The Data from the BSRN Archive and Its Application in the NASA GEWEX SRB and POWER Projects

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15 minutes

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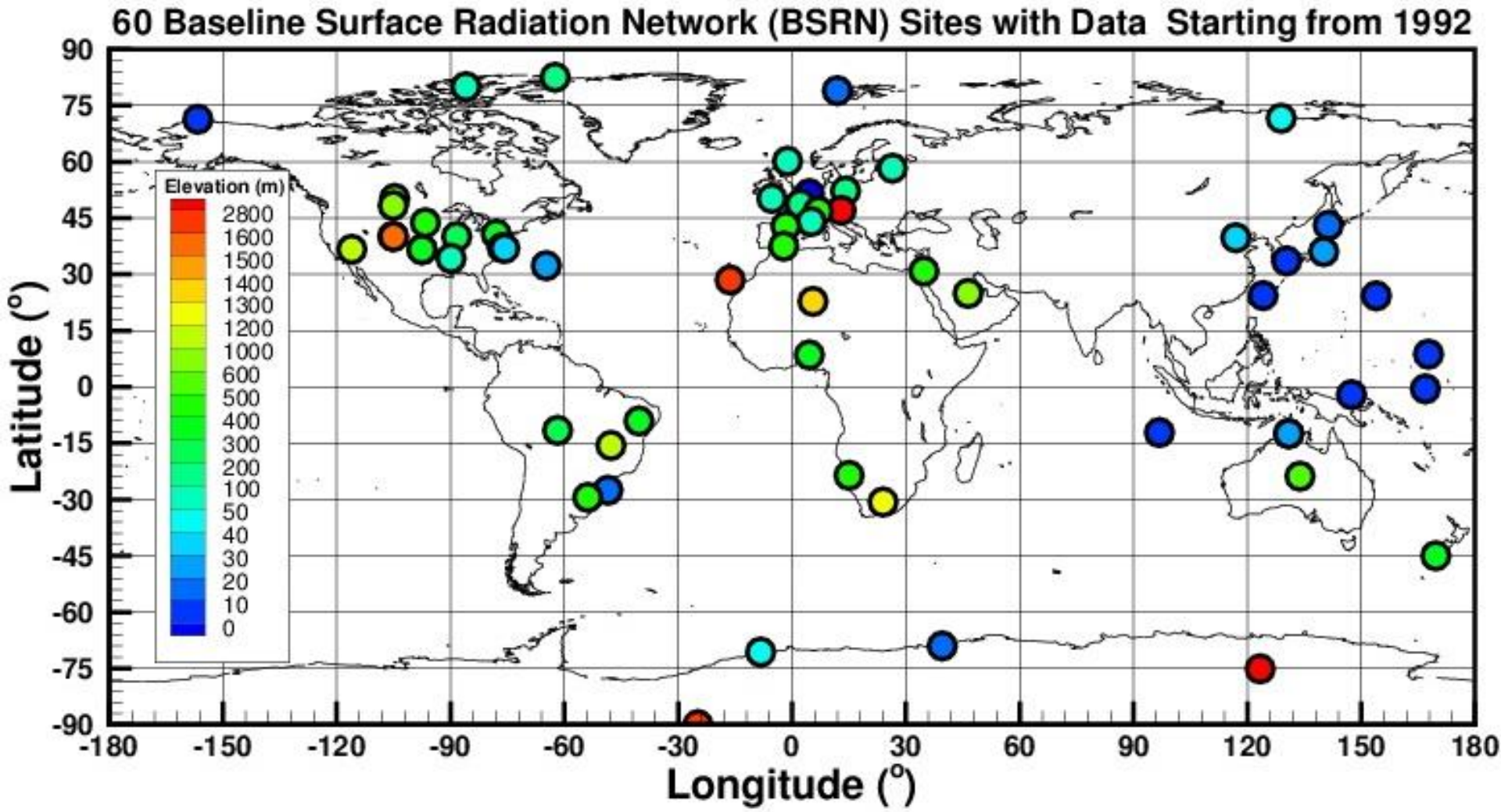
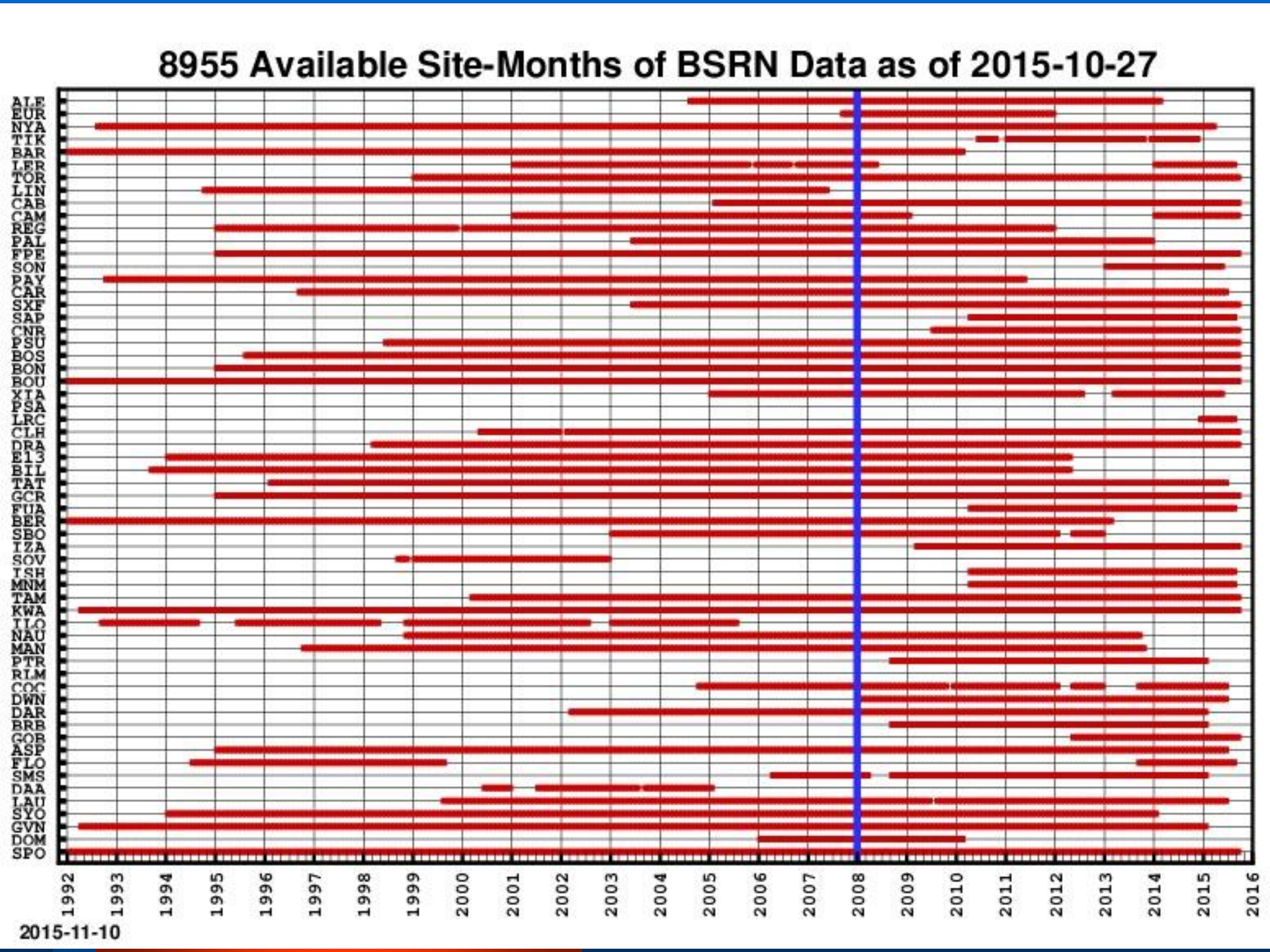
Outline of the Presentation …

- The BSRN data available as of 2015-10
- Generating the *3-hourly*, *3-hourly-monthly*, *daily* and *monthly* means
- Validating the GEWEX SRB and FLASHFlux GHI and POWER SSE DNI data against the BSRN data
- Summary and conclusions

BSRN sites as of 2015-10




8955 Available Site-Months of BSRN Data as of 2015-10-27
ALE
EUR
NYA
TIK
BAR
LER
TOR
LIN
CAB
CAM
REG
PAL
FPE
SON
PAY
CAR
SXF
SAP
CNR
PSU
BOS
BON
BOU
XIA
PSA
LRC
CLH
DRA
E13
BIL
TAT
GCR
FUA
BER
SBO
IZA
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ISH
MNM
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KWA
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NAU
MAN
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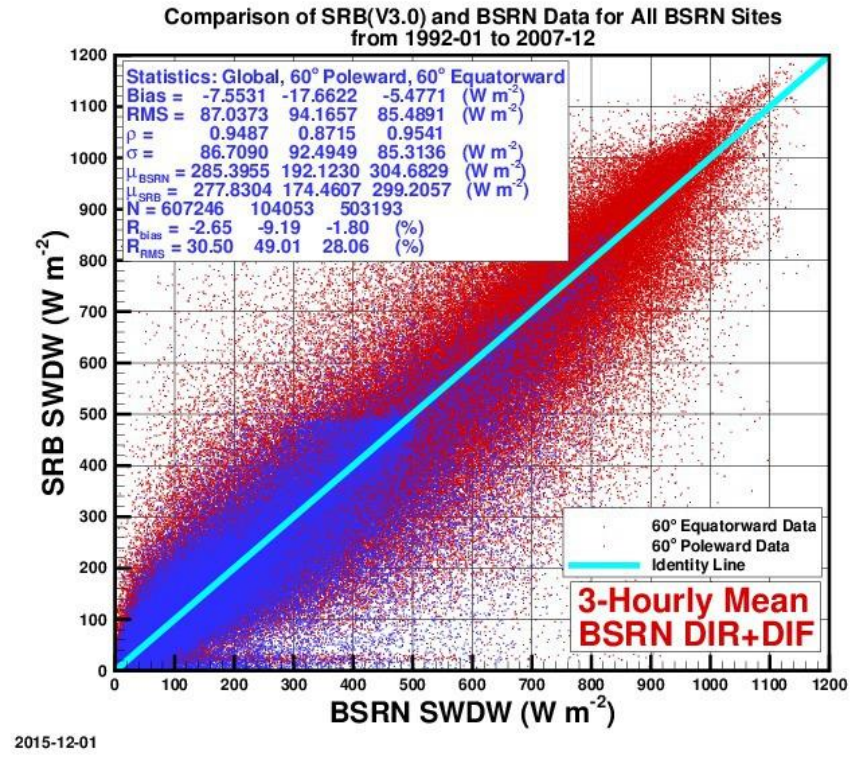
2016
2015-11-10

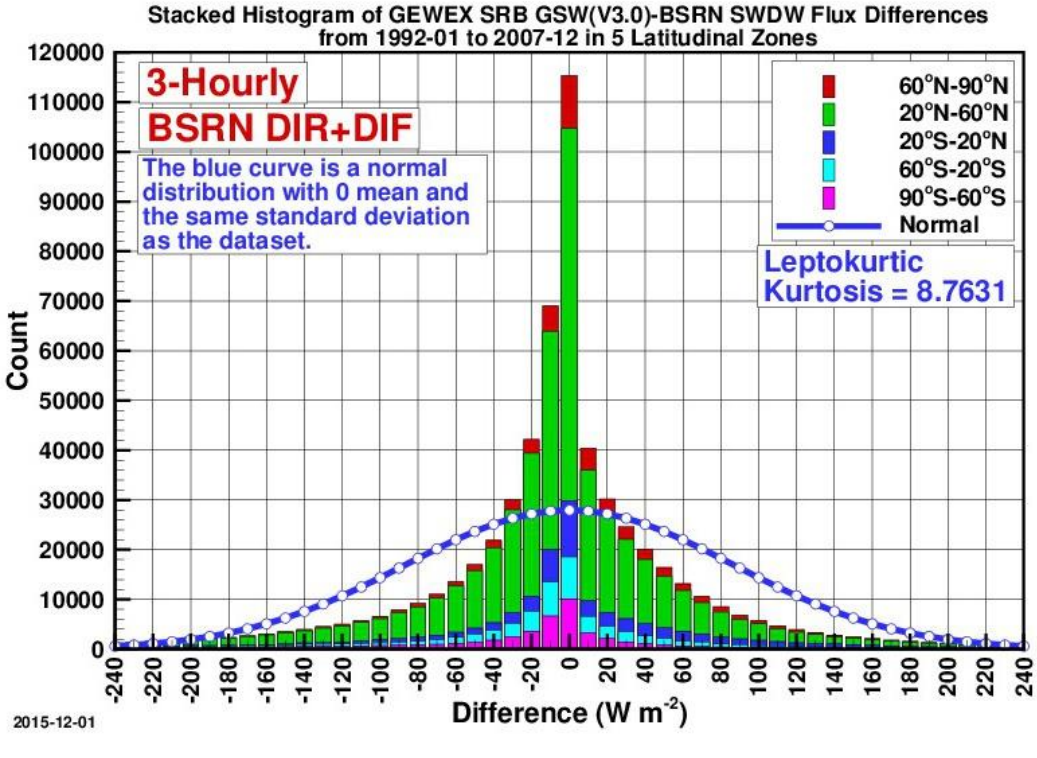
Flow Chart of Averaging the BSRN Data on Various Time Scales

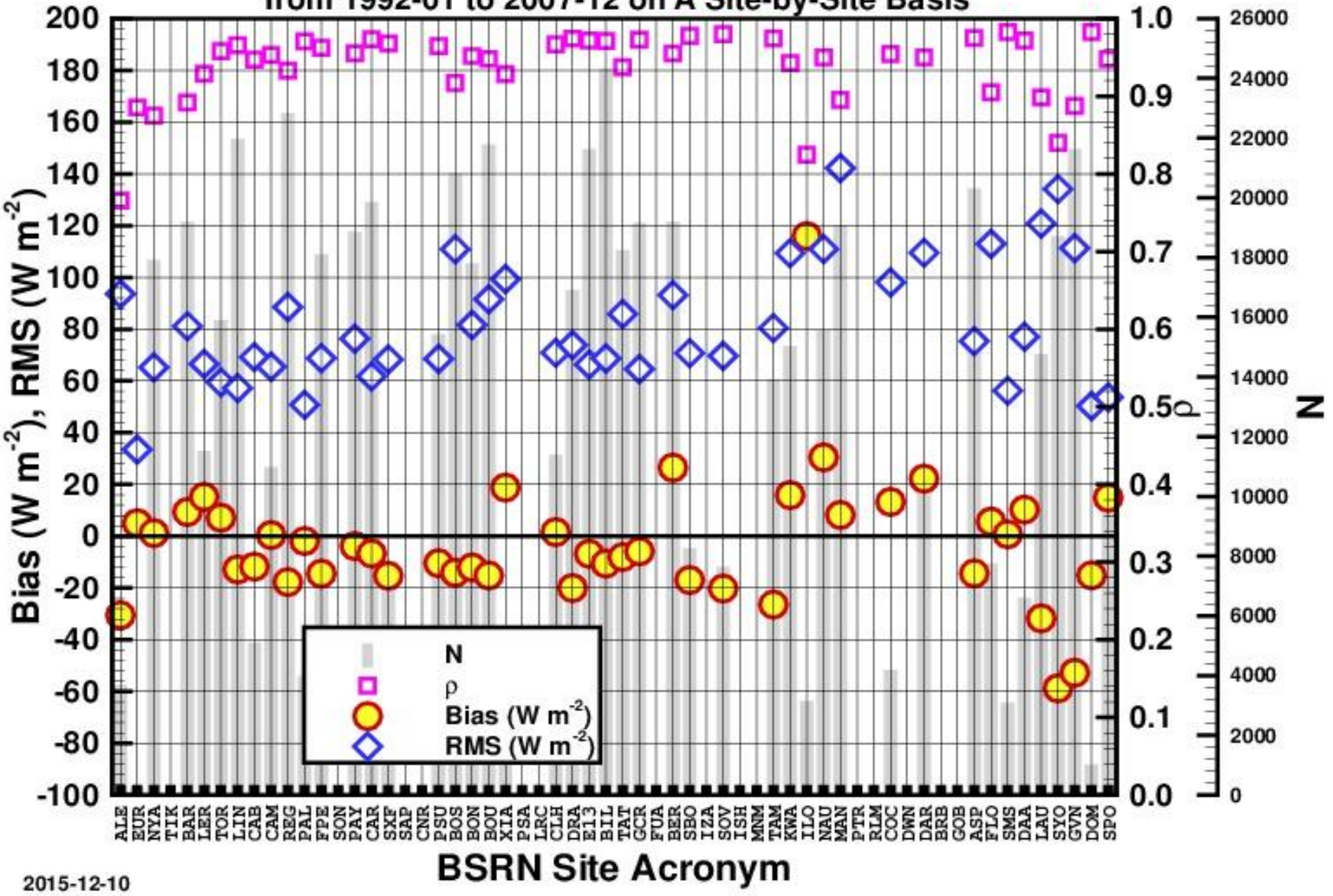
Validating the GEWEX SRB* *Global Horizontal Irradiance (GHI)* against the BSRN Data: 1992 - 2007

- GEWEX SRB Rel. 3.0 provides total shortwave downward fluxes, among other things, at the Earth's surface at 3-hourly, 3-hourly-monthly, daily and monthly time scales and quasi-equal-area 1° x1° resolution from 1983-07 to 2007-12;
- Rel. 4.0 products with new algorithm and inputs are in progress

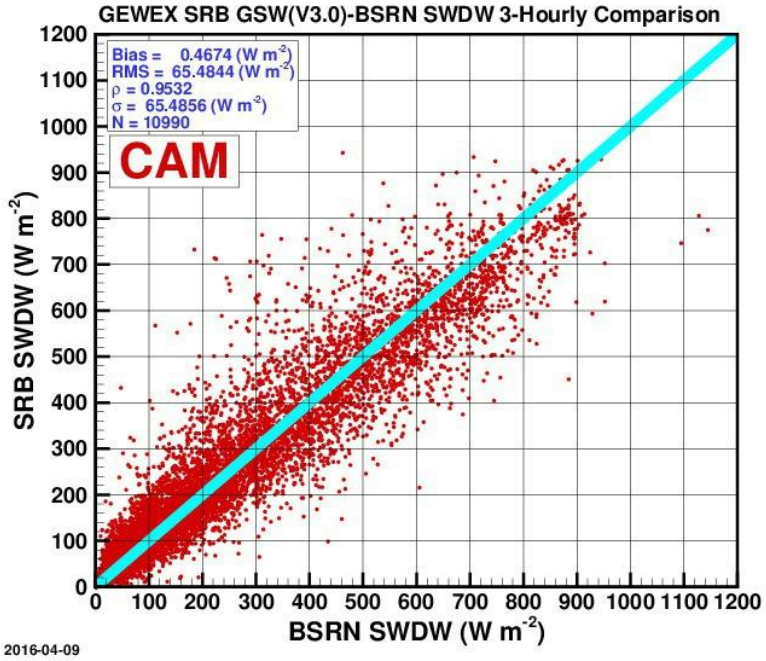
GEWEX SRB GSW(V3.0)-BSRN GHI 3-Hourly Comparison from 1992-01 to 2007-12

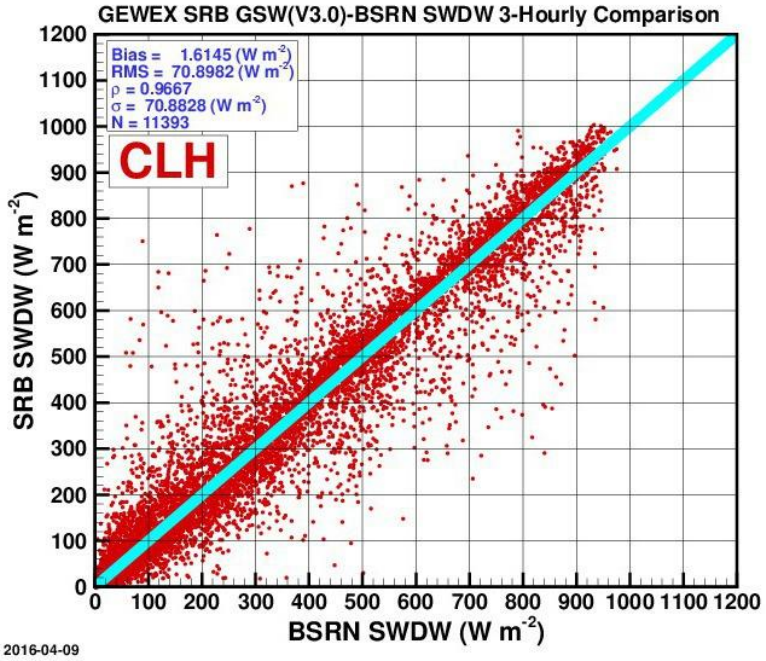


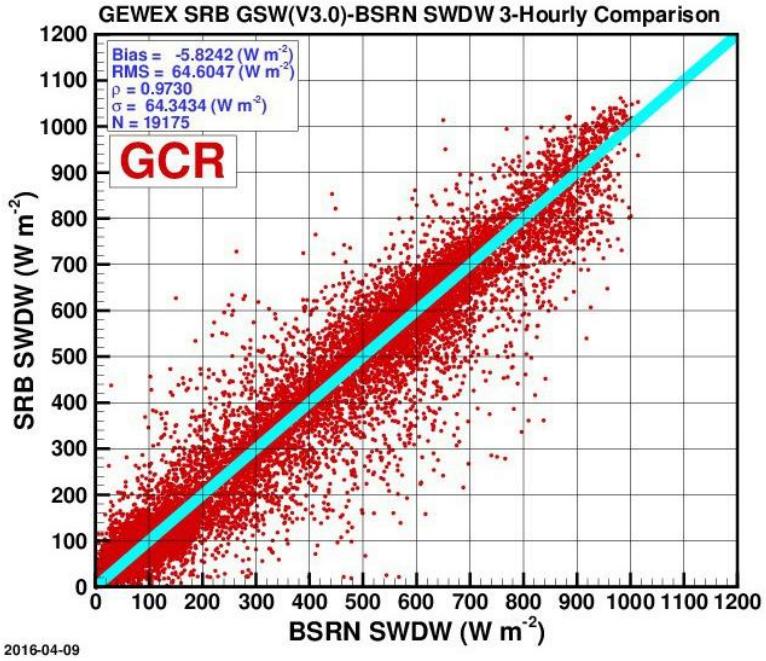


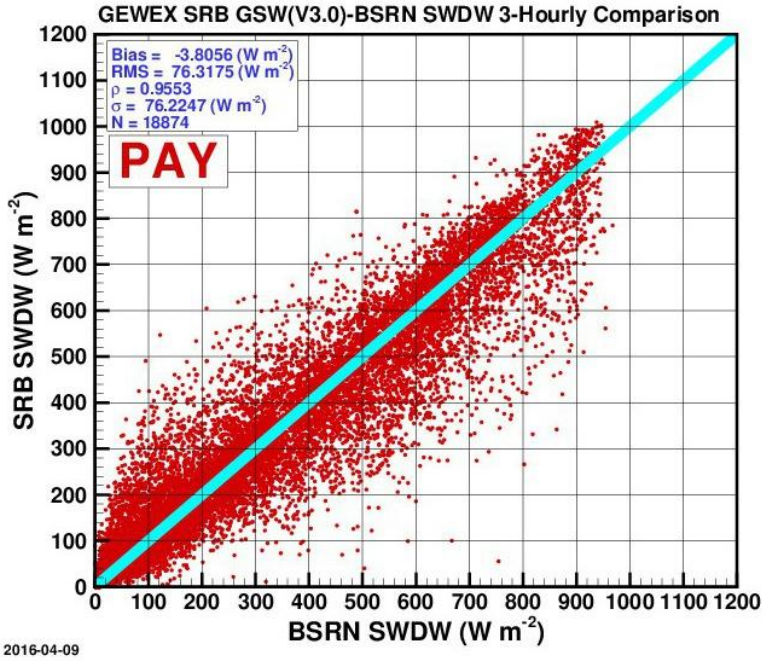

Statistics of SRB(V3.0)-BSRN SWDW 3-Hourly Mean Comparisons
from 1992-01 to 2007-12 on A Site-by-Site Basis
Bias (W m-2), RMS (W m-2)
ρ
N
BSRN Site Acronym
N
ρ
Bias (W m-2)
RMS (W m-2)
ALE EUR NYA TIK BAR LER TOR LIN CAB CAM REG PAL FPE SON PAY CAR SXF SAP CNR PSU BOS BON BOU XIA PSA LRC CLH DRA E13 BIL TAT GCR FUA BER SBO IZA SOV ISH MNM TAM KWA ILO NAU MAN PTR RLM COC DWN DAR BRB GOB ASP FLO SMS DAA LAU SYO GVN DOM SPO
2015-12-10

Examples of sites with good agreement

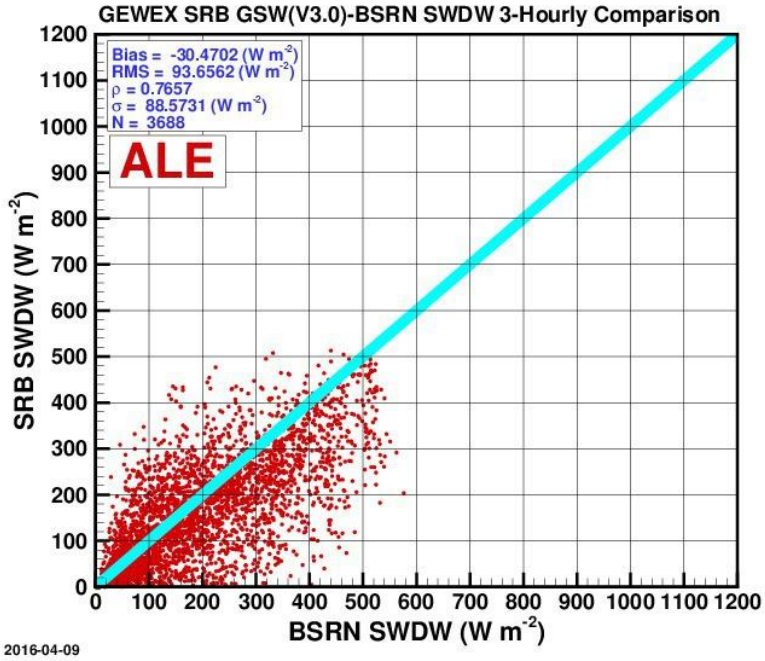


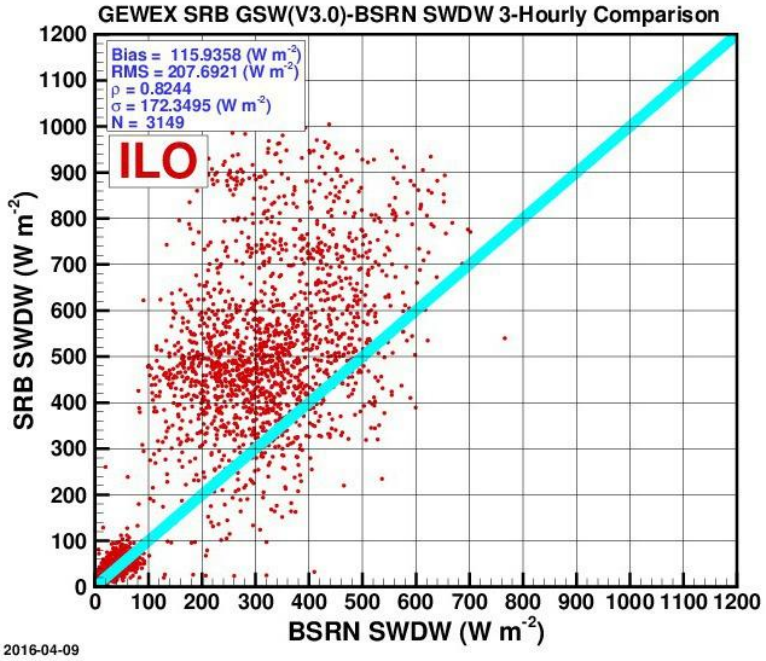


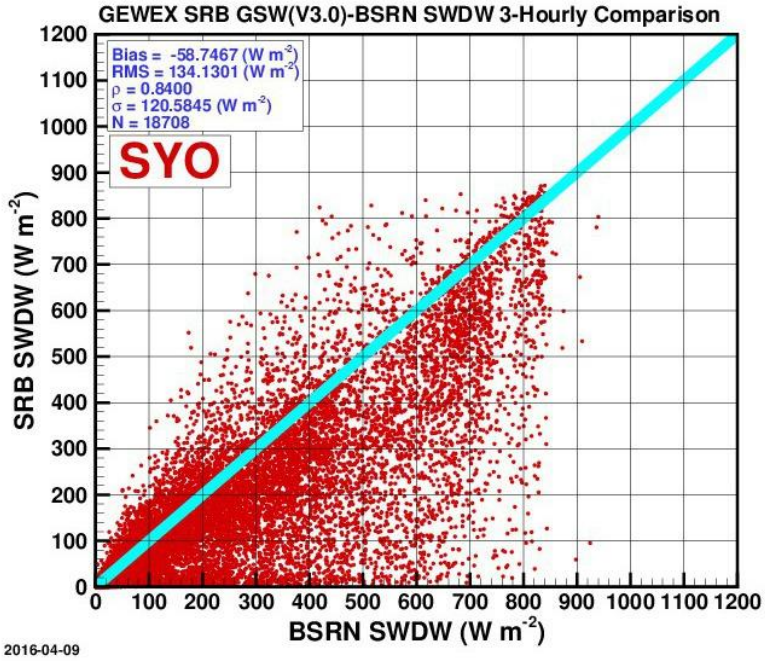


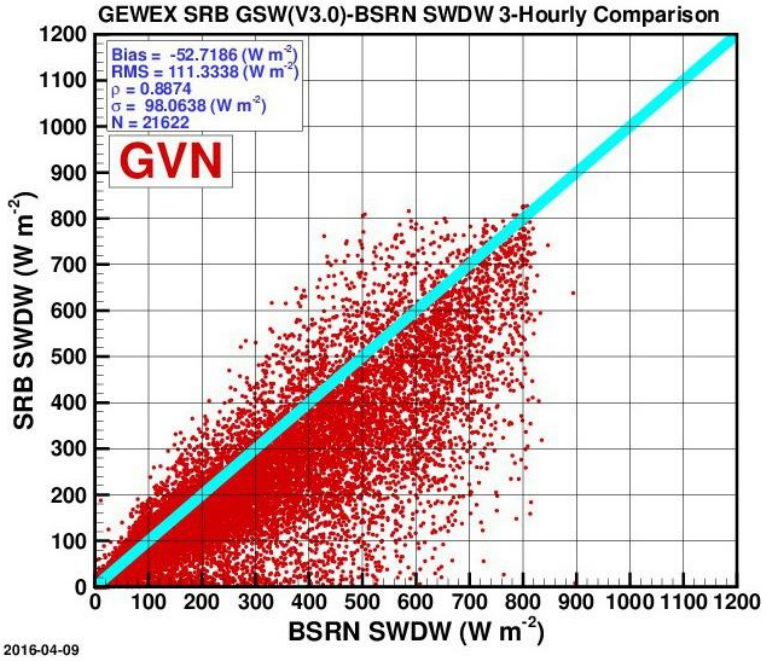


Four sites where unusual differences occur: ILO, in Nigeria, in flat farm land in rural area; ALE, SYO and GVN at high latitudes.

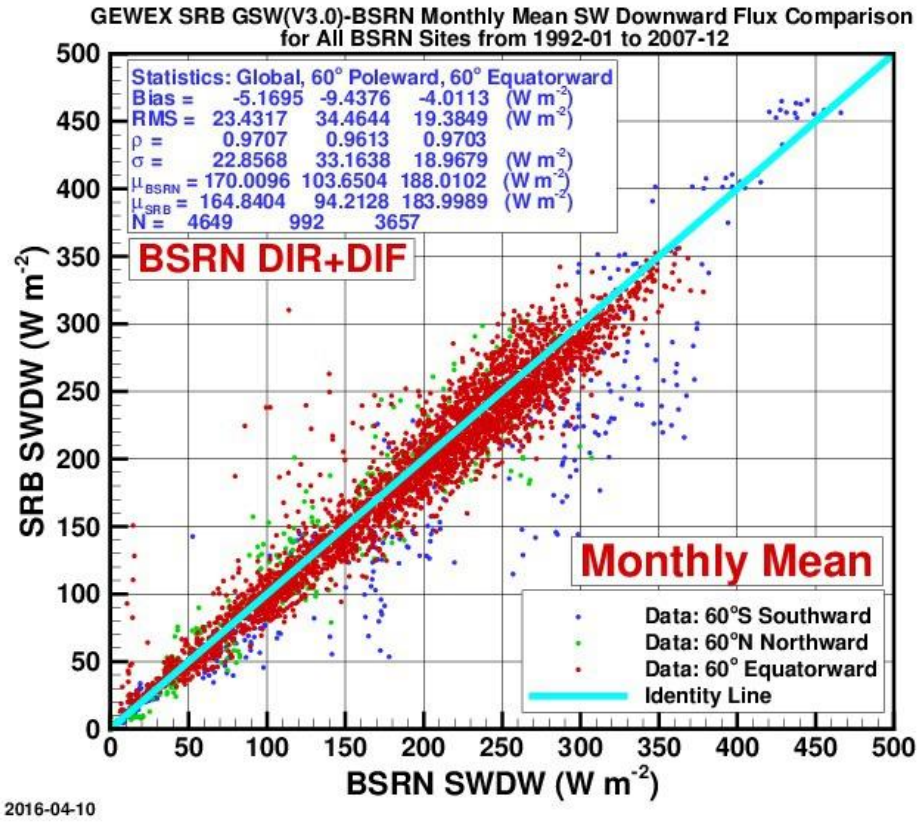


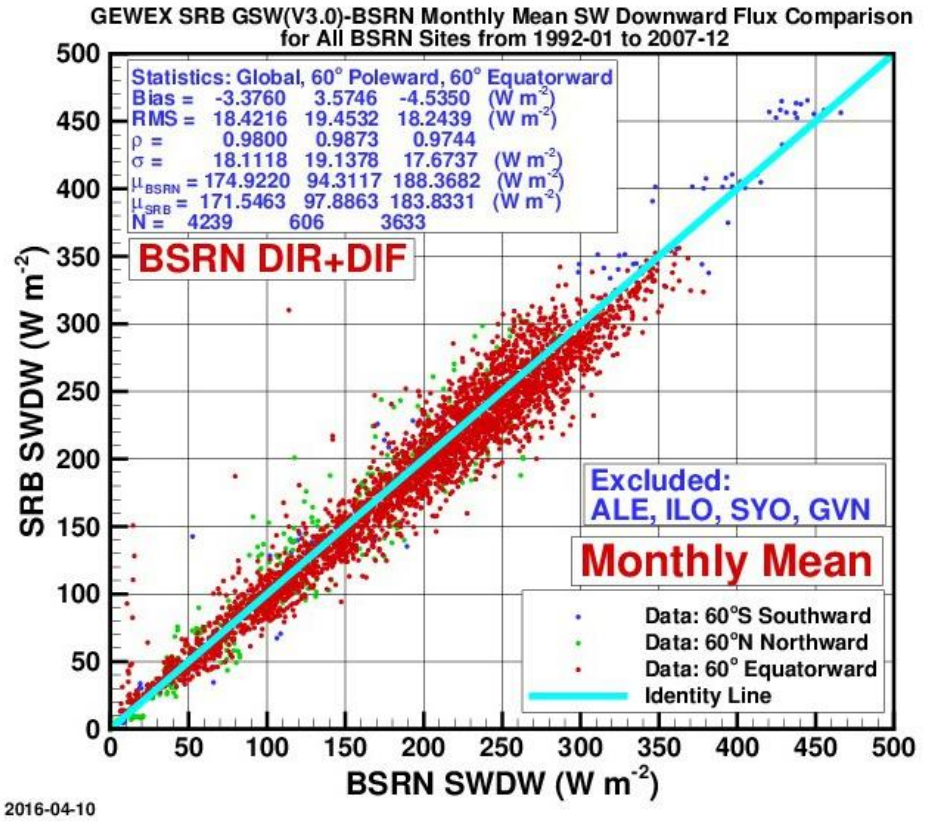






GEWEX SRB GSW(V3.0)-BSRN Monthly Mean GHI Comparison *with* and *without* ALE, ILO, SYO and GVN

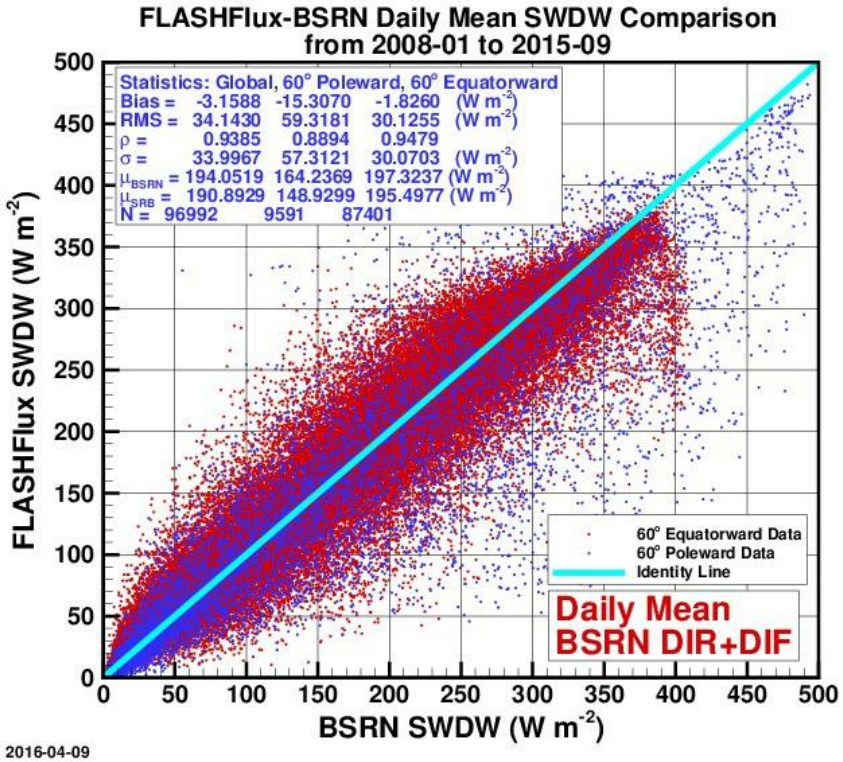


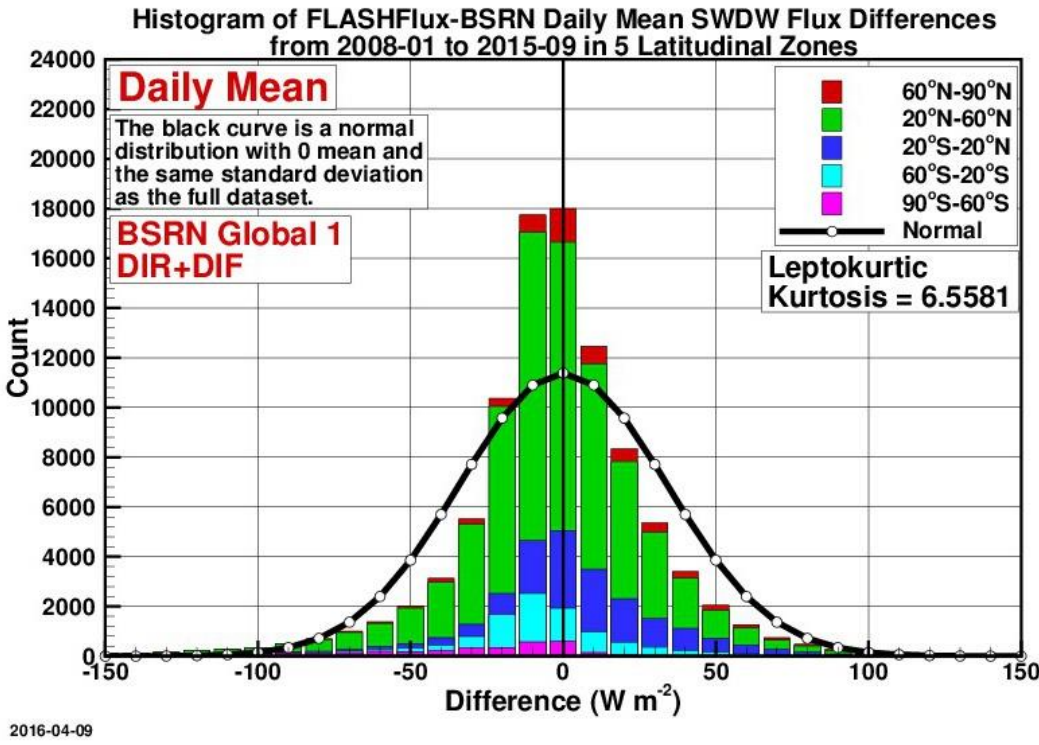


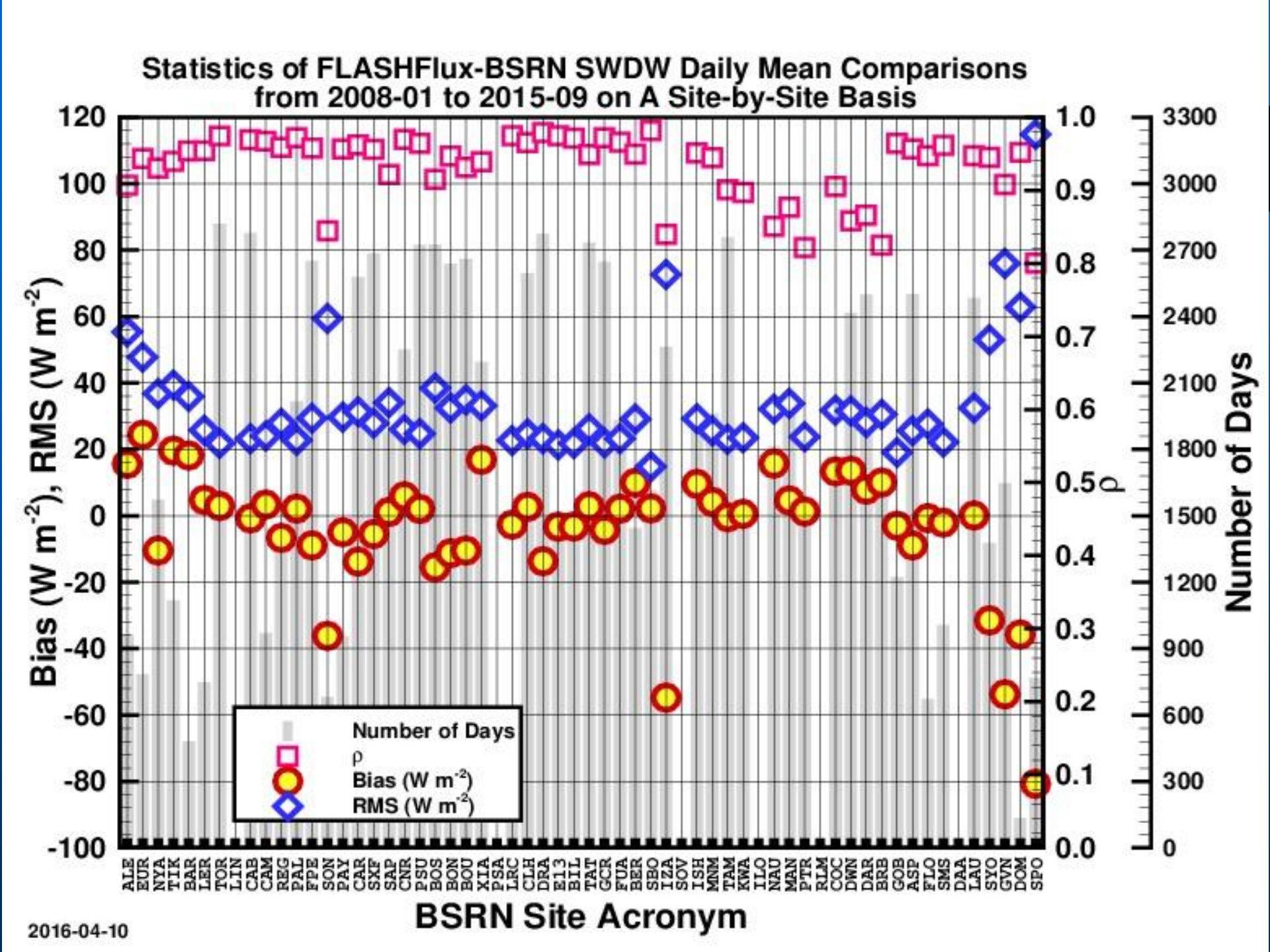
Validating the FLASHFlux* *GHI* against the BSRN Data: 2008 - 2015

* **FLASHFlux: "The Fast Longwave And SHortwave Radiative Fluxes (FLASHFlux) data products provide rapid release of Surface and Top of Atmosphere (TOA) radiative fluxes from CERES instruments." —*CERES FLASHFlux official website***
* **FLASHFlux provides source data for POWER Surface meteorology and Solar Energy (SSE)**

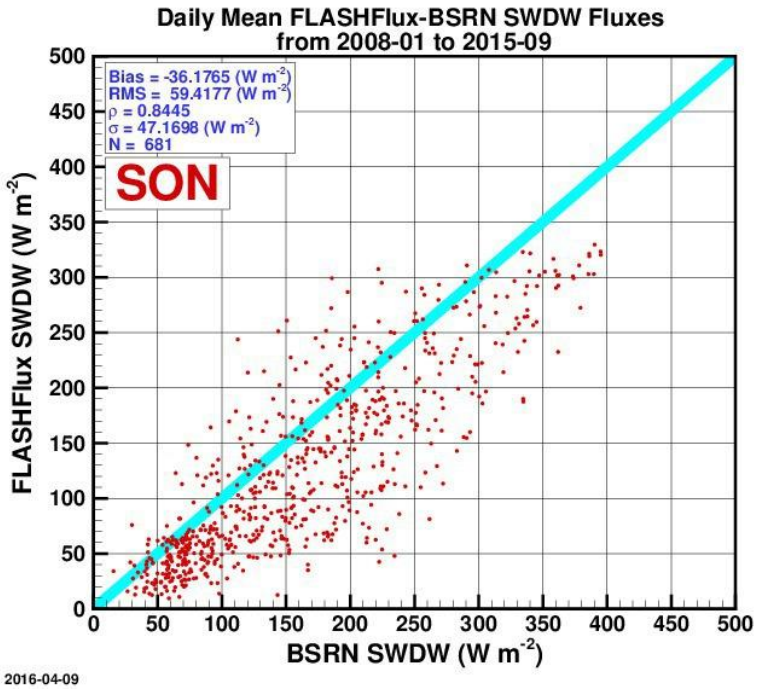
FLASHFlux-BSRN GHI Daily Mean Comparison from 2008-01 to 2015-09

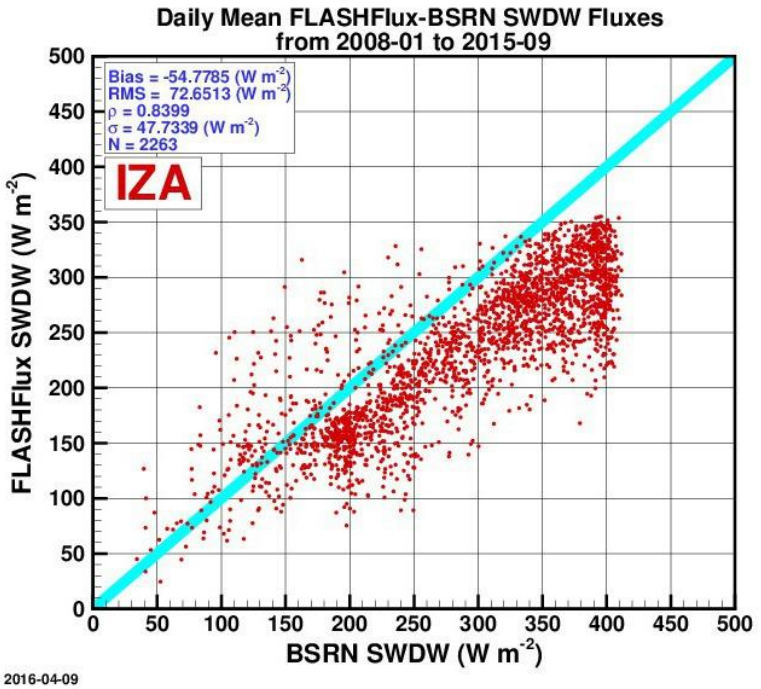


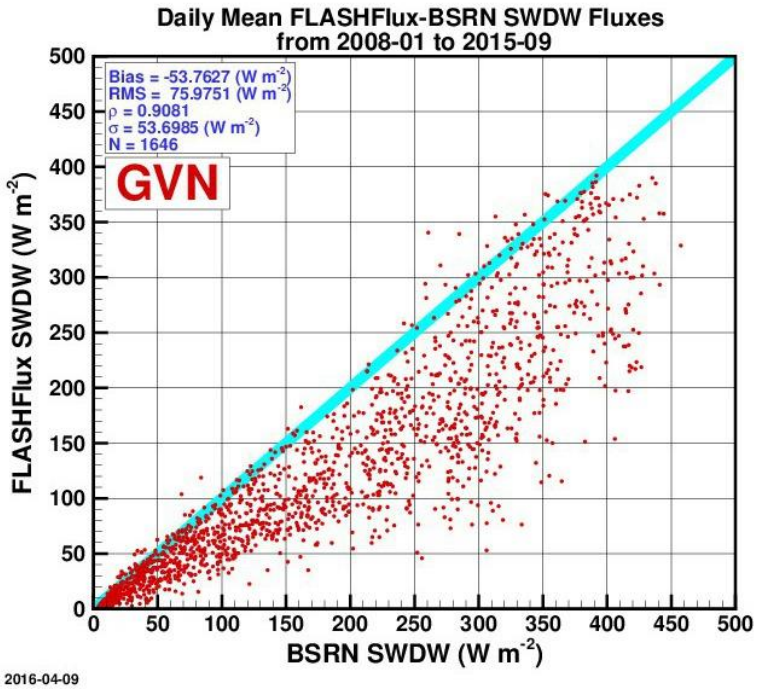


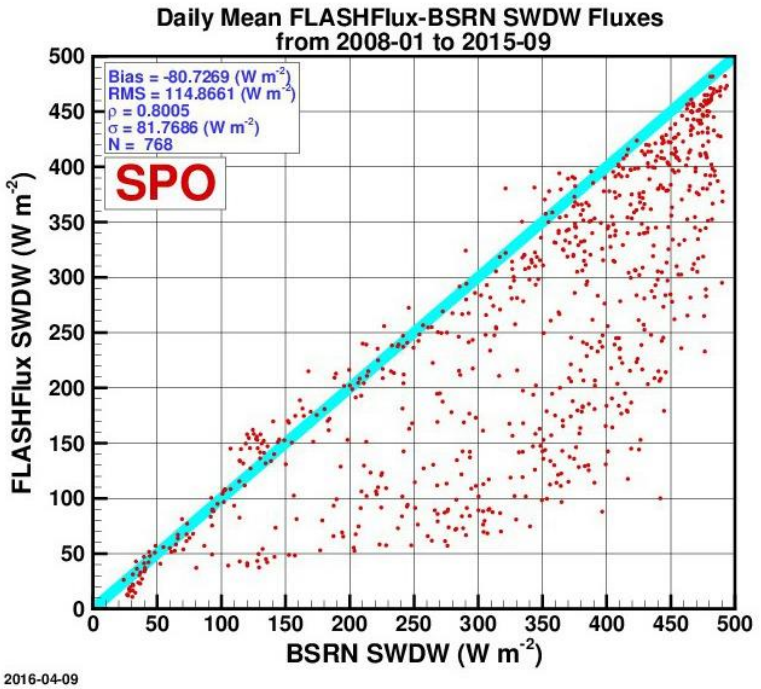

Statistics of FLASHFlux-BSRN SWDW Daily Mean Comparisons
from 2008-01 to 2015-09 on A Site-by-Site Basis
Bias (W m-2), RMS (W m-2)
ρ
Number of Days
Number of Days
ρ
Bias (W m-2)
RMS (W m-2)
ALE EUR NYA TIK BAR LER TOR LIN CAB CAM REG PAL FPE SON PAY CAR SXF SAP CNR PSU BOS BON BOU XIA PSA LRC CLH DRA E13 BIL TAT GCR FUA BER SBO IZA SOV ISH MNM TAM KWA ILO NAU MAN PTR RLM COC DWN DAR BRB GOB ASP FLO SMS DAA LAU SYO GVN DOM SPO
BSRN Site Acronym
2016-04-10

Four sites where unusual differences occur: SON and IZA at great altitudes; GVN and SPO at high latitudes.

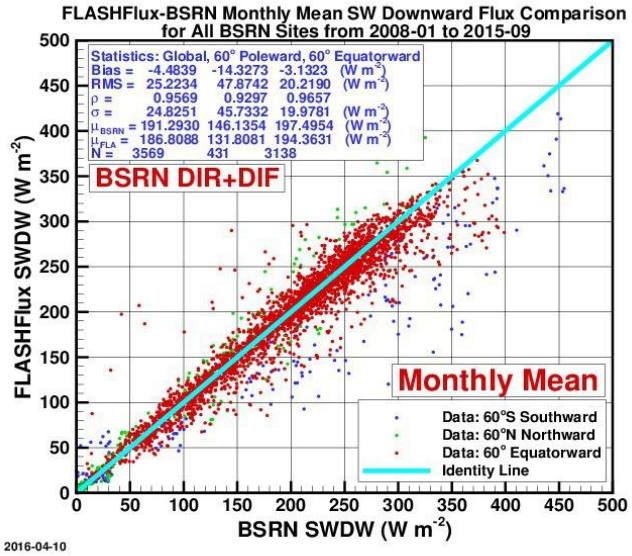


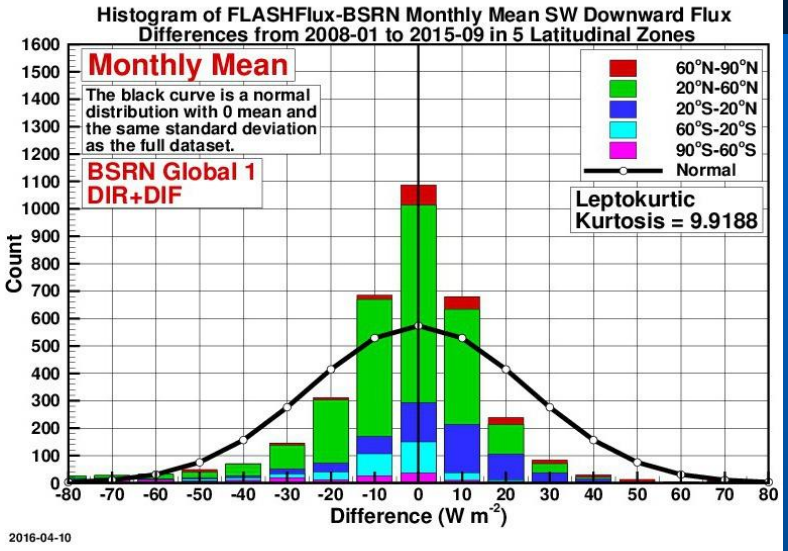


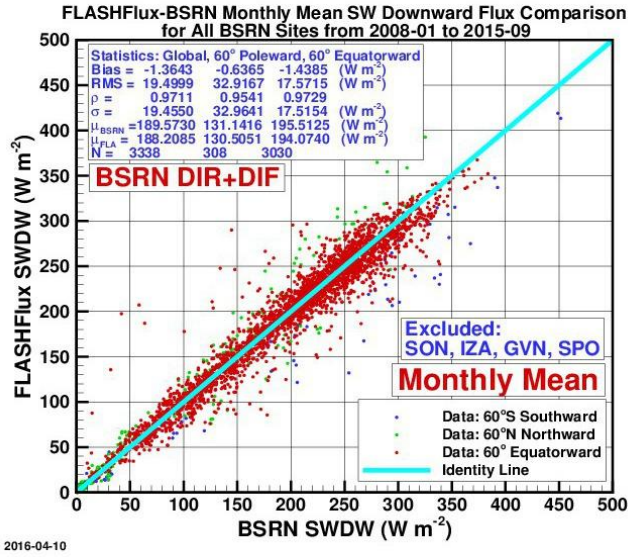


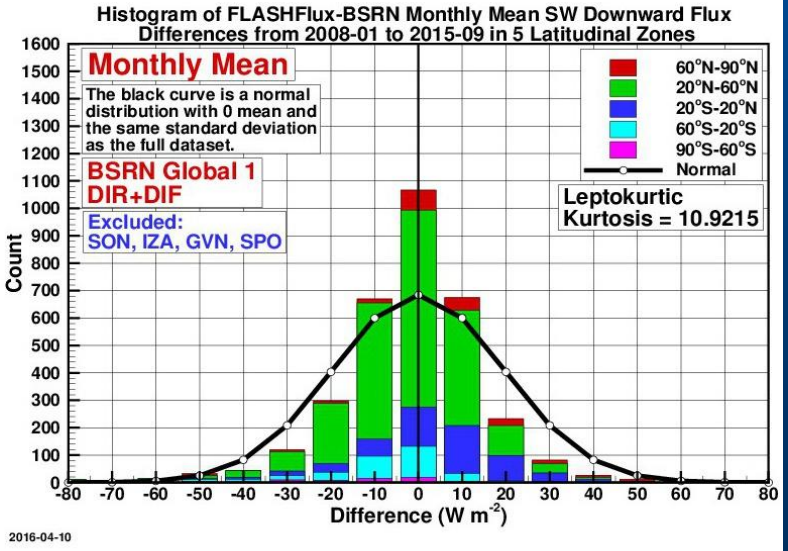


FLASHFlux-BSRN Monthly Mean GHI Comparison *with* and *without* SON, IZA, GVN and SPO









Validating the Model-Derived *Direct Normal Irradiance (DNI)** against the BSRN Data: 1992 - 2007

* The DNI 3-hourly, daily and monthly means are produced using the DirIndex model, a global-to-beam model, with the GEWEX SRB Rel. 3.0 all-sky and clear-sky GHI as inputs; other inputs include the MERRA atmospheric meteorology and daily mean aerosol optical depth derived from MAC-v1;
* The data are available through the NASA POWER SSE.

The DIRINDEX Model (Ineichen; Perez et al.)

$$I_n^{DIRINT} = I_n^{DISC} ! X(K_t'', Z, w, \# K_t''),$$

where

I_n^{DIRINT} is the DIRINT model output of hourly DNI;

I_n^{DISC} is the output of the DISC (Direct Insolation Simulation Code) model, and is derived by multiplying the DNI at TOA by the atmospheric DNI transmittance which is empirically related to the atmospheric GHI transmittance, or the clearness index;

X is the factor of insolation conditions;

$K_t^!$ is the solar zenith angle-independent clearness index;

Z is the solar zenith angle;

w is the atmospheric column water empirically derived from the surface dew-point temperature;

$! K_t''$ is the "stability index" which requires the previous and next hourly records in addition to the current hourly record.

$$I_n^{DIRINDEX} = I_{nc}^{SOLIS}(I_n^{DIRINT} / I_{nc}^{DIRINT}),$$

where

$I_n^{DIRINDEX}$ is the DIRINDEX model output hourly DNI;

I_{nc}^{SOLIS} is the output DNI from the simplified version of the SOLIS model;

I_n^{DIRINT} and I_{nc}^{DIRINT} are the output of DNI from the DIRINT model under all-sky and clear-sky conditions, respectively.

References

Maxwell, E.L., 1987. A quasi-physical model for converting hourly global horizontal to direct normal insolation. SERI/TR-215-3087. Solar Energy Research Institute, Golden, Colorado.

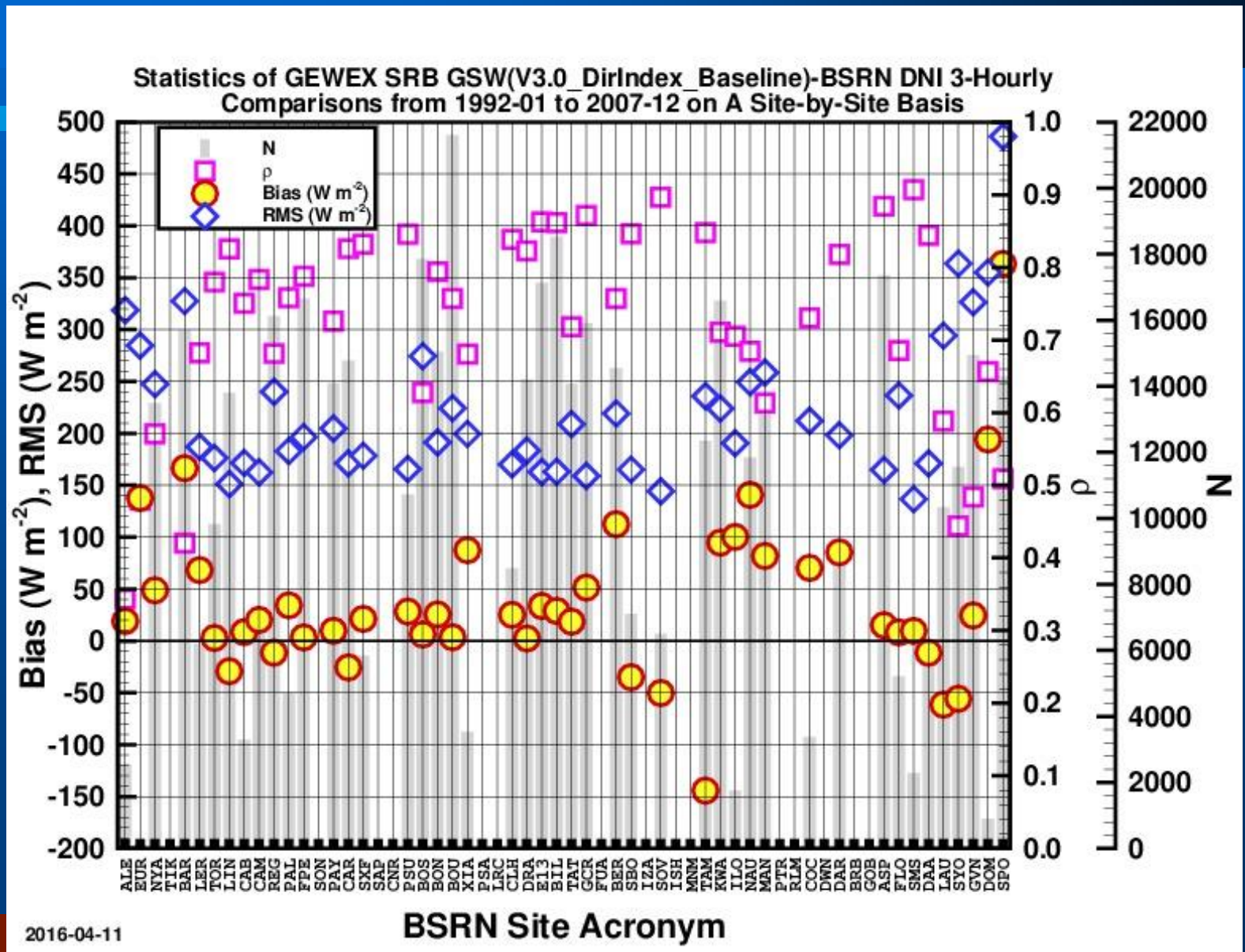
Perez, R.R., Ineichen, P., Maxwell, E.L., Seals, R.D., Zelenka, A., 1992. Dynamic global-to-direct irradiance conversion models. *ASHRAE Transactions-Research Series*, 354-369.

Ineichen, P., 2008a. Comparison and validation of three global-to-beam irradiance models against ground measurements. *Sol. Energy*, **82**: 501-512.

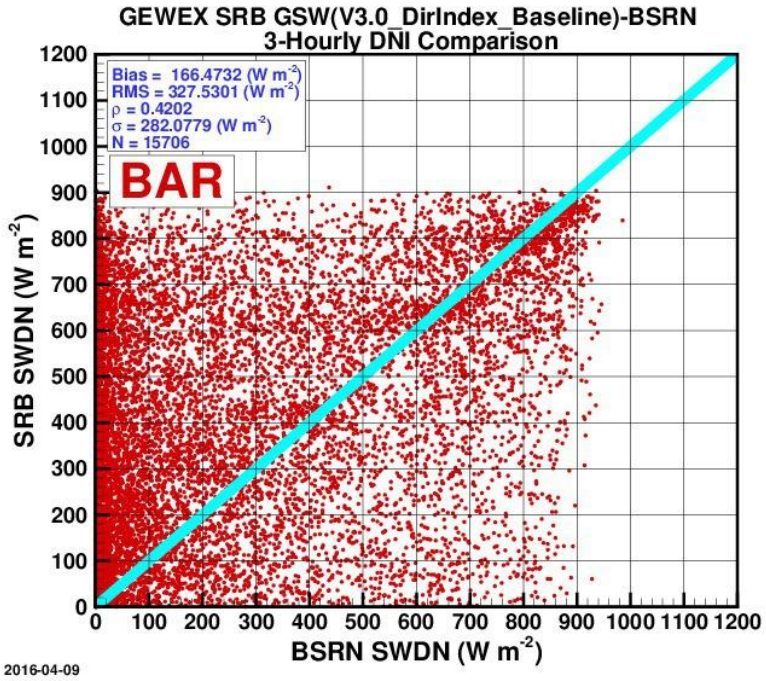
Ineichen, P., 2008b. A broadband simplified version of the SOLIS clear sky model. *Sol. Energy*: **82**, 758-762.

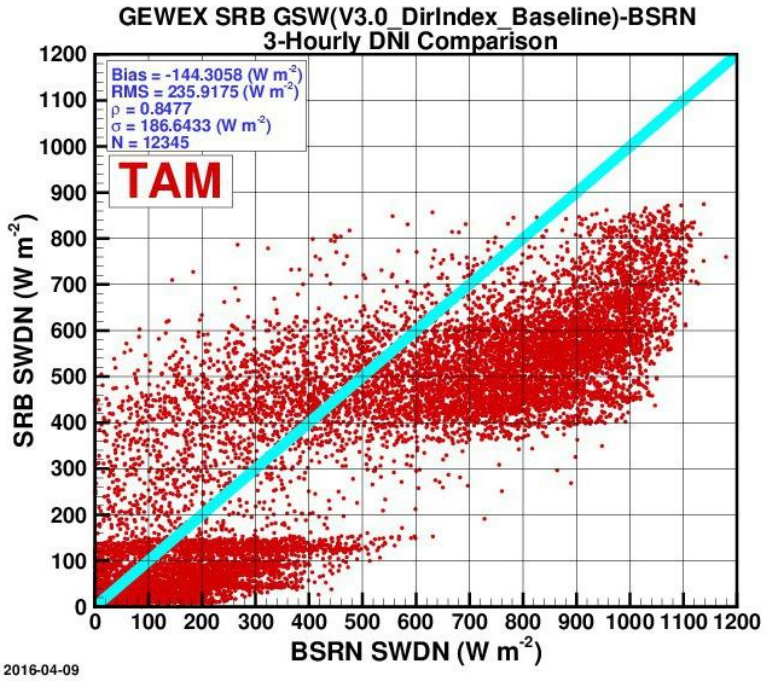
Zhang, T., Stackhouse Jr., P.W., Chandler, W.S., and Westberg, D.J., 2014. Application of a global-to-beam irradiance model to the NASA GEWEX SRB dataset: An extension of the NASA Surface meteorology and Solar Energy datasets. *Sol. Energy*, **110**: 117-131.

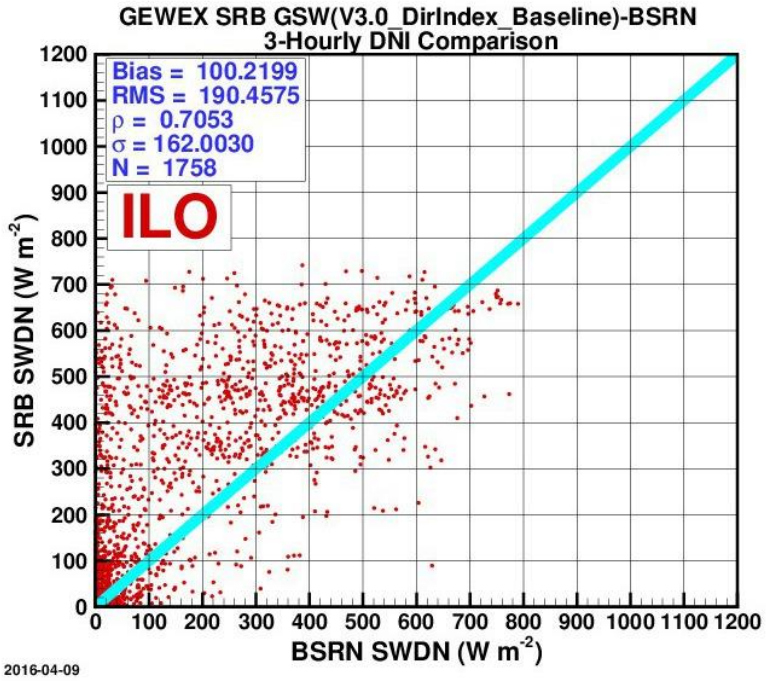
GEWEX SRB GSW(V3.0_DirIndex_Baseline)-BSRN 3-Hourly DNI Comparisons on A Site-by-Site Basis from 1992-01 to 2007-12

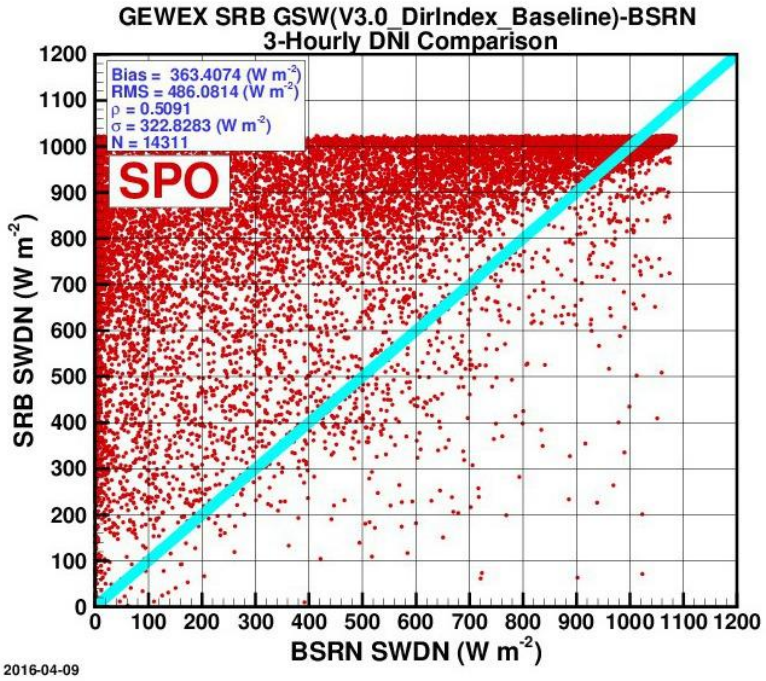


Four sites that show odd patterns in scatter plots: BAR, TAM, ILO, SPO

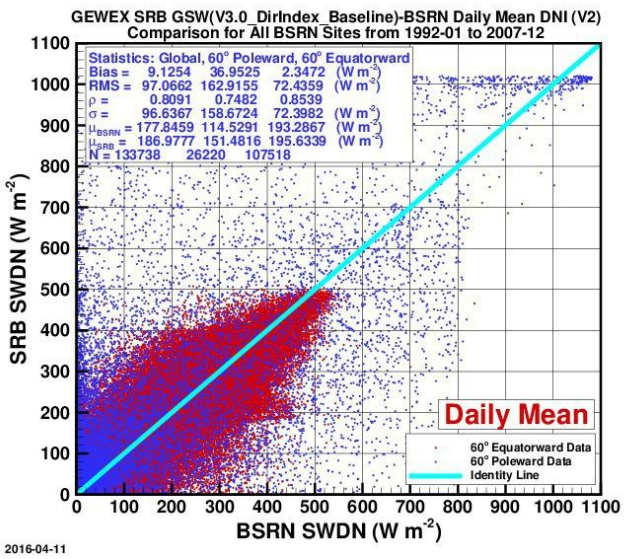


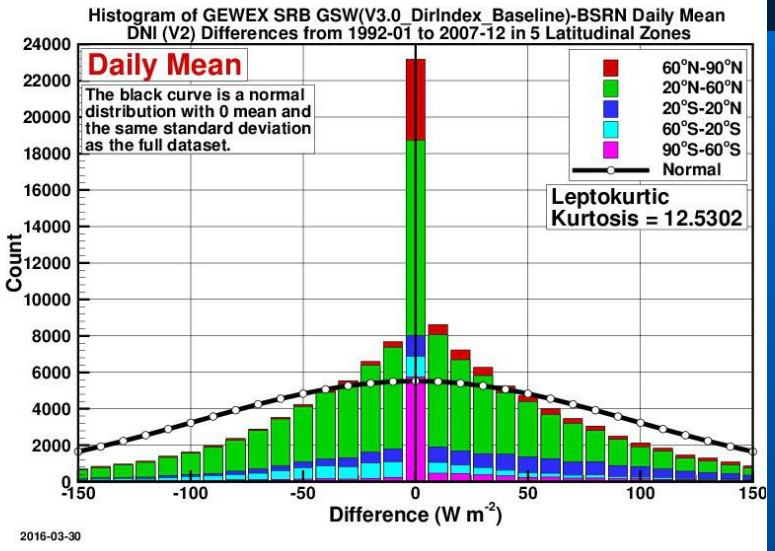


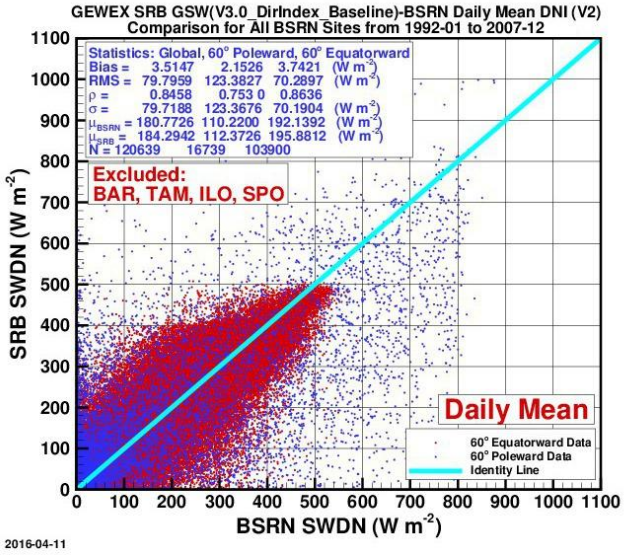


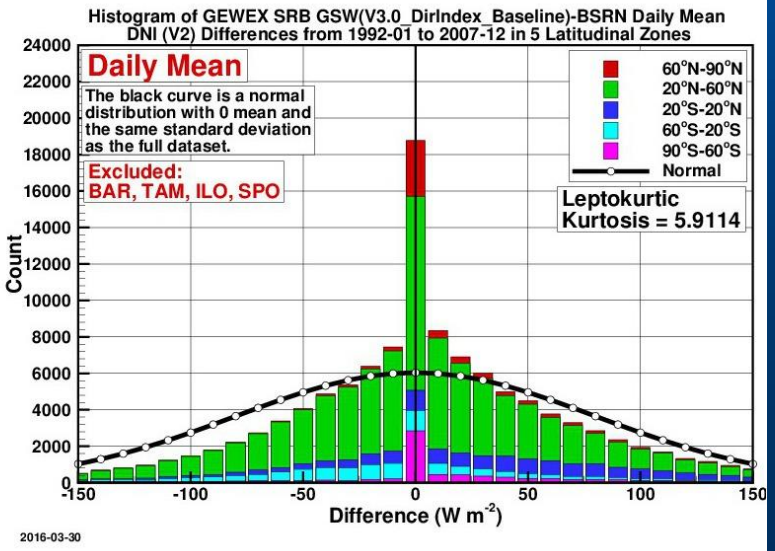


GEWEX SRB GSW(V3.0_DirIndex_Baseline)-BSRN Daily DNI Comparisons *with* and *without* BAR, TAM, ILO and SPO

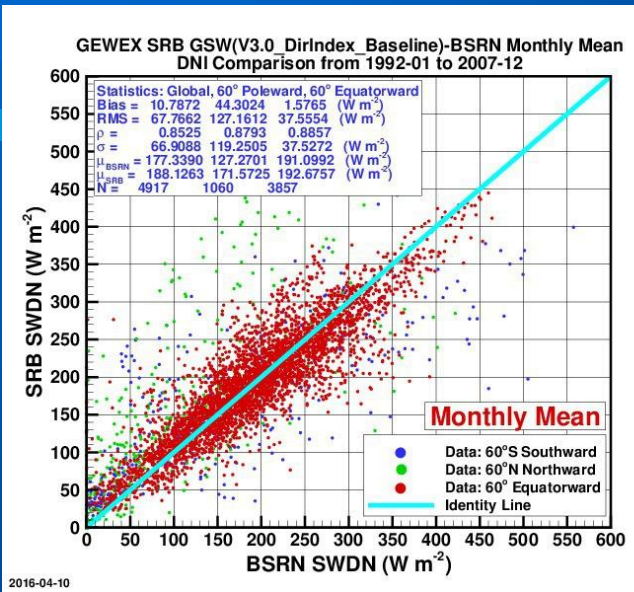


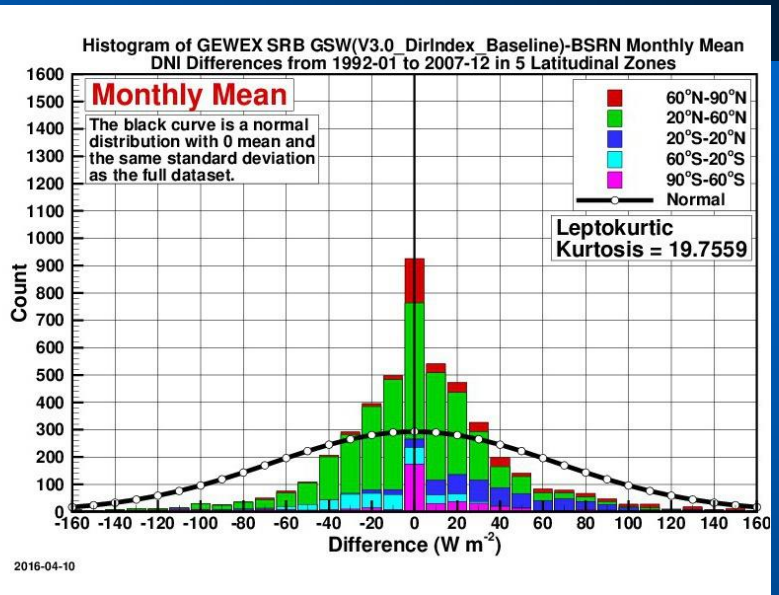


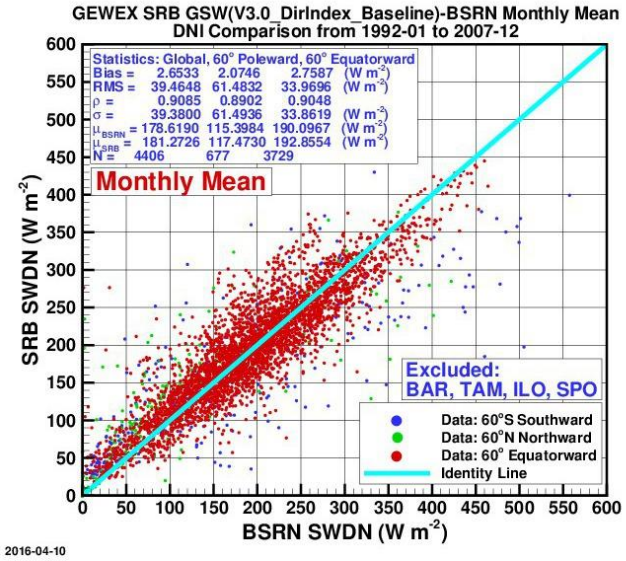


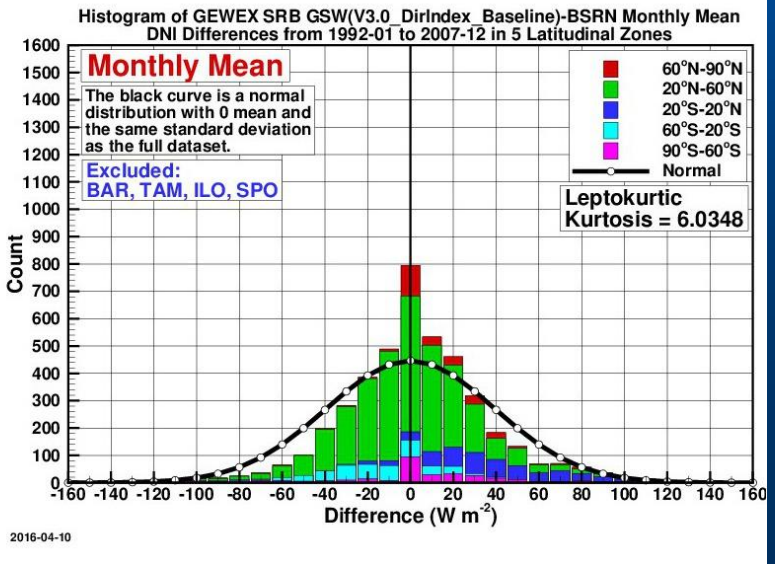


GEWEX SRB GSW(V3.0_DirIndex_Baseline)-BSRN Monthly DNI Comparisons with and without BAR, TAM, ILO and SPO









Conclusions

- As of October 2015, there are 8955 site-months of BSRN data from 60 BSRN sites, including data from SURFRAD sites since July 2009;
- Over the period from 1992 - 2007, the BSRN data used to validate the GEWEX SRB GHI and DNI derived therefrom; and from 2008 - 2015, the BSRN data are used to validate the FLASHFlux data. Therefore, all available BSRN data have been used;
- Sites that show unusual patterns in scatter plots are identified as ALE, BAR, SON, IZA, TAM, ILO, SYO, GVN, and SPO. High altitudes could contribute to the disagreement with SON and IZA, while snow and ice at high latitudes could partly explain the behavior of ALE, BAR, SYO, GVN and SPO;

Conclusions *(Continued …)*

- **In validation of either the GEWEX SRB GHI, or the FLASHFlux GHI, or the model-derived DNI, when 4 sites, albeit not all the same sites, are excluded, comparison statistics show significant improvement;**

- **Further work is needed to resolve the issues regarding the differences at these sites.**

Thank you!

For More Information about GEWEX SRB:

http://gewex-srb.larc.nasa.gov

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