The Hourly GHI, DHI and DNI: Intercomparison of the CERES-Based Data and the NSRDB Data through Comparison with the Ground-Based BSRN Data

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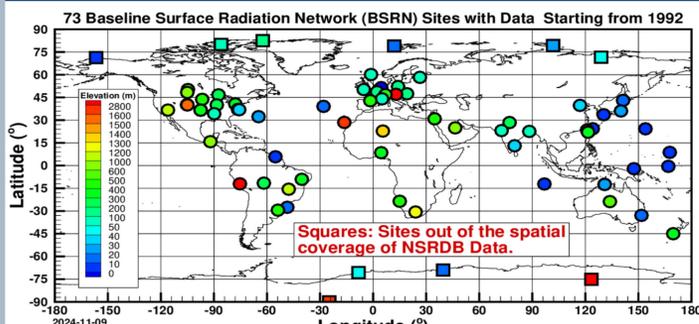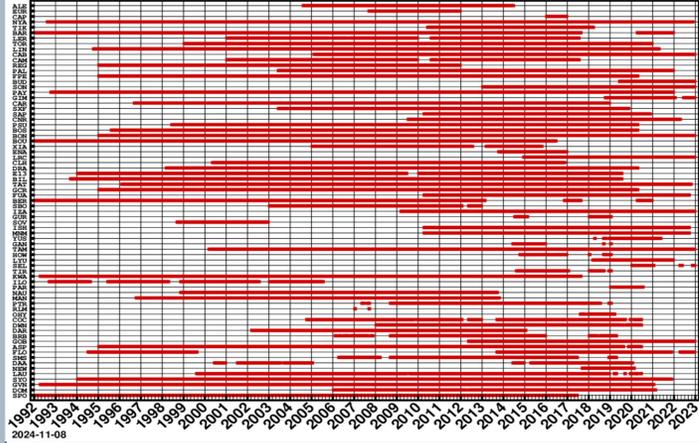1. AMA/NASA LaRC; 2. NASA LaRC; 3. NASA LaRC/Booz Allen Hamilton

Introduction

The NASA Clouds and the Earth's Radiant Energy System (CERES) SYN1deg(Ed4.1) provides hourly global horizontal irradiance (GHI), diffuse horizontal irradiance (DHI) and direct horizontal irradiance (DirHI) at 1° latitude by 1° longitude resolution, and the time span is from March 2000 to near present. While the GHI agrees well with the ground-based Baseline Surface Radiation Network (BSRN) data, the DHI and DirHI are, respectively, positively and negatively biased against the BSRN data, and so is the direct normal irradiance (DNI) derived simply by dividing the DirHI by the cosine of the hourly solar zenith angle (SZA). We found that the biases tend to be well-defined functions of cos(SZA) and the cloud fraction (CLFR). We thus performed a bias-correction on the hourly DHI and DNI in the latitude-cos(SZA)-CLFR phase space, and therefrom, we derived the hourly global tilted irradiance (GTI) at a number of tilt angles using the isotropic diffuse irradiance model, and the results agree well with the GTI derived from the original BSRN near-instantaneous records. Meanwhile, the National Renewable Energy Laboratory (NREL) has produced the National Solar Radiation Database (NSRDB) with finer spatiotemporal resolution using its Physical Solar Model (PSM) and surface-based measured data, model results and satellite-based data as inputs. Now the NSRDB data covers not only the United States and its neighboring regions, but Europe, Africa, Asia and Oceania. The available temporal resolutions are 5, 10, 15, 30 and 60 minutes and the spatial resolutions are 2, 4 and 10 km, depending on the selected region. In this presentation, we compare both the CERES-based and NSRDB GHI, DHI and DNI with their BSRN counterparts and show how finer spatial resolution may give us an advantage in data accuracy and usability. (**NASA POWER Data:** https://power.larc.nasa.gov/)
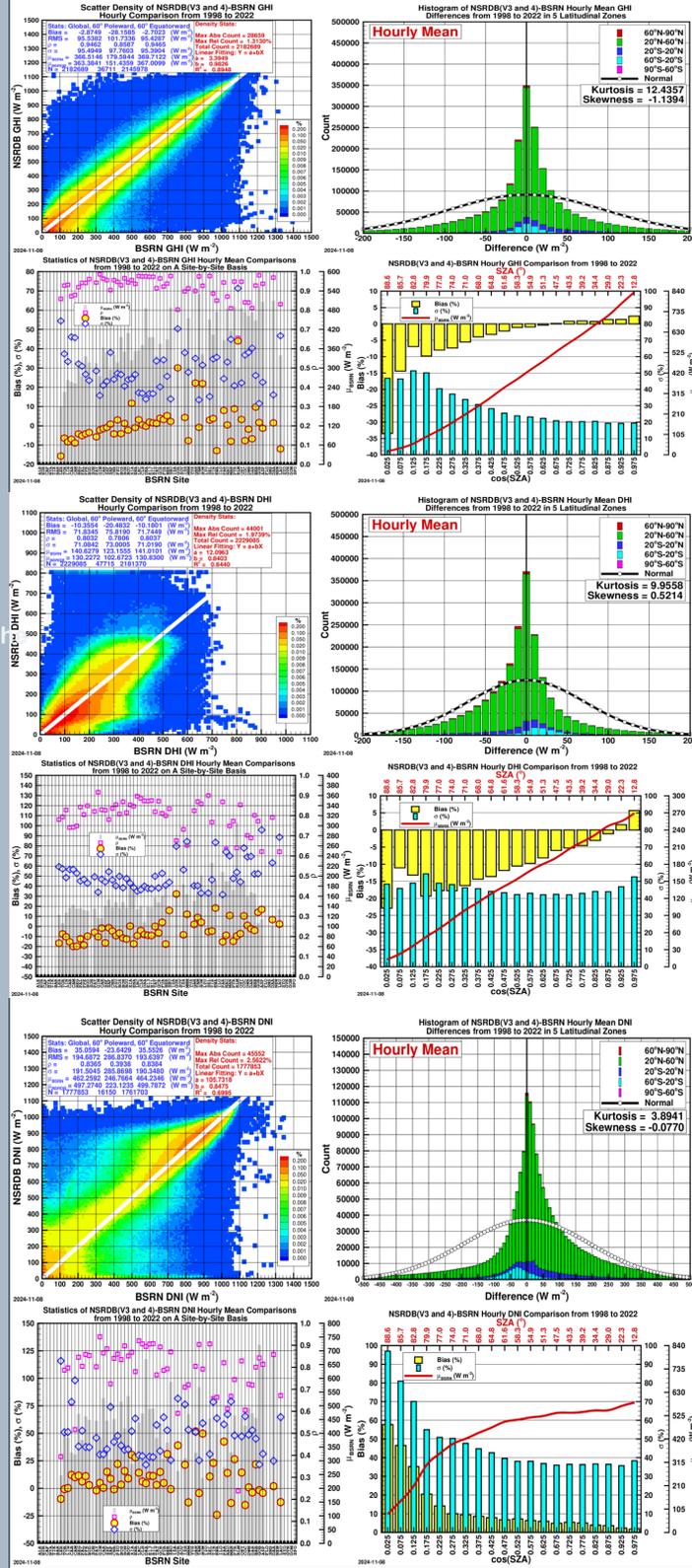
The Surface-Based BSRN Sites

73 Baseline Surface Radiation Network (BSRN) Sites with Data Starting from 1992

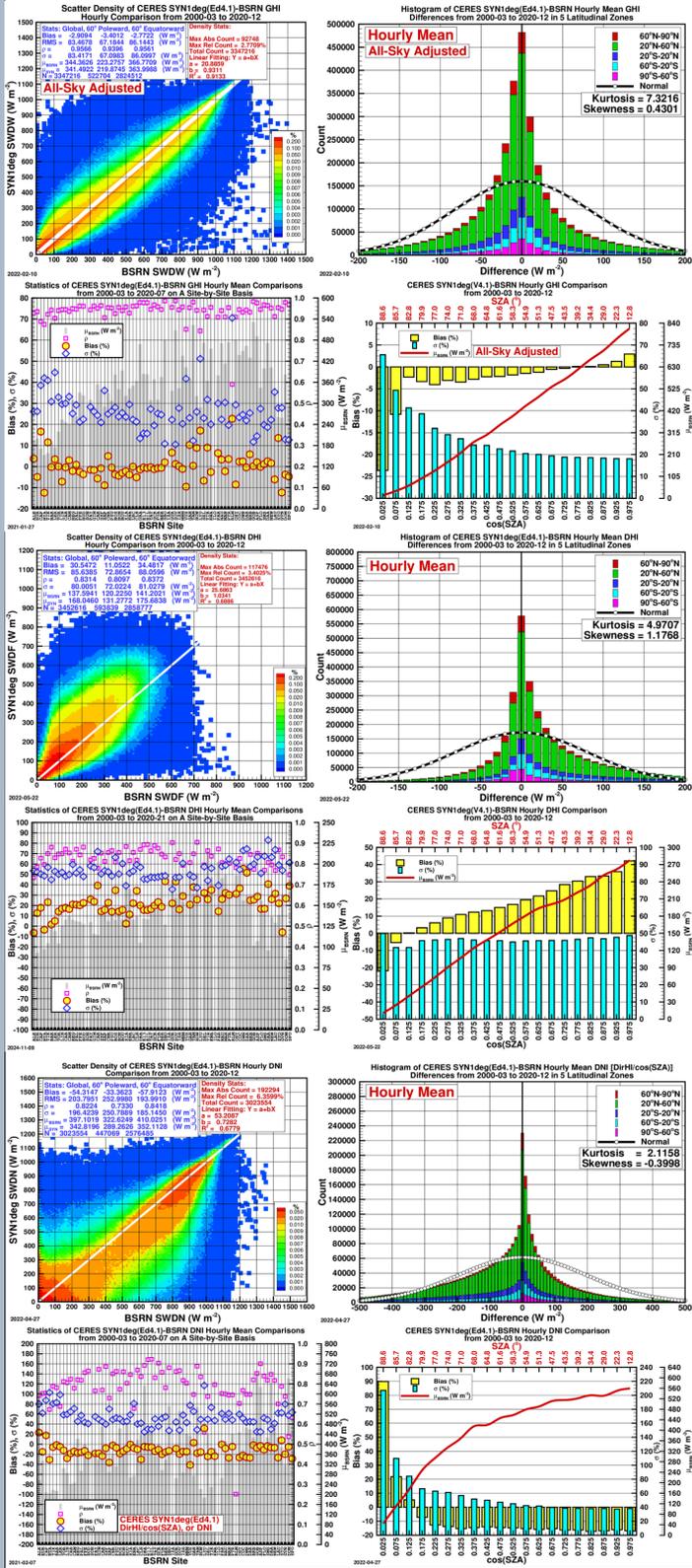Squares: Sites out of the spatial coverage of NSRDB Data.

12,756 Available Site-Months of BSRN Data at 73 Sites from 1992-01 to 2022-12
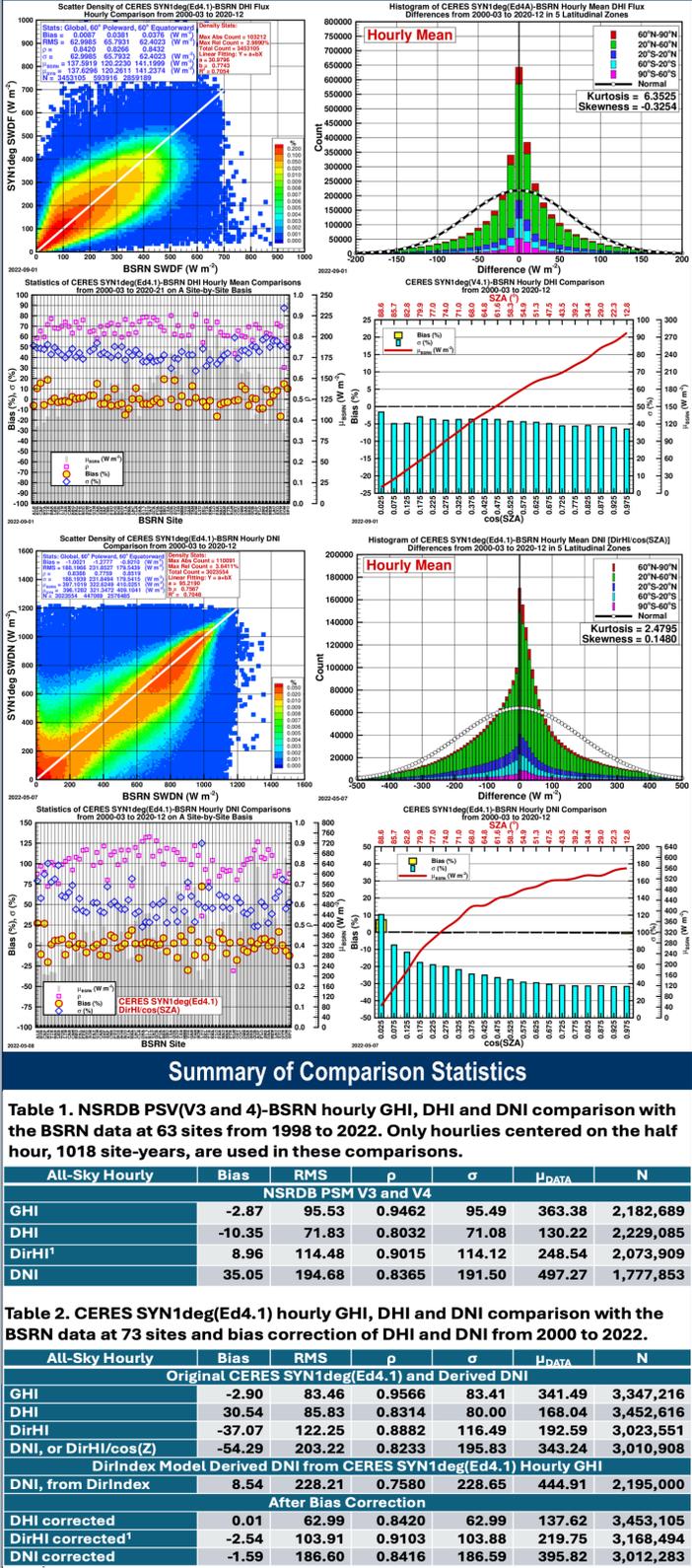
NSRDB-BSRN Hourly GHI, DHI and DNI Comparison

CERES SYN1deg(Ed4.1)-BSRN Hourly GHI, DHI and DNI Comparison

CERES SYN1deg(Ed4.1) Hourly DHI and DNI Bias Corrected

Summary of Comparison Statistics

Table 1. NSRDB PSV(V3 and 4)-BSRN hourly GHI, DHI and DNI comparison with the BSRN data at 63 sites from 1998 to 2022. Only hourlies centered on the half hour, 1018 site-years, are used in these comparisons.

All-Sky Hourly	Bias	RMS	ρ	σ	μ_{DATA}	N
NSRDB PSM V3 and V4						
GHI	-2.87	95.53	0.9462	95.49	363.38	2,182,689
DHI	-10.35	71.83	0.8032	71.08	130.22	2,229,085
DirHI[1]	8.96	114.48	0.9015	114.12	248.54	2,073,909
DNI	35.05	194.68	0.8365	191.50	497.27	1,777,853

Table 2. CERES SYN1deg(Ed4.1) hourly GHI, DHI and DNI comparison with the BSRN data at 73 sites and bias correction of DHI and DNI from 2000 to 2022.

All-Sky Hourly	Bias	RMS	ρ	σ	μ_{DATA}	N
Original CERES SYN1deg(Ed4.1) and Derived DNI						
GHI	-2.90	83.46	0.9566	83.41	341.49	3,347,216
DHI	30.54	85.83	0.8314	80.00	168.04	3,452,616
DirHI	-37.07	122.25	0.8882	116.49	192.59	3,023,551
DNI, or DirHI/cos(Z)	-54.29	203.22	0.8233	195.83	343.24	3,010,908
DirIndex Model Derived DNI from CERES SYN1deg(Ed4.1) Hourly GHI						
DNI, from DirIndex	8.54	228.21	0.7580	228.65	444.91	2,195,000
After Bias Correction						
DHI corrected	0.01	62.99	0.8420	62.99	137.62	3,453,105
DirHI corrected[1]	-2.54	103.91	0.9103	103.88	219.75	3,168,494
DNI corrected	-1.59	186.60	0.8416	186.59	395.82	3,012,283