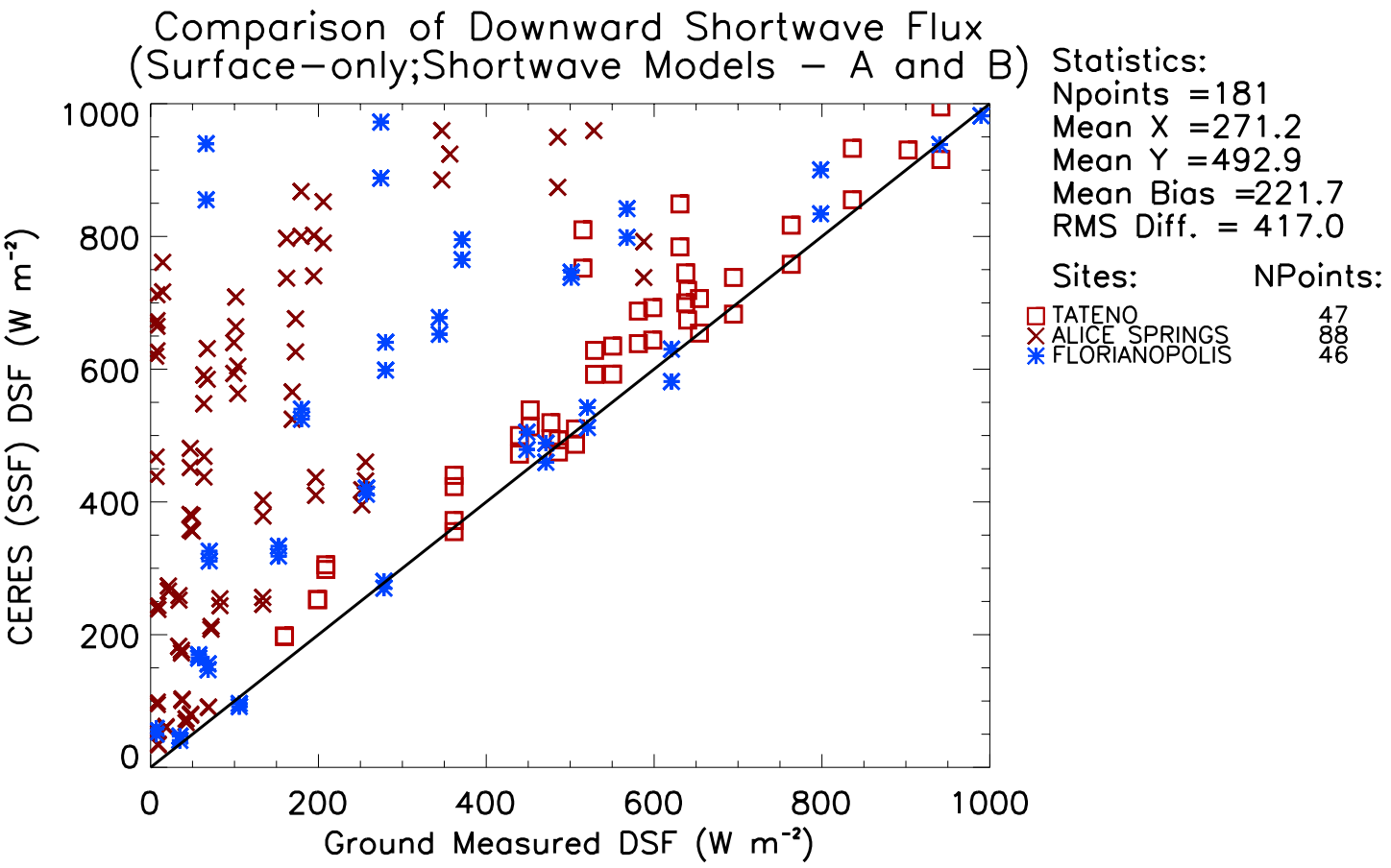

Comparison of Downward Shortwave Flux
(Surface−only;Shortwave Models − A and B)
CERES (SSF) DSF (W m⁻²)
Ground Measured DSF (W m⁻²)
0
200
400
600
800
1000
Statistics:
Npoints =87
Mean X =438.2
Mean Y =525.6
Mean Bias =87.3
RMS Diff. = 177.0
Sites: NPoints:
TATENO 47
FLORIANOPOLIS 40

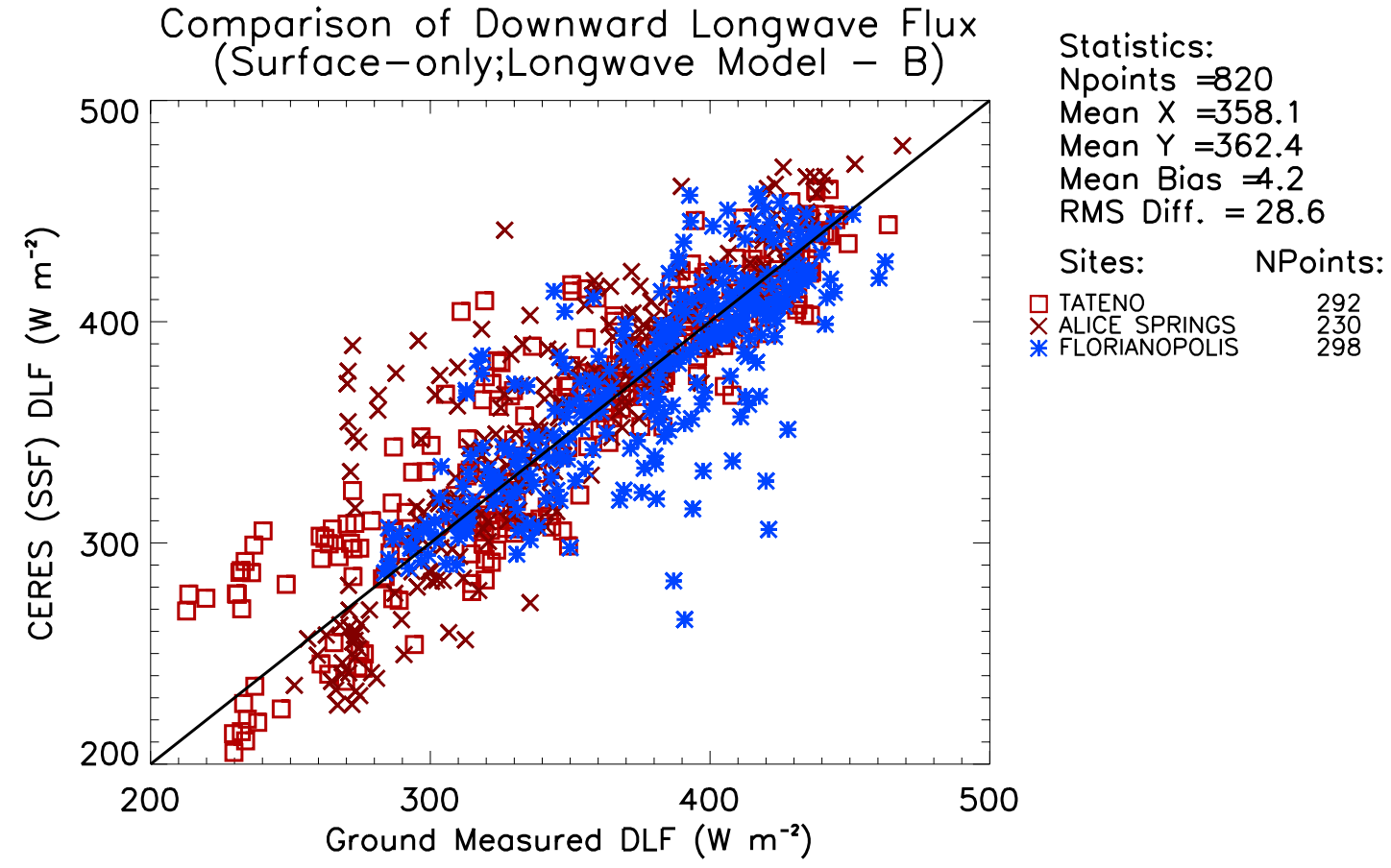

Comparison of Downward Longwave Flux
(Surface−only;Longwave Model − B)
CERES (SSF) DLF (W m⁻²)
Ground Measured DLF (W m⁻²)
200
300
400
500
Statistics:
Npoints =590
Mean X =364.8
Mean Y =366.4
Mean Bias =1.5
RMS Diff. = 26.6
Sites: NPoints:
TATENO 292
FLORIANOPOLIS 298


Comparison of Downward Shortwave Flux
(Surface−only;Shortwave Models − A and B)
Statistics:
Npoints =156
Mean X =543.6
Mean Y =560.9
Mean Bias =17.4
RMS Diff. = 50.0
Sites:
NPoints:
CENTRAL FACILITY 156
CERES (SSF) DSF (W m⁻²)
Ground Measured DSF (W m⁻²)
0
200
400
600
800
1000


Comparison of Downward Longwave Flux
(Surface−only;Longwave Model − B)
Statistics:
Npoints =326
Mean X =344.4
Mean Y =343.1
Mean Bias =−1.3
RMS Diff. = 26.2
Sites:
NPoints:
CENTRAL FACILITY 326
CERES (SSF) DLF (W m⁻²)
Ground Measured DLF (W m⁻²)
200
300
400
500


Comparison of Downward Shortwave Flux
(Surface−only;Shortwave Models − A and B)
CERES (SSF) DSF (W m⁻²)
Ground Measured DSF (W m⁻²)
0
200
400
600
800
1000
Statistics:
Npoints =164
Mean X =488.9
Mean Y =562.5
Mean Bias =73.7
RMS Diff. = 150.5
Sites:
NPoints:
BERMUDA 123
KWAJALEIN 2
SAMOA 39
Comparison of Downward Longwave Flux
(Surface−only;Longwave Model − B)
CERES (SSF) DLF (W m⁻²)
Ground Measured DLF (W m⁻²)
200
300
400
500
Statistics:
Npoints =586
Mean X =380.0
Mean Y =381.3
Mean Bias =1.3
RMS Diff. = 20.5
Sites:
NPoints:
BERMUDA 570
KWAJALEIN 16


Comparison of Downward Shortwave Flux
(Surface−only;Shortwave Models − A and B)
CERES (SSF) DSF (W m⁻²)
Ground Measured DSF (W m⁻²)
0
200
400
600
800
1000
Statistics:
Npoints =181
Mean X =271.2
Mean Y =492.9
Mean Bias =221.7
RMS Diff. = 417.0
Sites:
NPoints:
TATENO 47
ALICE SPRINGS 88
FLORIANOPOLIS 46


Comparison of Downward Longwave Flux
(Surface−only;Longwave Model − B)
CERES (SSF) DLF (W m⁻²)
Ground Measured DLF (W m⁻²)
200
300
400
500
Statistics:
Npoints =820
Mean X =358.1
Mean Y =362.4
Mean Bias =4.2
RMS Diff. = 28.6
Sites:
NPoints:
TATENO 292
ALICE SPRINGS 230
FLORIANOPOLIS 298